On the origins of bread cultures in the Near East: a new archaeobotanical study of charred meals and cooking practices from Neolithic Çatalhöyük (Turkey) and Jarmo (Iraqi Kurdistan)

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Volume I

Thesis submitted in fulfilment of the Degree of Doctor of Philosophy
Institute of Archaeology, University College London
July 2019

‘I, Lara González Carretero, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.'

Signed

Abstract

This PhD study integrates unstudied plant evidence from the Neolithic site of Çatalhöyük East (Turkey) and Jarmo (Iraqi Kurdistan), such as charred residues and amorphous charred organic material which were originally identified as "food" and "bread," combined with the study of artefact assemblages (clay balls, pots and grinding stones), ethnographical studies and experimental food preparation and charring experiments. The main aim of this thesis is to assess the extent to which these early sites can be characterised as a bread culture (e.g. Fuller & Rowlands 2011) and how much diversity of cereal preparation techniques were employed in the past and how these diversified over time. The methods developed in this research project have provided a new means of characterising archaeobotanical assemblages with charred food fragments as representative of Neolithic "recipes" the *chaîne opératoire*, which links harvested cereals to cooked products for consumption. The intention of this study is to characterise how these recipes changed over time and might have varied across the Neolithic Çatalhöyük and Jarmo communities, shedding light on socio-economical differences.

Impact statement

The study of archaeobotanical remains is a line of research of interest to many archaeologists around the world which has traditionally focused on the study of the origins of domestication and agricultural practices among others. This thesis offers the opportunity for interdisciplinary research in Archaeobotany as it combines the identification of macrobotanical remains with the analysis of unstudied archaeological remains of charred food through microscopy and the analysis of their molecular composition. Until now, there was a lack of systematic and consistent methods for the study of archaeological food remains therefore, the relevance of this thesis lies on the creation and development of a new methodology for the analysis of archaeological food remains recovered by flotation from two of the most important Neolithic sites in Southwest Asia (Çatalhöyük and Jarmo). These methods have been subsequently applied with successful results to other archaeological sites in a wide area of the world, as part of the ERC ComPAg Project led by Prof. Dorian Q Fuller at UCL, Institute of Archaeology.

The relevance for the investigation of past culinary traditions and *cuisine* in the Prehistory of Southwest Asia, and more specifically the significance of this doctoral dissertation lies on the possibility of identifying and distinguishing the forms in which early Neolithic people consumed the plant species available to them and commonly recovered from archaeological sites. Through the study of archaeological charred foods and the analysis of tools and installations directly related to food preparation and cooking, archaeologists can further our knowledge and understanding of culinary daily activities and habits and how these contributed to Neolithic cultural and economic development.

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Acknowledgements

I would like to firstly thank my principal supervisor Dorian Q Fuller for seeing the potential in me and helping me become the person I am today. Without you this research would have not been possible. Special thanks also to Michele Wollstonecroft for her moral, personal and academic support, who acted as a second supervisor for me. In addition, I am very grateful to Amy Bogaard and Mike Charles from University of Oxford who welcomed me in their team as one of their own.

My sincere thanks to the Çatalhöyük director Ian Hodder for allowing me to carry out this research, in addition to all the team members for their help and collaboration during my learning process at the site. Thank you to everyone in the Çatalhöyük Botany Lab, especially to Dragana Filipović and Ceren Kabukcu, for their help with the database and other lab procedures. Thank you also to my "Çatalhöyük friends", Aroa García Suárez, Patrycja Filipowicz and Karolina Joka, who helped me stay sane through the rough times at the site. My gratitude extends to everyone in the Jarmo team, especially Charlene Murphy and Leilani Lucas, for their flotation and archaeobotanical work respectively.

Thank you to all my colleagues from the IoA, especially to Chris Stevens, Eleanor Kingwell-Banham, Louis Champion, Anne de Vareilles Sommieres and Hanna Sosnowska, for their friendship and encouragement during my PhD. You have always been there for me and I could not imagine this journey without you. Thanks to my mum and my friends in Spain who, despite the distance, were always there for me, giving me their love and reminding me that the effort was worth it.

Lastly, thank you to my partner Dean, for being by my side during a crucial part of this journey. Thank you for always believing in me and never letting me give up.

This research project would not have been possible without the constant support of all my colleagues, friends and family. I will always be grateful to everyone who encouraged me to come to the UK and start an academic career and to everyone who has contributed to make this country my second home.

Chapter 1
Introduction

1.1. Research rationale

This PhD project integrates unstudied plant evidence from the Neolithic site of Çatalhöyük East (Turkey) and Jarmo (Iraqi Kurdistan), such as charred food residues and amorphous charred organic lumps of food preparations, which were originally identified as "food" and "bread," combined with the study of artefact assemblages (clay balls, pots, fire installations and grinding stones), ethnographical studies and experimental food preparation and charring experiments. The main aim is to assess the extent to which Neolithic Çatalhöyük and Jarmo can be characterised as a bread culture (e.g. Fuller & Rowlands 2011) near the origins of European bread cultures, and in relation to how much diversity of cereal preparation techniques were employed in the past and how these diversified over time. The methods developed in this research provide a new means of characterising archaeobotanical assemblages with charred food fragments as representative of Neolithic "recipes," the *chaîne opératoire*, which links harvested cereals to cooked products for consumption. The intention of this study is to characterise how these recipes changed over time and might have varied across the Neolithic Çatalhöyük and Jarmo community, shedding light on social differences.

The relevance for investigating past culinary traditions, and the more specific significance of this research lies on the possibility of identifying the forms in which early Neolithic people consumed the plant species commonly recovered from archaeological sites. Through the study of charred archaeological foods combined with the analysis of tools directly related with food preparation, archaeologists can further our understanding of culinary daily routines, and how these and food products contributed to Neolithic cultural and economic developments as well as diet and health. This research has been conducted within the Çatalhöyük Research Project and the ComPAg Project framework, with the support of a four-year AHRC (LAHP London Scheme) doctoral studentship.

1.2. Chronology and terminology

This thesis focuses on the Neolithic in Southwest Asia which spans a period of more 4000 years, beginning around 9600 cal. BC, with the culmination of the Younger Dryas and onset of Holocene conditions (Barker 2006, 131; Watkins 2009) and continuing until ca.5200 BC. Traditionally, the Neolithic in this area has been divided into an earlier Pre-Pottery Neolithic (PPN) and a later Pottery Neolithic (Hole 1987; Voigt & Dyson 1992). For the area of the Levant in the Fertile Crescent, this chronology further splits the Pre-Pottery Neolithic into a PPNA and PPNB phase, with subdivisions such as 'Early-PPNB' and 'Final-PPNB'.

The chosen case studies for this thesis, the sites of Çatalhöyük East and Jarmo, are examples of village-like sites which emerged during the PPNB in Anatolia and the Central Zagros Area respectively. For these two areas, the Levantine chronology has been adapted however there was the need for a better refinement and cultural and regional application (Asouti 2006). In this sense, for Anatolia this thesis uses the Neolithic terminology created by Özbasaran & Buitenheis (2002). In general terms, The ECA II period dates from the late 9th millenium BC to 7500 cal. BC at the same time the ECA III period is divided into two sub-phases, A and B. The subphase A runs from ca. 7500-6600 cal. BC, while subphase B dates back to ca. 6600-6000 cal. BC. During this time, Central Anatolia experiences a shift from foraging to farming with a full establishment of production of domesticated plant and animal resources during the ECA III. For the Central Zagros Area, this thesis uses Matthews *et al.* (2013; 2016) established a simplified and revised chronology, which divides the region into three time periods: Epipalaeolithic (ca.12,000-9600 cal. BC), Early Pre-Pottery Neolithic (ca.9600-7000 cal. BC) and Late Neolithic (ca.7000-5500 cal. BC).

1.3. Background to research

The way people and communities prepare and consumed their food has received much attention from archaeologists, anthropologists and ethnographers principally because of its fundamental role in the diverse cultural, economic and political developments of human societies (e.g. Dietler 1996; Dietler & Hyden 2001; Goody 1982; Hastorf 1991; 1998; Lévi-Strauss 1964; Sherratt 1999; Wright 2000). Archaeobotany and zooarchaeology, as disciplines for the study of how plant and animal resources were used by past societies, have seen significant growth, including developing methods for recognising how food preparations techniques may register as preserved traces, such as evidence for butchery marks, bone boiling or roasting (Koon *et al.* 2010; Munro & Bar-Oz 2005; Russell & Martin 2012; Speth 2000). Yet the forms in which prehistoric people consumed their plant food resources has only recently received scholarly attention (but see Hansson 2002; Hansson & Isaksson 1994; Heiss *et al.* 2017; 2019; Kubiak-Martens *et al.* 2015; Samuel 1994, 1999, 2000; Stahl 1989; Valamoti 2002, 2011; Valamoti *et al.* 2008; 2019; Wollstonecroft 2007; Wollstonecroft *et al.* 2008).

The form and content of ancient foods is important because it can help us to better understand culinary traditions and associated routine activities, i.e. processing and cooking, as well as providing information about their species selection and intensification practices (Stahl 1989; Wollstonecroft 2007) and the nutritional value of the food (Wandsnider 1997; Wollstonecroft *et al.* 2008; 2012). Archaeologists have typically inferred this type of information from indirect evidence such as associated artefacts and features, e.g. grinding stones, mortars and pestles, hearths, ovens and ceramics (e.g. Moore 1995; Wright 1994; 2000), in contrast, the inferences of archaeobotanists and zooarchaeologists are based on the analysis of direct evidence, archaeological plant and animal remains. Of note are recent archaeobotanical studies of organic residues from pottery (food crusts) that combine organic chemical analyses and observations by Scanning Electron Microscopy (SEM) (Kubiak-Martens *et al.* 2015; Raemaekers *et al.* 2013; Oudemans & Kubiak-Martens 2013).

Cereals were central to the economic transformations associated with the so-called ‘Neolithic revolution’ (Childe 1936). These were amongst the first food plants to be domesticated worldwide (Fuller *et al.* 2014) and they are the staple food for a variety of social and ecological systems nowadays (wheat in Europe and North America, maize in parts of Africa and South America, sorghum in India and parts of Africa, rice in East and Southeast Asia). It has been suggested that cereals, with their hard, dry and storable seeds were the key support to the rise of early states and the development of writing systems (Steensberg 1991). Nevertheless, the systematic study of the forms in which people consumed their cereal foods, whether as whole grains, bread, porridge, bulgur or otherwise, has been limited.

Despite the recent proliferation of the studies of archaeological remains of cereal products with a focus on bread-like products in Central Europe, this doctoral thesis presents the first example of a systematic study of Neolithic cereal-based products in the world, through the application of an innovative multiproxy methodology which includes not only microscopic observation of the food matrices, completed by the comparison with experimental reference materials.

1.4. <u>Aims and research questions</u>

The primary aim of this study is to provide and interpret new archaeobotanical data to study the use of plant ingredients for the preparation of food products during Neolithic of Southwest Asia. This is addressed by the analysis of archaeological remains of food preparations recovered by flotation and preserved in the form of amorphous charred organic lumps, believed to represent the remains of cereal-based products such as bread-like or porridge-like preparations. The samples chosen for this study were selected from the sites of Çatalhöyük East and Jarmo located in Anatolia and Central Zagros respectively.

Both sites presented a significant opportunity to develop a new systematic methodological approach for the analysis of archaeological food remains, due to the systematic recovery and sampling of archaeobotanical remains carried out at the sites, as well as their extremely good preservation. The creation of a new set of methods, based on the development of a range of attribute sets present in the food matrix (particles and voids) has been a considerable step forward into the analysis of archaeological remains of food preparations. In this sense, since its publication in 2017 (González Carretero *et al.* 2017), this methodology has been applied to numerous food remains coming from different geographical areas and chronological periods, and it has made the identification of multiple past recipes possible.

Through the analysis of the food assemblages recovered from Çatalhöyük East and Jarmo in conjunction with the study of the macrobotanical assemblages, experimentation and the interpretation of published datasets, this doctoral thesis aims to address the following principal research question:

- ✓ Can early *cuisine* at Çatalhöyük East and Jarmo be characterised as a bread culture (e.g. Fuller & Rowlands 2011) near the origins of European bread cultures, and how did it change through time?

This general question requires a number of subsidiary objectives and questions, including:

- ✓ How can Scanning Electron Microscopy (SEM) analysis clarify the ingredients and preparation that lead to amorphous charred fragments, previously interpreted as "food" or "bread"?

- ✓ Can we identify changing patterns in the choice of plant species and in the production and preparation of meals through the analyses of macrobotanical remains and experimental analysis?
- ✓ Can we infer inter-site and/or chronological differences in culinary practices and food preparation techniques in the Neolithic of Southwest Asia?
- ✓ How can the archaeobotany of food preparation relate to social differences between houses and households at Çatalhöyük East and Jarmo?

1.5. <u>Theoretical approach</u>

This research on the study and analysis of food remains from Neolithic Çatalhöyük and Jarmo is based on the idea that "food preparation practices constitute a form of labour that embraces specific kinds of relationships and food itself creates social relations among people" (Miracle & Milner 2002). As well as physical and physiological links between people and food, there is also cultural and social entanglement. Food, like all human-made artefacts are not isolated because they by definition depend on humans (Hodder 2011; 2012). Consequently, all forms of food production, procurement, preparation and consumption represent examples of the dependence of people on 'things' and of these 'things' on people (*sensu* Hodder 2011; 2012). Starting from the food production stages, domestication of cereals is an extremely good example of this type of entanglement (Fuller *et al*. 2010; Fuller *et al*. 2016; Hodder 2011, 228). As humans became more dependent on cereals not only their diets changed but also the tasks and labour investments associated with increasing cereal planting, harvesting and processing. Likewise, the plants themselves changed, evolving new domestication traits (Fuller *et al*. 2016; Hodder 2012). Thus, cereals became more dependent on people for propagation and Neolithic communities became reliant on these plants for subsistence. This entanglement is not exclusive to the stages of food production but also the types of food products and their associated processing and cooking techniques. As previously mentioned in the text, grinding of cereals into flours increased edible calories from a given amount of grain, increasing the yield from a cultivated piece of land and from the human labour investment (time/effort). In addition, and significantly, people came to depend on certain types of food products such as bread type products. This 'growing taste for these kinds of foods' reinforced the motivation for the increased labour that came with the entanglement of domestication (Fuller *et al*. 2016).

The same can be said in relation to cooking technologies and equipment. While our ancestors have used hearths for cooking for many millennia, it was only during the Neolithic that they began to be intensively used in conjunction with cereals. It was also only during the Neolithic that ovens appeared in Southwest Asia. Likewise, people began to use clay/mud for the construction of houses as well as ovens and the later use of clay for pottery. With the advent of the use of ceramics, new ways of cooking certainly arose and not only recipes changed but also the close relationship of people and food (Hodder 2011; 2012). The introduction of clay pots for cooking purposes most likely meant new types of entanglement with pots and their raw materials (e.g. nearby sources of clay, clay qualities, colours) as well as its products (the pots), in terms of human interactions with each other as well as human interactions with their tools and raw materials. For example, this would imply that the change from using clay balls as heating elements to using cooking pots possibly meant a reduction on the time the cook needed to spend and therefore a change in the relationship between the cook, the tools and the food itself. A similar shift can be inferred from the earlier introduction of the oven, which freed the cook from the necessary restrictions of tending an open hearth.

1.6. Thesis structure

Chapter 1 has provided a brief overview of the wider research context and defines the chronological framework used here, as well as articulating the main aims of the thesis and specific research questions. Chapter 2 delivers an overview of the available data in relation to bread-making traditions during the Neolithic of Southwest Asia and current evidence of bread-like products in a wider geographical area. Chapter 3 provides contextual archaeological information of the study area, followed by Chapter 4 which discusses the archaeology and characteristics of the case studies, including their chronology. Chapter 5 articulates and justifies the methods created for the application to this thesis and chapters 6 and 7 present and discuss the results from the sites of Çatalhöyük East and Jarmo respectively. In chapter 8 the datasets and results from each site are contextualised, compared, interpreted and discussed in relation to the specific research questions proposed. Finally, chapter 9 summarises the main results from this thesis and discusses further and future lines of this research.

Chapter 2

Early origins of bread cultures in Southwest Asia

2.1. Cooking traditions in Southwest Asia: Baking vs Boiling

From a western point of view, bread is a basic dietary item made of a mixture of cereal flour, yeast and water which is prepared by baking that is carried out in oven (Mondal & Datta 2008). However, this modern definition of bread seems limited when looking at the archaeological and ethnological record. Hard evidence of yeast, as a raising agent added to batters and doughs, is attested very late into the cooking traditions, with the earliest evidence of the use of yeast for bread making only 3,500 years ago, in Egypt (Samuel 1994). Similarly, we find evidence for various types of fire installations which could have been involved in the process of baking, such as hearths and fire pits. Baking on embers is believed to be the oldest baking method ever used by past communities (Curtis 2001) and examples of this are the 14.6k yea-old bread remains from Shubayqa I in Jordan (Arranz-Otaegui *et al.* 2018a).

In addition, bread is a product that results from a cultural, technological and chemical transformation of cereals. The creation of bread needs processing and cooking knowledge that forms and shapes culinary traditions all around the world. As Lévi-Strauss (1964) stated, human beings transformed nature into culture by cooking. This applies to bread-type foods which are the result of the transformation of cereals into flour and then into bread by cooking. In this sense, we should consider bread and bread-like products as social concepts and artefacts of culture.

This thesis on the origins of bread cultures in West Asia seeks to offer new insights into the definition of the term 'bread' in which yeast and baking are not essential nor exclusive. On the contrary, bread should not be understood as a single type of food but defined by a series of potential variables. Several ways of dough fermentation could have been taking place during the preparation of bread products in the past, including the natural fermentation of flour and water mixture or the preparation of a sour dough without the need of added yeast. In the same way, various types of cooking technologies could have been involved in the process of heating and transforming the dough into bread, such as hearths and ashes with no need of a typical baking oven (Table 2.1.). Therefore, a more appropriate definition of bread would suggest that 'bread' is *a cereal food made of flour and water to which heat is applied generally by baking or roasting*.

Table 2.1. Examples of bread products without added yeast around the world.

Name	Origin	Fermentation	Cereal	Preparation
Flat bread	Southwest Asia	No	Wheat/Barley	Oven
Tortillas	Mesoamerica	No	Meize	Clay plate on hearth
Injera	Ethiopia	Sourdough	Teff	Clay plate on hearth
Chapatis	South Asia	No	Wheat	Hearth

However, the process and preparation of cereals into a bread-type product is not universal. As a category of food concept and artefact, breads are particularly associated with the origins and spread of agriculture from Southwest Asia, as opposed to the cooking traditions associated with other early agricultural zones, whether the eastern Asian boiling/steaming tradition (Fuller & Rowlands 2009; 2011). Haaland (2007; 2009) was the first to draw attention to significant technological and cultural differences between the oven-based baking tradition in West Asia and the pottery-based boiling tradition in sub-Saharan Afric. Fuller & Rowlands (2011) expanded on Haaland, to define the geographic boundaries of the cereal/baking/bread traditions. They identify this cultural region as encompassing the Mediterranean, North Africa, West Asia and the Iranian Plateau, with an epicentre in Anatolian and Levantine areas in which wheat and barley were first cultivated ~11,000 years ago; here, grinding stones and milling tools have been recovered in high quantity and with evidence of milling traditions from the Epipaleolithic (Wright 1994; 2005). Fuller & Rowlands (2011) contrasted this western-based bread and baking cereal tradition with the distinct boiling and steaming cereal tradition that characterises East Asian cuisine, with China as the centre, based on rice and millets (ca. 7000-6000 BC) (Figure 2.1).

The archaeological record shows evidence of these two very different culinary traditions. In some areas of the world, especially in Southwest Asia, the beginnings of agriculture, grinding tools and ovens potentially used for bread making preceded the appearance of pottery (Fuller 2006; 2007; Fuller & Rowlands 2011; Moore *et al*. 2000). In this area, we find evidence of the exploitation of wild plants and preparation of ground cereals as early as 23,000 cal. BP at the site of Ohalo II where starch analysis on grinding tools show remains of barley flour on the surface (Dubreuil & Nadel 2015; Piperno *et al*. 2004). On this line of evidence, recently published phytolith analysis on early Neolithic grinding stones from the site of Göbekli Tepe shows the processing and use of wild and domesticated cereals from the 10^{th} Millennium BC in Anatolia (Dietrich *et al.* 2019).

In addition, the appearance of cooking hearths and ovens is at least 2,000 years earlier than pottery, finding evidence of the earliest ovens (pit-type ovens) at Mureybit (9500-9000 cal. BC) (Cauvin 2000, 41; Fuller & Rowlands 2011). Domed ovens and grinding tools will gradually become widely used in West Asia from the middle PPNB (7400 cal. BC) when this area will witness the emergence of large villages with fully established cereal agriculture (Fuller & González Carretero 2018).

In this sense, we can attest the creation and development of a specific culinary tradition based on cereals and multiple bread products in West Asia from the beginning of the early Holocene. This culinary tradition will continue during millennia throughout the Neolithic, Chalcolithic and later Mesopotamian historical periods with the evidence of preparation of multiple types of bread which, despite being made in many different ways, all of them share ground cereals as basic ingredient and the use of hearths and ovens for their preparation (Bottero 2004). The later addition of pottery vessels to the cooking scene in Southwest Asia did most likely create a whole new culinary tradition on its own. The emergence of the use of pots for cooking purposes would mean the development of new ways of cooking plant foods such as porridges, soups and stews among others alongside bread-making.

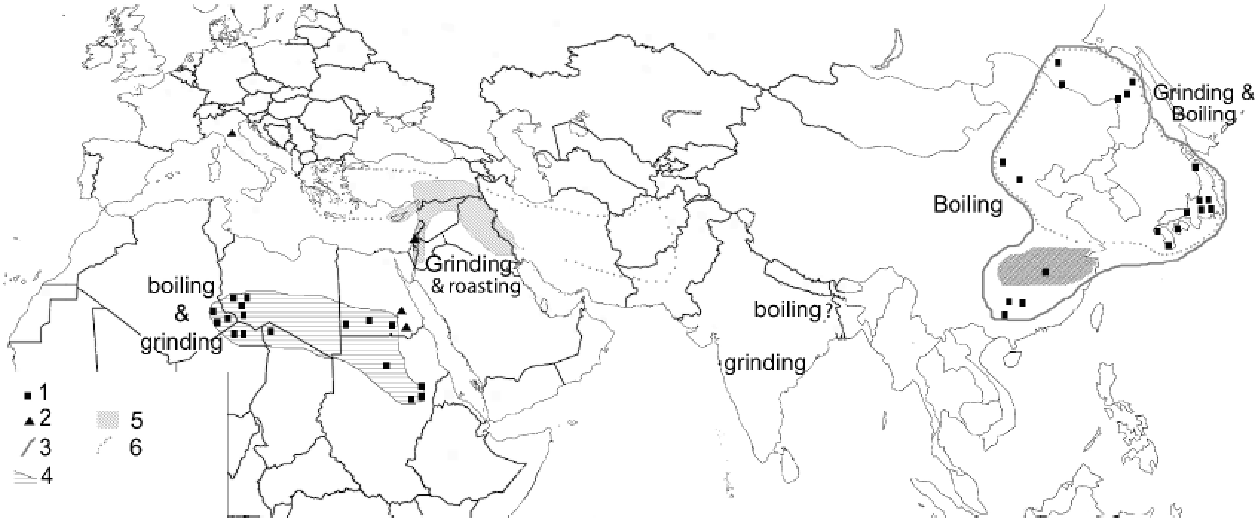


Figure 2.1. Map showing early culinary traditions in the early Holocene (Fuller & Rowlands 2011). Key: 1) Representative of sites with early pre-agriculture pottery; 2) Sites with early pre-agriculture querns; 3) Distribution of early ceramics in eastern Asia; 4) Distribution of early ceramics in Saharan Sudan; 5) "The Fertile Crescent" Area; 6) Core "grinding zone".

These generalisations based on artefactual evidence, although compelling, lacked for many years tangible archaeological evidence. Only recently, archaeobotanists have started to pay attention to the remains of food preparations available from the archaeological record. The development of the methods for the analysis of archaeological remains of cereal products for this doctoral thesis made possible the identification of ca. 14,600-year-old remains of bread-like products from the site of Shubayqa I in Jordan (Arranz-Otaegui *et al.* 2018a). This find is of extraordinary importance as it has pushed back the beginnings of bread making prior to agriculture and cereal domestication. Not only does it mean that bread was made before cereals were domesticated, but also that the wild progenitors of cereals were one among many wild gathered plant foods that were auditioned for early breads. This suggests the theory of a early "bread culture" in Southwest Asia, which seems to emerge during the Epipalaeolithic and which is established during the Neolithic period.

Further evidence has recently been published in Fuller & González Carretero (2018), with the aim of presenting the potential of microstructural analysis of charred remains of meals to documenting the empirical evidence of past cooking traditions. This is illustrated with examples of analysed archaeological food remains from Nubia and West Asia to show differences in prehistoric culinary traditions in different areas of the world. They consider this an emerging subfield of archaeobotany that studies and analyses prepared food products, and not just the plant species people gathered, grew and consumed. The current thesis develops this approach, both developing the methodological tools for recognizing and studying preserved charred food fragments, and through an extensive study of such remains from two early Neolithic sites in South West Asia, Çatalhöyük (Turkey) and Jarmo (Iraq).

2.2. Previous identification of prehistoric remains of cereal products

The identification of remains of cereal meals from archaeological sites has been very rare due to the lack of published methods and criteria in addition to preservation issues. To date, the earliest archaeological remains of flat bread-like products come from the Natufian site of Shubayqa I in Jordan, dating back to ca.14,600 cal. BP (Arranz-Otaegui *et al.* 2018a). In a collaboration with colleagues from University of Copenhagen, I analysed a portion of the charred food remains recovered by flotation from the hearths of Shubayqa I. Using the methods developed for this doctoral thesis, I carried out SEM analysis of 49 charred food remains concluding that 24 of them were bread-like products. Among the ingredients identified there were fine flours, presumably sieved, from wild cereals, including a single-celled thick aleurone layer which is consistent with that from wild einkorn wheat (*Triticum boeticum/urartu*), taxon which is present in the archaeobotanical assemblage from Shubayqa I. Fragments of parenchyma from wild sedge tubers were also identified in the microstructure of the bread remains. Tubers from sedges, in particular club-rush (*Bolbolschoenus glaucus*), have been recovered from the hearths at Shubayqa in great quantities, perhaps showing their importance as a dietary element during the Natufian.

The oldest examples of amorphous fragments of cereal products found outside Southwest Asia come from the late Neolithic sites of Limnochori, Anarghiri III and Dikili Tash in Macedonia (Valamoti 2007; 2015; Valamoti *et al.* 2019). These, together with the remains of cereal products uncovered from the Bulgarian site of Kapitan Dimitrievo are believed to represent bread/porridge-like fragments, categorised by the authors as “agglomerations of fragments in an amorphous matric” and “amorphous masses with bubbles” (Valamoti *et al.* 2019).

Remains of archaeological bread-like products are relatively more common in Central and Western Europe. Some of the earliest examples come from Switzerland in the early Fourth Millennium BC from the site of Twann/Douanne and Montmirail (Währen 1989; 2002) and

Parkhaus Opera in Lake Zurich (Heiss *et al.* 2017). Similarly, there are evidences for the preparation of bread in the Third Millennium BC from France and the Isle of Jersey from the sites of Villa Giribaldi, Baigneurs a Charavines and Pinacle (Lannoy *et al.* 2002). A recent review by Popova (2016) collects many examples of archaeological bread which have been recovered from archaeological sites, as well as some probable non-bread cereal foods across Europe, highlighting that most of the more securely identified bread finds are from the First Millennium BC or later.

Währen (1989; 2002) was the first to offer a typological classification of the different types of breads recovered from European archaeological sites from the Neolithic to Medieval times, based on their morphology and type of archaeological contexts they had been found in (e.g. barquettes, round loaves, etc). Later, Samuel (1994; 1999; 2000) carried out investigations of desiccated Egyptian bread from tombs in the New Kingdom (ca. 1550-1070 BC) which resulted in significant insights into ancient bread and beer making. More recent studies, (Heiss *et al.* 2015; 2017; Lannoy *et al.* 2002), which focused on identifying the cereal components of bread-like objects and "galettes", demonstrate the usefulness of applying anatomical analysis to identify cereal tissue types. Their results provide unique new information about the different ingredients used in bread preparation, as well as cereal processing techniques (e.g. grinding), and various ways of preparing doughs and potential cooking practices.

The systematic recovery of archaeobotanical evidence through flotation provides the potential to collect small charred fragments of food preparations (see Popova 2016). In this sense, Hansson and Isaksson (1994) were the first ones to carry out tissue-based analysis of this type of processed food fragments from several archaeological sites in Sweden (Västergarden, Vrå, Harrsjöbacken & Folåsa). Their study was the first successful application of SEM to identify the plant composition of amorphous fragments of cereal meals, which they augmented with chemical analyses. Building on this, Hansson (2002) then carried out detailed analyses of whole loaves of bread from other Swedish sites such as Birka, Helgö, Ljunga and Boberget.

2.3. <u>Milling and baking: past food preparation and cooking technology</u>

Based on the proposed working definition for bread-like products, grinding stones and hearths and ovens represent the essential tools for bread making in the Neolithic of West Asia. Grinding of cereals produces different types of flours which can be then cooked or baked into multiple variables of bread type products. The importance of food processing and cooking is well-established, not only in terms of creating desired tastes and textures but also in relation to the increase in nutritional value (Stahl 1989; Wollstonecroft *et al*. 2008). Such types of food processing techniques are regarded by many authors as a way of 'food intensification' and 'bioaccesibility' since they increase the amounts of digestible calories extracted from foods (Stahl 1989; Wright 1994; Wollstonecroft 2007; Wollstonecroft *et al*. 2008). In relation to cereals, grinding and baking are highly suitable cooking techniques. They make cereals more palatable and change the chemical properties of these (e.g. fibre, starch) into digestible foods. This specifically occurs when grinding, boiling, soaking/leaching, baking and roasting cereal grains change the nature of the food matrix so that becomes easily digestible making possible a better absorption of nutrients by the human body (Wollstonecroft 2007). Also, activities like pounding and grinding help the reduction of the particle size of cereal caryopsis (grain) to sizes that are easier to cook and eat, thus better exposing nutrients to agents (enzymes) of digestion (O'Dea *et al*. 1980, 763). Among these activities, grinding produces more homogeneous and finer particles of cereals (Wright 1992; 1994), such as different types of flours which are ideal for bread making.

From the 8th millennium BC, grinding stones (querns and grinders), hearths and ovens became essential for the transformation of cereals into edible products in western Asia. Regional differences are visible throughout the Levant and Anatolia and the earliest evidence of grinding stones date from the Upper Palaeolithic (Wright 1994). The occasional use of portable ground stones is evident from earlier times, but it is the Late Upper Palaeolithic and Early and Middle Epipalaeolithic periods (ca.24,000-12,780 cal. BC) ground stone tools become frequent and can be linked with processing wild cereals and other fruits (Hillman 1989; Wright 1994; 2005).

The best example of early use of ground stones comes from Ohalo II (ca.23,000 BC), already mentioned earlier in the text, where more than 30 different species of edible plants were identified in the archaeobotanical record and remains of cereal starch granules were recovered from the grinding tools (Dubreuil & Nadel 2015; Piperno *et al*. 2004). It was not until the Natufian period (12,780-10,040 cal. BC) that the use of ground stones for food processing became widespread. During the Natufian in the Levant we see the establishment of bigger communities more settled in the territory with a general intensification of food processing (Wright 1994; 2005). The intensification of the use of ground stones in the Levant will come during the *PPNA* (10,000-8940 cal. BC) and it has been interpreted as a consequence of the emergence of plant cultivation which took place during this time and the establishment of cereals as staple food. Variation in the forms and shapes of ground stone tools will increase during the late *PPNA* and reach its maximum during the *PPNB* (8940-6940 cal. BC). During this period, we see archaeological evidence for established plant domestication (Asouti & Fuller 2013; Fuller *et al.* 2011) and the creation of large Neolithic villages (12-15ha) with complex houses which had bigger storage facilities. As a result of the communities' increase in size, the ground stones record is dominated by large ground stones which would have permitted the processing of higher amounts of food to feed more people (Wright 2004, 35).

In relation to grinding tools in Central Anatolia, recently published results on the analysis of phytoliths recovered from grinding tools from Göbekli Tepe in South-eastern Anatolia shows evidence of established used of mortars and grinding slabs for cereal production as early as 9800 cal. BC (Dietrich *et al.* 2019). Later on, the ECA II (ca.8000-7500 cal. BC) and ECA III (ca.7500-6000 cal. BC) archaeological sites present equivalent characteristics to the PPNA and PPNB in the Levant. These periods in Central Anatolia show an increase in ground stones usage as well as the gradual intensification of plant domestication and the establishment of cereals as staple foods (Asouti & Fuller 2013; Fuller *et al.* 2011; Wright 2014). During the ECA III, Central Anatolia experiments the development of large Neolithic villages like those of the Levant during the late PPNA and early PPNB. Sites like Aşıklı Höyük and Can Hassan III appear at the end of the 9th millennium and will remain in this area until the abandonment of Çatalhöyük East around at the end of the 7th millennium. As seen in the Levant, during these periods ground stones increased in size and new shapes and raw materials appeared on scene. These variations have been seen as a result of a steady population growth taking place in the large Neolithic villages making necessary the procurement and process of higher amounts of foods (Wright 2014).

The importance and established role of bread-like products in these communities is attested some millennia later by the development of different types of clay ovens. During the upper Palaeolithic and early Neolithic in West Asia, hearths are the dominant fire installation in the archaeological record. Hearths might differ in size and shape, but they are present in practically any settlement from the beginning of the 13th millennium BC. Unravelling the use and meaning of hearths in late Pleistocene and early Holocene archaeological settlements is not always easy. However, their centrality in the house and their use as cooking installations, amongst other possible uses, has now been established. Evidence of cooking plant foods such as cereal-based foods on hearths has been widely recorded through ethnographical observation and study of traditional modern societies around the world. Samuel's research on Egyptian bread being cooked on the ashes of the hearths during the New Kingdom in Egypt and nowadays in the local village of Amarna provides one of the best examples (1994; 1999; 2000). The use of hearths for cooking purposes in Western Asia dates to the Middle Palaeolithic at Kebara Cave in Israel (Goldberg & Bar-Yosef 1998) where more than 450 species of edible plant food have been identified to have been part of the diet of these hominids who inhabited the cave (Lev *et al*. 2005). In addition, new evidence from the site of Shubayqa I in Jordan attests the use of lined hearths for bread-making purposes (Arranz-Otaegui *et al.* 2018a).

The first ovens in West Asia were filled with pebbles and rocks and fit more into the category of pit ovens (Fuller & Rowlands 2011). The first known example comes from the site of Mureybit in Syria (ca.9500 BC) and it is believed to have been used for meat roasting (Cauvin 2000). From the end of the Middle Pre-Pottery Neolithic B (ca.7500 cal. BC), we find evidence of domed ovens (*tabun* or *firin*) in the archaeological record as recovered from sites like Cafer Höyük (southeast Turkey), Abu Hureyra (Syria), Tell Bouqras (Syria), Jarmo (Iraqi Kurdistan) (e.g. Akkermans & Schwartz 2003; Cauvin 1989; Moore *et al.* 2000), and Çatalhöyük, from its earliest levels from ca. 7100 BC (Fuller & González Carretero 2018; Fuller & González Carretero forthcoming). A later type of oven will make its appearance during the second half of the 7th millennium BC. This type of oven, generally called *tannur* or *tandir,* is a tall cylindrical oven where bread is baked on the inside walls (Figure 2.2.). This type of oven, differs considerably from the *tabun* type as it does not have a dome and it is open on the top. In this sense, *tannur* ovens are thought to have been first built with a different purpose in mind, most likely specialised in bread-baking activities as attested by ethnographical examples (Parker 2011). In this sense, *tandir* ovens are built in a way that do not normally allow their for them to be used for any other cooking activity as for example they do not have openings such as those seen in *tabun* ovens, for vessels or other cooking dishes to be put inside for heating or cooking purposes. Having said this, personal observation by the author of cooking activities from local villages near the archaeological sites considered in this thesis, suggests that in some occasions *tandir* ovens have been seen to be serve different cooking purposes other than bread-baking. In this sense, skewers were seen to have been placed over the rim of the oven for roasting and in one occasion boiling was also achieved by hanging pots over the oven cylinder (pers. observation May and July 2017). The first known example of a *tannur* oven comes from the site of Tepecik Çiftlik in Central Anatolia dated to ca. 6400 BC (Akkermans & Schwartz 2003; Moore *et al.* 2000; Tkáčová 2015). As agriculture spread from Southwest Asia into Europe, domed ovens spread too as integral components of houses on Neolithic tell sites in

Greece, Macedonia and in the Balkans (e.g. Marinova 2007; Naumov *et al.* 2009; Renfrew 1971). Highly interesting is the fact that for the majority of these sites, ovens of various descriptions, preceded the emergence of pottery. It will not be until 1,000 years later that Neolithic communities will start using ceramics as cooking vessels. This, most likely, was the ignition for a very important change in the Neolithic culinary systems (Figure 2.3.).

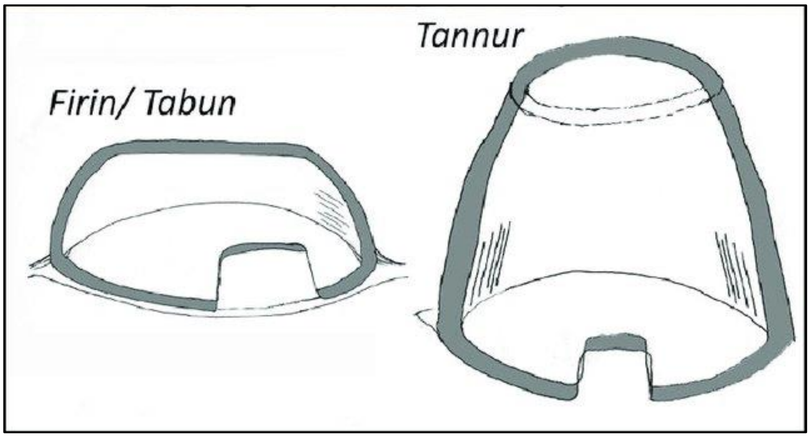


Figure 2.2. Examples of bread oven types showing sketches of general *firin* and *tannur* oven types (Fuller and González Carretero 2018).

Hearths and ovens had a key function in the Neolithic communities of West Asia as they were essential for household food processing and cooking activities. From the beginning of the 8th millennium, we see the proliferation of clay-lined hearths with raised rims at Aşıklı Höyük (8300-7500 BC) and Boncuklu Höyük (8300-7800 BC) in Anatolia (Baird *et al.* 2012; Baird *et al*. 2013b; Cutting 2004; 2005) and Tell Halula (7,800-5,700 cal. BC) in Syria (Ortiz *et al.* 2013). These are subsequently accompanied by domed ovens (*tabun* type) inside Neolithic houses, which most likely contributed to the development of installation-specific cooking activities like baking. This is the case for Cafer Höyük, in south Turkey, where Molist (1985; 1988) noticed their similarity with those which are later found in Hacılar (Mellaart 1967; 1975) and Çatalhöyük East. As noted by Hastorf (2012), Çatalhöyük fire installations played an important role in the daily lives of its inhabitants. Hearths and ovens have been intensively recovered from Çatalhöyük East throughout the sequence, from the earliest Pre-Pottery levels at the site (ca. 7200 BC) to the latest recorded contexts (6000 BC) (Cutting 2005; Hodder 2006). These ovens are typically found deeply set into the southern wall of the houses, in the central room and with a front opening on the other end. Hearths, while also placed in the southern area, are usually situated away from the wall (ibid.). Some of the Çatalhöyük buildings have had more than one oven during their occupation sequence and they seemed to be re-plastered and rebuilt on the same location or nearby after short periods of time (Hastorf 2012, 77). Similarly, from the site of Tell Hassuna in northern Iraq (ca. 6000-5500 BC) archaeologists have recovered several examples of domed *firin* ovens (Lloyd et al 1945). These ovens, as seen for Jarmo and Çatalhöyük, have been found within buildings and also outdoor adjacent to houses. This has been interpreted by Flannery (2002) as an indication of household baking and cooking facilities.

Very little is known about the cultural or social transformation which dealt to the construction and use of the first ovens during the Neolithic in western Asia. Further work is needed in order to understand the complex cultural and social changes that could have been happening and that influenced the transition from an exclusive use of hearths for cooking processes to the combination of these with the use of constructed ovens. There are clear differences in the way foods and in particular cereal foods could have been cooked in hearths and ovens. In hearths the heat source is located only underneath the food; however, the built structure of the oven permits the spreading of the heat which is absorbed by the walls of the oven. The walls act as retainers, concentrating the heat in the core of the oven. This way the foods which are being cooked in the oven receive the exact same amount of heat from every area of the fire installation. In this sense, it is highly probable that Neolithic communities discovered the advantages of baking cereal foods over traditional roasting on an open fire; or most likely they started to appreciate the differences in texture and taste that different types of cooking techniques provide.

Later, the emergence of ceramics as cooking pots from the seventh millennium BC will likely mean an addition of a different way of cooking which opened up a new world in relation to the preparation of meals. With cereals still as the staple food, it is highly probable that pottery incentivised the creation of new recipes such as soups, gruels or porridges. In other words, pots allowed for wet cooking with hot water, rather than the dry or drying cooking of ovens and roasting. The advent of pottery will mark new elaborations in *cuisine*, with animals and plants being cooked together into stews or soups, which were added to the already established bread baking and meat roasting tradition (Moore 1995).

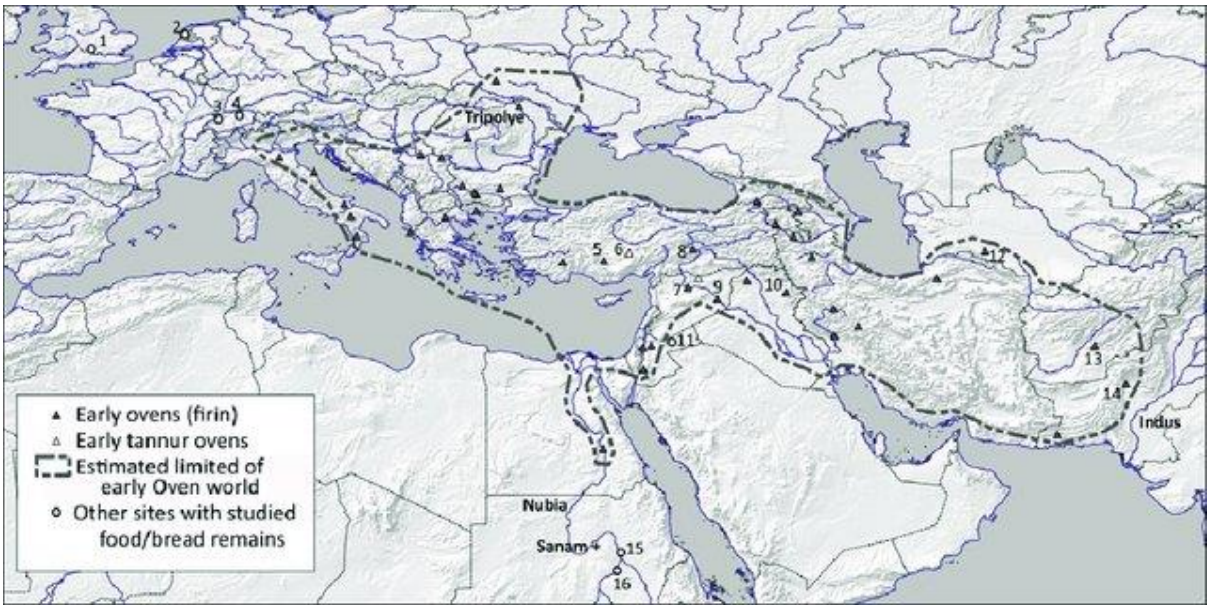


Figure 2.3. Map illustrating the early spread of ovens (mainly of *firin* type), and additional sites mentioned in the text (Fuller and González Carretero 2018). Selected sites numbered: 1. Yarnton, 2. Keinsmerburg, Mienakker, Zeewijk (Neolithic Netherlands), 3. Twann; 4. Zurich; 5. Çatalhöyük; 6. Tepecik Çiftlik; 7. Abu Hureyra; 8. Cafer Höyük; 9. Tell Bouqras; 10. Jarmo; 11. Shubayqa; 12. Jeitun; 13. Mundigak; 14. Mehrgarh; 15. Dangeil; 16. Hamadab. (Image by DQF).

2.4. Ethnoarchaeology of bread-baking traditions in Southwest Asia

During the last 40 years numerous ethnoarchaeological and experimental studies have been made on western Asian indigenous and non-mechanised plant food processing traditions (e.g. Ertuğ-Yaraş 1997; Hillman 1973, 1981, 1984; Procopiou & Treuil 2002). However, most of the relevant archaeobotanical ethnoarchaeology and experimental research has focused on crop-processing, while the study of food preparation and consumption is more limited (e.g. Samuel 1994; Wollstonecroft & Erkal 1999). Hillman (see Hillman 1973; 1981; 1984; Willcox 2009) pioneered ethnoarchaeological methods for linking patterns in the archaeobotanical record with various types of likely human plant-use activities (Capparelli *et al*. 2011, 1-2). Hillman, working with Turkish farmers in the 1970's and 80's, found that each stage on plant processing produces a distinct assemblage that can be recognised from the specific species, plant parts and their physical condition and that the patterning in the by-products of cereal processing, e.g. the proportions of cracked and crushed grains, fine groats, roasted grains, fine flour and malted grains corresponded with those of certain archaeological plant assemblages.

Following Hillman's seminal ethnoarchaeological fieldwork, ethnoarchaeological crop-processing studies became an intrinsic part of archaeobotanical methodology investigating the origins, evolution and spread of cereal agriculture in West Asia (e.g. Anderson *et al.* 2003; Butler *et al*. 1999; Hastorf 1988; 1998; Johanessen *et al*. 1990; Peña-Chocarro 1999; Peña-Chocarro *et al*. 2009; Peña-Chocarro & Zapata Peña 2003; Stevens 2003). Investigation into plant processing for the preparation of food and meals have more often been studied through processing equipment and artefacts rather than the processed matter resulting in the archaeobotanical remains (Procopiou & Treuil 2002a; 2002b; Wright 1994; 2005). Archaeobotanical studies of plant processing for the preparation of specific foods, include those of Samuel (1997; 2000; 2006) on bread and beer, Valamoti (2002) and Valamoti *et al*. (2008) on ground cereals in Greece and Wollstonecroft (2007; Wollstonecroft *et al*. 2008; Wollstonecroft & Erkal 1999) on wild sedge tubers. All these studies involved ethnographic observations and reproduction of traditional plant processing methods and techniques, followed by the examination of the resulting foods under Scanning Electron Microscope and the comparison of these with those recovered from the archaeological record. Special emphasis should be placed on the ethnoarchaeological studies of plant and animal foods in Central Anatolia by Ertuğ-Yaraş (1997; 2000). She studied the use and preparation of edible plants into foods in traditional villages in the modern Turkey. In relation to cereal meals preparation she focused on the traditional techniques carried out by the community in the village of Kizilkaya. She analysed the different types of bread and coarse grain meals and their different preparation processes. Ertuğ-Yaraş stresses the important cultural value of bread in modern Anatolia, where the word for bread '*ekmek*' means 'The food'. Bread is never thrown away, not even when not eaten and different cereal meals represent different stages in life. The role of women as the person in charge of the cereal processing and meal preparations is also pointed out by Ertuğ-Yaraş. This concept of bread had previously been explored by Carol Delaney (1991), whose social ethnographical studies in Turkish traditional villages found a symbolic link between bread-making and procreation and conception. According to Delaney, not only bread made up for the majority of the villagers' diet but also, as pointed out by Ertuğ-Yaraş, the word 'bread' is used to refer to 'food' in general. In addition, Delaney found that hearths and ovens were associated with the creation of a household, formed by men and women and "woman (wife/mother) transforms the wheat seed into bread just as she transforms the man's seed into a child" (Delaney 1991, 159).

Along these lines, Yakar (2000) explores the economic and social organization of traditional Anatolian communities of farmers and the cultivation, processing, preparation and consumption of cereals. His work is particularly interesting in relation to the different types of bread products that these communities prepare and consume on daily basis and how these are prepared and baked. We see a focus on four or five types of cereal meals: *Tandir ekmeği* (unleavened flat bread made of wheat flour and baked in a *tandir* oven), *firin ekmeği* (leavened bread made of wheat or barley flour and baked in a domed oven), *Gözleme* (unleavened thin bread made from oiled dough and baked on a hot metal plate), *Bazlama* (leavened dough made of a gritty flour and baked on a hot metal plate) and *bulgur* (coarse grain used for making soups or gruels). In general, in Anatolia, the ethnoarchaeological information gathered from personal observation and written sources talks about two different types of cereal processing techniques: half of the harvested grain is washed and dry-processed (ground) into fine flour to make different types of bread and the other half is boiled and transformed into *bulgur* and *tarhanas* (traditional soup made of cracked grain). The processing of dry grain into flour is still done by the use of traditional ground stones such as querns and grinders (Yakar 2000, 176). After both grinding the grain into flour or bulgur, they are sieved using traditional sieves made of a circular wooden frame and the strainer made of perforated animal skin or hair (Figure 2.4.). The finer flours are destined for bread making and the coarser flours are often mixed with fodder to feed the livestock. On the other hand, when preparing *bulgur* and *tarhanas*, different sizes of coarse grain are used for the preparation of different meals. For instance, the coarser *bulgur* is used for salads and *tarhanas* and the finest is used to thicken soups. Typically, these preparations take place on the house roof where the family members (mothers and daughters in particular) gather. *Bulgur* is commonly-left spread on the roof for several days to sun dry before being stored/used. A possible similar use of the roof for food processing (among other activities) has been inferred at Neolithic Çatalhöyük (Atalay 2005; Atalay & Hastorf 2006; Hodder 2005; 2006; 2012; Wright 2014).

Figure 2.4. Turkish woman sieving flour on the house's roof (Yakar 2000)

Surprisingly, despite the paucity of archaeological studies on prehistoric ovens, ethnographical studies about food in West Asia commonly describe and discuss them. *Tandir* and *firin* (domed ovens) types, represent a central element in the daily life of modern traditional communities in West and Southwest Asia. The most complete ethnoarchaeological studies on ovens to date are Parker & Uzel (2007) and Parker (2011) who carried out ethnographic work on the construction, uses and cultural significance of *tandir* ovens in south-eastern Turkey (Figure 2.5.) which later related to the fire installations recovered from the archaeological site of Kenan Tepe in South-eastern Anatolia (Figure 2.6.). While no evidence for the use of traditional *tandir* ovens was found in the early Ubaid levels (4960 BC), evidence for both the construction and use of *tandir* ovens was found in Late Bronze Age and Iron age levels (Parker & Uzel 2007; Parker 2011). In this sense, other ethnoarchaeological studies have shown evidence of *tandir* type ovens, particularly used for bread baking, from archaeological sites but the majority date from no earlier than 3rd millennium BC. As an example, Lawecka (2008) examines parallels between *tandir*-type ovens from the later levels of 3rd millennium BC archaeological site of Tell Arbid in Syria, and those used today by the residents of the nearby modern town (also of the same name). Similar ethnoarchaeological research was carried out by Crawford (1981) at Abu Salabikh in Iraq where similarities were observed between the archaeological ovens and hearths and those that were in use at the time (1970's, 1980's) in the nearby villages.

Parker's ethnographic research has provided insights into the construction and use of *tandir* ovens in traditional Turkish villages in South Anatolia (2011). During the course of this investigation, Parker observed that all types of ovens and hearths were mainly built during the summer months, when the temperature was at its highest, in order for the clay/mud to dry easily before the first use (Parker 2011, 607). This was also the case for pottery production, which was almost restricted to the months between June and September (*ibidem*). In connection with Delaney's observations, interesting gender patterns were seen by Parker in relation to the gathering and preparation of clay/mud for the construction of ovens. While the clay/mud was gathered always from the same source (around 1 km away from the village) by men, this was prepared and mixed with other materials to provide temper and stability by children and elderly women. The construction of the ovens was then carried out by a pair or group of women from the same family, always supervised by the eldest one (Parker 2011, 608). As ovens would normally last an average of 2 years of daily use, these had to be patched and fixed continuously, as seen also from the archaeological record at Çatalhöyük (see Chapter 6 for details).

During Parker's ethnographic work in Turkey, tandir ovens were reported to be used exclusively for unleavened flat bread-baking. The recipe for this was seen to be a simple mix of fine flour, salt and water which are then worked into dough-balls and let to rest for a variable period of time before baking. Parker also reports that bread-baking in these villages was entirely carried out by women, mostly daily and within the household but sometimes also communally as a social activity, using a group of ovens which were selected for communal use by a group of households (Parker 2011, 611-612). Interesting is the case of the village of Cöltepe, where every household was seen to have a private oven in their houses but in which sharing of these private ovens was the norm. This is a key case to have in mind as a possible comparison with the archaeological case studies considered for this PhD, Çatalhöyük and Jarmo, where ovens and hearths were a recurrent feature inside the houses (see Chapter 6). These ovens, have in principle, been considered as household private ovens, most likely used by the group of people or family inhabiting the house. However, this ethnographic example suggests the possibility of these having been perhaps shared and used by other members of the community.

Figure 2.5. *Tandir* bread adhering to the inside *tandir* oven during baking in the town Bismil (Parker 2011).

Figure 2.6. Oven from Kenan Tepe (Parker 2011).

Similar ethnographic and ethnoarchaeological work was carried out by Noor Mulder-Heymans on bread-baking in traditional villages in Syria (2002) where different types of ovens were observed and described, including *tabun* and *tandir* ones. This study is relevant as it shows that both types of ovens were used mainly for bread-baking activities with the addition of boiling and meat baking usgin the *tabun* but not the *tandir* ovens. Moreover, this study shows that flat bread was baked using the same technique of sticking the dough to the inside walls regardless of the type of oven (Mulder-Haymans 2002, 208). However, in general only tabun ovens were seen to be used for other cooking activities besides bread-baking, such as boiling in pots or vessels and meat and fish baking. These however, were considered as secondary activities to be carried out after the bread-baking was finished for the day (Mulder-Haymans 2002).

Ethnographic bread making and baking activities in the Central Zagros area has recently been explored by Floor (2015), establishing important differences between rural villages where traditional food preparation techniques are still in use, and urban bread baking with a diversification of the types of breads. In rural areas, bread was not baked daily, but it was baked in large batches which will last for a week; this required that the dough was unleavened so that the bread could be stored. In addition, bread making seemed to have been carried out mostly by women, similarly to what it was seen for Anatolian rural villages (Floor 2015). Grinding and sieving were essential activities which were performed by different people in the villages; while grinding was done by millers which were known by the community, sieving was again done by mostly women, by hand, using traditional sieves which would mean the bread still contained impurities such as wild weeds, etc.

In relation to baking activities, for the Central Zagros area, Floor (2015) talks about villagers using two different methods: on a hearth or in an oven. When using the hearth, the bread would be baked in hot ashes and embers or using a hot stone over the fire. Ovens were dependant on the wealth of the community or the household and they varied between *tabun* (*firin*) and *tannur* (*tandir*) types. Normally tabun ovens would be used at household level, while *tannur* ovens were more commonly used for communal baking activities. As seen for the Anatolian villages, many types of breads were baked in these ovens but flat breads (*naan*) were the main type. Leavened types would be baked in certain moments and for special occasions, such as religious festivals and other gatherings.

2.5. <u>Summary</u>

The creation and development of a specific culinary tradition based on cereals and multiple bread products in West Asia from the Natufian period can be attested. This culinary tradition can be characterised as a "bread culture" and is evidenced by the emergence and diversification of cooking facilities such as fire installations (hearths, ovens, etc) and food preparation and cooking tools, such as grinding stones, querns and pottery vessels. While the presence of these in the archaeological record has been noted for many decades, the archaeological remains of cereal-based foods and bread-like products is limited. These have long been disregarded by archaeobotanists, however recently more are the studies including the analysis of these types of remains.

This thesis proposes a new methodological framework and is the only example to date of a systematic study of archaeological food fragments, in combination with available published archaeological, ethnoarchaeological, and botanical data.

Chapter 3

Archaeological background to research

3.1. Agricultural development and social change in Southwest Asia

The study of the wide area of Southwest Asia is especially relevant in relation to the origins of food production, food processing, cooking and consumption because it constitutes the earliest and most archaeologically studied area in the world in which communities passed from being foragers to being farmers. Southwest Asia is also a geographical area with excellent conditions for the preservation of archaeological materials which makes it ideal for the study of plant foods. Figure 3.1. shows a map of the study area with the main archaeological sites.

Figure. 3.1. Map of Southwest Asia showing the location of the main archaeological sites in the area.

3.1.1. Epipalaeolithic communities

Palaeolithic and Epipalaeolithic communities had a wide and extended occupation in Southwest Asia. The earliest of Epipalaeolthic perios s represented by Kebaran Complex with regional and chronological variations. Kebaran communities had seasonal settlements, scattered around the Levant area. The base of their economy was hunting of wild animals such as deer and gazelle and gathering of wild plants, such as seeds, tubers, nuts, fruits, wild grasses, etc, accompanied by the regular use of pounding and grinding implements for food processing activities. An example of this are the analysis of grinding stones from the Early Epipaleolithic site of Ohalo II, near the Sea of Galilee. Archaeobotanical studies have yielded 40 different plant species, including large quantities of different types of grasses and edible fruits. Analysis of starch grains from the grinding stones has provided direct evidence of wild barley, and possibly wild wheat being processed for potential food preparation (Piperno *et al.* 2004).

Further changes in relation to food procurement practices occurred during the Late Epipalaeolithic in Southwest Asia. Around 14,600 cal. BC the climate warmed and rainfall increased, seeing a climatic improvement first in the Mediterranean forest of the southern Levant, with the increase of resource-rich annual plants (Hillman 1996; Van Zeist & Bottema 1991). Groups of hunter-gatherers in this Mediterranean area established permanent and semi-permanent settlements where food resources were more abundant (Bar-Yosef 1998). These groups known as the *Natufian* introduced more diverse subsistence technologies e.g. new tools such as sickles, which focused on foods requiring greater effort to gather and process, such as the annual grasses and forbs that gained importance in this period (Fuller *et al*. 2011; Hillman 1996). Moreover, an elaborate new range of ground stone tools, dominated by mortars and pestles, occur in higher frequencies than in earlier periods (Wright 1994; 2005). Social change also characterises the shift from the Early to Late Natufian with reductions in the sizes of domestic structures and number of hearths, indicating that they may have been inhabited by small family groups or individual families (Byrd 2000; 2005b).

During the Natufian we see the first evidence for substantial architectural structures which suggests that they required more planning than preceding Epipaleolithic structures (Simmons 2012). In this sense, of special importance is the site of Shubayqa I in Jordan which has also provided the earliest evidence of archaeological remains of plant-based food preparations and bread-making activities in Southwest Asia (Arranz-Otaegui *et al.* 2018a). Shubayqa I is a hunter-gatherer site dated to the early and late Natufian (14,600 to 11,600 cal. BP) located in the Black Desert. Excavations at the site have yielded two super-imposed buildings paved with rock made from local basalt. The building contained two fireplaces or large sunken stone-lined hearths which contained extremely high amounts of burnt archaeological materials, such as animal and plants (Arranz-Otaegui *et al.* 2018a; 2018b).

3.1.2. Neolithic communities of the Levant

Even greater social change occurred with the establishment of food-producing villages during the early Neolithic period in the Levant (see Table 3.1. for full chronology). During the Pre-Pottery Neolithic A (PPNA) there is an increase in social and economic complexity which has been seen as the result of cultural decisions that took place during the Late Epipaleolithic. This occurred soon after the increase in temperature, and rainfall, and further changes in the distribution and density of annual cereals and legumes (Byrd 2005b; Asouti 2006). The PPNA (ca.10,200-8800 cal. BC) in the Levant is frequently divided into the earlier Khiamian subphase and the later Sultanian subphase (Bar-Yosef 2001a; Bar-Yosef & Belfer-Cohen 1989a; 1989b; Byrd 2005b; Cauvin 2000, 22-33). The PPNA is characterised by the aggregation of people into larger groups, shifting settlement located at higher elevations with easier access to water, and carrying out plant cultivation without a complete dependence on rainfall (Bar-Yosef 1991, 2001a; Byrd 2005b). During the PPNA we also see an intensification of the use of annual plants and the archaeobotanical remains reveal a varied diet, with cereals being important, especially barley in the south and wheat elsewhere (Bar-Yosef 1991; Garrard 1999; Kislev 1992; Wilcox 1996). This is associated with a shift in processing practices from pounding by mortars and pestles, ideally suited to a diverse nuts and legumes emphasis in the Late Epipaleolithic, to grinding tools such as hand stones and slabs which are much more suited to cereal processing (Wright 1992; 1994; 2000; 2005).

This so-called “early village life” had its later maximum expansion during the Pre-Pottery Neolithic B (PPNB) (ca.8800-6750 cal. BC). During this period, we witness ritual and symbolic elaboration, the addition of managed and herd animals to the village economy over a wide region, substantial population growth, and the appearance of generally larger settlements (Bar-Yosef, 2001b; Byrd 2005). This is also the period of agricultural expansion and the time when complete plant and animal domestication took place, resulting from millennia of intensive wild plant and animal exploitation by reduction of mobility in hunter-gatherer communities (Bar-Yosef & Belfer-Cohen 1989; Cauvin 2000; Colledge 2001; Colledge & Conolly 2007;

Filipović 2012; Fuller *et al*. 2011; Willcox *et al*. 2008; Zeder 2011). These innovations have been considered to be associated with the transition from communal to household food production (e.g. Filipović 2012; Flannery 1972; 2002; Wilk & Netting 1984), whereby the residential household appeared as the fundamental social, economic, and ritual unit of the Neolithic society in Southwest Asia (Hodder 2007; Kuijt 2000). The emergence of the household as the base of the social unit in the community has been also seen as the trigger of the increase in complexity and social organisation (Asouti 2006; Byrd 2005).

Table 3.1. Levantine Neolithic chronology (Weninger et al. 2005)

Levantine Terminology	Chronology Cal. BC	General Trends
Upper Palaeolithic	46,170 - 22,020	Semisedentary foraging
Epipalaeolithic - Early	22,020 - 15,450	
Epipalaeolithic - Middle	15,450 - 12,780	
Epipalaeolithic - Late (Early Natufian)	12,780 - 11,180	
Epipalaeolithic - Late (Late Natufian)	11,180 - 10,040	
PPNA	10,040 - 8940	Pre-domestication cultivation
PPNB - Early	8940 - 8460	Plant domestication
PPNB - Middle	8460 - 7560	Sheep-goat domestication
PPNB - Late	7560 - 6940	Megasites
PPNC	6940 - 6400	Megasites, ceramics in Anatolia and Syria
Late Neolithic	6400 - 5480	Ceramics in South Levant
Chalcolithic	5480 - 4340	Cattle domestication
Early Bronze Age	4340 - 2520	Early use of metals

During the PPNB in Southwest Asia we see the formation of large villages which have been defined by archaeologists as ‘megasites’. These are believed to have been bigger than 10 ha, located in areas reasonably favourable to farming, and including house structures with consistent internal organisation and in-house food storage, food processing and likely preparation features (Byrd 1994, 2005b; Wright 1994; 2000; 2005). These communities most likely represented integrated family groups with shared beliefs and recognised rights to economic resources, such as food or cooking tools (Flannery 1995); various socio-political mechanisms, such as highly organised food production and consumption (Byrd 1994; 2005b), were probably developed in order to guarantee the maintenance of the Neolithic community.

Early PPNB sites in Southwest Asia also reveal a series of transformations in the organisation of living space in comparison with earlier PPNA settlements. While in the PPNA, oval houses were the dominant factor, PPNB 'villages' consisted of relatively large agglomerations of rectangular buildings, with interiors divided into functional spaces or rooms which, in combination with other archaeological evidence, suggests the beginning of a social differentiation between private and public spheres of activity (Wright 1994; 2005). Even though these houses show hints of social inequalities, it is still assumed that they would have accommodated small nuclear families, as was the case during the PPNA (Banning 2003; Byrd 2005a; 2005b). Furthermore, we see a marked shift from communal food sharing within the hunter-gatherer groups to private, house-based storage and consumption in sedentary communities has been recognised based on the decline of communal granaries and frequent occurrence of household storage (Banning 1998; 2003; Byrd 2005a; Flannery 1972; Peltenburg 2004). Additionally, artefacts related to food preparation become less visible and accessible to members of the broader community and are found inside houses and normally associated with individual houses (Wright 2000). The food preparation activities passed then from a communal and social practice to be a more private activity carried out possibly in specific rooms or concrete spaces inside the houses, such as kitchens or side rooms. This "privatization" of cooking and food preparation space also shows a most likely intensification of the variety of prepared foods during the PPNB and after (Wright 2000; 2005). This diversification of foods was also most likely acquired with the addition of the use of ovens (domed and *tandir* ones) from the middle PPNB and the changes in cooking techniques that came with their use (Fuller & González Carretero 2018).

In relation to social complexity, during the PPNB in the Levant and the Upper Euphrates, we start to witness the occurrence of non-domestic public spaces and structures such as bigger and elaborate buildings. Two examples of this new type of structures come from the sites of Beidha (Byrd 1994; 2005a) and 'Ain Ghazal (Rollefson *et al*. 1992). These buildings are significantly larger than normal houses and are often distinct in terms of architecture and associated artefacts (e.g. red-painted walls and floors, plastered floors; internal stone slab monoliths, benches and platforms). Different types of activities were most likely taking place in these new buildings. Very little is known about the nature of these activities, but they are believed to have greatly differed from the typical domestic activities such as food processing and preparation that took place inside the houses. These ‘special’ buildings have been interpreted by archaeologists as ‘shrines’ intended for ritual activities such as ritual commensality or feasting (Hayden 2001). Furthermore, the construction of these non-domestic buildings would have required labour investment from the wider community, which might have resulted in interactions beyond those occurring within a domestic household (Byrd 1994; 2005a). This could be understood as the evidence of some form of socio-political mechanisms for encouraging group integration and cohesion, in which plants and animal foods must have played an important role (Asouti & Fuller 2013; Byrd 2005a, 134).

3.2. The Anatolian Neolithic

3.2.1. Environment and subsistence

The Neolithic in Anatolia was first described by some archaeologists as the first archaeologically documented manifestation of a uniform culture including cultural changes such as the emergence of a global cosmology or religion and shared material cultures and at the same time also revealing strong regional characteristics (Bar-Yosef & Belfer-Cohen 1989; Bar-Yosef & Meadow 1995; Cauvin 2000). However, other authors have argued the idea of the Neolithic in Anatolia being much more culturally diverse, pointing out a higher level of regionalism in relation to settlement patterns, architecture, subsistence practices, ritual expression and socio-political organization (Asouti 2005a; 2007; Cutting 2005; Rollefson 2004) (Figure 3.2.).

In this sense, we find that there have been many different ways in which the Anatolian cultural regions have been studied. In 1991, Yakar proposed the division of Anatolia in six different regions in relation to environment and Mesolithic and Neolithic settlement patterns: Eastern Anatolia, Southeast Anatolia, the Eastern Mediterranean, Southern Anatolia (Konya Plain), the Lakes District and the Eastern Thrace. Some years later, a clearer division of Anatolia was proposed by Harmankaya *et al*. (1996) with the recognition of two regions, Central and Southwest Anatolia. Central Anatolia was also divided into two different regions, the Konya Plain and the Cappadocian highlands (Cutting 2004; 2005; Gerard & Thissen 2002, 85). This sub-division has been linked to the different environments and subsistence strategies derived from them. In general, from 8,000 cal. BC we see an increase in yearly temperatures and precipitation which influenced a change in vegetation with deciduous trees being replaced by the herb-steppe (Kuzucuoglu 2002, 37). More specifically, in Central Anatolia, we see that in Cappadocia, there was a clear improvement in climatic conditions, with a rise in rainfall around 7,600 cal. BC (Kuzucuoglu 2002, 34) while in the Konya Plain the increase in precipitation and the climatic change into a wetter environment was rather gradual and slow, reaching the 'optimum climatic conditions' by 6,000 cal. BC. In this sense, Kuzucuoglu (2002) has also shown differences in subsistence strategies in relation to the climatic conditions and environment of these regions. The Konya Plain is influenced by alluvial fans that would have been extremely favourable for agricultural practices, while the highland plateau of Cappadocia would have been generally more suitable for pastoralist communities. This new mid Holocene vegetation environments have been also seen as "semi-natural" ecosystems (Hunter 1996) that were shaped by people's activities from hunting and foraging to herding and cultivation (Asouti & Kabukcu 2014).

Figure 3.2. Map of the Anatolian Neolithic showing the location of the main archaeological sites in the area.

Most recently, Kabukcu (2018) showed the importance of early development woodlands following a warming climatic period in Central Anatolia, with the introduction of trees such as *Juniperus, Amygdalus* and *Pistacia* into the region from a very early stage. At the start of the Holocene, we see the establishment of the typical semi-arid tree taxa such as *Quercus, Juniperus*, *Amygdalus*, *Pistacia*, Maloideae and *Prunus*. During the early stages of the

Neolithic in Anatolia and the establishment of the first agropastoral economies the availability of these woodland areas in close proximity to the sites likely influenced the choice of location for permanent settlements.

The Anatolian Neolithic represents the latest expression of the so-called 'Neolithic way of life' or 'Neolithic package' in Southwest Asia. Cereal agriculture developed in the Levantine corridor during the early 10th millennium BC and spread through northern Levant, southern Anatolia and Cyprus becoming fully established in Central Anatolia during the first half of the 8th millennium BC (Colledge *et al*. 2004); by which time the major crops of Southwest Asia were domesticated in botanical terms (Fuller *et al.* 2018). Many are the studies on the appearance of agriculture and animal herding which demonstrate that plant and animal domestication occurred at the same time in the northern Fertile Crescent, and happened over multiple geographic regions including the Levant, as well as Southeast Turkey (Asouti & Fuller 2012; 2013; Fuller *et al*. 2011; Willcox 2002; Zeder 2008; 2011). Recent research on early agricultural systems in Central Anatolia have shown the importance of the combination of animal herding and management with the development of agriculture in this area (Filipović 2012; Baird *et al.* 2018; Ergun *et al.* 2018). Latest data from the sites of Aşıklı Höyük, Pınarbaşı and Boncuklu Höyük show evidence for an initial reliance on wild plant foods such as nuts and fruits as seen for Pınarbaşı (Fairbairn *et al.* 2013) and a later indigenous use of domesticated cereals, including emmer (*Triticum dicoccum*) and new type glume wheat (*Triticum* cf. *temopheevi*) in combination with the use of wild resources and animal herding (Baird *et al.* 2018; Ergun *et al.* 2018). The adoption of domesticated crops arriving to the indigenous community at Boncuklu Höyük most likely by trade (Baird *et al*. 2018; Jones et al. 2019), differs considerably from what it seems to be a potential process of domestication of cereal and pulses happening within the Aşıklı Höyük (Ergun *et al*. 2018). In both cases, however, wild plant resources for the major part of the archaeobotanical assemblage, and therefore were likely to constitute the most part of people's diet.

It was first suggested that the ideal settlement pattern for intensive farming in Central Anatolia is the one with dispersed farmsteads surrounded by cultivation plots (Bogaard & Isaakidou 2010; Filipović 2012). In this sense, cultivation plots could have supplied forage and fodder for the animals, while herding can make different manure available which improves soil fertility, tractability and regulates crop growth (Bogaard 2004a; Bogaard & Isaakidou 2010; Filipović 2012). This has been said to be the most likely scenario at Neolithic Çatalhöyük, where houses were being settled on top of earlier ones forming agglomerated mounds and the arable land located within a reasonably short distance (<5 km) from the settlement. This could have provided a sensibly high number of crops, enough to support the growing population through the Neolithic Çatalhöyük sequence (Asouti 2005a; 2006; Baird 2002). Central Anatolia and Çatalhöyük are also in the centre of the distribution of four of the major animals which were first domesticated during the Holocene (Martin *et al*. 2002). Although it has been difficult to reveal when and which animals were first domesticated during the Neolithic in Central Anatolia, new data from Çatalhöyük has started to clarify this matter. While there is evidence of domesticated sheep and goat in the Çatalhöyük archaeological record already from 7,000 cal. BC, domesticated cattle do not appear until the Late Neolithic levels (Russell *et al*. 2013). Dental microwear and oxygen isotope analyses have also suggested seasonal sheep herding at a short distance from the site (i.e. still on the alluvial fan), as well as moderate shifts in herding practices through time (Henton 2013; Russell *et al*. 2013). This was also the case for Boncuklu Höyük and Aşıklı Höyük, where herds of managed and selected sheep and goat were kept nearby the settlement and inside it, as attested by the accumulations of dung and urine salts in the soils in midden areas (Abell *et al.* 2019; García-Suárez *et al.* 2018; Middleton 2018).

Although little is known about the plant cultivation strategies for sites like Boncuklu Höyük or Aşıklı Höyük so far as both archaeobotanical assemblages and site formation processes are still under investigation, subsistence strategies seem to have relied on a combination of the adoption of domesticated crops and a slow process on plant domestication together with the gradual addition of animal management and herding. This made possible that the first 'Neolithic villages' continued relying on wild resources for a significant part of their subsistence at least until the beginning of the Chalcolithic period. This has been evidenced by the high number of archaeological remains of wild flora and fauna recovered from the main Neolithic sites in Anatolia, such as Boncuklu Höyük and Aşıklı Höyük, where the wild plant resources represent the majority of the botanical assemblages recovered from the sites (Baird *et al.* 2018; Ergun *et al.* 2018). This is also the case for Neolithic Çatalhöyük where the community based their subsistence not only the cultivated crop package formed by barley, wheats and pulses, but also on a variety of wild fruits and nuts (almonds, pistachios, acorns and possibly sedge tubers) and a wild mustard as oily seed (*Descurainia sophia*) (Bogaard *et al.* 2013; Fairbairn *et al.* 2007). In addition to this, a high number of species of wild fish and birds among other wild animals have been identified in the record, making clear the archaeological importance of wild resources for these early farming communities (Russell *et al.* 2013).

3.2.2. Settlement and social complexity

The origin of the Central Anatolian Neolithic is a topic which has been widely discussed during the last decades in archaeology. Central Anatolian archaeology of the Upper Palaeolithic is still very poorly known and the Epipalaeolithic period (ca.15,000-9000 cal. BC) has not yielded many archaeological sites in the region besides the site of Pınarbaşı excavated by Baird (2012) and a number of cave sites situated along the Mediterranean coastal line in the Antalya and Hatay regions (Özdoğan & Başgelen 1999, 226). This was long interpreted as an absence of occupation of Anatolia before the Neolithic period which was gradually colonised or acculturated by communities from the northern Levant coming into the Anatolian territory (Özdoğan & Başgelen 1999, 225-236). This interpretation was however questioned by other authors who have seen clear indigenous predecessors in the Neolithic material culture of Anatolia, such as the construction with mudbricks at Aşıklı Höyük and Çatalhöyük which could have had its origin in the small Mesolithic sites in the area (Baird 2002). Also, the early occupation of Cyprus from 9825 cal. BC onwards (Lucas 2012; Lucas *et al*. 2012), suggested that the main near eastern land (including Anatolia) was most likely occupied at least from the beginning of the 11th millennium BC. This has been proposed mainly in the basis of striking similarities between the main land and Cyprus, especially the northern and southern Levant areas from sites like Jerf el Ahmar, Abu Hureyra or Jericho (Colledge *et al*. 2004; Lucas 2012, 51; Peltenburg 2003; Simmons 2007). New evidence which contributes to this argument comes from the site of Pınarbaşı, a site located in the southern edge of the Konya Plain. The site was first occupied by ca.13,000 BC by a mobile group most likely coming from the northern Levant area based on the similarities in lithic technology, artistic representation, rituals and crafts found at the site (Baird *et al.* 2013a).

As it has been suggested earlier in this document, the terminology and categories used to characterise the Neolithic in the Levant do not seem to be useful to describe the Central Anatolian Neolithic. The majority of these terms, such as PPNA and PPNB in the Levant, express very marked characteristics which represent a very specific character of the Levantine Neolithic and using these terms for Anatolia would mean that all the sites on each Anatolian region present all and each of those. Anatolia's polycentric character and regional cultural variability is essential for the understanding of the archaeological record.

The Neolithic terminology created by Özbasaran & Buitenheis (2002) for Central Anatolia (Table 3.3.) spans from the Younger Dryas to beginnings of the 4th millennium cal. BC. In general terms, ECA II (ca.8000-7500 cal. BC) and ECA III (ca.7500-6000 cal. BC) archaeological sites show equivalent characteristics to the PPNA and PPNB sites in the Levant. During this time, Central Anatolia experiences a shift from foraging to farming with a full establishment of production of domesticated plant and animal resources during the ECA III. Development of large Neolithic villages like those of the Levant during the late PPNA and early PPNB also occurs in Central Anatolia at the beginning of the 9th millennium BC and it peaks at the beginning of the 7th millennium BC. This can be seen at sites like Pınarbaşı, Boncuklu Höyük, Aşıklı Höyük and Çatalhöyük East which was abandoned at the end of the 7th millennium BC.

Table 3.2. Central Anatolian chronology based on Özbaşaran & Buitenheis (2002).

ECA terminology – cal. BC	Main Anatolian Sites	Trends (regionally variable)
ECA I: 12,000–9000	Pınarbaşı	Semisedentary foraging
ECA II: 9000–7000	Pınarbaşı Asikli Höyük Can Hassan III Boncuklu Höyük	Plant early domestication, sheep/goat early domestication, megasites
ECA III: 7000–6000	Catalhöyük East	Megasites, fully domesticated agriculture, farming, pottery

During the ECA II period, the subsistence pattern depends on hunting and gathering as seen at Pınarbaşı by ca.9000 cal. BC (Fairbairn *et al.* 2014), although there is firm evidence of early food production, in particular wild crops under pre-domestication cultivation and early evidence of morphological domestication, from the site of Aşıklı Höyük in the Cappadocian area of Central Anatolia (Ergun *et al.* 2018; Van Zeist & De Roller 1995), Boncuklu Höyük (Baird *et al.* 2018; Fairbairn *et al.* 2014) by ca.8000 cal. BC. At the same time, although there is no clear evidence of animal domestication in this period, at Boncuklu Höyük and Aşıklı Höyük by ca.8500-7500 cal. BC there is evidence for a clear age selection of sheep and goat which suggests the possibility of management and control over these animals (Baird *et al.* 2018; Buitenhuis 1997). The significant reduction in size of Anatolian sheep and goats in comparison with their wild relatives suggests that the management and selection were most likely intensified by the mid-ninth millennium cal. BC (Peters *et al.* 2017). In addition, recent evidence of accumulation of dung and urine salts in the soil deposits in the middens between houses at Aşıklı Höyük suggests that animals were kept in captivity and adds to the idea of an early animal management at the site (Abell *et al.* 2019; Stiner *et al*. 2014). Considering all these aspects we can suggest a certain degree of sedentism, with stable occupation for a reasonably long period. This has been seen also in relation to the settlement pattern, with rectangular domestic buildings (houses) which have been constructed using mudbricks to build walls which were after plastered. Floors were made of loose material which was compacted and then plastered with pure clay like that used for the walls (Cutting 2005). No special buildings or buildings for specific functions have been found in central Anatolia during this period, however we see evidence for the construction of buildings which possibly had a more specific purpose at Aşıklı Höyük. These buildings were not only bigger in size but also, they had their floors plastered and painted in red (Esin & Harmankaya 1999).

In relation to how foods were prepared and cooked, oven type features are not present at these sites between 9000-7200 cal. BC in Central Anatolia, but they will be highly visible in the archaeological record during later Neolithic periods (Fuller & González Carretero forthcoming*;* Fuller & González Carretero 2018). The cooking facilities were dominated by different types of hearths, normally in a circular and in some cases slight quadrangular shape and located inside the houses with no clear specific orientation. At Boncuklu Höyük and Aşıklı Höyük we see evidence of buildings with and without hearths which differ in size, those with no hearths being slightly bigger (Baird *et al.* 2012; Cutting 2005, 41). Very interesting is also the discovery at Aşıklı Höyük of two hearths which had higher walls instead of the standard clay rims; but so far, no study of these features has been undertaken and they should probably be more clearly interpreted as evocative of later *tandir* type ovens. In relation to grinding stones, during the ECA II, we see a focus on the use of basalt and andesite mortars and pestles during this time. Also, there is an increase through time in the recovery of grinding stones from Central Anatolian sites during this period, as well as an increase in size of some of these such as those recovered from Aşıklı Höyük which weighed up to 10kg (Esin & Harmankaya 1999). This, together with the appearance of ovens around 7100 BC in Central Anatolia, could possibly be interpreted as a transition from the consumption of wild foods, such as nuts, fruits and wild grasses and pulses which are more suited for the processing in stone tools like mortars to the focus in consumption of domesticated cereals and pulses in high quantity which were processed to flour by milling and grinding.

This establishment of cereals and pulses as the staple food in most of the Neolithic communities will become more visible from 7000 BC onwards. During the ECA III (7200-6000 cal. BC) the production of food becomes clear with evidence of common domesticated plant and animal taxa. This period also sees the introduction of a new type of cooking technology: the use of pottery. The emergence of pottery during this period in Central Anatolia, not only shows the ability to manipulate and transform clay into material culture but also it implies a key cultural change in the Neolithic communities, in terms of the form and diversity of food preparation methods. The construction and use of ovens also show that the raw materials (clay/mud) and the knowledge of processing and transforming them (firing) needed for the production of pottery were not unknown for the pre-pottery Neolithic communities in Anatolia and the wider Near East. However, it will be from the beginning of the 7th millennium that pottery becomes visible in the archaeological record. Hence, the use of pottery does not emerge in Southwest Asia until millennia after the beginning of cereal cultivation and by then, plant domestication and animal herding are completely established (Fuller & Rowlands 2011; Moore 1995). The earliest evidence for the production of rudimentary pottery in Anatolia comes from the site of Boncuklu Höyük dating to the late ninth millennium cal. BC (Spartaro *et al*. 2017) and Çatalhöyük East, where some sherds were found in the earlier levels of excavation by 7100 cal. BC (Mellaart Level XII). These sherds have been interpreted to be pieces of serving bowls or plates not directly connected with the cooking of foods. Despite the early presence of pottery, it does not appear to have been commonly used in cooking and may initially have been for certain kinds of serving. It is not until the second half of the 7th millennium when we have evidence for the use of ceramic vessels for cooking purposes at Çatalhöyük and the rest of Anatolia. This will mean a clear "revolution" in terms of cooking and food processing techniques which will be deeply entangled with cognitive and cultural changes in these Neolithic societies (Hodder 2012).

3.3. Central Zagros area: environment, subsistence and social complexity

As happens with the Anatolian Neolithic, the well-established Neolithic chronology for the Levant is not easily extrapolated to the Zagros area. This is mainly due to the differences in material culture present in this area and to the fewer excavated and studied sites since the 1970s. Matthews *et al.* (2013; 2016) established a simplified and revised chronology for the area which is summarised in table (3.4.).

Table 3.3. Chronology for the Central Zagros Area (after Mathews *et al.* 2013; 2016).

Neolithic phase Zagros	Date cal. BC	Duration in years
Epipalaeolithic	12,000-9600	2400
Early Pre-pottery Neolithic	9600-7000	2600
Late Neolithic	7000-5500	1500

The Zagros region of Iran and Iraq is an area of great mountains which extends from Azerbaijan to the Persian Gulf in the South-East. The mountains are incised by rivers, in their majority flowing to the Tigris. Nowadays, the climatic diversity is very high between different areas of the Zagros region.

For the area of Iraqi Kurdistan, where the site of Jarmo is located, the nearest existing interpretations of the past environment are lake cores coming from Lake Zeribar and Mirabad. These suggest that the environment at the start of the Holocene included mainly a combination of grasslands and pistachio and almond trees in the Zagros region (Van Zeist 2008; Wasylikowa & Witkowski 2008).

3.3.1. Palaeolithic and Epipalaeolithic occupation of the Zagros

Population of this area are indicated by the presence of Neanderthal and human communities from 150,000 BC until the present. During the Middle Palaeolithic (100.000-40.000 BC) we see the reliance on goat hunting in the area (Matthews *et al.* 2013) with the increase of male goats being brought to the occupation sites like seen from Shanidar Cave (Trinkaus 1983). Between 40.000-20.000 we have rich evidence of the presence of communities in the Zagros region, now recognised to be anatomically modern humans, as the next occupation sequence from Shanidar cave shows. The anatomically modern humans who occupied this area continued basing their economy mainly in the hunting of goats (Olszewski 1999).

During the Epipalaeolithic in the Zagros region, from ca. 15,000 BC onwards, we see the broadening of the diet, with also other different types of material culture being found at the sites. Especially important is the recovery in great numbers of ground stone tools (present in the area by ca. 35,000 BC) which most likely had multiple uses such as the processing of pigments or the processing of plant foods such as nuts, fruits and grasses (Matthews *et al.* 2013). Examples of the diet expanding come from Shanidar Cave, level B2 dated to ca. 11,000 BC, where there is evidence for the consumption of snails in high quantity. Similarly, from

Zarzi rock shelter where gazelle, birds, fish and other water resources like shellfish, whose remains have been widely found at the site (Matthews 2000; Wahida 1981).

3.3.2. The Neolithic occupation of the Zagros

The early Neolithic in the Zagros is not very well understood due to the unstable political situation in recent decades. A great part of the information known about the Neolithic in the region comes from the late 1950s - 70s research with investigations led by Robert Braidwood (1960; Braidwood *et al.* 1961; 1983). Braidwood carried out excavations at the site of Jarmo in Iraqi Kurdistan and Asiab and Sarab in western Iran. At the same time, research was also taking place in the southern Zagros, at Ali Kosh (Hole *et al.* 1969), Chogha Bonut (Alizadeh *et al.* 2003) and Chogha Sefid (Hole 1977). Our knowledge of the Neolithic period was then further increased by excavation at the sites of Ganj Dareh (Smith 1976) and Abdul Hosein (Pullar 1990) in the Central Zagros. Subsequent geopolitical factors led to the interruption of fieldwork in this region from 1979 onwards and attention consequently shifted westwards, with the Levantine region and later the northern Fertile Crescent.

Despite the unstable situation in the region, some excavations and archaeological research was carried out at the sites of Sheikh-e Abad and Jani (Matthews 2013). Both sites show the establishment of early Neolithic settlements which depended on varied subsistence practices including the hunting of wild goat/sheep. There is also some indication that people at these sites carried out some type of agricultural practices in which cereals could have been the main cultivar. In addition, there is good evidence of the use of wild plant foods in these sites such as nuts (almonds and pistachios) and pulses (mainly lentils) (Matthews *et al.* 2013).

Recent archaeobotanical evidence recovered from the aceramic Neolithic sites of Chia Sabz and Choghan Golan, show pre-domestication cultivation of barley (*Hordeum spontaneum*) and emmer wheat (*Triticum dicoccum*) by the late ninth millennium (Rhiel *et al.* 2012; Weide *et al.* 2018). These argue against previous proposals that cereal cultivation was introduced from the Levant and other areas in Southwest Asia into the Zagros region, based on fully domesticated cereals (Bar-Yosef 1998). In addition, the totality of the wild package of the later Neolithic crop package was used at these two sites, including lentil (*Lens culinaris*), grass pea (*Lathyrus sativus*) and bitter vetch (*Vicia ervilia*) (Riehl *et al.* 2012).

These early Neolithic sites represent some of the first seasonal settlements of the Zagros region and give us valuable information about social complexity at the time. Despite showing a stable occupation and continuous exploitation of food resources, they seem to represent seasonal settlements which differ from the later Neolithic villages which people established near fresh water sources. In this sense, a number of architectural features were recovered from Chia Sabz; these structures, thought to represent seasonal houses, were built of dry-stone walls and hearths or fire places were rarely found. The floors of these houses were not plastered, like we see later in this area and in the wider Near East, but they were paved or covered by sand (Darabi *et al.* 2013). In contrast, at the site of Sheikh-e Abad, houses were built using walls made of *pisé* (Matthews *et al.* 2010) which indicated the use of locally available materials for the construction of the houses instead of a regional cultural pattern.

A number of features, which most likely represent food preparation tools and cooking facilities, have been found at these early Neolithic sites in the Zagros area. Hearths and fire spots, although not recovered in great numbers, are present indoors and outdoors. Also, ground stone tools such as querns, pounders and mortars were recovered from Chia Sabz, Choghan Golan and Sheikh-e Abad most likely used for processing of plant foodstuffs such as wild cereals and nuts among other possible uses. In connection to this, stone vessels and lithic and chipped stone tools were found in association, shedding light on food processing activities and food preparation at the sites (Darabi *et al.* 2013; Matthews *et al.* 2010; Riehl *et al.* 2013).

New evidence from the Pre-Pottery Neolithic period at the Zagros region comes from the work carried out by the Central Zagros Project from the University of Reading, UK at the Neolithic sites of Bestansur and Shimshara in Iraqi Kurdistan. The site of Bestansur is located near the city of Sulaimaniyha at the western edge of the Shahrizor Plain and has an occupation which spans from ca.9000 to 5300 cal. BC (Matthews *et al.* 2016). The architecture is comprised of structures which resemble houses made of mudbrick and *pisé* with plastered walls and floors. Although some evidence of the use of ceramics has been recovered from the site, stone tools have been found in great numbers and constitute almost the totality of the assemblage. In addition, cooking installations such as ovens and hearths have been recovered from Bestansur which show evidence of continuous use through time for food preparation (Whitlam 2015). Domesticated sheep/goat and pulses represent the majority of the animal and plant assemblage at the site although there is also evidence of the use of cereals, in particular glume wheats such as emmer (*Triticum dicoccum*) and new type wheat and barley (*Hordeum vulgare* var. *nudum*) (*Ibidem*).

The site of Shimshara is located in the Rania Plain and has been radiocarbon dated to ca.7300-7200 cal. BC. The structures at this site are not as well preserved as those seen at Bestansur but the stone tool assemblage shows similarities as well as the animal and plant records (Matthews *et al.* 2016).

Some evidence from the Late Neolithic in the area comes from the sites of At-Khaleshe (Iran) and Tepe Marani (Iraqi Kurdistan). At-Khaleshe is situated on a fertile alluvial plain of the Abharrud Basin ca.300m southwest of Khorram Dareh city, in the Zanjan province of north-western Iran. Khaleseh represents a Later Neolithic single-period site dating to ca.6000 – 5500 BC based on the ceramic culture recovered. All of the buildings excavated at Khaleseh are rectilinear and follow a northwest - southeast orientation. Their walls are constructed from mudbrick or *pisé* and are approximately 50 – 70cm thick, with surfaces covered by a plaster of mud and straw. A range of fire installations such as fireplaces and ovens attest to activities relating to cooking and craft activities across the site. However only a few ground stone tools, such as mortars or querns for the processing of foodstuffs, have been recovered from the site. Sheep/goat, pulses and cereals are present in great numbers at the site and constitute most of the food assemblage (Whitlam 2015). Amongst the cereals, naked barley is the most ubiquitous crops (*Hordeum vulgare* var. *nudum*), followed by glume wheat species (*Triticum monococcum/dicoccum*/new-type) and then free-threshing wheat (*Triticum aestivum/durum*). For the pulses, lentil (*Lens culinaris*) is the most recovered crop at the site followed by vetch (*Vicia* sp.) and grass pea (*Lathyrus* sp.) (*idem*.).

Tepe Marani in Iraqi Kurdistan provides additional information of the Late Pottery Neolithic in the region of the Shahrizor Plain. This site has yielded a large amount of Late Neolithic Pottery (Halaf period) which has contributed to its phasing. No architectural features have been found at Tepe Marani but radiocarbon dates of seeds from a series of midden deposits have provided more accurate information about the specific levels of the site, having dated the Neolithic Levels back to 5480–5230 cal. B.C (Wengrow *et al.* 2016). In terms of the economy at the site of Tepe Marani, the majority of the animal remains can be attributed to sheep/goat and the plant assemblage is dominated by pulses (in particular lentil), followed by cereals, such as emmer wheat and barley. There is also presence of flax seeds (*Linum ussitatissimum*) which could have been used as oil-seed or for its fibres. In addition, from Tepe Marani we have food fragments, similar to those analysed for this thesis (*ibidem*). These have provided extremely important information about food preparation and cooking practices by the 6^{th} millennium BC in Iraqi Kurdistan and will be used for comparison with those yielded from the site of Jarmo, considered for this thesis (*ibidem*).

3.4. Summary

Southwest Asia constitutes one of the main core areas of domestication of plants and animals. In this area we also see the addition of the use of pottery vessels for cooking purposes since very early on, at the end of the PPNB, around ca.7000-6500 cal. BC. The Neolithic way of life, with sedentary societies which relied on domesticated crops and animals, will develop at different times in different areas of the wider southwestern Asian territory with Anatolia and the Zagros as the later additions. Cereal-based products, such as bread-like products are believed to have been consumed as part of daily life from very early on as attested by the earliest evidence of bread recovered to date, from the Natufian site of Shubayqa I in Jordan.

Chapter 4

Case studies: The sites of Çatalhöyük and Jarmo

Figure 4.1. Map of the study area showing the location of Çatalhöyük East and Jarmo.

4.1. Neolithic Çatalhöyük (Turkey)

4.1.1. Location and chronology of the site

Neolithic Çatalhöyük is a 9,000-year-old Tell site in South-central Anatolia (32:49:41 N, 37:40:01 E) which had a long and continuous occupation from 7100-5950 cal. BC (Bayliss *et al.* 2015; Marciniak *et al.* 2015a) and spans the introduction of ceramics and, in the later levels, the addition of domesticated cattle and use of secondary animal products (Orton *et al.* 2018). A variety of domed ovens (*firin*) and open hearths have been identified at Çatalhöyük East dating from the late 8th millennium and preceding the use of ceramics as cooking vessels. Çatalhöyük has also been extensively sampled for archaeobotanical remains and produced rich and well-preserved plant assemblages (Bogaard *et al.* 2013; Bogaard *et al.* 2017; Fairbairn *et al.* 2005).

After its discovery in 1957, Çatalhöyük was excavated by James Mellaart and his team from 1961 to 1965. After Mellaart's final year, the site was left for almost 30 years until renewed excavations (The Çatalhöyük Research Project) began in 1993 under the supervision of Prof.

Ian Hodder from Stanford University and recently concluded in 2017. The site is divided in two different archaeological mounds, the East Neolithic Mound and the Chalcolithic West Mound which is believed to represent the continuation of the occupation (Orton *et al.* 2018). As part of the Çatalhöyük Research Project, my doctoral research focuses on material from the extensive occupation of the East Mound. As a result of the recent 20 years of excavation and research, Çatalhöyük is presently the most completely studied, detailed record of Neolithic households in Southwest Asia. Çatalhöyük is considered to represent a house-based egalitarian society in which every house in this Neolithic village a similar role and function in routine activities such as daily food processing and food preparation (Hodder 2005; 2006; 2007; 2013). No evident differences have yet been identified among houses in terms of food preparations and cooking during the Neolithic period at Çatalhöyük. However, signs of household-level specialisation in relation to crafts and tools have been very recently suggested (Wright 2014).

Çatalhöyük East Mound is one of the biggest archaeological sites in Anatolia (almost 13ha) and it is formed by two smaller mounds and targeted excavation areas: South and North, with the South one representing the larger and older occupation sequence from 7100 cal. BC to ca. 6500 cal. BC (Bayliss *et al.* 2015). The North mound has an occupation which spans from ca.6500 cal. BC to 6000 BC and in the Middle levels its occupation is contemporary to that of the South mound. In addition, the TPC area, located between the two mounds towards the north area of the South mound, has been excavated during the last years by a team from Poznan University and it represents a separate area of excavation itself (Marciniak *et al.* 2015a; 2015b). This area has the latest levels of the site, comprising the late Neolithic occupation and was intended as a connection area between North and South mounds. From 2015, a smaller excavation area was opened to re-evaluate the area between Mellaart's trenches A and B (Barański *et al.* 2015a) (Figure 4.2.).

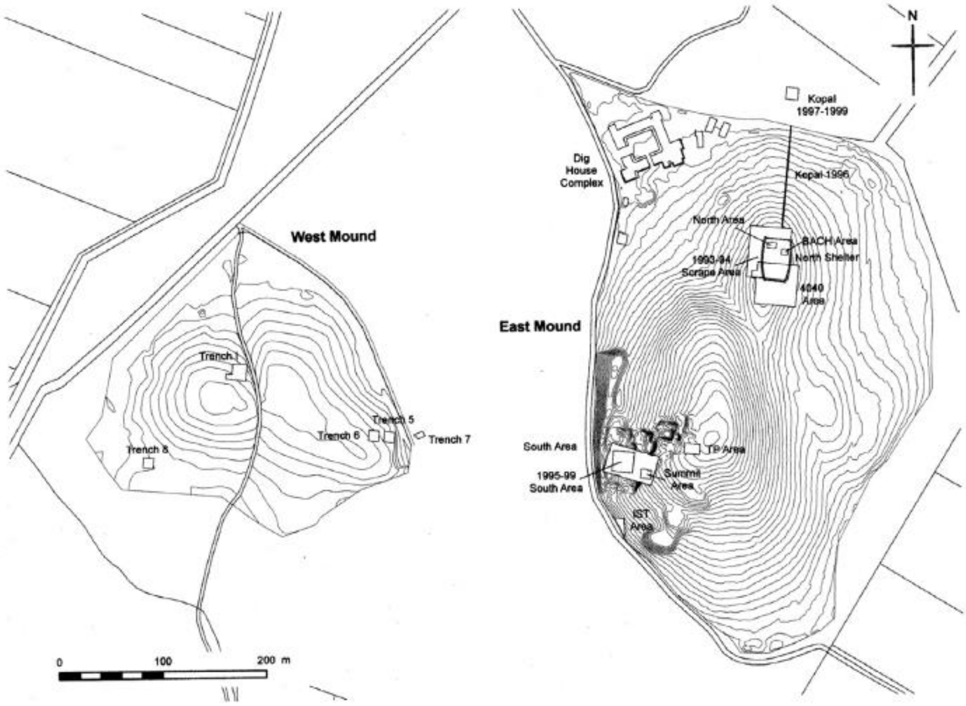


Figure 4.2. Topographic site plan of Çatalhöyük showing excavated areas.

One of the main aims of the Çatalhöyük Research Project directed by Prof. Ian Hodder has been the establishment of a chronology for the occupation of the East Mound. The first attempt to date Çatalhöyük was in the mid-sixties by Mellaart's team with 27 radiocarbon dates on bulk samples of charred seeds and charcoal being attained (Stuckenrath & Lawn 1969; Stuckenrath & Ralph 1965). These dates were interpreted as a series, considering the relative sequence of building levels and the duration of their occupation implied by plaster layers counts (Mellaart 1967, 49-53).

A new model for dating Çatalhöyük proposed by Alex Bayliss, was initiated in 2006 and it is in use until the moment of writing. The new model of radiocarbon dating for Çatalhöyük East was based on the Bayesian statistical model (see Bayliss *et al.* 2015), which allowed the site's chronology to be estimated, using an explicit statistical methodology, from both the radiocarbon dates and the buildings sequence revealed by archaeological excavation. This new model had the objective to provide precise dating for a complete section through the East Mound, with specific interest in establishing a clear chronology of the later Neolithic deposits represented in the TPC Area and the long stratigraphic sequence through the South Area (Bayliss *et al.* 2015). For this, 41 radiocarbon dates were obtained from the deep sounding sequence in the South Area in addition to five radiocarbon dates from the overlying B.23 and

B.18 (equivalent to Mellaart's Shrines E.X.1 and E.X.8, which have bonded walls), and two radiocarbon dates from core samples taking from the deep sounding through Mellaart's excavations in 1994. The results of this model provided an early date of 7100 cal. BC for the earliest occupation of the East Mound at Çatalhöyük and a date of 5950 cal. BC for the latest Neolithic levels from the TP area (See Table 4.1 for more details).

Table 4.1. Çatalhöyük East chronology based on Bayliss *et al.* 2015 and added new phases after I. Hodder (*pers. comm.* 2019)

<table>
<tr><td>Final</td><td>TP.O-R and TPC Trenches 1 and 2 (B109 and 115)</td><td></td><td>6300-5950 BC</td></tr>
<tr><td rowspan="6">Late</td><td>GDN</td><td rowspan="6">North.H,I,J and IST</td><td rowspan="6">6500-6300 BC</td></tr>
<tr><td>South.T. TP.N. TPC B110 and B150</td></tr>
<tr><td>South.S. TP.M. TPC B150 and B122</td></tr>
<tr><td>South.R</td></tr>
<tr><td>South.Q</td></tr>
<tr><td>South.P</td></tr>
<tr><td rowspan="3">Middle</td><td>South.O</td><td rowspan="3">North.F,G</td><td rowspan="3">6700-6500 BC</td></tr>
<tr><td>South.N</td></tr>
<tr><td>South.M</td></tr>
<tr><td rowspan="6">Early</td><td>South.L</td><td rowspan="6"></td><td rowspan="6">7100-6700 BC</td></tr>
<tr><td>South.K</td></tr>
<tr><td>South.J</td></tr>
<tr><td>South.I</td></tr>
<tr><td>South.H</td></tr>
<tr><td>South.G</td></tr>
</table>

4.1.2. Environmental reconstruction around Neolithic Çatalhöyük

4.1.2.1. Present day environment of the Konya plain

The Konya plain, where Çatalhöyük is situated, is located in the southern part of Central Anatolia, and it is bordered by the volcanic region of Cappadocia to the East and the Lake District in the highlands to the west (Kuzucuoğlu 2002). The landscape of Central Anatolia is varied due to differences in altitude and latitude and can be generally categorised in three general environmental zones: wetlands, highlands, and lacustrine and alluvial plains (Kuzucuoğlu 2002, 39-40).

Figure 4.3. View of the Konya Plain with East Mound, June 2017 (Photo by LGC).

The Konya plain is part of the semi-arid area of central Anatolia and its climate is characterised hot dry summers with up to a three-month period of drought in some years. The mean temperatures are normally above 22˚C with a maximum above 35˚C. In winter, temperatures are cold with average temperatures around 0˚C. The annual precipitation is on average very low and it normally occurs principally in winter and spring, rarely exceeding the 300-350 mm (Leng *et al.* 1999; Taha *et al.* 1981). In contrast, the mountains bordering the plain (the watershed catchment area) receive up to 1000 mm of precipitation per year and levels of humidity are high (Driessen 1970; Rosen & Roberts 2005). As the main body of water, the Çarşamba River flows from the uplands to the southlands of the Konya plain and splits into three branches further to the northern area. The Çarşamba alluvial extends approximately ca. 474 km² (Roberts 1995) and the town of Çumra (ca. 10 km to the south from Çatalhöyük) lies in its centre. At the moment, the Çarşamba fan represents the main agricultural area in the Konya basin (Driessen & de Meester 1969, 2), with agricultural fields being principally used for growing cereals, pulses and vegetables, in addition to sporadic isolated oaks stands (Asouti & Hather 2001; Driessen & de Meester 1969; Kuzucuoğlu 2002; Roberts *et al.* 2016).

In relation to its present-day vegetation, the Konya plain as part of Central Anatolia belongs to the floristic Irano-Anatolian province of the Irano-Turanian region (Zohary 1973, 88). As mentioned above, this climatic zone is characterised by a continental climate, with extreme changes in temperature from winter to summer months and very low precipitation. The very low humidity of the Konya benefits the growth of herbaceous flora and delays the growth of evergreen trees and shrubs. In this sense, the predominant vegetation is steppe, with species of the genus *Artemisia* as the main vegetation, accompanied by several species of *Stipa* and *Astragalus,* as well as taxa such as *Euphorbia,* wild *Linum, Phlomis, Poa,* and *Teucrium*. Reeds, rushes and sedges are common in marshlands and nearby bodies of water, while trees and scrubs concentrate around the where juniper, oak and hackberry trees occur, depending on different altitudes (Asouti 2005b; Asouti & Hather 2001; Davis *et al.* 1965-2000; Hillman 2000a; Kuzucuoğlu 2002; Zohary 1973) (Figure 4.3.).

4.1.2.2. Early Holocene environment of Central Anatolia and the Konya plain

Climate and environment have played an essential role in the archaeological interpretation of Çatalhöyük. Today, the site is situated in an area which is characterised as having a continental climate marked by cold winters and dry hot summers. The paleoenvironmental reconstruction of the area around the site is a topic which has been widely discussed and it has been central to the dialogue of a number of subjects such as agriculture and resources procurement. During the Neolithic occupation, between 7000 BC to 5500 cal. BC, the climate was considerably wetter with alluvial fans that could have started to accumulate around 7500 cal. BC (Hodder 2006). These specific climate conditions are directly related to the available resources on which the population of Çatalhöyük relied. At the beginning of the last decade, previous geoarchaeological research characterised the alluvial plain around the site from the Çarsamba River as a seasonally flooded marshy environment (Boyer *et al.* 2006; Roberts *et al.* 1999; Roberts & Rosen 2009). In this regard, it was proposed that agricultural practices had to have been carried out on the foothills and relatively far (12-14km) from the actual site as a result of the adjacent wet marshland being unsuitable for agriculture (Robert & Rosen 2009). However, this idea has been recently challenged by the existence of small elevated areas relatively close to the settlement (5km), where localised agriculture could have taken place (Ayala *et al.* 2017;

Bogaard & Isaakidou 2010; Filipović 2012). New data on this matter is showing also that, although it is clear that intensive gardening immediately around the site was been carried out, there must have been a much wider radius of cultivation with lower intensity maintenance (Green *et al.* 2018).

In relation to this debate, recently published geoarchaeological work carried out by Ayala *et al.* (2017) has been able to demonstrate that the environment around Çatalhöyük was highly variable and that the presence of Dark Clay soils is not stratigraphically constant around the site, as previously suggested. They carried out 29 coring location and sub sequential 3D modelling which has shown the variability of the alluvial landscape in the Konya plain and in particular around the site. They propose that the palaeoenvironmental evolution of the area surrounding the Çatalhöyük East and West mounds, up to the period of their occupation, go through four different phases of change: Phase 1 would have consisted of a period of dominant erosion due to wind and water that created an undulating surface of marl around the site. This was followed by Phase 2 at the end of the Pleistocene and beginning of the Holocene, with increasing wetness and the undulating topography is starting to infill during this time. In Phase 3a, this infilling increase will create a flat surface with fewer pockets of marl or wetter soils. The fluvial regime would have changed from humid to dryland anabranching conditions, which are more concentrated in the west of the study area. This is the earliest period of occupation of the East Mound and this interpretation is more consistent with the archaeological evidence from the site for a combination of both dry and wet conditions. Phase 3b coincides with the shift of occupation to the West Mound, when there is evidence for a localised wetter area to the southeast of the mound, but otherwise a continuation of the dryland anabranching system. Finally, Phase 4 most likely represents a shift to the pre-modern style of fluvial environment, modified by channelization as demonstrated by Boyer (1999) (see Ayala *et al.* 2017) (Figure 4.5.). In relation to the development of agricultural practices at Çatalhöyük East, this new evidence argues against the marshy conditions of the totality of the area around the site during the Neolithic, showing, on the other hand, that the anabranching system would have permitted the cultivation of nearby areas which remained dry.

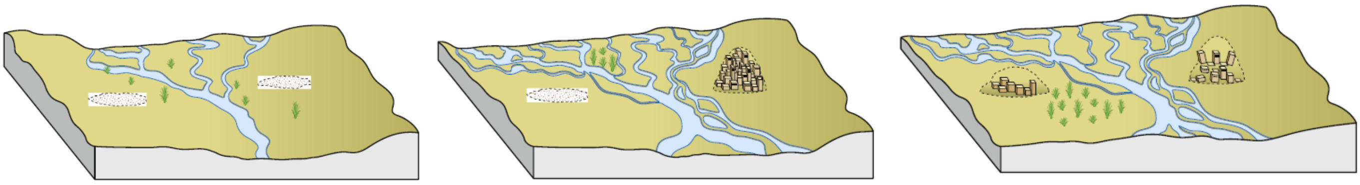


Figure 4.4. Schematics of the landscape-development phases (Ayala *et al.* 2017). Phase 1 (latest Pleistocene and early Holocene with the formation of a humid anabranching channel); Phase 2 (shift to dryland anabranching channel and ultimately occupation of the East Mound); and Phase 3 (continuation of dryland anabranching channel and shift to occupation of the West Mound).

4.1.2.3. Vegetation reconstruction around Çatalhöyük

Çatalhöyük and the vegetation around the site have been widely associated with a wet environment due to the abundant remains of wetland taxa which have been recovered from the archaeological record. The wood and charcoal assemblages show the presence of riparian and marsh vegetation in the nearby geographical area to Çatalhöyük. The wetter areas associated with the anabranching alluvial system around the site would have been an ideal growing environment for wetland grasses, reeds and rushes. In less wet areas riverine forest taxa such as willow/poplar and elm were common. In the drier areas of the Konya plain, different leading vegetation types have been observed: a) steppe/grassland on the margins of the Çarşamba anabranching system intermittently exposed to flooding ('marl steppe'), often interspersed with perennial shrubs such as plant families like Chenopodiaceae, Compositae, Labiateae; b) woodland steppe, including species such as hackberry, terebinth, and almond, growing on dry sandy areas; c) semi-open oak woodland in the uplands surrounding the Konya plain, towards the southern part of this area in combination with other species which included deciduous oak, wild pear and plum, hawthorn, almond, hackberry, juniper, woody legumes and rose bushes (Asouti 2003, 2005b; Asouti & Hather 2001; Asouti & Fairbairn 2002).

Kabukcu (2017) explores the woodland vegetation use in the Konya plain from 12500 BC to 6000 BC and identified several trends and shifts in woodland exploitation. During the earliest phases of occupation in the Konya plain (11th-10th millennia cal. BP), charcoal shows the focus on riparian and wet woodland habitats located around the archaeological sites. In later phases (9th-7th millennia cal. BP), corresponding to the beginning of the Çatalhöyük occupation by Level South G (late) through to the end of South T, there is indications for the routine exploitation of more distant vegetation zones, dominated by Oak (*Quercus*) and Juniper (*Juniperus*). Steppe woodland habitats located around the site, must have also been used throughout this period, as indicated by the presence of Ulmaceae and Salicaceae throughout the Çatalhöyük sequence, alongside *Pistacia*, *Amygdalus*, Maloideae and *Prunus*.

After Levels South Q-S, Juniper charcoal is much less commonly recovered in the plant and wood assemblages from Çatalhöyük East. From the TPC areas, which represent the final sequence of the site occupation, charcoal evidence points to more intensive use of local riparian woodlands with *Ulmaceae* dominating charcoal sample composition. On the other hand, during the occupation of the West mound, there is a mixed strategy of exploiting distant woodland resources with Juniper as the main species and local woodlands (Ulmaceae, Salicaceae). These swings in the recovery and use of *Juniperus* during the final phases of the occupation sequence at the site (South T, TPC levels and the West mound) has been understood as showing temporal changes in fuelwood preferences rather than changes in wood availability in the nearby environment (Kabukcu 2017).

The rich archaeobotanical assemblage from Çatalhöyük East adds more evidence in favour of the new paleoenvironmental reconstruction around the site which suggests a variable alluvial fan with wetter and dryer areas in the immediate vicinity to the site at the moment of occupation. This can be seen from the wild weeds and fruits/nuts assemblages, where there is a presence of wetland plant species, most likely from low-lying wetlands, as well as dry uplands/steppe taxa and a wide range of arable weeds (Bogaard *et al.* 2013; Fairbairn *et al.* 2005; Filipović 2012). Riparian and marsh taxa in the archaeobotanical assemblage are dominated by sedges and reeds such as *Bolboschoenus glaucus, Eleocharis, Carex, Aeluropus* and highly ubiquitous *Phragmites*. In addition, several salt-tolerant species have also been recovered, including *Suaeda, Beta, Atriplex, Salsola*. Amongst the steppe-like taxa several species have been identified, being the most common *Camphorosma, Artemisia, Eremopyrum* and *Stipa*. In relation to the arable weed taxa, many plant species which naturally grow in disturbed soils have been identified amongst the seed assemblage at Çatalhöyük East. Examples of these are *Taeniatherum caput-medusae*, *Helianthemum, Astragalus/Trigonella, Phlomis, Vaccaria pyramidata, Buglossoides arvensis* and probably *Heliotropium, Centaurea, Polygonum, Phalaris* (*idem*).

4.1.3. Architecture at Çatalhöyük East

Çatalhöyük East represents a Neolithic village, one of the best examples of the Neolithic 'megasites' which make their appearance in the Neolithic of West Asia around the mid PPNB.

There are not differentiated structures at Çatalhöyük, all buildings/houses seem to follow the same pattern of construction and they are all made of mudbrick. These we also under constant rebuilding and, when a house was abandoned, a new one was built on top for the next generation, implying a reuse of the last occupation phase of the buildings as the foundation for the next one (Düring 2005; Hodder 1996; Hodder 2006; Mellaart 1967) (Figure 4.6.). As new houses were rebuilt on top of old ones, sometimes a part of the space where the old house was, will become an open area for rubbish discard (midden), as a penning area and/or as a location for several outdoor activities (Hodder 2006, 102-104; Mellaart 1967).

Buildings vary in size, not only within but also between occupation levels/phases of those same buildings. The internal sizes for the majority of buildings at Çatalhöyük East have an average size of 25 m²; available data from measurements and calculations points at a range size from 12 m² to 38 m² (Düring 2006, 171) or 19 m² to 32 m² (Cutting 2005, 51). There are, however, examples of larger buildings and these are part of the named by Hodder as 'Special Buildings', such as B.1 (North G), B.52 (North G) or B.77 (North G). Each house was built around a main space, inside which daily activities such as tool-making, crafting, cooking, eating, sleeping were carried out. In addition, there was usually at least one small side room, used for food storage and some food preparation activities (Atalay 2005; Atalay & Hastorf 2006; Cutting 2005; Hodder 2006, 119-122).

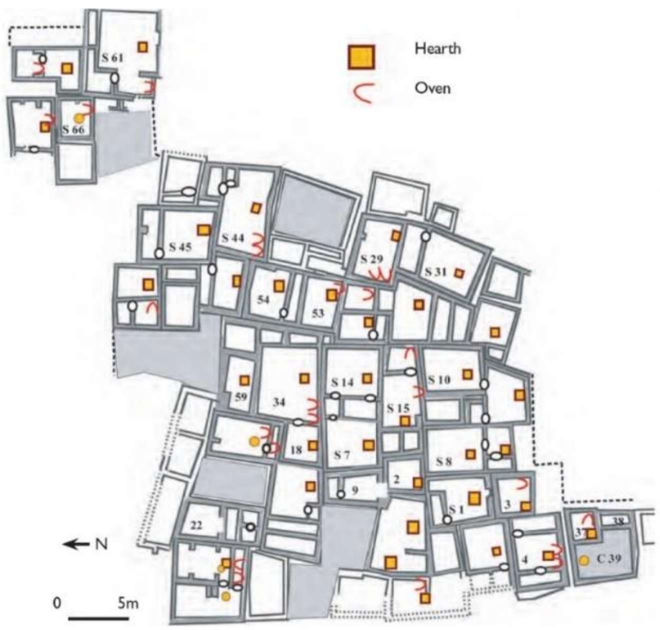


Figure 4.5. Plan of buildings in South Area (after Mellaart 1967)

Several types of archaeological features have been identified and excavated from the inside of the houses at Çatalhöyük East. Among these, fire installations such as ovens, hearths, fire spots are the most common, but we also find platforms, burial pits and artistic representations of various sorts (e.g. reliefs, wall paintings, bucrania). Burial pits were normally excavated through the raised platforms and then plastered on top as a sealed deposit (Hodder 2006, 119-122; Mellaart 1967, 54-62). The arrangement of the internal space in the houses is extremely uniform throughout the site's occupation (Düring 2005). The main room was visually divided unevenly into a larger, archaeologically speaking, 'clean' area (usually to the north), comprising the platforms, human burials and art/symbolic representations, and a smaller 'dirty' area, where food preparation and cooking took place, as well tool making and crafting (Matthews 2005; Hodder 2006). The clean area seems to have had a special social and ritual role, as it contains wall paintings, plastered benches, pillars mounted with plastered wild cattle skulls and horns and so on (Last 2005; Russell and Meece 2005) and may have functioned as a relatively public area of the house (Bogaard *et al.* 2009; Twiss *et al.* 2008; 2009).

Access to the houses was from the roof, using a ladder through an opening normally situated above the 'dirty' area and more specifically above the oven/hearth to help release the smoke from daily cooking and crafting activities. No evidence for windows or external doors has been found, although since only a portion of the walls is often preserved, the existence of windows cannot be completely excluded (Cutting 2005; Hodder 2006; Mellaart 1967). In this sense, a number of fragments of collapsed roof material was recovered from Building 3, with evidence of domestic activities such as remains of a hearth floor which contained plant and animal remains, pointing to the likely use of roof as another area for daily activities (Matthews 2005; 2010; Stevanović & Tringham 1998, 3). In addition, some of the burned buildings excavated during the last excavation seasons, especially in the South Area (Level South N-O), seem to show evidence of an upper storey (Buildings 79 and 80) (Barański *et al.* 2015b; Hodder 2009).

Figure 4.6. View of the North excavation area (Top). Building 119 (Bottom) (Photos by Jason Quinlan)

As previously mentioned, houses at Çatalhöyük East were built using a mix of sun-dried mudbrick and a type of *pisé* (mortar), made of clay or refuse material from the middens, and sustained by wooden posts, normally made of oak (Asouti 2005b; Asouti & Hather 2001; Cutting 2005; Mellaart 1967). All the materials for the construction of bricks were found locally (Doherty 2011; Love 2012). In early levels of the occupation of the site, mudbricks were made of dark silty clay (South K) and in the later levels, from the Middle phases onwards; they were substituted by bricks made of red loamy clay and in some occasions by bricks made of sand (Doherty 2007; Doherty 2011; Matthews *et al.* 1996). All bricks have been found to contain different types of temper such as reeds, sedge tubers, grasses and chaff from cereal spikelets and ears which could have been added in for the construction of the mudbricks or could have come from the source of clay/mud (Bogaard *et al*. 2009; Love 2012; Ryan 2011; Stevanović & St. George 2005). Micromorphological analyses carried out by Love (2012) and García-Suárez (2017) shed light on the elaboration of mudbricks at the household level, with different houses probably using different recipes for the preparation of mudbricks. In addition, the totality of the walls and floors of the buildings were regularly plastered and re-plastered, normally once a year but sometimes more often as seen in some buildings (Matthews 2005; 2010) (Figure 4.7.).

4.1.4. Evidence of processing, use and storage of plant foods at Çatalhöyük East

4.1.4.1. The archaeobotanical assemblage

Çatalhöyük East, after more than 20 years of intensive and systematic sampling and data analysis and recording, has yielded more than 10,000 archaeobotanical samples from a variety of archaeological contexts representing *in situ* accumulations of plant remains, burnt deposits, rake outs, occupation contexts and storage features among others. In this sense, the site of Çatalhöyük provides a unique opportunity for taking archaeobotany a step further into the study of plant food ingredients and cooking practices.

Archaeobotanical sampling has been carried out at Çatalhöyük East since 1995 and procedures for archaeobotanical data analysis were first established by Fairbairn in 2005 and then gradually updated by Hastorf (2005), Bogaard *et al.* (2013) and Filipović (2012). Specific procedures for the identification of charred plant remains from Çatalhöyük East are established in Bogaard *et al.* 2013, 94. In particular this included identification of cereal crops such as the differentiation of the glume bases and grains of the 'new type' glume wheat (*Triticum* cf. *timopheevii*) from emmer and einkorn (Jones *et al.* 2000; Kohler-Schneider 2001) and also differentiation of two- and six-row naked barley rachises using new criteria presented by Charles *et al.* (in preparation).

As a general procedure, a fraction of the flotation and heavy residue samples was scanned on site for a first assessment and identification of botanical remains present in the samples. In addition, samples which were considered particularly interesting for varied research purposes and 'Priority Samples' (samples from contexts which were prioritised by archaeologists at the moment of excavation), were selected for full archaeobotanical analysis. For this purpose, archaeological plant remains were quantified by counting a 'minimum number of individuals' (mni) using diagnostic anatomical regions of cereal grains (apical and embryo ends), pulse seeds (embryo ends) and 'chaff' components (glume bases, upper parts of rachis internodes, culm nodes, etc). For large fruit stones and nuts/nutshells, fragment counts were converted to mni estimates (Bogaard *et al.* 2013, 94).

Bogaard *et al*. (2013) highlight the importance of cereals and pulses as well as a core set of nuts/fruits as staple food at Neolithic Çatalhöyük. The plant assemblage indicates consistent long-term use of six cereals (the hulled wheats einkorn, emmer and 'new' type'; two- and six-row naked barley; bread wheat), three pulses (pea, lentil, bitter vetch), wild mustard, three nuts (almond, acorn, pistachio) and two fruits (hackberry, fig). This core set of staples confirms that these early crops were used in combination at the household level, plus an oily seed wild mustard, (*Descurainia sophia*), as well as fruits/nuts (hackberry, almond, acorn, pistachio). Thus, it reflects management of perennial shrubs/trees together with cultivation of annual seed crops (Bogaard *et al.* 2013). Fairbairn *et al*. (2005) demonstrated that residues raked out of fire installations constitute the most concentrated deposits of charred plant material produced through routine practices; these primary deposits were subsequently reused through secondary (midden) and tertiary (building fills, construction material) contexts.

Of the cereals, einkorn, emmer/new type glume wheat, naked barley and free-threshing/bread wheat occur throughout the Neolithic sequence. Among the pulses, lentil and bitter vetch occur throughout while we see an absence of pea from two of the middle south levels. Of the nuts, almond (/plum), acorn and pistachio occur more or less throughout, as does fig and wild mustard. Other wild plant materials such as club rush seeds and tubers occur in every level. While club rush tubers have been shown to be a potential human food (e.g. González Carretero *et al.* 2017; Wollstonecroft and Erkal 1999), no clear 'storage' concentrations of nutlets or tubers have been recovered from Çatalhöyük East. There are some tuber-rich 'clusters', but in unburnt houses and likely derived from rake-out deposits which might represent fuel rather than food stores (Fairbairn *et al.* 2005). Among the glume wheats, two-seeded grain types (emmer, new type and two-seeded einkorn) generally outnumber one-seeded einkorn; similarly, emmer/new type glume bases outnumber einkorn glume bases (Bogaard *et al*. 2013). Hulled barley is absent in early South Area levels; it appears in Level South Q and occurs sporadically through later levels, as well as in Levels North G through. Preliminary assessment of the latest Neolithic on the East Mound (TPC Area) indicates that hulled barley becomes more frequent than in earlier levels (Bogaard *et al.* 2013; Bogaard *et al.* 2017; Bogaard *et al.* in preparation).

In terms of temporal changes in the archaeobotanical assemblage, in summary we see a higher variety of crops and wild plants recovered from the earliest levels at Çatalhöyük East (from South G to South I), with a broader range of cereal crops and pulses present in the archaeobotanical record (Bogaard *et al.* 2017). In addition, there is a general trend of glume wheats dominating in the Early, Middle and Late phases of the occupation and a change towards the higher use of free-threshing wheat species in the Final phase of the site (Bogaard *et al.* 2017; Bogaard *et al.* in preparation). In relation to specific crops, there are several noticeable trends in the archaeobotanical assemblage from Neolithic Çatalhöyük. The first shift seems to be the replacement of six-row naked barley by two-row naked barley by the end of the Middle phase of the site as attested by the difference in recovery of two-row and six-row naked barley rachises (Bogaard *et al.* 2013; Bogaard *et al.* 2017). The change from six- to two-row naked barley seems to have occurred around the same time in the South and North Areas of the settlement and resulted in a clear preponderance of two-row naked barley by levels South N and North G (Bogaard *et al.* 2017). As mentioned earlier, another important change in the archaeobotanical assemblage is the appearance of hulled barley in the late phases of the occupation, from levels North G-F and South Q. Recent work on the archaeobotanical samples from TPC shows the importance of this crop in the Final phases at Çatalhöyük as well as naked barley (Bogaard *et al.* in preparation). There are also changes in the wheat species used by the Neolithic Çatalhöyük community; there is a dominance of emmer over new type glume wheat in the early levels in the South area, while new type is dominant over emmer in the North area from the earliest levels. Einkorn, in contrast, occurs as a minor cereal crop throughout the whole sequence in comparison with emmer and new type assemblages, based on the grain count and chaff identification (Bogaard *et al.* 2013; Bogaard *et al.* 2017; Bogaard *et al.* in preparation) (Figure 4.8.).

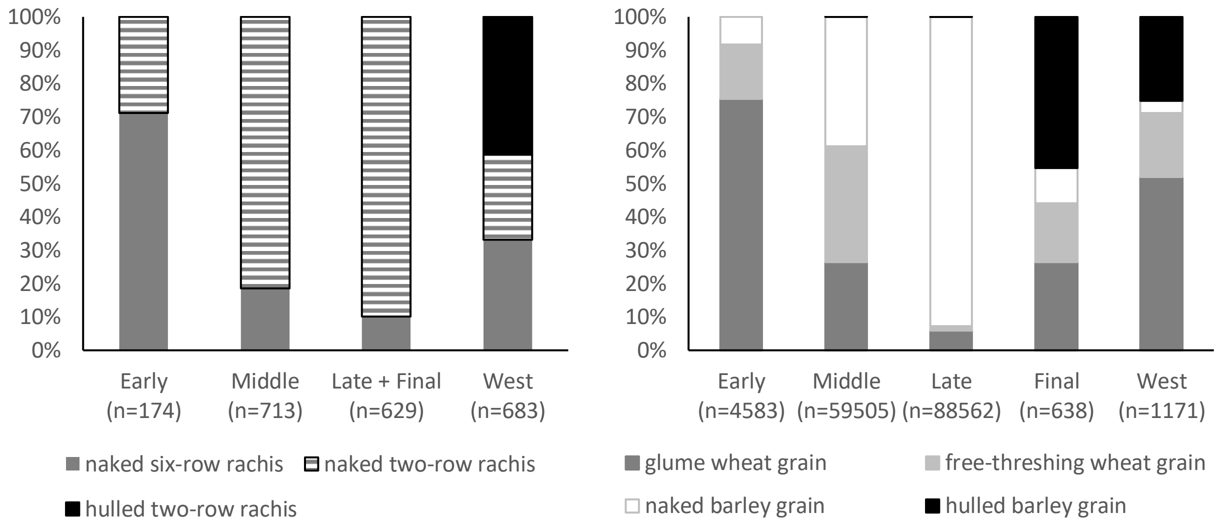


Figure 4.7. Bar charts showing ubiquity of barley and wheat varieties through time at Çatalhöyük (Bogaard et al. in preparation)

Pulses, fruits and nuts were also subjected to changes through time in the archaeobotanical record at Çatalhöyük East. For pulses, while chickpea has a sporadic presence and its presence is concentrated on the earliest levels (South G-H) of the sequence at the site; while lentil, bitter vetch, grass pea and pea are present throughout. This said, there is a clear shift from a high use of lentil to a high use of pea and a decrease in the use of lentil as the main pulse crop from levels South O and North H onwards, as well as a decrease in the presence of bitter vetch (Bogaard *et al.* 2017). For the fruits/nuts there is a continuous presence of sedge tubes, especially from *Bolboschoenus glaucus* sedges, through time as well as a continuous attested consumption of hackberry and pistachio (Bogaard *et al.* 2013; Bogaard *et al.* 2017; Bogaard *et al.* in preparation). Other fragmented nut/fruit shell remains of *Prunus* species such as plum or almond in addition to fig seeds have been recovered along the sequence at the site, however their importance as part of people's diet at Neolithic Çatalhöyük is not clear yet. Also, there is an early use of acorn in the South Area which decreases by the Middle phases of the occupation coinciding with the decrease in the use of oak wood recovered from the site (Bogaard *et al.* 2017; Bogaard *et al.* in preparation; Kabukcu 2017) (Figure 4.9.).

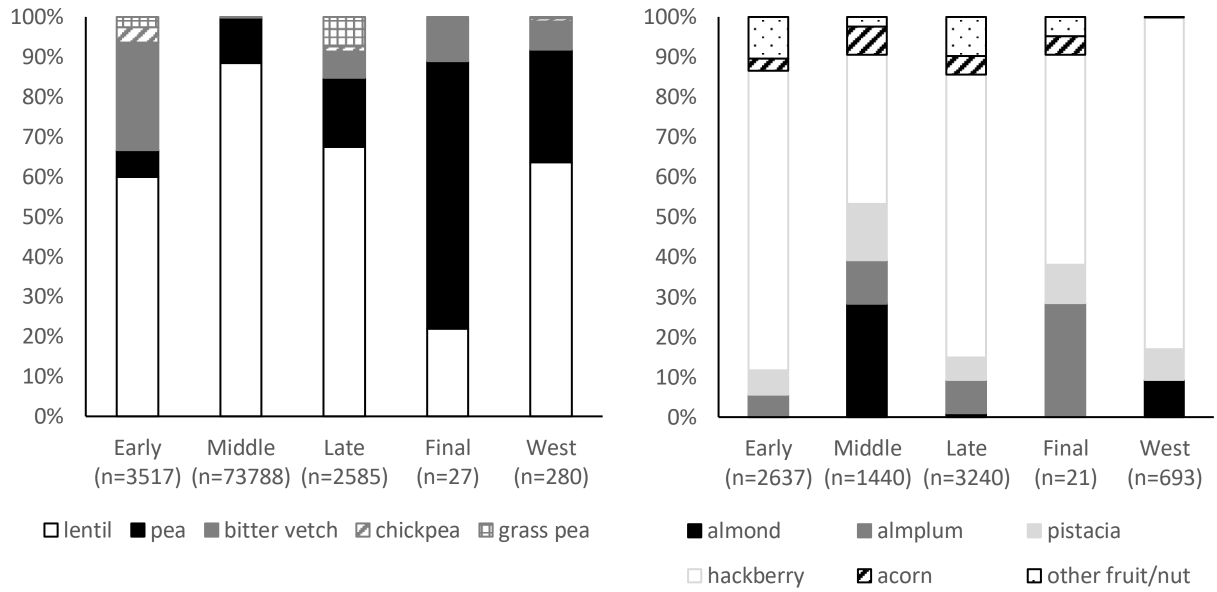


Figure 4.8. Bar charts showing ubiquity of pulses and nut/fruit varieties through time at Çatalhöyük (Bogaard *et al.* in preparation)

4.1.4.2. Storage and processing of plant foods

Some of the best-preserved plant assemblages recovered from Çatalhöyük East come from storage features such as bins, baskets, containers and clusters from burned buildings. As a general trend, all houses seem to have had their own storage capability and bins occur widely, in small numbers, and usually in side rooms inside the houses. Overall phytolith evidence suggests that different crops were stored in different ways and that there was a general link between baskets and wheat species (Ryan 2013). Review of storage space in Çatalhöyük buildings has found that they could generally accommodate not only the household's annual requirements for staple plant foods but also 'normal surplus' as insurance against future shortages (Bogaard *et al*. 2009; 2013; Demirergi *et al*. 2014). On the other hand, the actual scale of storage in side room spaces is unknown, and bin capacity per structure was highly variable among buildings at Çatalhöyük East (Bogaard *et al*. 2009). Storage bins are often medium in size (1-1.5 wide and 1m tall) however small stores (clusters) of bones, pulses and wild seeds have been also found (Bogaard *et al*. 2013; Demirergi *et al*. 2014).

Plant resources stored in bins or side rooms at Çatalhöyük East are thought to have been stored as food for regular consumption by the inhabitants of the houses. The relative high abundance of glume bases recovered from floor contexts across most buildings and external spaces point to regular dehusking of glume wheat species which were most likely stored in spikelet form and possibly in ear form (Bogaard *et al.* 2013; Bogaard *et al.* 2017). This contrasts with the storage of (semi) clean grain of naked wheat and barley, which was probably threshed and winnowed off site, with only later crop processing stages such as fine sieving being done on site as attested by the low quantities of naked wheat and barley rachises recovered from floors and other contexts inside the buildings (Bogaard *et al.* 2013; Fairbairn *et al.* 2005). Pulses and wild mustard seeds also appear in storage at Neolithic Çatalhöyük often in high quantities and separate from cereals. Pulses and wild mustard appear to have been stored in the form of (semi) clean seeds deposits instead of in the pods.

Important plant storage concentrations have been recovered from several burned buildings during the years of excavation and sampling at the site. Special importance was attributed to the excavation of the last occupation phase of B.77 (North G) from which abundant concentration of plant remains was retrieved. Grain, pulses and wild mustard concentrations were found inside several storage bins and baskets in combination with grinding stones and obsidian tools. This 'display' of plant food resources which was purposely burnt at the end of the building occupation is believed to be an intentional event and might not represent the daily life of the B.77. B.77 has provided rare evidence for the storage of glume wheat in spikelet form in storage areas, in particular from the side room in the building (Sp.337) (Bogaard *et al.* 2013). Recent study of these remains has concluded that this deposit was mainly a concentration of "new type" glume wheat which we most likely grown and stored separately from other glume wheats such as emmer or einkorn (Bogaard *et al.* 2013; Bogaard *et al.* 2017). The storage bins in the side room were virtually empty, however, residual concentrations of charred plant remains were found in them. Figure 4.10. shows the different proportions of plant remains present in B.77 at the time of burning before abandonment. Especially relevant is the presence of wild seeds such as wild mustard (*Descurainia sophia*) in bins F.3092 which suggest a possible storage of wild seed species (Bogaard et el. 2013).

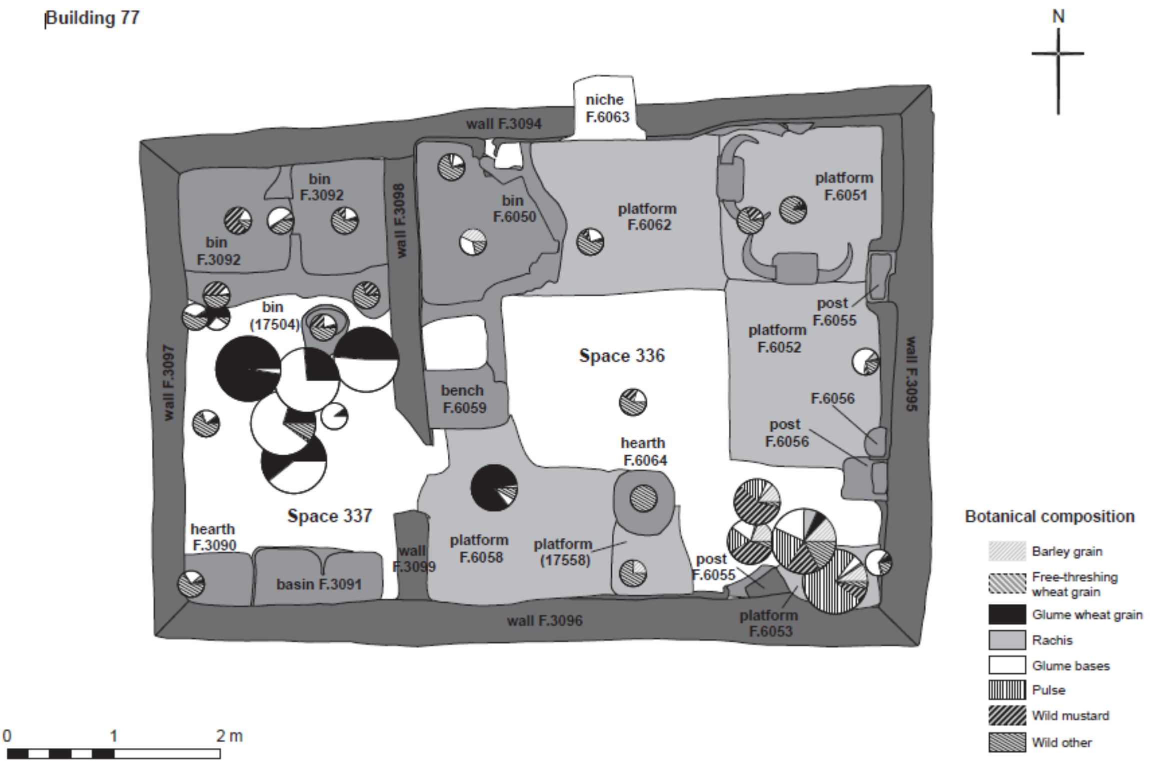


Figure 4.9. Plan of building 77 showing spatial distribution of plant remains (Bogaard *et al.* 2013)

Similarly to the storage in B.77, a nearby building in the North area, B.131 (North G), presents evidence of another burnt deposit of "new type" glume wheat excavated by the author in 2015. This assemblage is still under study but preliminary analysis points to the storage of these cereals in spikelet form as we saw for B.77 (Bogaard *et al.* 2017). Moreover, a building in the South area, B.79 (South O), has yielded a deposit of pure emmer wheat grain also stored in their spikelets. This storage deposit also contained remains or free-threshing wheat grain which adds more support to the idea of "new type" wheat being grown and stored separately from other wheat species (*idem*). Two similar stores of glume wheat were excavated by Mellaart in the South area; these were previously identified by Helbaek as emmer, however recent analysis by Fairbairn has shown that they are mainly composed of "new type" glume wheat (*idem)*. One of them is from B.VI.1 which could be from level VI.A or South O or level VI.B or South N which would fit with the North and South chronology of the recent buildings which yielded stores of plant foods.

From the late Neolithic levels of the site, there are also large stores of naked barley grains (Buildings E.IV.4, A.III.4, A.II.1) of the Mellaart archive material which was studied by Helbaek (1964) from Mellaart's excavations of the 1960s; this is thought to be six-row barley as there is a lack of asymmetrical grains in the assemblage (Bogaard *et al.* 2017). This fits with a large concentration of (semi) clean barley grain was excavated from TPC Building 122 (Green *et al.* 2018). From the late Neolithic levels at TPC, corresponding to the Late and Final phases of occupation, the only glume-wheat concentration excavated so far is a burned storage room (Sp.493) of TPC's Building 122. This deposit has yielded a large concentration of 'new type' spikelets (Fuller *et al.* 2014) which are currently under study.

4.1.5. Plant processing tools and cooking installations at Çatalhöyük East

4.1.5.1. Fire installations and clay balls

Two types of cooking fire installations have been identified at Çatalhöyük East, hearths and ovens, with addition of small and localised fire spots. The main fire installation for cooking purposes within the houses was most likely the oven, which was typically found deeply set into the southern wall and with a front opening. Hearths, on the other hand, while also placed in the southern area, are usually situated away from the wall but nearby the oven. These features would have probably been a secondary cooking installation perhaps for short or sporadic cooking events and/or more related to boiling activities.

Ovens, usually associated with a hearth, are a recurrent feature inside the houses (see also Hodder 2006). Ovens have been recovered from every excavated building and generally from each occupation phase (although there are exceptions) from the earliest level South G (7100 cal. BC) at Çatalhöyük East. Occasionally, large ovens have also been found outdoors, possibly related to communal activities such as communal bread baking or food preparation while crafting or tool making activities were taking place. These large outdoor ovens have been recovered from yards and open spaces and are most likely associated with communal cooking activities by a group of households or individuals (Bogaard *et al.* 2014; Mellaart 1967).

Indoor ovens at Çatalhöyük East are small oval-rectangular domed structures (1-1.5m diameter), of the *firin*/*tabun* type (Figure 4.11.) made of mud and clay or sometimes using a mix of both materials as seen for the construction of mudbrick. The material for the construction of the ovens was highly tempered as well, often using plant remains such as straw, chaff, reeds, etc. Outdoor ovens were generally larger in size (up to 2m in diameter) and higher, also made of clay/mud and with a domed superstructure. Ovens had an opening at the front through which fuel and food would be placed inside as well as for releasing smoke. Micromorphological work has recently shown that ovens and hearths were also plastered and re-plastered after a period of use, maybe even annually (García-Suárez 2017). This was done after applying a layer of make-up using mud/clay material. The plaster layers range from 3-5cm thickness but sometimes these have been found to be thicker than 7cm. A possible explanation for this is the constant exposure of these clay structures to heat which would provoke the clay dome and walls of the ovens to crack or even collapse (*idem*).

Figure 4.10. Oven in building 80 with in situ accumulation of stones possibly used as heaters (Photo by Jason Quinlan)

During the early pre-ceramic levels of occupation of the Neolithic East Mound, ovens are often found in association with collections of clay balls which, according to Atalay & Hastorf (2006), were used as 'boilers.' The use of heating stones as heating elements for cooking is widely reported both ethnographically and archaeologically; e.g. hot stones dropped into a container of water (or other liquids) can cause it to boil; hot stones spread out horizontally can be used to roast cuts of meat (Atalay 2005; Atalay & Hastorf 2006; Thoms 2009). At Çatalhöyük, clay balls may have been used to create this heating effect, although the use of heating stones cannot be completely discarded. Clusters of small stones in association with the oven have been recovered from a number of buildings in North and South areas. In particular, B.77 and B.80

have yielded a high concentration of this type of stones which could have been used for multiple purposes, not only for cooking but also as heaters (Wright 2014) (see Figure 4.11.). Clay balls appear to have been kept by the oven, heated in it, and then probably placed in liquid-filled containers, such as wooden containers or baskets lined with mud, or laid out to heat food. Broken and cracked clay balls are frequently found until level VII (Hodder 2006; Wright 2014) (see Figure 4.12.). Petrographic analyses of a small number of these balls have shown that numerous methods were used to make the balls and differed from one house to another. Atalay (2005) interpreted these patterns as indicating differences in available clay resources or the use of different sources by different persons, and further observed that figurines, clay balls, mini clay balls and other artefacts, each differed in their clay sources. In addition, 13 clay balls were analysed via HT-GC and none were found to contain significant concentrations of absorbed lipid residues. The lack of absorbed residues may be due to the balls being used in boiling water, or not coming in direct contact with lipid-rich foodstuffs (Copley *et al.* 2005; Pitter *at el*. 2013).

Figure 4.11. Oven from building 112 with associated clay ball embedded in the fill (Photo by LGC)

4.1.5.2. <u>Emergence of pottery at Neolithic Çatalhöyük</u>

The decrease on the recovery of clay balls from Çatalhöyük East goes together with the introduction of a type of ceramic vessels which are believed to have been used for cooking activities. This shift between the use of clay balls and cooking pots took place sometime around 6,500-6,400 cal. BC (Level South L-O or Mellaart Level VI-VII) and, although there is evidence of small serving bowls/pots at earlier levels (Hodder 2011; Last *et al.* 2005), these are the first attested vessel which were suitable for cooking purposes. There is no evidence of these early serving pots being used for cooking directly on the fire and at Level South M-O clay balls die out and ceramic vessels became the main tool used for cooking practices. Pottery studies at Çatalhöyük have shown that Deep Jars of Dark Line pottery, made with thinner walls which would have absorbed heat easier, become the main ceramic vessel for cooking purposes around Level South O (Yalman *et al*. 2013). As mentioned previously, there are some earlier examples of pottery which does not seem to be suitable for cooking as the recovered sherds do not seem to show traces of direct heating and they are too thick and porous for heat distribution over the pots for cooking (Yalman *et al.* 2013) (Figure 4.13).

Figure 4.12. Collection of Neolithic Pottery. Units 10044, 10644, 10674, 11234, 11985 (Photo by Jason Quinlan)

One possible explanation for the change between the use of clay balls as potential heaters or boilers is to increase cooking efficiency. It has been suggested that when using clay balls for baking, it would have been necessary that the cook paid continuous and close attention to the food being cooked to avoid burning. By replacing clay ball technology with clay pot technology, the cook was then free to attend to other tasks during the cooking process (Atalay 2005; Atalay & Hastorf 2006). Parallel shifting methods of cooking can also mean a possible change in cuisine with the rise of meat filleting versus cuts consumption. Likewise, the introduction of clay cooking pots would also have made easier the otherwise laborious process of bone boiling (to obtain bone grease) (Bar-Oz and Munro 2007; Munro and Bar-Oz 2005; Yalman *et al*. 2013).

The shift between the use of clay balls and ceramics as cooking vessels could have possibly influenced a change in cooking techniques and therefore an increase on the different types of food being cooked. In relation to cereals, traditional archaeobotanical data has recently provided some evidence about a possible change in the use of plant foods after Level M-O with a shift between emmer to "new type" glume wheat. Additionally, ovens are present through the whole sequence and most likely bread type products were baked in them during the time of occupation. Significantly, with the introduction of cooking pots, a whole new range of cereal-based foods, such as porridges or soups were made possible.

4.1.5.3. Ground stone tools

Another group of artefacts that are essential for cereal processing are ground stone tools such as querns and grinding slabs. From previous research at Çatalhöyük East more than 3000 artefacts have been recovered from more than 20 different buildings and 9 open spaces. The largest ones include types which could have been involved in the processing of plant foods for food preparation such as grinding slabs (passive grinding tools involving linear motions) and querns (passive grinding tools involving oval motions). Most of these ground stones were found in the interior of the houses and the majority have been identified to be broken in small pieces and stored somewhere near the ovens. These small tools were identified by Wright (2014) as portable querns versus big, fixed ground stones found mainly in storage rooms which are believed to have been used for daily crop processing and possibly flour making. A good example was found in Building 77. Building 77 is defined by Hodder as a "special" building which considers the presence of art and a high number of burials underneath the floors. This structure is also notable for its storage of botanical resources, high frequencies of tools used in daily routines, and a platform dedicated to ground stone making within the north side room (Wright 2014). Upon this there was a large quern and evidence for quern manufacture: hammers, roughouts and debitage. This platform also reveals deliberate breaking of querns into small hand-sized fragments possibly used as portable handstones for food processing in the house. Wright (2014) has interpreted this assemblage as evidence of a possible specialisation in ground stone production in some elaborated and special buildings at Çatalhöyük. Other elaborated buildings at Çatalhöyük follow this same pattern presenting a large diversity of ground stones (Buildings 77, 52, 65 and 49), showing a possible relation between elaborated buildings and ground stone making (idem). The idea of a possible specialisation of food processing tools at Çatalhöyük would suggest slow social changes happening at household-level, possibly moving away from a perfectly egalitarian society.

Figure 4.13. Ground Stone, Quern GS 402, U.17547 in building 77 (Photo by Jason Quinlan)

Tsoraki (2018b) identifies that fixed querns inside the buildings (e.g., Building 77, 89 and 80) present wear traces associated with cereal contact which clearly suggests that cereal processing activities (such as grinding) were mainly performed inside the houses. While there is abundant macrobotanical and microbotanical evidence for dehusking activities taking place inside the houses at Neolithic Çatalhöyük (Bogaard *et al.* 2013; Ryan 2013), there is no direct evidence of the use of querns or grinding slabs for this task (Tsoraki 2018). Traditionally, de-husking activities have been associated with the use of a mortar and a pestle, which could be made either of wood or a combination of a wooden pestle and a stone mortar (Hamon and Le Gall 2013, 112). Although so far, no example of these has been recovered from Çatalhöyük, the use of this type of technique for crop-processing activities should not be discarded.

An interesting example of the use of querns comes from Building 77 (Figure 4.14.). According to the last analysis of querns and grinding slabs from B.77, Tsoraki (2018; forthcoming a, b) shows how querns and grinding slabs left during abandonment of the building were used for processing of cereals and other plant resources. Microwear analyses of the large fixed quern found in the middle of the main room suggest its use for cereal processing. Although the specific uses of this quern have not been fully established at this point, activities like dehusking and grinding were most likely among the activities carried out. Phytolith and starch analyses of a small quern found in a storage bin in the side room show evidence of cereal processing, mainly grinding of already dehusked grain (Tsoraki 2015; Tsoraki 2018; forthcoming a).

4.1.6. Previous research into cooking practices and cuisine at Çatalhöyük

Çatalhöyük provides an ideal site for the study of Neolithic patterns in cooking practices and *cuisine* (i.e. style or method of cooking and select set of ingredients) and changes in those practices over time. Previous research into food preparation and cooking at Çatalhöyük has mainly focused on the potential ingredients (archaeobotanical and zooarchaeological data) and possible technology used (pottery, ground stone tools, fire installations, clay balls, etc) for the elaboration of meals by the community during the Neolithic and Chalcolithic. However, little has been said about the actual choice of ingredients and the different processes behind the preparation of food and meals at Çatalhöyük, especially on the East Mound.

During the Mellaart excavations, several fire installations, storage bins and other related archaeological features in combination with deposits of archaeobotanical and zooarchaeological materials were interpreted as artefacts for food preparation, cooking and consumption. Mellaart (1967) suggests a range of possible types of food preparations and meals which the Çatalhöyük community could have been preparing and consuming, based on the plant and animal foods recovered from the site. These ideas, although rather speculative, set the bases for future research into foodways at Çatalhöyük.

Mellaart was also the first one to make reference to a possible Neolithic bread making tradition present at Çatalhöyük. Beside the great amount of cereal remains being recovered from the early excavation seasons at the site, Mellaart also used evidence from archaeological features such as fire installations, pottery, grinding stones, etc to suggest an early bread culture at Çatalhöyük East. Perhaps the most remarkable example would be the discovery and excavation of a large sequence of outdoor ovens to the west of a courtyard, belonging to Level V (South P-H) in Sp.333. Mellaart described this as 'domestic courtyard, open to the Sky' and that this space would be a place dedicated to 'communal use' and most specifically categorised as a 'bakery' (1967, 67). Bogaard *et al.* (2014) revisited Mellaart's interpretation of this sequence of large outdoor ovens and other similar ones and proposed the possibility of these being used for communal food preparation and cooking in determinate occasions, most probably while these open spaces were used for rebuilding, crafting and tool making activities. Communal bread making could have certainly been a possible use of these ovens, as attested by ethnographic work in Central Anatolia and in other areas of West Asia (Bogaard *et al.* 2014; Ertuğ-Yaraş 1997).

Atalay & Hastorf (2006) reviewed the plant and animal ingredients available to the Çatalhöyük community during the Neolithic and proposed a varied list of ways in which daily and communal meals could have been prepared and cooked. Although no solid archaeological evidence was presented for the majority of these suggestions, their study was highly valuable as it shed light on the use of wild resources and on possible cooking technologies and cooking methods during the Neolithic. The authors also noticed that the available ingredients at Çatalhöyük East were not strongly subjected to changes and proposed that if they were used/cooked differently it must have been as a result of cultural or personal choice. Especially relevant was the observation and interpretation of the shift on the use of clay balls and pottery for boiling purposes and the possible culinary reasons behind this (see section 4.1.5.2 in this chapter). However surprising is the little attention paid to bread making and baking, concluding that these activities would have probably been carried out on a very 'limited basis' in the light of ground stone and dental evidence available at the time (Atalay & Hastorf 2006, 310).

In relation to animal resources, in the last decade there have been some suggestions about which part of the animals were used as well as the type of fish and molluscs and the ways in which these could have been prepared and cooked by the Çatalhöyük community. Russel *et al.* (2013) and Demirergi (2015) reviewed the cut marks present in sheep/goat and cattle bones with the intention of investigating preparation and cooking of meat products. In summary, this study shows the importance of dismembering and filleting during the Neolithic at Çatalhöyük, with an increase of the latter over dismembering through time. According to Russel *et al.* (2013), both sheep/goat and cow-size bones display consistency in the frequency of dismemberment cuts from Levels South H-M to Levels South P-T, but the frequency of filleting cuts increases by a factor of four from Levels South H-M to Levels South P-T at the same time that consumption-like cut marks decrease considerably. The increase in filleting suggests an inclination towards cooking boneless meat, while the decrease in consumption cut marks suggests either cooking boneless meat or the boiling of whole cuts for prolonged episodes so that the flesh easily detaches from the bone. In this sense, they suggest that, with the pass of time, the inhabitants of Çatalhöyük developed a preference for stewed meat over roasted meat. The data from pottery supports this idea with the increase in the presence of cooking pots from Level South P-O.

Similarly, Van Neer (2013) showed that fish and water resources were of importance for the inhabitants of Çatalhöyük. Fish might have been a rather regular food ingredient in the diets of the Çatalhöyük inhabitants as attested by the find of the remains of some type of food preparation similar to a "soup" from U. (16498), (17513) and (17519) from B.77. The remains were analysed concluding that the fish and botanical remains had been mixed together before burning occurred and it contained a mix of fish, peas and a small amount of naked barley. The particular fish types chosen for the preparation of this food were small cyprinids, both *Capoeta* and *Pseudophoxinus* mainly between 5 and 10cm and sometimes still in anatomical articulation (Van Neer *et al.* 2013). Although other ways of cooking fish and molluscs would have included roasting or smoking (Atalay & Hastorf 2006; Van Neer *et al.* 2013), these resources do not seem to be commonly present throughout the whole Çatalhöyük sequence, with a decrease in their presence after South M-P.

To date the most comprehensive study on cooking practices and food remains from Çatalhöyük comes from the chemical analysis of ceramic vessels from the Chalcolithic West Mound. For this study, analysis on the isotopic and lipid composition of several sherds from 9 ceramic bowls and 1 jar were carried out. The analyses revealed that these bowls had been used for the preparation and cooking of a wide range of foods, including dairy from sheep, goat and cows (Bovinae, Caprinae, *Ovis*, *Capra hircus*), wheat and barley cereal grains (*Hordeum vulgare, Triticum*, Triticeae), legumes such as pea and vetch (*Pisum sativum* and *Vicia* sp.) and non-dairy animal proteins (Caprinae, Cervidae and Bovinae haemoglobin) (Hendy *et al.* 2018). In contrast with previous chemical analysis of ceramic vessels from Çatalhöyük which had focused on the detection of milk and animal, Hendy *et al.* (2018) has shown how early farmers' pottery was also used for the preparation of plant-based foods such as soups or porridges made of cereals and pulses. These data are of extreme importance as they support the results obtained from the analysis of charred remains of meals from the East Mound (see chapter 7 for results).

4.1.7. Temporal changes at Çatalhöyük East

As previously mentioned, the East Mound at Çatalhöyük has a long and continuous occupation for more than 1100 years. It has not been unusual to interpret Çatalhöyük Neolithic occupation and social organisation as one entity due to the high level of social and economic equality among households and areas of the site. However, in the last years, new lines of evidence have shed light on important changes and shifts occurring at Çatalhöyük and especially from the second half of the 7th millennium BC (ca. 6500 cal. BC).

The latest research at Çatalhöyük East has highlighted a major change in the social and economic structure of the community from 6500 cal. BC onwards (Hodder 2014). There is a noticeable decrease in the overall population of the settlement in addition to a clear shift in the structural aspects of the occupation, moving away from the so characteristic agglomerated settlement structure towards a looser one, with fewer but larger houses being built. Hodder (2014) has interpreted this change as the result of a change in the social organisation of the community, which was characterised by egalitarianism throughout the sequence, but that social differentiation, competition and economic specialisation became more pronounced after 6500 BC. Several are the changes taking place around this time, with some important differences in burial practices, introduction of cooking pots, the emergence of hulled barley cultivation (Bogaard *et al.* 2017) and a sharp decline in aurochs and equid hunting, with the dominance of the zoological assemblage by domestic sheep, goat and the first clearly domesticated cattle (Russell *et al*. 2013).

The TP and TPC areas at Çatalhöyük East, both excavated by the team from Poznan University, have provided evidence for this economic and social change. The TP area was excavated from 2001 until 2008, when the Poznan team moved to a new area, TPC, where excavation lasted until 2017. These areas represent the late Neolithic occupation sequence at the site until it becomes abandoned at ca. 5950 cal. BC. Excavation of these two areas has generated key evidence of a progressive change at Çatalhöyük East, with the development of new architectural and structural rules. In general, by the end of the Neolithic sequence, there is a trend for the construction of longer and bigger buildings, with pebble paved houses up to 70m^2. In addition, indoor and outdoor fire installations seem to decrease in number as well as in the number of burials under the platforms/floors. On the contrary, the late Neolithic inhabitants of the site preferred the creation of burial chambers like the elaborated burial chamber (Sp. 327) in B.72 dated to ca. 6200-6125 cal. BC (Marciniak *et al.* 2015).

Marciniak *et al.* (2015) and Hodder *et al.* (2014) have interpreted these changes as the result of the Late Neolithic at site marking the emergence of a new domestic mode of production, which was not based on the neighbouring relationships between houses, but on the an increasingly independence and perhaps individualism of the household. In this sense, a group of individuals living in the same house would have taken decisions based on the domestic social and economic situation rather than based on the structure and social-economic organisation of the wider Çatalhöyük community.

After the abandonment of B.33 in the TP area around 5950 cal. BC, the occupation of the East Mound ends and any remaining population moves to the Chalcolithic West Mound. On the contrary to what it was previously thought, new research from the West Mound at Çatalhöyük has provided evidence for the parallel occupation of East and West Mounds during roughly 50-100 years during the final Neolithic level (Orton *et al.* 2018).

4.1.8. Summary

The site of Çatalhöyük, with a long a continuous occupation of more than 1000 years, is ideal for the study of dietary practices from the early Neolithic to the Chalcolithic. Incredibly well-preserved burnt houses and middens areas have captured the essence of the Neolithic way of life for thousands of years. The environment around the site has been object of multiple studies with the recent conclusion of a shift between a humid environment to a dryland anabranching system, right at the beginning of the occupation of the East Mound. This fluvial system would have contributed to a reliable and changeable agricultural system which relied on cereal crops as the staple food, with the addition of pulses and other wild plant foods gathered year-round.

In this sense, the Çatalhöyük community relied on these crops for the preparation of daily meals, an especially cereal-based meals such as bread, porridges, etc. The analysis of the material culture from Çatalhöyük in combination with the study of the archaeobotanical record has provided insights into cooking technology and food processing and preparation which will complement the analysis of the archaeological remains of food, the object of study of this doctoral thesis.

4.2. Jarmo (Iraqi Kurdistan)

4.2.1. Location and chronology of the site

Jarmo is a Neolithic site located in a valley on the foothills of the Zagros Mountains in the Chamchamal Plain in Sulaimaniyah Province (35°33'20.87"N, 44°55'49.05"E). The site was established in the proximities of the Basian Pass and lies on a natural promontory above the Cham-Gawra wadi, at an altitude of 800m above sea-level (Figure 4.15.)

Jarmo, similarly to Çatalhöyük in Central Anatolia, is an example of the Neolithic "megasite" which emerged at the beginning of the PPNB in Western Asia. It was thought to extend up to 5 hectares (Braidwood *et al.* 1983), and, like Çatalhöyük East, it is believed to have had a long and continuous occupation for longer than 1500 years. According to past and present research, Jarmo was presumably inhabited between ca. 7500 – 5800 BC all year around, however, the dating and population estimation of the site remains problematic (see below). Jarmo has yielded abundant archaeological evidence which supports its interpretation as another example of a large PPNB village, which makes it a perfect candidate for comparison to Çatalhöyük in relation to the use of plant foods, food preparation and cooking practices across different regions of the West Asian Neolithic.

Figure 4.14. View of Jarmo to the East (September 2012, Photo by DQF)

The site of Jarmo was first excavated by Robert and Linda Braidwood and their team from the Oriental Institute at the University of Chicago in the 1950s during three fieldwork seasons (1947-48, 1950-51 and 1954-55). The initial season meant the survey and evaluation of the site's archaeological nature and it was not until the 1950-51 field season, that larger and systematic excavation was carried out. In 1950-51 several large tranches were opened and excavated such as step trenches A and J-I and trenches J-II, J-III, reaching a general depth of 7m below the top of the mound. During the excavations for their last campaign 1954-55, Braidwood's team applied a multidisciplinary approach for the first time, in an attempt to improve their research methods and carry out an in-depth investigation into the origins of the domestication of plants and animals in the area. For this purpose, and in order to expose a complete settlement plan, the team carried out the opening and excavation of 151 small (2x2m) trenches to a maximum depth of 1.75m in a form of a grid. The overall evidence yielded from the site after Braidwood's excavations provided relevant archaeological information and new insights into the Neolithic in the Zagros area. However, their multi-disciplinary approach, pre-dated the advent of flotation, so archaeobotanical data were rather limited and haphazard (see Watson 1983).

A new project led by Prof. Dorian Q Fuller from the UCL Institute of Archaeology started in 2012 until 2014 with the aim of re-evaluating the Jarmo sequence established by Braidwood and the idea of Jarmo as one of the Neolithic sites with the earliest signs of domestication of plants and animals in Western Asia. As part of this new project, in 2012 two 1x1m test pits were excavated next to and on top of partially excavated Braidwood's J-II trench. In addition, in 2014 three new trenches were opened with the aim of matching the Braidwood sequence and have a full view of occupation levels: Jarmo West (JW) – adjacent to Braidwood's J-I bottom); Jarmo Central Buildings (JCB) on top of J-II; Jarmo Central Midden (JCM), lying between J-II and J-III. In order to assess the amount of slope wash and modern fill in the former trenches a small-scale coring project was carried out by Dr Mark Altaweel from the UCL Institute of Archaeology. This new archaeological exploration confirmed the presence of occupation layers ca. 40-50 cm below the old Braidwood units and carried out extensive and systematic recovery of plant and animal remains by bucket flotation (2012) and machine flotation and dry-sieving (2014) of all non-floated sediments.

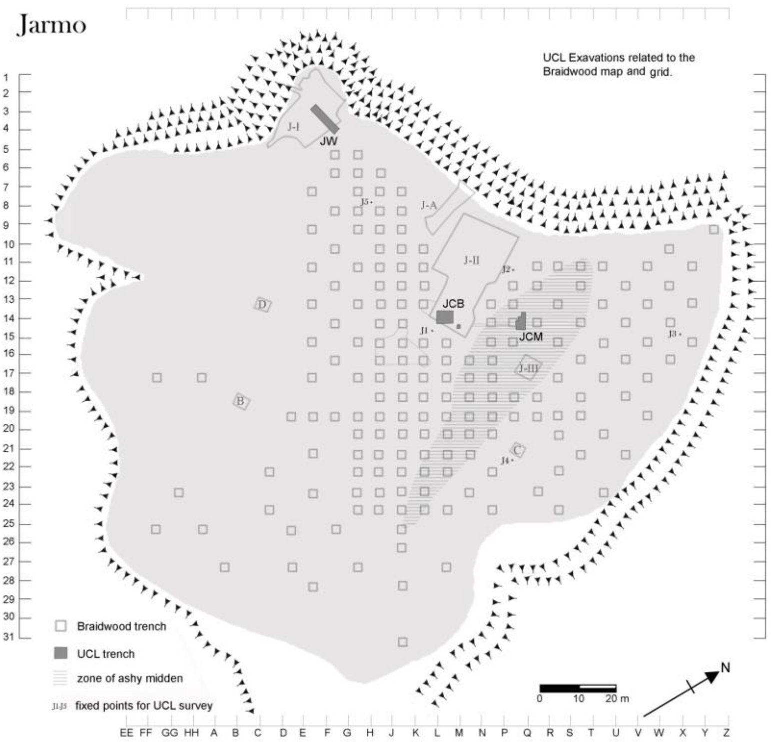


Figure 4.15. Updated plan of Jarmo including Braidwood trenches and new UCL project trenches

As mentioned earlier, Jarmo is believed to represent a continuous occupation from ca.7500 to 5800 cal. BC which spanned from Pre-Pottery Neolithic levels until the Late Neolithic (ceramic) levels. Due to a variety of complications regarding the early state of radiocarbon dating technology at the time of Braidwood excavations and the nature of the samples (Kozłowski 1994), as well as bad preservation of both archaeobotanical and archaeozoological samples in the more recent dating, samples from Jarmo have only yielded a small amount of accurate dates.

As a result of the excavations by Braidwood in the 1950s, 9 building (occupation) levels were identified. In summary, Levels 1 and 2 were associated with a potsherds' midden and preserved stone wall foundations. From Level 4 downwards there is no evidence of ceramics, while a small number (32 sherds) of pottery remains were reported stratified from Level 3 (Adams 1983). In the Central Buildings part of the site (Braidwood Trench J.II) a large amount of pottery sherds (>1000) were recovered from the top two levels (Levels 1 and 2) and surface deposits. Thus Levels 1 and 2 are believed to represent a true Pottery Neolithic in both trenches J.I and J.II. The latest pre-pottery layers have recently been dated through an AMS of pig bone, suggesting ca. 7250 cal. BC, and the keeping of domesticated pig by this time (Price & Arbuckle 2015). In addition, the new UCL Jarmo project under the ComPAg ERC Project has provided new C14 dates for the Jarmo Central Buildings at 7050-6710 cal. BC and the Jarmo Midden at 7030-6650 cal. BC (Fuller *et al.* in preparation).

In the light of these new dates and their correlation with the Braidwood's sequence, a new and revised hypothetical phasing of the site has been proposed by Fuller *et al.* (in preparation). The details of this chronology for Jarmo are summarised in the table below (Table 4.2.).

Table 4.2. Jarmo revised chronology and phasing (after Fuller *et al.* in preparation.)

Hypothetical Chronological Phase	Braidwood J.I	J.II and elsewhere	UCL: JW (=E or F)	JCB (=MN14)	JCM (=QR14)
Phase 4: Late Neolithic (ca.6500-6000 cal. BC)	J-I, 1	J.II.1-2, Upper midden of J.III	F4-5 (L.1-9)		Layers A-B (Up to spit 7)
Phase 3: Pottery Neolithic (ca.6800-6500 cal. BC)	J-I, 2	J-II, 3 J-III	F4-5 (Layers 10-13)	M14-15 MN14, 1-4	Layer C-D (spit/layers 8-16)
Phase 2: Terminal PPNB and Incipient Pottery (ca.7300-6800 cal. BC)	J-I, 3	J-II-4-5	EF4, 1-3	MN14, 5-11	Layer E (16-21) QR14 - 9
Phase 1: Middle? To Late PPNB (ca. 8000?-7300 cal. BC)	J-I, 4-9	J-II, 6 and below (unexcavated)	Lower EF4 (4,5) E4 E-3-4		

4.2.2. Environmental reconstruction around Jarmo

4.2.2.1. Present day environment of the Chamchamal plain

No many records have been found in relation to the environmental investigation of the Chamchamal Plain. In summary, the Chamchamal plain is one of the widest plains located on the foothills of the Zagros Mountains with the Gamasiab and Dinavar rivers as the two main rivers flowing from the east to the west of the plain. The Chamchamal plain is located in the Zagros region, which currently has a Mediterranean climate with hot and dry summers, especially at lower altitudes, in addition to cold and wet winters which become milder the closer to the Zagros foothills zone (Wright 1962: 136). Annual precipitation, often in form of snow, ranges from 250-400 mm in the piedmont, near to where Jarmo is located, to about 1,500 mm in the central part of the high mountains. Most of the precipitation falls between late autumn and spring with almost no rainfall during the summer (Wright 1962: 136-138; Zohary 1963: 5-6). Specifically for the Chamchamal Plain, the winters are cool and short in addition to very hot summers and an annual rainfall of around 463 mm (Chamchamal station measurements during 2000–2014). Maximum monthly average rainfall occurs in January (105 mm) and the minimum monthly average of rainfall occurs in July (< 1 mm), with snowfall rarely occurring in the area. The average minimum monthly temperature occurs in January (7.1°C) and the average maximum monthly temperature is in August (33.2°C) (Marsh *et al.* 2018). We can therefore estimate that modern rainfall of Jarmo should be between 400mm and 500mm per annum, which is sufficient rainfall to have regular annual crops of wheat or barley, as is indeed practiced locally.

The present-day vegetation in the Zagros region can be divided into four broad zones due to climatic differences from west to east: the lowland Mesopotamian steppe; the pistachio-almond forest-steppe (or savanna) of the foothills; the Zagros oak forest; and the steppe of the interior plateau (Zohary 1963). The site of Jarmo is located in the foothills in the middle of the Moist Steppe Zone. The present geology of the area consists of sandstone, clay and sandy gravel and the soil type is sandy clay. Among the botanical species endemic to this area are *Anthemis plebeia*, *Centaurea rigida* var. *schizophylla*, and *Thymus neurophyllus*. In addition, near-endemic botanical species are *Echinops mosulensis*, and nationally rare species were *Juncus effusus* and *Glaucium corniculatum*. Nowadays, the area is occupied by extensive crop and vegetable fields, with special focus on wheat and barley species (*Triticum aestivum*, *Triticum durum* and *Hordeum vulgare*) (NatureIraq reports 2005 Figure 4.17).

Figure 4.16. Qaradag mountains, Iraqi Kurdistan, May 2013 (Photo by DQF)

4.2.2.2. Early Holocene environment

Although no much palaeobotanical work has been done in the area around Jarmo, in general, the climatic conditions during the Younger Dryas (c 11,000-9,500 cal. BC) were colder and drier with an increase in temperatures and precipitation levels after ca.9500 cal. BC. Analyses of pollen records done on samples from cores collected from the Mirabad and Zeribar Lakes in the Zagros Mountains, suggest that the landscape was generally dominated by open vegetation. Recent work by Marsh *et al.* (2018), has provided new evidence which supports an increase in precipitation during the early to middle Holocene in the Zagros Area with conditions getting drier in the Late-Holocene slowly over the last 2500–2000 years. In addition, the analysis of phytoliths and speleothem from Shalaii Cave suggest a high level of climatic seasonality with one rainy season between at least 6075 cal. BC and 5027 cal. BC. In this sense, phytoliths suggest that water availability in the soils was high during the whole year during the Early and Middle Holocene, and slowly decreased during the 6th millennium BC but still allowing rain-fed crop agriculture in the Zagros area (*idem*.).

In terms of the available vegetation in the Zagros area during the Holocene, herbaceous species such as Chenopodiaceae, Artemisia and Apiaceae would have dominated this region. In addition, a variety of edible plants, such as perennial grasses, legumes and tubers would have been available to the communities in this area during the early, middle and late Holocene, although in low densities (Hillman 1996, 178-181). Trees, such as *Pistacia*, *Amygdalus*, *Quercus* and *Acer* expanded from the end of the Pleistocene, resulting in forest-steppe vegetation during the Early Holocene which could have also influenced and benefited the expansion of agricultural cereal fields (Hillman 1996, 181-192). Similarly, the expansion of a steppe vegetation would have benefited the hunting of animals such as gazelles, wild sheep and goats, etc, which could have favoured animal domestication during the Holocene in this area (Smith 1995, 50-51). Also, wild barley is found in the wadis and foothill grasslands in the Sulimeniyeh valley and can be expected to occur around Jarmo under wetter Early Holocene conditions (*personal observation*).

4.2.3. Architecture from Jarmo

Jarmo is an example of the well-evidenced Neolithic villages which emerged during the middle PPNB in West-Asia. Although fragmentary and generally poorly preserved, there is evidence of a variety of architectural structures at Jarmo. Many partially preserved buildings and floor levels were unearthed during Braidwood's excavations and, although not much investigation was dedicated to these, they are believed to represent the remains of rectilinear houses, made of *tauf* or mudbricks with stone foundations, formed by several rooms (at least two) and open middens and courtyards between buildings (Braidwood *et al.* 1983). The best examples of architecture from Jarmo were found in the excavation area J-II where 8 'floors' levels were identified within 3.75m in depth of the operation and four distinctive architectural phases were positively distinguished (Braidwood *et al.* 1983, 160). In area J-I Braidwood's team was able to identify up to 10 architectural phases with a well-preserved house with a courtyard which yielded abundant archaeological remains such as antler, horn, animal bones, stone tools and flint and sickles (Braidwood *et al.* 1983, 159). In addition, one of Braidwood's test trenches exposed a fragment of an enigmatic one-metre thick *tauf* wall, located near an ashy deposit (Braidwood *et al.* 1983, 165). Although no complete plan of the occupation of the site was uncovered, no evidence of specialised buildings was identified during Braidwood's excavations. All structures seem to follow the same plan and in terms of the archaeological remains recovered from these, they all seem to represent domestic structures (houses) (Figure 4.18).

As constituents of the houses, Braidwood (Braidwood *et al.* 1983, 157) identified several fire installations and fire features such as fire spots, hearths and ovens. These were described in the earlier levels as "baked-in-place basins", interpreted as simple roasting-pit ovens lined with burnished clay or a flat stone and often filled with ash, charcoal and stones. According to Braidwood, these were subsequently slowly replaced by "oven-like features" which would correspond to domed ovens (*firin*) made of clay or *tauf* materials. Some of the structures excavated in J.II, and especially structure 6, showed signs of having had some type of door or opening with connected the outdoor spaces with the indoor domestic space. In addition, similar types of doors or openings were seen from other "houses" in addition to ventilation features which have been interpreted as possible "windows" (Braidwood *et al.* 1983, 161). As mentioned earlier, many floor levels were identified by Braidwood's team, most of them having been layered with reeds forming a perfect matting (Braidwood *et al.* 1983, 163).

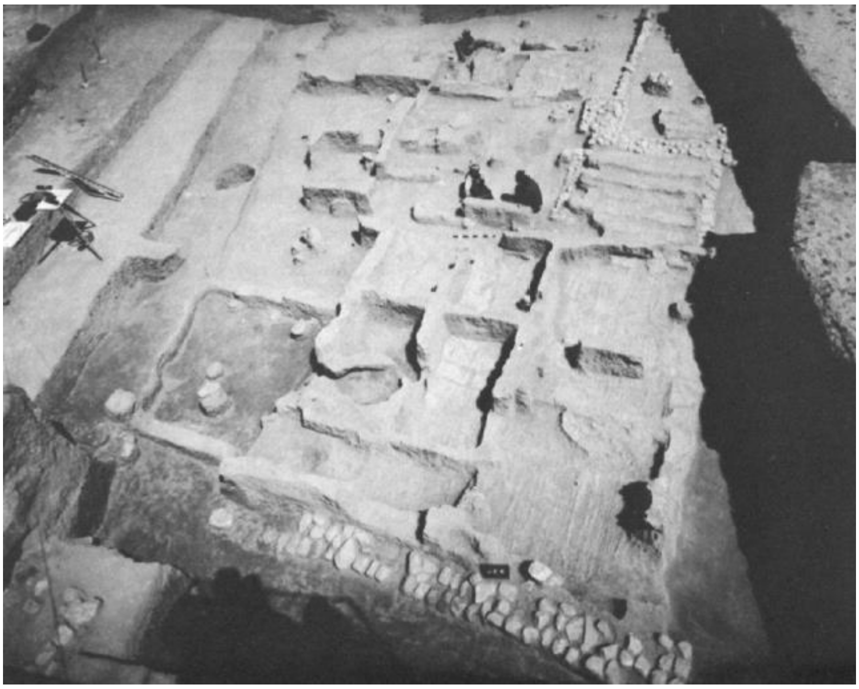


Figure 4.17. Jarmo buildings exposed during Braidwood excavations (Braidwood *et al.* 1983)

4.2.4. The archaeobotanical assemblage from Jarmo

4.2.4.1. Previous archaeobotanical investigation at Jarmo

The archaeobotanical assemblage from Jarmo was first analysed during Braidwood's excavations in the 1960s by Hans Helbaek producing some of the earliest evidence of the presence of domesticated wheat and barley species in the Zagros area. Helbaek (1960) provides a summary of the plant remains found in Jarmo and their importance in the archaeobotanical state of the art at the time. Helbaek identified remains of two glume wheat species, einkorn and emmer (*T. monococcum* and *T. dicoccum*), both as carbonised grains and impressions on the floors and ovens (Helbaek 1960, 107); in addition to archaeological remains of "cultivated" 2-row barley which constituted the earliest evidence of this crop at the time. From Helbaek's reports, it is not clear if these remains of barley were thought to be hulled species rather than naked ones; however later reports state that, although naked barley has been recovered from nearby sites and other sites in West Asia, no remains of naked barley were found at Jarmo (Watson 1983, 502). There is no mention of chaff in Helbaek's reports or from Watson's later summary (1983) however they make reference to numerous impressions of wheat and barley ears and spikelets being observed on the floors which would imply that some type of storage and crop-processing activities took place inside the buildings.

A range of pulses were also identified by Helbaek (1960) including pea (*Pisum sativum*), lentil (*Lens culinaris*) and vetch (*Vicia* sp.) but there was no specification about these being wild or domesticated types. In addition, Helbaek's reports did not provide evidence of wild weed seeds or other plant species being recovered from Jarmo at the time. However, the absence of wild seeds (arable seeds in particular) in the archaeobotanical assemblage from Braidwood's excavations seems highly unlikely. Full details, such as table or quantification of finds, were never published. Nevertheless, collection methods, which did not include sieving or flotation, mean that whatever assemblage he did recover can be expected to be biased against smaller items.

4.2.4.2. Archaeobotanical results from UCL Jarmo Project

The macrobotanical assemblage from Jarmo

New excavations directed by Prof. Dorian Q Fuller from the UCL Institute of Archaeology as part of the ERC ComPAg Project were carried out in 2012 and 2014 with the main aim of carrying out intensive sampling and flotation for the recovery of archaeobotanical remains. During these seasons, single context environmental sampling was applied to Jarmo and an estimation of ca.3400 litres of soil were processed through bucket and machine flotation. A total of 83 flotation samples have provided information about the archaeobotanical assemblage from Jarmo, shedding light on agricultural practices, plant use and foodways at this early Neolithic site.

Preliminary analysis and identification of the plant remains recovered from flotation during 2012 and 2014 seasons were carried out by Dr. Leilani Lucas. Posterior in depth analysis of the flots was carried out for this PhD study, in order to establish secure identifications for the crop remains and identification of potential food remains.

Figure 4.19 shows the frequency of plant remains recovered from Jarmo. Table 2 and Table 3 in Appendix (V) contain full taxa counts and frequency and ubiquity percentages for the botanical remains identified from the Jarmo archaeobotanical assemblage. In summary, crop material dominates the archaeobotanical assemblage from Jarmo with the presence of both cereals and pulses. It is important to say that the presence of cereals in the archaeobotanical assemblage from Jarmo is attested in its majority from the presence of glume wheat chaff (spikelet forks and glume bases), being the remains of cereal grains (kernels) considerably lower in numbers. The majority of the glume wheat chaff from Jarmo is constituted by glume bases of what it is believed to be most likely emmer (cf. *T. dicoccum*, 13.69%) however, due to poor preservation and their fragmentary state, only a small portion (1.94%) have been positively identified as derived from emmer wheat (*T. dicoccum*). Amongst the pulses, lentil (*Lens culinaris*) has the highest ubiquity, having been identified in 39.76% of the samples, followed by grass pea (*Lathyrus sativus*) and vetch (*Vicia* spp.). Occasional remains of pea (*Pisum sativum*) have also been identified, but in much lower numbers than the rest of the pulses, perhaps showing the lower importance of this crop in the early Neolithic in the area in comparison to other pulses and particularly lentil.

Surprisingly, barley has a very low presence in the archaeobotanical assemblage from Jarmo having been identified only in the 6.02% of the samples. Only 6 grains and no remains of chaff have been identified in the samples from 2012 and 2014 excavations, constituting only a 0.83% of the total botanical remains. Similarly, virtually no remains of einkorn have been identified in the samples analysed by the UCL Jarmo Project, reducing the presence of this crop to an unclear emmer/einkorn grain.

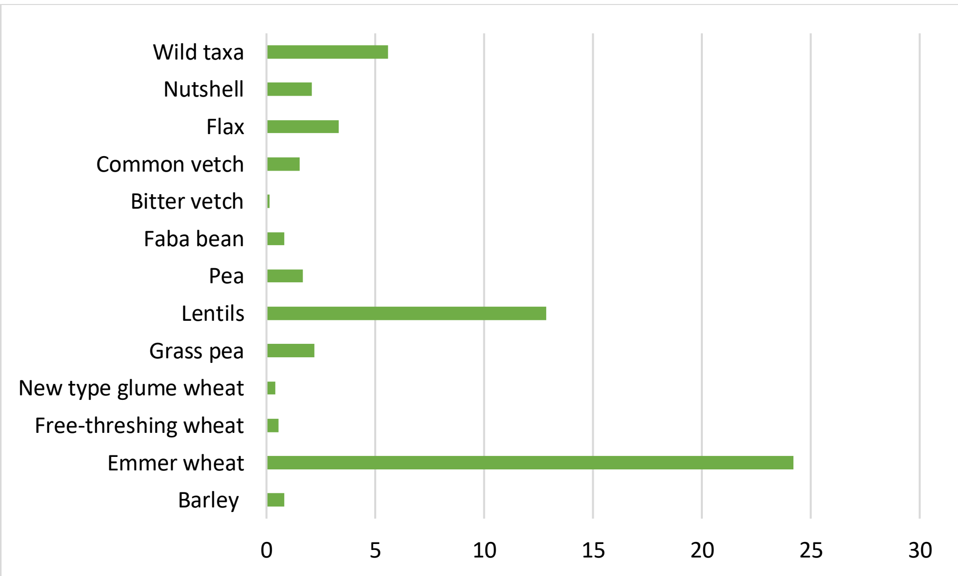


Figure 4.18. Bar chart showing frequency percentages of plant remains recovered from Jarmo.

On the other hand, the new Jarmo excavations carried out in 2012 and 2014, have yielded some especially interesting botanical remains which had not been identified before, such as free-threshing wheat (*Triticum aestivum/durum*), "new type" glume wheat (*Triticum* cf. *timopheevi*) and flax (*Linum usitatissimum*). Although the remains of naked wheat and new type glume wheat represent a very low portion of the cereal crops recovered from Jarmo, they provide very early evidence of the presence and use of these taxa in the Zagros area. A total of 4 grains and no chaff from bread wheat have been identified in addition to only 1 grain and 2 spikelet forks from “new type” glume wheat.

The presence of flax in the assemblage is slightly higher with ubiquity of 18.07% and a total of 24 seeds and seed fragments. This is of relevance as it represents one of the earliest examples of the use of the use of flax by Neolithic communities in the area. Helbaek, despite not having identified remains of flax from Jarmo during his analysis, was able to identify the earliest evidence of flax in the area from the earliest levels (ca.7500-6750 BC) at Ali Kosh is South West Iran. Although measurements of the flax seeds and morphometric analyses are on-going (Fuller *et al.* in preparation), the preliminary measurements situate the flax seeds from Jarmo among the domesticated type (*Linum usitatissimum*). These have been recovered from the earliest levels of the site excavated from the step trench (EF4, 5, ca. 8000-7300 cal. BC) to the later layers excavated from the midden deposits (QR14-15, 22) and, if the new chronology and dating for these trenches are confirmed, these remains of flax seeds might just be among the earliest to date.

In terms of non-crop taxa and types, arable weeds and wild grasses such as Poaceae (9.62%) and *Galium* sp. (6.02%) occur occasionally across the archaeobotanical samples followed by fragments of *Pistacia* sp. (4.82%) and indeterminate nut remains (8.43%). Other taxa and types identified include very occasional remains of Cyperaceae nutlets (3.61%), often of *Bolboschenus* sp. type.

It is clear when considering the assemblage as a whole that the majority of samples from Jarmo produced extremely low quantities of identifiable plant remains, particularly in comparison to the assemblages recovered from Çatalhöyük East; this is true whether considering raw counts and/or densities of material.

Differential distribution of botanical remains from Jarmo

During environmental sampling on site for the 2012 and 2014 UCL excavation seasons at Jarmo, from the three different opened trenches, the midden (JCM or QR14) deposits were especially targeted for archaeobotanical investigations. A total of 54 samples out of the 83 analysed samples were collected and floated from the midden contexts at the site. In comparison, the number of samples collected from the domestic structures and from the earliest occupation levels is lower, with a total of 17 from JCB (MN14-15) and a total of 12 samples from the step trench or JW (E and F) (see Tables 2 and 3 in Appendix V for full details).

– Midden deposits (JCM, QR):

Despite the JCM assemblage yielding the highest concentration of botanical remains, this is most likely due to the larger number of samples collected as these themselves did not produce a high number of plant materials. The most frequent plant remain recovered from the middens at Jarmo are pulses and fragments of pulses, representing up to 38.69% of the total midden assemblage. Among the pulses, lentil is the most ubiquitous constituent of the assemblage having been recovered from 40% of the midden samples. In contrast, remains of cereal chaff, weeds and cereal grains, which would be typical of assemblages derived from crop-processing activities, are present in very low concentrations. The second most frequently recovered plant materials are in fact amorphous charred remains of food (the object of this thesis) with 108 fragments having been recovered from the midden, representing 24.43% of the total midden botanical assemblage (Figure 4.20).

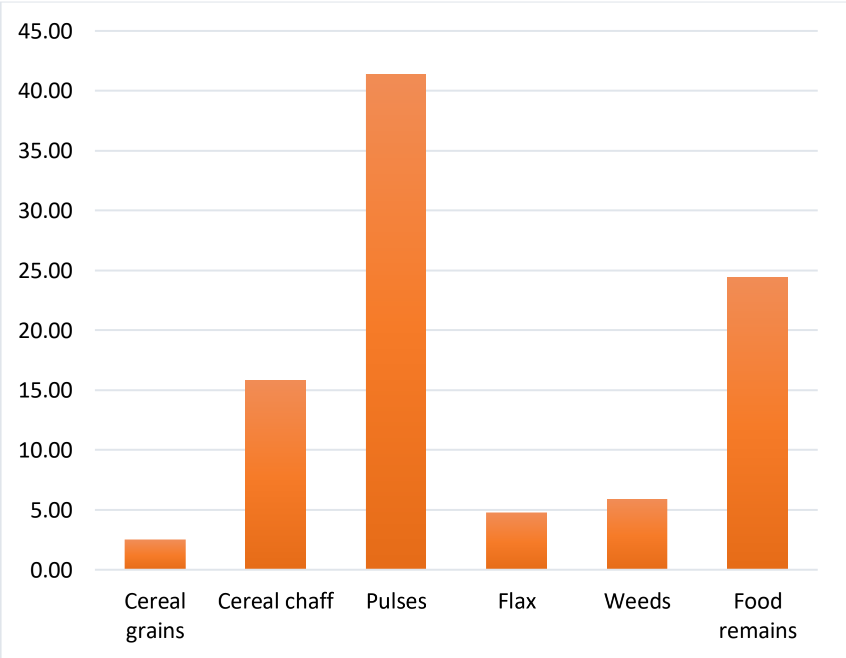


Figure 4.19. Bar chart showing frequency percentages of plant remains recovered from Jarmo midden deposits.

– Domestic structures (JCB, MN):

The 17 samples collected from the Jarmo Central Buildings area have yielded a medium concentration of archaeobotanical remains in general. It is interesting however that these samples contained the highest concentration of cereal chaff in contrast with the low presence of chaff amongst the samples collected from the midden contexts. Cereal chaff is the most frequent (42.75%) and ubiquitous plant material recovered from this area and it is dominated by wheat chaff, in particular glume bases and spikelet forks derived from emmer. Emmer chaff has been recovered from 35.29% of the samples and constitutes 42.65% of the JCB assemblage. The second most ubiquitous (47.06%) items in the archaeobotanical assemblage from the buildings from Jarmo are remains of lentils, followed by amorphous charred remains of food which have been recovered from 23.53% of the samples and constitute the 13.24 % of the total archaeobotanical remains recovered from this area of the site (Figure 4.21).

The high concentration of chaff contrasts with the low presence of weed seeds which constitute only 5.39% of the assemblage from JCB. The high presence of chaff in combination with low presence of cereal grains and weed seeds from JCB suggest that certain crop-processing activities, such as pounding and dehusking of semi-clean wheat spikelets, was most likely carried out inside the houses (Stevens 2014).

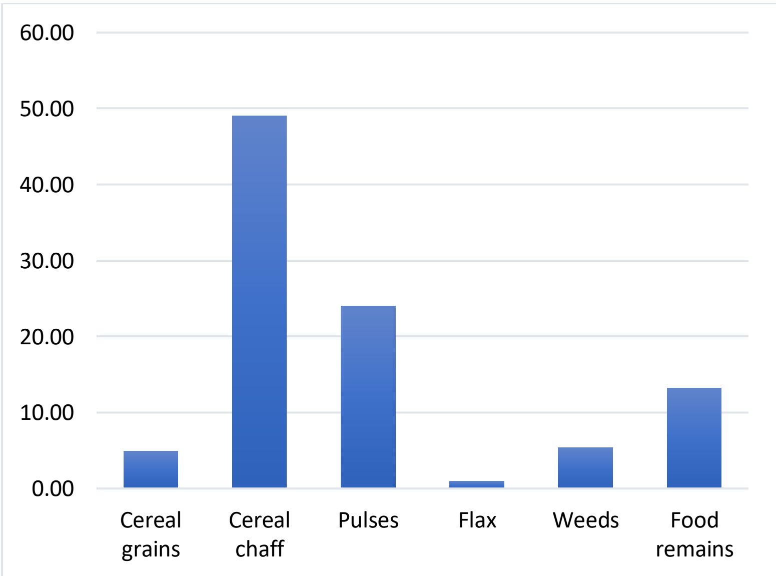


Figure 4.20. Cumulative frequency percentage of plant remains recovered from Jarmo indoor deposits

– Step Trench - JW (E-F levels):

A total of 11 samples were collected from the earliest levels of the Jarmo sequence, from the JW area. These samples have produced the lowest concentration of botanical remains in comparison to the JCM and JCB areas. Although emmer glume bases and spikelet forks are the most ubiquitous plant remains having been recovered from 36.36% of the samples, amorphous fragments of food are the most frequently recovered item, constituting more than half (52.08%) of the total archaeobotanical assemblage from the Step Trench. In addition, pulses and fragments of pulses (including lentils) are also relatively high amongst the samples from the earliest levels at Jarmo, representing the 18.75% of the assemblage from the Step Trench (Figure 4.22).

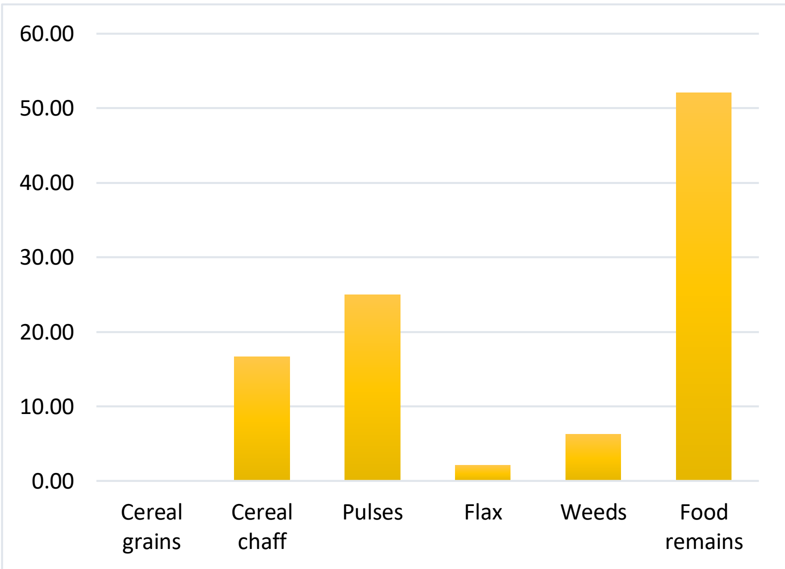


Figure 4.21. Cumulative frequency percentage of plant remains recovered from Jarmo step trench

4.2.5. Plant processing tools and cooking installations at Jarmo

4.2.5.1. Fire installations: hearths and ovens

As mentioned above, fire installations were recognised as part of the domestic arrangement of the houses and spaces at Jarmo. During Braidwood's excavations, a variety of features were interpreted as fire installations and more specifically as "oven-like" features or "baked-in place-basins". During the new UCL 2014 season and consequent post-excavation analysis and interpretation, these features have been found to represent possible pit ovens, hearths and ovens, similar to those recovered from other Neolithic ‘megasites’ such as Çatalhöyük.

Braidwood (1983, 157) indicates the presence of these types of structures inside the domestic architectural spaces (houses) and distinguishes between two types: a type of fire installation which appears in the early levels from Jarmo, described as “baked-in-place basins”, which were found similar to roasting-pit ovens lined with burnished clay or a flat stone and often filled with ash, charcoal and stones. These were subsequently slowly replaced by “oven-like features” with a dome in the later levels, which would correspond to domed ovens (or *tabun*/*firin*) made of clay or *tauf* materials. These two types of features have been found normally on their own, and there is only one example of them being found together from Braidwood’s Trench J-I level 6b.

The “baked-in-place basins” were interpreted by Braidwood as possible pit-ovens or roasting-pits mainly due to the abundant remains of charcoal and stones recovered from them. On the light of new observation and review of these features by Fuller *et al.* (in preparation), a wider categorisation of these has been created. Although, in fact some of them are filled with stones which could have been used for roasting or food heating purposes for cooking activities, the majority of them represent hearths with raised rims, such as those identified from a number of Neolithic sites in Western Asia (e.g. Aşıklı Höyük, Çatalhöyük, Bestansur, etc). It seems perfectly reasonable that these were also use for baking bread on their walls as well as other cooking activities (as argued by Fuller & González Carretero 2018; *under review*). At Jarmo, these were seen to have been excavated in the floor of the houses down to a maximum of 50cm depth and lined with clay and plant tempered. The “oven-like” features have been found to be oval in plan, with an opening at the front and heavily burnished and tempered with clay and plant materials (Braidwood *et al.* 1983, 157). These structures were also seen to have been rebuilt and re-tempered with clay to help cover the cracks and fractures which were made during their use span. Excellent examples of these fire installations come from level J-II, 6, with numerous ones having been recovered from a partially excavated building (Figure 4.23.).

At the time of Braidwood’s investigations, the function of these fire installations was not clear, and although they presumed their use for cooking purposes, there was no in-depth investigation into their possible uses. Braidwood initially suggested the role of the “oven-like” features for bread baking but as a consequence of the presence of both crops and wild seeds in the archaeobotanical record, Helbaek (1960) suggested an alternative use of these installations for dehusking of glume wheat and hulled barley species, similarly to the European "corn-dryers" (Braidwood *et al.* 1983, 158). As it was argued earlier in this chapter, the presence of the combination of crops (cereal and pulses) and wild seeds in the macrobotanical assemblage from Jarmo is more likely derived from the use of dung as fuel and the burning of residue from crop-processing activities as a result of routine cleaning of the houses, as seen from other Neolithic sites in Western Asia.

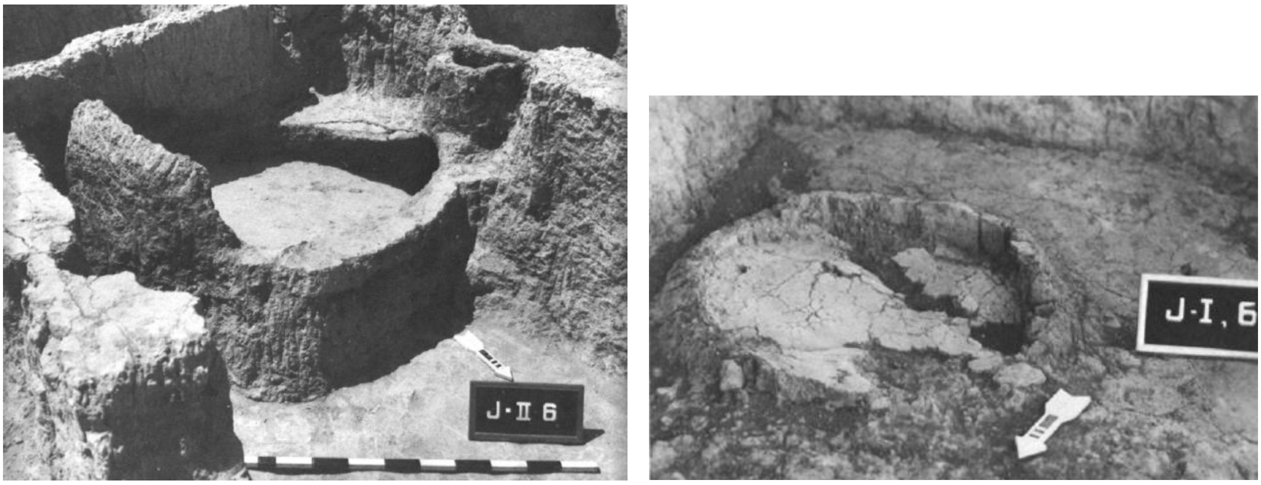


Figure 4.22. Examples of fire installations excavated from Jarmo: Oven-like structure (left) and baked-in basin (right) (Braidwood *et al.* 1983).

4.2.5.2. Ground stone tools

The archaeological assemblage from Jarmo has provided numerous examples of ground stone tools including querns, grinding slabs and handstones believed to have been involved in food processing and preparation among other activities.

Although not much research has been carried out into the analysis of the ground stone tools from Jarmo, it is important to remark that many examples were recovered during excavation by Braidwood's team and during the new UCL project. Numerous fragmentary querns, in their majority made of limestone and chert, were found in the buildings and courtyards from Jarmo. These have been interpreted as "fixed-in place" stones which were most likely involved int the processing of plant foods such as cereals and other crops through grinding (Moholy-Nagy 1983, 291). These foods were ground on the surface of the querns with help of handstones, many having also been recovered from Jarmo. A total of 41 handstones were analysed by Moholy-Nagy (1983, 290) from Braidwood's excavations providing some details about their manufacture and possible uses. In summary, these did not exceed a maximum size of 22cm and seemed to have been made in their majority of limestone, with some being made out of chert and other non-identified materials (Figure 4.24.). Most of them also looked like they had been used unifacially, however there were some examples which had sings of polishing in more than one side of the tool.

In addition, many portable grinding slabs have been recovered from Jarmo and have been interpreted as tools for crushing pigments and other materials such as plant foods (nuts, spices, etc) (Moholy-Nagy 1983, 291). They seemed to have been made of limestone in their majority, as seen for the querns and handstones.

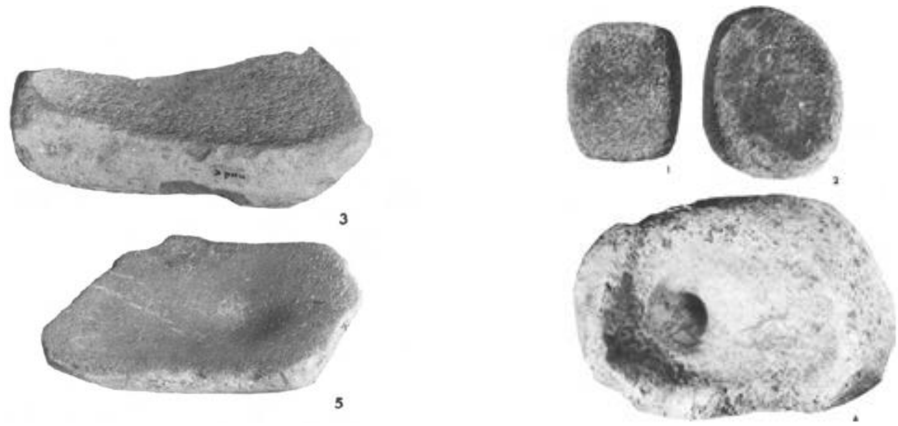


Figure 4.23. Examples of ground stone tools recovered from Jarmo (Braidwood *et al.* 1983)

An aspect to consider about the ground stone assemblage in relation to cereal processing is that it resembles the types of tools seen for the other site considered for this PhD study, Çatalhöyük East. The same categories, such as fixed large querns, smaller portable grinding slabs and handstones have been identified from both assemblages, showing that the same types of tools were manufactured and used for perhaps the same type of activities. Another similarity between the ground stone tools for plant processing from Jarmo and Çatalhöyük is their fragmentary state. As mentioned in the chapter dedicated to Neolithic Çatalhöyük, the majority of the querns and grinding slabs which have been recovered from the site seem to have been intentionally broken at the moment of abandonment of the house. This has been interpreted as a possible sign of ownership over these tools by the inhabitants of the houses (Wright 2014).

4.2.5.3. Stone vessels and the emergency of pottery at Jarmo

During both the Braidwood's and UCL excavations, Jarmo yielded a large variety of archaeological materials. Perhaps the most remarkable example of material culture is the worked stone industry which has provided exquisite items such as stone vessels, numerous beads for bracelets and pendants and other ornaments and rings. A total of 1323 stone vessels was recovered from Braidwood's first two excavation seasons showing impressive aesthetic finish with polish thin walls. Adams (1983) studied the materials used for the fabrication of these and concluded that the preferred materials were marble, limestone and less often sandstone, some of them of aesthetically pleasing mottled type or varieties with red or grey veins. It has been suggested by H.E. Wright that these materials would be available locally and most likely from the large boulders in the wadi below or from the bottom of the ridge several kilometres to the east of the site (Adams 1983, 210). Many different types of vessels were distinguished among the recovered assemblage, including saucers/plates, cups and bowls with rounded or flat bases, with flaring or vertical rounded side. The variety of forms among the stone vessels seems to decrease throughout the sequence in combination with a decrease in the use of large stone vessels (Figure 4.25.). This has been interpreted as perhaps a consequence of the emergence of production of pottery vessels and therefore a widening of types of cooking or storage implements available (Adams 1983, 212).

Figure 4.24. Examples of stone vessels (left) and pottery vessels (right) recovered from Jarmo (Adams 1983 in Braidwood *et al.* 1983).

Pottery starts appearing in the archaeological record from Jarmo late in the sequence of occupation, with the highest concentration of pottery sherds recovered from the latest two levels of Braidwood's excavations. From Braidwood's level 4 downwards there is no evidence of ceramics, while a small number (32 sherds) of pottery remains were reported stratified from level 3 (Adams 1983). In the Central Buildings part of the site (Braidwood Trench J.II) a large amount of pottery sherds (>1000) were recovered from the top two levels (levels 1 and 2) and surface deposits. All the examples of pottery recovered from Jarmo was handmade and primarily tempered with chaff and straw. Initially, it was rather of good quality but the uppermost artefacts were cruder and less frequently decorated (Adams 1983, 213). Many of the earlier ceramics were burnished, but from the outside only and there is also evidence of some painted sherds, which were often subsequently burnished, and their patterns were simple and linear. Initially the most typical decorations were continuous diagonal 'blobby' lines, followed by patterns of horizontal bands and vertical lines as well as decorated with a thin band along the top; in the uppermost layers only two painted examples were found including one which had an unusual crosshatch pattern (Adams 1983, 216–8). The decrease in elaboration in the pottery forms suggests that the very first examples of ceramics could have been imports from other areas into the Jarmo community and subsequently replaced by indigenous production of ceramics (Adam 1983, 222-3).

Although there are some similarities between the forms in which stone and pottery vessels were made, in general pottery vessels were more associated with the use of large pots and bowls, while the most commonly recovered stone vessels represent small forms such as plates, cups and small serving bowls. This, together with the decrease in the production of stone vessels could have been due to a specialisation of each type of fabric for different uses (Adams 1983, 221), with ceramics perhaps more associated with cooking activities.

4.2.6. Previous research into cooking practices and *cuisine* at Jarmo

Virtually no research into cooking practices and food preparation has been previously done at Jarmo. Until the current PhD investigation, the only evidence of the preparation of plant and animal resources into food by the Jarmo community was limited to a low number of references in relation to possible uses of pottery, fire installations and ground stone tools for the processing of foods.

As previously mentioned, although no microware analyses of micro traces have been performed of the ground stone tools from Jarmo, querns and grinding slabs have been interpreted as used for the processing of plant foods such as cereals, pulses, nuts/fruits and possible wild plants used as condiments (Moholy-Nagy 1983, 291). Similarly, fire installations, such as ovens and hearths have been interpreted by Braidwood as features for food processing and cooking, including activities like parching and drying of cereal ears before dehusking or threshing (Helbaek 1960 in Braidwood *et al.* 1983). Particularly interesting is Braidwood's interpretation of the Jarmo ovens as installations dedicated to bread baking. With the purpose of learning more about the possible functions of these ovens, ethnographical investigations were carried out in Kani Sard, the local village near Jarmo; where they performed traditional bread making and baking using ovens built by the local community (Braidwood *et al.* 1983).

Other types of cooking practices and serving references have been made in relation to stone vessels and pottery recovered from Jarmo. It has been suggested that stone vessels, whose presence in the archaeological record is very high during the early levels of the occupation at the site, and pottery vessels might have had different cooking functions, perhaps even with relation to different mixes of ingredients or "recipes" (Adams 1983, 221). In addition, throughout the Jarmo sequence stone vessels are seen to decrease in number in relation to the high presence in the earlier levels, while the remains of pottery vessels increased in number from the middle levels onwards. This increase on the use of pottery at Jarmo did not mean a complete disappearance of stone vessels, however these seem to decrease in size and their presence gets reduced to small forms. At the same time, pottery vessels seem to increase in size and imitate the shapes of those stone vessels recovered during the earlier levels, which in combination with the reduction of stone vessels to small cups and bowls, has been interpreted as evidence for specialised uses of the two types of vessels (*idem*). Most likely this 'vessel type specialisation' had to do more with different functions, with large pottery vessels being used mainly for cooking (boiling, stewing, etc) while small stone vessels might have been linked to serving and consumption activities.

4.2.7. Summary

The site of Jarmo in the Central Zagros is an early Neolithic site which has served of comparison with the site of Çatalhöyük East in relation to plant food preparation and culinary traditions. The site of Jarmo, first excavated by Braidwood, is another example of a Neolithic megasite of southwest Asia which emerged at the beginning of the PPNB, around ca. 8000 cal. BC. Despite the limited excavations carried out at Jarmo the macrobotanical assemblage has provided an abundant concentration of food fragments, which represent the remains of cereal meals consumed by the Jarmo community during the Neolithic.

Chapter 5

Materials and methods

5.1. Background to methodology

Despite charred amorphous fragments of cereal meals being commonly recovered with routine archaeobotanical flotation, these remains have often been overlooked by archaeobotanists due to their undistinctive appearance, elaborated methodology and time-consuming analyses needed for their successful identification. Consequently, more easily recognisable materials, such as whole loaves of bread have frequently received archaeologists' attention.

In this sense, the first study to provide a typological classification of bread types which had been recovered from archaeological sites in Europe was Währen (1989; 2002). He based his typology on modern examples of bread products which he then compared to the ones recovered from Neolithic, Bronze Age, Iron Age, Roman and Medieval periods. This typological classification of archaeological breads was based on the morphological characteristics present in them, such as shape and thickness. Along this line of research was the study of desiccated Egyptian bread from tombs in the New Kingdom (ca. 1550-1070 BC) carried out by Samuel (1994, 1999, 2000) which provided significant insights into ancient bread and beer making in Egyptian times. More recent studies by Lannoy *et al.* (2002), Heiss *et al.* (2015; 2017) and Primavera *et al.* (2018), have focused on identifying the cereal components of Roman bread-like objects and "galettes" applying anatomical analysis under Scanning Electron Microscope (SEM) to identify cereal tissue types. Their results provide unique new information about the different ingredients used in the preparation of these breads, as well as cereal processing techniques (e.g. grinding, sieving of flour, etc), and various ways of preparing doughs and potential cooking practices.

In the last decade there has been an increase in the interest that archaeobotanists have paid to the analysis of charred amorphous fragments of plant-based food preparations. The systematic recovery of archaeobotanical remains through flotation provides the potential to collect small charred fragments of food preparations from most archaeological sites in the world (see Popova 2016). Hansson and Isaksson (1994) were the first ones to carry out tissue-based analysis of this type of fragments of processed food from several archaeological sites in Sweden

(Västergarden, Vrå, Harrsjöbacken and Folåsa). Their study was the first successful application of SEM to identify the plant composition of amorphous fragments of cereal meals, which with the addition of chemical analyses. Since the publication of this thesis' methods (González Carretero *et al.* 2017), studies of amorphous charred remains have proliferated. Of particular importance were the identification and the analysis of the oldest known fragments of bread-like products from the site of Shubayqa I in Jordan by the author of this thesis in collaboration with University of Copenhagen (Arranz-Otaegui *et al.* 2018). In addition, a recent study by Valamoti *et al.* 2019, building on previous identification of charred remains of cereal products from several sites in Bulgaria and Greece (Valamoti 2002; Valamoti *et al.* 2008), has explored the idea of the categorization of a variety of cereal products recovered from a series of archaeological sites from the in Southeast Europe however without fully succeeding.

Before the current doctoral study, there was no previous cohesive methodology for the analysis of archaeological food remains and therefore, this chapter presents the first integrated methodology for the analysis of archaeological cereal meals applied to the samples retrieved from the sites of Çatalhöyük and Jarmo (González Carretero *et al.* 2017). The methodology described here uses Scanning Electron Microscopic (SEM) observation to analyse the microstructures of amorphous charred food fragments from Neolithic Çatalhöyük (Turkey) and Jarmo (Iraqi Kurdistan), which is compared with SEM observations of experimentally-produced reference materials. This methodology focuses on four aspects:

a) The analysis of the plant species composition present in the food fragments (main plant ingredients).
b) The analysis of the food fragments' microstructure to determine different preparation and cooking processes, such as baking or boiling.
c) The comparison of archaeological food fragments with experimentally prepared reference materials.
d) The analysis of the molecular and lipid composition of selected food fragments to investigate the possible use of animal products in conjunction with plant ingredients.

Significant progress has been made in studying the remains of archaeological food in different areas of the world. In particular, investigations carried out under the European Research Council PLANTCULT Project led by Soultana Maria Valamoti have made an attempt to the analysis of amorphous remains of cereal meals from Prehistoric and Ancient archaeological sites in South Europe. In the context of this project, recent publications have focused on SEM observation of different types of amorphous food remains found in the archaeological record (Valamoti et al. 2019). These have added valuable information about the types of ingredients used for their preparation. In this thesis I add two further elements: in-depth observation of the food's microstructures, and the application of experimental archaeology. These give extra insights into the potential cooking processes behind these remains and consequently into the types of cereal meals Prehistoric people might have consumed

In this sense, experimentation is a key aspect of the methodology presented in this PhD thesis which has facilitated the comparison of the abundant archaeological food remains with experimentally cooked materials, allowing the investigation and interpretation of what type of cereal meals and preparations Neolithic people intended to create.

5.2. Field sampling

Due to the lack of a previous integrated methodology applied to the recovery of archaeological food samples, a new systematic procedure for the collection of amorphous food remains on site was developed for this study. For the initial recovery of macrobotanical remains, I followed sampling and processing methods developed during the 1990s excavations at Çatalhöyük, including machine flotation and wet sieving (Hastorf 2005). From Çatalhöyük, random subsamples of the flot in 1mm-4mm size range was extracted with a riffle-box for sorting of an initial subsample of ca.10 ml to provide a first quantitative assessment of seed and chaff remains, while the >4mm fraction was scanned for non-wood charred remains (nuts, tubers, or food fragments). Flot samples that appeared to contain amorphous charred cereal products during assessment were selected for further analysis.

During scanning and selection of samples, amorphous remains of food were clearly distinguishable from other macroremains of similar physical appearance such as charred tuber fragments and remains of dung. Observation under the binocular microscope allows for the identification of differences between characteristics of the microstructure of food remains and those of tubers and dung remains. Remains of food have a unique porous and even microstructure, in which small fragments of tissues from the cereal kernel are often visible. In the case of tuber fragments, their microstructure is completely different and are formed by easily distinguishable parenchyma cells and vascular bundles. In the case of dung, although if fragmented show an amorphous appearance, these are not so porous and have a more compacted microstructure. When examining dung fragments closer under the microscope, small plant tissues, in their majority from leaves, stems and cereal chaff are seen in great quantities, making the distinction of these and food remains clear.

In total, 245 flotation samples from contexts that span the major phases of Çatalhöyük were selected for further analysis from the North, South, GDN and TPC areas of the site during 2013-2017 excavation seasons. Initial scanning on site suggested that these samples are representative of, primarily, *in situ* food processing contexts such as rake outs from ovens, hearths, fire spots and refuse accumulations indoors and outdoors contexts as well as representing aspects of 'Neolithic recipes' before, during and after cooking. These samples were then sorted in their entirety of >1mm seed remains, and smaller fractions were subsampled and scanned. After scanning of the flots, 182 flots were found to contain archaeological food fragments. From each flot, one or two food fragments were then chosen for further analysis under binocular microscope and SEM. A total of 170 archaeological food fragments were fully analysed following the developed methodology for this study and the results of these are presented in chapter 6 (see Volume II for details). Samples and food fragments were assigned the corresponding levels and categorised in phases of occupation according to the data available in the Çatalhöyük Research Project Database (http://www.Çatalhöyük.com/research/database). A number of samples were recovered from truncated Neolithic contexts in the TPC area (marked as Final-T in "Phase" category in Appendix II) and are believed to be representative of Neolithic activities, which were truncated by Post-Neolithic features (A. Marciniak 2019, *pers. comm*). These are marked as Post-Neolithic, Chalcolithic and Post-Chalcolithic in Appendix I, as the contexts were assigned the levels from the late features at the moment of excavation.

From Jarmo, 80 flotation samples were scanned and sorted from the 2012 and 2014 excavation seasons. During the sorting process, charred food fragments were noticed and put aside for comparison with Çatalhöyük materials. Out of 80 scanned flots, 18 contained remains of charred food from which 28 fragments were selected for full analysis under binocular microscope and SEM following the developed methodology for this study. The results of these analyses are reported in chapter 7.

5.3. Microscopy

As it was mentioned above, several techniques have proved successful in previous research for the analyses of archaeological fragments of charred cereal preparations, from morphological to microanatomical tissue analysis and the application of chemical methods (Hansson and Isaksson 1994, Valamoti 2002; Valamoti *et al.* 2008; Währen 1989, 2002). However, these analyses were always applied in a unilateral way without following a coherent and cohesive process. Due to the food fragments from Çatalhöyük and Jarmo being very numerous and varied, I chose to develop a multiproxy integrated methodological approach which combines the use of microscopic analyses and experimental preparation of cereal meals in order to compare cooking processes and ingredients used for their preparation. In this sense, the methods for this study follow a process formed by four steps: i) microscopy: the study of microstructures and plant cell-tissues under low-powered binocular; ii) SEM: more detailed characterisation under Scanning Electron Microscope, including the study of the food matrix through semi-quantitative recording of voids and plant particles and anatomical description of any included recognisable plant tissues; and iii) the experimental preparation of cereal meals to use as reference materials for comparison with the archaeological charred food fragments; iv) isotopic and lipid analyses to investigate the possible addition of animal products to the preparation of these foods (Figure 5.6.).

Initial observation of the samples under low-powered microscope was made using a Leica EZ4 binocular microscope at magnifications of 8x to 50x; images were created using a Leica S6D microscope and a Leica EZ3 camera. From these, food fragments that present visible plant inclusions (such as plant tissues) were selected for further study under SEM. For SEM observation, samples are cleaned from soil sediments with a brush, sputter coated with ca. 1micron of gold, and examined using a Hitachi S-3400N scanning electron microscope at the UCL Institute of Archaeology. During the microscopic analyses, two main aspects are investigated: the identification of specific types of plant tissue in order to clarify the ingredients used for the preparation of these meals; and the exploration of the food fragments' microstructures, which are a result of the processing and cooking techniques used for their preparation.

The first aspect of investigation is based on identification characters developed by Korber-Grohne (1981), Dickson (1987), Colledge (1989), Holden (1990), Heiss *et al.* (2015; 2017) and Primavera *et al.* (2018) and botanical reference materials from the UCL Institute of

Archaeology plant reference collection. In this sense, the following plant tissues have been considered (as previously tested by Heiss 2010; 2012; Heiss *et al.* 2015; 2017 Primavera *et al.* 2018): tissue layers present in the cereal kernels (pericarp and endosperm), chaff (epidermis of paleas and lemmas), other parenchyma tissues (pulses and sedge tubers), specific vascular tissues (sedge tubers), and starch granules. Starch granules, which are not easily preserved in charred material, can provide important information about processes used in food preparation (Samuel 1994; Valamoti 2002; Valamoti *et al.* 2008).

As mentioned earlier in the text, no previous example of a cohesive and systematic methodology for the study of microstructures of amorphous charred food fragments was found. Aside from the early work by Hansson and Isaksson (1994) and a brief mention of possible cooking processes in relation to their shape and consistency (Lannoy *et al.* 2002), the other more recent studies such as Valamoti's and Heiss' work, lack a unified and consistent methodology for the identification of amorphous food fragments. In this sense, one of the main aims of this study was to create a specifically designed methodology for the study of microstructures of archaeological food remains. Specially, three features were chosen for further exploration: i) cooking processes which could have affected a lower or higher presence of pores (voids) in the food matrix and the quantity, shapes and types; ii) various pre-cooking processes, such as different types of grinding techniques or water content and the cultural choices of ingredients/flours which directly determine the type of particles present in the food matrix, and how they are preserved in the charred product; and iii) ingredients used for their preparation.

5.4. <u>Typological data sets for the analysis of archaeological food remains</u>

For the creation of reliable and accurate typological data sets for the analysis of internal structure of archaeological charred cereal products, typological work on the description of different archaeological materials such as soil, sediments and pottery were explored. Based on Lévi-Strauss' (1988) comparison of pottery and cereal products such as bread, as the process in which 'a shapeless mass is first prepared, then given form, before being cooked in a kiln', I chose to build on the principles developed to study ceramic fabrics in relation to porosity, hardness and inclusions, as developed for example by Washburn (1921), Grimshaw (1971), Rice (1998), and Matthew *et al.* (1991). In particular, voids are characterised to assess the nature of porosity, included particles such as non-plastic inclusions in ceramic matrix can be characterised in terms of size, distribution, and angularity of inclusions. In the case of food, these inclusions often include anatomically recognisable fragments of plant cell tissues but may also represent transformed amorphous starch.

Following the attribute sets used for the study of thin sections of pottery in Archaeology, I created three attribute sets to describe the internal structure (matrix) of the archaeological food fragments:

- *Attribute set A* focuses on the quantification and measurement of visible plant inclusions or particles, such as fragments of cereal tissues, in the food matrix (Figure 5.1.). An estimation chart was created for the classification of the visible plant inclusions present in the food matrix, separating particles by size and quantity. The particles size and quantity were divided into categories. For the particle size three categories were created: particles measuring 50-400µm, 400-800µm and >800µm; and for the number of particles four categories were created: 1-2 particles, 3-4 particles, 5-6 particles and >6 particles.

- *Attribute set B* focuses on the estimation, quantification and measurement of voids (air or gas bubbles) present in the food matrix (Figure 5.2.). An estimation chart was created for the estimation of the percentage of porosity present in the food matrix. Voids size and percentage of voids were divided into categories. For the voids size three categories were created: voids whose mean area ranges 50-300µm, 300-600µm and >600µm. For the percentage of voids, porosity levels were divided in four categories: 5% porosity, 10-20% porosity, 20-30% porosity and >30% porosity.

- *Attribute set C* focuses on the typological classification of the previously quantified voids (air or gas bubbles), in terms of void types and shapes (Figure 5.3.). Three different categories of voids, like those seen in the pottery thin layers and categorised by Matthew *et al.* (1991), have been observed in the food matrix: cracks or channel voids, micropores and closed voids.

Following the different attribute categories described above, the selected archaeological food fragments were analysed using SEM for specific observation of the matrix/microstructure. During this, up to six images of the matrix of each food fragment were captured, at 16-20 mm working distance (depending on food fragment size) and at 50x magnification, to cover the whole surface. Then, the particles (attribute A) and voids (attribute B and C) were estimated, quantified, measured and categorised following a simple process.

First, visible particles (inclusions) on the 50x magnification image were counted and the average was calculated when having more than one image. Then each particle length was measured using the SEM Hitachi measurement tool and the average length among particles was calculated (see Figure 5.1.).

Second, using the estimation chart (Figure 5.2.), gas bubbles or voids visible on the 50x magnification images were quantified and measured. Voids were estimated depending on their size and the percentage of matrix surface that they covered. Following the categories created on the charts, a mean size and an estimated percentage of voids in the food matrix were calculated. To minimise error, the percentage of voids was estimated again using Gwyddion, a free access modular program for SPM (scanning probe microscopy) data visualization and image analysis (© David Nečas and Petr Klapetek, Department of Nanometrology, Czech Metrology Institute). This was done through the “data process” option, choosinf to mark the “grains” with “threshold”. This process allowed confirmation or correction of the accuracy of estimated made by eye.

Third, the matrix was classified based on the shapes of voids, based on the most frequent void shape/type encountered on the 50x magnification images (micropores, closed voids or cracks/channel voids) (see Figure 5.3.).

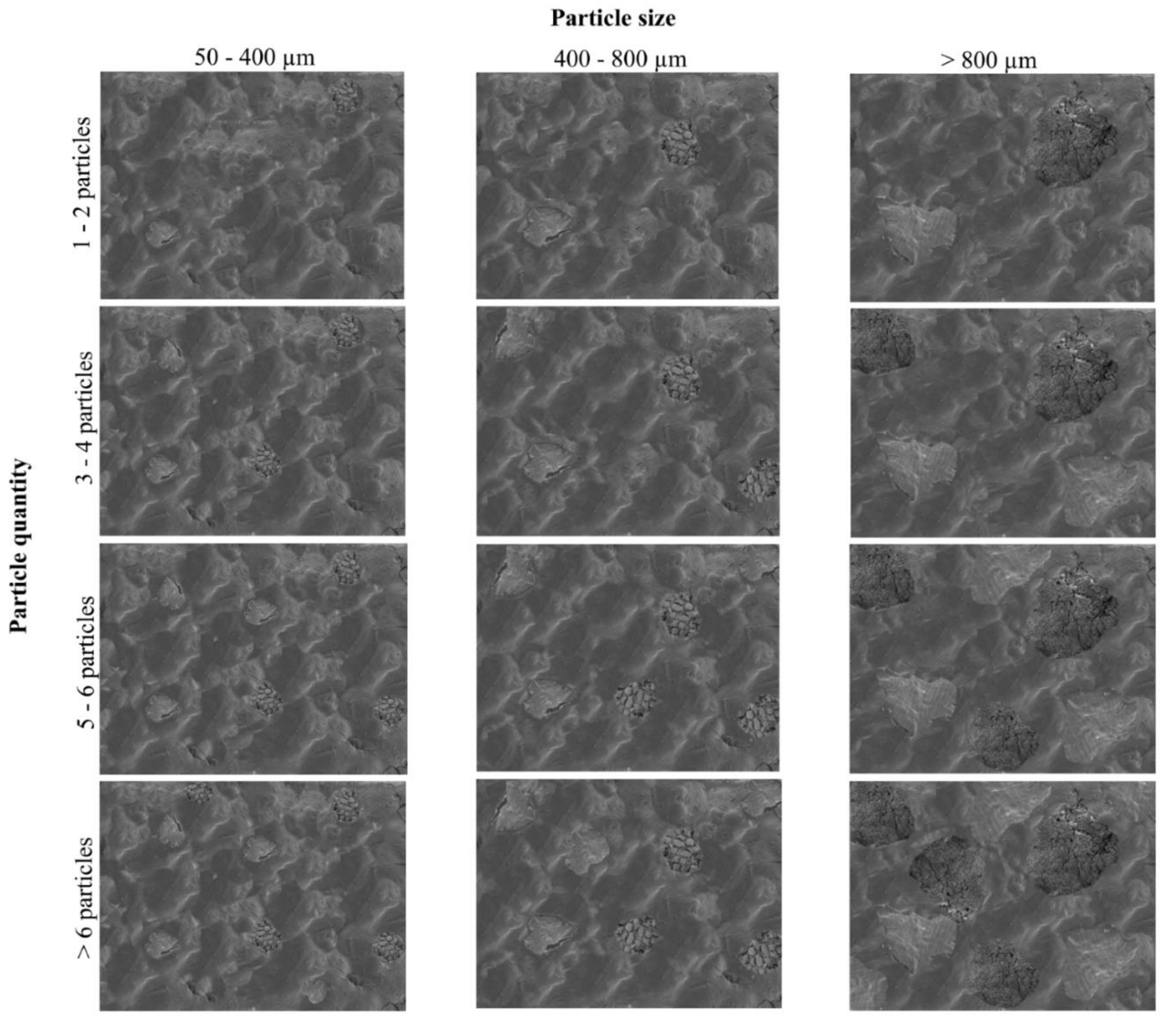


Figure 5.1. Estimation chart for the quantification and measurement of visible plant inclusions or particles visible in the food matrix (published in González Carretero *et al.* 2017).

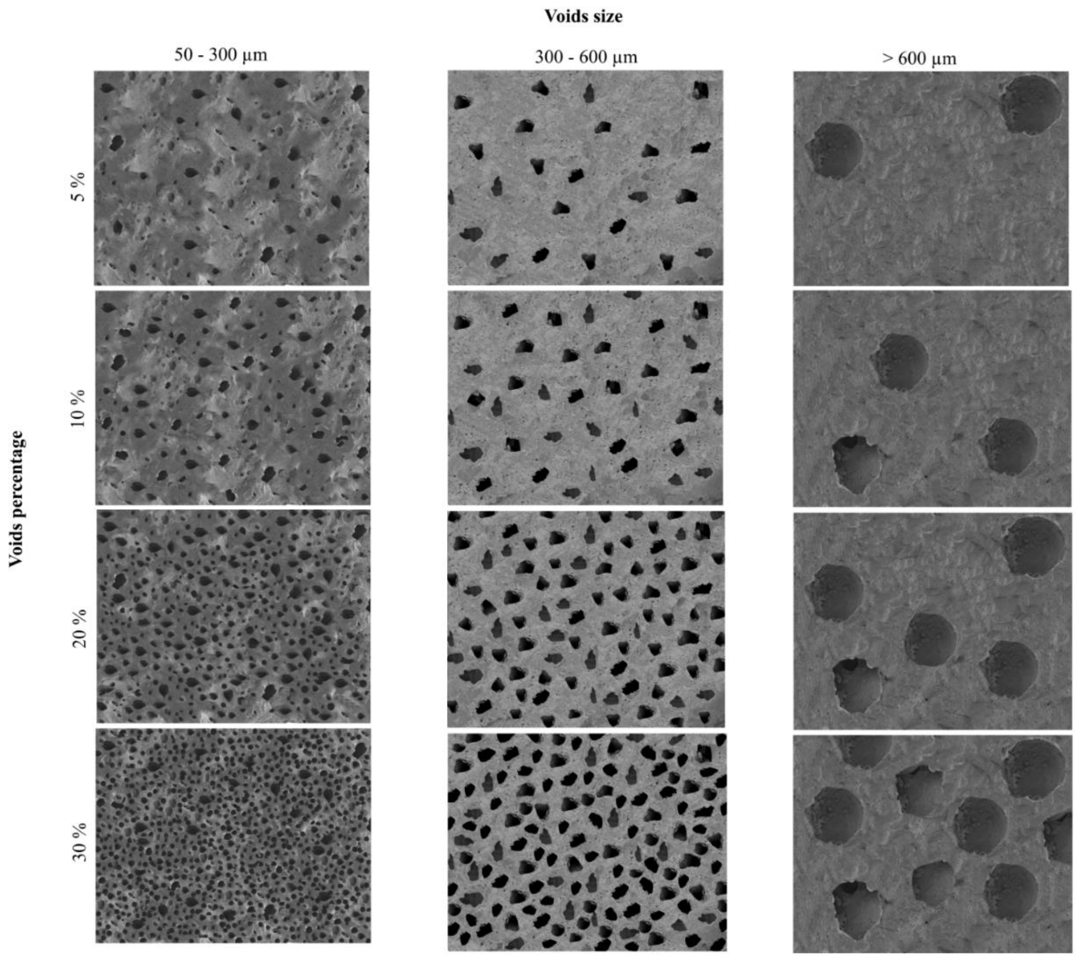


Figure 5.2. Estimation chart for the quantification and measurement of voids percentage in the food matrix (published in González Carretero *et al.* 2017).

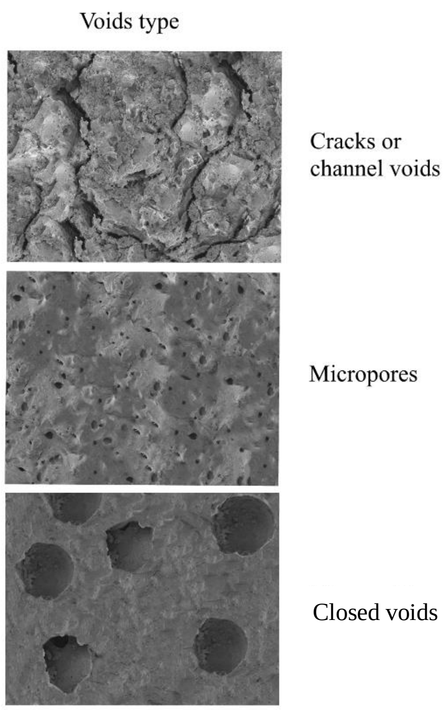


Figure 5.3. Classification of voids types within the archaeological food fragments (published in González Carretero *et al.* 2017).

5.5. <u>Creation of experimental reference materials</u>

Experimental cooking and charring experiments are a major component of the methodology for this research study. Experimentally prepared and charred foods, which were created under controlled conditions, have served as a reference collection for identifying their contents and preparation processes that led to the carbonised archaeological food fragments under study.

5.5.1. First set of experiments: Cereal meals

Due to the previous identification of Çatalhöyük charred foods as “bread” (Bogaard *et al.* 2013) and because of their frequent visible cereal inclusions in the matrix, cereal foods were chosen for this first set of experiments.

Different cereal grain materials were treated as part of these experiments. Two types of cereals, which are present in the archaeobotanical record at Çatalhöyük East (Bogaard *et al.* 2013), were chosen for this first set of experiments: naked barley (*Hordeum vulgare*) and bread wheat (*Triticum aestivum*). Bread wheat and barley were chosen in order to explore differences in the way they react to processing and cooking in addition to studying the differences between microstructures of cereal meals prepared using a gluten-rich cereal type (bread wheat) in contrast with those prepared with barley, a cereal known by its low gluten content. The bread wheat was harvested in Dorset (UK) and it was cleaned and threshed following traditional methods as part of the PrimTech experimental Archaeology course organised by UCL Institute of Archaeology. Naked barley was purchased already threshed and cleaned from fields in Germany through the Fairtrade company Bolandiol Knauf. Both types of grain received three different treatments followed by processing and preparation into three cereal products/meals:

a) 200ml no water treated wheat or barley grain → ground into flours → dough, bread and porridge
b) 200ml soaked (12h) wheat or barley grain → air-dried → ground into flours → dough, bread and porridge
c) 200ml boiled (15min) wheat or barley grain → air-dried → ground into flours → dough, bread and porridge

- ✓ Grinding:

Grinding was done until a majority of fine flour was produced (45m to 1.5h), using an andesite hand stone and quern measuring 40x18x11cm. To grind, a small handful of grain was placed in the middle of the quern and short strokes broke down the grain and easily milled into flour. Soaked, boiled and dry wheat and barley grain were all ground to fine flour using this technique. After grinding, the flour was sieved using two different geological sieves whose sizes resemble the observed ethnographical examples (1.0mm and 0.5mm). Three different types of flour resulted from the sieving: fine flour or dunst (particles smaller than <0.5mm), *semolina* or *fine bulgur* (>0.5mm) and grist or *coarse bulgur* (>1mm) mixed with cracked grain and flakes.

- ✓ Preparation and cooking:

These three flours were then prepared into a dough, flat bread and porridge or gruel following traditional ethnographical methods previously observed in modern Turkish villages (Hillman 1973, 1981, 1984; Yakar 2000). For the preparation of the doughs, 15ml of water was added to 50ml (approximately equal to 30g) of a mixture of fine flour (<0.5mm) and *semolina* (>0.5-1mm) to achieve approximately 50% hydration of the dough. The different doughs were then kneaded for approximately 2 minutes until a flexible consistency was reached.

For the preparation of the flat breads, 80ml of fine flour (approximately equal to 43g) were mixed with 30ml of water aiming for a higher hydration percentage of the dough at roughly 70% as seen in most of “rustic” types of fat breads and traditional flat breads in modern Turkey and Iraq. Then the dough was kneaded until the consistency of a flexible bread dough was reached and this was then put on a baking tray and baked at 180˚C for 30min using an electric oven. An additional set of flat breads was baked using *tannur* oven built by the author as part of the experimental archaeology course (Primtech) for first year undergraduate students at UCL, Institute of Archaeology (Figure 5.4.).

Finally, for the preparation of porridges, 100ml of the coarsest grain or grist produced (>1.0mm) during grinding was added to 100ml of boiling water in a ceramic container; then the mixture was boiled for 3 minutes until the consistency of a paste or gruel was reached and the excess of water evaporated.

✓ Charring:

The prepared cereal meals were then charred using a muffle furnace at the UCL Institute of Archaeology. Three pieces of similar measures (30x15x10cm) of each cereal preparation were charred at 300˚C for 1, 2 and 3h to recreate a possible intentional burning and understand the behaviour of the matrix, starches and tissues when charring for different times in the archaeological food remains. These experimentally created charred food specimens were then studied under low powered binocular microscope and SEM following the described methodology developed for this research study.

Figure 5.4. Experimental *tannur* oven building and bread baking

5.5.2. Second set of experiments: The addition of pulses

Due to the identification of pulse tissues in the analysed food fragments from Çatalhöyük and Jarmo, I carried out a second set of experiments which included cereal and pulses. The chosen cereal species was bread wheat (*Triticum aestivum*), harvested in Dorset (UK) and a mixture of pulses, all of them present in the Çatalhöyük and Jarmo archaeobotanical record. The pulses used were purchased in Turkey in the Konya local food market and included lentil (*Lens culinaris*), chickpea (*Cicer arietinum*), pea (*Pisum sativum*) and bitter vetch (*Vicia ervilia*).

The aim of this new set of experiments was to compare the microstructures of two types of archaeological foods which were identified during observation under SEM amongst the analysed food fragments. The first type is a foodstuff with a porous microstructure which resembled bread-like products; the second one has a lumpy microstructure with cracks and resembled porridge-like products. Both types of products were observed to contain a mixture of a small proportion of fine particles of wheat (<0.5mm) and a high concentration of fine (<0.5mm) and coarse (>0.5mm) particles of pulses. Also, it was possible to observe differences in pulse *testa* patterns and thickness of palisade layers within the food fragments which led to the conclusion that these two types of products were most likely made with a mixture of fine wheat flour and fine and coarse flours from pulses.

Bread wheat and the chosen pulses were all processed in a dry state in this occasion and were processed and prepare into four different types of meals.

- ✓ Grinding:

Grinding of bread wheat and pulses was done until a majority of fine flour was produced (from 20min for the pulses to 1h for the wheat), using the andesite hand stone and quern used for the first set of experiments. To grind, a small handful of grain was placed in the middle of the quern and short strokes broke down the grain and easily milled into flour. Grinding of pulses was somewhat more complicated as the hard *testa* of some of them, such as chickpea and bitter vetch, impeded the breakage of the seed coats. In this sense, the processing of these two pulses required initial pounding prior to grinding.

After grinding, the wheat and pulse flour was sieved using the 1.0mm and 0.5mm geological sieves used for the previous set of experiments. Three different types of wheat and pulse flour resulted from the sieving: fine flour or dunst (particles smaller than <0.5mm), *semolina* or *fine bulgur* (>0.5mm) and grist or *coarse bulgur* (>1mm) (Figure 5.5.).

- ✓ Preparation and cooking:

The different cereal and pulse flours were then prepared into a flat bread and a porridge-like meal which I called "gruel" in order to distinguish it from previous experimentally prepared meals.

For the preparation of the flat breads, 50ml of a mixture of fine and coarse pulse flours (<1mm) and 30ml of wheat fine flour (approximately equal to 43g) were mixed with 30ml of water aiming for a hydration percentage of the dough at roughly 70%. Then the dough was kneaded until the consistency of a flexible bread dough was reached and this was then put on a baking tray and baked at 180˚C for 30min using an electric oven.

For the preparation of the gruels, 80ml of a mixture of fine and coarse pulse flours (<1mm) and 20ml of wheat fine flour were added to 100ml of boiling water in a ceramic container; then the mixture was boiled for 3 minutes until the consistency of a paste or gruel was reached and the excess of water evaporated.

- ✓ Charring:

The flat bread and gruel were then charred using a muffle furnace at the UCL Institute of Archaeology. One piece of similar measures (30x15x10cm) of each preparation were charred at 300˚C for 3h. These specimens were then studied under low powered binocular microscope and SEM following the described methodology developed for this research study.

Figure 5.5. Experimental grinding of pulses (left) and resultant flour types (right).

5.5.3. Third set of experiments: The addition of milk

In this sense, this third set of experiments contributed to the understanding of the possible changes which occur in the food matrix with the use of milk instead of water for the preparation of porridge-like products. In this occasion bread wheat (*Triticum aestivum*) and naked barley (*Hordeum vulgare*) were chosen for the preparation of porridge-like products.

- ✓ Grinding:

Grinding of wheat and barley was done until a majority of fine flour was produced (45min), using the andesite hand stone and quern measuring 40x18x11cm used for previous experimental grinding. To grind, a small handful of grain was placed in the middle of the quern and short strokes broke down the grain and easily milled into flour. After grinding, the flour was sieved using the 1.0mm and 0.5mm geological sieves resulting three different types of flour: fine flour or dunst (particles smaller than <0.5mm), *semolina* or *fine bulgur* (>0.5mm) and grist or *coarse bulgur* (>1mm) mixed with cracked grain and flakes.

- ✓ Preparation and cooking:

This time only one type of meal (porridge) was prepared. For its preparation, I followed the procedure from the first set of experiments but in this occasion, I used a mixture of wheat and barley flours: 50ml of the coarsest barley flour (>1.0mm) and 50ml of the coarsest wheat flour (>1.0mm) were added to 100ml of boiling fresh organic goat's milk in a ceramic container. Then this mixture was boiled for 3 minutes until the consistency of a paste or gruel was reached and the excess of milk evaporated.

- ✓ Charring:

The porridges were then charred using a muffle furnace at the UCL Institute of Archaeology. One piece of similar measures (30x15x10cm) of each preparation were charred at 300˚C for 3h. These specimens were then studied under low powered binocular microscope and SEM following the described methodology developed for this research study.

5.5.4. Fourth set of experiments: Fermentation

Two types of dough fermentation processes were explored during this fourth set of experiments. In first place, a natural fermentation process was done prior to baking; in second place yeast was added to the dough and kneaded. In both cases, the aim was to analyse and understand the changes in the food matrix as the result of different fermentation processes. The cereal used for this set of experiments was bread wheat (*Triticum aestivum*) which was processed dry and then prepared into breads.

- ✓ Grinding

Grinding of bread wheat was done until a majority of fine flour was produced (45min), using the andesite hand stone and quern measuring 40x18x11cm used for previous experimental grinding. To grind, a small handful of grain was placed in the middle of the quern and short strokes broke down the grain and easily milled into flour. After grinding, the flour was sieved using the 1.0mm and 0.5mm geological sieves resulting three different types of flour: fine flour or dunst (particles smaller than <0.5mm), *semolina* or *fine bulgur* (>0.5mm) and grist or *coarse bulgur* (>1mm) mixed with cracked grain and flakes.

- ✓ Preparation and cooking

Two loaves of bread were prepared for this set of experiments. For that 80ml of fine flour (approximately equal to 43g) were mixed with 30ml of water aiming for a higher hydration percentage of the dough at roughly 70% as seen in most of "rustic" and traditional types of breads. Two types of fermentation were chosen for the preparation of these breads: a natural fermentation process and the addition of commercial yeast. For the first one, the dough was kneaded for 10min until a very flexible mix was reached and then left to rest and to naturally leaven for 3h. This was then baked for 30min at 180 ˚C. For the second type of fermentation I chose to add yeast to the water when preparing the dough, then mix the flour in and knead it for 5minutes. The dough was then rested for 10min before being baked for 30min at 180 ˚C.

- ✓ Charring:

The breads were then charred using a muffle furnace at the UCL Institute of Archaeology. One fragment of each bread (30x15x10cm) was charred at 300˚C for 3h. These specimens were then studied under low powered binocular microscope and SEM to investigate changes in the microstructure due to fermentation processes and their similarities with the archaeological food remains.

5.5.5. Fifth set of experiments: The addition of wild mustard oil-seeds

This last set of experiments was done with the purpose of investigating the changes in the food microstructures with the addition of oil-seeds such as those found in the archaeobotanical record at Çatalhöyük. A range of Brassicaceae oil-seeds are found at the site however the main one which has been recovered from the site is a wild mustard (*Descurainia sophia*). Due to the identification of this species inside the archaeological food fragments from Çatalhöyük, I chose to add these seeds to the preparation of experimental breads. Seeds used for this experiment were gathered from the Çatalhöyük surrounding landscape using traditional methods.

✓ Grinding

Grinding of bread wheat was done until a majority of fine flour was produced (45min), using the andesite hand stone and quern measuring 40x18x11cm used for previous experimental grinding. To grind, a small handful of grain was placed in the middle of the quern and short strokes broke down the grain and easily milled into flour. After grinding, the flour was sieved using the 1.0mm and 0.5mm geological sieves resulting three different types of flour: fine flour or dunst (particles smaller than <0.5mm), *semolina* or *fine bulgur* (>0.5mm) and grist or *coarse bulgur* (>1mm) mixed with cracked grain and flakes.

✓ Preparation and cooking

Flat bread was prepared for this set of experiments. For that 80ml of fine flour (approximately equal to 43g) were mixed with 30ml of water aiming for a higher hydration percentage of the dough at roughly 70% as seen in most of "rustic" and traditional types of flat breads. Before kneading of the dough, 10ml of wild mustard seeds were added to the mix. Then the dough was kneaded until the consistency of flexible bread dough was reached and this was then put on a baking tray and baked at 180˚C for 30min.

✓ Charring:

The breads were then charred using a muffle furnace at the UCL Institute of Archaeology. One fragment of each flat bread (30x15x10cm) was charred at 300˚C for 3h. These specimens were then studied under low powered binocular microscope and SEM to investigate changes in the microstructure when oil-seeds are added.

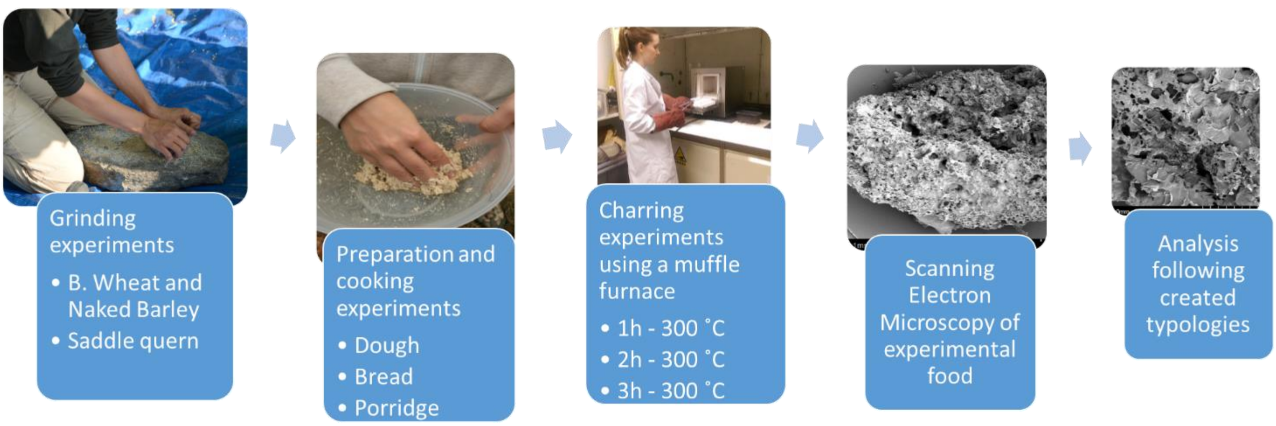


Figure 5.6. Flow chart displaying methodological steps for the preparation of experimental food reference materials

5.6. <u>Analysis of the isotopic and lipid composition</u>

Previous work by Evershed *et al.* (2008) and Pitter *et al.* (2013) has shown evidence for the use of animal fats, milk and honey at Çatalhöyük. In order to investigate the composition of the food remains from Çatalhöyük and Jarmo in depth, and the possibility of animal products being used in combination with plant ingredients for the preparation of cereal products, a combination of bulk isotopes and lipid analyses was carried out. These analyses were done in collaboration with Prof. Oliver Craig at University of York.

In total, 21 archaeological food fragments were selected for bulk isotope analyses, 19 fragments spanning all chronological phases from Çatalhöyük (see Table 5.1.) and 2 food fragments from Jarmo (see Table 5.2.). Previous Scanning Electron Microscopy of the food fragments had revealed their rich cereal composition and the different cooking processes involved in their preparation (different matrices, see results section). However, no previous evidence of the presence of animal products, such as milk, fat, egg, fish or honey among others was observed. In this sense, samples were chosen from the different chronological levels and excavation areas at Çatalhöyük, from level South L to TP O/TP P; as well as from the different categories of foods (bread, dough and porridge) to see if differences in composition were found.

The 21 samples were selected for analysis of their basic molecular composition as a first step prior to the full analysis of their lipid compound composition. This decision was made based on a the only known previous example of these analyses carried out on similar amorphous charred materials from the Jomon culture in Japan (Heron *et al.* 2016). After carrying out bulk isotope analyses, a further 4 food samples were selected for lipid analysis in order to test the potential of this method for the identification of any animal materials which could have potentially been added for the preparation of these foods.

Samples' preparation was carried out at UCL, Institute of Archaeology laboratories. Isotopic and Lipid analyses were carried out at the Department of Archaeology at University of York in collaboration with Prof. Oliver Craig and Dr. Alexander Lucquin.

Table 5.1. Selected samples for Isotope and lipid analyses from Çatalhöyük

Area	Unit	Flot	Level	Building	Context
South	1074	192	South L	none	asy midden
South	4869	3148	South G	none	midden
South	4869	3151	South G	none	midden/dump
South	5302	3666	South G	none	spread
South	18609	9053	South P	370	burnt spot in dump
South	18616	9085	South P	370	fill
North	19044	9229	4040 G	77	burial fill
South	19115	9232	South P	86	midden layer
TPC	20255	10020	TPC Neolithic	none	oven
TPC	30757	10720	TP M	121	infill
TPC	30761	10721	TP M	121	infill
TPC	30778	10742	TP M	121	infill
TPC	30870	10967	TP Neolithic	none	midden
North	21117	11129	Unstratified Neolithic	113	in situ layer
North	21645	11747	North	none	burnt midden
TPC	22709	11922	TPC neolithic/Melaart II or III	122	bottom of bin
TPC	22764	12021	TPC Neolithic	none	fill

Table 5.2. Selected samples for Isotope and lipid analyses from Jarmo

Area	Unit	Flot	Level	Context
QR14-15	18	144_1	Phase 2	midden
QR14-15	22	159	Phase 2	midden

5.6.1. Bulk isotope analysis

Organic and inorganic materials recovered from archaeological sites, such as plant remains, contain distinct ratios of heavier and lighter isotopes of carbon (13C/12C), nitrogen (15N/14N), oxygen (18O/16O) and strontium (87Sr/86Sr) (Vaiglova 2016). The ratios of these isotopes are altered due to fractionation caused by chemical and biological transformations during processes such as the carbon cycle, the nitrogen cycle, the hydrological cycle, digestion and photosynthesis (in the case of the stable isotopes: 13C/12C, 15N/14N, 18O/16O) or due to radioactive decay (in the case of 87Sr/86Sr) (Sharp 2007). As a result, measurements of isotopic ratios can be used to study aspects of soil growing conditions of cultivated crops and human/animal diets and geographical origins (Sharp, 2007).

With this purpose, 19 food fragments from Çatalhöyük and two from Jarmo were selected for bulk isotope analysis, with special focus on carbon (13C/12C) and nitrogen (15N/14N) values and the ration between the two of them. The 21 selected archaeological food fragments were ground and homogenised using a gate pestle and mortar and the samples (0.8-1.4mg) were weighed in duplicates into tin capsules. Then, approximately 1 mg of each sample/standard were analysed on a Sercon 20-22 IRMS connected to a Sercon Europa GSL preparation unit at the Department of Archaeology at University of York. For quality control of the samples, IAEA600 Caffeine (C + N), Iso Analytical R006 Cane (C Only), IAEA N2 Ammonium Sulphate (N only) were used as well as cold water fish gelatin (traceable to international standards) was used as reference material.

Samples were then loaded into the 66 place autosampler and dropped into an oxygen rich combustion tube held at 1000°C. As part of this process, the tin capsule ignites and burns exothermally at ~1700°C causing the sample to oxidise. The sample is carried through a layer of chromium oxide and copper oxide which ensure complete oxidation, followed by a layer of silver wool to remove unwanted sulphur and halides. The sample' gases pass into a second furnace containing copper held at 600°C where excess oxygen is removed, and nitrogen oxides are reduced to elemental nitrogen. Any water is removed using a magnesium perchlorate trap. The sample then passes into a GC column which separates CO2 and N2 from each other. The resultant gases are then introduced into the 20-22 mass spectrometer where the samples are ionised, and the various masses separated in a magnetic field, focused into Faraday collector arrays and analysed.

Data was then imported into excel and normalised to international standards. Sample uncertainties were calculated using the Kragten spreadsheet method.

5.6.2. Lipid analysis Gas Chromatography – Mass Spectrometry (GC-MS)

Analyses were carried out using an acid/methanol extraction and gas chromatography mass spectrometry to determine lipid composition and likely source. For this purpose, approximately 20mg of material was homogenised using a gate pestle and mortar and acid extracted alongside a method std and blank.

Sample extraction was carried out in controlled sterile laboratory conditions. Methanol (4ml) was added to each sample in clean glass tubes and ultrasonicated for 15 min. These were then acidified with concentrated sulphuric acid, vortexed and heated in closed vials at 70°C for 4 hours. Following centrifugation, the acidified supernatants were transferred to clean glass vials. The solvent soluble portion was then extracted with 3 x 2 ml hexane, combined and dried under a stream of nitrogen. Each sample was spiked with an internal standard and made up in 100ul hexane prior to analysis.

Analysis was carried out by combined gas chromatography-mass spectrometry (GC-MS) using a Hewlett Packard 5890 series II GC connected to a 5972 series mass selective detector. The splitless injector was maintained at 300°C and helium was the carrier gas at constant inlet pressure. The temperature of the oven was programmed from 50°C (2 min.) to 325°C (15 min.) at 10°C/min. The GC was fitted with a 30m X 0.25mm, 0.25µm DB-5MS phase fused silica column. The column was directly inserted into the ion source where electron impact (EI) spectra were obtained at 70 eV with full scan from m/z 50 to 800.

Molecular results were observed and compered with typical examples of GC-MS results on reference materials.

5.7. Exploring variability across the macrobotanical and food assemblages

An additional and final aim was to assess the variation in the food assemblage in relation to ingredients, microstructures of the fragments, cooking processes, excavation areas, chronology and buildings was assessed. For this purpose, the selected flotation samples which contained food remains were scanned for the identification of plant remains present in them and their macrobotanical composition statistically assessed.

5.7.1. Addition of macrobotanical data from selected flots

The macrobotanical composition of the selected flotation samples from which food fragments were extracted for analysis was assessed. In this sense, the sorting and identification of macrobotanical remains was carried out following the procedures previously outlined for the Çatalhöyük Research Project (see Bogaard *et al.* 2013; Stroud *et al.* 2017) and standard procedures for Jarmo Research Project under the ComPAg Project at UCL Institute of Archaeology.

5.7.1.1. Assessment and analysis

- *Çatalhöyük*

The selected samples for this study underwent three different types of analysis depending on the level of detail required by other researchers on the project and their specific research questions. All samples were subjected to an initial scan on site following the 'sieve-scan' methodology established for on-site preliminary sorting of macrobotanical remains in Bogaard *et al.* (2015) and Filipović *et al.* (2016). For this, the light fraction from flotation was sieved at 4mm, 1mm and 0.3mm and the 4mm was scanned for wood, nuts, and tubers etc. and their presence noted. The 1mm fraction was scanned to assess the botanical composition of the sample, in relation to types of materials such as cereals, pulses, wild seeds, etc.

In addition to this initial scanning on-site, a third of the samples underwent a full analysis which was carried out by Prof. Amy Bogaard and Dr. Elizabeth Stroud during 2016-2018. For this, samples from *in situ* burning activities were targeted and the aim was to analyse a subsample containing around 300 crop and 30 wild items as a minimum number of items. If the 1mm fraction was seen to contain more than 300 crop items, a random subsample expected to produce this amount was sorted. For the 0.3mm fraction, a random subsample equivalent to no more than 1/8 of the associated 1mm fraction was analysed. Additional subsamples were sorted if the analysed ones together had not yet provided at least 300 crop and 30 wild plant remains. Moreover, the 4, 2 and 1mm fractions of the heavy residue from each sample were sorted for botanical remains along with the flot material to produce amalgamated counts of items per sample (Bogaard *et al.* 2013; Stroud *et al.* 2017).

Finally, another third of the flotation samples and in particular those from the TPC area, were analysed following a different criterion for this study with the main aim of assessing their crop composition. This analysis was an adaptation of the level 2 priority analysis carried out on the samples collected from priority excavation contexts (see Bogaard *et al.* 2005; Stroud *et al.* 2017 for details). For this, the 4mm fraction and a subsample of the 1mm were sorted for macrobotanical remains and identified to species where possible. A minimum number of 30 identified cereal grains were aimed for and if in case this was not reached, additional subsamples of the 1mm fraction were sorted.

- *Jarmo*

Assessment and analysis of archaeobotanical samples from Jarmo followed standard procedures established for the ComPAg Project under the supervision of Prof. Dorian Q Fuller at the UCL Institute of Archaeology. Archaeobotanical samples from Jarmo underwent full analysis and all macrobotanical remains were identified to species level when possible.

Initial sorting and identification were carried out by Dr. Leilani Lucas, followed by in depth analysis of flots in order to establish secure ids for the crop remains and identification of potential food remains.

5.7.1.2. Identification and quantification

- *Çatalhöyük*

The identification of the macrobotanical remains present in the flotation samples was carried out following the procedures established for the Çatalhöyük Research Project (see Bogaard *et al.* 2013 for details). In summary, all charred seeds, nuts, fruits and chaff were identified using modern seed reference collections (Department of Botany at Selçuk University, UCL Institute of Archaeology and University of Oxford). Criteria for the differentiation of families, genera and species were based on seed atlases (Beijerinck 1947; Berggren 1969; 1981; Anderberg 1994), archaeobotanical publications (e.g. Jacomet *et al.* 1989; Jones *et al.* 2000; Körber-Grohne 1991; Kohler Schneider 2001) and personal observations. Once identified to the genus level, lists of geographically relevant species were extracted from *Flora of Turkey* (Davis *et al.* 1965-2000). Macrobotanical remains were identified using a low-powered binocular microscope (x6.3-57) and the nomenclature generally followed Davis *et al.* (1965–2000).

The macrobotanical remains were quantified following the previously established procedures for Çatalhöyük. The 'minimum number of individuals' principle (Jones 1991) was used in order to depict a complete picture of the composition of the macrobotanical assemblage. In this sense, embryo ends of cereal grains, embryos of pulses and other seeds, glume bases of glume wheats and the upper 'nodal' parts of rachis segments of free-threshing cereals were counted. Fragmented shells or kernels were common in the assemblage having to estimate the number of whole items from fragments. This was done by counting hilar scars, or by dividing the number of fragments by 20. Wood charcoal, tuber and dung sorted from the >2mm size fractions of flot and heavy residue were quantified according to their volume (ml) (Bogaard *et al.* 2013).

- *Jarmo*

The identification of the macrobotanical remains present in the flotation samples was carried out following standard procedures established for the ComPAg Project. In summary, the total number of plant remains recovered from the flots such as seeds, nuts, fruits and chaff were identified using modern seed reference collections at the UCL Institute of Archaeology. Criteria for the differentiation of botanical families, genera and species were based on seed atlases (Anderberg 1994; Beijerinck 1947; Berggren 1969; 1981), archaeobotanical publications (e.g. Jacomet *et al.* 1989; Jones *et al.* 2000; Körber-Grohne 1991; Kohler Schneider 2001) and personal observations. Once identified to the genus level, lists of geographically relevant species were extracted from *Flora of Iraq* and *Flora of Turkey*. Macrobotanical remains were identified using a low-powered binocular microscope (x10-60) and the nomenclature generally followed Davis *et al.* (1965–2000).

The quantification procedures replicated those followed for Çatalhöyük. In summary all items were counted including embryo ends of cereal grains, embryos of pulses and other seeds, glume bases of glume wheats and the upper 'nodal' parts of rachis segments of free-threshing cereals. Due to the low number of fragments of seeds, nutshells, kernels and fruit stones, these were noted as "fragments" and were counted separately without carrying out an estimation of number of whole items.

5.7.1.3. <u>Amalgamation of macrobotanical data</u>

In order to carry out statistical analysis and calculate the botanical variation within the assemblages, the detailed botanical taxa were amalgamated in wider categories.

- *Çatalhöyük*

Due to the subsampling strategy chosen for the analysis of flots from Çatalhöyük, in order to calculate the total number of botanical specimens in the flotation samples, the total number of items per taxon per sample was calculated by adding together the totals from all sorted fractions (4 mm, 2 mm, 1 mm and 0.3 mm) of flots and heavy residue. Where 1mm and 0.3mm fractions were subsampled, the item totals were multiplied up by the subsample factor used for 1 mm fraction of the flot.

Comprehensive and broad cereal categories such as “glume wheat grains”, “free-threshing wheat grains” and “barley grains” were chosen for the amalgamation of archaeobotanical data with the aim of assessing the presence of the different plant food ingredients in the archaeobotanical samples. The same was done for chaff remains, which were amalgamated into “free-threshing wheat rachis”, “glume wheat glume bases” and “barley rachis”, and cereal culm and internodes were counted together as well as reed culm. In addition, four types of pulses: “lentil”, “bitter vetch”, “pea” and “chickpea” were chosen to be represented due to their importance in the archaeobotanical record from the selected sites for this study. Fruit stones and nutshells, with the exception of mineralised remains of hackberry, were amalgamated together to represent total presence of fruits and nuts in the samples. Finally, wild taxa were summed up together with the exception of Cyperaceae (sedges) seeds due to the high proportion of these in the assemblages (for more details see Table 2 in Appendix V).

- *Jarmo*

All items present in the flotation samples from Jarmo were counted and quantified using standard archaeobotanical methods. As no subsampling was carried out for this site, the calculation of the total number of items was straight forward and was based on the sum of the total number of items by botanical species, per sample.

Standard frequency and ubiquity of plant species was calculated using simple statistical methods. Amalgamation of samples was carried out in order to carry out more complex statistical analysis such as correspondence analyses. This followed the same procedure applied to the amalgamation of plant species from Çatalhöyük (see details above).

5.7.2. Statistical analysis

5.7.2.1. Multivariable comparative Excel charts

Multivariable comparative pivot tables and graphs were used to display differences in food types among excavation areas/trenches and chronological periods. For this purpose, Excel spreadsheet was the software of choice to create multivariable charts for the comparison of typological datasets (A, B, C see section 4 in this chapter for details) throughout the samples in relation to the areas and periods were these were recovered from.

One of the aims was to show the archaeological and chronological distribution of different types of food products in relation to their typological attributes and therefore their type of microstructure. In addition, the different distribution of the use of plant ingredients across the different areas at the sites and periods were also explored and displayed using this method.

5.7.2.2. Correspondence analyses

Correspondence analyses were applied to the archaeobotanical assemblage from Çatalhöyük East by Bogaard *et al.* (in preparation) in order to explore patterns, trends and variation resulting from differences in the botanical composition of the samples and in the provenance of the materials. The results obtained have been incorporated into this thesis with the permission of the author. For this purpose, the software used was the statistical computer package Canoco 5 for Windows (ter Braak & Smilauer 2000) and CanoDraw for Windows (Smilauer 1992) for the creation of scatter plots to show results.

Correspondence analyses are a statistical multivariate exploratory technique used in archaeobotany with the purpose of investigating variation among samples in terms of their botanical composition, contexts, period, etc. The main aim of this method is to identify major trends and patterns in the chosen dataset (e.g. Baxter 2003; Bogaard 2004; Colledge 2001; Lange 1990; Shennan 1997). In general, the purpose of using correspondence analysis in archaeobotany is to organise units of analysis (flots/samples) along four axes based on the combination and abundance of the variables used for the analysis. In this sense, this method compares the similarities and differences in the botanical composition of each sample with every other sample (Bogaard 2004; Filipović 2012; Lange 1990; Shennan 1997). As a result, the generated scatter plots show the distribution of the sample and possible trends in the variation of the botanical sample composition.

5.8. Summary

This doctoral thesis proposes a new methodology for the analysis of archaeological remains of cereal-based products through a multiproxy approach which includes the observation of the food microstructures under SEM, the identification of ingredients contained in those microstructures and the comparison with experimentally prepared cereal products. These methods have taken inspiration in the analysis of pottery thin sections and include qualitative and quantitative analysis of voids and particles observed in the food microstructures.

This methodology has been applied to the sites of Çatalhöyük East and Jarmo in Southwest Asia. Having obtained promising results, these methods are currently being applied to food remains recovered from other areas of the world in order to distinguish possible patterns and/or differences between culinary traditions.

Chapter 6

Results from Çatalhöyük East

6.1. Introduction

This chapter outlines the principal results from the analysis of the selected food fragments collected from Çatalhöyük East. Firstly, the results from the experimental cooking and charring experiments are presented in order to offer a better categorisation of the archaeological food fragments. Secondly, this chapter exposes the identification of the ingredients and components used in the preparation of these foods, in addition to the categorisation of the food fragments into different types of cereal meals in relation to their microstructure.

Data from the assessment and analysis of the macrobotanical constituents of the flots where food samples come from was also incorporated alongside the results from the analyses on the food fragments in order to shed light on culinary household activities. In this sense, the ingredients identified were compared and discussed in accordance with the macrobotanical assemblages.

6.2. Results from the cooking and charring experiments

This section presents the results from the cooking and charring experiments carried out to compare the archaeological food fragments from Çatalhöyük East with experimentally prepared meals. The experiments were carried out in sets, each of them targeting specific ingredients and cooking processes and with a different purpose (see Volume II, catalogue 3 for full details).

6.2.1. First set of experiments: Cereal meals

The first set of experiments carried out for the present study provided insights into the Neolithic food processing and cooking techniques at Çatalhöyük East.

Firstly, the pre-processing water treatments to which grain was subjected (soaking and boiling) affected the subsequent grinding process. Grain that was soaked or boiled became soft and showed higher resistance to grinding, making it more difficult to produce fine flour. Conversely, dry grain was easily ground into fine flour. Additionally, during the grinding experiments, naked barley proved to be more productive, resulting in 20% more fine flour than modern bread wheat. Another observed advantage of barley over bread wheat is that, when under the same environmental conditions, soaked and boiled barley dried out in less than 2h, while soaked and boiled wheat never dried completely.

Secondly, during the preparation of the three different types of cereal meals (dough, bread and porridge), the flour produced with dry grain was more suitable for bread making; flour produced with wet grain appeared compacted and was more difficult to prepare into a soft and elastic dough. In this sense, bread wheat proved to be more suitable for bread and dough making than naked barley; due to its high gluten content bread wheat provides the necessary viscosity (thickness and texture) and elasticity to the mix. For the preparation of porridge however, boiled and soaked grain was shown to be better, taking less time to soften and producing a smoother paste. No clear differences in behaviour between wheat and barley were found during the preparation of porridge.

Lastly, during charring, although no real differences in behaviour were found between cereal taxa, prepared cereal products responded differently to charring. While doughs completely carbonised during the first hour in the furnace, breads and porridges needed at least 2h to char. These disparate behaviours are likely due to difference in water content of the foods (moisture). Also, the charring of doughs resulted in the creation of a crust on the outside and a hollow matrix inside; conversely, charring the breads resulted in almost no differentiation between crust and crumb.

The most significant results thus are from the comparison of the experimental charred cereal meals with the archaeological foods. In general terms, mixing of flour and water to make a dough is a crucial part of the process of bread making as it allows air to be incorporated in the dough and it helps the distribution of starch and proteins (such as gluten) evenly (Autio & Laurikainen 1997). Using modern references, after mixing bread dough contains gas cells or voids which range from 1-100µm in diameter which will then burst and coalesce into larger ones while dividing and moulding of the dough. The most important changes in the microstructure happen during baking, when the heating process causes the expansion of the gas cells and starch gelatinization (*idem*).

Using the binocular microscope and subsequently the SEM, striking similarities between the internal structures of the experimental food and archaeological food specimens were observed. A close analysis following attribute B (voids quantity and size) and attribute C (type of voids), revealed that experimental dough, bread and porridge present three different types of internal structure, which were almost identical to *Matrix Type 1*, *Matrix Type 3 and Matrix Type 4* seen in the archaeological food fragments:

- *Doughs:* these experimental materials have a hollow matrix, with large closed voids (see description of attributes in page 112), 200-800µm, which cover more than 30% of their surface. The high porosity of these products was seen to be a result of the high-water content within the product, as these were charred prior to baking, while still raw. In this sense, the charring process provoked a rapid evaporation process of the water contained in the product which created multiple large voids in the matrix.

- *Flat Breads:* have a lower quantity of small closed voids and micropores (see description of attributes in page 112), 50-250µm and cover between 10-20% of their matrix. The relatively low porosity of these cereal products has been linked to the lower gluten content of Neolithic cereal species in addition to the presence of bran epidermis in the grains (Autio and Laurikainen 1997). In this sense, the presence of bran has been seen to produce thinner and less porous doughs. According to Gan *et al.* (1992), the outer layers of bran present in the cereals used to make such doughs, caused the disruption of the starch-gluten matrix and also restricted and force gas cells to expand in a particular way and direction. This would certainly affect the crumb morphology and microstructure, making a less elastic and more compacted bread dough.

- *Porridges:* present a distinctive internal structure with channel voids and cracks (see description of attributes in page 112), which vary 200-500µm in size and cover between 10-20% of the matrix. The distinctive microstructure of these products was seen to be related to the use of coarse grain over fine flour for their preparation. In addition, the use of boiling as cooking method in combination with a high water or moisture content are linked to the creation of a different type of voids in the matrix. These voids are, in contrast with those created while boiling, mainly in the form of cracks as no mixing or baking are in place to help the expansion of gas cells as seen from bread dough.

Moreover, the same range of visible plant food particles, such as bran or grain fragments, were also found in the experimental specimens, with a marked correspondence in quantity and size among matrix types. For instance, following attribute set A (Particle quantity and size), experimental doughs and flat breads present a low number of visible particles (0-3) which generally vary in size 50-600μm; while porridges present a high number of visible food particles (5-15) with sizes between 500-1800μm. (Figure 6.1.).

Figure 6.1. Experimental flat bread, dough and porridge-like materials for comparison with archaeological remains of food.

6.2.2. Second set of experiments: Pulses

The second set of experiments investigated the addition of pulses to cereal preparations as seen in the archaeological food fragments from Çatalhöyük.

Firstly, different species of pulses were found to have different properties. In terms of grinding, bitter vetch was the hardest one and required initial pounding prior to grinding in order to detach the seed coat or *testa* and facilitate the grinding of the endosperm into flour. Something similar was seen for chickpea but without the initial detachment of the *testa*. Lentil and pea however, were found to be soft and easily ground into flour without detachment of the *testa*, perhaps sue to their thinner *testa*.

Previous work by Valamoti (2011) showed the importance of soaking, boiling and pounding prior to processing of bitter vetch and grass pea into food due to the high percentage of toxins contained in their *testa* or seed coat. However, none of these pre-treatments were carried out as part of the second set of experiments as fragments of seed coats constitute the majority of the pulse tissues identified in the analysed food fragments from Çatalhöyük.

After observation of the experimental foods under the SEM four were the major conclusions reached:

- Experimental breads (see methodology chapter for more information) showed striking similarities with the archaeological food fragments which contain particles of legumes and were categorised as having a bread-like microstructure (*Matrix Type 3*).

- Experimental gruels (see methodology chapter for more information) present a microstructure which is largely similar to that of archaeological food fragments which contain legumes and were categorised as having a porridge-like microstructure (*Matrix Type 4*).

- Experimental breads and gruels made of particles of pulses/legumes smaller than 1mm were found to be more similar to the archaeological food fragments than those made of coarser flour types.

- Wheat particles observed in the archaeological food fragments which contained pulses/legumes match those observed in the experimentally prepared foods. These were mainly patches of transverse bran cells and aleurone layers.

6.2.3. Third set of experiments: Milk

The third set of experiments investigated the addition of milk for the preparation of porridges and how this would affect their food microstructure.

As a general result, the microstructures of porridges made with milk differed considerably from those made with water (see first set of experiments). The microstructures of the experimentally prepared porridges which contained milk were observed to be more porous and have bigger voids. In addition, the particles (barley grain fragments in this case) display a loss of shape and their tissues and cell patterns were less visible and identifiable.
Therefore, the porridges experimentally prepared with milk do not show a microstructure comparable to the archaeological food fragments from Çatalhöyük.

6.2.4. Fourth set of experiments: Leavened bread

Leavened bread subjected to a natural fermentation process (see methodology for details) showed a similar microstructure to *Matrix Type 2*. This set of experiments helped with the identification of the food fragments from Çatalhöyük which presented a microstructure similar to *Matrix Type 2* as most likely some type of naturally leavened bread. These presented a very porous microstructure, dominated by the presence of very small voids or micropores.

Leavened bread whose dough was prepared adding yeast showed no similarities with the archaeological food fragments analysed for this study which suggest that fermentation, if intentional, did not involve the use of added yeast. Therefore, a natural fermentation process during which airborne yeast gets incorporated to the dough seems more likely. This is also indicated by the high percentage of uniform micropores present in *Matrix Type 2*, which has been linked to low amounts of carbon dioxide in the dough (Autio & Laurikainen 1997, 182).

6.2.5. Fifth set of experiments: Wild mustard

Bread prepared with the addition of wild mustard (*Descurainia sophia*) show a vitrified surface and microstructure most likely due to the high content of oil from these seeds. Despite the visible inclusion of the seeds in the food matrix, no other similarities have been observed between the experimental breads containing wild mustard and the archaeological ones from Çatalhöyük. However, the number of food fragments recovered from Çatalhöyük which contain this wild mustard is very low (only 2), what makes any comparison difficult.

6.3. <u>Plant components of the Çatalhöyük food</u>

Of the 245 archaeobotanical flotation samples selected from Neolithic Çatalhöyük, 181 contain charred food fragments that have provided information about their plant composition. The amount of archaeological food per sample varies between 0.1 - 8.7ml and the sizes of these fragments fluctuate from 0.1 - 3.2cm. These food fragments were all seen to have a starchy microstructure and a porous matrix, which together indicate well-processed and cooked plant components, with cereals as the main ingredient. Seen under the regular binocular microscope, plant ingredients, mainly cereal tissues, appear as small shiny areas on the surface of the charred food remains. Further identification of these areas to specific tissue types and plant species was only possible via Scanning Electron Microscopy.

From Çatalhöyük, 170 charred food fragments have been fully analysed under regular binocular microscope and SEM and categorised accordingly following the methods developed for this study previously explained in chapter 5. From the 170 food fragments, 164 were positively identified as fragments of food preparations and 155 of these have provided information about their plant food ingredients (see Table 1 in Appendix I for full list). Previous study of the amorphous charred fragments by other archaeobotanists at the site suggested their identification as possible remains of cereal meals such as breads or porridges. After subjecting them to the analyses described in chapter 5, it can be concluded that there is a general consistency in the plant food components of the Çatalhöyük food fragments with cereals as the main plant component (ca. 90%). Only ca. 10% of the components observed under SEM can be characterised as non-cereal components, some of which were recognised as fragments of pulses, sedge tubers and wild seeds (Figure 6.2.).

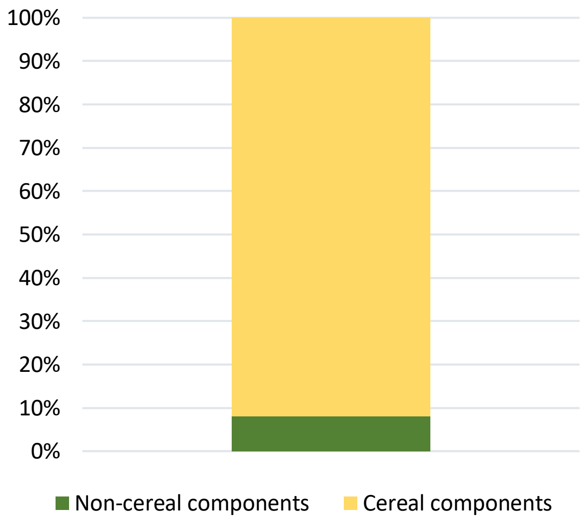


Figure 6.2. Percentage of cereal components and non-cereal components in the analysed food fragments from Çatalhöyük East

6.3.1. Cereal components

For the cereal ingredients, the majority of identified tissues are internal tissues of the kernel. Among these, pericarp tissues such as bran layers (transversal and longitudinal cells) and endosperm cell structures such as aleurone layers and endosperm starch containing cells were observed. In some cases, identification of cereal components to specific wheat and barley genus has also been possible, due to their cell and tissue shapes, sizes and patterning. Among the recorded components, visible cereal fragments from broken (ground) grains, bran fragments (longitudinal and transverse cells) and patches of aleurone tissue are very abundant (see Appendix I for more details). Figure 6.4. shows the frequency of different cereal components identified within the analysed food fragments.

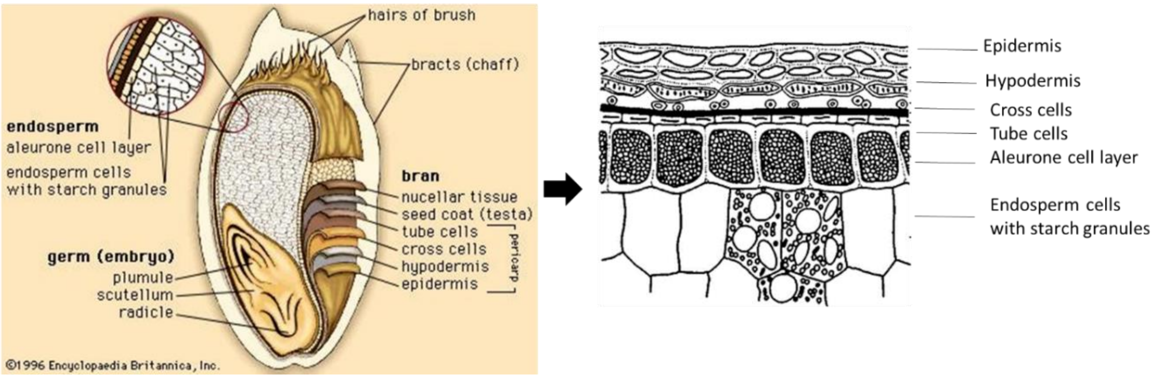


Figure 6.3. Cereal kernel layers as seen in cross-section (Encyclopaedia Britannica 1996)

- *Fragments of cereal grains*: a total of 218 broken cereal grains which measured from 0.5-1.2mm were found in 70 of the 170 analysed food fragments (ca. 41% of the samples). The identification of these visible broken grains to genus level was possible in most of the cases based on the type of aleurone layer (single-celled for wheat species and double or triple-celled for barley species) and the measurements and shape of longitudinal and transverse cell layers.

  Only 7 samples of the 70 which contain broken grains have a mixture of barley and wheat. Overall, there is a differential distribution of the presence and type (wheat or barley) of fragments of grain in the food remains from Çatalhöyük. The majority of food remains which contain fragments of broken cereal grains come from the Late and Final occupation phases of the site, from 6500 cal. BC onwards and mainly from the late North levels and TPC area. In the same way, wheat and barley broken grains are not evenly distributed among the Çatalhöyük food fragments. In general, there is a higher proportion of wheat versus barley and whereas wheat grains are present in the food from Level South M onwards, there is a higher presence of barley broken grains from level South Q onwards with a particular high concentration in the food fragments from levels TP N to TP Q.

In total, 113 fragments of wheat (*Triticum* spp.) were found in 47 of the 170 analysed food fragments (27.65%). While only a total of 29 broken grains of barley (*Hordeum vulgare* L.) were identified in 18 of the 170 analysed food fragments from Çatalhöyük (10.59%). For the rest of the broken grains visible in the food matrices, identification to the genus level has not been possible due to the lack of visible aleurone cells and/or longitudinal and transverse cells. These comprise a total of 76 of the 218 total grain fragments which were categorised as "indeterminate cereal grains". This was due to the poor preservation of the visible pericarp bran cells and/or incomplete aleurone layers which did not allow for genus identification.

Examples of the identified fragments of grains are the broken barley grains (*Hordeum vulgare* L.) identified in Fl.10967 and Fl.11177. These have been identified from the specific disposition of bran transverse cells measuring ~ 30-70 x 10-20 µm on the surface (Dickson 1987). In other cases, double and triple-celled aleurone layers typical from barley species have been observed as for example in Fl.12278.2. Wheat grains have also been identified; one almost complete (*Triticum* sp.) in Fl.10661 and a fragmented specimen exhibiting the kernel cross-section with single-layered aleurone and endosperm cells in Fl.3099. In one occasion the identification to species level of a fragment of naked barley (*Hordeum vulgare* L. var. *nudum*) was possible in Fl.9822 due to its distinctive shape, rippling surface and a fragmented double-layered aleurone (see Volume II).

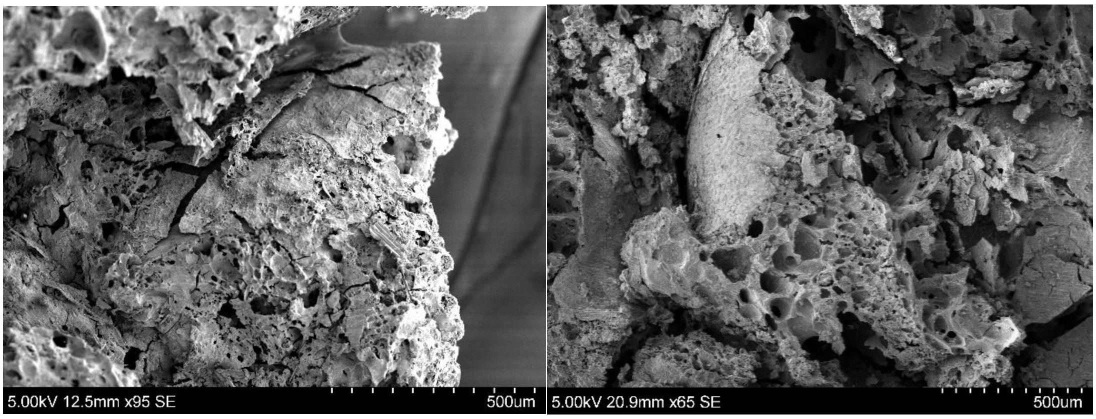


Figure 6.4. Examples of grain fragments in matrix. Fl. 6577 (left); Fl. 9822 (right).

- *Pericarp tissues (bran)*: fragments of bran, which include longitudinal and transverse cells layers present in the pericarp of cereal kernels, are by far the most commonly found particles among the food remains from Çatalhöyük. A total of 673 fragments of bran layers have been observed in the food matrices from Çatalhöyük and they occurred in 152 of the 170 analysed samples (ca. 90%) with an area size of 50 to 1500 µm. The distinction between wheat species (*Triticum* sp.) and barley (*Hordeum* sp.) transverse cells has been generally possible and was made following criteria established by Dickson (1987), Holden (1990), Colledge (1989) and Heiss *et al.* (2015; 2017).

As a general trend, fragments of wheat and barley bran cells appear separated in different food fragments which reiterates, as seen with the fragments of grains, a conscious choice of only one type of cereal ingredient for the preparation of these foods. Only 17 out of the 170 analysed fragments contain fragments of wheat and barley bran mixed together. Fragments of wheat bran layers are present in the food fragments from the earliest levels at the site (7100 cal. BC) from South G onwards until the end of the Çatalhöyük sequence. However, barley bran layers are only visible from the Late and Final phases of the site from levels North G/South P onwards (ca. 6500 cal. BC). This, together with the evidence from broken grains, indicate the early preference of using wheat over barley and that barley was a later addition for the preparation of these foods. Good examples of these components were found in a 1.5mm area of long and narrow *Triticum* cf. transverse bran cells (70-280 x 10-18 µm) from Fl.3666 (Fig. 7d); and shorter transversal cells (30-70 x 10-20 µm), distinctive to barley species from Fl.10553. (See Volume II).

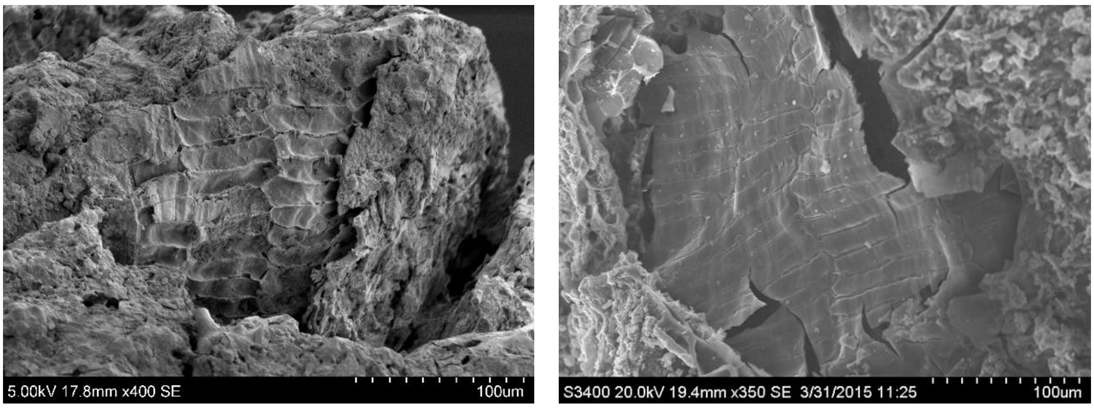


Figure 6.5. Examples of bran tissue fragments inside food matrix. Barley transverse cells in Fl. 9884 (left); wheat transverse layers in Fl. 6939 (right).

- *Aleurone tissue*: is the second most common cereal tissue present in the food remains from Çatalhöyük. A total of 306 fragments of both single-celled (as in wheats, oats, millets and rye), multi-celled (only in barley) aleurone tissue fragments and indeterminate aleurone tissues were found in 112 of the 170 analysed food fragments (ca. 66%). As seen for broken grains and bran fragments, wheat aleurone tissues (single-celled) are present in the majority of the food fragments and throughout the whole sequence from the earliest level at the site (South G) onwards. On the other hand, barley aleurone tissue (multi-celled) have been identified in only 17 of the 112 food fragments and mostly span from level South O and North G (ca. 6500 cal. BC) onwards.

  As examples, Fl.3099, Fl.6939, Fl.9924, Fl.10570 and Fl.10661 contained single-celled aleurone patches that are distinctive of wheat (Fig. 6.6). On the contrary, in FL.7880, Fl.9822, Fl.9016 and Fl.13596 barley double-celled aleurone layers are clearly visible. (See Volume II).

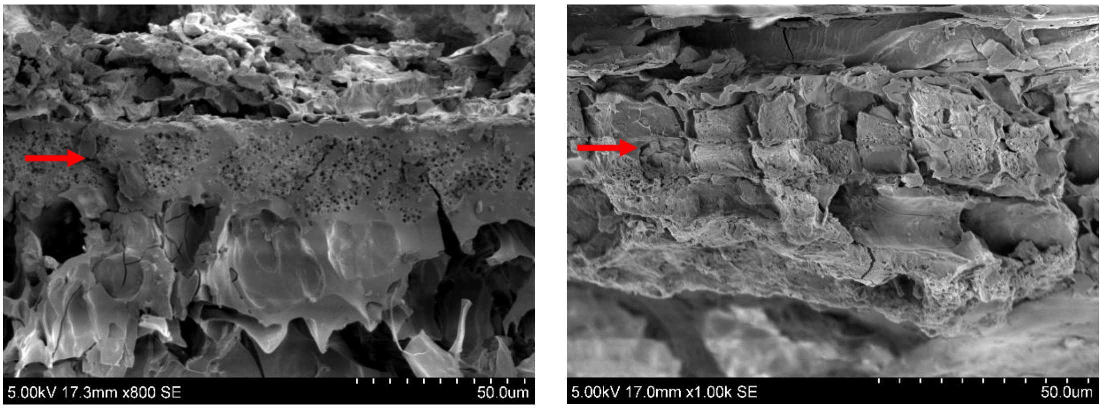


Figure 6.6. Examples of aleurone tissue fragments in food matrix. Single aleurone layer (wheat) in Fl. 7860 (left); double aleurone layer (barley) in Fl. 7880 (right).

- *Cereal chaff*: only a very small proportion of cereal chaff was identified among the food fragments from Çatalhöyük. In total 29 remains of glume epidermis and 2 possible awn fragments have been identified in 10 of the 170 food fragments analysed (ca. 7%). The small and sporadic presence of chaff visible in the Çatalhöyük food fragments suggests the general use of clean grain for the preparation of these foods and the conscious removal of residual chaff, in most of the cases, before grinding.

  Some examples of partial remains of glume epidermis can be seen in Fl.3666 and Fl.9016 with no further species identification; a complete barley rachis is visible in

Fl.9822. Its identification was possible through the observation of the typical *Hordeum* sp. glume epidermis "twin" arrangement of two short cells with a larger crescent shaped cell encircling a smaller circular one (*see* Winton & Winton 1932). (See Volume II).

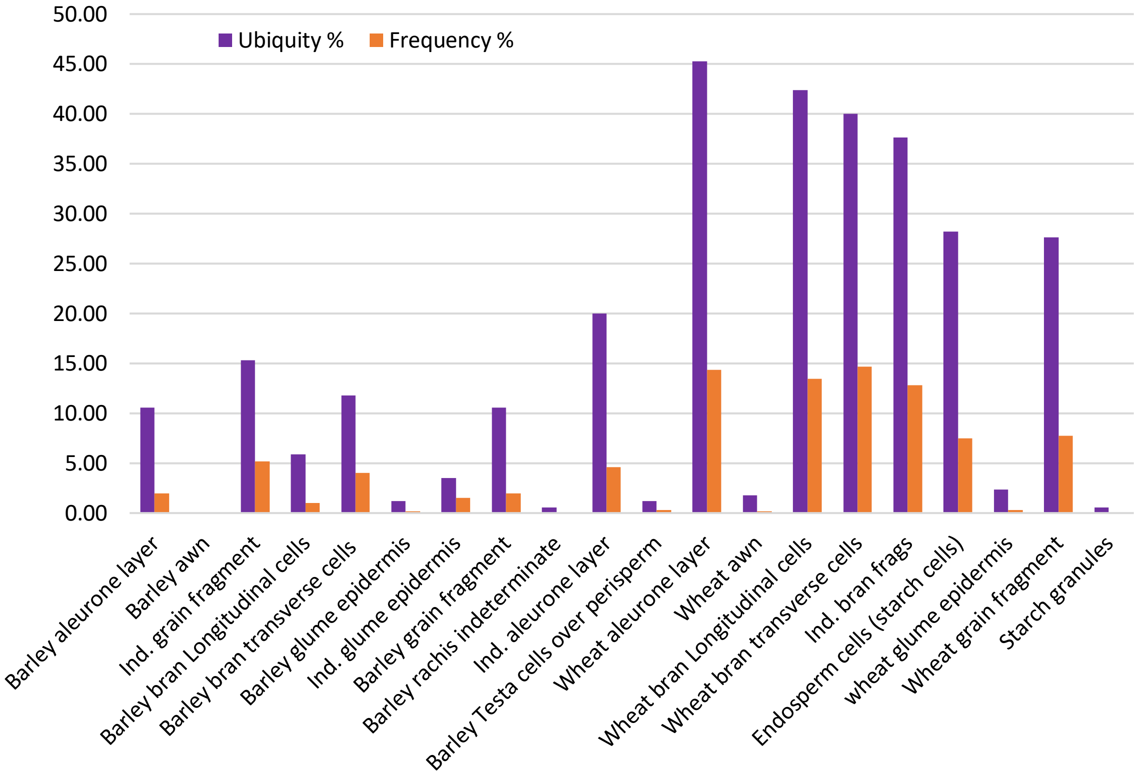


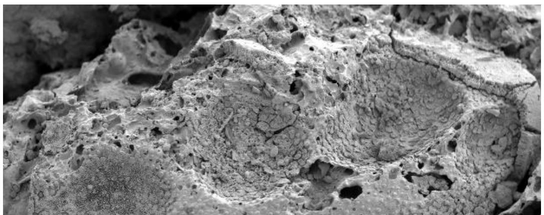
Figure 6.7. Bar chart showing ubiquity and frequency percentages of different types of cereal tissues identified in the analysed food fragments from Çatalhöyük East

6.3.2. Non-cereal components

Non-cereal ingredients such as pulses and wild seeds have also been observed in the food matrices of the charred food fragments from Çatalhöyük. However, the proportion of these is very low in contrast to cereal components. Only 18 of the 170 analysed food fragments contain non-cereal plant ingredients (ca.10%). Figure 6.5. shows the frequency of non-cereal components identified within the analysed food fragments.

- *Pulses*: A total of 55 fragments of pulse tissues, in particular fragments of seed coat (palisade layer and *testa*), have been identified in 11 of the 170 analysed food fragments from Çatalhöyük. Especially interesting is that different types of pulses have been identified mixed in the food fragments normally with small particles of wheat (<0.5mm). The 11 samples which contain pulses, have a mixture of different types of legumes as attested by the diverse seed shapes, seed coat thickness and *testa* patterning in addition to small fragments of wheat bran layers.

The presence of pulses in the food fragments from Çatalhöyük is limited to a very specific time frame of approximately 200-300 years during the Middle occupation phase of the site, from levels South L and North F to South O and North G (ca. 6700 to 6400 cal. BC). In some cases, a positive identification to the species level, based on the *testa* patterning has been possible. In particular bitter vetch (*Vicia ervilia*) and lentil (*Lens culinaris*) *testa* patterning was identified in food fragments Fl.3099, Fl.10770, Fl.10798, Fl.11137, Fl.11235 and Fl.11240 (after Butler 1990) (Fig.). In other cases, although positive identification to species has not been possible, identification to genus level was done based on the thickness of the seed coat and palisade layers. In this sense, fragments of seed coat with palisade layers and hourglass cells whose measures range from 70-120 µm are most likely to come from bigger pulses such as pea (*Pisum sativum*), chickpea (*Cicer arietinum*) or possibly grass pea (*Lathyrus* sativus). On the other hand, fragments of seed coat whose palisade layers and hourglass cells' thickness ranges from 20-70 µm are most likely from smaller pulses such as lentil (*Lens culinaris*) and bitter vetch (*Vicia ervilia*) (after Winton & Winton 1932) (See Volume II).



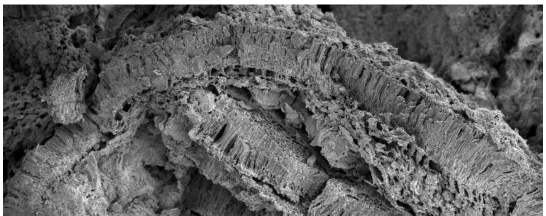


Figure 6.8. Examples of pulse tissue fragments in food matrix. Large pulse fragment with lentil-like testa patterning (after Butler 1990) in Fl. 11240 (left); different palisade layers in Fl. 11239.

- *Wild plants*: amongst the analysed food fragments we see the presence of two different types of wild ingredients, sedge tubers and wild seeds such as the wild mustard (*Descurainia sophia*) which is present at Çatalhöyük in high quantities in storage and cooking contexts. Their presence is low having only identified them in 2 of the 170 food fragments (ca. 1.1%). Examples of the wild mustard seeds are recognised by the distinctive seed coat in fragment Fl.3099.

In addition, a single seed identified as possible wild flax (cf. *Linum* spp.) has been identified in FL.192, however the possibility of this seed being a poorly preserved wild mustard seed (*Descurainia sophia*) should not be discarded. Also, preliminary identification of material from finely ground sedge tubers of the species *Bolboschoenus glaucus,* (see Wollstonecroft *et al.* 2011 for identification) was possible in 4 of the 170 analysed food fragments (ca. 2.3%), suggested by the shape and organisation of parenchyma cells and vascular bundles. Examples of these are Fl.7928, Fl.8641 and Fl.10664. (See Volume II).

Although not many are the examples of wild foods identified in the food fragments, the presence of wild ingredients seems to be associated with the early levels of the site. The addition of wild seeds to the preparation of food products from Çatalhöyük seems to be limited to the Early phase of the site, as seen from samples coming especially from level South L. Similarly, the addition of sedge tuber for the preparation of cereal meals seems a tradition which starts from the Early phases to the end of the Middle sequence of the site from Levels South H to South P.

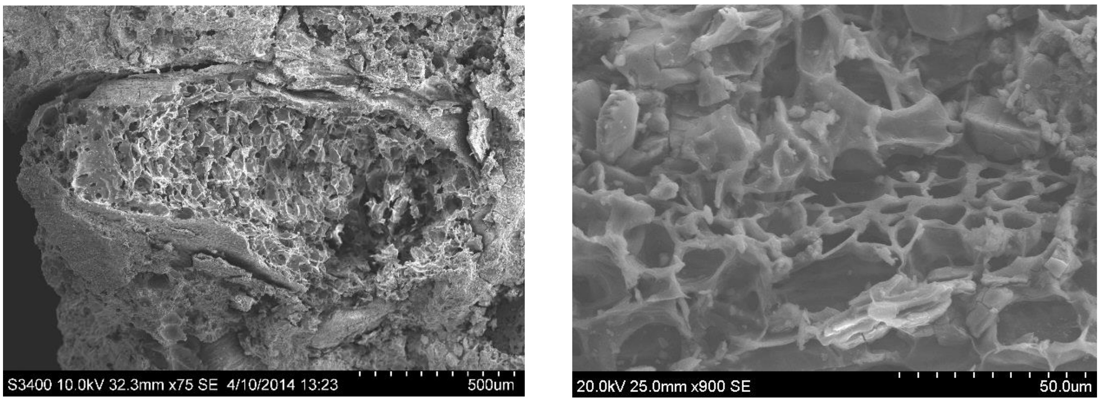


Figure 6.9. Examples of wild components in food fragments. Wild mustard seed in Fl. 3099.1 (left); club-rush tuber parenchyma and vascular bundle in Fl. 8641 (right).

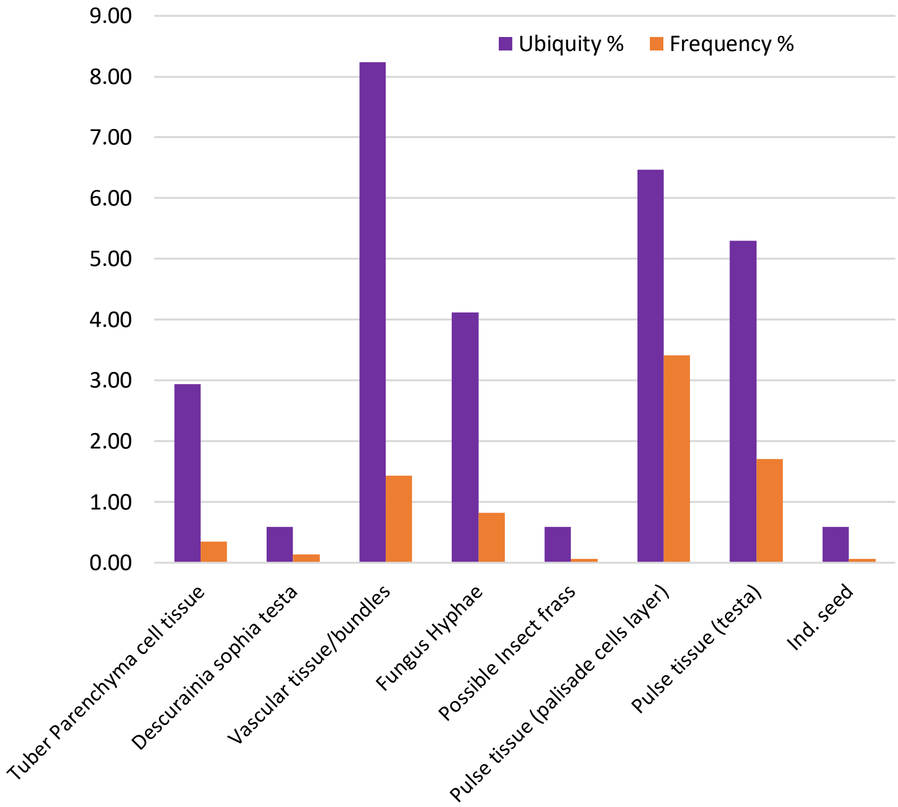


Figure 6.10. Bar chart showing ubiquity and frequency of different types of cereal tissues identified in the analysed food fragments from Çatalhöyük East.

6.3.3. Chronological distribution of plant ingredients at Çatalhöyük East

The use of plant ingredients for the preparation of cereal meals at Çatalhöyük East shows patterns of continuation and also certain variation through time.

For the cereal ingredients, there is a higher presence of wheat particles in the food fragments throughout the whole sequence, from the Early phase to the Final phase at the site. In general, wheat seems to have been the preferred cereal used in the preparation of these foods, representing more than half (50.72%) of the total particles identified. Among the cereal particles, fragments of wheat pericarp layers of the kernel (bran cells and aleurone tissues) are the most commonly identified as they represent particles of fine flour, representing 29.05% of the total particles. Barley, on the other hand, although used in the preparation of these products, is present in very low quantities, with only two fragments containing only barley and making up to only 9.57% of the total particles identified. Not only the presence of barley is generally lower than the presence of wheat in the analysed food fragments, but also shows a different trend through time, with a higher use of barley as a cereal component towards the later occupation phases, particularly after South P and North I Levels.

Because non-cereal components representing a very low quantity in comparison to the cereal components at Çatalhöyük East, the majority have not provided information about trends of use throughout the occupation sequence. However, particles of pulses show an interesting pattern, with their presence mainly in fragments collected from the Middle phase of the occupation, with only two samples from the latest level of the Early occupation phase (South L). In this sense, the presence of pulses in the food fragments from Neolithic Çatalhöyük seems to be concentrated around a very specific time frame of approximately 200-300 years during the Middle occupation phase of the site, from levels South L to South O and North G (ca. 6700 to 6400 cal. BC).

In addition, the identification of wild seeds such as those of Wild Mustard (*Descurainia sophia*) and other wild seeds is concentrated in the food fragments from the Early phase of the occupation at Neolithic Çatalhöyük. However, due to the very low number of fragments which contain wild seeds, this might not be representative of the whole assemblage. What seems clear however, looking at the use of plant ingredients from Çatalhöyük, is that there is a higher use of a wider variety of plant components at the beginning of the sequence up to the beginning of the Late occupation phase, from Level South G to South P and North F to North G. During this time, sedge tubers, pulses, and wild seeds are added to a base of cereal flour, in order to prepare meals. During the Late and Final phases of occupation at the site, the use of non-cereal ingredients seems to stop, with only wheat and barley components being identified in the food fragments. (Figure 6.6.)

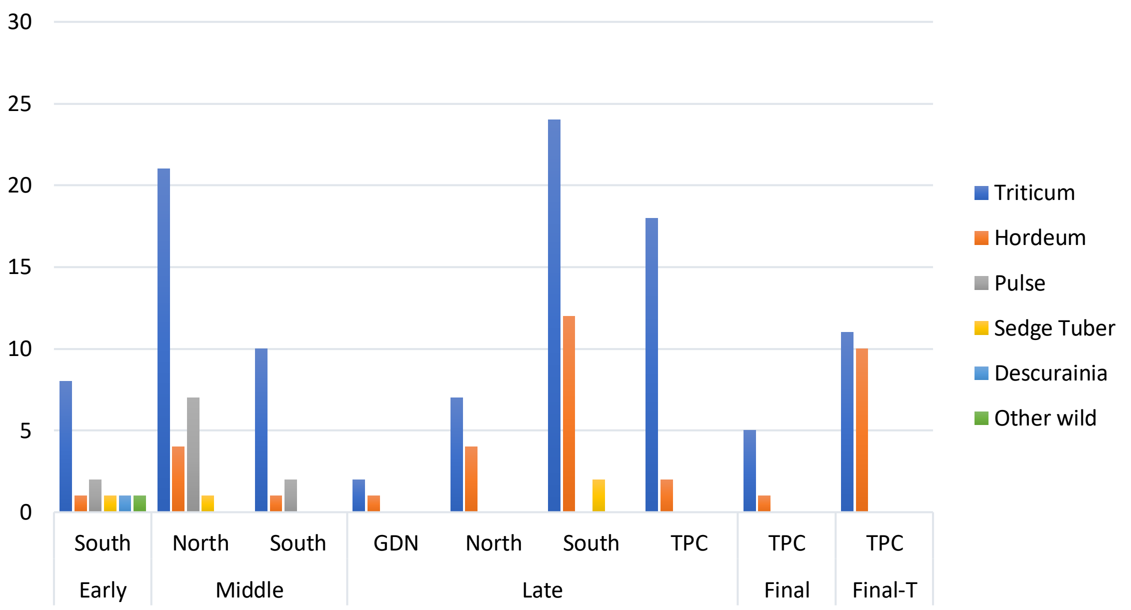


Figure 6.11. Chronological and spatial distribution of the food fragments' composition from Çatalhöyük East

6.4. Morphology and microstructure of the archaeological food fragments

6.4.1. General description

In addition to the identification of the plant ingredients used for the preparation of the archaeological food remains recovered from Çatalhöyük, a key aim of this study was to distinguish different types of cooking processes or techniques which could have led to the preparation of these meals. In this sense, four different types of internal microstructures (matrices), which differed considerably in relation to their porosity and inclusions, were identified among the charred food fragments recovered from Neolithic Çatalhöyük. After comparison with the experimental reference materials it was concluded that these are most likely the remains left behind of four types of cereal products, which underwent different types of preparation methods and cooking processes such as baking or boiling (see Chapter 5 for full explanation on methodology).

Based on the typological datasets created for this study and observations of the archaeological materials, and their comparison with the experimental specimens, some preliminary conclusions can be drawn about the possible food preparation activities at Çatalhöyük East. We were able to identify four types of food matrices among the food fragments recovered from the North, South and TPC areas, of which three were observed to be analogous to the internal structures of experimentally prepared dough, flatbread, naturally leavened bread and porridge.

- *Matrix Type 1*: The cereal products under this category have been seen to be similar to dough-like remains after comparison with experimental materials (see above and Figure 6.13.). This type of matrix shows very few and small visible particles (0-2; 50-600µm) and large close voids, ranging in size from 200 to 800µm and which cover a high percentage of the microstructure surface (>30%) (Figure 6.7. a-b). The analysed food fragments categorised under this type present an average particle size of 0.36mm (36µm) and voids average size of 0.34mm (34µm) (see Appendix II and III for summary table and full list of values). This type of foods are likely to represent the remains from bread dough, perhaps discarded or fallen into the fire during dough preparation or whilst baking.

- *Matrix Type 2*: The cereal products under this category have been seen to be similar to possible leavened bread-like products after comparison with experimental materials (see above and Figure 6.13.). This matrix type shows a low number of small (1-3; 50-600µm) and sporadic medium visible particles (1-3; 200-900µm) in which the air bubbles or voids are micropores (50-300µm) and in general cover more than 30% of the surface (Figure 6.7. c-d). In general, the food fragments categorised under this type, have an average particle size of 0.51mm (50µm) and an average pores size of 0.11mm (11µm) (see Appendix II and III for summary table and full list of values).

- *Matrix Type 3*: The cereal products under this category have been seen to be similar to flat bread-like products after comparison with experimental materials (see above and Figure 6.13.). This matrix type shows a relatively low number of small and medium visible particles (1-4; 50-900 µm) and a low percentage of small closed voids and micropores (25-300µm), covering between 10-20% of the surface (Figure 6.7. e-f). The analysed food fragments categorised under this type present an average particle size of 0.46mm (46µm) and voids average size of 0.14mm (14µm) (see Appendix II and III for summary table and full list of values).

- *Matrix Type 4*: The cereal products under this category have been seen to be similar to porridge-like or gruel products after comparison with experimental materials (see above and Figure 6.13.). This is a strikingly different type of matrix, showing a lumpy structure with a very high number of large visible particles (4-15; 500-1800µm) and a medium percentage of large (200-500µm) cracks and channel voids (10-20%) (Figure

6.7. g-h). The analysed food fragments categorised under this type present an average particle size of 0.83mm (82μm) and voids average size of 0.14mm (14μm) (see Appendix II and III for summary table and full list of values).

While the first three types of matrices (1,2 and 3) are characterised by a low number (0-3) of small and medium visible particles (50-900μm), the fourth type of matrix (4) is characterised by its clearly bigger (500-1800μm) and numerous (4-15) visible plant particles which correspond to grain and pulse fragments and very large bran cells areas. In addition, there are differences in the types of voids in the different matrices. *Matrix Type* 1 fragments contain a very high percentage of large air bubbles (voids) in contrast to the very high concentration of micropores from *Matrix Type* 2 fragments (both voids percentage >30%). While *Matrix Type* 3 and 4 fragments have a medium percentage of voids (ca. 15%), *Matrix Type* 2 fragments are characterised by their microstructure formed by small closed voids and micropores in contrast to the channel and tunnel voids seen in *Matrix Type* 4 fragments (see Figures 6.9. and 6.10.).

In total, the average number of particles observed in the food fragments from Çatalhöyük is 3 and their average size is 0.56mm. In terms of voids (air bubbles), the average size of the voids is 0.16mm and the average of matrix coverage is 17.87% (see Table 6.1. for details). The particle measures are comparable to modern flat bread-like products showing the importance of the use of fine or relatively fine flour for the preparation of the majority of these foods at Çatalhöyük. In relation to the voids, data shows a more compacted microstructure and considerably low air bubble presence. This is not directly comparable with the data available from modern flat-bread making as these are made using wheat grains which are genetically bred to contain higher quantity of gluten and normally prepared adding leaving agents such as yeast.

Flat bread-like fragments (which correspond to *Matrix Type 3* after comparison with experimental materials) are the most common among the analysed food fragments from Çatalhöyük and they represent the 44.1% of the samples. Then, porridge-like fragments (which correspond to *Matrix Type 4* after comparison with experimental materials) are the second most common products identified among the analysed food remains from Çatalhöyük. A total of 47 fragments (27.64%) have been found to possess a similar microstructure to experimentally prepared porridges (see identification criteria). Dough-like fragments (which correspond to *Matrix Type 1* after comparison with experimental materials) represent only 12.35% of the total analysed fragments of food from Çatalhöyük. And lastly, foods categorised under *Matrix Type*

2, which has been found to show similarities with naturally leavened bread-like products, represents only the 10% of the analysed food fragments from Çatalhöyük. The rest 6.3% not accounted for correspond to those food fragments which could not be categorised under one single category and show characteristics of more than one type of matrix. These are in their majority food remains which do not present a clearly categorisable microstructure to any of the experimental ones and could either be bread or porridge-like fragments (*Matrix Type 3* or *Matrix Type 4*) based on the type of porosity present in their microstructure. Perhaps these fragments represent a different type of product however further experimentation would be needed in order to reach a definite conclusion.

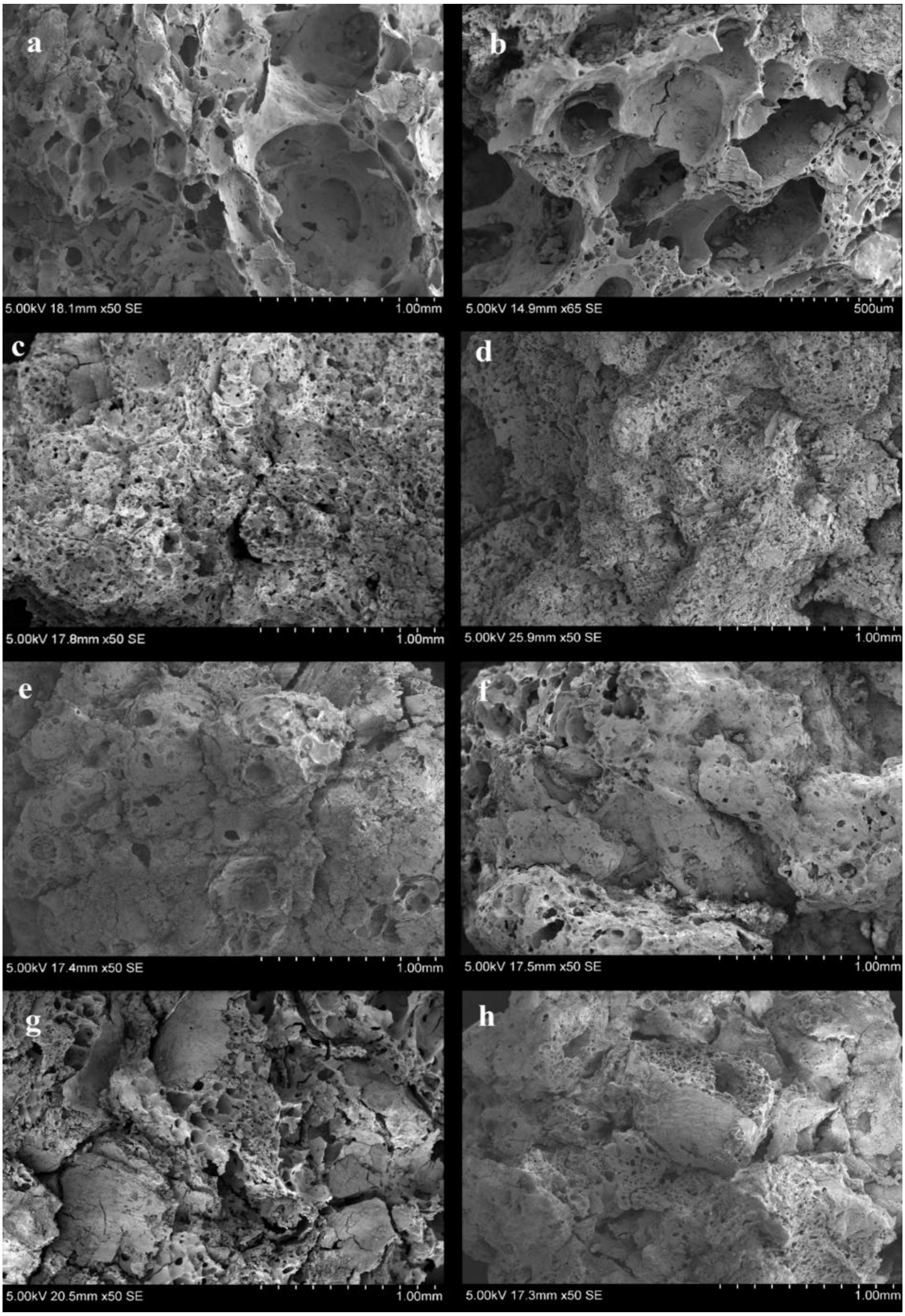


Figure 6.12. Examples of archaeological food matrices from Çatalhöyük. *Matrix Type 1* (a, b); *Matrix Type 2* (c, d); *Matrix Type 3* (e, f); *Matrix Type 4* (g, h).

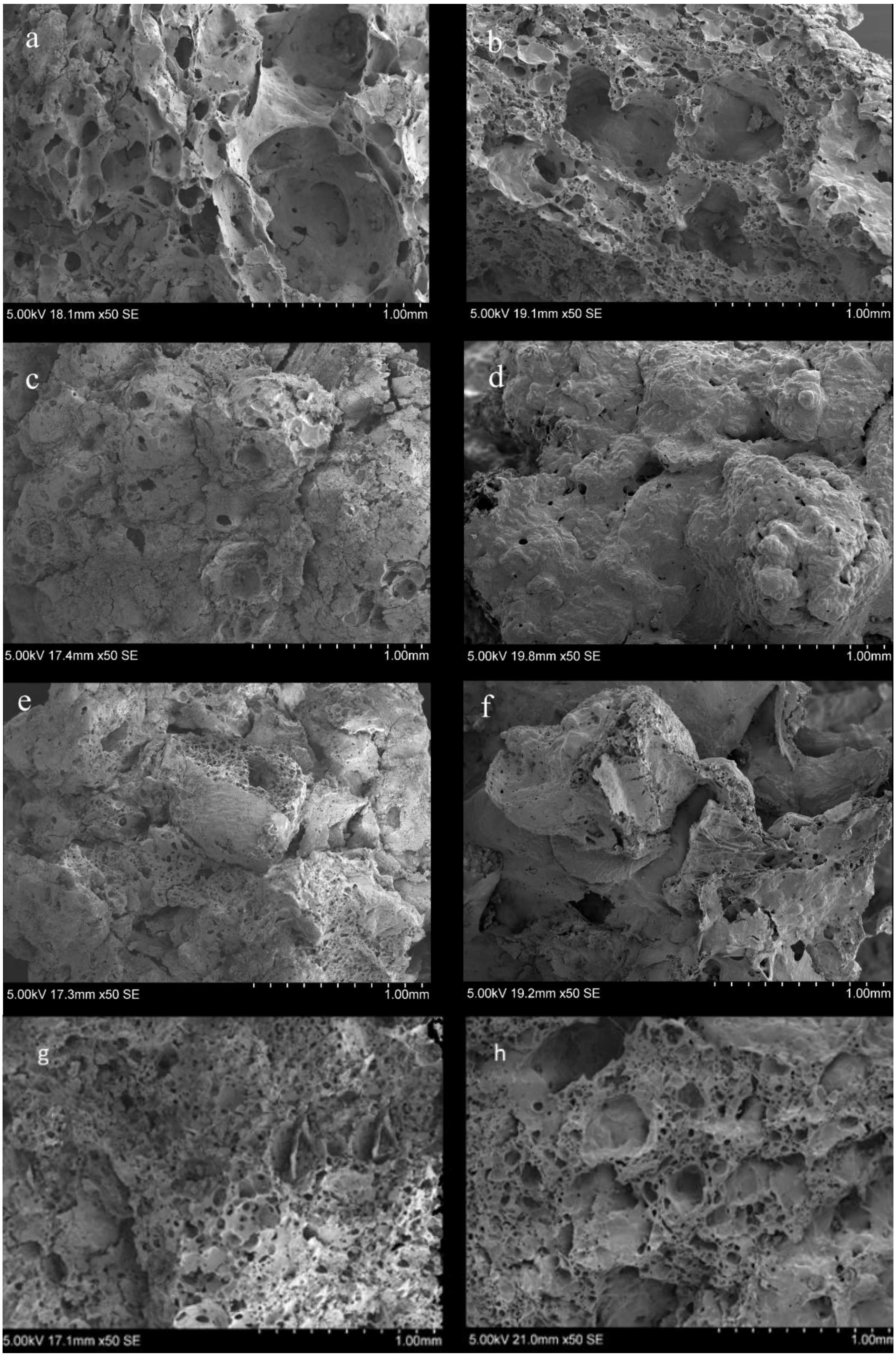


Figure 6.13. Comparison of archaeological food matrices (a, c, e, g) with experimental food matrices (b, d, f, h). *Matrix Type 1* equivalent to dough-like products (a, b); *Matrix Type 2* equivalent to possible leavened bread-like products (c, d); *Matrix Type 3* equivalent to flat bread-like products (e, f); *Matrix Type 4* equivalent to porridge-like products (g, h).

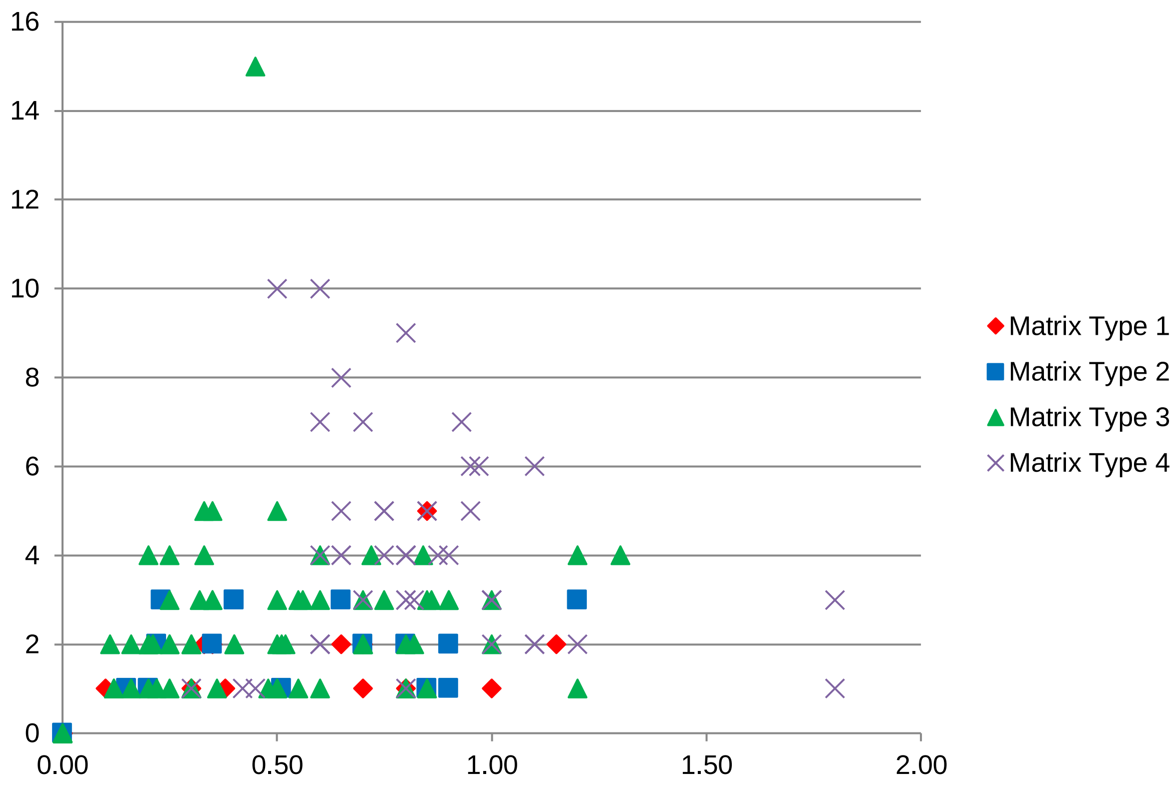


Figure 6.14. Plot showing correspondence of matrix types with average number of particles (*Y* axis) and particle size (mm) (*X* axis). Full list of values in Table 3 in appendix IV.

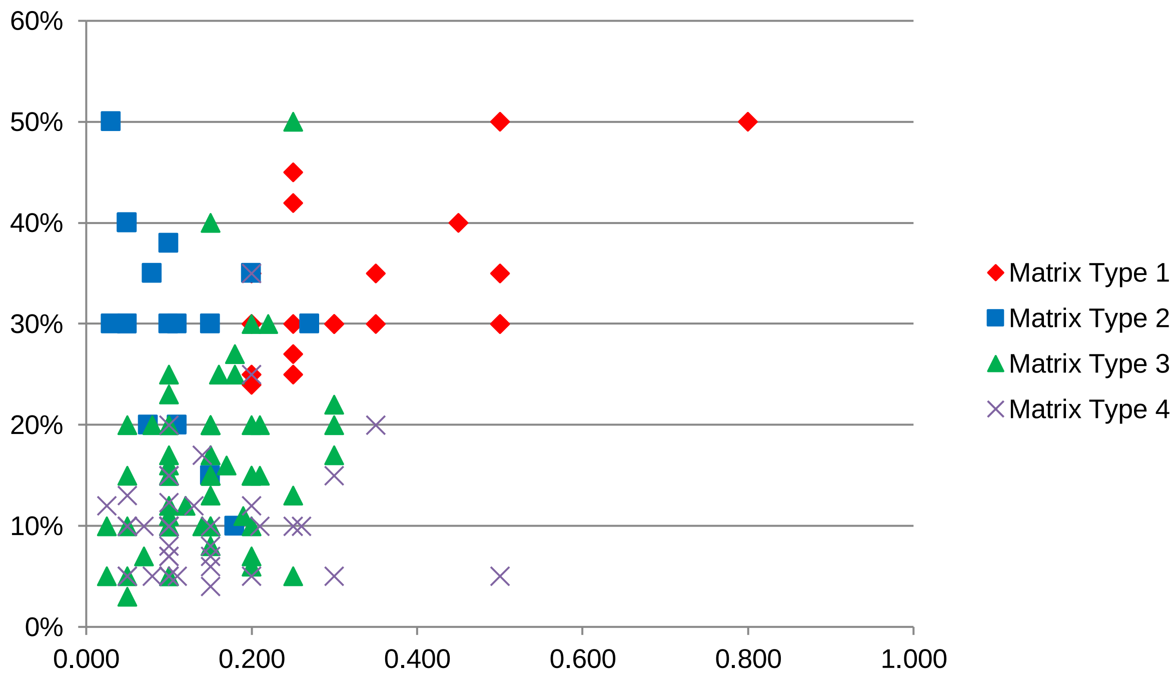


Figure 6.15. Plot showing correspondence of matrix types with porosity percentage (*Y* axis) and void mean size (mm) (*X* axis). Full list of values in Table 7 in appendix IV.

The measured fragment sizes of pulse and cereal tissues indicate that the main component used for the preparation of the meals present in *Matrices Types 1, 2* and *3* must have been fine cereal and pulse flour and been sieved after grinding, or at least been subjected to repeated grinding. No tissue parts were visible to the naked eye; only 5 of the measured components exceeded a maximum length of 500 µm, while the major part measured between 100 and 500 µm. According to Dickson (1990), without sieving, large bran fragments of 500µm in length and above should have been visible in the respective cereal product. On the other hand, the measured broken grains and bran particles in *Matrix Type 4* foods, indicate that coarse grain must have been their main ingredient. This pattern might be due to shorter grinding periods or else due to an intentional choice of coarse grain over fine flour for the preparation of these meals. The possibility that these materials were not sieved has been considered however, due to the virtual absence of small particles (100-500µm), they do not show a deliberate mixture of fine flour and coarse grain. Altogether, the fact that all visible particles range between 500-1500µm, in addition to the arrangement and type of voids, and a lack of crumb indicate a different cooking technique more related to a porridge or gruel preparation rather than bread baking (Dickson 1990; Lannoy *et al.* 2002).

Table 6.1. Average number and size of particles and estimate percentage and size of voids in the food matrices

Row Labels	Particle size (mm)	number of Particles	Void size (mm)	Percentage voids
Dough	0.36	1.10	0.34	33.48%
Leavened Bread	0.51	1.82	0.11	30.18%
Flat Bread	0.46	2.25	0.14	15.31%
Porridge	0.83	4.09	0.14	10.54%
Grand Total	**0.56422**	**2.59375**	**0.162**	**17.87%**

6.4.2. Chronological distribution of cereal products at Çatalhöyük East

Despite a random selection of samples from "in situ" burnt contexts around the site and which span from the beginning of the sequence to the later levels and from the three excavation areas at Çatalhöyük, different types of food remains seem to fall into specific excavation areas and time periods (Figure 6.10.):

- *Matrix Type 1* food fragments (dough-like products) are evenly distributed between areas South, North, GDN and TPC. Besides one exception with one food fragment coming from level South L, they seem to concentrate around the Middle-Late levels of the Çatalhöyük sequence, coming from levels South O-P and North G (ca. 6500 cal. BC), and continue onwards until the latest levels at TPC.

- *Matrix Type 2* food fragments (leavened bread-like products) are similarly coming from samples from the Middle-Late levels of occupation of the site (ca. 6700-6500 cal. BC), being concentrated on levels South M-O and North F-G with only one sample coming from the Final phase of the site from the TPC area and preliminary dated back to ca. 6300 cal. BC.

- *Matrix Type 3* food fragments (flat bread-like products) are present in samples collected from all occupation levels at Çatalhöyük East from the Early part of the occupation sequence in level South G. The remains of flat breads continue from South G levels onwards into the Middle occupation with no particular area or period showing a main concentration. Towards the Late-Final part of the sequence (ca.6500-6300 cal. BC), the concentration of bread-like remains decreases considerably in the South and North areas and only 21 of the total bread-like fragments were recovered from the TPC area. This shows a particular decrease in the production of bread-like products at Çatalhöyük after ca.6500 cal. BC, with a larger focus on the production of porridge-like products, especially among those samples recovered from the latest levels (TP M-Q). Interestingly, no remains of flat bread-like products have been recovered from inside the buildings for the Late Phase in the North Area. In contrast, the remains of flat breads from the late occupation of the North area come from outdoor midden areas and specifically from deposits from Level North I.

- *Matrix Type 4* food fragments (porridge-like products) make their appearance at Çatalhöyük at the beginning of the Middle occupation phase and will continue onwards until the Final phase occupation levels (TP Q). Remains of porridge-like products are mainly coming from TPC area (Levels TP M-Q) representing more than half of the total porridge-like remains (27 fragments). The other 20 porridge-like fragments, except 2 fragments from level South H which have been seen to be similar to gruel-like products containing large particles of tuber material, come from the South and North areas from level South O and North G onwards (ca.6500 cal. BC).

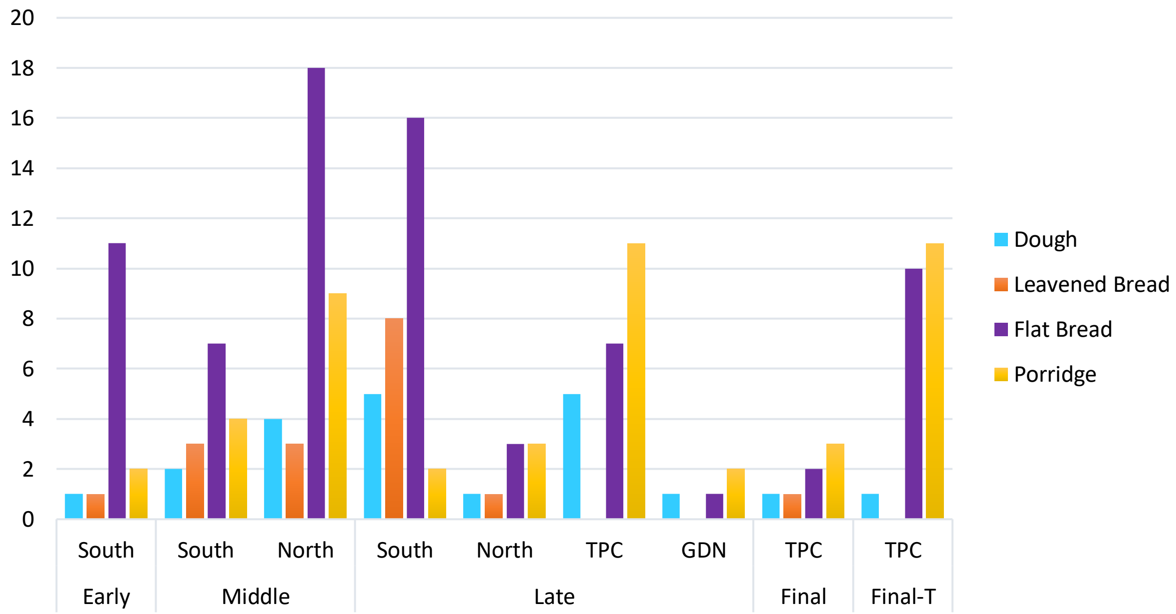


Figure 6.16. Bar chart showing the chronological and spatial distribution of cereal product types from Çatalhöyük.

6.5. Spatial distribution of food fragments at Çatalhöyük East

This section presents the patterns and differences in the distribution by building/space and type of contexts of the recovered food fragments from Çatalhöyük East. Figure 6.12 shows the distribution of cereal products among buildings and Figure 6.11. shows details on type of contexts within buildings.

6.5.1. Building by building discussion

6.5.1.1. South Area (Early Phase)

- Building 118:

This building dates back to one of the earliest levels at the site (South H) around ca.7000 cal. BC. It was excavated by Mellaart as House 25 and re-excavated in 2013 as part of the new excavation team. Food samples were recovered from three samples from U.30614, U.30615 and U.30626 from occupation layers in Sp.510. Of the three fragments analysed, one of them has been categorised as flat bread-like material, while the other two correspond to the only examples of porridge-like materials recovered from the Early Phase. These remains were recovered as part of the occupation make-up layer of the floors and they do not seem to be in direct link with features dedicated for food preparation. These layers, however, seem to have been formed by mixed materials, including charcoal and other plant remains most likely derived from the fire installations rake outs, which could have been part of crop-processing and food preparation refuse found on the floor in the moment of sealing it.

The food fragments analysed from B.118 were seen to contain remains of cereals and sedge tubers. These ingredients correlate with the macrobotanical remains recovered from these deposits which include a high concentration of cracked grains, glume bases and occasional sedge tubers and nutlets.

- Building 2:

Building 2 is the second earliest building from which food remains were recovered. In this case, the samples were collected from a series of deposits which are believed to represent dumped materials and contain a mix of organic materials and building materials. The dumping of materials on this building has been interpreted as perhaps a task carried out as part of the abandonment of the building. The food fragments analysed from this deposit indicate a flat bread-like microstructure, although the identification of plant ingredients was not possible due to preservation issues.

- Building 4:

The food remains recovered from Building 4 come from an accumulation of refusal materials and possible rake outs from two ovens in Sp.151. These two ovens seem to have been in use at the same time for food preparation, among other activities which were carried out in the large room of the building. The building seems to have been in use sometime during ca.6700 cal. BC (Level South L).

The food remains collected from these ovens were seen to present a microstructure which resembles dough-like materials. Due to the recovery of these from the inside of the fire installation, it is plausible that these are the result of accidental burning of dough during one or multiple baking events.

- Building 6:

This building is part of the main early occupation of the East Mound which seems to have been in use at the same time as building 4, sometime around ca.6700 cal. BC or Level South L. The food remains which have been analysed from this building were recovered from deposits which were formed by the rake out of materials from two fire installations within the small side room, sp.173. As mentioned above, the recovered food fragments are the result of the accidental burning of remains from baking which took place in the ovens.

The food remains analysed from these deposits have been found to present a flat bread-like microstructure and to contain cereal ingredients, in particular wheat, in addition to fragments of pulses and wild mustard seeds. These fragments represent some of the most varied food remains from Çatalhöyük East as they do not only contain cereal ingredients but also pulses and wild seeds. The results from the analysis of these fragments constitute the earliest evidence of the use of pulses and wild mustard for the preparation of cereal-based foods at the site.

- Building 43:

This building is contemporary of B.4 and B.6 dating also back to sometime around 6700 cal. BC (Çatalhöyük Project Database). As seen for B.4 and B.6, the food remains were recovered from oven deposits, in this case from the infill of oven F.7509. During the excavation, this oven was recognised as the earliest oven in use in B. 43, and its fill was seen to contain a high concentration of plant remains and charcoal lenses which were most likely derived from the use of this for food preparation. In this sense and similarly to the food fragments from B.6, the analysed food remains from B.43 have been categorised as flat bread-like products which were made from wheat with the addition of pulses. Interestingly, the finds from B.6 and B.43 adds evidence to the emergence of a new cooking tradition which is based on the addition of pulses to the preparation of cereal-based products around 6700 cal. BC at Çatalhöyük East.

6.5.1.2. South Area (Middle Phase)

- Building 89:

Food samples from the earliest part of the Middle Phase were recovered from Building 89. This building dates back to Level South N and it is composed of two rooms and an annexe which were completely excavated at the end of the 2016 season. B.89, as a norm, did not yield a high concentration of plant remains during the excavation of its various occupation phases, which has been interpreted as a result of continuous cleaning and dumping off of the refuse materials. However, a series of dirty floors and burnt pit deposits yielded remains of foods which were categorised after analysis as being derived from the preparation of bread-like and porridge-like products. These were seen to have been made entirely using cereal flour, mainly wheat species; this correlates with the macrobotanical assemblages from these deposits which contained a high concentration of wheat grains and chaff.

- Building 76:

This building stratigraphically overlies B.89; it was built on top of it and was in use after this was abandoned. This building was excavated in the 1960s and contained a large L-shaped room (sp.137) and a smaller room, probably storage side room (Sp.368).

In the case of the food remains which were analysed from this building, these were recovered from within the burial fill deposits, in combination with a high concentration of macrobotanical remains, such as cereal grains, chaff, etc. The interpretation of the presence of high concentration of plant remains in burial fills from Çatalhöyük East is an on-going discussion. In the light of preliminary analysis of archaeobotanical samples from burial fill deposits, these have been seen to contain similar archaeobotanical assemblages to midden and dirty floor deposits (Fuller *pers. comm*). In this sense, the recovery of food remains from these deposits seems plausible as they are likely to represent residues deposited in the midden/dirty floors which were derived from cooking/baking activities.

Interestingly, two of the four food fragments analysed from B.76 were categorised as remains of porridge-like products based on their microstructure, in addition to one fragment of dough-like product and another one which is likely to represent the remains of a leavened bread-like product. The porridge-like fragments from B.76 were seen to have been made using only cereals (wheat and barley), while the dough-like fragment also contained fragments of pulses.

- Building 79:

This building was in use during Level South O (ca. 6500 cal. BC) and was posteriorly sealed by the external space Sp.344. Food remains from this building were recovered from accumulated deposits between the walls of the building. It is possible that these remains were accumulated there during the later phase of the use of this space, perhaps as part of cooking activities which were carried out in Sp.344.

The food fragment recovered from this deposit was seen to have a bread-like microstructure and have been made using wheat flour.

- Building 97:

This building was in use during Level South O (ca. 6500 cal. BC) and was posteriorly sealed by the external space Sp.372. The building is comprised of a large room (Sp.365) and a side room to the west (Sp.469).

Two food fragments have been analysed from deposits in this building, one from the side room and another one from the main room; both of them likely to represent residues from foods prepared and cooked within B.97. The one recovered from the occupation layer in Sp.365 represents a bread-like product, made of wheat flour. On the other hand, the food fragment analysed from the side room was recovered as part of a storage bin fill, which most likely was accumulated during the abandonment of the building. This fragment was seen to represent remains from some type of dough-like product, made of cereal flour.

- Building 80:

Building 80 is an example of the building category termed by Hodder as “special buildings” due to the elaborated decoration and high number of burials within the house. B.80 was also completely burnt as part of the ritual of abandonment, and therefore plant remains are extremely well preserved.

Two food fragments were analysed from B.80, having been recovered from the fill of the main oven in operation in the main room (Sp.135) and the floor annexe to the oven. The fragment recovered from the oven presented a very elastic and porous microstructure, similar to the experimentally created leavened bread and was made using cereal flour.

- Building 87:

Building 87, as seen for B.97, was in use during Level South O (ca. 6500 cal. BC) and was posteriorly sealed by the external space Sp.372. Although the building was not fully excavated, remains of food were recovered as part of the archaeobotanical assemblage from the occupation layers within the main room (Sp.374). Both of the analysed food fragments are thought to be remains of bread made with cereal flours (mainly wheat), one from a flat bread-like product and the other one from a possible leavened bread-like product.

6.5.1.3. South Area (Late Phase)

- Building 75

This building was in use during the Late Phase of occupation of the South area at the site, during Level South P (ca.6600 cal. BC). It is contiguous with Spaces 333 and 329 and was badly truncated on its western side by Mellaart's section during the 1960s excavations.

One food fragment was analysed from B.75, recovered from the inside of a hearth in the middle of the main building. It is believed this hearth was in use during the Middle and Late occupation phases of the building, in conjunction with a main oven located on the Southwestern wall. This has been categorised as a fragment of a possible leavened bread-like product, which is most likely derived from baking activities which took place either in the hearth or in the nearby oven. Although not impossible, baking bread over a hearth would not have been B.75 occupants' first choice, which means that these remains could be linked to the cleaning of the oven or remains from cooking/consumption which were then dumped into the fire in the hearth. These routine cleaning habits are well attested from Çatalhöyük East and other Neolithic sites in West Asia (Hodder & Cessford 2004; Shillito *et al.* 2011).

6.5.1.4. North Area (Middle Phase)

- Building 119

Building 119 is located on the eastern side of B.5, and the western side of B.102. It was in use during Level North F (ca. 6600 cal. BC) and it is comprised of a side room (Sp. 512) and a main room (Sp. 513), covering an area of 6.20 m by 5.60 m. Spaces 512 and 513 are divided by two partition walls, one to the north, F.7145, and one to the south F. 7144. An access hole, F.8108 also links spaces 512 and 513 by the southern partition wall. The building was excavated through 2012 to 2014 when it was noticed that the northern wall contained a unique wall painting in the shape of lozenges. The features of the building represent a typical Çatalhöyük building – with raised platforms to the north and east, and the hearth and oven to the south.

Two food fragments were analysed from B.119; according to the characteristics of the microstructure these were categorised as a fragment of flat bread-like product and a fragment from porridge-like products. The food fragments recovered from this building were found among the organic remains of a burnt pit and a burnt occupation or dirty floor layer which suggests that these remains could be derived from the deposition of refuse materials discarded during or after cooking. Interestingly, both of the food fragments which were analysed from B.119 were made of wheat fine flour with the addition of fragments of pulses. Having recovered these two fragments from different contexts within the building and in different areas of the house, it would be safe to assume that the addition of pulses to the preparation of cereal-based foods was most likely a routine practice for the occupants of B.119.

- Building 132

This building was not completely outlined by excavation, having only recovered in part as small portions of Sp.511 and Sp.531. Only one food fragment was analysed from this building but interestingly, as seen for this time frame especially in the North area, it was also seen to have been made using cereal flour and pulses. In this case, the analysed food fragment was recovered from an occupation layer of Sp.511 and its microstructure fitted the criteria for dough-like products. According to the excavation records, this occupation layer was rich in organic materials, such as charcoal, ash and other plant remains including cereals and pulses. In this sense, it is likely that the food remains recovered from this context represent discarded materials during food preparation and cooking.

- Building 52

Building 52 is an example of burned building from the northern excavation area at Çatalhöyük. Current stratigraphic information places B.52 in Level North G (ca. 6500-6400 BC) (Farid 2014) and Hodder has defined it as an elaborate/large house due to its large size and its complex layout and attached rooms (Hodder 2013). B.52 has provided evidence of a full larder of cultivated crops (wheat, barley, peas) and wild seed foods (almonds, hackberries and wild mustard), as well as raw materials of animal origin such as bone and antler (Bogaard *et al.* 2009; Twiss *et al*. 2009). Cattle bucrania in a niche, and several goat/sheep frontlets incorporated in a bench on the west side of the building suggest symbolic storage of past feasting events, while the burning of full grain and seed stores must have signalled "plenty" and a secure surplus. The building is thought to have been destroyed by an accidental fire which caused the collapse of the walls and inside rooms. Building 51 was subsequently built on top, close after the destruction of B.52.

Food fragments were recovered from a variety of contexts from B.52, including burial fills which, as mentioned earlier, are representative of midden/dirty floors materials. The analysed food fragment from B.52 was recovered from a burial fill in Sp.94 and was categorised as remains of a flat bread-like product. As seen from other buildings in this area, this fragment was seen to contain not only cereal flour, but also fragments of pulses which were added to its preparation. The results from B.52 add more evidence to the idea that the choice of pulses for the preparation of cereal-based foods was a widespread practice among the occupants of the houses in the North area during the Middle Phase of the occupation at Çatalhöyük.

- Building 1

Only one sample containing fragments of food was recovered from this building, from U.1442. This sample was collected from a burnt deposit from a plastered "basin-like" feature in Sp.187 (originally Sp.70), which was believed to have been used to store some type of liquid. In this sense, the food remains analysed from this deposit present a hollow microstructure, typical from dough-like products, which contain a high content of water/moisture. Due to this deposit being considered a basin-like feature, it is possible that the recovered food remains were either residue from crop-processing or food preparation activities carried out using the water stored in it.

- Building 114

Building 114 is a small building comprised of spaces 88 and 87 and investigations in 2016 showed that it was truncated by the construction of B.113 (García-Suárez 2017). Due to the good preservation and large size of the food fragments recovered from this building, a total of five of them were chosen for full analysis.

Four of the five fragments presented a microstructure which matched the criteria for the identification of flat bread-like products and the remaining one showed similarity with porridge-like products. All of them were seen to have been made of wheat flour and, interestingly, the porridge-like fragment was also seen to contain fragments of pulses. These fragments were recovered from the main room (Sp. 87), from hearths, rake-outs from fire installations and "in-situ" burning of dumped materials excavated across the building. In particular U.20961 represents a fire pit with an abundant accumulation of plant remains; it is believed that the burning event took place right before the construction of the above platform (Tung 2015). This context contained a high amount of archaeobotanical materials, in its majority represented by cereal grains and chaff and have been interpreted as showing more than one depositional event. It is likely that the recovered food remains are derived from food preparation which took place in this area, perhaps in combination with the use of the nearby oven for bread-baking activities.

- Building 113

Building 113 was built after the abandonment of B.114 and it is believed to have had a short occupation sequence as it did not reveal any burials. The food remains recovered from this building come from the infill layers deposited during and after the construction of the foundation walls of the building. The working hypothesis is that for the construction of the foundations of B.113, B.114 was heavily truncated and its contents most likely used as back-fill or packing deposit. In addition, this layer contained fire spots and charcoal and ash concentrations from which food remains and macrobotanical remains were recovered. In this sense, it is likely that the food fragments could be derived from the preparation of foods perhaps while construction of the foundations for B.113.

Four food fragments were fully analysed, distinguishing between 3 fragments of bread-like products and one porridge-like product. The bread-like fragments were seen to have been made of wheat flour while the porridge-like fragment was seen to have been made using barley flour and pulses. Once again, the results from the analysed food fragments from B.113 add evidence to the idea of a culinary tradition during the Middle occupation of the site, which focused on the addition of pulses to the preparation of cereal-based foods, such as porridge-like or gruel-like materials but also bread-like products, as seen from other buildings in this sequence.

- Building 49

Building 49 had an irregular floor plan and measured approximately 3.85m north-south and 4.30m east-west; with an internal ground plan of ca.14.70m². Building 49 consisted of a central occupation area, Space 100, and a smaller side room, Space 334. Excavation revealed a typical pattern of dirtier floors in the south of the building, associated with a hearth and an oven, and cleaner white floors in the north. The central floors of the building appear to represent more mixed use with both clean and dirty surfaces. The patchy, worn nature of the floors across the centre of the building indicates regular use. As with most of the houses excavated at the site, most of the surfaces inside Building 49 appear to have been kept very clean during its use, and as a result relatively few finds were recovered from stratified occupation deposits.

A total of six food fragments were fully analysed from building 49, covering all the different types of matrices and identified product types. Of the 6 fragments, 3 were categorised as remains of flat-bread, and from the rest one was identified as a porridge-like product, another one was identified as the remains of possible leavened bread and the remaining one was categorised as dough-like material. All of them were made using cereal flour, mainly wheat species, except the porridge-like fragment (Fl.7947.1) which was seen to contain only barley particles. In addition, one of the flat bread fragments (Fl.8006) also contained legume flour, as seen from other buildings in this area and timeframe. The analysed food fragments from B.49 were recovered from an indoor oven and a series of dirty floors around it which suggests the food remains are likely to be derived from food preparation and cooking activities.

- Building 77

This building is considered one of the main "elaborated" buildings which were preserved by burning. It was fully excavated and comprises a large structure. The current consensus is that B.77 was destroyed by intentional fire set as part of the ritual practices involved in house closure (Hodder and Farid 2014, 18). The layout consists of a main room (Space 336), which has a sequence of six platforms and a bench and measures 4.4 m × 4.4 m, and a side room (Space 337), measuring 4.1 m × 2.0 m with evidence for storage facilities (House 2014). The building exhibits a high degree of elaboration with ritual and symbolic features concentrated mainly in the northern part of the building, which also contains a long burial sequence (Hodder and Farid 2014, 27). Building 77 yielded a remarkable large amount of archaeological material presumably left in its interior during the last phase of occupation prior to its abandonment. These included large quantities of animal bones, cattle horn cores and antler, bone and stone tools, and concentrations of botanical remains.

A total of 11 food fragments were analysed. Of the 11 fragments, 6 of them were categorised as remains of flat bread-like products, 3 others were seen to be similar to porridge-like products and the remaining 2 were categorised as possible leavened bread-like products. These were in their majority made of cereal flour, with wheat and barley seen in equivalent proportions, in addition to sedge tuber particles seen in one of the porridge-like fragments.

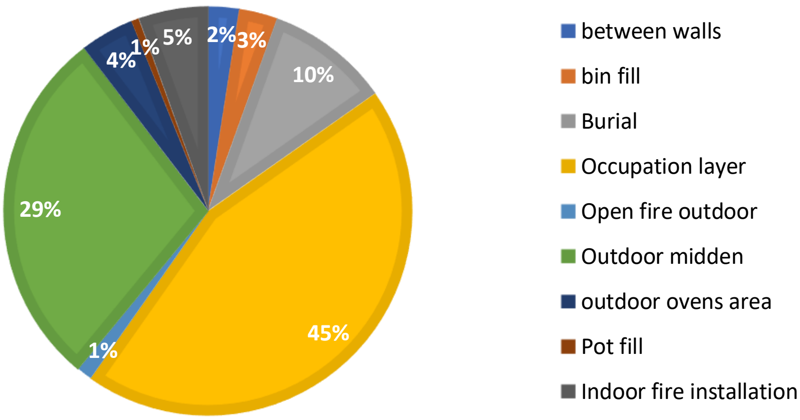


Figure 6.17. Distribution of food remains by type of context at Çatalhöyük East

6.5.1.5. North Area (Late Phase)

- Building 45

Building 45 is a large Neolithic building of over 7m² in size. It consists of a main activity space 228 (Sp.228) and a side room (Sp.238). This building was preserved by burning after its last phase of occupation.

Amongst the recovered food fragments, a single food fragment was fully analysed from this building, having been categorised as a dough-like product which was made using wheat fine flour. This was recovered from an occupation deposit layer which contained a large quantity of bone, pot sherds and clean cereal grain concentrations, associated with daily preparation of food.

- Building 129

Building 129 is a highly eroded building located within the North Shelter between building 1 and building 77 and built on top of the burnt remains of building 131. It is about 11m long and 5m wide and consists of two main spaces: one large side room (Sp.74 and 75) and a main space (Sp.76 and 77).

On porridge-like fragment was recovered and analysed from a burial infill from U.20428. This fragment was seen to have been made using only coarse barley flour and constitutes an example of the increase in the use of barley for the preparation of porridge-like foods during the Late and Final phases of the site.

- Building 47

Building 47 is the latest structure in the North area, postdating all the other features and structures, having been assigned to Level J, right at the end of the Late phase of the North area.

Two food fragments from this building were fully analysed and have been found to be similar to porridge-like and possible leavened bread-like products. Both of the fragments were seen to contain only wheat particles among the ingredients identified and were recovered from the fill of a hearth believed to be a collapsed oven (F.1555) in the middle of the main room (Sp.237). As seen for other buildings, the remains of food products recovered from hearths or ovens are most likely directly related to the use of these for cooking and baking activities.

6.5.1.6. <u>TPC Area (Late Phase)</u>

- Trench 2 – Building 121

Building 121 in the TPC area was exposed in 2013 but not fully excavated as the limits of the building were found beyond the limits of the excavation area. The area of the building which was excavated yielded a platform area with decorative paintings.

Botanical materials and in particular food fragments were recovered in large quantities from this building. In total 5 food fragments from different occupation layers were fully analysed, from which 3 of them have been categorised as porridge and 2 as flat bread-like products. They were all recovered from infill deposits within the main excavated area of the building, in combination with other plant, animal, pots and construction materials typical from occupation debris concentration. The analysed food fragments were all seen to have been made of wheat except one flat bread-like fragment from U.30778 which contained in its majority barley particles.

- Trench 3

Building 122

Building 122 represents one of the largest structures of the TPC area which shares characteristics with the late Neolithic buildings from the North Area. The main excavated space from B.122 is sp.493 which is believed to had been used as a storage side room to the main area. This space contained four storage bins, two of which contained large deposits of barley grain and construction materials, possibly from the collapsed roof.

Two food fragments were fully analysed from B.122 recovered from the side storage room Sp.493. One of them was categorised as a porridge-like product made of barley and other indeterminate cereal particles which did not allow for genus identification. The other analysed fragment was identified as a flat bread-like product made of both wheat and barley.

Building 166

Building 166 is a narrow rectangular space to the west of TPC trench 3. The main excavated area is comprised of a platform and a series of floors. The fragments of food recovered from this building have been recovered from Sp.515, associated with a series of occupation floors.

Two food fragments were analysed from this space and both of them have been categorised after full analysis as fragments of porridge-like products, made of cereals, mainly of wheat although there are other non-identifiable tissues which could possibly belong to barley species; however, the preservation is not sufficient to reach this conclusion.

- Trench 4 - Building 150

Building 150 is the oldest building in trench 4 and in the TPC area. It is comprised of a number of spaces which represent main rooms and side rooms.

A total of 14 food fragments from Building 150 were fully analysed due to the large quantity of food remains recovered from this building. They show a range of characteristics and have been categorised within a wide range of food types which include the main four types of microstructures described above (*Matrix Type 1*, *2*, *3* and *4*). In general, porridge-like fragments are more ubiquitous, having identified 5 of them among the 14 total analysed fragments. Most of these food fragments come from the Late phase of occupation in the TPC area, from Sp. 639 in B.150 (U.32803 in infill U.23993). These units yielded two reed containers kept the remains of a food preparation made using barley and legumes (lentil, pea, bitter vetch and grass-pea) in combination with a wooden tool, probably used for pounding (Ceren Kabukcu personal communication July 2017) associated with remains of coarse ground cereal grains. These deposits seem to be part of accumulation of food resources which were put together before the abandonment of the house perhaps as an example of cooking and eating events which took place in those buildings.

- Trench 1 - Building 110

Building 110 represents the later Neolithic period at TPC (Level TP N). Three fragments of food have been analysed from a series of infill deposits and have been categorised as a fragment of a porridge-like product and a fragment of a dough-like product. They both were seen to have been made of cereals, and particularly using wheat species. One of the analysed porridge fragments was found to be made entirely of barley, which shows the increasing importance of this crop for the preparation of foodstuffs during the later levels of occupation at the site.

6.5.1.7. <u>GDN Area (Late Phase)</u>

- Space 420 – Outdoor midden

Despite this being an outdoor space, it has been included in this section due to the possibility of the remains being part of B.81 abandonment phase accumulation. Sp.420 constitute an area of a group of midden-like deposits that accumulated over the remnants of B.81 (Marciniak and

Czerniak 2008: 76). In 2015 this open area was further excavated to the Southwest, where units investigated consisted of a thick and finely stratified midden (U. 22829 and U. 22834).

Four food fragments recovered from this space were analysed, having identified two fragments of porridge-like products, a dough-like product and a flat bread-like product. Wheat particles were identified in one of the porridge-like remains and in the dough-like fragment. However, the other porridge-like fragment was seen to contain barley particles and other unidentified cereal tissues. Latest investigations in these area (Baranski 2015) suggest these remains are, in fact, coming from the midden deposits, dating back to Level TP N (ca. 6000 cal. BC), which would make them contemporary with those recovered and analysed from the TPC area.

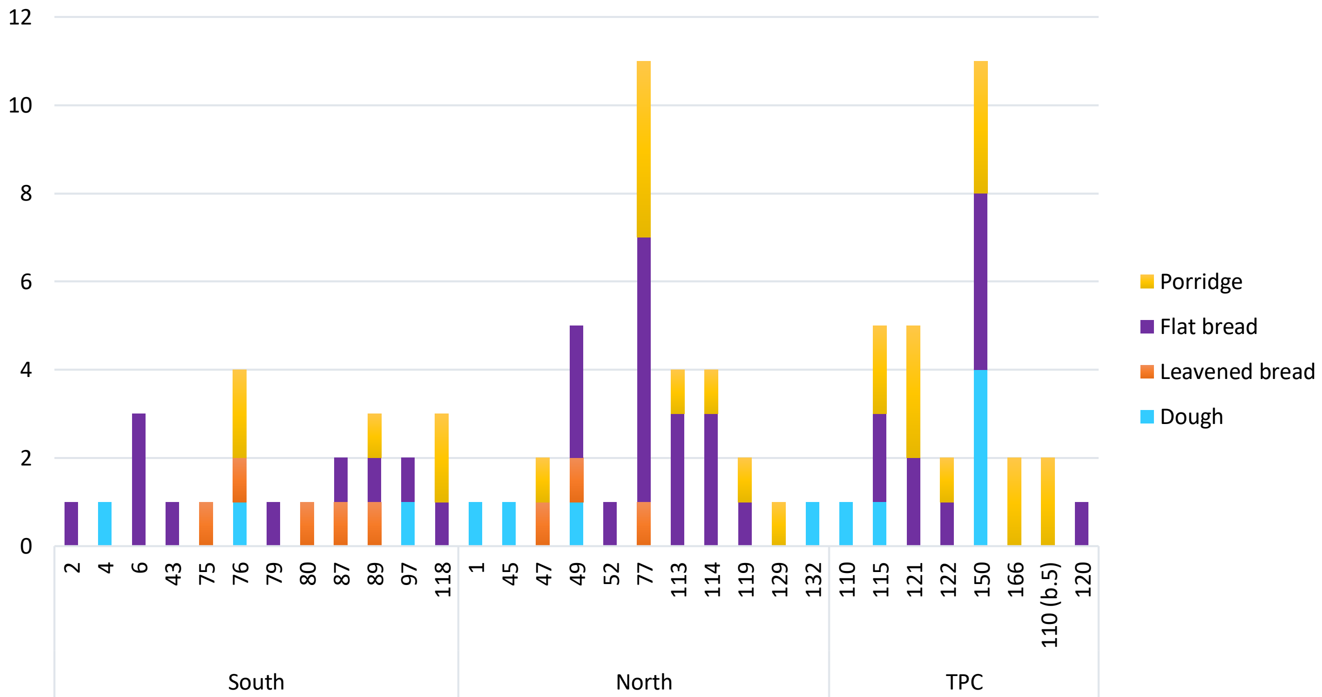


Figure 6.18. Spatial distribution of cereal product types by building and excavation area from Çatalhöyük East

6.5.2. Outdoor spaces and middens

Outdoor spaces and middens at Çatalhöyük represent a contrast with the primary activity spaces as they represent a secondary reflection of the activities that took place inside houses (Bogaard *et al.* 2014). In this sense, food remains recovered from outdoor areas are likely to represent residues and remains from cooking activities which took place inside the houses but also cooking and food preparation happening in those outdoor spaces, perhaps while other activities were going on such as crafting or building (*idem*).

Due to the great variety of outdoor spaces and the singularity of each of them, this section explores chronological changing patterns on food preparation and cooking in outdoor spaces. In some cases, reference to the specific nature of the outdoor area was needed for the interpretation of these patterns.

6.5.2.1. Early outdoor spaces

A total of seven food fragments from outdoor spaces dated to the early phase of occupation at the site have been fully analysed. Interestingly, these have been seen to be mostly remains of flat bread-like products, except one example coming from Sp.181 whose internal matrix showed characteristics of possible leavened bread-like products (Fl.3666). In this sense there is a significant reduction of the variety of cereal based products recovered from outdoor and midden spaces during the Early phase of occupation at Çatalhöyük.

In relation to the ingredients used for the preparation of these foods, the analysed fragments show only remains of cereal components, mainly wheat, with only one fragment having been made using barley. In contrast with what it has been seen from indoor areas, these foods do not show evidence of the use of non-cereal components for their preparation.

6.5.2.2. Middle outdoor spaces

In contrast to what we see from the early levels, outdoor areas used during the Middle phase of occupation at the site show a variety of food products. Despite the variety, flat bread-like and porridge-like products are the most commonly recovered in addition two single examples of dough-like product and possible leavened bread-like product.

In terms of the composition of the recovered food remains, wheat seems to be the main component in addition to two fragments which also contained pulses. Interestingly, these two fragments containing pulses are both remains of porridge-like products. No barley has been seen to be used in the preparation of these food remains which shows a similar pattern to the early occupation levels.

No major differences were noticed between North and South areas in the type of foods recovered or the combination of ingredients used. Food remains containing fragments of pulses, as it was noted in previous sections in this chapter, are more commonly recovered from the North area, however food recovered from outdoor spaces does not seem to follow this pattern.

6.5.2.3. Late outdoor spaces

A total of 36 food fragments from outdoor spaces from the Late phase of occupation at the site were analysed. In general, there is a variety of cereal-based products being recovered from these spaces however more than half of them are representative of flat bread-like products. In addition, virtually all food fragments were made of cereal components, with a no with a noticeable increase in the use of barley. In the majority of the cases, barley was identified in conjunction with wheat particles and in some cases also with remains of club rush tubers.

Some interesting patterns are seen when looking at particular cases. For example, Sp.333, believed to be an area for outdoor cooking activities, perhaps shared among different households from adjacent buildings (Bogaard *et al.* 2014), shows evidence for bread making and baking activities. Samples from this area have been recovered from associated ovens and hearths which are thought to have been in use at the same time during a particular period of time. On this line of evidence, all the analysed food fragments from this space showed a dominance in the use of wheat for their preparation; with only one containing in addition barley and club rush tuber. The preference for wheat species for the preparation of bread-like products is perhaps related to their higher gluten content in contrast to barley species.

6.5.2.4. Final outdoor spaces

A total of 22 food fragments were analysed from the Final phases of the occupation sequence at the site. Except three fragments, the majority of them come from contexts which have been truncated by later features which makes the process of interpretation difficult. An interesting aspect of the food assemblage from outdoor spaces in the Final phases is that are dominated by remains of porridge-like products, which fits with the results obtained from the indoor spaces and with the general increase in the preparation of porridges, removing the focus from bread baking activities.

In addition, the food fragments which were identified as bread coming from outdoor spaces in the Final phases were seen to contain abundant barley in combination with wheat. This is really distinct and differs considerably from previous phases, when barley was a minor component in the preparation of bread-like products.

6.7. Isotopic and lipid composition of the food remains from Çatalhöyük

This section presents the results from the bulk isotope analyses and lipid analysis carried out on 19 food fragments from Çatalhöyük.

Firstly, carbon and nitrogen isotopes were measured in the 19 selected food fragments to broadly distinguish possible animal materials used in the preparation of these foods (e.g. marine/freshwater/terrestrial sources). Second, lipids extracted from four of the 19 fragments were analysed by gas chromatography mass spectrometry to identify their likely source. Samples which were seen to contain non-cereal ingredients such as pulses, sedge tubers or wild seeds were not selected as the specific d15N values of pulses and sedge tubers would alter the nitrogen signal, making interpretation harder. In this sense, pulses are N2–fixing plants, which obtain most of their N from the atmosphere, and are thus expected to have values close to 0‰. On the other hand, sedge tubers grow in wetland soils and its values thus may be able to provide an indication of 15N–enrichment in waterlogged soils. As the main purpose of these analyses was exploratory, to look for potential mixing of plant and animal components and assess the potential of chemical analysis approaches to charred food fragments.

6.7.1. Bulk isotope analyses

Carbon and nitrogen stable isotope ratios were measured by elemental analysis isotope ratio mass spectrometry (EA-IRMS). Please refer to Appendix IV for full dataset derived from bulk isotope analyses carried out on the selected food fragments.

The d15N values of the 19 selected food remains varies from 2.93‰ to 18.60‰ with a mean of 9.07 ± 0.33‰ which, a priori, seems relatively high for such cereal-based products (Figure 6.13. shows full details of d15N and d13C values). However, when looking at the results closer, we see there is a correlation between the d15N values from the food fragments and those of charred plant remains from Çatalhöyük (Styring *et al.* 2015; Vaiglova 2016). Styring *et al.* (2015) carried out bulk isotope analysis on charred grains recovered from the archaeobotanical assemblage in order to compare with bone collagen samples to study possible patterns in diet and animal consumption during the Neolithic. They found that cereals (*H. vulgare*, *T. dicoccum*, *Triticum durum/aestivum*, *T. monococcum*) from Çatalhöyük showed relatively high d15N values, with a mean of 6.7 ± 0.9‰. The authors suggested this is could be a result of manuring, or perhaps a factor of the environment, e.g. aridity. Building on this, Vaiglova (2016) carried out isotope analysis on a variety of plant remains from Çatalhöyük which provided higher d15N values, in accordance with those from the cereal-based food fragments. The author obtained the following mean d15N values of the main cereal types: bread wheat = 9.7 ± 1.5‰, naked barley = 8.8 ± 2.4‰, new type glume wheat = 12.2 ± 3.2‰.

The d13C values of the 19 selected food remains range between –15.61‰ and –24.98‰ with a mean of –22.92 ± 0.16‰. These values overlap with those obtained by Vaiglova (2016) from charred cereal grains and ranged between –20.5‰ and –25.3‰, with a mean of –22.9 ± 0.3‰.

Plants have distinct d13C values depending on how they fix carbon from the atmosphere during photosynthesis (Cerling *et al.* 1997; Chisholm *et al.* 1982; Dawson *et al.* 2002). In general, C3 plants, like barley and wheat, have d13C values between –21 and –34‰ (mean –26.7 ± 2.3‰, Cerling *et al.* 1997). In contrast, C4 plants, such as millets and maize, form 4–carbon compounds (carboxylic acid) and have d13C values between –9 and –17‰ (mean –12.5± 1.1‰, Cerling *et al.* 1997). In the case of Çatalhöyük, all food fragments except one had d13C values between –20.58 and –24.98 ‰ which correlates with the values obtained for C3 plants (e.g. cereals).

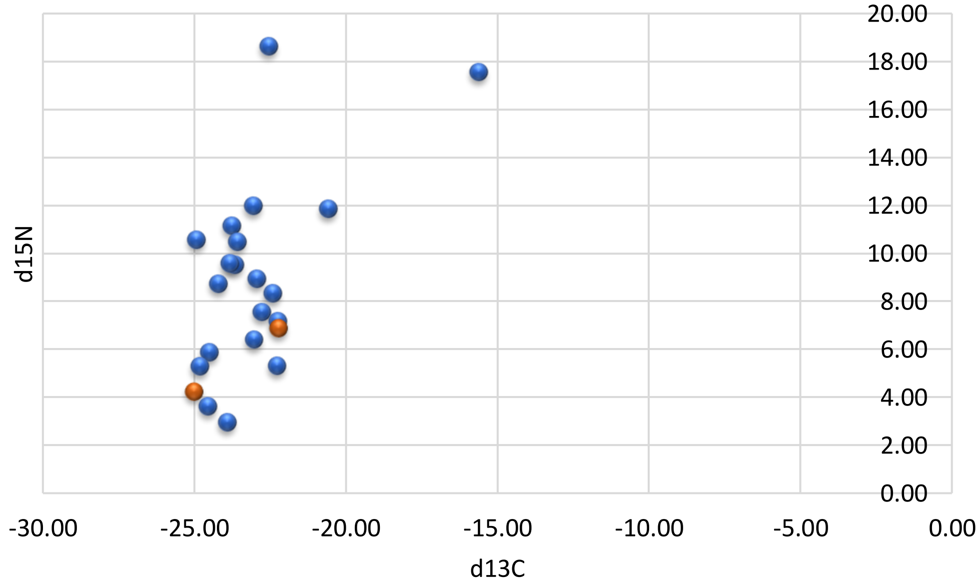


Figure 6.19. Plot of d15N and d13C values from the selected food fragments from Çatalhöyük East (blue) and Jarmo (orange)

6.7.2. Lipid analyses

Analysis of lipids from the food remains provides a more robust approach for identifying the original contents than bulk isotope analysis. For this reason and in order to exclude the possibility that relatively high d15N values obtained from the food fragments from Çatalhöyük were derived from the use of animal materials in the preparation of these meals, lipid analyses were carried out in 4 of the 19 fragments.

Typical examples of the GC-MS results are shown in Appendix IV. The molecular data is summarised in Table 1 in Appendix IV which includes the sample number, molecules extracted from each sample and interpretation of the recovered lipids.

Molecular analysis of samples revealed that all samples contained lipid in very low quantity, indicating poor preservation. The extracts from the burnt residues yielded a range of predominantly mid and long chain (C12:0 to C24:0) saturated fatty acids and in one sample (CH FL9232), trace *n*-alkanes were also present.

The total lipid content was very low (12 – 63ug/g) and all samples contained polyaromatic hydrocarbons which would be as expected in such carbonised remains. With the exception of CH FL9232, the majority of the lipids extracted from the burnt residues were fatty acids, in all cases, dominated by the presence of both C16:0 and C18:0 (>86% of the total lipid composition). CH FL9232 composition was split between fatty acid and alkanes.

Based on the low level of lipids recovered and the degraded fatty acid distribution, it was not possible to identify the source any further (i.e. to distinguish animal fat from plant oils or waxes). It is sometimes possible to use the sterol cholesterol and other phytosterols to determine input of animal or plant material, but there was no evidence of these markers found within the extracts. In this sense, further analysis to determine the isotopic composition of the fatty acids would be extremely challenging given their low abundance.

6.8. <u>Summary</u>

The analysis of the food remains from Çatalhöyük East and the comparison of these with experimentally prepared and charred materials, have provided insights into food preparation and cooking and consumption of cereal meals during the Neolithic. A total of 174 food fragments from Çatalhöyük East were analysed for this thesis, having identified four different types of cereal-based products: flat bread, porridge, dough and possible leavened bread-like products, which were made using a wide range of plant food ingredients, not only cereal and other crops such as pulses, but also wild plant resources such as sedge tubers and wild mustard seeds.

Interesting patterns in food preparation and use of plant ingredients have been seen through time, with a well-established culinary tradition based on bread-like products from the beginning of the occupation sequence at the site (7100 cal. BC), with the addition of porridge-like products later on, with an increasing presence of these types of materials from the Middle phase onwards. The use of wheat species for the preparation of these meals is attested throughout the sequence as the major ingredient used, with sporadic and minor presence of barley (most common towards the Late phase of the sequence), pulses (mainly used during the Middle phase) and wild resources (mainly used during the Early phase).

In addition, the bulk isotopic and lipid composition of a small sample of the analysed food fragments have shown no evidence of the use of animal products for their preparation, however further analysis and interpretation as well as experimentation is needed on this subject.

Chapter 7

Results from Jarmo

7.1. Introduction

This chapter outlines the principal results from the analysis of the selected food fragments collected from Jarmo, in comparison with the data and results derived from the analysis of the food fragments from Çatalhöyük East. Firstly, the results from the experimental cooking and charring activities are presented in order to offer a better categorisation of the archaeological food fragments. Secondly, this chapter exposes the identification of the ingredients and components used in the preparation of these foods, in addition to the categorisation of the food fragments into different types of cereal meals in relation to their microstructure.

Data from the assessment and analysis of the macrobotanical constituents of the flots where food samples come from was also incorporated in the results from the analyses of food fragments in order to shed light in culinary household activities. In this sense, the ingredients identified were compared and discussed in accordance with the macrobotanical assemblages.

7.2. Comparison with experimental materials

This section presents the results from the cooking and charring experiments carried out in order to compare the archaeological food fragments from Jarmo with experimentally prepared meals. The experiments were performed in sets, each of them targeting specific ingredients and cooking processes and with a different purpose.

7.2.1. First set of experiments: Cereal meals

This set of experimentally prepared and charred cereal products provided comparative materials for the analysis of the archaeological food fragments from Jarmo.

As seen for Çatalhöyük, the experimental charred cereal meals showed remarkable similarities with the archaeological foods from Jarmo. Using the binocular microscope and subsequently the SEM, internal structures of the experimental food and archaeological food specimens were analysed. A close study for the quantification and categorisation of voids and particles observed in the microstructures, revealed that experimental dough, bread and porridge present three different types of internal structure, which were almost identical to *Matrix Type A*, *Matrix Type C* and *Matrix Type D* seen in the archaeological food fragments:

- *Doughs:* these experimental materials have a hollow matrix, with large close voids (see attribute set C), 200-800µm, which cover more than 30% of their surface and very few and small visible particles (0-2; 50-600µm). This structure corresponded to *Matrix Type A*.

- *Flat Breads:* have a lower quantity of small closed voids and micropores (see attribute set C), 50-250µm and cover between 10-20% of their matrix and a relatively low number of small and medium visible particles (1-4; 50-900 µm). This structure corresponded to *Matrix Type C.*

- *Porridges:* present a distinctive internal structure with channel voids and cracks (see attribute set C), which vary between 200µm and 500µm in size and cover between 10-20% of the matrix. Also this matrix contains a very high number of large visible particles (4-15; 500-1800µm) This corresponded to *Matrix Type D.*

7.2.2. Second set of experiments: Pulses

This second set of experiments was been key for the identification of some of the archaeological food fragments from Jarmo.

Among the plant products created for this set of experiments, in particular one of the experimental products has been categorised as highly similar to the archaeological food fragments which contain pulses from Jarmo:

- Experimental gruels (see methodology chapter for more information). These have a microstructure comparable to those of the archaeological food fragments from Jarmo which contain legumes and were categorised as having a porridge-like microstructure (*Matrix Type D*).

7.2.3. Third set of experiments: Milk

Similarly to the results from Çatalhöyük, the porridges experimentally prepared with milk do not show a microstructure which is comparable to the archaeological food fragments from Jarmo. No similarities with the archaeological food fragments were observed when observing the microstructures of the experimental products which were prepared using milk instead of water. These results fit with the negative results for animal products obtained from the organic chemical analysis (Isotopes and Lipid analysis) carried out on a fraction of the samples.

7.2.4. Fourth set of experiments: Leavened bread

Leavened bread subjected to a natural fermentation process (see methodology for details) showed a similar microstructure to *Matrix Type B*. These presented a very porous microstructure, dominated by the presence of very small voids or micropores.

As seen for Çatalhöyük food remains, leavened bread whose dough was prepared adding yeast, shows no similarities with the archaeological food fragments analysed from the site of Jarmo.

7.3. <u>Plant components of the Jarmo food</u>

Of the 83 archaeobotanical flotation samples selected from Jarmo, 18 samples contained charred food fragments and have provided information about their plant composition. These 18 samples have yielded up to a total of 160 food fragments, with the amount of archaeological food fragments per sample varying between 0.1 – 2.5ml in volume and sizes of fragments fluctuate from 0.1 – 1.1cm. These food fragments have, like those from Çatalhöyük, a starchy microstructure and a porous matrix, which indicate well-processed and cooked plant components, with cereals as the main ingredient.

A small sample of the 160 food fragments recovered was fully analysed for comparison with those recovered from Neolithic Çatalhöyük. In total 28 charred food fragments have been analysed under low-powered binocular microscope and SEM. These were then categorised accordingly following the methods developed for this study previously explained in chapter 5. From the 28 food fragments, 19 fragments have provided information about their plant food ingredients and all of them have provided data about the possible cooking processes which led to their formation. After subjecting them to the analyses described in chapter 6, we can conclude that there is a general consistency in the plant food composition of the Jarmo food fragments with cereals as the main plant component (87.80%). Only ca. 12.20% of the components observed under SEM can be characterised as non-cereal components, which were in their totality recognised as being fragments of pulses. (See Appendix I and II for full lists) (Figure 7.1.).

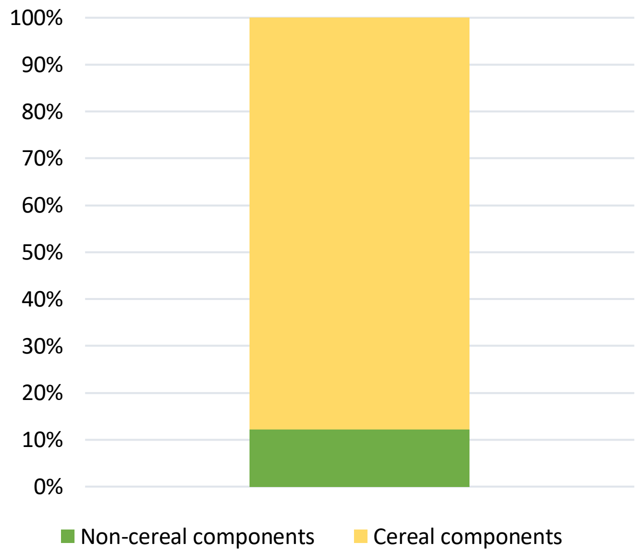


Figure 7.1. Percentage of cereal components and non-cereal components in the analysed food fragments from Jarmo.

7.3.1. Cereal components

The majority of the plant particles identified in the food fragments from Jarmo correspond to cereal ingredients, such as internal tissues of the cereal kernel. Among these, pericarp tissues such as bran layers (transversal and longitudinal cells) and endosperm cell structures such as aleurone layers and endosperm starch containing cells were observed. In some cases, the identification of cereal components to specific genus, such as wheat and barley, has also been possible, due to their cell and tissue shapes, sizes and patterning. Among the recorded components, visible cereal fragments from broken grains, bran fragments (longitudinal and transverse cells) and patches of aleurone tissue are very abundant (Figure 7.2.):

- *Fragments of cereal grains*: A total of 14 fragments of grain from 3 different food fragments have been identified among the 28 analysed fragments from Jarmo. These represent only the 17.07% of the identified particles and contrasts with the results from Çatalhöyük East where fragments of grains were present in up to 40% of the analysed food fragments. No barley grain fragments have been identified in the food fragments from Jarmo and only 3 of the 15 grain fragments have allowed for genus identification as wheat (*Triticum* sp.), specifically from samples Fl.144.3 and Fl.178. The rest of the broken grains visible in the food matrix from sample Fl.64.1, did not allow identification to the genus level due to the lack of visible aleurone cells and/or longitudinal and transverse cells.

The low quantity of broken grains among the food fragments from Jarmo can be seen as a clear evidence for the use of fine flour over coarse flour. Also, the absence of barley among the broken grains, suggests a preference for the use of wheat species over barley for the preparation of cereal products at Jarmo. In relation to the spatial distribution of the food fragments with broken grains, two of the three samples which contained broken grains (Fl.178 and Fl.144.3) come from midden contexts (JCM/QR14-15 Trench) and date back to the early-middle occupation levels (Phase 2 and Phase 3) of the site from ca. 7300-6500 cal. BC. The other sample (Fl.64.1) comes from the step trench or JW and dates back to Phase 4, ca. 6500-6000 cal. BC. (See Volume II).

- *Pericarp tissues (Bran)*: fragments of bran, which include longitudinal and transverse cell layers present in the pericarp of cereal kernels, are by far the most commonly found particles among the food remains from Jarmo as seen for Çatalhöyük East. A total of 32 fragments of bran cell layers have been identified in the food fragments from Jarmo, representing 39.02% of the total identified particles. Bran cells occurred in 15 of the 28 analysed samples (ca. 53.57%) with an area size of 20 to 1400 µm. The distinction between wheat species (*Triticum* sp.) and barley (*Hordeum* sp.) transverse cells has been generally possible and was made following criteria established by Dickson (1987), Holden (1990), Colledge (1989) and Heiss *et al.* (2015; 2017).

  As seen from the broken grains, there is a very low presence of barley among the analysed food fragments from Jarmo. Only two barley bran fragments from two different food samples Fl.155 and Fl.175.1 have been identified from Jarmo. These barley bran fragments appear mixed with wheat particles adding more evidence to the argument of a preference of wheat over barley for the preparation of cereal products at

Neolithic Jarmo. In contrast, a total of 21 fragments of wheat bran have been identified in 11 of the 27 analysed food fragments, representing the 25.61% of the total identified particles. The rest of the bran fragments, representing 9.76% of the total particles, fall under the category of indeterminate as they are too degraded to allow any further identification to the genus level. (See Volume II).

In general, food fragments which contain bran fragments span the whole Neolithic Jarmo sequence from the earliest levels excavated in 2014 (JW - EF4 and E4) to the latest excavated levels (JCB Trench). Barley bran fragments, however, seem to be limited to the very early levels in Phase 1 (ca.8000?-7300 cal. BC) from the JW- Step Trench (levels E4 and EF4). However, due to the low numbers of barley particles found, the interpretation of this as a possible trend could be problematic.

- *Aleurone tissue*: as seen for Çatalhöyük, patches of aleurone layer are the second most common cereal tissue present in the food remains from Jarmo, representing 36.59% of total identified particles. Up to 22 fragments of single-celled (as in wheats, oats, millets and rye) and indeterminate aleurone layers were found in 13 of the 28 analysed food fragments (ca. 46.42%). Amongst the aleurone cell tissues, remains of barley aleurone layers (multi-celled) are absent from the food fragments from Jarmo. In contrast, wheat aleurone tissues (single-celled) are present in 10 of the 13 samples with visible aleurone remains, being the rest 3 of indeterminate category as they are too degraded to allow further identification. Examples of wheat aleurone layers can be observed in samples Fl.144, Fl.152, Fl.175, Fl.178, Fl.24 and Fl.32 (see Volume II).

  As seen for the bran fragments, food fragments which contain patches of aleurone layers span the whole Neolithic Jarmo sequence from the earliest levels excavated in 2014 (Step Trench - E4) to the latest excavated levels (JCB Trench).

- *Cereal chaff*: although in small quantity, some chaff remains were observed in the food remains from Çatalhöyük, however, no chaff has been observed within the food fragments from Jarmo. The absence of chaff residues in the food fragments shows evidence of the exhaustive cleaning of grain prior to grinding and processing for the preparation of these meals. However, the sample size from Jarmo is remarkably smaller than that from Çatalhöyük so the possibility of finding some food remains with chaff if more food fragments from Jarmo were analysed should not be excluded.

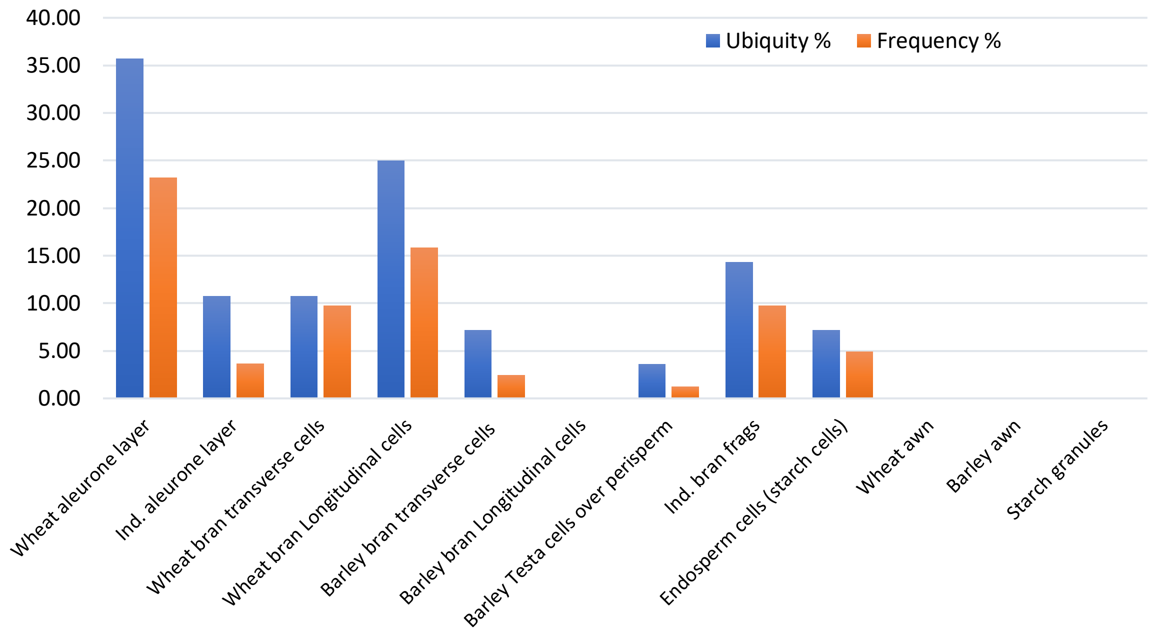


Figure 7.2. Ubiquity and frequency of different types of cereal components identified in the analysed food fragments from Jarmo

7.3.2. Non-cereal components

Showing the consistency of the food preparations seen from Çatalhöyük, a small amount of non-cereal components has been identified among the food fragments analysed from Jarmo. The proportion of the non-cereal components is very low, reduced to only two samples which contain fragments of processed pulses (ca. 7.5%) (Figure 7.3.).

- *Pulses*: a total of two food fragments containing three fragments of pulses have been identified in the food remains from Jarmo. The particles identified are fragments of seed coats from pulses (palisade layer and *testa*) and as seen from the food from Çatalhöyük, different types of pulses have been identified mixed in the food fragments and accompanied normally with wheat components such as bran fragments and aleurone.

  The presence of pulses in the food fragments from Jarmo is limited to a very specific time frame similar to the results from Çatalhöyük. Only samples Fl.28 and Fl. 32 contain fragments of pulses and these come from contexts from Phase 3 of the occupation, from ca. 6800-6500 cal. BC). Although the number of analysed food fragments is low for Jarmo, due to the high presence of pulses in the archaeobotanical record and in particular of lentils, one would expect a higher presence of these within the food fragments. This shows the differential use of plant ingredients, perhaps with a preference of eating pulses whole in soups or stews, as seen in the present time. (See Volume II).

- *Vascular material*: a small quantity of vascular material (8.54%) has been identified among the analysed food fragments from Jarmo. Further identification of type of vascular material was not possible in this occasion, not being able to categorise these under any specific plant tissue type. The possibility of these remains being vascular material from the cereal kernel cannot be excluded, however due to the absence of specific identification criteria they were chosen to be recorded under the non-cereal components' category. (See Volume II).

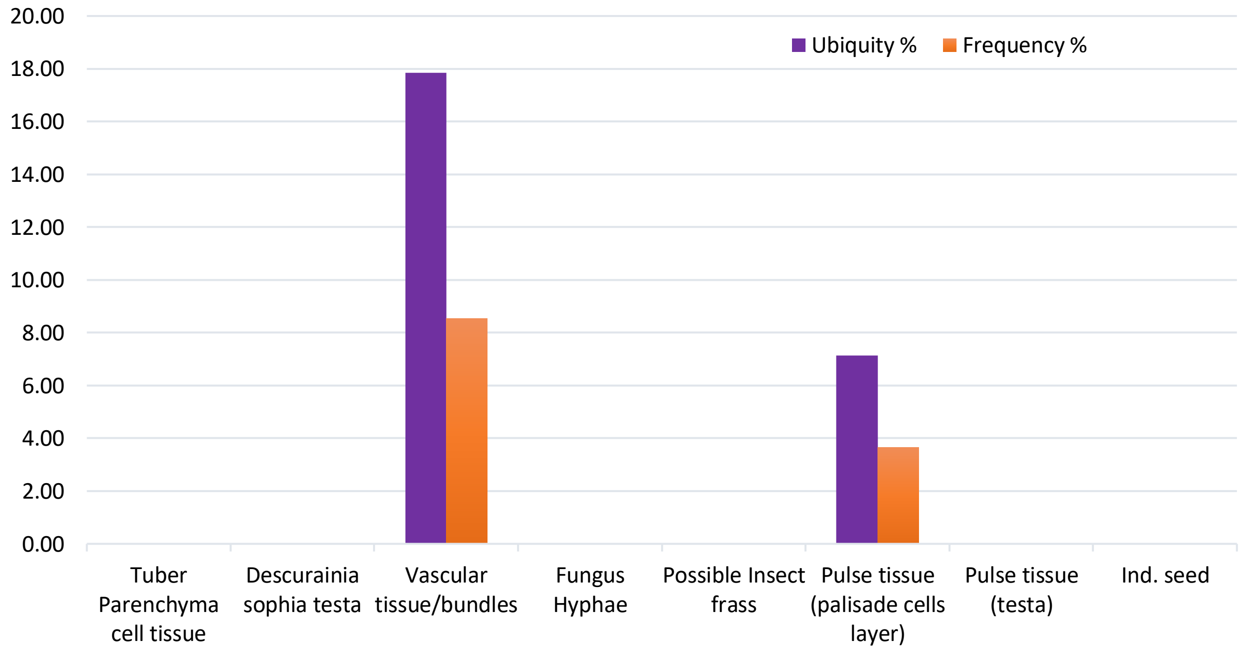


Figure 7.3. Ubiquity and frequency of different types of non-cereal components identified in the analysed food fragments from Jarmo.

7.3.3. Chronological distribution of plant ingredients at Jarmo

Although the number of analysed food fragments from Jarmo is low in comparison with that from Çatalhöyük East, some general trends and specific chronological patterns have been observed in relation with a differential use of plant ingredients.

As above mentioned, there is a continuous and general presence of wheat particles in the food fragments from Jarmo from the earliest levels in Phase 1 (ca. 8000?-7300 cal. BC) to the latest occupation levels in Phase 4 (ca. 6500-6000 cal. BC). From Phase 1, however, only one fragment was seen to contain particles of wheat, in addition to two fragments which contained barley particles. After ca.7300 cal. BC, there is a high increase in the use of wheat in correlation with the absence of evidence for the use of barley. In relation to non-cereal ingredients, the analysed food fragments from Phase 3 contained particles from different types of pulses, including lentil and probably pea or grass pea. In this sense and similarly to the results from Çatalhöyük East, the use of pulses for the preparations of meals at Jarmo seems to be reduced to a very specific time frame, in this case from ca. 6800-6500 cal. BC, with no earlier or later examples of their use (Figure 7.4.).

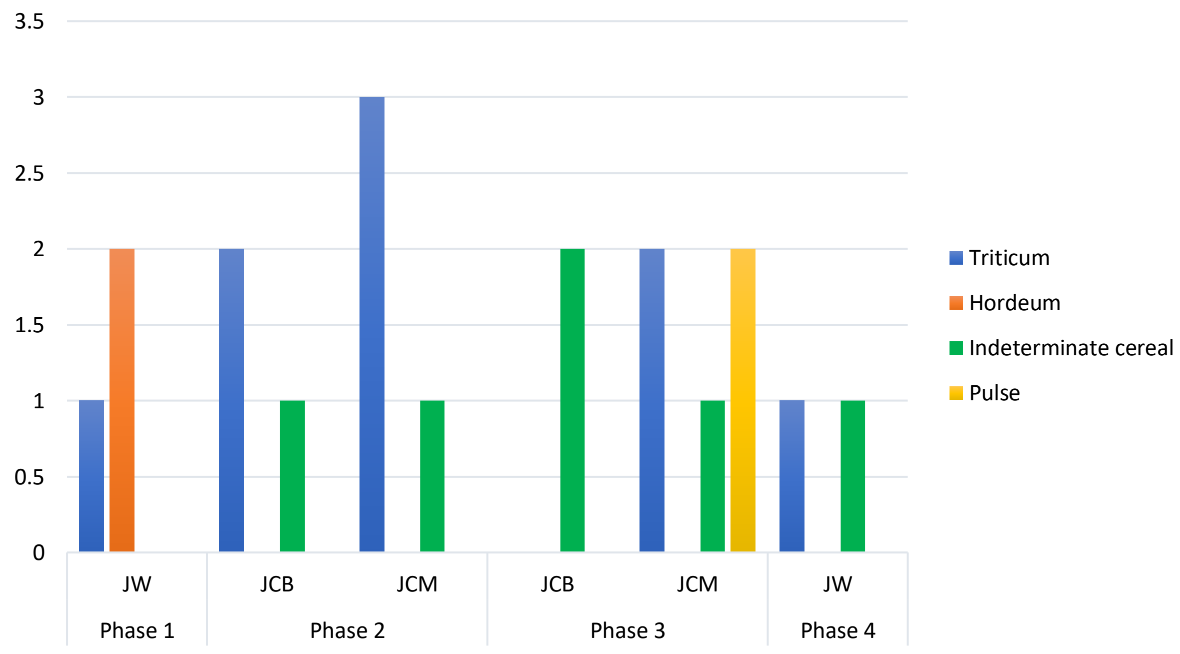


Figure 7.4. Chronological and spatial distribution of the food fragments' composition from Jarmo

7.4. Morphology and microstructure of the archaeological food fragments

7.4.1. General description

After comparison of the archaeological food fragments from Jarmo with the fragments produced by the cooking and charring experiments, I was able to distinguish different types of cooking processes or techniques which could have led to the preparation of these meals. In this sense, four different types of internal microstructures (matrices) were identified among the charred food fragments recovered from Jarmo which also parallel the four matrices identified from Çatalhöyük:

- *Matrix Type A*: matrix with very few and small visible particles (0-2; 50-600µm) and large close voids (see typological attribute C) from 200 to 800µm which cover a high percentage of the microstructure surface (>30%). This matrix corresponds to *Matrix Type 1* from Çatalhöyük and dough-like experimental products (Figure 7.5. a-b).

- *Matrix Type B*: matrix with a low number of medium visible particles (1-3; 200-900µm) in which the air bubbles or voids are micropores (50-300µm) and in general cover more than 30% of the surface. This matrix corresponds to *Matrix Type 2* from Çatalhöyük and leavened bread-like experimental products (Figure 7.5. c-d).

- Matrix Type C: matrix with a relatively low number of small and medium visible particles (1-4; 50-900 µm) and a low percentage of small closed voids and micropores (25-300µm), covering between 10-20% of the surface. This matrix corresponds to *Matrix Type 3* from Çatalhöyük and flat bread-like experimental products (Figure 7.5 e-f).

- *Matrix Type D*: lumpy matrix with a very high number of large visible particles (4-15; 500-1800µm) and a medium percentage of large (200-500µm) cracks and channel voids (10-20%). This matrix corresponds to *Matrix Type 4* from Çatalhöyük and porridge-like experimental products (Figure 7.5. g-h).

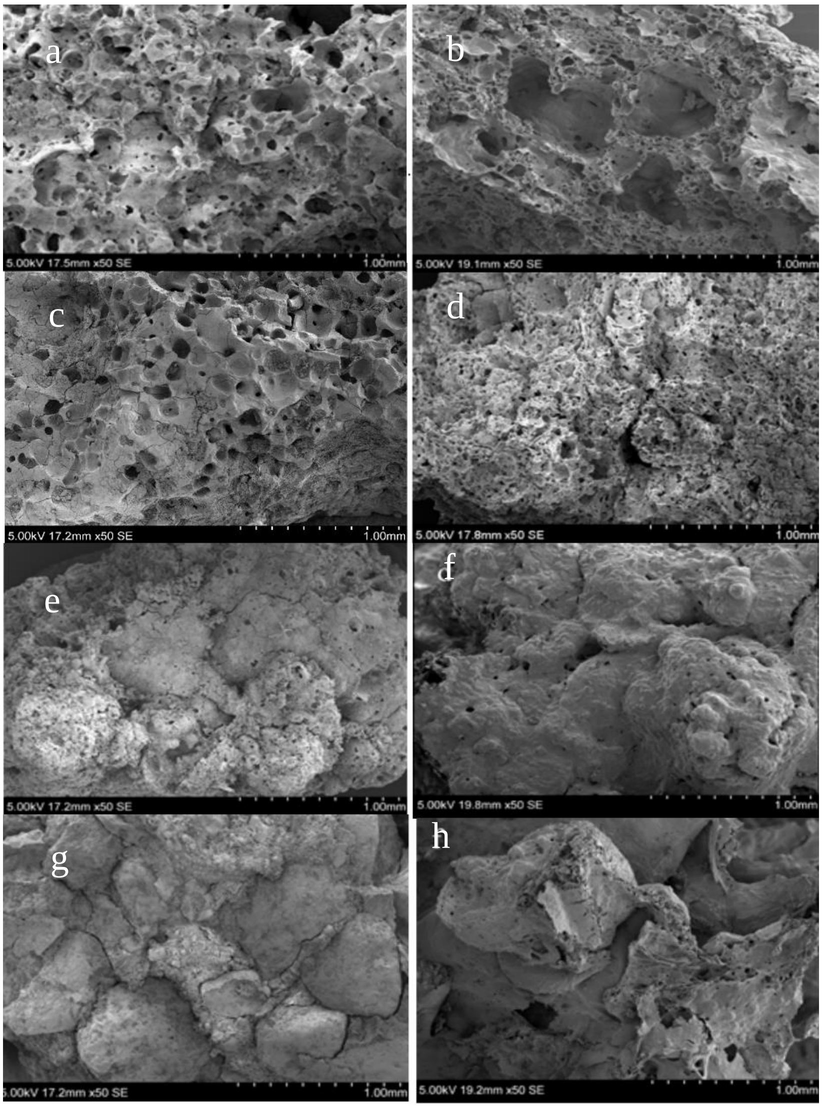


Figure 7.5. Comparison of archaeological food matrices from Jarmo (a, c, e and g) and experimental food matrices (b, d, e and h). Matrix Type A equivalent to dough-like products (a, b); Matrix Type B equivalent to possible leavened bread-like products (c, d); Matrix Type C equivalent to flat bread-like products (e, f); Matrix Type D equivalent to porridge-like products (g, h).

As seen in the food fragments from Çatalhöyük, dough and bread-like products and therefore *Matrices Type A, B* and *C* (*Matrix Type 1, 2* and *3* from Çatalhöyük) are characterised by a low number (0-3) of small and medium visible particles (50-900µm). On the other hand, porridge-like products or *Matrix Type D* (*Matrix Type 4* from Çatalhöyük) are characterised by its clearly bigger (500-1800µm) and numerous (4-15) visible plant particles which correspond to grain and pulse fragments and very large bran cells areas. In addition, there are differences in the types of voids in the different matrices. *Matrix Type A* and *B* fragments contain a very high percentage of air bubbles or closed voids (ca.30%) in contrast to *Matrix Type C* and *D* fragments which have a medium percentage of voids (ca. 15%) (see Figures 7.6. and 7.7.).

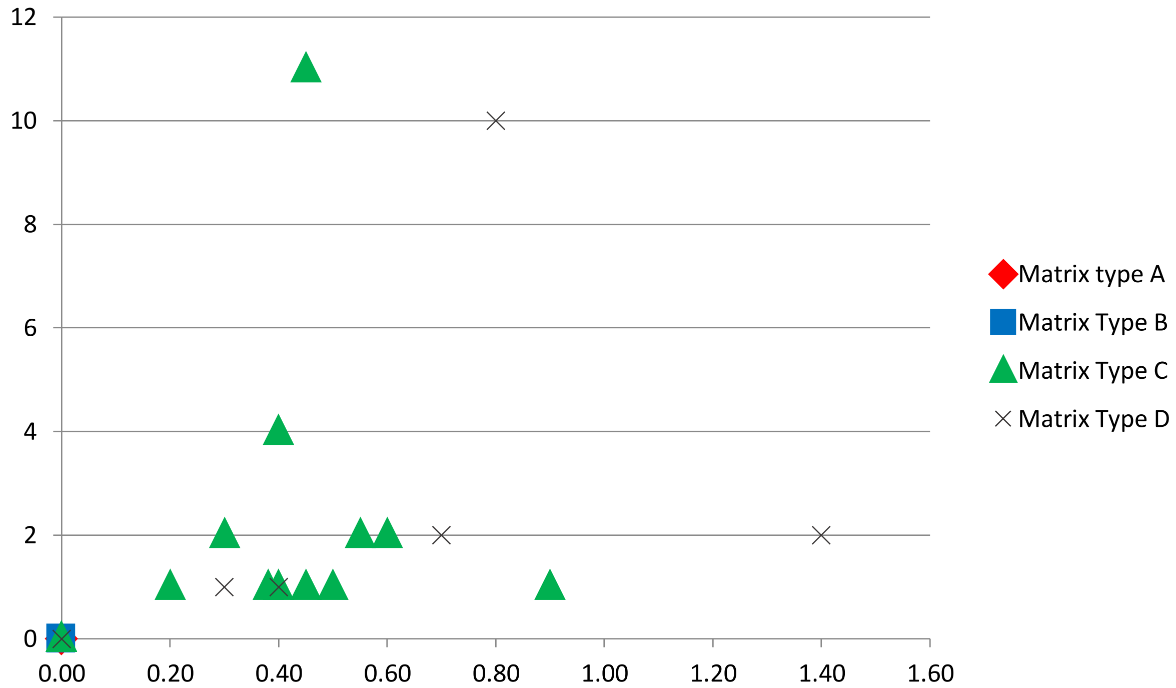


Figure 7.6. Plot showing correspondence of matrix types with average number of particles (*Y* axis) and particle size (mm) (*X* axis). Full list of values in Table 11 in appendix IV.

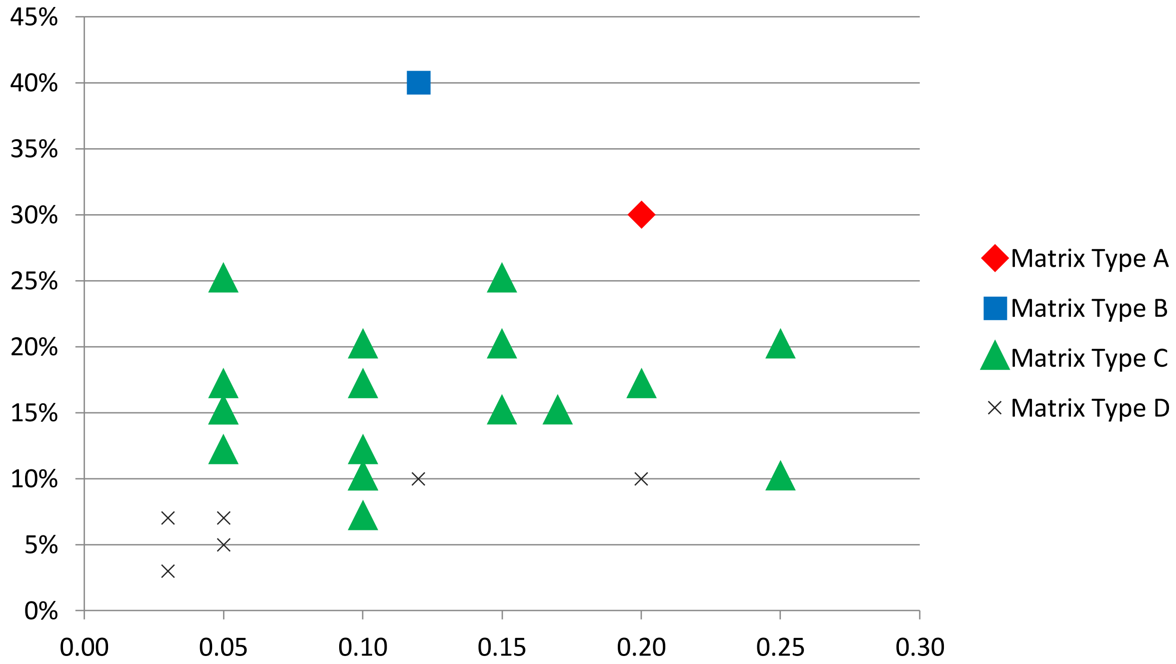


Figure 7.7. Plot showing correspondence of matrix types with porosity percentage (*Y* axis) and void mean size (mm) (*X* axis). Full list of values in Table 14 in appendix IV.

In total, the average number of particles observed in the food fragments from Jarmo is 1.57 and their average size is 0.33mm. In terms of voids (air bubbles), the average size of the voids is

0.11mm and the average of matrix coverage is 14.57%. As seen for the Çatalhöyük food fragments, the particle measures are similar to those from modern flat breads, once again showing the importance of the use of fine or relatively fine flour for the preparation of the majority of these foods at Jarmo. On the other hand, the voids data show that these foods had a more compacted microstructure even than those from Çatalhöyük and also lower air bubble presence. In this sense, this is not directly comparable with the data available from modern flat-breads as per the reasons already mentioned for the case of Çatalhöyük food fragments.

Flat bread-like fragments (which correspond to *Matrix Type C* after comparison with experimental materials) are the most common among the analysed food fragments from Jarmo and they represent the 67.85% of the total samples. A total of 19 fragments were identified as flat bread-like products and 10 of them contained identifiable particles of wheat.

Porridge-like fragments (which correspond to *Matrix Type D* after comparison with experimental materials) are the second most common products identified among the analysed food remains from Jarmo. A total of 6 fragments (21.42%) have been found to possess a similar microstructure to experimentally prepared porridges (see identification criteria). Five of them contain wheat particles and two of them contain fragments of pulses mixed with wheat.

Only one fragment among the food fragments analysed from Jarmo has been found to have a microstructure similar to those of dough-like fragments (*Matrix Type A*). This is also the case for *Matrix Type B* or leavened bread-like products, with only one fragment which can be categorised as this.

7.4.2. Spatial and chronological distribution of food fragments at Jarmo

Although the recovery of archaeological remains of food from Jarmo is generally high, their distribution and types present in the different excavation areas differ (Figure 7.8.). This section summarises the results from the different excavation areas in order to investigate patterns and differences, if any, among the food remains recovered from Jarmo, their associated archaeological context and the macrobotanical remains recovered in them.

7.4.2.1. JCM (midden)

A total of 11 samples out of the 54 collected environmental samples from JCM have yielded archaeological charred remains of cereal products. From those 11 samples, 16 food fragments were selected for full analysis. From these fragments, 7 did not provide information about their plant ingredients and the remaining 9 fragments are almost in their totality made of wheat, in addition to one fragment which also contains particles of pulses (see Table 2 in Appendix I and Table 2 in Appendix II for full details). In terms of the type of cereal products which these fragments represent, from the 16 fragments 10 have been identified as fragments of flat bread-like products (*Matrix Type C*) and 4 porridge-like fragments (*Matrix Type D*), including the one which contains pulses. In addition, the only examples of dough-like products and possible leavened bread-like products have also been recovered from the midden contexts in JCM area.

7.4.2.2. JCB (buildings)

A total of 4 out of the 17 samples from the JCB area excavated in 2012 and 2014 have yielded archaeological fragments of food products. From these, 7 fragments were fully analysed and only one did not produce information about its plant ingredients as no visible tissues were identified. All the rest contained cereal particles such as bran and aleurone layers, in addition to one fragment which also contained particles of pulses (see Table 2 in Appendix I and Table 2 in Appendix II for full details). In terms of the type of cereal products that these fragments represent, all except the one which contains pulses, have been seen to have a microstructure equivalent to experimental flat bread-like products (*Matrix Type C*). The remaining fragment which contains not only cereal particles but also remains of pulses, presents a microstructure closer to porridge-like products (*Matrix Type D).*

7.4.2.3. JW (step Trench)

JW area excavated during 2014 has yielded a total of 25 food fragments from 3 out of the 12 sampled contexts. A total of 5 food fragments from JW have been fully analysed and only one fragment did not produce information about its ingredients with no particles identified. The rest allowed for the identification of cereal components to genus level. Although most of these are fragments of wheat grains and wheat bran and aleurone layers, the only barley particles identified in the food fragments from Jarmo come from the samples collected from the Step

Trench and in particular, from the earliest levels (ca. 8000-7300 cal. BC) (see Table 2 in Appendix I and Table 2 in Appendix II for full details). In terms of the type of food product which these fragments represent, 4 out of the 5 analysed fragments presented microstructures which are similar to experimental flat bread-like products (*Matrix Type C*), with the remaining one being similar to porridge-like products (*Matrix Type D*).

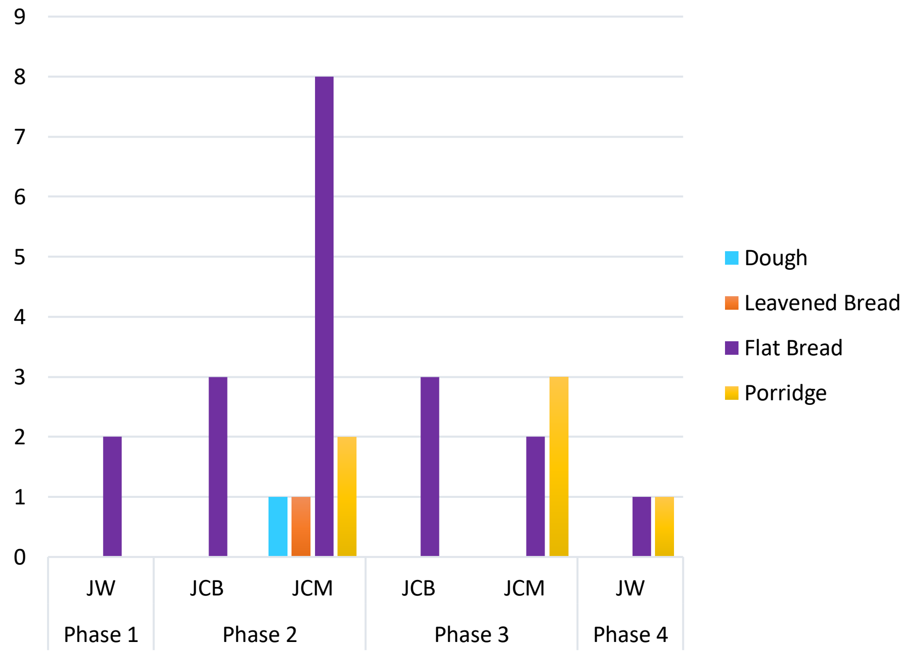


Figure 7.8. Chronological and spatial distribution of cereal products from Jarmo

7.5. <u>Isotopic composition of the food remains from Jarmo</u>

This section presents the results from the bulk isotope analyses carried out on 2 food fragments from Jarmo. Despite the sample size being very small and therefore not statistically significant, isotopic composition estimations give us an idea of the use of animal products for the preparation of cereal meals at Jarmo. In this sense, carbon and nitrogen bulk isotopes were measured in the 2 selected food fragments to broadly distinguish possible animal materials used in the preparation of these foods (e.g. marine/freshwater/terrestrial sources). Samples which were seen to contain non-cereal ingredients such as pulses, were not selected as the specific d15N values of pulses can alter the main purpose of these analyses as pulses are N_2–fixing plants, which obtain most of their N from the atmosphere, and are thus expected to have values close to 0‰.

Carbon and nitrogen stable isotope ratios were measured by elemental analysis isotope ratio mass spectrometry (EA-IRMS) (Figure 7.9.). Please refer to Appendix IV for full dataset derived from bulk isotope analyses carried out on the selected food fragments.

The d15N values of the 2 selected food remains varies from 4.2‰ to 6.37‰ with a mean of 5.28 ± 0.33‰, which broadly correlate with d15N values of cereal crops carried out in other Neolithic sites in West Asia (Bogaard *et al.* 2007; Styring *et al.* 2015; Vaiglova 2016). Interestingly, these values are lower than those for the food fragments from Çatalhöyük, which adds evidence to the theory of natural and potentially anthropogenic 15N–enrichment of the soils around the Çatalhöyük site.

The d13C values of the 2 selected food remains range between –24.98‰ and –23.03‰ with a mean of –24.01 ± 0.21‰. These values appear to be within the normal range for cereal crops as C3 plants, like barley and wheat, have d13C values between –21 and –34‰ (mean –26.7 ± 2.3‰, Cerling *et al.* 1997). Also, these values overlap with those obtained for other Neolithic sites, including Çatalhöyük, by Vaiglova (2016) from charred cereal grains and ranged between –20.5‰ and –25.3‰, with a mean of –22.9 ± 0.3‰.

Considering the low d15N values and d13C values in correlation with the ones typically obtained for cereal crops from Neolithic sites in West Asia and Europe (Bogaard *et al.* 2007; Styring *et al.* 2015; Vaiglova 2016), the analysed food fragments from Jarmo do not show evidence of the use of animal resources for their preparation. However, due to the small sample size, the addition and use of animal products for the preparation of cereal meals at Jarmo cannot be discarded. Further analyses are needed to assess the use of animal materials, such as milk, animal fats or honey for the preparation of daily cereal-based products at Jarmo.

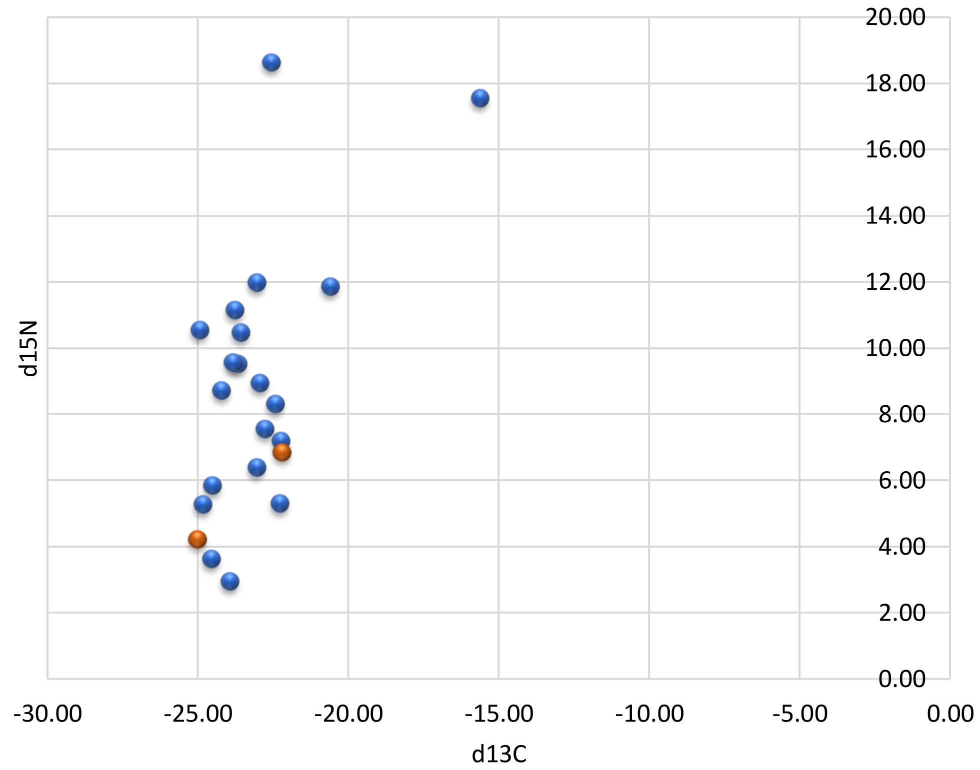


Figure 7.9. Plot of d15N and d13C values from the selected food fragments from Çatalhöyük East (blue) and Jarmo (orange)

7.6. Summary

The analysis of the food remains from Jarmo and the comparison of these with experimentally prepared and charred materials, have provided insights into food preparation and cooking and consumption of cereal meals during the early Neolithic. A total of 28 food fragments from Jarmo were analysed for this thesis, having identified four different types of cereal-based products: flat bread, porridge, dough and possible leavened bread-like products, which were made using a wide range of plant food ingredients, not only cereals but also other crops such as pulses have been identified within the microstructures of these remains.

Interesting patterns in food preparation and use of plant ingredients have been seen through time, with a well-established culinary tradition based on bread-like products from the beginning of the occupation sequence at the site (ca.8000 cal. BC), with the addition of porridge-like products later on, with an increasing presence of these types of materials from Phase 3 onwards. The use of wheat species for the preparation of these meals is attested throughout the sequence as the major ingredient used, with sporadic and minor presence of barley at the beginning of the sequence and pulses, which use will be limited to Phase 3 of occupation at the site.

In addition, the bulk isotopic composition of a small sample of the analysed food fragments have shown no evidence of the use of animal products for their preparation, however further analysis and interpretation as well as experimentation is needed on this subject.

Chapter 8

Analysis and discussion

8.1. Çatalhöyük East

The analysis of archaeological food remains from Çatalhöyük East has helped shed light on the nature of the culinary traditions and cooking practice during the Neolithic in Central Anatolia. The results obtained from the microscopic observation and comparison with experimental materials have provided with a series of chronological and spatial patterns and differences during the occupation of the site. This section discusses those results and analyses the seen patterns in order to establish a better understanding of the use of plants as ingredients during daily food preparation at Çatalhöyük through time.

8.1.1. Neolithic plant ingredients

8.1.1.1 Correspondence with the archaeobotanical record

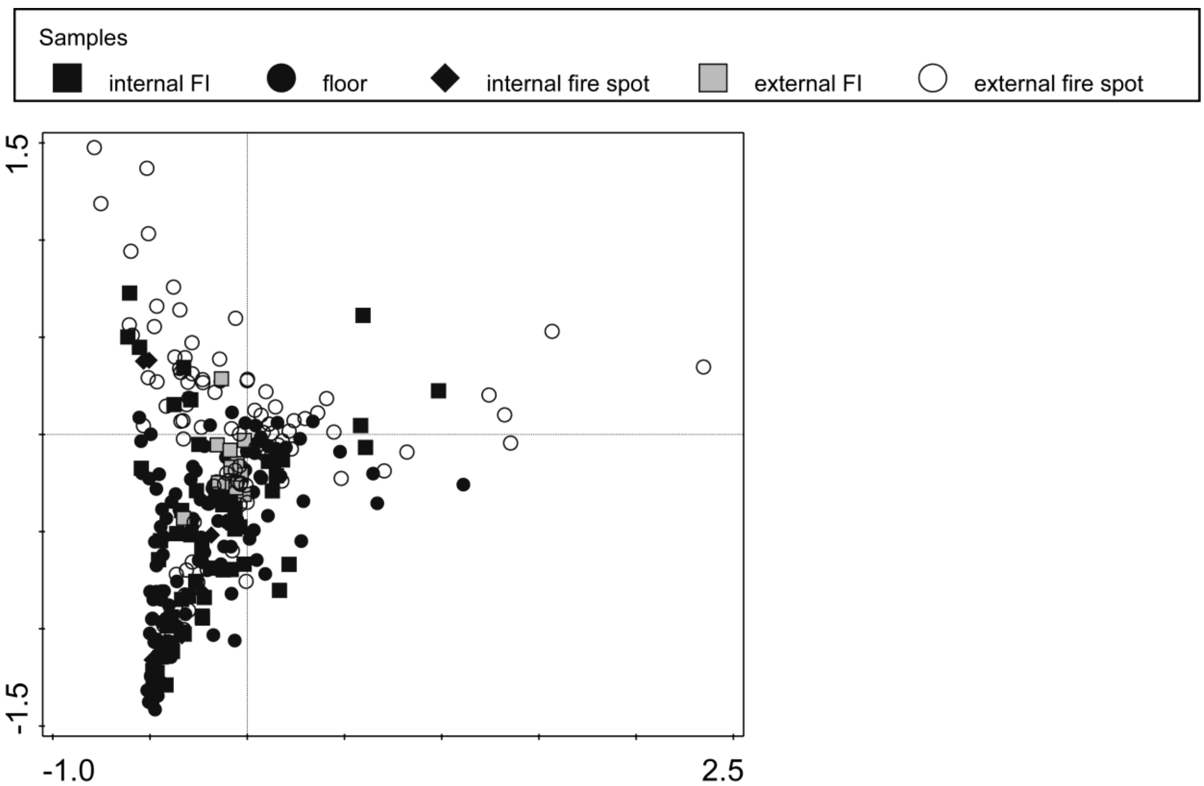
As previously seen, among the ingredients identified in the food fragments from Çatalhöyük, there is a consistency in the presence of domestic staple foods such as cereals and pulses, having identified particles from these in ca.90% of the analysed fragments. Among these, four pulses (*Lens culinaris*, *Cicer arietinum*, *Pisum sativum* and *Vicia ervilia*), barley (*Hordeum vulgare*) and wheat species (*Triticum* sp.) are the most likely ingredients of the analysed Çatalhöyük cereal-based meals. In addition, among the total analysed food fragments from Neolithic Çatalhöyük we also find the presence of wild plant ingredients such as the extensively used wild mustard *Descurainia sophia* (see Bogaard *et al.* 2013; Fairbairn *et al.* 2007) which has been identified in 2 of the 100 analysed food fragments, a single seed of possible wild flax and sedge tubers from the species *Bolboschoenus glaucus* (as identified by Wollstonecroft *et al.* 2011) which so far has been found to be a component of three food fragments.

The cereal particles identified in the food fragments did not allow for identification of the observed wheat (*Triticum* sp.) or barley (*Hordeum* sp.) cell tissues to the species level due to transverse and longitudinal cells (bran) being highly eroded and incomplete. However, in accordance to the macrobotanical remains from Çatalhöyük, the most likely wheat ingredients must have been either einkorn (*T. monococcum*), emmer wheat (*T. dicoccum*), 'new type' glume wheat (*Triticum* cf. *temopheevii*) and bread wheat (*T. aestivum*) in addition to naked barley (*Hordeum vulgare* var. *nudum*). The differential use of these cereals for food preparation among houses at the site is currently unknown, but we have clear archaeobotanical evidence of the high presence of these species throughout the occupation sequence at the site (Bogaard *et al.* 2013; Bogaard *et al.* 2017). In general, among the wheats, emmer/new type grains and glume bases outnumber those of einkorn and bread wheat which suggests that emmer/new type glume wheat was predominant throughout the sequence. Additionally, although barley is present throughout the sequence, there is a shift from two to six-row naked barley from the Early to Late phases of occupation with a noticeable increase in the presence of naked barley and the introduction of hulled barley in the Late to Final levels (Bogaard *et al.* 2017; Bogaard *et al.* in preparation). In this sense, the highest use of barley for the preparation of cereal-based foods at the end of the sequence correlates with a general increase in the cultivation and use of this crop after ca.6300 cal. BC at Çatalhöyük East. This is especially evident for the food remains and storage deposits recovered and analysed from the TPC (Green *et al.* 2018; Bogaard *et al.* in preparation).

In relation to possible range of pulses, peas are the most common while lentil and bitter vetch occur in 10-20 per cent of sample and chickpea occurs in a small minority of samples sporadically later throughout the sequence (Bogaard *et al.* 2013; Bogaard *et al.* 2017; Bogaard *et al.* in preparation). In the light of the last archaeobotanical analysis from Çatalhöyük, there seem to be a clear shift from a highest use of pea to a highest use of lentil after the Middle phase (Bogaard *et al.* in preparation). This change in preference from one species of pulses to another is however not reflected in the preparation of cereal-based products, as the evidence of pulses from the analysed food fragments shows a mixture of different types of pulses, with no evident use of one species over the other.

The presence of wild resources such as mustard (*Descurainia sophia*) and club rush tubers throughout the sequence is constant, having recovered large quantities of this oilseed in storage features in the South and North excavation areas (Fairbairn *et al.* 2007; Bogaard *et al.* 2013). Although the specific uses of this wild mustard at Çatalhöyük are not clear, many possible uses have been suggested; among others this seed could have been gathered due to its high oil-content or because of its "slightly spicy" taste (González Carretero *personal observation*). In any case, its intentional addition as ingredient to cereal products at Çatalhöyük is among the earliest evidence of use of condiments in the world.

As seen from the analysis of the macrobotanical remains contained in the flot samples in combination with the food remains, these are mostly found in samples dominated by crops/collected plants, with some exceptions, in contrast those with high percentage of chaff remains and wild taxa, derived from arable weeds or dung-rich deposits. Food fragments normally co-occur with other botanical evidence of crops or collected plants, such as wild mustard. In this sense, the purest plant food-related activities tended to be carried out indoors, where crops and other food plants were stored, in contrast with outdoor activities where dun fuel was used in great proportions. The below correspondence analysis plots (Figure 8.1.) show the distribution of samples from indoor and outdoor contexts and their correlation with samples from which food fragments were selected and analysed for this study. Samples which contain a high proportion of food remains are also those which contain a high concentration of cereal grains and pulses, in contrast with a low concentration of chaff and wild seeds. These samples are also in their majority coming from indoor deposits, from contexts such as occupation layers, oven and hearth fills, etc. Similarly, in the case of the samples with food remains from outdoor contexts, these also present a high concentration of crops, especially those from the outdoor oven area, representing a deposit most likely related to food preparation activities.



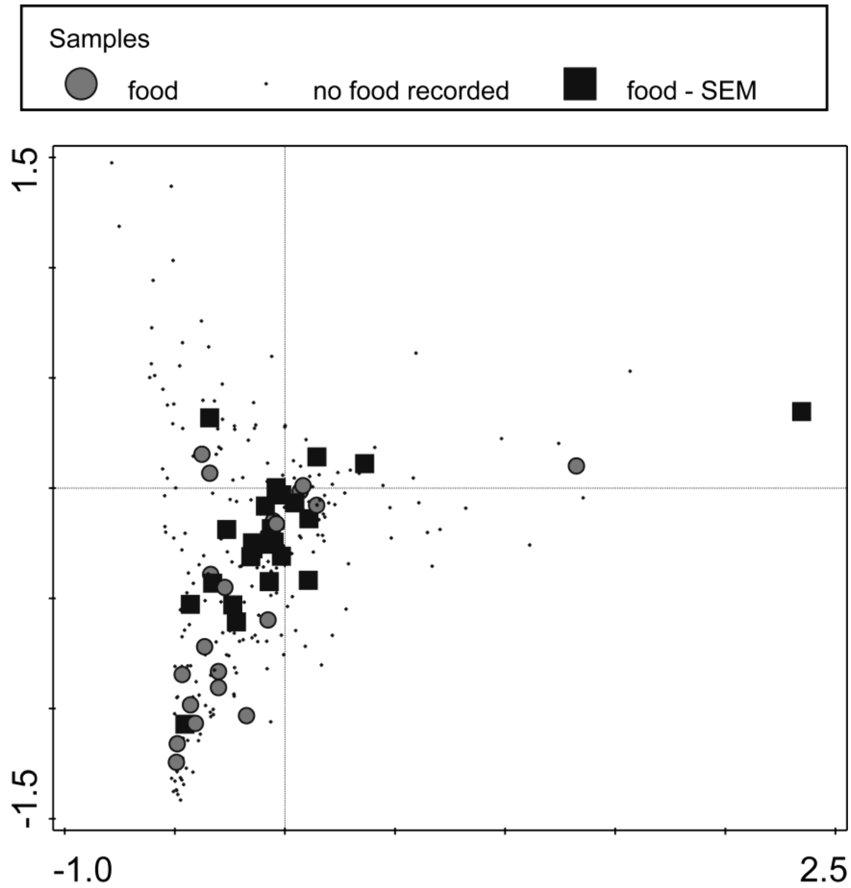


Figure 8.1. Correspondence analysis plots showing the distribution of flotation samples which contained remains of archaeological food in relation to indoor and outdoor contexts from Çatalhöyük East.

8.1.1.2. Differential use of ingredients through time

The analysis of the archaeological food remains from Çatalhöyük has showed a differential use of plant ingredients through time (Figure 8.2.). As seen in the archaeobotanical assemblage, in general we see a higher variety of crops and wild plants recovered from the earliest levels at Çatalhöyük East (from South G to South I), with a broader range of cereal crops and pulses present in the archaeobotanical record (Bogaard *et al.* 2017). Similarly, the analysed food fragments also show a higher variety of used ingredients among the ones from the early and middle phases of the occupation, with the addition of wild mustard, sedge tuber and pulses to a cereal-based preparation.

Although specific proportions of the mentioned cereals and pulses in the food fragments cannot be quantified due to the small surface observed in the analyses, there is a clear dominance of cereals and wheat species among them. In general, wheat particles outnumber barley components among the analysed food fragments, however there is an increase in the use of barley for the preparation of cereal-based foods during the later levels of occupation. This is especially visible from samples recovered from the TPC area during the final levels, when barley particles in the food fragments have been identified almost as commonly as wheat ones. This correlated with a preference in the use of free-threshing varieties of cereals, mostly barley, in the final levels of occupation at the site (Bogaard *et al.* 2013; Bogaard *et al.* 2017; Bogaard *et al.* in preparation). Furthermore, this shift could be interpreted as a consequence of changes in ‘culinary choice’, with an increase in the use of naked and potentially hulled barley for the preparation of cereal meals, especially porridges, towards the end of the Neolithic sequence at Çatalhöyük. However, the analysed contexts at TPC are still very limited and further investigation is needed to assess the possible presence of other cereal species.

Table 8.1. Quantity of identified food fragments per period containing wheat, barley, indet. cereal and pulses from Çatalhöyük East.

Period	Food fragments	Wheat	Barley	Indet. Cereal	Pulses
Early (7100 - 6700 cal. BC)	15	8	1	6	2
Middle (6700 - 6500 cal. BC)	53	31	5	29	9
Late (6500 - 6300 cal. BC)	58	46	19	26	0
Final (5300 - 5950 cal. BC)	29	16	11	19	0

There is a clear pattern in the use of pulses for the preparation of cereal-based meals at Neolithic Çatalhöyük. As it appears, the addition of pulses (lentils, bitter vetch, peas and possibly chickpeas) to a wheat base, seems to have been a culinary tradition which appeared in a very specific timeframe and did not continue through time. The first examples of this culinary traditions come from the last levels of the early phase of occupation, from level South L. It will be by North G/South N that this tradition became widespread, and perhaps especially in the North area, from where the majority of the food fragments containing pulses come from. From the analysis of the selected food remains, the use of pulses for the preparation of cereal-based products seems to disappear after Level North G, after which pulses remain present in the archaeobotanical record, however not as part of the recovered charred food preparations. In relation to the wild resources used for the preparation of cereal meals at Çatalhöyük there are different patterns depending on the type of plant food. Interestingly, although wild mustard has been recovered in large quantities from storage deposits from the early to late levels at the site

(Bogaard *et al.* 2013; Bogaard *et al.* 2017), only two of the analysed food fragments from the early levels of occupation contained embedded seeds. It is important to consider however, that wild mustard and other wild plant resources could have been incorporated into the cereal products through accidental contamination while grinding or mixing. Even if this were the case, it would still prove the role of these plant resources in food preparation and cooking as these would have been ground or used in some way previously in order for them to get incorporated into the cereal meals accidentally. On the contrary, there is a sporadic use of club rush tubers throughout the sequence, with a few examples from the Early, Middle and Late phases which suggests a relevant role of these tubers as food materials. The use of club-rush tuber and other similar tubers for flour making has traditionally been linked to moments of famine (Wollstonecroft 2008) when this could have been added to cereal flour in order to make bread or similar products.

The addition of pulses and wild plant ingredients to cereal meals can be seen as a culinary tradition with a number of reasons behind it. In the case of wild plant resources, seeds such as wild mustard, could have been added in order to create new tastes or add new flavours to cereal meals. The addition of pulses to a base of wheat flour is a well-known present and past culinary practice as a way to increase the nutritional value of cereal meals. Similarly, certain pulses such as bitter vetch and grass pea which contain a high concentration of toxins in their seed coat, have been historically been added to a base of wheat or barley flour in order to make them more palatable and reduce their toxicity (Valamoti 2011).

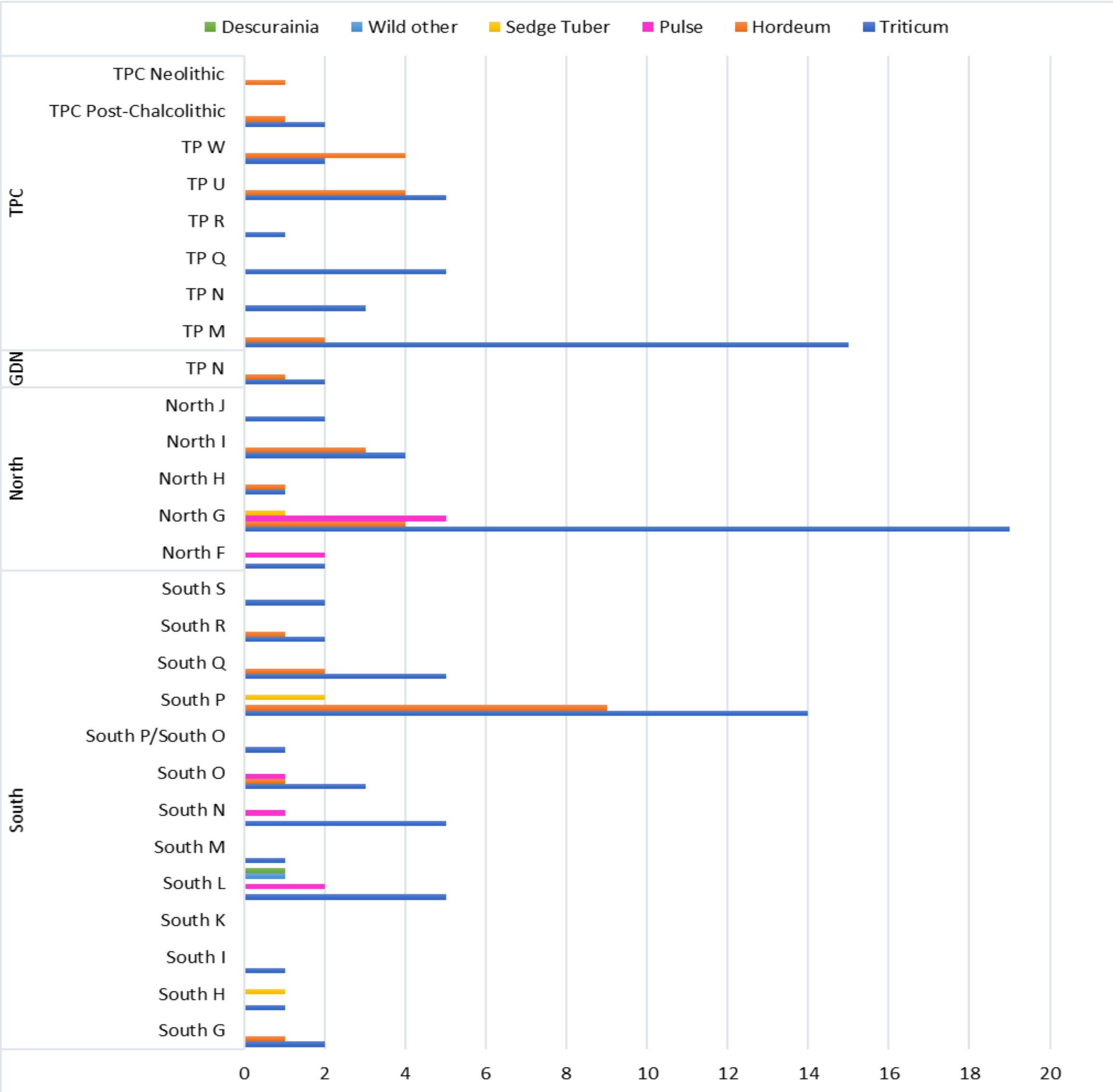


Figure 8.2. Chronological and spatial distribution of plant components identified in the analysed food fragments from Çatalhöyük East.

8.1.2. Food preparation processes and Neolithic recipes

8.1.2.1. Evidence of Neolithic recipes from Çatalhöyük East

Based on the typological datasets created and observations of the archaeological materials, and their comparison with the experimental specimens, this study has been able to identify four types of food matrices among the food fragments recovered from the North, South, TPC and GDN areas, of which three were observed to be analogous to the internal structures of experimentally prepared dough, bread and porridge.

Although wheat is the main component of the food remains from Çatalhöyük, the preparation of different types of food products seem to have involved different combinations of ingredients (Figure 8.4.). In addition, these combinations of ingredients into different food types or "recipes", show varied temporal distributions throughout the sequence at Neolithic Çatalhöyük (Figure 8.3.).

In general, flat bread-like products are the most commonly recovered from Neolithic Çatalhöyük with a total of 75 fragments identified as *Matrix Type 3*. Interestingly, from these, only 17 of them contained barley particles in their majority mixed with wheat. In addition, 5 fragments of wheat-based flat bread-like products contained fragments of pulses (possible lentil, bitter vetch and other larger pulses such as pea, chickpea or grass pea).

Flat breads from Neolithic Çatalhöyük contained the highest variety of plant ingredients, as they are the only type of product which contains three different types of non-cereal components: wild seeds, pulses and sedge tubers, mixed with a base of wheat fine flour. This was especially evident during the Early phase of the occupation, when flour made from pulses and wild seeds (wild mustard and wild flax in particular) were added to the cereal mix. Later in the occupation, the use of pulses and wild seeds for the preparation of flat breads stopped, however remains of flour made from sedge tubers has been identified among the flat bread-like products from the Late levels of the site. From the Final phase of occupation, the few recovered remains of flat breads show a simpler "recipe", with these being made in their totality from cereals (wheat and barley), without the addition of non-cereal ingredients.

Remains of porridge-like products are the next more commonly recovered food type from Neolithic Çatalhöyük after flat breads. From the 47 identified porridge-like fragments, only 13 of these contained barley particles and always mixed with wheat. In addition, 5 fragments of wheat-based porridge-like products contained fragments of pulses (possible lentil, bitter vetch and other larger pulses such as pea, chickpea or grass pea). Similarly to flat bread-like products, remains of porridge from the Early and Middle phases of occupation show a wider range of plant ingredients, with not only pulses but also remains of sedge tuber particles identified in 2 fragments. From the Late phase of occupation, there is only evidence of cereal-based porridges, with a higher use of wheat over barley. This, however, will change considerably by the Final levels, when the use of wheat for the preparation of porridge-like products decreases considerably, and barley becomes dominant.

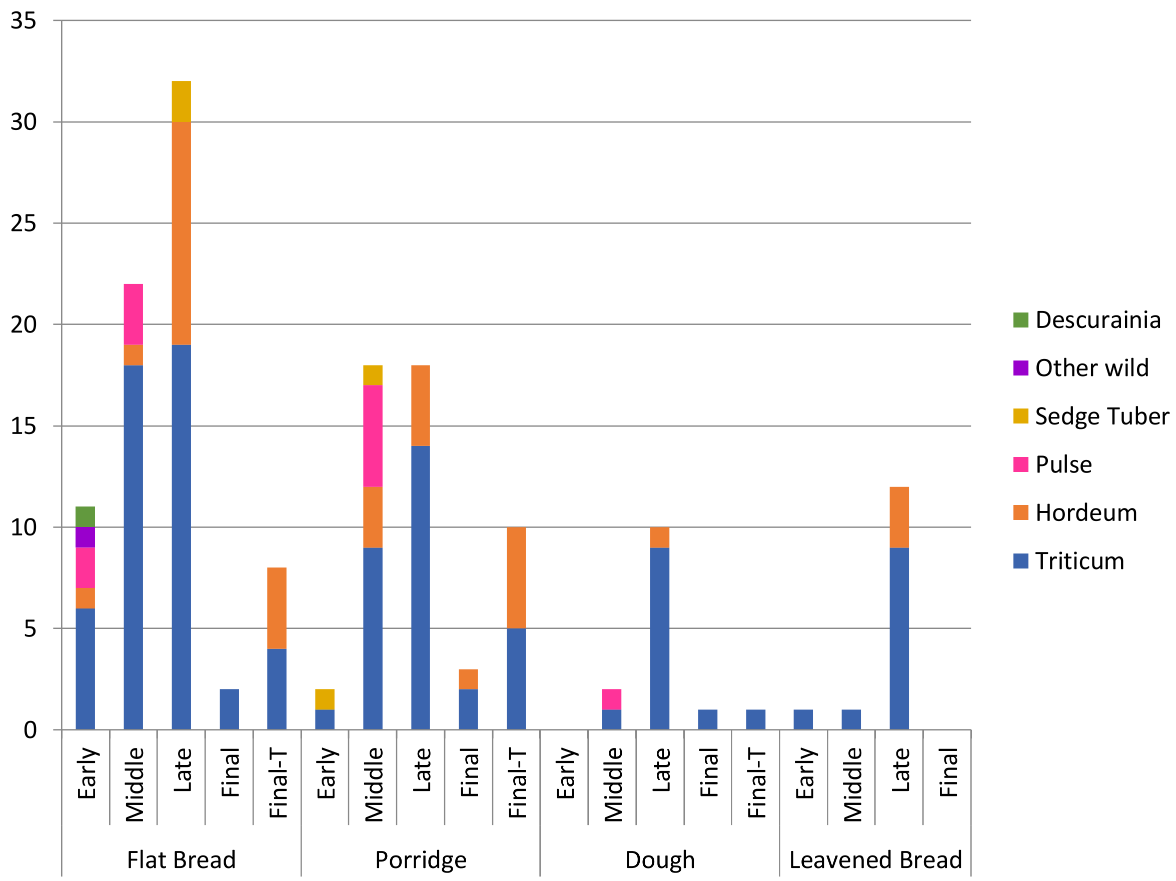


Figure 8.3. Chronological distribution of types of cereal-based products and their plant composition showing variation through time at Çatalhöyük East.

An interesting fact to consider is that only bread-like and porridge-like fragments have been found to contain particles of pulses/legumes, maybe underlining the conscious choice of adding these ingredients for the preparation of breads and porridges.

Comparatively to flat breads, except two fragments which contained barley mixed with wheat, possible remains of leavened breads were in their totality made of wheat. The number of recovered remains of what it seems to be some kind of leavened bread is concentrated during the Late levels at Neolithic Çatalhöyük, from level South M-O and North F-G. Only one fragment of possible leavened bread was recovered from the Final levels, which is surprising, as leavened breads are generally considered to be a later addition to the culinary traditions in West Asia and, therefore, expected to be found in higher quantities from the Late Neolithic onwards.

Finally, the remains of dough-like products, although most likely representative of fragments of bread doughs which were discarded prior to baking or as accidents of baking, the possibility of these being a completely different type of meal (such as a batter or soup made with fine flour) should not be disregarded. Due to the majority of dough-like fragments coming from fire installation fill deposits, it is probably safe to assume that these are likely to represent the remains of bread dough which were discarded while preparing the dough or that fell into the fire while baking.

The combination of ingredients seen for the preparation of dough-like products are expected to be similar to those seen among the bread-like products. From the total 21 dough-like fragments, except one fragment which was made of a mix of wheat and barley flours and another fragment which contained pulses, the 90% of the dough-like fragments are entirely made of wheat. The majority of the fragments of dough come from the Middle and Late occupation levels with no fragments of dough before level North F.

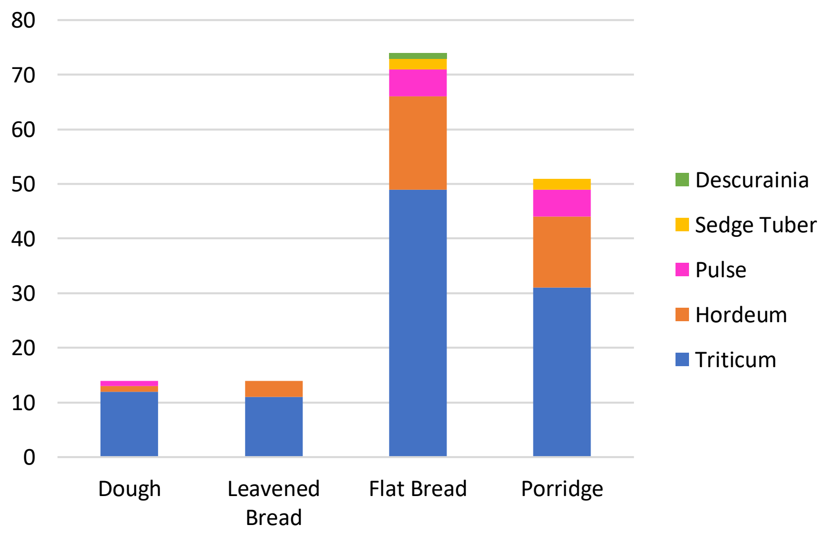


Figure 8.4. Bar chart showing cereal-based products and their composition from Çatalhöyük East

It is important also to consider that many must have been the types of food preparations which did not survive in the archaeological record. Although a variety of dishes and meals were likely cooked as part of daily eating and special occasions, only a very small amount of these have preserved. In this sense, many are the possible plant foods involved in their preparation, such as nuts or fruits which, although their outer shells and stones are present in the archaeobotanical record, they did not preserve as food. Similarly, it would be inaccurate to think that cereals and pulses were uniquely cooked in bread and porridge-like mixes, as these were the staple foods of the Çatalhöyük community and therefore likely to have been prepared in many different forms.

8.1.2.2. Chronological patterns and changing *cuisine* at Çatalhöyük

As seen from the distribution and identification of different cereal meal recipes, in general, there seems to be a clear pattern among the food type fragments recovered from Çatalhöyük. A key element of this pattern is the presence of flat bread-like fragments throughout the whole sequence from the earliest levels in the South area (Level South G), dated back to ca.7100 cal. BC, to the late Neolithic levels at the TPC area (Level TP Q) dated back to ca.6100-6000 cal. BC. This shows a well-established knowledge of bread making and baking tradition in the Çatalhöyük community already by the beginning of the occupation in the late 8th millennium BC. In contrast, other food types such as leavened bread-like products, dough-like products and porridge-like products seem to have their initial appearance at Çatalhöyük around ca.6500 cal. BC and continue throughout until the late Neolithic and, most likely, until the end of the occupation by ca. 6000 cal. BC. This shows a diversification of cereal products at Çatalhöyük by the second half of the 7th millennium with the introduction of a wider range of recipes such as porridge-like products and possible leavened bread (Figure 8.6.).

This change in *cuisine,* which sees its start during the late phase of occupation, will have its peak during the final phases, right before the abandonment of the site and the occupation of the Chalcolithic West Mound by ca.6000 cal. BC. The measured fragment sizes of pulse and cereal tissues indicate that the main component used for the preparation of the vast majority of the dough and bread-like products must have been different types of fine flour which had been sieved after grinding, or it had at least been subjected to repeated grinding until fine flour was obtained. For bread and dough-like fragments, during the early and middle phases, virtually no tissue parts were visible to the naked eye; only five of the measured components exceeded a maximum length of 500 µm, while the major part measured between 100 and 300 µm. According to Dickson (1990), without sieving, large bran fragments of 500 µm length and above should have been visible in the respective cereal product.

On the other hand, the measured broken grains, bran and chaff particles in porridge-like foods indicate that coarse grain must have been the main ingredient. Similarly, there is an increase in the size of the particles present in the bread-like and dough-like fragments during the late and final phases of occupation (Figure 8.5.). This pattern might be due to shorter grinding periods or else due to an intentional choice of coarse grain over fine flour for the preparation of these foods. For porridge-like fragments, although the possibility that these materials were made using types of flour which were not sieved has been considered, however due to the absence of small particles (100–400 µm) they do not show a deliberate mixture of fine flour and coarse grain. For porridge-like food, the fact that all visible particles range between 500–1,500 µm, in addition to the arrangement and type of voids and a lack of crumb structure, indicates a different cooking technique more related to a porridge or gruel preparation rather than bread baking (Dickson 1990; Lannoy *et al.* 2002).

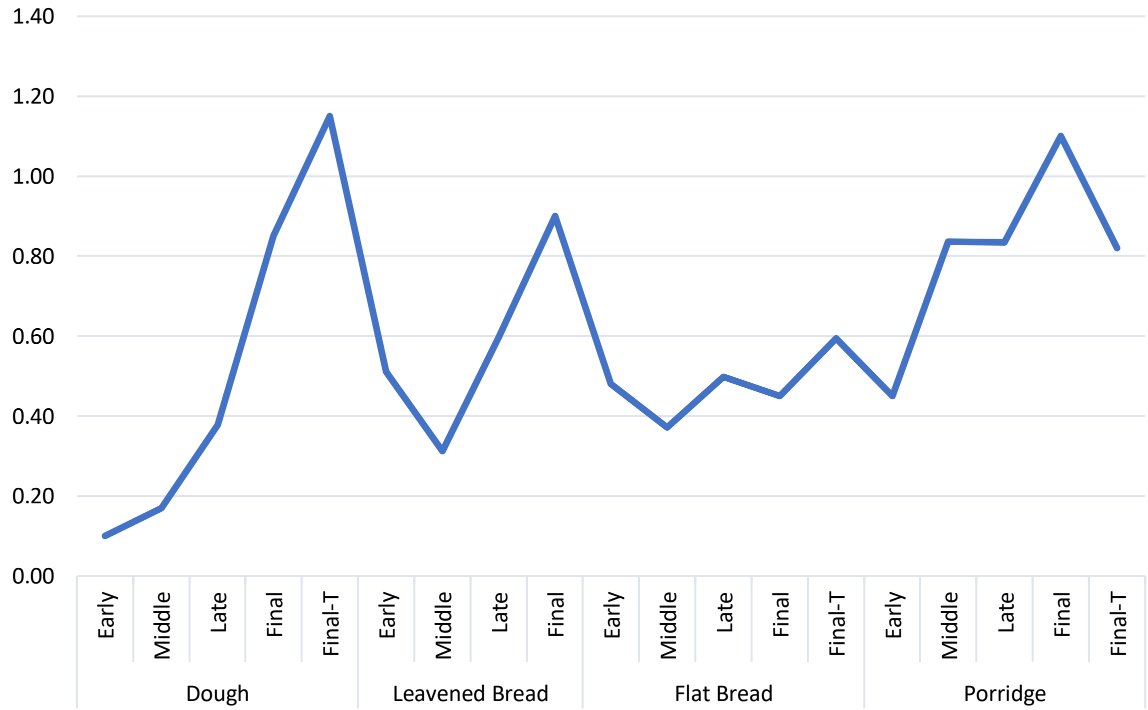


Figure 8.5. Chart showing the chronological distribution of average particle size (mm) for the different cereal-based products at Çatalhöyük

It has been suggested that Çatalhöyük East will experience a period of certain instability and change after the second half of the 7th millennium BC (Marciniak *et al.* 2015; Orton *et al.* 2018) and, what it seems like a diversification of types of cereal meals from this period onwards, is most likely a consequence of a variety of structural and social changes occurring at the time. This is attested by the decrease in the variety of plant ingredients used for the preparation of these meals, in addition to the higher use of barley by the final phases of occupation in the TPC area. The use of barley in itself is an interesting factor which relates to the need for a more resilient and drought resistant crop by the end of the 7th millennium as the climate and environmental conditions were becoming dryer around the site (Ayala *et al.* 2017; Bogaard *et al.* in preparation). This, combined with the increase in the preparation of meals which require coarser grain such as porridges or gruels, suggests a shift in culinary traditions, with boiling and pottery gaining importance, parallel to the making and consumption of bread-like products. The reason for this change is unknown and many could be the reasons for this culinary shift. One possible explanation could be the progressive drying of the area around the site which could have had influenced the shift to a preference for free-threshing and "new type" wheat for bread making and barley, more suitable for porridge and gruels making, due to its low gluten content.

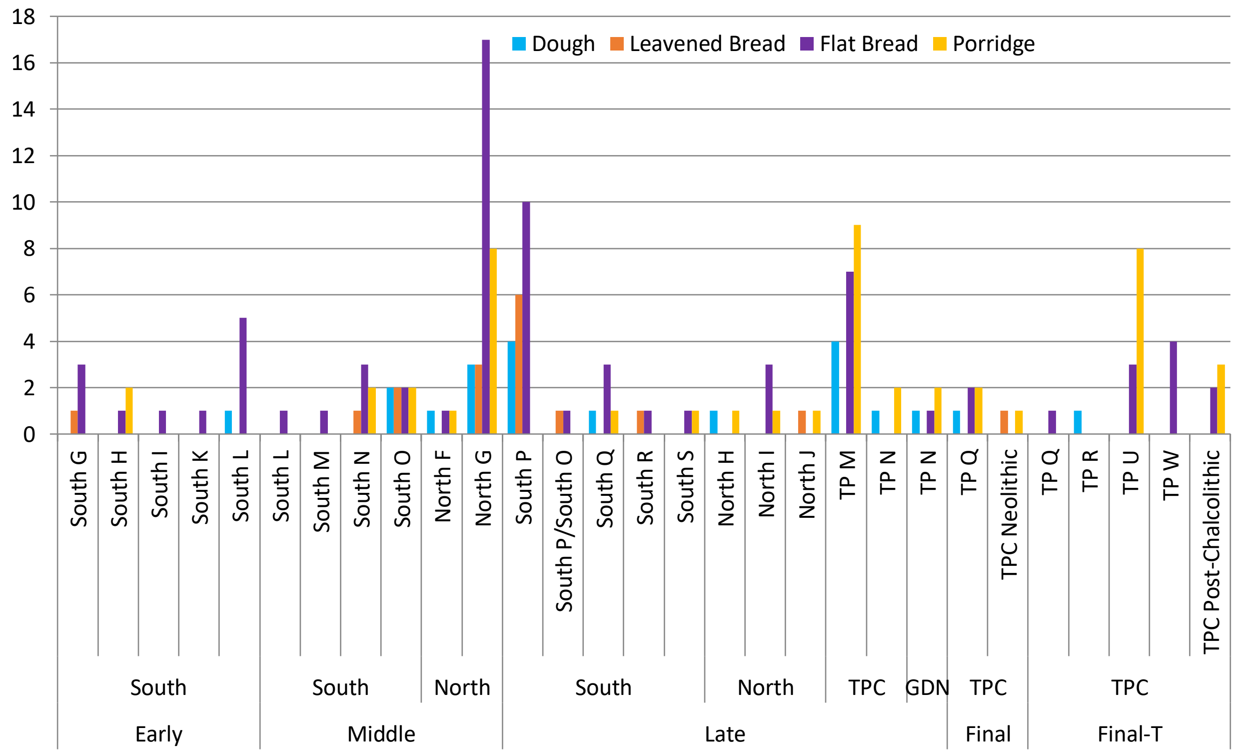


Figure 8.6. Chronological distribution of cereal-based products from Çatalhöyük East by occupation level and excavation area

8.1.3. Cooking patterns and differences among spaces at Çatalhöyük East

There are a series of visible trends and patterns in relation to spatial distribution which are derived from the analysis of the archaeological food remains from Çatalhöyük (Figure 8.7.). Perhaps the most noticeable one is the variability among different occupation areas at the site, especially between South and North in comparison to the TPC area. The South and North areas show similar concentration of types of cereal-based products which also correlate with the number of samples recovered from each area. In contrast, however, the TPC area shows a very high concentration of porridge-like products, even higher than any other occupation area, and also greater than the concentration of bread-like remains. This pattern is, however, related to a culinary change through time as a result of the excavation and sampling strategy focused on the earlier levels of the late phase from South and North areas. As a consequence, a very small sample of food fragments was recovered and analysed from the later levels of the late phase from South and North areas. In this sense it becomes evident when broken down to specific occupation levels, that porridge-like foods become more common after level South O and North G and they will outnumber bread-like products by the final levels of occupation.

An interesting pattern however is seen in relation to the indoor and outdoor spaces for the recovery of bread-like products in comparison with the recovery of porridge-like products. Considering the total number of units from which food fragments have been analysed, very similar amounts of bread and porridge-like products were found in indoor contexts. In particular, from occupation layer deposits (infills, dirty floors, etc) identical quantities of bread and porridge-like materials have been recovered. In contrast, outdoor midden deposits and outdoor oven/open fire areas show a very small concentration of porridge-like materials in comparison with high quantities of bread-like remains. This is especially noticeable from the outdoor area in Sp.333 in the South area, which consisted on a series of large ovens thought to have been used in communal activities (Bogaard *et al.* 2014). This was also Mellaart's idea, when his team excavated an adjacent area to the west of this area which contained a series of large oven-like structures which he interpreted as a communal "bakery" instead of a private domestic space (Mellaart 1967:67). From these spaces, only dough and bread-like remains have been recovered which supports the interpretation of these oven area as a dedicated space for bread baking activities. This type of communal baking activities have been reported from ethnographic studies in traditional villages in Turkey, where a group of ovens are set in a centric location for their use by a group of adjacent households (Parker 2011; see Chapter 2).

In general, buildings at Çatalhöyük show the same range of food types across area and through time in correlation with the culinary patterns described above (e.g. buildings located in the TPC area yielded a higher amount of porridge-like remains). However, individual buildings have been seen to yield different types of foods through time, at the same time contemporary buildings which were built near each other have produced similar remains of cereal-based products. Example of this are the group of contemporary buildings from the early phase from the South area (B.2, B.4, B.6 and B.43), from which only flat bread and dough-like products have been recovered. In relation to the ingredients used for their preparation, these food remains show the greatest variety of plant ingredients used, including wild resources (as previously mentioned in relation to the differential use of plant ingredients through time).

Towards the middle part of the occupation of the South area, we see the emergence of leavened bread-like products coming from a group of contemporary and annexe buildings (B.76, B.80 and B.89) as well as for B.75 and B.87 during the late phase of occupation in the South area. In contrast, the occupation and fire installation deposits from the buildings of the middle phase in the North area have yielded a majority of flat bread-like products in addition to a small amount of porridge-like materials made of a mix of wheat and pulses flour.

A visible change is seen for late phase of occupation from which, as mentioned earlier, there is an increase in the presence of porridge-like materials, in parallel with the recovery of abundant remains of flat breads. Interestingly, during the late occupation, indoor contexts have only yielded one single fragment of leavened bread-like materials and a few examples of dough-like products.

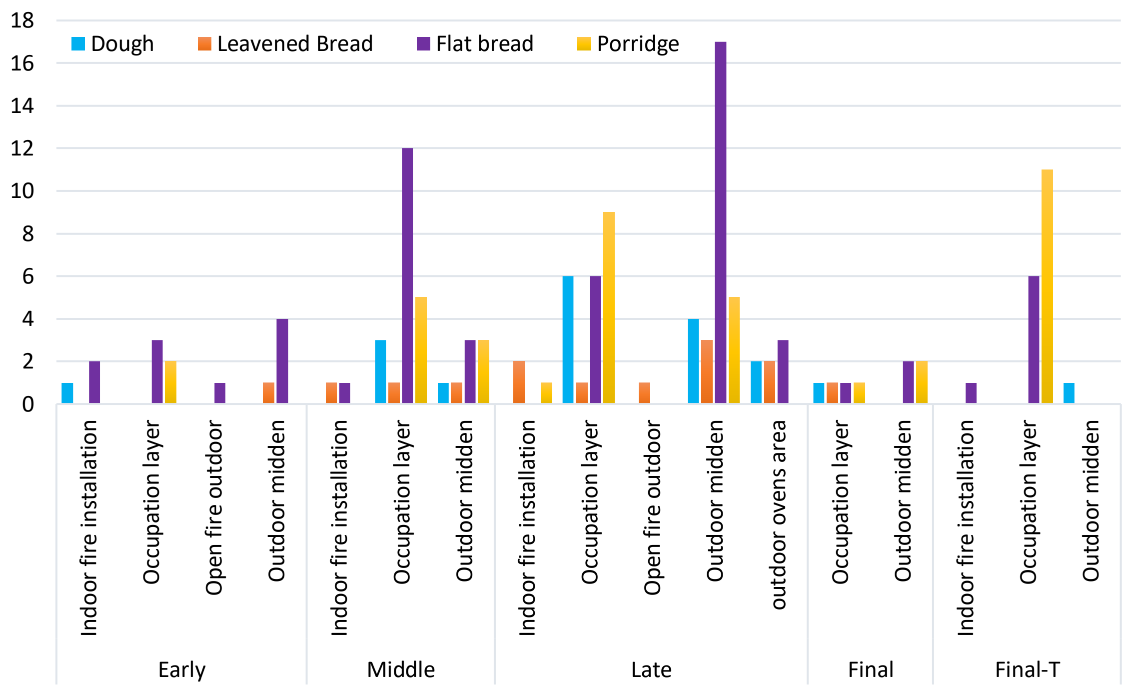


Figure 8.7. Indoor-outdoor distribution of cereal-based products at Çatalhöyük East

8.1.4. Food remains' isotopic and lipids composition in context

In relation to the d15N values obtained from the food fragments from Çatalhöyük, within their relatively high signature, they overlap with the values obtained from the analysis of cereal grains from the site (Styring *et al.* 2015; Vaiglova 2016). According to Vaiglova (2016) the high nitrogen signature of crops from Çatalhöyük is most likely due to the enrichment in soil 15N. In this sense, a number of studies reported negative correlation between plant d15N and mean annual precipitation (Ambrose 1991; Amundson *et al.* 2003; Craine *et al.* 2009; Szpak *et al.* 2013 in Vaiglova 2016). However, for the Konya plain, anthropogenic factors are most likely to be the cause of this enrichment. These would include methods to improve soil fertility such as tillage, burning and application of animal manure or decomposing midden material. Application of manure/compost causes enrichment in 15N because during the process of decomposition, the material releases N in the form of gaseous ammonia (NH3) to the atmosphere. Because manuring leaves a residual effect on the d15N value of soils, this enrichment will last for several years and agricultural use can thus be detected even after the practice has ceased (Koerner *et al.* 1999).

According to Vaiglova (2016), the average d15N value of wild herbivores (cattle, hares, deer) at Çatalhöyük is higher here than at any other Neolithic/Mesolithic site in Europe. In addition, amino acid d15N values of herbivores from Çatalhöyük suggest that the plants consumed by the herbivores were significantly enriched in 15N (Styring 2012). This suggests that an environmental factor caused a landscape-wide 15N–enrichment of the soils around Çatalhöyük. In this sense, aridity is one factor that can cause such systematic enrichment and has been found to be correlated with higher d15N plant values in the Eastern Mediterranean (Hartman & Danin 2010). Significant 15N–enrichment caused by aridity only occurs in very low rainfall zones; Çatalhöyük is thought to have received above the current precipitation average of 350mm of rainfall a year (Leng *et al.* 1999; Taha *et al.* 1981), therefore aridity is unlikely to be the main and only cause of natural enrichment (Vaiglova 2016).

In addition, Vaiglova (2016) obtained a wide range of d15N values which suggests that the soils in which the crops grew did not all undergo the same processes of nitrogen transfer, and the reasons might have been both natural and anthropogenic. In this sense, she suggested that one possible natural cause of d15N variability could have been the differences in the topography around the site. In relation to anthropogenic causes, Bogaard et al (2007), Styring *et al.* (2016) and Vaiglova (2016) suggest that part of the soil nitrogen enrichment may have been caused by organic waste being used for manuring the land or penned animals dropping their dung on the soils.

After taking all these factors into account, it can be concluded that the relatively high d15N values of the selected food fragments are therefore not linked to the use of animal products for their preparation. Instead, these values overlap with those obtained from the charred cereal grains from Çatalhöyük, most likely consequence of a natural and potentially anthropogenic 15N–enrichment of the soils around the site. This is attested by the very low amount of lipids obtained by GC-MS analyses of the 4 selected food fragments, adding evidence to the idea of the Çatalhöyük food fragments being residues from cereal-based meals.

8.1.5. Correspondence with food preparation tools and cooking facilities

The archaeological evidence from the querns, clay balls, pottery and ovens/hearths adds evidence to the idea of a culinary change after ca. 6300 cal. BC. This is not only evidenced from the analysis of food fragments as per this PhD thesis, but also from the analysis of cut marks from animal bones as well as new research into the potential uses of clay balls for boiling activities during the Early phase of occupation. This culinary change, based on the preparation of more liquid foods such as porridges or stews, is evidenced in parallel with the emergence of ceramic vessels as cooking pots around 6500 cal. BC.

Stone tools such as querns and grinding slabs were an essential element in the processing of plant materials required for the preparation of these meals. Latest results show that plant and, mainly cereal processing at Çatalhöyük, was carried out with andesitic querns and grinders (Wright 2013; Tsoraki forthcoming b). Microwear analyses conducted on grinding tools have confirmed their use for plant processing activities and mostly cereal processing (Tsoraki forthcoming b). As an example, microwear analyses in combination with phytolith and starch analyses of a small quern found in a storage bin in the side room of B.77 provided evidence of this tool having been used for processing dehusked cereal grains and therefore most likely for flour making (Tsoraki 2015; Tsoraki 2018; Tsoraki forthcoming b). Further residue samples from grinding tools that derive from buildings 80, 52 and 44 were selected for a combined protocol of phytoliths and starch extraction (Santiago-Marrero *et al*. in preparation). Preliminary results revealed the presence of phytoliths from cereals and reeds, suggesting the use of some grinding tools for specific activities (e.g. cereal de-husking, cereal processing), and others for multiple ones. Although very little change in size is seen during the Early and Middle occupation levels at the site, recent studies on grinding stones show a gradual decrease in size and volume by 15% during the last 400 years of occupation (6600-6000 cal. BC). This is seen in parallel to a shift in the way these tools were used, from grinding with both hands to the grinding with only one hand, which has implications in the decrease on quality of the flour production (Sadvari *et al*. 2015).

Fire installations, in particular ovens and hearths, were essential to the Çatalhöyük community and, with heating, providing light, and cooking as their main purposes. During the early pre-ceramic levels of occupation of the Neolithic East Mound, ovens are often found in association with collections of large clay balls (>6cm in diameter) which were initially interpreted as boilers or heaters, as per comparison with ethnographical examples examples (Atalay 2005; Atalay, Hastorf 2006; Thoms 2009). Çatalhöyük East will see an evident decrease in the use of clay balls and fire-cracked rocks happening sometime around 6500-6400 cal. BC, in parallel with the emergence of cooking pots (Level South L-O or Mellaart Level VI-VII) (Atalay 2005; Hodder 2006; Bennison-Chapman forthcoming; Tsoraki forthcoming). See Table 8.1. for correlation between types of cereal products analysed and the artefacts for cooking recovered from the same levels.

Recent investigation into the role of clay balls support the idea of these being heated in ovens and used by the people at Çatalhöyük East inside the houses (Bennison-Chapman forthcoming). Although clay balls were found to have been re-heated several times for a long period of time until they cracked and become unusable, no clear evidence has been found that links the clay balls with direct cooking activities. Although their potential use as 'boilers' would have allowed for the preparation of liquid foods (porridge-like, soups, stews, etc) from the begining of the occupation sequence at the site, there is very little archaeobotanical and zooarchaeological evidence for it. In this sense, evidence from the study of cut marks in the sheep and cattle bones suggest a change in the main meat cooking practices around the Middle phase of occupation of the site (Demirergi 2015). In the Early and Middle Phases, cut marks in animal bones are dominated by consumption cuts which would have been produced after the cuts have been cooked, as the meat is removed from the bone prior to consumption (Russell & Martin 2005, 85). Such marks are largely produced on bones when large cuts of meat have been baked or roasted, most likely in an oven or on a hearth. In contrast, during the Late and Final phases of occupation, there is an evident decrease in consumption cuts over time which might suggest a temporal decrease in the roasting and baking of meats at Çatalhöyük (Russell *et al*. 2013; Demirergi 2015, 144-45; Pawłowska forthcoming). This decrease is parallel to a rise in the filleting cut marks on animal bones which could indicate the processing and cooking of smaller pieces of meat which were cut off the bone (Demirergi 2015, 133-143). In this sense, the evidence provided by the analysis of cut marks in animal bones suggest a higher tendency to cook animal meat in the bone during the earlier phases of occupation in contrast with a later tradition which included the cooking of previously cut off the bones pieces of meat, with boiling or stewing as the main cooking techniques (Demirergi 2015, 143-44; Pawłowska forthcoming; Russell *et al.* 2013).

The above results adds evidence to the idea of the appearance of a new and different culinary tradition during the second half of the seventh Millenium BC at Çatalhöyük East, with a potential shift from a baking tradition with daily meals which involved bread and meat as their main components, to a more boiling-focused tradition, with products like porridges and stews as the main dishes.

Over the second half of the Late phase there is also a decrease in the presence of indoor oven features, as seen from the TPC area with fewer ovens recovered by building, in contrast with the continuous presence of ovens in every house on each occupation level in the South and North areas during the previous phases of occupation. This change in the TPC area, which corresponds with increasing numbers of outdoor fire installations (Bogaard *et al*. 2014), suggests parallel changes in culinary traditions. However, caution is needed in order to interpret this as the visible reduction in the presence of ovens could be a result of truncation and rebuilding of structures in TPC area. More research is needed in order to establish if there is a change in the nature or use of fire installations during the final levels of the occupation at the site. Interestingly, the decrease in the number of ovens does not correspond with a greater number of hearths or fire spots being used during the late and final phases of occupation (Fuchs-Khakhar 2019), which adds evidence to the idea of a cultural culinary change, rather than it being a result of a change in cooking technology.

New uses of pottery are also seen towards the end of the Neolithic sequence at Çatalhöyük. Deep cooking jars, which emerged from Levels South M-O (ca. 6700-6500) and are believed to be mainly used for extracting fat from animal bones, will be gradually replaced from Level South T (ca. 6300-6000) by closed bowls more suitable for cooking plant foods such as cereals (Last *et al*. 2005, 102; Yalman *et al*. 2013). Moreover, starch and organic residue analyses on these two types of cooking pots have shown an absence of starch granules and presence of absorbed lipids for the deep cooking jars and an absence of lipids for the later bowls. Therefore, the earlier deep jars do not seem to have been used intensively for cooking carbohydrates the same way the later bowls at TPC do not seem to have been used for cooking animal products (Pitter *et al*. 2013). In addition, ongoing analysis of the TPC pottery assemblage has provided new evidence in relation to a change in the use of the closed bowls during the final levels. In this sense, a rapid reduction in the types of bowls to only one has been attested, suggesting perhaps that these were used as multipurpose cooking tools, rather than for one unique, specific use (Tarakan 2018, *pers comm*). Similarly, a reduction in the types of chipped stone tools has also been noticed for the final levels of the sequence at Çatalhöyük East, however, this did not mean a reduction in the type of tasks that were carried out with them, as the use wear analyses show that these were multifunction tools (Doyle 2019 *pers comm*; Doyle forthcoming).

In conclusion, the combination of archaeobotanical, zooarchaeological and material culture suggests a clear shift in culinary traditions during the Late and Final phases of occupation at the site. Meat roasting and baking accompanied by bread-making, both with the oven as the main cooking installation in use, would have been perhaps the main culinary activities. After the introduction of cooking pots during the Middle phase of occupation from level South O and North F, we see the emergence of a new way of cooking with the addition of new cereal meals, in the form of porridge-like products and meat stews. These meals, made of cracked grain and cooked in pots, would have ethnographic parallels with *tarhanas* and other cereal soups/gruels, and represent a whole new way of making food, which will become increasingly common during the final levels of occupation, before the collapse of Çatalhöyük East.

Table 8.2. Correlation of cereal product types with artefacts for food preparation at Çatalhöyük East

Period	Flat bread	Porridge	Dough	Leavened bread	Clay balls	Pottery	Hearths	Ovens
Early (7100 - 6700 cal. BC)	11	2	1	1	yes	no	yes	yes
Middle (6700 - 6500 cal. BC)	25	13	6	6	yes	yes	yes	yes
Late (6500 - 6300 cal. BC)	25	13	11	9	no	yes	yes	yes
Final (5300 - 5950 cal. BC)	12	14	2	1	no	yes	yes	yes

8.2. Jarmo

The analysis of archaeological food remains from Jarmo has helped shed light on the nature of the culinary traditions and cooking practice during the Neolithic in the Central Zagros Area and the comparison with the materials and results from Çatalhöyük East has made possible the establishment of a wider culinary tradition, with bread products as the main staple food. The results obtained from the microscopic observation and comparison with experimental materials have provided with a series of chronological and spatial patterns and differences during the occupation of the site. This section discusses those results and analyses the seen patterns through time.

8.2.1. Neolithic plant ingredients

8.2.1.1 Correspondence with the archaeobotanical record

Among the ingredients identified in the food fragments from Jarmo, there is a consistency in the presence of domesticated crops such as cereals and pulses, having identified particles from these in almost 90% of the analysed fragments. Among these, four pulses such as lentil, pea, grass pea and two types of vetch (*Lens culinaris*, *Pisum sativum*, *Lathyrus sativus* and *Vicia* *ervilia/sativa*), barley (*Hordeum vulgare*) and wheat species (*Triticum* sp.) are the most likely ingredients of the Neolithic cereal-based meals from Jarmo.

The cereal particles identified in the food fragments from Jarmo did not allow for identification of the observed wheat (*Triticum* sp.) or barley (*Hordeum* sp.) cell tissues to the species level due to transverse and longitudinal cells (bran) being highly eroded and incomplete. However, in accordance to the Jarmo macrobotanical assemblage, the most likely wheat ingredients must have been either emmer wheat (*T. dicoccum*), 'new type' glume wheat and bread wheat (*T. aestivum*) in addition to naked barley (*Hordeum vulgare* var. *nudum*). These cereal species have been identified in the archaeobotanical record in very low quantities which contrasts with the high number of cereal particles identified within the food fragments. In this sense, the presence of cereal crops at Jarmo is attested by the presence of chaff (glume bases in particular) and not by the presence of grains. The almost complete absence of grain from Jarmo could be linked to its use for the preparation of cereal meals, grinding the grain down to flour. However, it is more likely that the small numbers of cereal grains recovered from Jarmo are a result of the type of contexts excavated and differential use of the space (indoor/outdoor) for crop-processing activities.

Due to the low number of houses/building excavated at Jarmo, the differential use of these crops for food preparation at the site is currently unknown, but we have clear archaeobotanical evidence of the presence of these species throughout the occupation sequence at the site (see chapter 4). In general, among the cereals, emmer/new type glume bases outnumber remains of bread wheat and barley which suggests that emmer/new type glume wheat was predominant throughout the sequence. In relation to pulses, lentil is the most ubiquitous and frequent plant material from Jarmo throughout the sequence and its high presence suggests the wide use of lentils in the preparation of daily meals. Due to the variety of pulse seed coats identified among the pulse tissues identified in the food fragments, it is safe to assume that not only lentils were used for the preparation of these meals, but also other species, most likely pea or grass pea as the thicker seed coat suggests.

8.1.1.2. Differential use of ingredients for food preparation through time

In relation to the differential use of plant ingredients through time (Figure 8.8.), the use of wheat species is attested from the beginning of the occupation sequence at Jarmo until the latest levels of the site. In the archaeobotanical assemblage from Jarmo in general there is a higher variety of crops and wild plants recovered from the earliest levels, with the presence of barley in correlation to the identification of barley tissues from the food fragments from the earliest levels in Phase 1 (ca.8000-7300 cal. BC). In addition, pulses have been only identified in the food fragments from Phase 3 (ca. 6800 to 6500 cal. BC) which, interestingly, correlates with the emergence of the use of pulses for the preparation of cereal meals at Çatalhöyük East.

The presence in the archaeobotanical record of other plant foods, such as flax, is attested from the beginning of the sequence to the latest levels dating back to ca. 6000 cal. BC. however, particles from these have not been found within the analysed food fragments. Although this could be a consequence of the small sample number of analysed fragments, it suggests that flax was not used for the preparation of the cereal-based meals identified from Jarmo. Flax, however, was most likely used at Jarmo, perhaps as a source of oil, which would be invisible in the archaeological record.

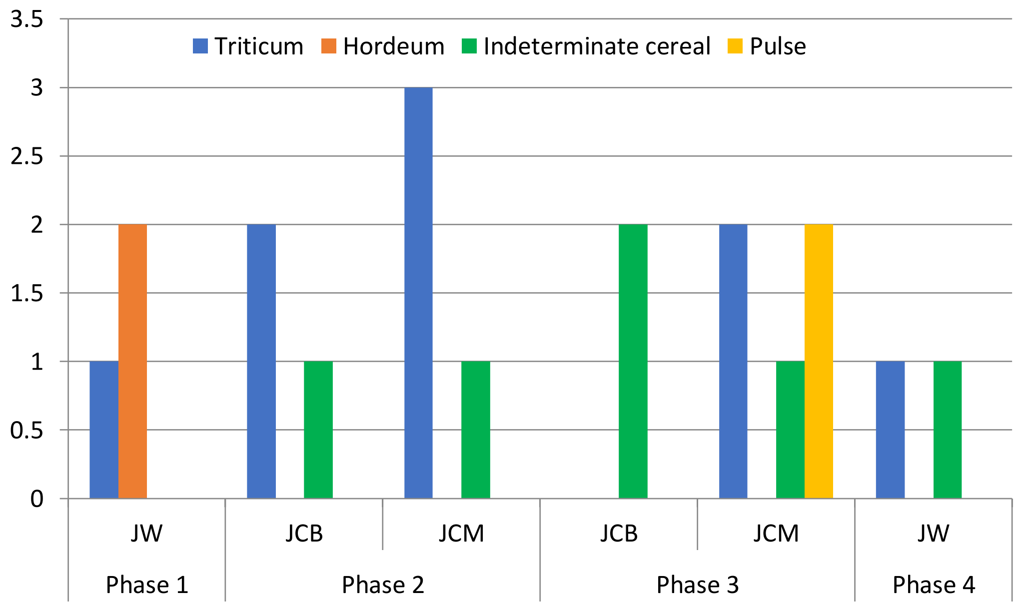


Figure 8.8. Bar chart showing the chronological distribution of plant ingredients in the analysed food fragments from Jarmo.

8.2.2. Food preparation processes and Neolithic recipes

8.2.2.1. <u>Evidence of Neolithic recipes from Jarmo</u>

The remains of food recovered from Jarmo, together with those from Çatalhöyük East, have made possible the identification of different types of Neolithic meals or "recipes" (Figure 8.9.).

Remains of flat bread are the most commonly recovered from Jarmo, as it was also seen for Çatalhöyük East. Similarly, these were made using mainly wheat, in addition to the use of barley in small quantities in Phase 1 (ca. 8000-7300 cal. BC). Flat breads analysed from Phases 2, 3 and 4 only contained remains of wheat in addition to a number of particles which did not allow for genus identification due to their degradation.

Remains of porridge-like products are the next most commonly recovered food type from Jarmo, however as mentioned above, they are absent from Phase 1 and become more common from the middle Phase 2 onwards (after ca.7300 cal. BC). Porridges recovered from Phases 2 and 4, are made purely using cereals, in particular wheat, while those from Phase 3 also contained particles of pulses (possible lentil, bitter vetch and other larger pulses such as pea or grass pea as attested by different measurements of the seed coat). Interestingly, similar to the results from Çatalhöyük East, the only type of food product which contained pulses are porridges. In this sense, the case of Jarmo is even more particular than Çatalhöyük, as pulses represent the majority of the macrobotanical assemblage however only two porridge-like samples have produced evidence of their use for the preparation of cereal products. In this sense, it seems highly possible that these porridge-like products which contain pulses are representative of a type of legume-based gruel or “soup”.

In addition, only one fragment of dough and leavened bread-like products were identified among the analysed food fragments from Jarmo. Unfortunately, neither of them has provided information about their plant composition as no plant particles were seen in their food matrices. These low quantities could be a result of the excavation and sampling strategies and more work would be needed to attest the presence of these food types at Jarmo.

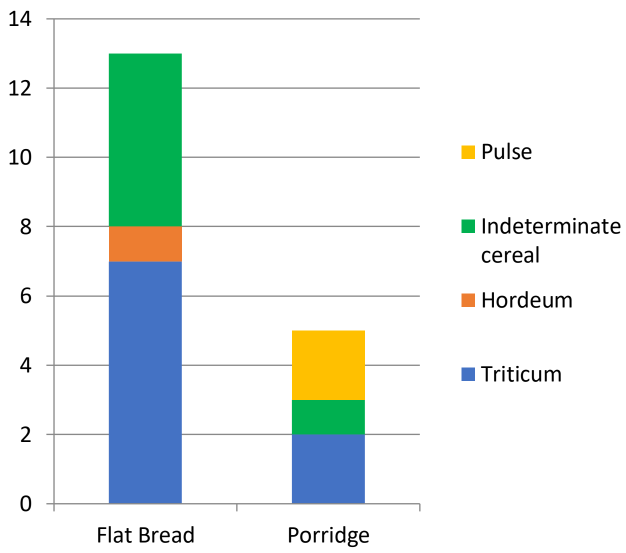


Figure 8.9. Bar chart showing the cereal product types from Jarmo and their plant ingredients' composition

8.2.2.2. Chronological patterns and changing *cuisine* at Neolithic Jarmo

Similarly to the results seen from the food fragments at Çatalhöyük, flat bread-like products (*Matrix Type C*) are present at Jarmo from the earliest excavated levels in Phase 1, dating back to ca. 8000-7300 cal. BC (equivalent to Braidwood Levels J.I 4-9), from the Jarmo West area excavated in 2014 (see Table 4.2. for more details). Flat bread-like fragments have also been recovered from the Middle and Late occupation phases of the site until sometime around ca. 6500 cal. BC. Even though the specific date of these levels has not been fully established yet, the fact that bread-like remains have been recovered shows the importance of bread-making and baking at least from the beginning of the PPNB in the area.

Porridge-like remains (*Matrix Type D*), as seen for Çatalhöyük, appear later in the occupation sequence at Jarmo, with a single porridge-like fragment having been identified from Phase 2 (ca. 7300-6800 cal. BC). Porridge-like fragments are concentrated on the late phases, from ca. 6800 to 6500 cal. BC, in particular. In contrast to what has been noticed at Çatalhöyük, the presence of porridge-like products seems parallel to the continuation in the production of bread-like products and no decline or decrease in bread-baking activities with the advent of porridge-like products is observed at Jarmo. This shows a clear diversification of cooking technology and recipes, as attested from Çatalhöyük, with the addition of porridge-like products such as cereal and pulse gruels from the end of the 8th and beginning of the 7th millennium BC. This diversification in preparation of cereal meals could have been influenced by the emergence of pottery at the site during Phase 3 (Braidwood's level 3), which could have been specifically used for the cooking of porridge or soup-like like foods.

The remains of dough-like products (*Matrix Type A*) and possible leavened bread (*Matrix Type B*) are very scarce in the Jarmo assemblage and they are limited to one fragment representing each category. Both of these come from Phase 2 of the site dated from ca. 6800 to 6500 cal. BC which adds evidence in favour of a greater diversification of plant food products during the second half of the 7th millennium BC.

8.2.3. Cooking patterns and differences among spaces at Jarmo

In contrast with the uniformity of the use of spaces at Çatalhöyük East, Jarmo offers spatial differences in the way that different trenches determine which activities were carried out and how different types of spaces are used.

In this sense, the excavated midden contexts were seen to represent the richest deposits of perhaps one of the main middens at the site, located between buildings. The excavated layers of the midden were seen to contain a high concentration of refuse material from daily activities such as tool making, crop-processing, food preparation among others. The finds recovered from this area include high number of animal bones, lithics, fragments of ground stone tools, *tauf* remains and ash/charcoal deposits. The remains of cereal products recovered from this area come from contexts which also yielded a variety of archaeobotanical materials. As explained in previous chapters, the main plant constituent from the JCM area is pulses and fragments of pulses, representing up to 38.69% of the total midden assemblage. Among the pulses, lentil is the most ubiquitous constituent. In addition, remains of cereal chaff (wheat glume bases) and seeds from weeds and other wild plants have been recovered from these contexts, however, generally in low concentrations. In this sense, the archaeobotanical remains recovered from the midden seem to match with those materials which would be disposed as part of cleaning processes from daily activities such as crop-processing, food preparation, cooking and crafting of tools. Along these lines, the recovered fragments of charred foods most likely represent residues from cooking activities such as bread baking other among others.

In terms of the time frame from which these foods have been recovered, all the food remains from JCM come from contexts which have a provisional date from ca.6800-6500 cal. BC (Phase 3). This specific time frame shows a variety of cereal products being produced at the time at Jarmo which included breads, porridges and other meals such as legume "soups" suggesting a wide diversification in the culinary uses of cereals and pulses in the 7th millennium BC.

In contrast, the JCB area where the buildings are located, have yielded a far less rich assemblage. These contexts appeared to contain patches of charcoal and ash concentration and remains of *tauf* materials, as the main components of the archaeological fills. In combination with the food remains, these have produced a wide variety of plant remains and in particular an abundant concentration of cereal chaff. Cereal chaff is the most frequent (42.75%) and ubiquitous plant material recovered from this area and it is dominated by wheat chaff, in particular glume bases and spikelet forks derived from emmer. The second most ubiquitous (47.06%) items in the archaeobotanical assemblage from the buildings from Jarmo are remains of lentils. It is interesting however that these samples contained the highest concentration of cereal chaff in comparison with those from the midden contexts. The high presence of chaff in combination with low presence of cereal grains and weed seeds from JCB suggest that crop-processing activities such as pounding or dehusking were most likely carried out inside the houses (Stevens 2014), and that these remains were charred in household fire features and deposited near the houses. In this sense, it is safe to consider that food remains from habitational contexts from JCB, are probably derived from the preparation, cooking and consumption of daily meals, all of them activities which would most likely take place inside the houses for the most part.

The excavation records from UCL Jarmo Project do not provide information about specific features being excavated from JCB and the contexts seem to represent layers of occupation within the buildings and deposits of waste inside abandoned buildings. In this sense, the high concentration of botanical remains from inside the houses are not associated with specific features such as hearths or ovens but most likely with refuse materials which gradually accumulated as part of daily activities.

Last but not least, the excavated contexts from JW trench have exposed the earliest levels of occupation at Jarmo. And consequently, the contexts from which food remains were analysed, span from the beginning of the Jarmo occupation sequence sometime around ca. 8000 cal. BC to the late occupation levels by ca. 6500 cal. BC. All of them were reported to contain remains of *tauf* walls, which most likely represent partial remains of buildings, lithics, animal bone and ashy layers with concentrations of charcoal. The archaeobotanical remains found in conjunction with the archaeological remains of food products represent a very low concentration and are reduced to a couple of emmer glume bases and 3 grass peas. As seen for the JCB area, the excavation records from UCL Jarmo Project do not provide information about specific features being excavated from JW and the contexts seem to represent layers of occupation within possible buildings marked by the remains of *tauf* walls. The low concentration of plant remains from JW is most likely due to the limited exposed excavation area, meant to target the excavation of the earliest occupation levels in a short period of time.

Despite the low concentration of archaeobotanical remains, the presence of fragments of cereal-based products from JW is of extreme importance as they provide evidence of bread-making activities as early as ca. 8000 cal. BC at Jarmo. In addition, the presence of barley exclusively in the foods recovered from the earliest levels from Jarmo, suggests perhaps that the use of barley for making bread might have been an early culinary choice. The absence of barley and only presence of wheat in the food fragments analysed from later phases from Jarmo, adds evidence to this theory.

8.3. <u>Food preparation and cooking at Neolithic Çatalhöyük and Jarmo</u>

The analysis of food remains recovered by flotation from the two sites have made possible the establishment of the nature and origin of different cereal-based products, presumably consumed on the daily basis by these Neolithic communities.

Whereas the sampling strategy being more systematically established and the sample being larger from Çatalhöyük East, the results from this study show a well-established bread culture by the beginning on the 7th millennium cal. BC in Southwest Asia. Neolithic communities at Jarmo and Çatalhöyük East had a good understanding and daily knowledge of bread-making techniques as well as baking technology using hearths and different types ovens. This is attested by the recovery and presence of flat bread-like products, in their majority made of wheat, barley and the addition of wild resources such as wild mustard and sedge tubers from the Early Neolithic levels from ca.8000 cal. BC. Later on, this study has shown how there is a diversification in the preparation and cooking of types of cereal meals, with the addition of porridge-like products to the already established bread culture. This diversification goes in detriment of the bread-like products for the site of Çatalhöyük East, however in Jarmo, these represent a small fraction of the food assemblage recovered and studied, and it is clear they are prepared and consumed in parallel to the consumption of bread.

The preparation of other types of products, such as leavened bread-like products and dough-like products represent a small part of the analysed food fragments. In relation to dough-like products, these are most likely to represent remains of bread making activities and dough preparation which were accidentally charred as part of bread baking activities or discarded as refuse materials at the end of meals or while cooking. Leavened bread-like products seem to have been a later addition to the already settled bread culture, with flat breads as the base. Although more experimentation and research in needed in order to establish the origin and the specific processes of fermentation, based on the ubiquity of these types of bread do not seem to have been prepared and consumed on the daily basis, but perhaps as part of special occasions or feasting activities.

Differences in the use of ingredients are seen between sites. In general, wheat is the most used ingredient in the preparation of these meals, followed by barley. However, barley is virtually absent from the analysed food fragment from Jarmo. In addition, the use of wild plant foods for the preparation of cereal meals seem to have been a more generalised practice at the beginning of the occupation (7100 cal. BC) at Çatalhöyük East. While these wild foods are found mostly inside bread-like products, the use of pulses is a later Neolithic addition seen at both sites. These appear to have been mixed with cereals and mostly wheat flour, for the preparation of a porridge-like product.

Chapter 9

Conclusions and future directions

While archaeobotany, in the traditional sense, has been very successful in tracking the origins of domesticated plants and crop choices from Prehistoric time to the present around the world, it has always lacked the methods and the empirical evidence to study the way in which past communities prepared and consumed plant foods. This study has provided a new methodological approach for the analysis and study of preserved fragments of archaeological food preparations, applied to two unstudied archaeological food assemblages from the sites of Çatalhöyük East and Jarmo. In addition, this thesis has provided extensive information about the type of food preparations that the Neolithic communities in Southwest Asia prepared and consumed, presumably as part of their daily cooking and eating habits.

This final chapter focuses on summarising the main results from the current study and how these have addressed the main aims and research questions. In addition, this chapter also outlines the key directions for future work in the context of the results reported here.

9.1. <u>The emergence and establishment of bread cultures in Southwest Asia</u>

Bread-like products have been suggested to be a characteristic of the cultural traditions of the Southwest Asian Neolithic, in contrast to porridge and beer-based Neolithic food systems in some other world regions, such as Africa or East Asia (Fuller & Rowlands 2011; Haaland 2007). In this sense, Southwest Asia is one of the world regions in which crop domestication took placed in communities without ceramic cooking vessels, in contrast to the early development of ceramics amongst foraging societies, for example in the African Sahara or in eastern Asia (Jordan *et al.* 2016; Kuzmin 2013). While flour production through grinding has long been inferred as central in western Asian cultural traditions, from prior to and during the Neolithic, based on the preponderance of grinding slabs and quern stones (Fuller & Rowlands 2011; Wright 1994; 2014), what has been less certain is when the preparation of bread-like products began, and the relative importance of breads versus porridge-like products or other preparations. Bread products are central to the long-term cultural traditions in the Southwest Asia, for example later on in time during the Mesopotamian era, in contrast to regions like

Nubia (Haaland 2007) or eastern Asia where boiled *cuisine* was earlier and more culturally important (Fuller & Rowlands 2011).

It was hypothesised that bread preparations might have well preceded cereal domestication in Southwest Asia and might have even be a factor in the preference of cereals with gluten protein (*Triticum* and *Hordeum* mainly) amongst early cultivars (Fuller & Rowlands 2011; Lyons and D'Andrea 2003; Rowlands & Fuller 2009). The recent discovery and analysis of the Natufian bread-like products from the site of Shubayqa I in Jordan by the author of this thesis and colleagues, adds evidence to this theory. Similarly, the social importance of bread, and its properties as a cultural foodstuff, have most likely contributed to the importance of cereal consumption and been one of the factors that promoted cultivation and domestication (Maeda *et al.* 2016). The methods presented in the current study provide a means to establishing both the presence and frequency of bread-like and porridge-like products as a food stuff in the past communities. This thesis has shown how the microscopic observation of the food microstructures should be combined with other approaches, such as organic chemical analyses and experimental food preparation, where this is possible. Large scale archaeobotanical flotation programs can be expected to produce amorphous charred fragments from the remains of prepared foods, even period prior to ceramic production. Some of these charred "food lumps" can be categorised by microscopic analyses as likely deriving from bread-like preparations, porridge-like preparations, or others.

As illustrated by the case studies' materials from Neolithic Çatalhöyük and Jarmo, the majority of the recovered food remains can be inferred to derive from bread and dough-like products from the beginning of the sites' occupation (ca. 8000-5950 cal. BC). This has shown how bread, in its varied forms, was established and had a relevant role in people's diets during the Pre-Pottery Neolithic prior to and during the era that the sites were founded. Bread-like remains are associated in both sites with the presence of hearths and ovens as one of the main features of the house, remarking the importance of a baking culinary tradition from the beginning of the 7th Millennium BC. Of interest is that porridge type remains become prominent in the later phases at both sites (ca. 6800-6000 cal. BC), which correlates with the beginning of the creation and use of ceramic vessels and cooking pots (Adams 1983; Last *et al.* 2005; Yalman *et al.* 2013). The data obtained from the analysis of the food assemblages from Çatalhöyük East and Jarmo suggest that diversification of cereal *cuisine* beyond bread to include more porridge-like products took place together with diversification in ceramics in the early stages of the pottery Neolithic.

9.2. Changing culinary traditions and *cuisine* at Çatalhöyük and Jarmo

The analysis of the food assemblages from these two sites has made possible the establishment and understanding of the *chaîne opératoire* of plant-based foods during the Neolithic in Southwest Asia. In this sense it can be concluded that this study has developed new methods and has provided new datasets to characterise how food preparation and choice of plant ingredients changed through time during the Neolithic in the chosen geographical areas, which was one of the main objectives of this research.

Through the study of amorphous remains of charred food preparations, it has been possible to distinguish culinary patterns and changes through time, not only in the ingredients used, but also in the way people prepared, cooked and even consumed plant-based products. Neolithic communities in Anatolia and the Zagros Area, as attested by the materials from Çatalhöyük and Jarmo, had the ability and knowledge, as well as the cultural tradition of making bread-like products from the early Neolithic (ca.8000 cal. BC). These early bread-like products, although mainly made using wheat species most likely preferred due to their high gluten-content in comparison to barley species, also contained a selection of other plant foods available to these communities. These additional ingredients included the sporadic use of barley, pulses and small amount of wild resources such as sedge tubers, wild mustards and other seeds, such as possible wild flax. The later addition of porridge-like products after ca.6800 cal. BC to the daily dietary habits of the Çatalhöyük and Jarmo communities meant the diversification of cereal meals and general *cuisine*. These porridge-like products have been found to be made of cereals with the addition of pulses and occasionally sedge tubers. Interestingly, the recovery and identification of remains of bread-like and porridge-like products containing pulses are limited to the middle sequence of occupation at both sites which spans approximately from ca.6800 to 6200 cal. BC.

Extremely important is also the identification of possible leavened bread-like products which have been recovered from both sites in small quantities. It was thanks to the methodology developed for this thesis and the diversification of experimental food preparation that this identification was possible. After analysis, these remains appear to have been made using exclusively wheat fine flour and during the late phase of occupation at Çatalhöyük East, with a decrease in their presence during the final phase. From Jarmo, although remains of possible leavened bread have been recovered, these represent a very small amount of the analysed food fragments and more work would be needed in order to establish the importance of this food type.

9.3. Economic and social implications of Neolithic dietary habits

Whilst this study has shown changes in the choice of ingredients for the preparation of food products during the Neolithic, not many are the differences seen between the case studies considered here. Perhaps the main difference is the use of barley for the preparation of cereal-based meals at Çatalhöyük East in contrast with the very rare use of this crop at Jarmo. This, as mentioned earlier in this document, could be a sign of resilience due to a gradual drying process occurring after ca.6400 cal. BC in the Konya Plain. This climatic change could have forced the inhabitants of Çatalhöyük East to intensify the use of cereal crops which have a higher tolerance to drought such as barley. In itself, the choice of wheat species over barley for the preparation of these meals shows a clear culinary choice, perhaps more dictated by the preferred food products. In this sense, for the preparation of bread-like products, the studied communities would have consciously chosen the use of wheat species, most likely due to their higher gluten-content which would make doughs and bread-products more elastic and palatable.

Another interesting fact is the choice in the use of non-cereal resources for the preparation of these meals. Especially remarkable is the addition of pulses to wheat-based bread and porridge-like preparations, which could have been linked not only to nutritional reasons but also a preference for certain taste or flavour. The fact that preparations containing pulses recovered from both sites are concentrated in a specific time period suggests that this practice might have been a regional cultural tradition which emerged sometime at the beginning of the 7th Millennium BC and continued until mid-7th Millennium BC. In the case of Çatalhöyük East, there is also a concentration of food remains containing pulses from the North area of the site, almost as if it represented a different localised culinary tradition, perhaps ingrained in the culture of a very specific group of people within the community. Along these lines, the use of sedge tubers has marked a before and after in the current understanding of these are potential sources of food. While, traditionally, the presence of sedge tubers and nutlets in the archaeobotanical record at Çatalhöyük East had been considered to be a consequence of dung burning activities and use of these as fuel, this thesis has shown the role of these as food. Although small, the presence of sedge tubers in the archaeological food fragments from

Çatalhöyük East has provided evidence of their food value. This has also been attested from the site of Shubayqa I, in Jordan, where analysis of archaeological bread-like products and other food remains showed the use of sedge tubers of the same species (*Bolboschoenus glaucus*) for their preparation (Arranz-Otaegui *et al.* 2018). This suggests that this species had a long and continuous economic and perhaps social value as a food source before domestication of plants took place. Although the full social and economic value of this species cannot be inferred from the analysis of the food fragments Çatalhöyük East, their mere presence has been proven relevant for the understanding of the use of wild plant for daily food preparation.

In relation to the types of meals prepared and consumed by the Çatalhöyük East and Jarmo communities, no marked differences are found between the two case studies. This thesis has shown that flat bread-like products and the process of their preparation was well-understood and established in the culture of the first farmers of Southwest Asia. Later, a diversification in culinary practices with the addition of porridge-like products to the Neolithic food repertoire is inferred, perhaps associated with the beginning of the use of pottery vessels as cooking pots around ca.6800 cal. BC. While at Çatalhöyük East the widening on cereal-based recipes suggests a possible decrease in bread-making activities, at Jarmo bread-like products seem to remain as the main cereal-based product. At Çatalhöyük East this change in culinary practices is also attested by the study of faunal assemblages and specifically of cut marks on bones. In this sense, filleting marks have been reported to increase in parallel with the appearance of cooking pots and the increase in the preparation of porridge-like meals, suggesting perhaps a new culinary taste for wet foods such as stews or soup-like dishes. Moreover, an apparent decrease in the presence of oven features inside the houses during the Final phase at Çatalhöyük, adds evidence to the idea of the community's focus being shifted from a bread-based baking culinary tradition to a boiling/stewing one.

As this diversification of cereal preparations, with the addition of porridge-like products to a well-established bread culture, is seen from the two different case studies which are located in distant areas of Southwest Asia, it would be safe to assume that this is most likely to represent a cultural choice rather than a functional one. Although it would not be difficult to imagine this event as a consequence of the use of pottery for cooking activities, the knowledge of boiling technology was no mystery by these communities as attested by the presence of stone vessels and clay balls from both sites. In this sense, the introduction of porridge-like products to the Neolithic communities' diets could be interpreted as new cultural culinary tradition which was incorporated into a bread-based *cuisine.* Further research is needed in order to elucidate the origin of this new “porridge culture” which will appear in Southwest Asia during the second half of the 7th Millennium BC, and the potential social, economic and cultural reasons behind it.

9.4. The potential of combining SEM, experimentation and chemical analysis

This study has shown the importance of the combination of a variety of techniques for the complete and comprehensive study of archaeological food preparations in the Neolithic of Southwest Asia. An essential part of this methodology has been the development of quantitative and qualitative attribute sets (voids and particles) and their observation and comparison with experimental materials under Scanning Electron Microscope (SEM). SEM analysis have been proven to be exceptionally successful for the identification of ingredients and particles present within the food fragments’ matrices as well as for the observation, quantification and categorisation of their porosity.

Experimental preparation of cereal meals following traditional recipes for the subsequent comparison with the archaeological food fragments is unique characteristic of this PhD study. Unlike other studies and research project working on similar materials (Heiss *et al*. 2019; Primavera *et al*. 2018; Valamoti *et al*. 2019), this doctoral project has shown the importance of experimentation and creation of reference materials for the comparison with archaeological food remains. In this sense, the comparison of the experimentally prepared and charred specimens has been proved to be extremely helpful for the positive identification of archaeological meals, in relation to not only ingredients used but more importantly in relation to their microstructures. In this sense, the positive comparison of the experimental materials with the archaeological ones has made possible the categorisation of the Neolithic meals into types and therefore into potential meals/dishes.

In order to obtain as much information as possible and fully understand the preparation of past plant-based foods, microscopic analyses were complemented with chemical residue analyses such as bulk isotopes and lipid analyses. Despite the sample selected representing only a small fraction of the recovered archaeological food remains from Çatalhöyük East and Jarmo, bulk isotopic signature and lipid analysis provided a better understanding of the composition of cereal products from both sites. Further application of these methods to larger datasets has the potential to establish if animal products played an important role in the preparation of cereal products during the Neolithic or if animal resources were, on the contrary, used for the preparation of other types of meals such as stews or consumed roasted as traditionally thought.

9.5. Final remarks

This study has provided evidence for the presence of a well-established bread culture in Southwest Asia from the beginning of the Neolithic. The analysis of amorphous charred fragments of cereal products from the sites of Çatalhöyük East and Jarmo has made possible the understanding of the *chaîne opératoire* of plant-based food preparations, from the procurement of plant ingredients to the final product. This has been possible through the creation and application of a new set of methods, based on a multiproxy approach, which included experimental food preparation, microscopic analyses and chemical analyses. Although promising, further research on this front should focus on the selection of a larger sample of food fragments for the analysis of their isotopic and lipid composition, in order to shed light on the use of animal resources in combination with plant materials for the preparation of meals.

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Appendix I:

Tables: Analysed food samples and identified plant components from Çatalhöyük and Jarmo

Table 1. Total analysed food fragments and total count of identified plant components from Çatalhöyük East

Area	South	North	South	South	South	South	South	South	South	South	South	South	North	North	4040	North
Unit number	1074	1442	1835	2346	3600	4917	4937	4937	4866	4869	4869	5302	10240	10240	10081	7948
Flot number	192	516	639	1010	1924	2985	3099.1	3099.2	3133	3148	3151	3666	5826.1	5826.2	5859	5860
Hodder Level	South L	North G	South K	South L	South L	South M /South L	South L	South L/VIII	South G	South G	South G	South G	North J	North J	North H	North I
Building	none	1	2	4	none	6	6	6	none	none	none	none	47	47	45	49
Space	115	187	116	151	115	169/173	173	173	181	181	181	181	237	237	238	100
Context type	ashy midden	fill	bin fill	fill	oven fill	Bin fill/posthole fill	Rake-out	Rake-out	ashy dump	midden / dump	midden / dump	spread	hearth fill	hearth fill	burnt layer	oven fill
Non-cereal components																
Tuber Parenchyma cell tissue																
Descurainia sophia testa								2								
Vascular tissue/bundles						1	1	1			2	2				
Fungus Hyphae					5											
Possible Insect frass																
Pulse tissue (palisade cells layer)							2									
Pulse tissue (testa)							1									
Ind. seed	1															
Cereal components																
Barley aleurone layer											1					
Barley awn																
Ind. grain fragment																
Barley bran Longitudinal cells																
Barley bran transverse cells																
Barley glume epidermis																
Ind. glume epidermis																
Barley grain fragment																
Barley rachis indeterminate																
Ind. aleurone layer									2	2						
Barley Testa cells over perisperm																
Wheat aleurone layer					4		3	2					10	4		
Wheat awn																
Wheat bran Longitudinal cells					10			2				1	3	4		1
Wheat bran transverse cells					10	1	2	2		1		1	10	5	1	
Ind. bran frags	2			1		1	5	4	5	4						6
Endosperm cells (starch cells)	1					1	1	2		1						
wheat glume epidermis												1				
Wheat grain fragment							1						5	1		
Starch granules																

4040	4040	North	North	South	South	South	South	South	South	South	South	South	South	South	North	North	North	South	North
13107	13183	14186	14179	15724	15724	15749	16224	16246	16279	16507	16507	16505	16518	16534	14472	14468	14468	16548	14496
6577	6939	7196	7205	7558.1	7558.2	7654	7807	7835	7857	7860.1	7860.2	7880	7884	7928	7937	7947.1	7947.2	8000	8006
North I	North I	North I	North I	South Q	South Q	South P	South P	South Q	South P	South S	South S	South P	South P	South S	North G	North G	North G	South P	North G
none	none	none	none	none	none	none	none	none	75	none	none	none	none	none	49	49	49	none	49
279	279	279	279	299, 305	299, 305	427	371	1	328	319	319	333	333	333	100	100	100	333	100
midden	midden	midden	midden	midden layer	midden/dump	fire spot	fire spot	dumped layer	hearth	midden	midden	oven floor	layer	layer	floor	floor	floor	ash spread	makeup
														1				1	
	1													2					
2								1											
																			4
																			2
			1									2							
1			5				5	4			2								
																2			
1	2					2		1											
			1																
							2		10	1	2				3			3	
2	1		2		1	3	3	1		1	3		3				1		1
	1																		
	1	2	2	4	3	7	1		1				2				2		1
1							4	2				1							
3			2				20		14	1	2							2	
			1			2	5	2											
	1									1									
					2		3	2			3								

4040	South	South	South	North	North	South	South	South	South	North	South	North	4040	North	South	South	South	South	South	South	South
16715	16570	16543	16595	16722	14469	17027	17039	17081	17308	16484	17339	16493	17525	17527	18511	18441	18565	18194	18537	18548	18608
8017	8019	8061	8123	8138	8143	8161	8183	8340	8375	8456	8470	8493	8641	8654	8946	8987	8994	9016	9018	9027	9047
North G	South P	South P	South P	North G	North G	South R	South R	South Q	South Q	North G	South P	North G	North G	North G	South P	South O	South O	South P	South P	South P	South P
none	none	none	none	52	49	none	none	none	none	77	none	77	77	77	none	76	79	none	none	none	87
60	333	333	333	91,92	100	339	339	299, 305	299, 305	336	333	336	336	336	344	137	134	372	344	344	369
Ash deposit	surface/dump	ash spread	Oven floor	burial fill	floor	fire spot	midden	firespot	fire pit fill	burnt fill	fill	in situ horns	burnt fill	stone cluster	dump	burial fill	plaster	fire spot	dump	fire spot	fire spot
													1								
													2			2					
																		1			
														1				1	1		
3								2						1				1			1
							1							2	1						
				20										1					3		
																		1			
																2					
							2	1							1				1		1
								1		1						2			1		
								2													2
	2	2	2		1	4		2	2		4						1	1	1	5	
	2	2	2			3	1	3							1		1			2	
	2	2	4		1	6		2	2											2	
5					2					1	1			2	1	2		1			2
					1						1							2	2	2	
1	2	1			1	4	1	1											1	3	
																	1				

South	South	South	South	South	South	4040	South	South	South	South	South	South	South	South	South	North	North	South	South
18609	18616	18616	18489	18489	18465	19044	19115	19115	19114	18953	19128	19344	19349	19349	19603	19295	19295	19243	18782
9053	9085.1	9085.2	9091.1	9091.2	9092	9229	9232.1	9232.2	9233	9258	9266	9395	9405.1	9405.2	9518	9520.1	9520.2	9668	9669
South P	South P - South O	South P - South O	South O	South O	South O	North G	South P	South P	South P	South O	South P	South N	South N	South N	South O	North G	North G	South O	South O - South N
87	87	87	76	76	76	77	86	86	none	80	none	none	none	none	97	77	77	97	76, 89
369	369, 374	369, 374	137	137	137	336	344	344	333, 344	135	344	460	459	459	365, 469	336	336	365, 469	368, 379
dump	fill of cut	fill of cut	burial fill	burial fill	burial fill	burial fill	midden layer	midden layer	midden layer	oven fill	midden	dump	midden	midden	bin fill	burial fill	burial fill	room infill	pit fill
											2								
											1								
1																			
			1											10					
														3					
					1			1	2										
								2					1						
									2		2								
											2								
										2									
				1				2					2		2	1			
		16										1						1	1
		7			1		1							1					
		14												4				1	
					1		2	6	1	3	3	1				1	2	4	1
					2					2									
		6																	

South	TPC	TPC	TPC	North	North	TPC	TPC	TPC	TPC	TPC	TPC	TPC	TPC	TPC	TPC	TPC
18782	20140	20149	20154	20428	20472	20215	20215	20232	20507	20511	20249	20261	20255	20187	20260	20184
9669.2	9822	9855	9868	9884	9909	9924	9924.2	9954	10007	10009	10010	10012	10020	10027	10028	10043
South O - South N	TPC U	TPC U	TPC U	North H	North G	TPC Q	TPC Q	TPC Q	TPC Q	TPC Q	TPC Post-Chalcolithic	TPC Post-Chalcolithic	TPC Unknown	TPC W	TPC U	TPC U
76, 89	none	none	none	129	none	115	115	115	115	115	none	none	none	none	none	none
368, 379	495	496	496	76,77	489	491	491	491	491	491	484	483	494	498	496	496
pit fill	pit fill	pit fill	pit fill	burial infill	midden	midden	midden	midden	floor	fill	Pit fill	bricky layer	infill	burial infill	wall mortar	posthole fill
						1										
	3	1	2													
			5				9		1	10		2			2	2
			1													
	6	2		2										2	2	
	2															
					12								1			
	3	2	2	2												
	1															
1													2			2
2			2			1		2	6	2				2		
2			2			1	1		2	2				2	2	
2			2			1		2	7	2						
1		6	8				8			3	3	2		1	1	2
		2					8			10			2		2	
			2					1	1	2				1		

South	TPC	TPC	TPC	TPC	TPC	North	North	North	North	South	North	TPC	TPC	North	TPC	TPC	North	North
20521	20168	20254	20168	20189	20192	20488	19570	20625	20625	30601	20961	30288	30274	20686	30285	30271	20988	30547
10048	10051	10054	10055	10074	10079	10255	10260	10342.1	10342.2	10507	10521	10526	10543	10553	10563	10570	10600	10622
South M	TPC W	TPC N	TPC W	TPC U	TPC U	North G	North G	North G	North G	South H	North G	Chalcolithic	TPC U	North G	Post-Neolithic	TPC Q	North F	North F
none	none	110	none	129	none	114	114	77	77	118	114	none	120	77	none	none	132	119
470	498	486	498	496	495	87	87	336	336	510	87	508	509	336	507	506	511	512
preparation layer	burial infill	Infill	burial infill	pit infill	Infill	dump	Infill	burial fill	burial fill	burnt fill	hearth	pit infill	wall plaster	burial fill	infill	floor	infill	dump
																		1
														1				
																		10
																		5
	1		2		2													
					1									1				
	2													1				
															4			
2	1				1							2						
3		2		2														
2	1			4		4		2	3		1	4				1		1
														1				
	1	3						1	3		1	2				1		
3		3		8	2	5			2		1	2						
	4		2								4		2		4			
		2	2	1		2			2		3							
	1	1		2	1	2			3			2						1

North	TPC	South	South	TPC	South	TPC	South	TPC	TPC	TPC	North	North	South	North	TPC	TPC	TPC	North	North	North
20989	30738	30614	30615	30745	19379	30747	19879	30757	30761	30778	30561	30503	30626	30106	30732	30806	30870	21117	21108	21109
10634	10661	10662	10664	10675	10679	10681	10691	10720	10721	10742	10769	10770	10779	10798	10803	10804	10967	11129	11130	11137
North G	TPC M	South H	South H	Chalcolithic	South M	TPC N	South O - South N	TP M	TP M	TP M	North G	North G	South H	North F	TPC R	TPC M	P Neolithi	North G	North G	North G
77	121	118	118	none	none	110	76, 89	121	121	121	114	52	118	119	121	121	none	113	113	113
336	514	510	510	508	470	485	368, 379	514	514	514	87	94	510	512, 513	519	514	643	527	527, 607	95,96
burial fill	infill	make-up	dirty floor	Pit infill	foundation cut	infill	burial fill	infill	infill	infill	Ash deposit	infill	fill	pit infill	oven	infill	midden	mortar	fill	Infill
			1																	
2		2	1																	
		1																		
												7		3						1
												3								2
										3							1			
							1		5								1			
																	1			
										3							2	1		
														1						
										2							1			
							1	1		1	1		1							
	4		1	3	2									2	2			2	2	
					1															
	3			3	3	2			1					2	3			5	2	
				2	2	2		2	1		2			2	2			3	1	
2							1		2	1	3	2	1			2				4
	2			3	2					1							2			
																1				
	2			6	2			1	1						2					

North	TPC	South	North	North	TPC	North	North	North	TPC	TPC	TPC	TPC	TPC	South	GDN	GDN	TPC	GDN	GDN
21140	30436	30364	22032	21170	21061	21645	21659	21661	21089	21095	21051	22709	22764	21964	22834	22834	31353	22850	22850
11162	11177	11235	11239	11240	11723	11747	11750	11799	11822	11832	11860	11922	12021	12054	12155.1	12155.2	12267	12278.1	12278.2
North G	TPC W	South L	North G	North G	TPC U	North G	North G	North G	TPC U	TPC M	TPC U	TPC M	TPC M	South O - South N	TPC N	TPC N	TPC M	TPC N	TPC N
113	none	43	132	114	none	none	none	none	none	122	none	122	150	76, 89	none	none	150	none	none
527	528	236	488	87	495	490	490	489	495	493	495	493	639	368, 379	420	420	639	420	420
Infill	burial fill	oven fill	fire-spot	rake-out	oven fill	midden	midden	midden	pit infill	pit fill	infilll	bottom of bin	infill	pit infill	midden	midden	infill	retrieval pit	retrieval pit
		1	7	4															
		1	6	2															
										3									2
												5							4
	2																		
	2									2									
	3									2									1
								2			1	1			3				3
1				2	3		2		7	2			1	5		6		1	
		3	1	3			7	7	5	1		2		10		4			
2			1	4	1		3	7	5	1			1	10		3		2	
						2							1		3				3
	2	3		1	2		1	2	5	3		5		1					
									6	2	3			2		6			

TPC	TPC	TPC	TPC	TPC	South I	TPC	TPC	TPC	TPC	TPC	TPC	TPC	TPC	TPC
21038	20761	30888	20798	31870	23216	31894	20766	20766	23700	23717	23778	23778	32803	23993
12405	12982	13012	13017	13024	13255	13511	13596.1	13596.2	13607	13617	13717.1	13717.2	13850	13882
TPC M	TPC M	TPC M	TPC M	TP M	South I	TPC M	TPC M	TPC M	TPC M	TPC N	TPC M	TPC M	TPC M	TPC M
150	150	150	150	150	none	150	150	150	150	150	166	166	150	150
597	594	594	594	594	620	594	594	594	594	585	515	515	637	639
midden	pot	platform	platform	platform	oven base	fill	oven base	oven base	bin fill	infill	layer	layer	cluster	infill
2						1	3							
											2			
4	5	5	2		1	6		3	2	1		4		
5	2	3	2	10		6		1	2	1				
4	4	3		10		6		4	1	1		2		
					2						1			
3		2				3		1	1			1		
4	5	4	2			5			1			3		

Table 2. Total analysed food fragments and total count of identified plant components from Jarmo

Trench	QR14-15	M14-15	M14-15	QR14-15	QR14-15	QR14-15	QR14-15	QR14-15	QR14-15	MN14	QR14-15	QR14-15	F4-5	F4-5	E4	E4
Area	JCM	JCB	JCB	JCM	JCM	JCM	JCM	JCM	JCM	JCB	JCM	JCM	JW	JW	JW	JW
context/layer	22	20	20	20	20	18	18	18	18	6	22	22	5	5	10	10
flot no.	159	160_1	160_2	184_1	184_2	144_1	144_2	144_3	144_4	17_1	180_1	180_2	64_1	64_2	175_1	175_2
vol. (4463 L)	18	16	16	18	18	18	18	18	18	80	17	17	-	-	20	20
Period	Phase 2	Phase 3	Phase 3	Phase 2	Phase 2	Phase 2	Phase 2	Phase 2	Phase 2	Phase 2	Phase 2	Phase 2	Phase 4	Phase 4	Phase 1	Phase 1
Context type	Midden	Ashy fill	Ashy fill	Midden	Midden	Midden	Midden	Midden	Midden	Habitation	Midden	Midden	Midden	Midden	Step trench	Step trench
Non-cereal components																
Tuber Parenchyma cell tissue																
Descurainia sophia testa																
Vascular tissue/bundles						2		1	1			1				
Fungus Hyphae																
Possible Insect frass																
Pulse tissue (palisade cells layer)																
Pulse tissue (testa)																
Ind. seed																
Cereal components																
Barley grain fragment																
Wheat grain fragment								2								
Ind. grain fragment								1					10			
Barley rachis indeterminate																
Barley glume epidermis																
wheat glume epidermis																
Ind. glume epidermis																
Barley aleurone layer																
Wheat aleurone layer								2						1	1	2
Ind. aleurone layer			1				1									
Wheat bran transverse cells							5									2
Wheat bran Longitudinal cells								1						1	1	2
Barley bran transverse cells															1	
Barley bran Longitudinal cells																
Barley Testa cells over perisperm							1									
Ind. bran frags		3							1	2		2				
Endosperm cells (starch cells)							2									
Wheat awn																
Barley awn																
Starch granules																

Trench	QR14-15	QR14-15	QR14-15	QR14-15	EF4	QR14-15	MN14	MN14	QR14	QR14	MN14	QR14
Area	JCM	JCM	JCM	JCM	JW	JCM	JCB	JCB	JCM	JCB	JCB	JCM
context/layer	11	20	21	21	5	15	9	9	10	9	3	8
flot no.	148	150	152_1	152_2	155	178	24_1	24_2	32	28	6	27
vol. (4463 L)	20	20	21	21	18	18	40	40	80	60	40	120
Period	Phase 3	Phase 2	Phase 2	Phase 2	Phase 1	Phase 3	Phase 2	Phase 2	Phase 3	Phase 3	Phase 3	Phase 3
Context type	Midden	Midden	Midden	Midden	Step Trench	Midden	Habitation	Habitation	Midden	-	Habitation	Midden
Non-cereal components												
Tuber Parenchyma cell tissue												
Descurainia sophia testa												
Vascular tissue/bundles			2									
Fungus Hyphae												
Possible Insect frass												
Pulse tissue (palisade cells layer)									2	1		
Pulse tissue (testa)												
Ind. seed												
Cereal components												
Barley grain fragment												
Wheat grain fragment						1						
Ind. grain fragment												
Barley rachis indeterminate												
Barley glume epidermis												
wheat glume epidermis												
Ind. glume epidermis												
Barley aleurone layer												
Wheat aleurone layer			4	3		1	1	3	1			
Ind. aleurone layer	1											
Wheat bran transverse cells									1			
Wheat bran Longitudinal cells			>10	3			2	3				
Barley bran transverse cells					1							
Barley bran Longitudinal cells												
Barley Testa cells over perisperm												
Ind. bran frags												
Endosperm cells (starch cells)							2	2				
Wheat awn												
Barley awn												
Starch granules												

Table 3. Frequency and ubiquity percentages of components identified in the food fragments from Çatalhöyük East

Non-cereal components		**Total**	**Presence**	**Ubiquity %**	**Frequency %**
Tuber Parenchyma cell tissue		6	5	2.94	0.35
Descurainia sophia testa		2	1	0.59	0.14
Vascular tissue/bundles		21	14	8.24	1.44
Fungus Hyphae		12	7	4.12	0.82
Possible Insect frass		1	1	0.59	0.07
Pulse tissue (palisade cells layer)		50	11	6.47	3.42
Pulse tissue (testa)		25	9	5.29	1.71
Ind. seed		1	1	0.59	0.07
	Total	**118**			**8.01**
Cereal components					
Barley aleurone layer		31	19	11.18	2.12
Barley awn		0	0	0.00	0.00
Ind. grain fragment		81	27	15.88	5.54
Barley bran Longitudinal cells		16	11	6.47	1.09
Barley bran transverse cells		59	20	11.76	4.03
Barley glume epidermis		3	2	1.18	0.21
Ind. glume epidermis		22	6	3.53	1.50
Barley grain fragment		31	19	11.18	2.12
Barley rachis indeterminate		1	1	0.59	0.07
Ind. aleurone layer		67	34	20.00	4.58
Barley Testa cells over perisperm		4	2	1.18	0.27
Wheat aleurone layer		212	78	45.88	14.49
Wheat awn		3	3	1.76	0.21
Wheat bran Longitudinal cells		199	73	42.94	13.60
Wheat bran transverse cells		217	69	40.59	14.83
Ind. bran frags		195	65	38.24	13.33
Endosperm cells (starch cells)		110	48	28.24	7.52
wheat glume epidermis		4	4	2.35	0.27
Wheat grain fragment		115	48	28.24	7.86
Starch granules		1	1	0.59	0.07
	Total	**1345**			**93.71**
	Total samples	**170**			

Table 4. Frequency and ubiquity percentages of components identified in the food fragments from Jarmo

Non-cereal components		**Total**	**Presence**	**Ubiquity %**	**Frequency %**
Tuber Parenchyma cell tissue		0	0	0.00	0.00
Descurainia sophia testa		0	0	0.00	0.00
Vascular tissue/bundles		7	5	17.86	8.54
Fungus Hyphae		0	0	0.00	0.00
Possible Insect frass		0	0	0.00	0.00
Pulse tissue (palisade cells layer)		3	2	7.14	3.66
Pulse tissue (testa)		0	0	0.00	0.00
Ind. seed		0	0	0.00	0.00
	Total	**10**			**12.20**
Cereal components					
Barley grain fragment		0	0	0.00	0.00
Wheat grain fragment		3	2	7.14	3.66
Ind. grain fragment		11	2	7.14	13.41
Barley rachis indeterminate		0	0	0.00	0.00
Barley glume epidermis		0	0	0.00	0.00
wheat glume epidermis		0	0	0.00	0.00
Ind. glume epidermis		0	0	0.00	0.00
Barley aleurone layer		0	0	0.00	0.00
Wheat aleurone layer		19	10	35.71	23.17
Ind. aleurone layer		3	3	10.71	3.66
Wheat bran transverse cells		8	3	10.71	9.76
Wheat bran Longitudinal cells		13	7	25.00	15.85
Barley bran transverse cells		2	2	7.14	2.44
Barley bran Longitudinal cells		0	0	0.00	0.00
Barley Testa cells over perisperm		1	1	3.57	1.22
Ind. bran frags		8	4	14.29	9.76
Endosperm cells (starch cells)		4	2	7.14	4.88
Wheat awn		0	0	0.00	0.00
Barley awn		0	0	0.00	0.00
Starch granules		0	0	0.00	0.00
	Total	**72**			**87.80**

Appendix II:

Table 1: Summary data from SEM and Image analyses on selected food fragments from Çatalhöyük East

Table 2: Summary data from SEM and Image analyses on selected food fragments from Jarmo

Table 1. Summary table containing all data from the analysed food fragments from Çatalhöyük East

Flot Number	Unit Number	Level	Period	Area	Texture	Visible inclusions	Average Particle size (mm)	Avarage number of Particles	Wheat	Barley	Indet. Cereal	Pulses	Tuber	Wild Mustard	Other	Average void size (mm)	Percentage of voids	Type of Voids	Matrix type
192	1074	South L	Early	South	porous	seed	0.80	1			x				x	0.21	15%	Small closed voids	3
516	1442	North G	Middle	North	Very porous, hollow	none	0.00	0								0.500	35%	Closed voids	1
639	1835	South K	Early	South	porous	none	0.00	0								0.3	17%	small closed voids	3
1010	2346	South L	Early	South	Very porous, hollow	none	0.10	1			x					0.500	50%	Closed voids	1
1924	3600	South L	Early	South	porous	bran fragments	0.45	15	x							0.250	5%	small closed voids	3
2985	4917	South L	Middle	South	porous	none	0.12	1	x		x					0.300	20%	small closed voids	3
3099.1	4937	South L	Early	South	porous	grain fragment	1.20	1	x			x				0.100	10%	small closed voids	3
3099.2	4937	South L	Early	South	porous	seed	0.90	3	x					x		0.100	10%	small closed voids	3
3133	4866	South G	Early	South	porous	none	0.11	2			x					0.120	12%	Closed voids	3
3148	4869	South G	Early	South	porous	none	0.25	1	x		x					0.220	30%	Closed voids	3
3151	4869	South G	Early	South	porous	none	0.12	1		x						0.100	10%	Small closed voids and micropores	3
3666	5302	South G	Early	South	Very porous	none	0.51	1	x							0.200	35%	micropores	2
5826.1	10240	North J	Late	North	porous	none	0.65	4	x							0.100	10%	cracks and channel voids	4
5826.2	10240	North J	Late	North	porous	none	0.35	2	x							0.150	15%	micropores	2
5859	10081	North H	Late	North	Very porous, hollow	none	0.00	0	x							0.5	30%	Closed voids	1
5860	7948	North G	Middle	North	porous	none	0.25	4	x		x					0.025	10%	Closed voids	3
6577	13107	North I	Late	North	porous	grain fragment	0.50	3	x	x	x					0.100	15%	micropores and small closed voids	3
6939	13183	North I	Late	North	porous	Awn. Grain fragments.	1.00	3	x	x	x					0.150	8%	micropores and small closed voids	3
7196	14186	North I	Late	North	porous	none	0.30	1	x							0.100	10%	Closed voids	3
7205	14179	North I	Late	North	compact	grain fragments	0.65	4	x	x	x					0.100	20%	cracks and channel voids	4
7558.1	15724	South Q	Late	South	porous	none	0.35	2	x							0.350	30%	Closed voids	1
7558.2	15724	South Q	Late	South	porous	bran fragment	0.70	2	x							0.050	20%	micropores and small closed voids	3
7654	15749	South P	Late	South	porous	none	0.23	3	x	x						0.110	20%	micropores	2
7807	16224	South P	Late	South	porous	none	0.35	5	x		x					0.080	20%	small closed voids	3
7835	16246	South Q	Late	South	compact	grain fragments	0.95	5	x	x	x					0.300	15%	cracks and channel voids	4
7857	16279	South P	Late	South	Very porous	none	0.70	2	x		x					0.270	30%	micropores and small closed voids	2
7860.1	16507	South S	Late	South	porous	none	0.00	0	x		x					0.15	17%	small closed voids	3
7860.2	16507	South S	Late	South	compact	grain fragments	0.90	4	x		x					0.15	10%	cracks and channel voids	4
7880	16505	South P	Late	South	porous	none	0.20	4	x	x						0.100	10%	closed voids	3
7884	16518	South P	Late	South	very porous	none	0.65	2	x							0.450	40%	Closed voids	1
7937	14472	North G	Middle	North	very porous	none	0.40	3			x					0.100	30%	micropores	2
7947.1	14468	North G	Middle	North	compact	none	0.25	2		x						0.025	10%	micropores and cracks	3,4
7947.2	14468	North G	Middle	North	very porous	none	0.38	1	x							0.200	30%	closed voids	1
8000	16548	South P	Late	South	porous	none	0.25	2			x		x			0.17	16%	small closed voids	3
8006	14496	North G	Middle	North	porous	pulse fragment	0.55	1	x			x				0.1	15%	small closed voids	3
8017	16715	North G	Middle	North	compact	grain fragments	0.80	3	x		x					0.35	20%	cracks and channel voids	4
8019	16570	South P	Late	South	Very porous	grain fragments	0.65	3	x							0.11	30%	micropores	2
8061	16543	South P	Late	South	porous	none	0.50	1	x							0.14	10%	micropores and small closed voids	3
8123	16595	South P	Late	South	very porous	none	0.90	2	x							0.030	50%	micropores	2
8143	14469	North G	Middle	North	porous	grain fragment	0.82	2	x							0.15	15%	Closed voids	3
8161	17027	South R	Late	South	porous	none	1.20	3	x							0.08	35%	micropores	2
8183	17039	South R	Late	South	porous	none	0.30	1	x	x						0.25	13%	Closed voids	3
8340	17081	South Q	Late	South	porous	none	0.40	2	x	x	x					0.1	23%	Closed voids	3
8375	17308	South Q	Late	South	porous	none	0.48	1	x							0.100	12%	Closed voids	3
8456	16484	North G	Middle	North	porous	none	0.50	1			x					0.07	7%	micropores	3
8470	17339	South P	Late	South	porous	none	0.33	2	x		x					0.25	45%	Closed voids	1
8493	16493	North G	Middle	North	very porous	none	0.00	0								0.25	50%	closed voids	3
8641	17525	North G	Middle	North	porous	parenchyma	1.80	1					x			0.050	10%	cracks	4
8654	17527	North G	Middle	North	compact	grain fragments	0.65	8		x	x					0.15	8%	cracks and channel voids	4

8946	18511	South P	Late	South	porous	none	0.70	1	x	x						0.300	30%	Closed voids	1
8987	18441	South O	Middle	South	compact	ind fragments	1.20	2			x					0.300	5%	cracks and channel voids	4
8994	18565	South O	Middle	South	compact	none	0.20	2	x							0.150	10%	small closed voids	3
9016	18194	South P	Late	South	porous	parenchyma	0.15	1	x	x	x					0.030	30%	micropores	2
9018	18537	South P	Late	South	porous	none	0.40	3	x	x	x					0.180	10%	micropores	2
9027	18548	South P	Late	South	porous	none	0.40	2	x							0.100	20%	Closed voids	3
9047	18608	South P	Late	South	porous	none	0.33	4		x	x					0.100	10%	closed voids	3
9053	18609	South P	Late	South	Very porous, hollow	none	0.00	0								0.200	35%	Closed voids	1
9085.1	18616	South P/South O	Late	South	compact	none	0.00	0								0.300	22%	closed voids	3
9085.2	18616	South P/South O	Late	South	very porous	grain fragments	0.80	2	x							0.100	38%	micropores	2
9091.1	18489	South O	Middle	South	very porous	none	0.14	1				x				0.200	30%	Closed voids	1
9091.2	18489	South O	Middle	South	very porous	none	0.00	0			x					0.050	40%	micropores	2
9092	18465	South O	Middle	South	porous	none	0.60	4	x	x	x					0.200	35%	cracks and channel voids, closed voids	4
9229	19044	North G	Middle	North	porous	none	0.00	0								0.05	5%	micropores	3
9232.1	19115	South P	Late	South	porous	none	0.35	3	x		x					0.200	10%	small closed voids	3
9232.2	19115	South P	Late	South	porous	none	1.20	4		x	x					0.150	10%	Closed voids	3
9233	19114	South P	Late	South	porous	none	0.50	2		x	x					0.100	5%	closed voids	3
9258	18953	South O	Middle	South	porous	none	0.22	2			x					0.075	20%	micropores	2
9266	19128	South P	Late	South	porous	none	1.00	2		x			x			0.100	17%	closed voids	3
9395	19344	South N	Middle	South	porous	none	0.16	1	x		x					0.100	5%	closed voids	3
9405.1	19349	South N	Middle	South	porous	none	0.70	2			x					0.200	7%	Closed voids	3
9405.2	19349	South N	Middle	South	compact	pulse fragment	0.85	5	x			x				0.100	5%	cracks and channel voids	4
9518	19603	South O	Middle	South	Very porous	none	0.20	1			x					0.250	42%	closed voids	1
9520.1	19295	North G	Middle	North	porous	none	0.85	1			x					0.100	20%	closed voids	3
9520.2	19295	North G	Middle	North	porous	none	0.20	1			x					0.050	30%	micropores and small closed voids	2
9668	19243	South O	Middle	South	porous	none	0.35	3	x		x					0.150	20%	closed voids	3
9669.1	18782	South N	Middle	South	porous	none	0.90	1	x		x					0.200	15%	closed voids and cracks	3,4
9669.2	18782	South N	Middle	South	porous	none	0.21	2	x		x					0.150	15%	closed voids	3
9822	20140	TP U	Final-T	TPC	compact	grain fragments	1.10	6		x						0.100	15%	cracks and channel voids	4
9855	20149	TP U	Final-T	TPC	compact	grain fragments	0.75	5		x	x					0.1	15%	cracks and channel voids	4
9868	20154	TP U	Final-T	TPC	porous	grain fragments	0.75	4	x	x	x					0.025	12%	micropores, cracks and channel voids	4
9884	20428	North H	Late	North	compact	grain fragment	0.80	4		x						0.150	4%	cracks and channel voids	4
9924.1	20215	TP Q	Final	TPC	compact	grain fragments	0.70	2	x							0.100	11%	micropores and closed voids	3
9924.2	20215	TP Q	Final	TPC	compact	grain fragments	0.80	9	x		x					0.050	5%	cracks and channel voids	4
9954	20232	TP Q	Final	TPC	porous	none	0.20	2	x							0.150	20%	closed voids	3
10007	20507	TP Q	Final	TPC	porous	none	0.85	5	x		x					0.200	24%	closed voids	1
10009	20511	TP Q	Final	TPC	compact	grain fragment	0.70	7	x		x					0.1	10%	cracks and channel voids	4
10010	20249	TPC Post-Chalcolithic	Final-T	TPC	compact	grain fragments	0.50	10			x					0.110	5%	cracks	4
10012	20261	TPC Post-Chalcolithic	Final-T	TPC	compact	none	0.51	2			x					0.050	3%	micropores	3
10020	20255	TPC Neolithic	Final	TPC	compact	Vascular material	0.90	1			x					0.150	30%	small closed voids	2
10027	20187	TP W	Final-T	TPC	compact	grain fragments	0.90	3	x	x	x					0.200	15%	Closed voids	3
10028	20260	TP U	Final-T	TPC	compact	grain fragments	0.42	1	x	x	x					0.200	25%	cracks and channel voids	4
10043	20184	TP U	Final-T	TPC	compact	grain fragments	1.00	3			x					0.250	10%	cracks and channel voids	4
10051	20168	TP W	Final-T	TPC	compact	grain fragments	0.60	3	x	x	x					0.100	16%	Closed voids	3
10054	20254	TP N	Late	TPC	compact	grain fragments	1.10	2	x		x					0.210	10%	cracks and channel voids	4
10055	20168	TP W	Final-T	TPC	compact	grain fragments	0.16	2		x	x					0.150	20%	closed voids	3
10074	20189	TP U	Final-T	TPC	compact	grain fragments	0.56	3	x		x					0.15	15%	closed voids	3
10079	20192	TP U	Final-T	TPC	compact	grain fragments	0.82	3	x	x	x					0.1	10%	cracks	4
10255	20488	North G	Middle	North	porous	none	0.80	2	x							0.2	15%	closed voids	3
10260	19570	North G	Middle	North	porous	none	0.00	0								0.2	6%	closed voids	3

10342.1	20625	North G	Middle	North	porous	none	0.80	1	x							0.2	20%	small closed voids	3
10342.2	20625	North G	Middle	North	compact	grain fragment	0.80	3	x		x					0.1	5%	cracks and channel voids	4
10521	20961	North G	Middle	North	compact	grain fragments	0.50	2	x		x					0.250	20%	closed voids and cracks	3,4
10526	30288	TPC Post-Chalcolithic	Final-T	TPC	compact	grain fragments	1.00	3	x	x						0.200	5%	cracks and channel voids	4
10543	30274	TP U	Final-T	TPC	compact	none	0.20	2			x					0.2	15%	closed voids and cracks	3
10553	20686	North G	Middle	North	porous	none	0.20	1	x	x						0.025	5%	micropores	3
10563	30285	TPC Post-Chalcolithic	Final-T	TPC	compact	none	0.85	3			x					0.1	10%	micropores	3
10570	30271	TP Q	Final-T	TPC	porous	none	0.00	0								0.1	10%	closed voids	3
10600	20988	North F	Middle	North	Very porous	none	0.00	0								0.350	35%	closed voids	1
10622	30547	North F	Middle	North	compact	pulse fragments	0.70	3	x			x				0.150	7%	cracks and channel voids	4
10634	20989	North G	Middle	North	porous	none	0.45	1	x		x					0.100	7%	cracks	4
10661	30738	TP M	Late	TPC	compact	grain fragments	0.95	6	x							0.26	10%	cracks and channel voids	4
10662	30614	South H	Early	South	compact	none	0.30	1								0.1	7%	cracks and channel voids	4
10664	30615	South H	Early	South	porous	none	0.60	2	x				x			0.15	6%	cracks and channel voids	4
10675	30745	TPC Post-Chalcolithic	Final-T	TPC	compact	none	0.93	7	x							0.13	12%	cracks and channel voids	4
10679	19379	South M	Middle	South	porous	none	0.52	2	x							0.15	8%	closed voids	3
10681	30747	TP N	Late	TPC	Very porous	none	1.00	1	x							0.25	30%	closed voids	1
10691	19879	South N	Middle	South	very porous	none	0.85	1			x					0.050	30%	micropores	2
10720	30757	TP M	Late	TPC	compact	grain fragments	0.60	2	x		x					0.1	10%	cracks	4
10721	30761	TP M	Late	TPC	compact	grain fragments	0.85	5	x		x					0.2	12%	cracks and channel voids	4
10742	30778	TP M	Late	TPC	porous	grain fragments	0.72	4		x	x					0.21	20%	closed voids	3
10769	30561	North G	Middle	North	porous	none	0.50	1	x		x					0.150	17%	Small closed voids and micropores	3
10770	30503	North G	Middle	North	porous	none	0.25	2			x	x				0.15	13%	closed voids	3
10779	30626	South H	Early	South	porous	none	0.60	1			x					0.1	25%	closed voids	3
10798	30106	North F	Middle	North	porous	none	0.33	5	x		x	x				0.150	15%	closed voids	3
10803	30732	TP R	Final-T	TPC	very porous	grain fragment	1.15	2	x							0.2	25%	closed voids	1
10804	30806	TP M	Late	TPC	porous	none	0.32	3	x		x					0.1	15%	closed voids	3
10967	30870	TPC Neolithic	Final	TPC	compact	grain fragments	1.80	3		x	x					0.1	10%	cracks and channel voids	4
11129	21117	North G	Middle	North	porous	none	0.30	2	x		x					0.16	25%	closed voids	3
11130	21108	North G	Middle	North	porous	bran fragment	0.36	1	x							0.18	25%	closed voids	3
11137	21109	North G	Middle	North	compact	pulse fragments	0.65	5		x	x	x				0.100	8%	cracks	4
11162	21140	North G	Middle	North	compact	none	0.30	1	x							0.1	15%	closed voids	3
11177	30436	TP W	Final-T	TPC	porous	none	1.30	4		x						0.2	30%	closed voids	3
11235	30364	South L	Early	South	porous	pulse	0.60	4	x			x				0.19	11%	closed voids	3
11239	22032	North G	Middle	North	compact	pulse fragments	0.97	6	x			x				0.5	5%	Channel voids	4
11240	21170	North G	Middle	North	compact	parenchyma	0.60	7	x			x				0.05	13%	Channel voids	4
11723	21061	TP U	Final-T	TPC	porous	none	0.86	3	x							0.15	20%	closed voids	3
11747	21645	North G	Middle	North	porous	none	0.30	1			x					0.8	50%	closed voids	1
11750	21659	North G	Middle	North	very porous	none	0.22	1	x							0.15	40%	closed voids	3
11799	21661	North G	Middle	North	very porous	none	0.20	1	x		x					0.05	40%	micropores	2
11822	21089	TP U	Final-T	TPC	compact	grain fragments	0.75	5	x							0.14	17%	cracks and channel voids	4
11832	21095	TP M	Late	TPC	compact	grain fragments	0.84	4	x	x						0.18	27%	closed voids	3
11860	21051	TP U	Final-T	TPC	porous	none	1.00	3			x					0.1	5%	Channel voids	4
11922	22709	TP M	Late	TPC	compact	grain fragments	0.88	4	x		x					0.1	10%	cracks and Channel voids	4
12021	22764	TP M	Late	TPC	very porous	none	0.00	0	x		x					0.25	27%	closed voids	1
12054	21964	South N	Middle	South	compact	bran and grain fragments	0.80	4	x							0.1	15%	cracks and channel voids	4
12155.1	22834	TP N	Late	GDN	very porous	none	0.30	2			x					0.1	15%	closed voids	3
12155.2	22834	TP N	Late	GDN	compact	grain fragments	1.00	2	x							0.1	10%	cracks and channel voids	4
12267	31353	TP M	Late	TPC	very porous	none	0.00	0								0.5	30%	closed voids	1
12278.1	22850	TP N	Late	GDN	Very porous	none	0.80	1	x							0.25	25%	closed voids	1

12278.2	22850	TP N	Late	GDN	compact	grain fragments	0.80	4		x	x					0.1	10%	cracks and channel voids	4
12405	21038	TP M	Late	TPC	porous	bran fragments	0.75	3	x							0.15	15%	closed voids	3
12982	20761	TP M	Late	TPC	compact	grains and bran fragments	0.60	10	x							0.05	5%	cracks and channel voids	4
13012	30888	TP M	Late	TPC	porous	none	0.50	5	x							0.05	15%	micropores and small closed voids	3
13017	20798	TP M	Late	TPC	very porous	none	0.70	2	x							0.3	30%	closed voids	1
13255	23216	South I	Early	South	porous	none	0.25	3	x		x					0.05	10%	micropores and small closed voids	3
13511	31894	TP M	Late	TPC	compact	grain fragments	1.10	2	x							0.07	10%	cracks and channel voids	4
13596.1	20766	TP M	Late	TPC	compact	grain fragments	1.00	3			x					0.05	10%	cracks and channel voids	4
13596.2	20766	TP M	Late	TPC	very porous	none	0.55	3	x							0.1	20%	micropores and small closed voids	3
13607	23700	TP M	Late	TPC	porous	none	0.70	3	x							0.15	10%	closed voids	3
13617	23717	TP N	Late	TPC	compact	bran	0.80	1	x							0.08	5%	cracks and channel voids	4
13717.1	23778	TP M	Late	TPC	compact	none	0.60	2			x					0.1	12%	cracks and channel voids	4
13717.2	23778	TP M	Late	TPC	compact	grain fragments	0.80	4	x							0.05	10%	cracks and channel voids	4
13850	32803	TP M	Late	TPC	very porous	none	0.00	0								0.3	30%	closed voids	1
13882	23993	TP M	Late	TPC	very porous	none	0.00	0								0.15	25%	micropores and small closed voids	2,3

Table 2. Summary table containing all data from the analysed food fragments from Jarmo

Flot Number	Context	Trench	Area	Level	Phase	Texture	Visible inclusions	Average Particle size (mm)	Avarage number of Particles	Wheat	Barley	Indet. Cereal	Pulses	Average void size (mm)	Percentage of voids	Type of Voids	Matrix type
159	22	QR14-15	JCM	ca.7300-6800 cal. BC	Phase 2	Very porous, hollow	none	0.00	0					0.12	30%	Closed voids	A
160.1	11	M14-15	JCB	ca.6800-6500 cal. BC	Phase 3	porous	none	0.20	1			x		0.17	15%	small closed voids	C
160.2	11	M14-15	JCB	ca.6800-6500 cal. BC	Phase 3	porous	aleurone	0.40	1			x		0.25	10%	small closed voids	C
184.1	20	QR14-15	JCM	ca.7300-6800 cal. BC	Phase 2	porous	none	0.00	0					0.25	20%	Closed voids	C
184.2	20	QR14-15	JCM	ca.7300-6800 cal. BC	Phase 2	compact	none	0.00	0					0.10	20%	Closed voids	C
144.1	18	QR14-15	JCM	ca.7300-6800 cal. BC	Phase 2	porous	vascular material	0.50	1					0.15	20%	Closed voids	C
144.2	18	QR14-15	JCM	ca.7300-6800 cal. BC	Phase 2	porous	bran	0.40	4	x		x		0.05	15%	small closed voids, micropores	C
144.3	18	QR14-15	JCM	ca.7300-6800 cal. BC	Phase 2	compact	grain fragments	1.40	2					0.20	10%	cracks and channel voids	D
144.4	18	QR14-15	JCM	ca.7300-6800 cal. BC	Phase 2	compact	vascular material	0.00	0					0.12	10%	cracks and channel voids	D
17.1	6	MN14	JCB	ca.7300-6800 cal. BC	Phase 2	porous	none	0.45	1			x		0.10	12%	micropores	C
180.1	22	QR14-15	JCM	ca.7300-6800 cal. BC	Phase 2	porous	none	0.00	0					0.20	17%	Closed voids	C
180.2	22	QR14-15	JCM	ca.7300-6800 cal. BC	Phase 2	porous	none	0.00	0					0.10	10%	Closed voids	C
64.1	5	F4-5	JW	ca.6500-6000 cal. BC	Phase 4	compact	grain fragments	0.80	10			x		0.05	5%	cracks and channel voids	D
64.2	5	F4-5	JW	ca.6500-6000 cal. BC	Phase 4	compact	none	0.90	1	x				0.10	10%	micropores	C
175.1	10	E4	JW	ca. 8000?-7300 cal. BC	Phase 1	porous	none	0.38	1	x	x			0.10	17%	Closed voids	C
175.2	10	E4	JW	ca. 8000?-7300 cal. BC	Phase 1	porous	none	0.00	0					0.15	15%	Closed voids	C
148	11	QR14-15	JCM	ca.6800-6500 cal. BC	Phase 3	porous	none	0.00	0			x		0.05	15%	Closed voids	C
150	20	QR14-15	JCM	ca.7300-6800 cal. BC	Phase 2	Very porous	none	0.00	0					0.15	40%	micropores	B
152.1	21	QR14-15	JCM	ca.7300-6800 cal. BC	Phase 2	porous	bran fragments	0.45	11	x				0.05	25%	Closed voids	C
152.2	21	QR14-15	JCM	ca.7300-6800 cal. BC	Phase 2	porous	bran fragments	0.30	2	x				0.15	25%	Closed voids	C
155	5	EF4	JW	ca. 8000?-7300 cal. BC	Phase 1	compact	bran	0.55	1		x			0.10	4%	micropores	?
178	15	QR14-15	JCM	ca.6800-6500 cal. BC	Phase 3	compact	grain fragments	0.30	1	x				0.03	7%	cracks and channel voids	D
24.1	9	MN14	JCB	ca.7300-6800 cal. BC	Phase 2	porous	aleurone	0.55	2	x				0.05	12%	Closed voids	C
24.2	9	MN14	JCB	ca.7300-6800 cal. BC	Phase 2	porous	bran	0.60	2	x				0.05	17%	Closed voids	C
32	10	QR14	JCM	ca.6800-6500 cal. BC	Phase 3	compact	none	0.70	2	x			x	0.05	7%	cracks and channel voids	D
28	9	QR14	JCM	ca.6800-6500 cal. BC	Phase 3	compact	pulse fragments	0.40	1				x	0.03	3%	cracks and channel voids	D
6	3	MN14	JCB	ca.6800-6500 cal. BC	Phase 3	porous	none	0.00	0					0.10	10%	Closed voids	C
27	8	QR14	JCM	ca.6800-6500 cal. BC	Phase 3	porous	none	0.00	0					0.10	7%	Closed voids	C

Appendix III:

Çatalhöyük East

Jarmo

Table 1. List of particle size values by excavation area at Çatalhöyük East

Flot Number	Area	Average Particle size (mm)	Avarage number of Particles
9822	TPC	1.10	6
9855	TPC	0.75	5
9868	TPC	0.75	4
9924.1	TPC	0.70	2
9924.2	TPC	0.80	9
9954	TPC	0.20	2
10007	TPC	0.85	5
10009	TPC	0.70	7
10010	TPC	0.50	10
10012	TPC	0.51	2
10020	TPC	0.90	1
10027	TPC	0.90	3
10028	TPC	0.42	1
10043	TPC	1.00	3
10051	TPC	0.60	3
10054	TPC	1.10	2
10055	TPC	0.16	2
10074	TPC	0.56	3
10079	TPC	0.82	3
10526	TPC	1.00	3
10543	TPC	0.20	2
10563	TPC	0.85	3
10570	TPC	0.00	0
10661	TPC	0.95	6
10675	TPC	0.93	7
10681	TPC	1.00	1
10720	TPC	0.60	2
10721	TPC	0.85	5
10742	TPC	0.72	4
10803	TPC	1.15	2
10804	TPC	0.32	3
10967	TPC	1.80	3
11177	TPC	1.30	4
11723	TPC	0.86	3
11822	TPC	0.75	5
11832	TPC	0.84	4
11860	TPC	1.00	3
11922	TPC	0.88	4
12021	TPC	0.00	0
12267	TPC	0.00	0
12405	TPC	0.75	3

12982	TPC	0.60	10
13012	TPC	0.50	5
13017	TPC	0.70	2
13511	TPC	1.10	2
13596.1	TPC	1.00	3
13596.2	TPC	0.55	3
13607	TPC	0.70	3
13617	TPC	0.80	1
13717.1	TPC	0.60	2
13717.2	TPC	0.80	4
13850	TPC	0.00	0
13882	TPC	0.00	0
192	South	0.80	1
639	South	0.00	0
1010	South	0.10	1
1924	South	0.45	15
2985	South	0.12	1
3099.1	South	1.20	1
3099.2	South	0.90	3
3133	South	0.11	2
3148	South	0.25	1
3151	South	0.12	1
3666	South	0.51	1
7558.1	South	0.35	2
7558.2	South	0.70	2
7654	South	0.23	3
7807	South	0.35	5
7835	South	0.95	5
7857	South	0.70	2
7860.1	South	0.00	0
7860.2	South	0.90	4
7880	South	0.20	4
7884	South	0.65	2
8000	South	0.25	2
8019	South	0.65	3
8061	South	0.50	1
8123	South	0.90	2
8161	South	1.20	3
8183	South	0.30	1
8340	South	0.40	2
8375	South	0.48	1
8470	South	0.33	2
8946	South	0.70	1
8987	South	1.20	2

8994	South	0.20	2
9016	South	0.15	1
9018	South	0.40	3
9027	South	0.40	2
9047	South	0.33	4
9053	South	0.00	0
9085.1	South	0.00	0
9085.2	South	0.80	2
9091.1	South	0.14	1
9091.2	South	0.00	0
9092	South	0.60	4
9232.1	South	0.35	3
9232.2	South	1.20	4
9233	South	0.50	2
9258	South	0.22	2
9266	South	1.00	2
9395	South	0.16	1
9405.1	South	0.70	2
9405.2	South	0.85	5
9518	South	0.20	1
9668	South	0.35	3
9669.1	South	0.90	1
9669.2	South	0.21	2
10662	South	0.30	1
10664	South	0.60	2
10679	South	0.52	2
10691	South	0.85	1
10779	South	0.60	1
11235	South	0.60	4
12054	South	0.80	4
13255	South	0.25	3
516	North	0.00	0
5826.1	North	0.65	4
5826.2	North	0.35	2
5859	North	0.00	0
5860	North	0.25	4
6577	North	0.50	3
6939	North	1.00	3
7196	North	0.30	1
7205	North	0.65	4
7937	North	0.40	3
7947.1	North	0.25	2
7947.2	North	0.38	1
8006	North	0.55	1

8017	North	0.80	3
8143	North	0.82	2
8456	North	0.50	1
8493	North	0.00	0
8641	North	1.80	1
8654	North	0.65	8
9229	North	0.00	0
9520.1	North	0.85	1
9520.2	North	0.20	1
9884	North	0.80	4
10255	North	0.80	2
10260	North	0.00	0
10342.1	North	0.80	1
10342.2	North	0.80	3
10521	North	0.50	2
10553	North	0.20	1
10600	North	0.00	0
10622	North	0.70	3
10634	North	0.45	1
10769	North	0.50	1
10770	North	0.25	2
10798	North	0.33	5
11129	North	0.30	2
11130	North	0.36	1
11137	North	0.65	5
11162	North	0.30	1
11239	North	0.97	6
11240	North	0.60	7
11747	North	0.30	1
11750	North	0.22	1
11799	North	0.20	1
12155.1	GDN	0.30	2
12155.2	GDN	1.00	2
12278.1	GDN	0.80	1
12278.2	GDN	0.80	4

Chart 1: Scatter plot showing distribution of particle size by excavation area at Çatalhöyük

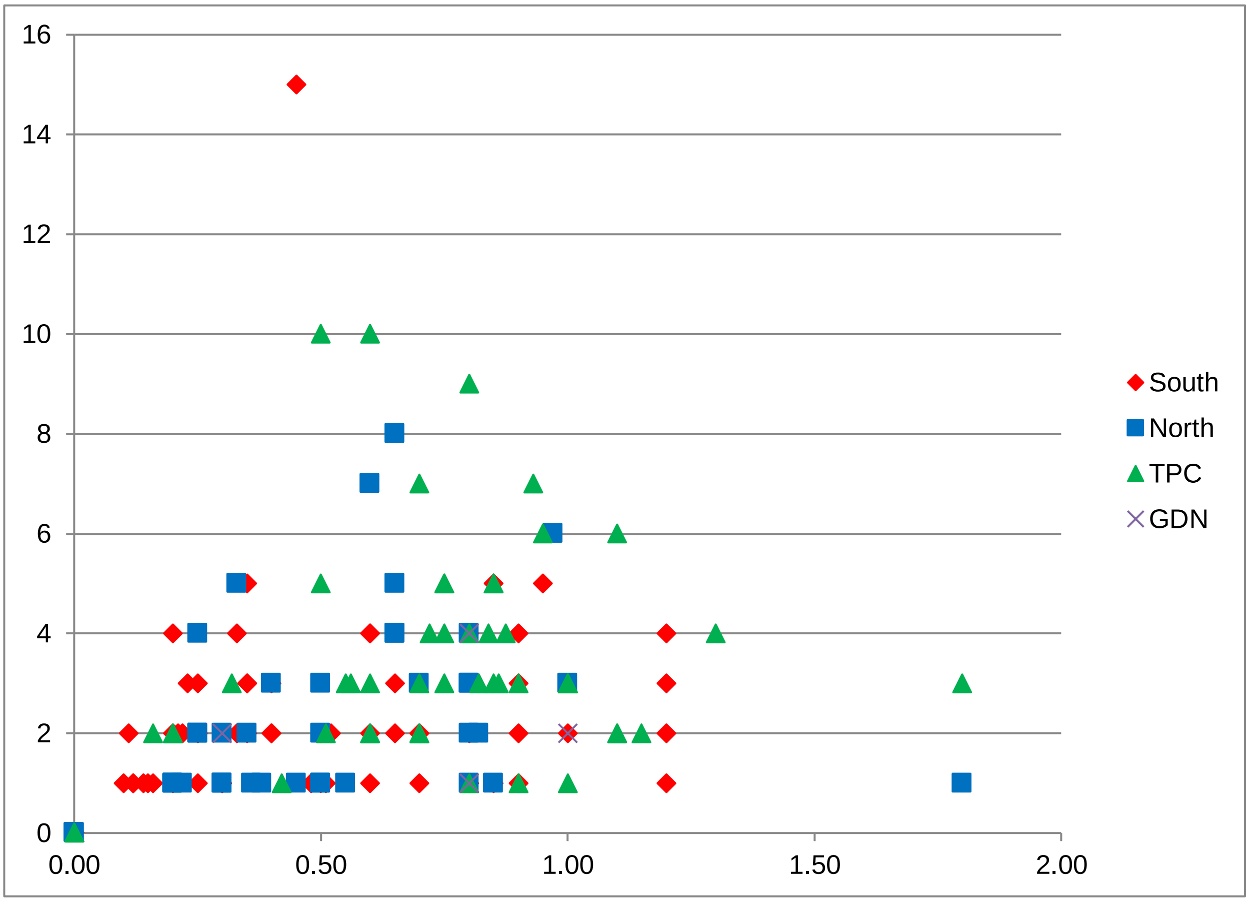


Table 2. List of particle size values by occupation phase at Çatalhöyük

Flot Number	Period	Average Particle size (mm)	Avarage number of Particles
192	Early	0.80	1
639	Early	0.00	0
1010	Early	0.10	1
1924	Early	0.45	15
3099.1	Early	1.20	1
3099.2	Early	0.90	3
3133	Early	0.11	2
3148	Early	0.25	1
3151	Early	0.12	1
3666	Early	0.51	1
10662	Early	0.30	1
10664	Early	0.60	2
10779	Early	0.60	1
11235	Early	0.60	4
13255	Early	0.25	3
516	Middle	0.00	0
2985	Middle	0.12	1
5860	Middle	0.25	4
7937	Middle	0.40	3
7947.1	Middle	0.25	2
7947.2	Middle	0.38	1
8006	Middle	0.55	1
8017	Middle	0.80	3
8143	Middle	0.82	2
8456	Middle	0.50	1
8493	Middle	0.00	0
8641	Middle	1.80	1
8654	Middle	0.65	8
8987	Middle	1.20	2
8994	Middle	0.20	2
9091.1	Middle	0.14	1
9091.2	Middle	0.00	0
9092	Middle	0.60	4
9229	Middle	0.00	0
9258	Middle	0.22	2
9395	Middle	0.16	1
9405.1	Middle	0.70	2
9405.2	Middle	0.85	5
9518	Middle	0.20	1
9520.1	Middle	0.85	1
9520.2	Middle	0.20	1

9668	Middle	0.35	3
9669.1	Middle	0.90	1
9669.2	Middle	0.21	2
10255	Middle	0.80	2
10260	Middle	0.00	0
10342.1	Middle	0.80	1
10342.2	Middle	0.80	3
10521	Middle	0.50	2
10553	Middle	0.20	1
10600	Middle	0.00	0
10622	Middle	0.70	3
10634	Middle	0.45	1
10679	Middle	0.52	2
10691	Middle	0.85	1
10769	Middle	0.50	1
10770	Middle	0.25	2
10798	Middle	0.33	5
11129	Middle	0.30	2
11130	Middle	0.36	1
11137	Middle	0.65	5
11162	Middle	0.30	1
11239	Middle	0.97	6
11240	Middle	0.60	7
11747	Middle	0.30	1
11750	Middle	0.22	1
11799	Middle	0.20	1
12054	Middle	0.80	4
5826.1	Late	0.65	4
5826.2	Late	0.35	2
5859	Late	0.00	0
6577	Late	0.50	3
6939	Late	1.00	3
7196	Late	0.30	1
7205	Late	0.65	4
7558.1	Late	0.35	2
7558.2	Late	0.70	2
7654	Late	0.23	3
7807	Late	0.35	5
7835	Late	0.95	5
7857	Late	0.70	2
7860.1	Late	0.00	0
7860.2	Late	0.90	4
7880	Late	0.20	4
7884	Late	0.65	2

8000	Late	0.25	2
8019	Late	0.65	3
8061	Late	0.50	1
8123	Late	0.90	2
8161	Late	1.20	3
8183	Late	0.30	1
8340	Late	0.40	2
8375	Late	0.48	1
8470	Late	0.33	2
8946	Late	0.70	1
9016	Late	0.15	1
9018	Late	0.40	3
9027	Late	0.40	2
9047	Late	0.33	4
9053	Late	0.00	0
9085.1	Late	0.00	0
9085.2	Late	0.80	2
9232.1	Late	0.35	3
9232.2	Late	1.20	4
9233	Late	0.50	2
9266	Late	1.00	2
9884	Late	0.80	4
10054	Late	1.10	2
10661	Late	0.95	6
10681	Late	1.00	1
10720	Late	0.60	2
10721	Late	0.85	5
10742	Late	0.72	4
10804	Late	0.32	3
11832	Late	0.84	4
11922	Late	0.88	4
12021	Late	0.00	0
12155.1	Late	0.30	2
12155.2	Late	1.00	2
12267	Late	0.00	0
12278.1	Late	0.80	1
12278.2	Late	0.80	4
12405	Late	0.75	3
12982	Late	0.60	10
13012	Late	0.50	5
13017	Late	0.70	2
13511	Late	1.10	2
13596.1	Late	1.00	3
13596.2	Late	0.55	3

13607	Late	0.70	3
13617	Late	0.80	1
13717.1	Late	0.60	2
13717.2	Late	0.80	4
13850	Late	0.00	0
13882	Late	0.00	0
9924.1	Final	0.70	2
9924.2	Final	0.80	9
9954	Final	0.20	2
10007	Final	0.85	5
10009	Final	0.70	7
10020	Final	0.90	1
10967	Final	1.80	3
9822	Final-T	1.10	6
9855	Final-T	0.75	5
9868	Final-T	0.75	4
10010	Final-T	0.50	10
10012	Final-T	0.51	2
10027	Final-T	0.90	3
10028	Final-T	0.42	1
10043	Final-T	1.00	3
10051	Final-T	0.60	3
10055	Final-T	0.16	2
10074	Final-T	0.56	3
10079	Final-T	0.82	3
10526	Final-T	1.00	3
10543	Final-T	0.20	2
10563	Final-T	0.85	3
10570	Final-T	0.00	0
10675	Final-T	0.93	7
10803	Final-T	1.15	2
11177	Final-T	1.30	4
11723	Final-T	0.86	3
11822	Final-T	0.75	5
11860	Final-T	1.00	3

Chart 2: Scatter plot showing distribution of particle size by occupation phase at Çatalhöyük

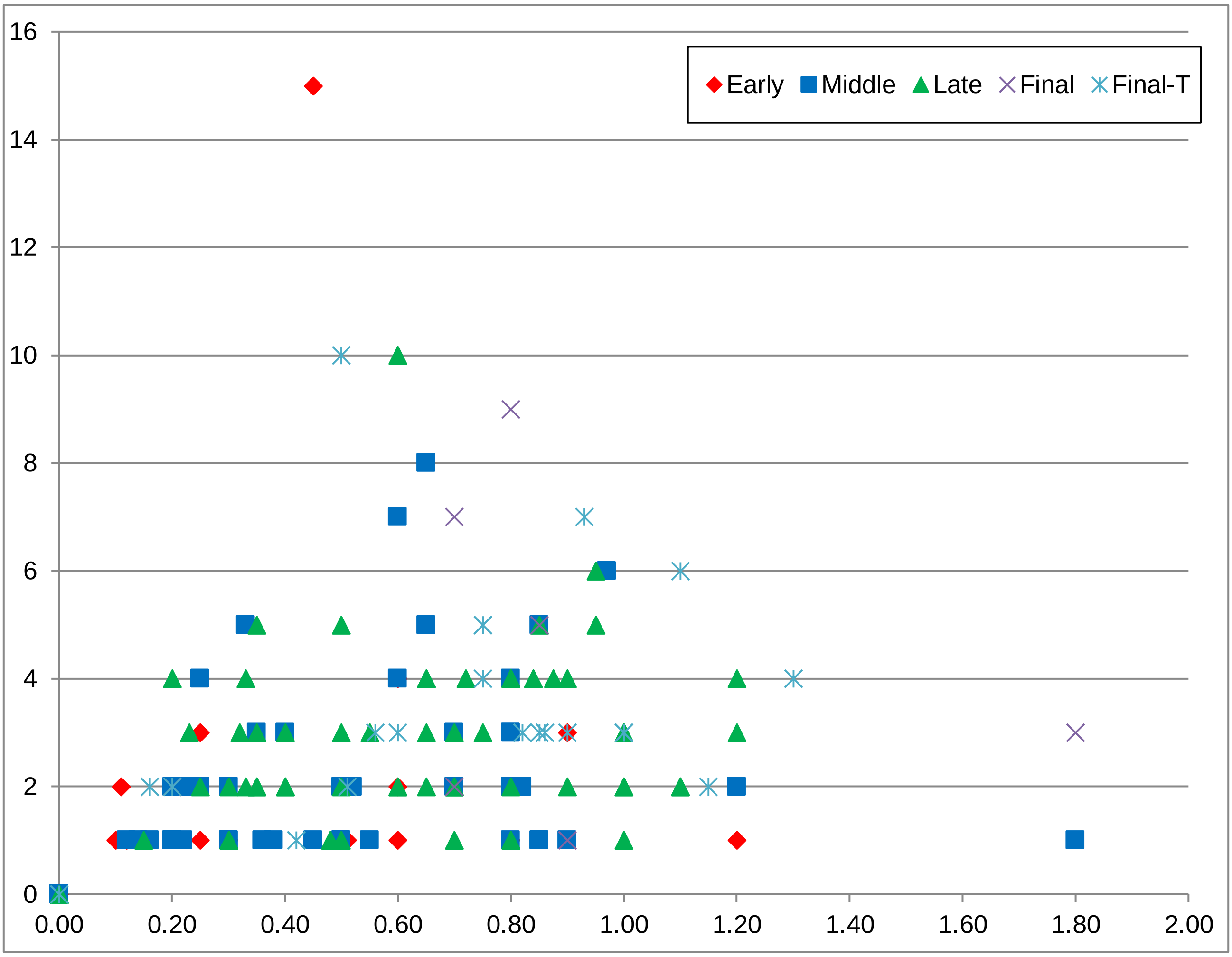


Table 3. List of particle size values by food matrix type at Çatalhöyük East

Flot Number	**Matrix type**	**Average Particle size (mm)**	**Avarage number of Particles**
516	1	0.00	0
1010	1	0.10	1
5859	1	0.00	0
7558.1	1	0.35	2
7884	1	0.65	2
7947.2	1	0.38	1
8470	1	0.33	2
8946	1	0.70	1
9053	1	0.00	0
9091.1	1	0.14	1
9518	1	0.20	1
10007	1	0.85	5
10600	1	0.00	0
10681	1	1.00	1
10803	1	1.15	2
11747	1	0.30	1
12021	1	0.00	0
12267	1	0.00	0
12278.1	1	0.80	1
13017	1	0.70	2
13850	1	0.00	0
3666	2	0.51	1
5826.2	2	0.35	2
7654	2	0.23	3
7857	2	0.70	2
7937	2	0.40	3
8019	2	0.65	3
8123	2	0.90	2
8161	2	1.20	3
9016	2	0.15	1
9018	2	0.40	3
9085.2	2	0.80	2
9091.2	2	0.00	0
9258	2	0.22	2
9520.2	2	0.20	1
10020	2	0.90	1
10691	2	0.85	1
11799	2	0.20	1
192	3	0.80	1
639	3	0.00	0
1924	3	0.45	15
2985	3	0.12	1
3099.1	3	1.20	1

3099.2	3	0.90	3
3133	3	0.11	2
3148	3	0.25	1
3151	3	0.12	1
5860	3	0.25	4
6577	3	0.50	3
6939	3	1.00	3
7196	3	0.30	1
7558.2	3	0.70	2
7807	3	0.35	5
7860.1	3	0.00	0
7880	3	0.20	4
8000	3	0.25	2
8006	3	0.55	1
8061	3	0.50	1
8143	3	0.82	2
8183	3	0.30	1
8340	3	0.40	2
8375	3	0.48	1
8456	3	0.50	1
8493	3	0.00	0
8994	3	0.20	2
9027	3	0.40	2
9047	3	0.33	4
9085.1	3	0.00	0
9229	3	0.00	0
9232.1	3	0.35	3
9232.2	3	1.20	4
9233	3	0.50	2
9266	3	1.00	2
9395	3	0.16	1
9405.1	3	0.70	2
9520.1	3	0.85	1
9668	3	0.35	3
9669.2	3	0.21	2
9924.1	3	0.70	2
9954	3	0.20	2
10012	3	0.51	2
10027	3	0.90	3
10051	3	0.60	3
10055	3	0.16	2
10074	3	0.56	3
10255	3	0.80	2
10260	3	0.00	0
10342.1	3	0.80	1
10543	3	0.20	2
10553	3	0.20	1

10563	3	0.85	3
10570	3	0.00	0
10679	3	0.52	2
10742	3	0.72	4
10769	3	0.50	1
10770	3	0.25	2
10779	3	0.60	1
10798	3	0.33	5
10804	3	0.32	3
11129	3	0.30	2
11130	3	0.36	1
11162	3	0.30	1
11177	3	1.30	4
11235	3	0.60	4
11723	3	0.86	3
11750	3	0.22	1
11832	3	0.84	4
12155.1	3	0.30	2
12405	3	0.75	3
13012	3	0.50	5
13255	3	0.25	3
13596.2	3	0.55	3
13607	3	0.70	3
5826.1	4	0.65	4
7205	4	0.65	4
7835	4	0.95	5
7860.2	4	0.90	4
8017	4	0.80	3
8641	4	1.80	1
8654	4	0.65	8
8987	4	1.20	2
9092	4	0.60	4
9405.2	4	0.85	5
9822	4	1.10	6
9855	4	0.75	5
9868	4	0.75	4
9884	4	0.80	4
9924.2	4	0.80	9
10009	4	0.70	7
10010	4	0.50	10
10028	4	0.42	1
10043	4	1.00	3
10054	4	1.10	2
10079	4	0.82	3
10342.2	4	0.80	3
10526	4	1.00	3
10622	4	0.70	3

10634	4	0.45	1
10661	4	0.95	6
10662	4	0.30	1
10664	4	0.60	2
10675	4	0.93	7
10720	4	0.60	2
10721	4	0.85	5
10967	4	1.80	3
11137	4	0.65	5
11239	4	0.97	6
11240	4	0.60	7
11822	4	0.75	5
11860	4	1.00	3
11922	4	0.88	4
12054	4	0.80	4
12155.2	4	1.00	2
12278.2	4	0.80	4
12982	4	0.60	10
13511	4	1.10	2
13596.1	4	1.00	3
13617	4	0.80	1
13717.1	4	0.60	2
13717.2	4	0.80	4

Chart 3. Scatter plot showing distribution of particle size by food matrix type from Çatalhöyük

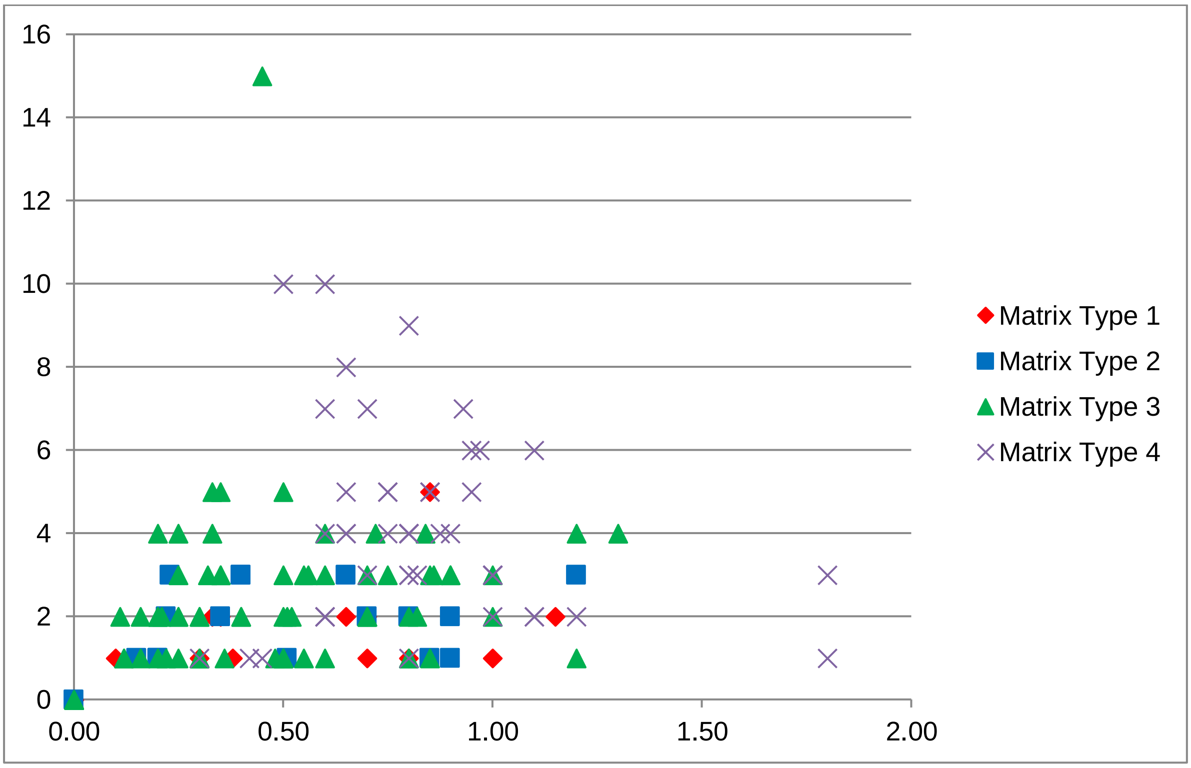


Table 4. List of particle size values by level at Çatalhöyük East

Flot Number	Level	Average Particle size (mm)	Avarage number of Particles (mm)
10010	TPC Post-Chalcolithic	0.50	10
10012	TPC Post-Chalcolithic	0.51	2
10526	TPC Post-Chalcolithic	1.00	3
10563	TPC Post-Chalcolithic	0.85	3
10675	TPC Post-Chalcolithic	0.93	7
10020	TPC Neolithic	0.90	1
10967	TPC Neolithic	1.80	3
10027	TP W	0.90	3
10051	TP W	0.60	3
10055	TP W	0.16	2
11177	TP W	1.30	4
9822	TP U	1.10	6
9855	TP U	0.75	5
9868	TP U	0.75	4
10028	TP U	0.42	1
10043	TP U	1.00	3
10074	TP U	0.56	3
10079	TP U	0.82	3
10543	TP U	0.20	2
11723	TP U	0.86	3
11822	TP U	0.75	5
11860	TP U	1.00	3
10803	TP R	1.15	2
9924.1	TP Q	0.70	2
9924.2	TP Q	0.80	9
9954	TP Q	0.20	2
10007	TP Q	0.85	5
10009	TP Q	0.70	7
10570	TP Q	0.00	0
10054	TP N	1.10	2
10681	TP N	1.00	1
12155.1	TP N	0.30	2
12155.2	TP N	1.00	2
12278.1	TP N	0.80	1

12278.2	TP N	0.80	4
13617	TP N	0.80	1
10661	TP M	0.95	6
10720	TP M	0.60	2
10721	TP M	0.85	5
10742	TP M	0.72	4
10804	TP M	0.32	3
11832	TP M	0.84	4
11922	TP M	0.88	4
12021	TP M	0.00	0
12267	TP M	0.00	0
12405	TP M	0.75	3
12982	TP M	0.60	10
13012	TP M	0.50	5
13017	TP M	0.70	2
13511	TP M	1.10	2
13596.1	TP M	1.00	3
13596.2	TP M	0.55	3
13607	TP M	0.70	3
13717.1	TP M	0.60	2
13717.2	TP M	0.80	4
13850	TP M	0.00	0
13882	TP M	0.00	0
7860.1	South S	0.00	0
7860.2	South S	0.90	4
8161	South R	1.20	3
8183	South R	0.30	1
7558.1	South Q	0.35	2
7558.2	South Q	0.70	2
7835	South Q	0.95	5
8340	South Q	0.40	2
8375	South Q	0.48	1
9085.1	South P/South O	0.00	0
9085.2	South P/South O	0.80	2
7654	South P	0.23	3
7807	South P	0.35	5
7857	South P	0.70	2
7880	South P	0.20	4
7884	South P	0.65	2
8000	South P	0.25	2
8019	South P	0.65	3
8061	South P	0.50	1
8123	South P	0.90	2

8470	South P	0.33	2
8946	South P	0.70	1
9016	South P	0.15	1
9018	South P	0.40	3
9027	South P	0.40	2
9047	South P	0.33	4
9053	South P	0.00	0
9232.1	South P	0.35	3
9232.2	South P	1.20	4
9233	South P	0.50	2
9266	South P	1.00	2
8987	South O	1.20	2
8994	South O	0.20	2
9091.1	South O	0.14	1
9091.2	South O	0.00	0
9092	South O	0.60	4
9258	South O	0.22	2
9518	South O	0.20	1
9668	South O	0.35	3
9395	South N	0.16	1
9405.1	South N	0.70	2
9405.2	South N	0.85	5
9669.1	South N	0.90	1
9669.2	South N	0.21	2
10691	South N	0.85	1
12054	South N	0.80	4
10679	South M	0.52	2
192	South L	0.80	1
1010	South L	0.10	1
1924	South L	0.45	15
2985	South L	0.12	1
3099.1	South L	1.20	1
3099.2	South L	0.90	3
11235	South L	0.60	4
639	South K	0.00	0
13255	South I	0.25	3
10662	South H	0.30	1
10664	South H	0.60	2
10779	South H	0.60	1
3133	South G	0.11	2
3148	South G	0.25	1
3151	South G	0.12	1
3666	South G	0.51	1
5826.1	North J	0.65	4

5826.2	North J	0.35	2
6577	North I	0.50	3
6939	North I	1.00	3
7196	North I	0.30	1
7205	North I	0.65	4
5859	North H	0.00	0
9884	North H	0.80	4
516	North G	0.00	0
5860	North G	0.25	4
7937	North G	0.40	3
7947.1	North G	0.25	2
7947.2	North G	0.38	1
8006	North G	0.55	1
8017	North G	0.80	3
8143	North G	0.82	2
8456	North G	0.50	1
8493	North G	0.00	0
8641	North G	1.80	1
8654	North G	0.65	8
9229	North G	0.00	0
9520.1	North G	0.85	1
9520.2	North G	0.20	1
10255	North G	0.80	2
10260	North G	0.00	0
10342.1	North G	0.80	1
10342.2	North G	0.80	3
10521	North G	0.50	2
10553	North G	0.20	1
10634	North G	0.45	1
10769	North G	0.50	1
10770	North G	0.25	2
11129	North G	0.30	2
11130	North G	0.36	1
11137	North G	0.65	5
11162	North G	0.30	1
11239	North G	0.97	6
11240	North G	0.60	7
11747	North G	0.30	1
11750	North G	0.22	1
11799	North G	0.20	1
10600	North F	0.00	0
10622	North F	0.70	3
10798	North F	0.33	5

Chart 4. Scatter plot showing the distribution of particle size by level at Çatalhöyük East

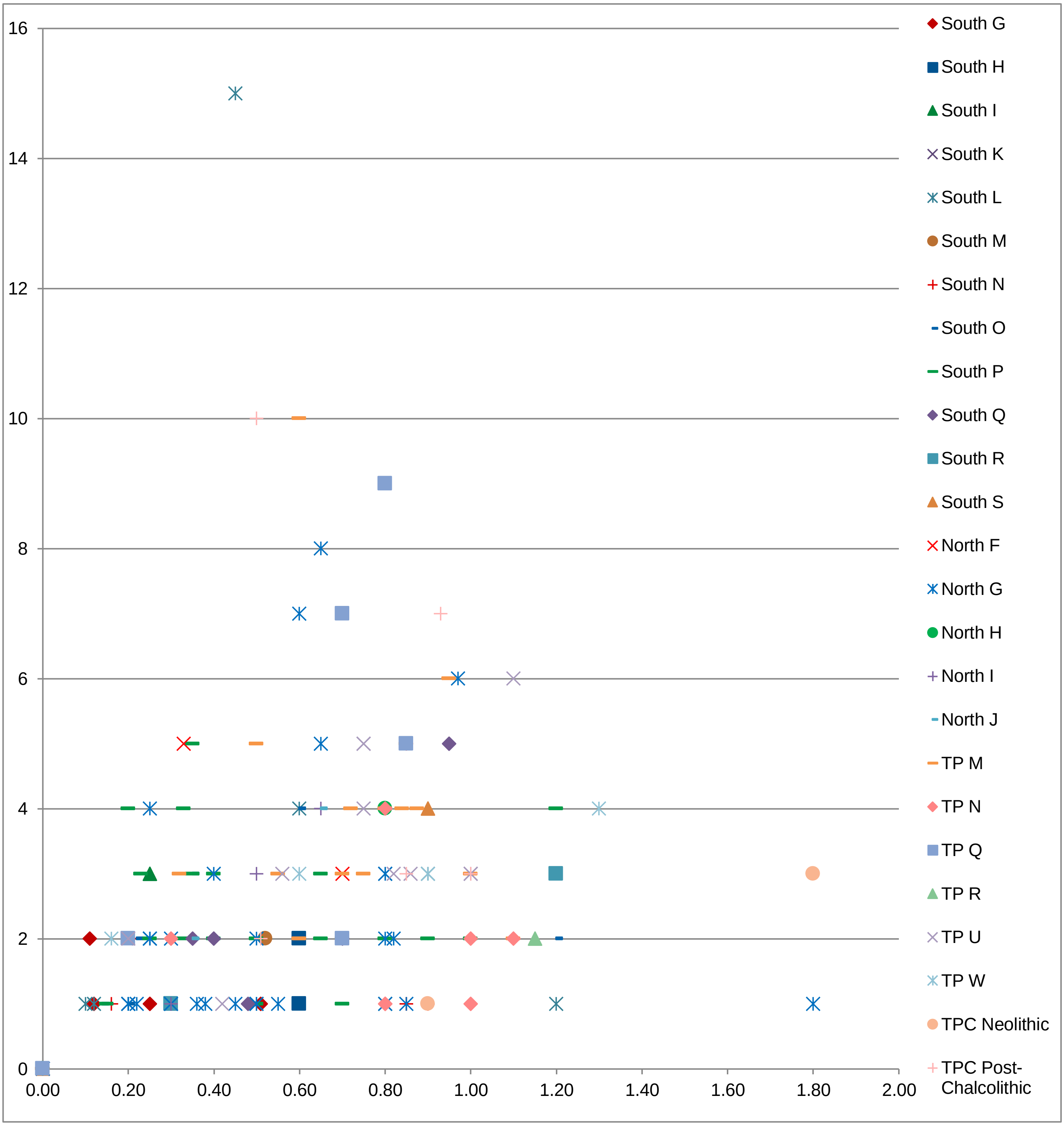


Table 5. List of porosity estimation values by excavation area from Çatalhöyük East

Flot Number	**Area**	**Average void size (mm)**	**Percentage of voids**
12155.1	GDN	0.1	15%
12155.2	GDN	0.1	10%
12278.1	GDN	0.25	25%
12278.2	GDN	0.1	10%
516	North	0.500	35%
5826.1	North	0.100	10%
5826.2	North	0.150	15%
5859	North	0.5	30%
5860	North	0.025	10%
6577	North	0.100	15%
6939	North	0.150	8%
7196	North	0.100	10%
7205	North	0.100	20%
7937	North	0.100	30%
7947.1	North	0.025	10%
7947.2	North	0.200	30%
8006	North	0.1	15%
8017	North	0.35	20%
8143	North	0.15	15%
8456	North	0.07	7%
8493	North	0.25	50%
8641	North	0.050	10%
8654	North	0.15	8%
9229	North	0.05	5%
9520.1	North	0.100	20%
9520.2	North	0.050	30%
9884	North	0.150	4%
10255	North	0.2	15%
10260	North	0.2	6%
10342.1	North	0.2	20%
10342.2	North	0.1	5%
10521	North	0.250	20%
10553	North	0.025	5%
10600	North	0.350	35%
10622	North	0.150	7%
10634	North	0.100	7%
10769	North	0.150	17%
10770	North	0.15	13%
10798	North	0.150	15%
11129	North	0.16	25%
11130	North	0.18	25%

11137	North	0.100	8%
11162	North	0.1	15%
11239	North	0.5	5%
11240	North	0.05	13%
11747	North	0.8	50%
11750	North	0.15	40%
11799	North	0.05	40%
192	South	0.21	15%
639	South	0.3	17%
1010	South	0.500	50%
1924	South	0.250	5%
2985	South	0.300	20%
3099.1	South	0.100	10%
3099.2	South	0.100	10%
3133	South	0.120	12%
3148	South	0.220	30%
3151	South	0.100	10%
3666	South	0.200	35%
7558.1	South	0.350	30%
7558.2	South	0.050	20%
7654	South	0.110	20%
7807	South	0.080	20%
7835	South	0.300	15%
7857	South	0.270	30%
7860.1	South	0.15	17%
7860.2	South	0.15	10%
7880	South	0.100	10%
7884	South	0.450	40%
8000	South	0.17	16%
8019	South	0.11	30%
8061	South	0.14	10%
8123	South	0.030	50%
8161	South	0.08	35%
8183	South	0.25	13%
8340	South	0.1	23%
8375	South	0.100	12%
8470	South	0.25	45%
8946	South	0.300	30%
8987	South	0.300	5%
8994	South	0.150	10%
9016	South	0.030	30%
9018	South	0.180	10%
9027	South	0.100	20%
9047	South	0.100	10%

9053	South	0.200	35%
9085.1	South	0.300	22%
9085.2	South	0.100	38%
9091.1	South	0.200	30%
9091.2	South	0.050	40%
9092	South	0.200	35%
9232.1	South	0.200	10%
9232.2	South	0.150	10%
9233	South	0.100	5%
9258	South	0.075	20%
9266	South	0.100	17%
9395	South	0.100	5%
9405.1	South	0.200	7%
9405.2	South	0.100	5%
9518	South	0.250	42%
9668	South	0.150	20%
9669.1	South	0.200	15%
9669.2	South	0.150	15%
10662	South	0.1	7%
10664	South	0.15	6%
10679	South	0.15	8%
10691	South	0.050	30%
10779	South	0.1	25%
11235	South	0.19	11%
12054	South	0.1	15%
13255	South	0.05	10%
9822	TPC	0.100	15%
9855	TPC	0.1	15%
9868	TPC	0.025	12%
9924.1	TPC	0.100	11%
9924.2	TPC	0.050	5%
9954	TPC	0.150	20%
10007	TPC	0.200	24%
10009	TPC	0.1	10%
10010	TPC	0.110	5%
10012	TPC	0.050	3%
10020	TPC	0.150	30%
10027	TPC	0.200	15%
10028	TPC	0.200	25%
10043	TPC	0.250	10%
10051	TPC	0.100	16%
10054	TPC	0.210	10%
10055	TPC	0.150	20%
10074	TPC	0.15	15%

10079	TPC	0.1	10%
10526	TPC	0.200	5%
10543	TPC	0.2	15%
10563	TPC	0.1	10%
10570	TPC	0.1	10%
10661	TPC	0.26	10%
10675	TPC	0.13	12%
10681	TPC	0.25	30%
10720	TPC	0.1	10%
10721	TPC	0.2	12%
10742	TPC	0.21	20%
10803	TPC	0.2	25%
10804	TPC	0.1	15%
10967	TPC	0.1	10%
11177	TPC	0.2	30%
11723	TPC	0.15	20%
11822	TPC	0.14	17%
11832	TPC	0.18	27%
11860	TPC	0.1	5%
11922	TPC	0.1	10%
12021	TPC	0.25	27%
12267	TPC	0.5	30%
12405	TPC	0.15	15%
12982	TPC	0.05	5%
13012	TPC	0.05	15%
13017	TPC	0.3	30%
13511	TPC	0.07	10%
13596.1	TPC	0.05	10%
13596.2	TPC	0.1	20%
13607	TPC	0.15	10%
13617	TPC	0.08	5%
13717.1	TPC	0.1	12%
13717.2	TPC	0.05	10%
13850	TPC	0.3	30%
13882	TPC	0.15	25%

Chart 5. Distribution of porosity estimation values by excavation area from Çatalhöyük East

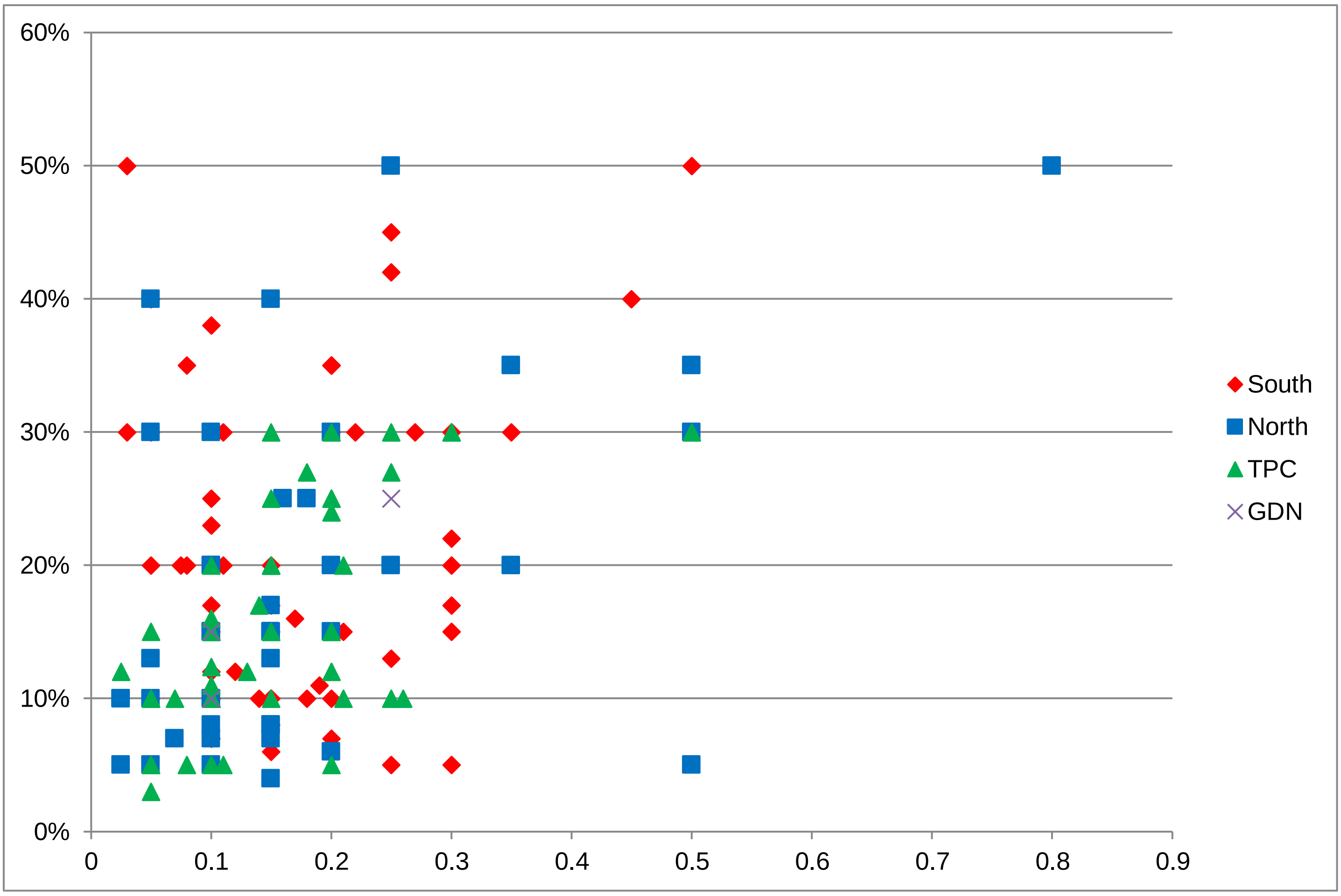


Table 6. List of porosity estimation values by occupation phase from Çatalhöyük East

Flot Number	**Period**	**Average void size (mm)**	**Percentage of voids**
192	Early	0.21	15%
639	Early	0.3	17%
1010	Early	0.500	50%
1924	Early	0.250	5%
3099.1	Early	0.100	10%
3099.2	Early	0.100	10%
3133	Early	0.120	12%
3148	Early	0.220	30%
3151	Early	0.100	10%
3666	Early	0.200	35%
10662	Early	0.1	7%
10664	Early	0.15	6%
10779	Early	0.1	25%
11235	Early	0.19	11%
13255	Early	0.05	10%
516	Middle	0.500	35%
2985	Middle	0.300	20%
5860	Middle	0.025	10%
7937	Middle	0.100	30%
7947.1	Middle	0.025	10%
7947.2	Middle	0.200	30%
8006	Middle	0.1	15%
8017	Middle	0.35	20%
8143	Middle	0.15	15%
8456	Middle	0.07	7%
8493	Middle	0.25	50%
8641	Middle	0.050	10%
8654	Middle	0.15	8%
8987	Middle	0.300	5%
8994	Middle	0.150	10%
9091.1	Middle	0.200	30%
9091.2	Middle	0.050	40%
9092	Middle	0.200	35%
9229	Middle	0.05	5%
9258	Middle	0.075	20%
9395	Middle	0.100	5%
9405.1	Middle	0.200	7%
9405.2	Middle	0.100	5%
9518	Middle	0.250	42%
9520.1	Middle	0.100	20%
9520.2	Middle	0.050	30%

9668	Middle	0.150	20%
9669.1	Middle	0.200	15%
9669.2	Middle	0.150	15%
10255	Middle	0.2	15%
10260	Middle	0.2	6%
10342.1	Middle	0.2	20%
10342.2	Middle	0.1	5%
10521	Middle	0.250	20%
10553	Middle	0.025	5%
10600	Middle	0.350	35%
10622	Middle	0.150	7%
10634	Middle	0.100	7%
10679	Middle	0.15	8%
10691	Middle	0.050	30%
10769	Middle	0.150	17%
10770	Middle	0.15	13%
10798	Middle	0.150	15%
11129	Middle	0.16	25%
11130	Middle	0.18	25%
11137	Middle	0.100	8%
11162	Middle	0.1	15%
11239	Middle	0.5	5%
11240	Middle	0.05	13%
11747	Middle	0.8	50%
11750	Middle	0.15	40%
11799	Middle	0.05	40%
12054	Middle	0.1	15%
5826.1	Late	0.100	10%
5826.2	Late	0.150	15%
5859	Late	0.5	30%
6577	Late	0.100	15%
6939	Late	0.150	8%
7196	Late	0.100	10%
7205	Late	0.100	20%
7558.1	Late	0.350	30%
7558.2	Late	0.050	20%
7654	Late	0.110	20%
7807	Late	0.080	20%
7835	Late	0.300	15%
7857	Late	0.270	30%
7860.1	Late	0.15	17%
7860.2	Late	0.15	10%
7880	Late	0.100	10%
7884	Late	0.450	40%

8000	Late	0.17	16%
8019	Late	0.11	30%
8061	Late	0.14	10%
8123	Late	0.030	50%
8161	Late	0.08	35%
8183	Late	0.25	13%
8340	Late	0.1	23%
8375	Late	0.100	12%
8470	Late	0.25	45%
8946	Late	0.300	30%
9016	Late	0.030	30%
9018	Late	0.180	10%
9027	Late	0.100	20%
9047	Late	0.100	10%
9053	Late	0.200	35%
9085.1	Late	0.300	22%
9085.2	Late	0.100	38%
9232.1	Late	0.200	10%
9232.2	Late	0.150	10%
9233	Late	0.100	5%
9266	Late	0.100	17%
9884	Late	0.150	4%
10054	Late	0.210	10%
10661	Late	0.26	10%
10681	Late	0.25	30%
10720	Late	0.1	10%
10721	Late	0.2	12%
10742	Late	0.21	20%
10804	Late	0.1	15%
11832	Late	0.18	27%
11922	Late	0.1	10%
12021	Late	0.25	27%
12155.1	Late	0.1	15%
12155.2	Late	0.1	10%
12267	Late	0.5	30%
12278.1	Late	0.25	25%
12278.2	Late	0.1	10%
12405	Late	0.15	15%
12982	Late	0.05	5%
13012	Late	0.05	15%
13017	Late	0.3	30%
13511	Late	0.07	10%
13596.1	Late	0.05	10%
13596.2	Late	0.1	20%

13607	Late	0.15	10%
13617	Late	0.08	5%
13717.1	Late	0.1	12%
13717.2	Late	0.05	10%
13850	Late	0.3	30%
13882	Late	0.15	25%
9924.1	Final	0.100	11%
9924.2	Final	0.050	5%
9954	Final	0.150	20%
10007	Final	0.200	24%
10009	Final	0.1	10%
10020	Final	0.150	30%
10967	Final	0.1	10%
9822	Final-T	0.100	15%
9855	Final-T	0.1	15%
9868	Final-T	0.025	12%
10010	Final-T	0.110	5%
10012	Final-T	0.050	3%
10027	Final-T	0.200	15%
10028	Final-T	0.200	25%
10043	Final-T	0.250	10%
10051	Final-T	0.100	16%
10055	Final-T	0.150	20%
10074	Final-T	0.15	15%
10079	Final-T	0.1	10%
10526	Final-T	0.200	5%
10543	Final-T	0.2	15%
10563	Final-T	0.1	10%
10570	Final-T	0.1	10%
10675	Final-T	0.13	12%
10803	Final-T	0.2	25%
11177	Final-T	0.2	30%
11723	Final-T	0.15	20%
11822	Final-T	0.14	17%
11860	Final-T	0.1	5%

Chart 6. Distribution of porosity estimation values by occupation phase from Çatalhöyük East

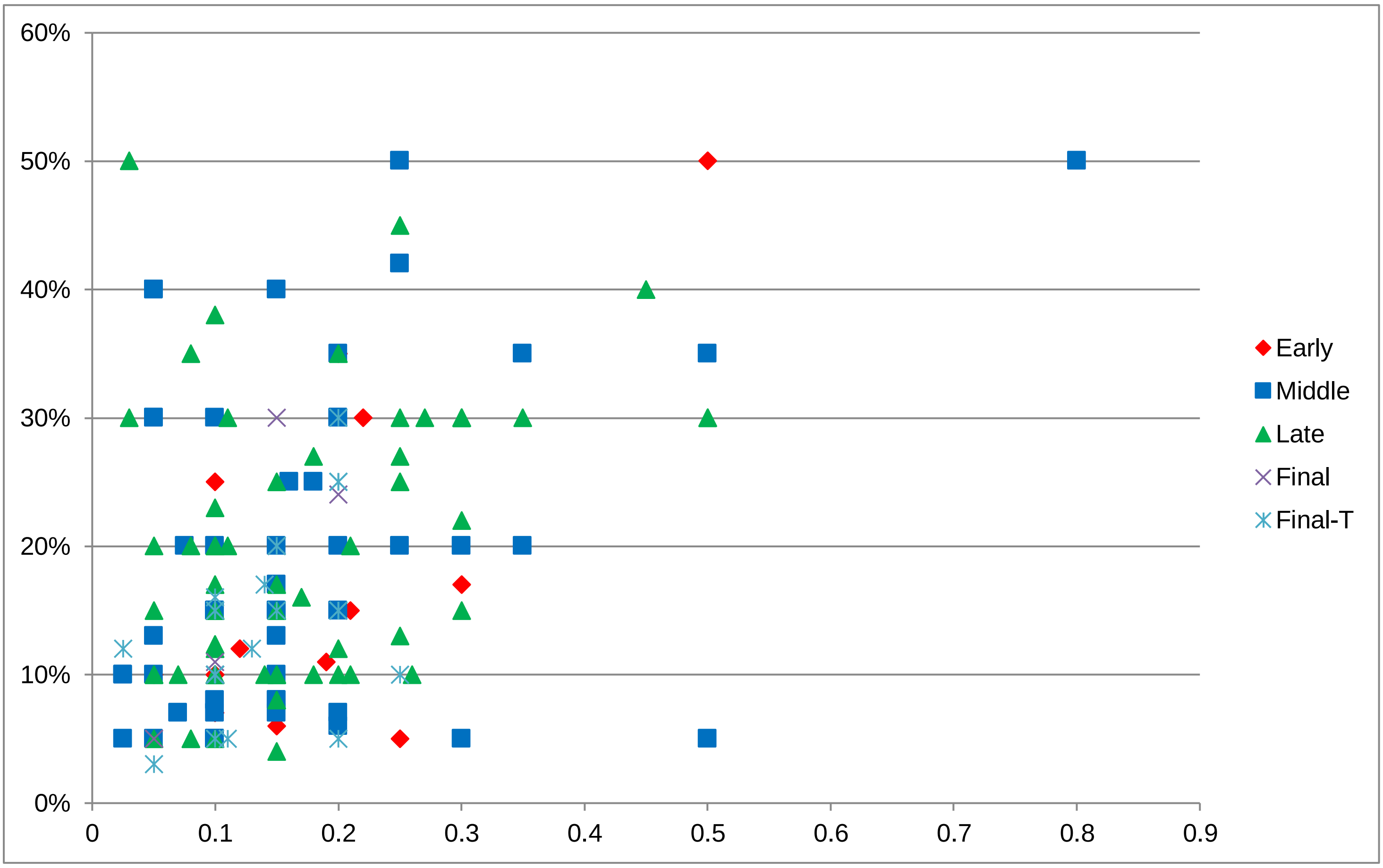


Table 7. List of porosity estimation values by matrix type from Çatalhöyük East

Flot Number	Matrix type	Average void size (mm)	Percentage of voids
516	1	0.500	35%
1010	1	0.500	50%
5859	1	0.5	30%
7558.1	1	0.350	30%
7884	1	0.450	40%
7947.2	1	0.200	30%
8470	1	0.25	45%
8946	1	0.300	30%
9053	1	0.200	35%
9091.1	1	0.200	30%
9518	1	0.250	42%
10007	1	0.200	24%
10600	1	0.350	35%
10681	1	0.25	30%
10803	1	0.2	25%
11747	1	0.8	50%
12021	1	0.25	27%
12267	1	0.5	30%
12278.1	1	0.25	25%
13017	1	0.3	30%
13850	1	0.3	30%
3666	2	0.200	35%
5826.2	2	0.150	15%
7654	2	0.110	20%
7857	2	0.270	30%
7937	2	0.100	30%
8019	2	0.11	30%
8123	2	0.030	50%
8161	2	0.08	35%
9016	2	0.030	30%
9018	2	0.180	10%
9085.2	2	0.100	38%
9091.2	2	0.050	40%
9258	2	0.075	20%
9520.2	2	0.050	30%
10020	2	0.150	30%
10691	2	0.050	30%
11799	2	0.05	40%
192	3	0.21	15%
639	3	0.3	17%
1924	3	0.250	5%
2985	3	0.300	20%
3099.1	3	0.100	10%
3099.2	3	0.100	10%

3133	3	0.120	12%
3148	3	0.220	30%
3151	3	0.100	10%
5860	3	0.025	10%
6577	3	0.100	15%
6939	3	0.150	8%
7196	3	0.100	10%
7558.2	3	0.050	20%
7807	3	0.080	20%
7860.1	3	0.15	17%
7880	3	0.100	10%
8000	3	0.17	16%
8006	3	0.1	15%
8061	3	0.14	10%
8143	3	0.15	15%
8183	3	0.25	13%
8340	3	0.1	23%
8375	3	0.100	12%
8456	3	0.07	7%
8493	3	0.25	50%
8994	3	0.150	10%
9027	3	0.100	20%
9047	3	0.100	10%
9085.1	3	0.300	22%
9229	3	0.05	5%
9232.1	3	0.200	10%
9232.2	3	0.150	10%
9233	3	0.100	5%
9266	3	0.100	17%
9395	3	0.100	5%
9405.1	3	0.200	7%
9520.1	3	0.100	20%
9668	3	0.150	20%
9669.2	3	0.150	15%
9924.1	3	0.100	11%
9954	3	0.150	20%
10012	3	0.050	3%
10027	3	0.200	15%
10051	3	0.100	16%
10055	3	0.150	20%
10074	3	0.15	15%
10255	3	0.2	15%
10260	3	0.2	6%
10342.1	3	0.2	20%
10543	3	0.2	15%
10553	3	0.025	5%
10563	3	0.1	10%

10570	3	0.1	10%
10679	3	0.15	8%
10742	3	0.21	20%
10769	3	0.150	17%
10770	3	0.15	13%
10779	3	0.1	25%
10798	3	0.150	15%
10804	3	0.1	15%
11129	3	0.16	25%
11130	3	0.18	25%
11162	3	0.1	15%
11177	3	0.2	30%
11235	3	0.19	11%
11723	3	0.15	20%
11750	3	0.15	40%
11832	3	0.18	27%
12155.1	3	0.1	15%
12405	3	0.15	15%
13012	3	0.05	15%
13255	3	0.05	10%
13596.2	3	0.1	20%
13607	3	0.15	10%
5826.1	4	0.100	10%
7205	4	0.100	20%
7835	4	0.300	15%
7860.2	4	0.15	10%
8017	4	0.35	20%
8641	4	0.050	10%
8654	4	0.15	8%
8987	4	0.300	5%
9092	4	0.200	35%
9405.2	4	0.100	5%
9822	4	0.100	15%
9855	4	0.1	15%
9868	4	0.025	12%
9884	4	0.150	4%
9924.2	4	0.050	5%
10009	4	0.1	10%
10010	4	0.110	5%
10028	4	0.200	25%
10043	4	0.250	10%
10054	4	0.210	10%
10079	4	0.1	10%
10342.2	4	0.1	5%
10526	4	0.200	5%
10622	4	0.150	7%
10634	4	0.100	7%

10661	4	0.26	10%
10662	4	0.1	7%
10664	4	0.15	6%
10675	4	0.13	12%
10720	4	0.1	10%
10721	4	0.2	12%
10967	4	0.1	10%
11137	4	0.100	8%
11239	4	0.5	5%
11240	4	0.05	13%
11822	4	0.14	17%
11860	4	0.1	5%
11922	4	0.1	10%
12054	4	0.1	15%
12155.2	4	0.1	10%
12278.2	4	0.1	10%
12982	4	0.05	5%
13511	4	0.07	10%
13596.1	4	0.05	10%
13617	4	0.08	5%
13717.1	4	0.1	12%
13717.2	4	0.05	10%

Chart 7. Distribution of porosity estimation values by matrix type from Çatalhöyük East

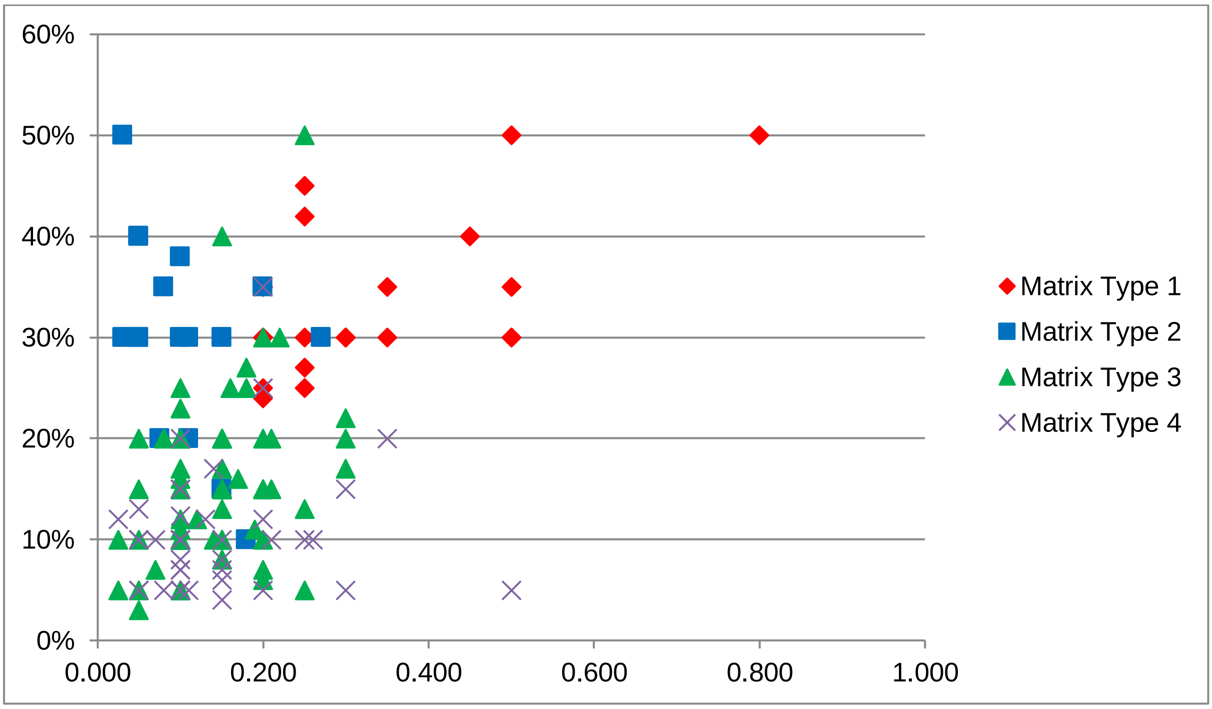


Table 8. List of porosity estimation values by level from Çatalhöyük East

Flot Number	Level	Average void size (mm)	Percentage of voids
10010	TPC Post-Chalcolithic	0.110	5%
10012	TPC Post-Chalcolithic	0.050	3%
10526	TPC Post-Chalcolithic	0.200	5%
10563	TPC Post-Chalcolithic	0.1	10%
10675	TPC Post-Chalcolithic	0.13	12%
10020	TPC Neolithic	0.150	30%
10967	TPC Neolithic	0.1	10%
10027	TP W	0.200	15%
10051	TP W	0.100	16%
10055	TP W	0.150	20%
11177	TP W	0.2	30%
9822	TP U	0.100	15%
9855	TP U	0.1	15%
9868	TP U	0.025	12%
10028	TP U	0.200	25%
10043	TP U	0.250	10%
10074	TP U	0.15	15%
10079	TP U	0.1	10%
10543	TP U	0.2	15%
11723	TP U	0.15	20%
11822	TP U	0.14	17%
11860	TP U	0.1	5%
10803	TP R	0.2	25%
9924.1	TP Q	0.100	11%
9924.2	TP Q	0.050	5%
9954	TP Q	0.150	20%
10007	TP Q	0.200	24%
10009	TP Q	0.1	10%
10570	TP Q	0.1	10%
10054	TP N	0.210	10%
10681	TP N	0.25	30%
12155.1	TP N	0.1	15%
12155.2	TP N	0.1	10%
12278.1	TP N	0.25	25%
12278.2	TP N	0.1	10%
13617	TP N	0.08	5%
10661	TP M	0.26	10%

10720	TP M	0.1	10%
10721	TP M	0.2	12%
10742	TP M	0.21	20%
10804	TP M	0.1	15%
11832	TP M	0.18	27%
11922	TP M	0.1	10%
12021	TP M	0.25	27%
12267	TP M	0.5	30%
12405	TP M	0.15	15%
12982	TP M	0.05	5%
13012	TP M	0.05	15%
13017	TP M	0.3	30%
13511	TP M	0.07	10%
13596.1	TP M	0.05	10%
13596.2	TP M	0.1	20%
13607	TP M	0.15	10%
13717.1	TP M	0.1	12%
13717.2	TP M	0.05	10%
13850	TP M	0.3	30%
13882	TP M	0.15	25%
7860.1	South S	0.15	17%
7860.2	South S	0.15	10%
8161	South R	0.08	35%
8183	South R	0.25	13%
7558.1	South Q	0.350	30%
7558.2	South Q	0.050	20%
7835	South Q	0.300	15%
8340	South Q	0.1	23%
8375	South Q	0.100	12%
9085.1	South P/South O	0.300	22%
9085.2	South P/South O	0.100	38%
7654	South P	0.110	20%
7807	South P	0.080	20%
7857	South P	0.270	30%
7880	South P	0.100	10%
7884	South P	0.450	40%
8000	South P	0.17	16%
8019	South P	0.11	30%
8061	South P	0.14	10%
8123	South P	0.030	50%
8470	South P	0.25	45%
8946	South P	0.300	30%
9016	South P	0.030	30%
9018	South P	0.180	10%

9027	South P	0.100	20%
9047	South P	0.100	10%
9053	South P	0.200	35%
9232.1	South P	0.200	10%
9232.2	South P	0.150	10%
9233	South P	0.100	5%
9266	South P	0.100	17%
8987	South O	0.300	5%
8994	South O	0.150	10%
9091.1	South O	0.200	30%
9091.2	South O	0.050	40%
9092	South O	0.200	35%
9258	South O	0.075	20%
9518	South O	0.250	42%
9668	South O	0.150	20%
9395	South N	0.100	5%
9405.1	South N	0.200	7%
9405.2	South N	0.100	5%
9669.1	South N	0.200	15%
9669.2	South N	0.150	15%
10691	South N	0.050	30%
12054	South N	0.1	15%
10679	South M	0.15	8%
192	South L	0.21	15%
1010	South L	0.500	50%
1924	South L	0.250	5%
2985	South L	0.300	20%
3099.1	South L	0.100	10%
3099.2	South L	0.100	10%
11235	South L	0.19	11%
639	South K	0.3	17%
13255	South I	0.05	10%
10662	South H	0.1	7%
10664	South H	0.15	6%
10779	South H	0.1	25%
3133	South G	0.120	12%
3148	South G	0.220	30%
3151	South G	0.100	10%
3666	South G	0.200	35%
5826.1	North J	0.100	10%
5826.2	North J	0.150	15%
6577	North I	0.100	15%
6939	North I	0.150	8%
7196	North I	0.100	10%
7205	North I	0.100	20%

5859	North H	0.5	30%
9884	North H	0.150	4%
516	North G	0.500	35%
5860	North G	0.025	10%
7937	North G	0.100	30%
7947.1	North G	0.025	10%
7947.2	North G	0.200	30%
8006	North G	0.1	15%
8017	North G	0.35	20%
8143	North G	0.15	15%
8456	North G	0.07	7%
8493	North G	0.25	50%
8641	North G	0.050	10%
8654	North G	0.15	8%
9229	North G	0.05	5%
9520.1	North G	0.100	20%
9520.2	North G	0.050	30%
10255	North G	0.2	15%
10260	North G	0.2	6%
10342.1	North G	0.2	20%
10342.2	North G	0.1	5%
10521	North G	0.250	20%
10553	North G	0.025	5%
10634	North G	0.100	7%
10769	North G	0.150	17%
10770	North G	0.15	13%
11129	North G	0.16	25%
11130	North G	0.18	25%
11137	North G	0.100	8%
11162	North G	0.1	15%
11239	North G	0.5	5%
11240	North G	0.05	13%
11747	North G	0.8	50%
11750	North G	0.15	40%
11799	North G	0.05	40%
10600	North F	0.350	35%
10622	North F	0.150	7%
10798	North F	0.150	15%

Chart 8. Distribution of porosity estimation values by level from Çatalhöyük East

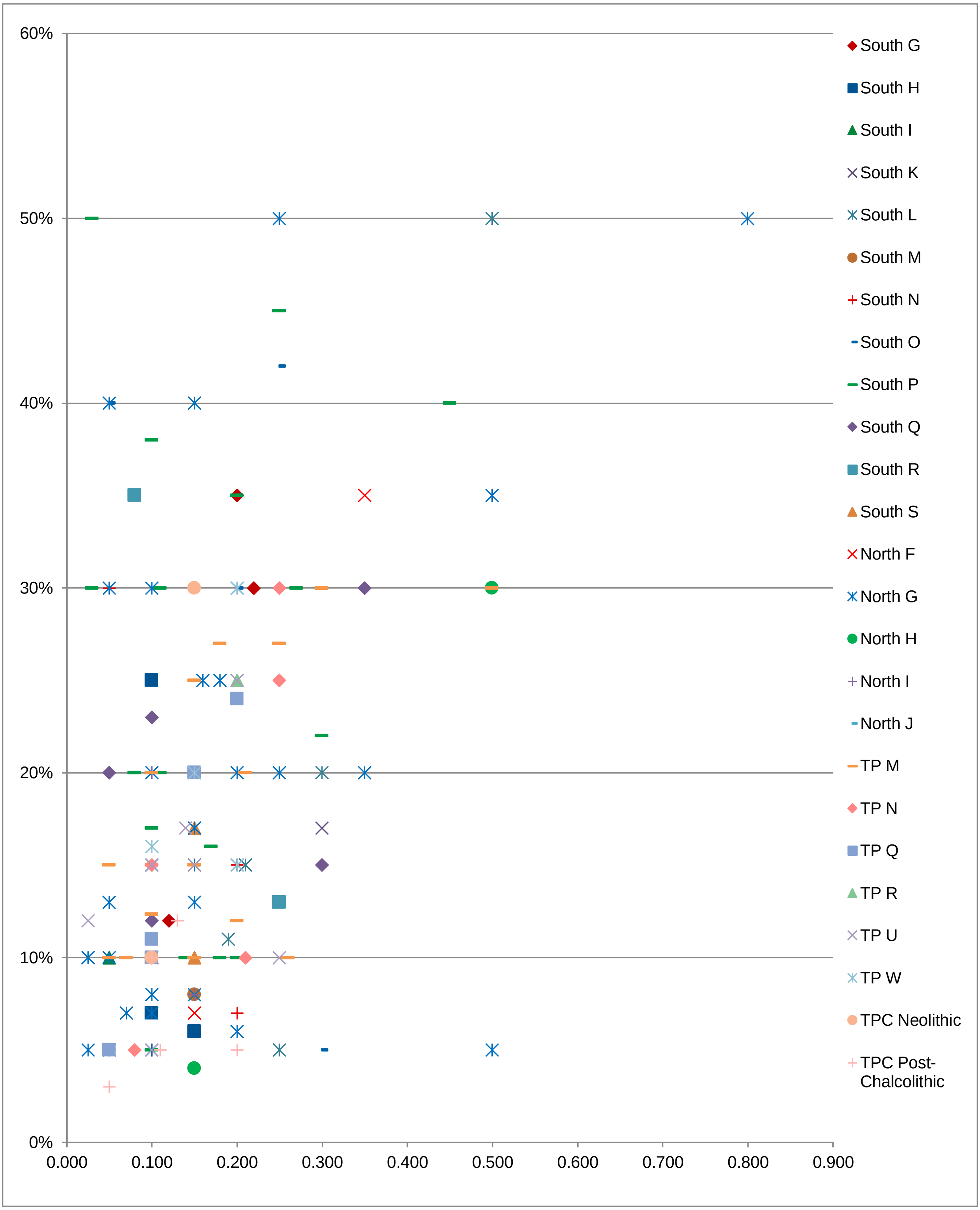


Table 9. List of particle size values by excavation area from Jarmo

Flot Number	Area	Average Particle size (mm)	Avarage number of Particles
160.1	JCB	0.20	1
160.2	JCB	0.40	1
17.1	JCB	0.45	1
24.1	JCB	0.55	2
24.2	JCB	0.60	2
6	JCB	0.00	0
159	JCM	0.00	0
184.1	JCM	0.00	0
184.2	JCM	0.00	0
144.1	JCM	0.50	1
144.2	JCM	0.40	4
144.3	JCM	1.40	2
144.4	JCM	0.00	0
180.1	JCM	0.00	0
180.2	JCM	0.00	0
148	JCM	0.00	0
150	JCM	0.00	0
152.1	JCM	0.45	11
152.2	JCM	0.30	2
178	JCM	0.30	1
32	JCM	0.70	2
28	JCM	0.40	1
27	JCM	0.00	0
64.1	JW	0.80	10
64.2	JW	0.90	1
175.1	JW	0.38	1
175.2	JW	0.00	0
155	JW	0.55	1

Chart 9. Distribution of particle size values by excavation area from Jarmo

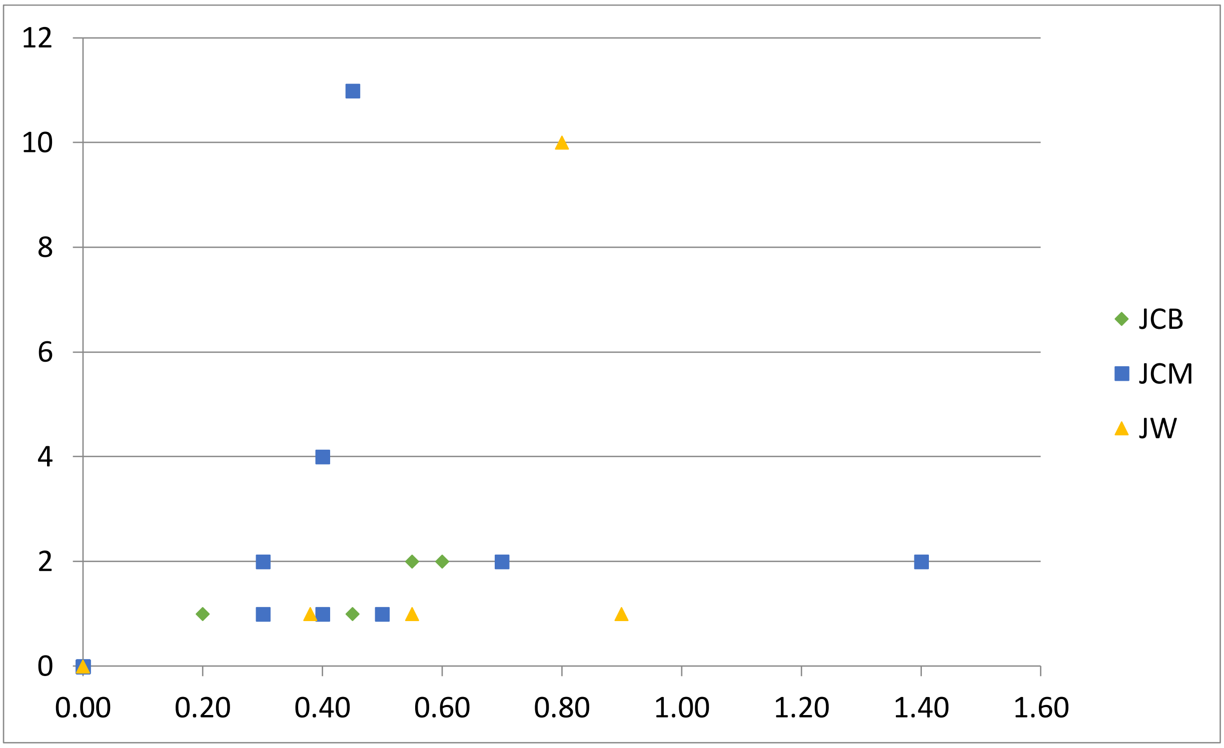


Table 10. List of particle size values by occupation phase from Jarmo

Flot Number	**Phase**	**Average Particle size (mm)**	**Avarage number of Particles**
175.1	Phase 1	0.38	1
175.2	Phase 1	0.00	0
155	Phase 1	0.55	1
159	Phase 2	0.00	0
184.1	Phase 2	0.00	0
184.2	Phase 2	0.00	0
144.1	Phase 2	0.50	1
144.2	Phase 2	0.40	4
144.3	Phase 2	1.40	2
144.4	Phase 2	0.00	0
17.1	Phase 2	0.45	1
180.1	Phase 2	0.00	0
180.2	Phase 2	0.00	0
150	Phase 2	0.00	0
152.1	Phase 2	0.45	11
152.2	Phase 2	0.30	2
24.1	Phase 2	0.55	2
24.2	Phase 2	0.60	2
160.1	Phase 3	0.20	1
160.2	Phase 3	0.40	1
148	Phase 3	0.00	0
178	Phase 3	0.30	1
32	Phase 3	0.70	2
28	Phase 3	0.40	1
6	Phase 3	0.00	0
27	Phase 3	0.00	0
64.1	Phase 4	0.80	10
64.2	Phase 4	0.90	1

Chart 10. Distribution of particle size values by occupation phase from Jarmo

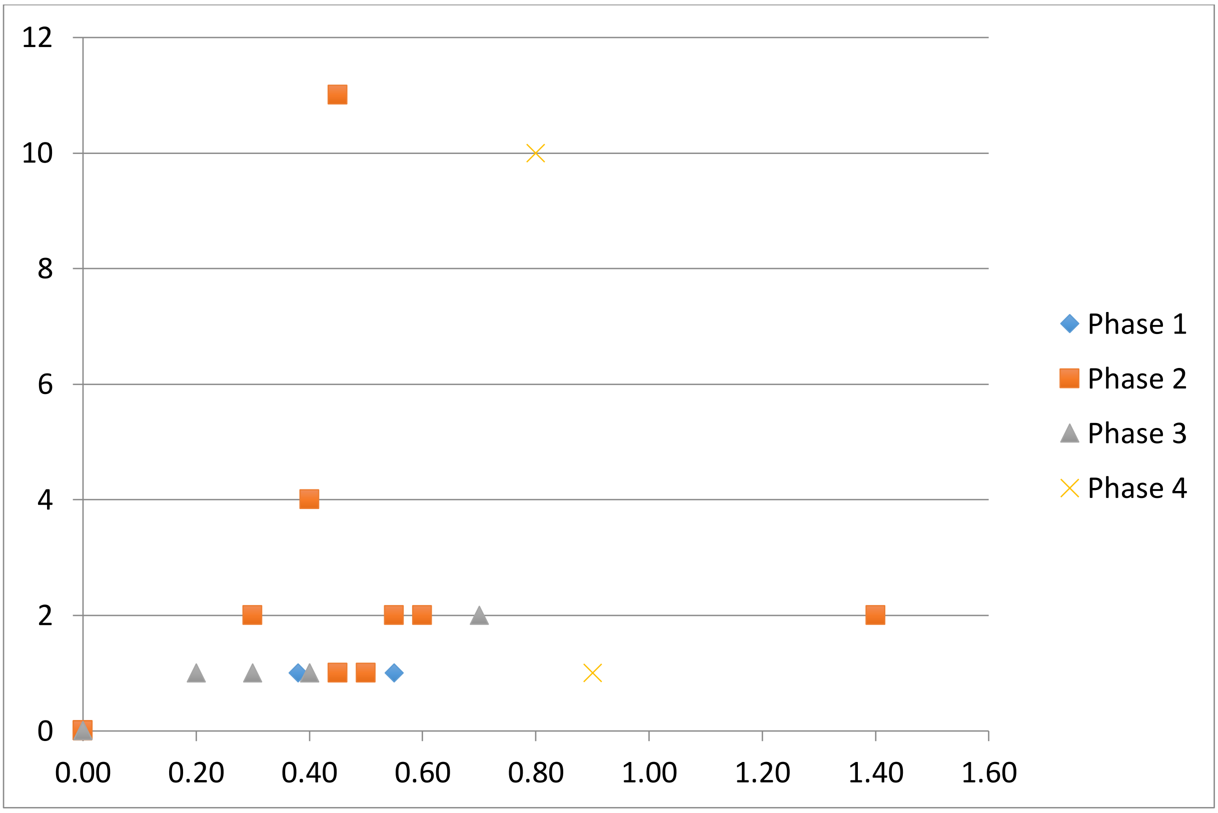


Table 11. List of particle size values by matrix type from Jarmo

Flot Number	**Matrix type**	**Average Particle size (mm)**	**Avarage number of Particles**
155	?	0.55	1
159	A	0.00	0
150	B	0.00	0
160.1	C	0.20	1
160.2	C	0.40	1
184.1	C	0.00	0
184.2	C	0.00	0
144.1	C	0.50	1
144.2	C	0.40	4
17.1	C	0.45	1
180.1	C	0.00	0
180.2	C	0.00	0
64.2	C	0.90	1
175.1	C	0.38	1
175.2	C	0.00	0
148	C	0.00	0
152.1	C	0.45	11
152.2	C	0.30	2
24.1	C	0.55	2
24.2	C	0.60	2
6	C	0.00	0
27	C	0.00	0
144.3	D	1.40	2
144.4	D	0.00	0
64.1	D	0.80	10
178	D	0.30	1
32	D	0.70	2
28	D	0.40	1

Chart 11. Distribution of particle size values by matrix type from Jarmo

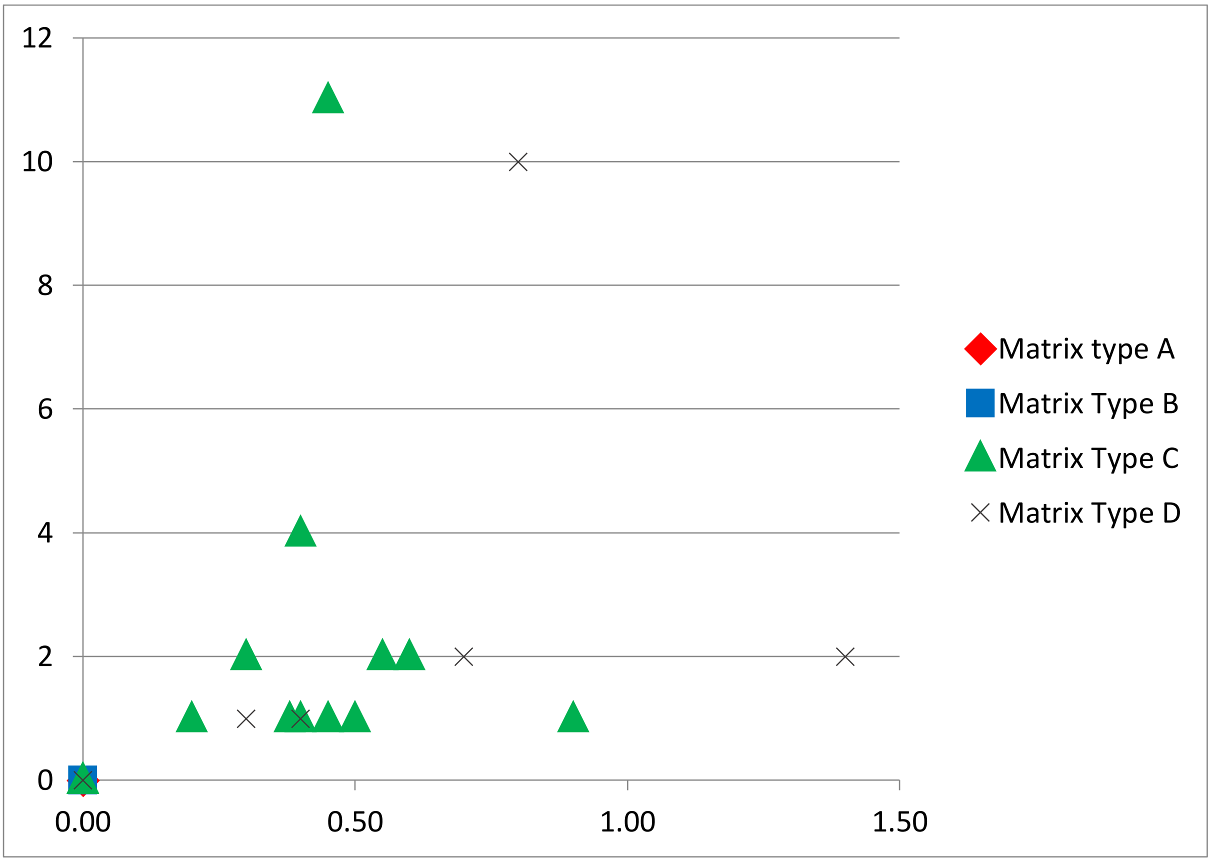


Table 12. List of porosity estimation values by excavation area from Jarmo

Flot Number	**Area**	**Average void size (mm)**	**Percentage of voids**
160.1	JCB	0.17	15%
160.2	JCB	0.25	10%
17.1	JCB	0.10	12%
24.1	JCB	0.05	12%
24.2	JCB	0.05	17%
6	JCB	0.10	10%
159	JCM	0.12	30%
184.1	JCM	0.25	20%
184.2	JCM	0.10	20%
144.1	JCM	0.15	20%
144.2	JCM	0.05	15%
144.3	JCM	0.20	10%
144.4	JCM	0.12	10%
180.1	JCM	0.20	17%
180.2	JCM	0.10	10%
148	JCM	0.05	15%
150	JCM	0.15	40%
152.1	JCM	0.05	25%
152.2	JCM	0.15	25%
178	JCM	0.03	7%
32	JCM	0.05	7%
28	JCM	0.03	3%
27	JCM	0.10	7%
64.1	JW	0.05	5%
64.2	JW	0.10	10%
175.1	JW	0.10	17%
175.2	JW	0.15	15%
155	JW	0.10	4%

Chart 12. Distribution of porosity estimation values by excavation area from Jarmo

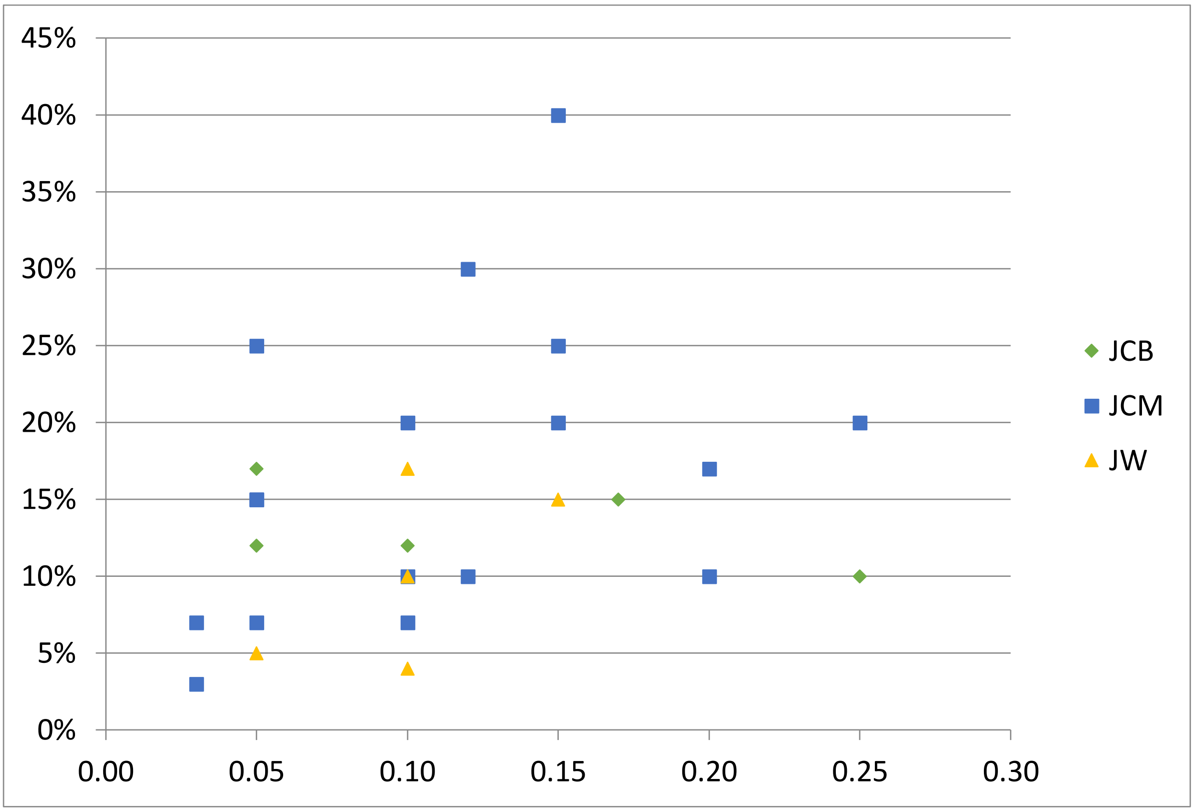


Table 13. List of porosity estimation values by occupation phase from Jarmo

Flot Number	Phase	Average void size (mm)	Percentage of voids
175.1	Phase 1	0.10	17%
175.2	Phase 1	0.15	15%
155	Phase 1	0.10	4%
159	Phase 2	0.12	30%
184.1	Phase 2	0.25	20%
184.2	Phase 2	0.10	20%
144.1	Phase 2	0.15	20%
144.2	Phase 2	0.05	15%
144.3	Phase 2	0.20	10%
144.4	Phase 2	0.12	10%
17.1	Phase 2	0.10	12%
180.1	Phase 2	0.20	17%
180.2	Phase 2	0.10	10%
150	Phase 2	0.15	40%
152.1	Phase 2	0.05	25%
152.2	Phase 2	0.15	25%
24.1	Phase 2	0.05	12%
24.2	Phase 2	0.05	17%
160.1	Phase 3	0.17	15%
160.2	Phase 3	0.25	10%
148	Phase 3	0.05	15%
178	Phase 3	0.03	7%
32	Phase 3	0.05	7%
28	Phase 3	0.03	3%
6	Phase 3	0.10	10%
27	Phase 3	0.10	7%
64.1	Phase 4	0.05	5%
64.2	Phase 4	0.10	10%

Chart 13. Distribution of porosity estimation values by occupation phase from Jarmo

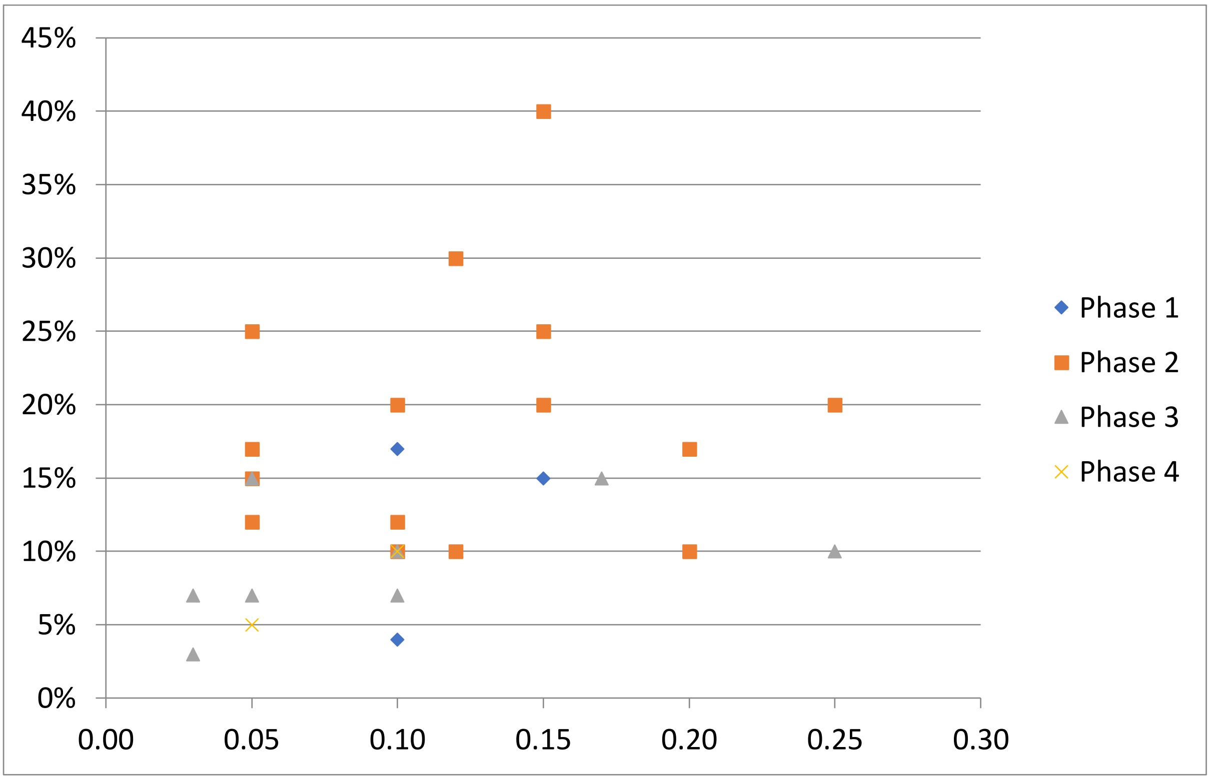
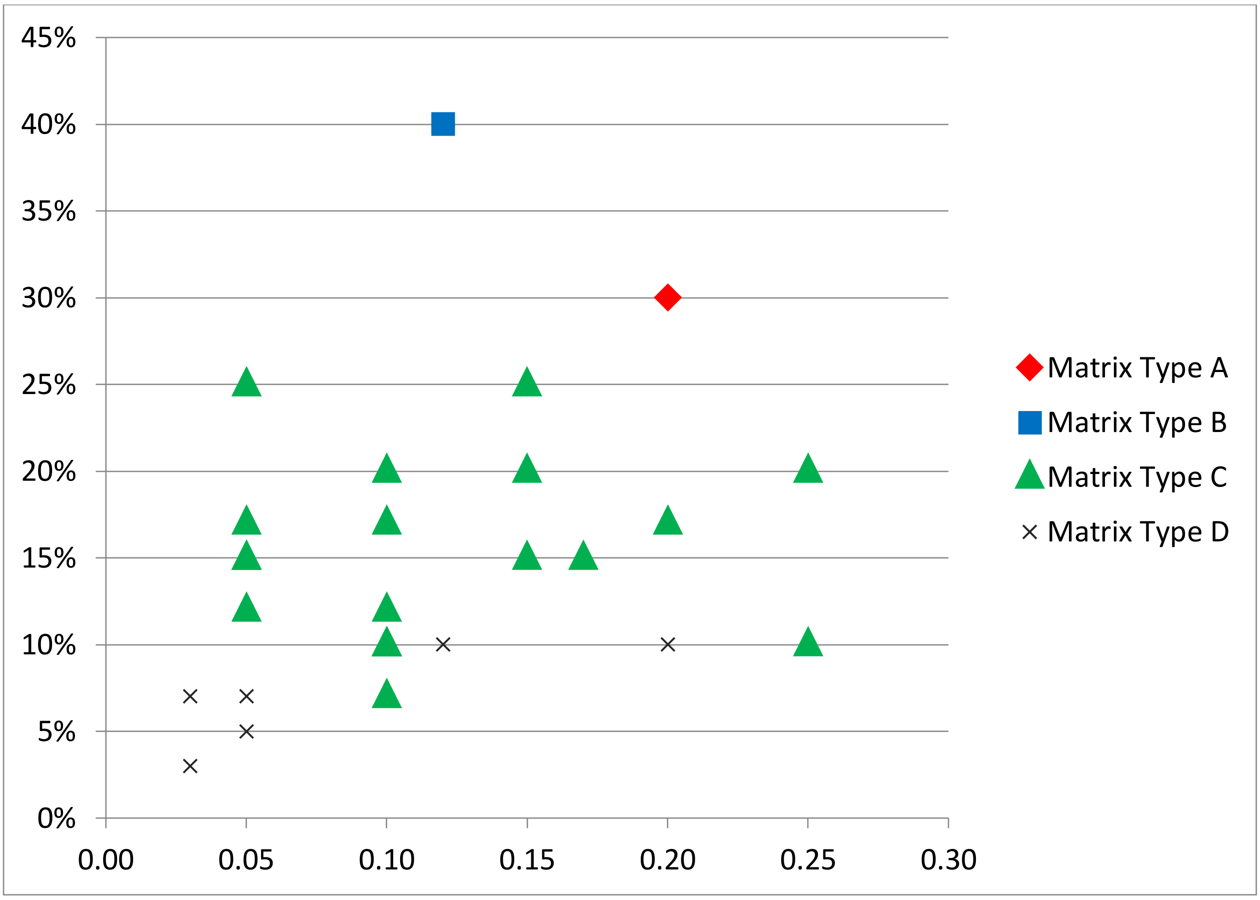


Table 13. List of porosity estimation values by matrix type from Jarmo

Flot Number	**Matrix type**	**Average void size (mm)**	**Percentage of voids**
155	?	0.10	4%
159	A	0.20	30%
150	B	0.12	40%
160.1	C	0.17	15%
160.2	C	0.25	10%
184.1	C	0.25	20%
184.2	C	0.10	20%
144.1	C	0.15	20%
144.2	C	0.05	15%
17.1	C	0.10	12%
180.1	C	0.20	17%
180.2	C	0.10	10%
64.2	C	0.10	10%
175.1	C	0.10	17%
175.2	C	0.15	15%
148	C	0.05	15%
152.1	C	0.05	25%
152.2	C	0.15	25%
24.1	C	0.05	12%
24.2	C	0.05	17%
6	C	0.10	10%
27	C	0.10	7%
144.3	D	0.20	10%
144.4	D	0.12	10%
64.1	D	0.05	5%
178	D	0.03	7%
32	D	0.05	7%
28	D	0.03	3%

Chart 14. Distribution of porosity estimation values by matrix type from Jarmo



Appendix IV:

Table 1: Isotope and lipid analyses summary table

Table 2: Quality control data table

Charts: Scatter plots showing d15N and d13C values from the selected food fragments from Çatalhöyük East and Jarmo

Table 1: Isotope and lipid analyses summary table

Sample Data																	
	Weight/Vol	N (Sam)	15N (Sam)	C (Sam)	13C (Sam)	Delta C			% C		C:N Ratio		Delta N			% N	
Name		%	DeltaAir	%	DeltaPDB	Corrected Average	Sample Uncertainty	Replicate Precision	Average	St Dev	Individual	Average	Corrected Average	Sample Uncertainty	Replicate Precision	Average	St Dev
CATAL 10020 A	0.89	1.09	3.43	15.61	-24.36						16.65						
CATAL 10020 B	0.95	1.10	3.51	15.34	-24.43	-24.55	0.12	0.04	15.47	0.13	16.30	16.47	3.61	0.18	0.04	1.10	0.00
CATAL 10720 A	0.93	2.31	9.17	30.23	-23.76						15.28						
CATAL 10720 B	1.04	3.00	9.71	38.52	-23.30	-23.66	0.26	0.23	34.37	4.14	15.00	15.14	9.49	0.30	0.27	2.65	0.34
CATAL 10721 A	0.85	1.26	10.89	11.68	-23.23						10.80						
CATAL 10721 B	1.17	3.99	12.97	34.76	-22.63	-23.04	0.32	0.30	23.22	11.54	10.16	10.48	11.95	1.04	1.04	2.63	1.37
CATAL 10742 A	0.85	3.24	8.73	39.21	-24.07						14.13						
CATAL 10742 B	0.96	2.87	8.52	34.63	-24.05	-24.20	0.11	0.01	36.92	2.29	14.07	14.10	8.69	0.18	0.10	3.05	0.18
CATAL 10804 A	1.12	2.42	11.20	33.77	-23.68						16.28						
CATAL 10804 B	0.92	3.53	10.96	48.86	-23.59	-23.77	0.11	0.04	41.31	7.55	16.14	16.21	11.12	0.19	0.12	2.98	0.56
CATAL 10967 A	1.09	4.35	10.41	41.18	-23.48						11.04						
CATAL 10967 B	1.20	4.02	10.39	37.80	-23.42	-23.58	0.11	0.03	39.49	1.69	10.98	11.01	10.44	0.14	0.01	4.18	0.17
CATAL 11129 A	0.89	1.88	7.16	25.84	-22.88						16.02						
CATAL 11129 B	0.96	3.13	7.70	42.42	-22.45	-22.77	0.24	0.21	34.13	8.29	15.82	15.92	7.52	0.31	0.27	2.51	0.62
CATAL 11747 A	0.96	2.67	7.43	39.11	-21.93						17.11						
CATAL 11747 B	0.80	0.72	6.06	10.25	-22.29	-22.19	0.21	0.18	24.68	14.43	16.71	16.91	6.84	0.69	0.69	1.69	0.98
CATAL 11922 A	1.18	2.34	10.34	46.91	-24.82						23.40						
CATAL 11922 B	0.94	3.58	10.64	74.58	-24.72	-24.93	0.13	0.05	60.74	13.83	24.33	23.86	10.53	0.21	0.15	2.96	0.62
CATAL 12021 A	1.03	6.95	11.67	38.65	-20.58						6.49						
CATAL 12021 B	1.38	6.43	11.93	35.99	-20.49	-20.58	0.10	0.05	37.32	1.33	6.53	6.51	11.83	0.19	0.13	6.69	0.26
CATAL 13717 A	1.08	1.83	6.09	15.39	-24.29						9.82						
CATAL 13717 B	0.89	2.04	5.35	16.90	-24.40	-24.50	0.12	0.05	16.15	0.75	9.65	9.74	5.83	0.40	0.37	1.94	0.11

CATAL 13850 A	0.93	7.61	17.46	38.13	-15.96						5.84						
CATAL 13850 B	1.12	8.28	17.70	43.10	-15.45	-15.61	0.27	0.25	40.62	2.49	6.07	5.96	17.53	0.21	0.12	7.95	0.34
CATAL 192 A	0.82	3.16	2.59	36.38	-23.98						13.45						
CATAL 192 B	1.19	3.56	2.96	40.04	-23.59	-23.92	0.22	0.19	38.21	1.83	13.14	13.29	2.93	0.26	0.19	3.36	0.20
CATAL 3148 A	1.20	1.03	5.05	13.27	-22.15						15.00						
CATAL 3148 B	0.80	0.93	5.29	11.37	-22.22	-22.27	0.10	0.03	12.32	0.95	14.32	14.66	5.29	0.20	0.12	0.98	0.05
CATAL 3151 A	0.90	3.49	6.63	33.77	-22.21						11.28						
CATAL 3151 B	1.20	3.32	7.51	29.29	-22.09	-22.23	0.11	0.06	31.53	2.24	10.29	10.79	7.16	0.46	0.44	3.41	0.09
CATAL 3666 A	1.05	2.57	9.50	43.42	-23.67						19.70						
CATAL 3666 B	0.95	2.57	9.46	43.73	-23.72	-23.83	0.11	0.03	43.58	0.16	19.82	19.76	9.54	0.14	0.02	2.57	0.00
CATAL 9053 A	1.19	1.76	5.10	31.49	-24.71						20.88						
CATAL 9053 B	0.89	2.68	5.15	48.40	-24.62	-24.83	0.12	0.04	39.94	8.46	21.11	20.99	5.24	0.17	0.03	2.22	0.46
CATAL 9085 A	0.82	2.43	8.11	29.10	-22.99						13.99						
CATAL 9085 B	0.87	3.19	9.58	36.89	-22.66	-22.93	0.20	0.17	32.99	3.90	13.48	13.74	8.91	0.74	0.73	2.81	0.38
CATAL 9229 A	1.20	5.51	18.81	36.94	-22.41						7.82						
CATAL 9229 B	1.05	5.48	18.53	36.71	-22.48	-22.54	0.10	0.04	36.82	0.11	7.82	7.82	18.60	0.23	0.14	5.50	0.02
CATAL 9232 A	0.91	2.52	7.98	33.99	-22.38						15.77						
CATAL 9232 B	0.92	3.16	8.45	41.66	-22.26	-22.41	0.11	0.06	37.83	3.84	15.38	15.57	8.29	0.27	0.24	2.84	0.32
JARMO 144 A	0.90	1.19	3.89	15.98	-24.78						15.63						
JARMO 144B	0.80	1.68	4.25	21.98	-24.86	-24.98	0.12	0.04	18.98	3.00	15.28	15.46	4.20	0.25	0.18	1.44	0.24
JARMO 159 A	1.10	0.72	5.89	7.58	-23.19						12.33						
JARMO 159 B	1.20	3.27	6.65	36.59	-22.65	-23.03	0.29	0.27	22.08	14.51	13.05	12.69	6.37	0.41	0.38	1.99	1.28

Table 2. Quality control data table

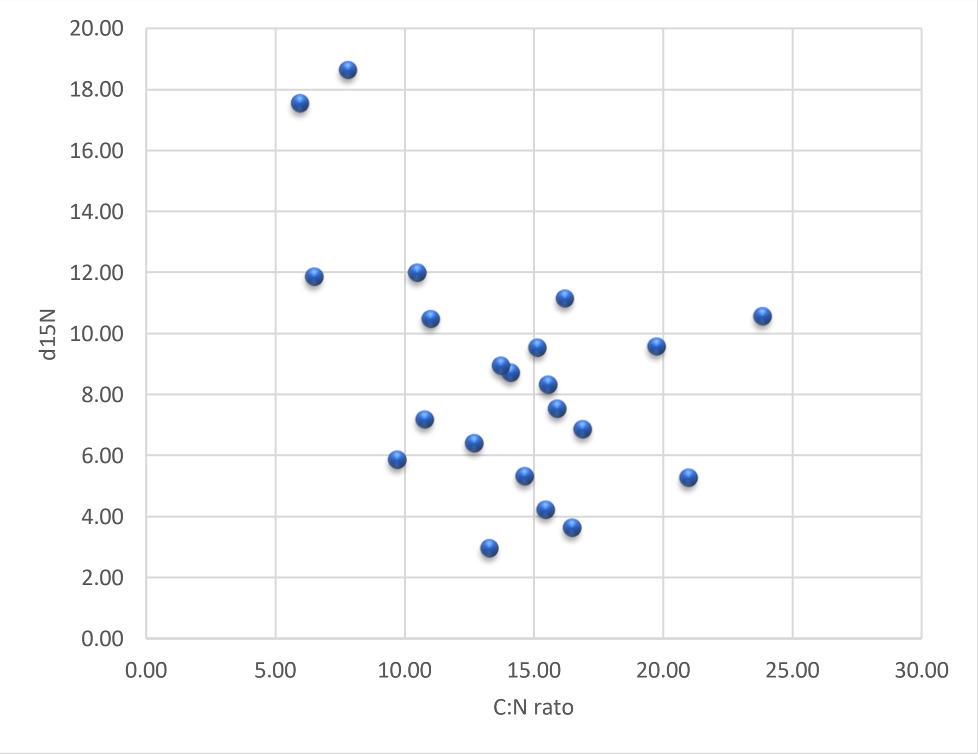
Quality Control

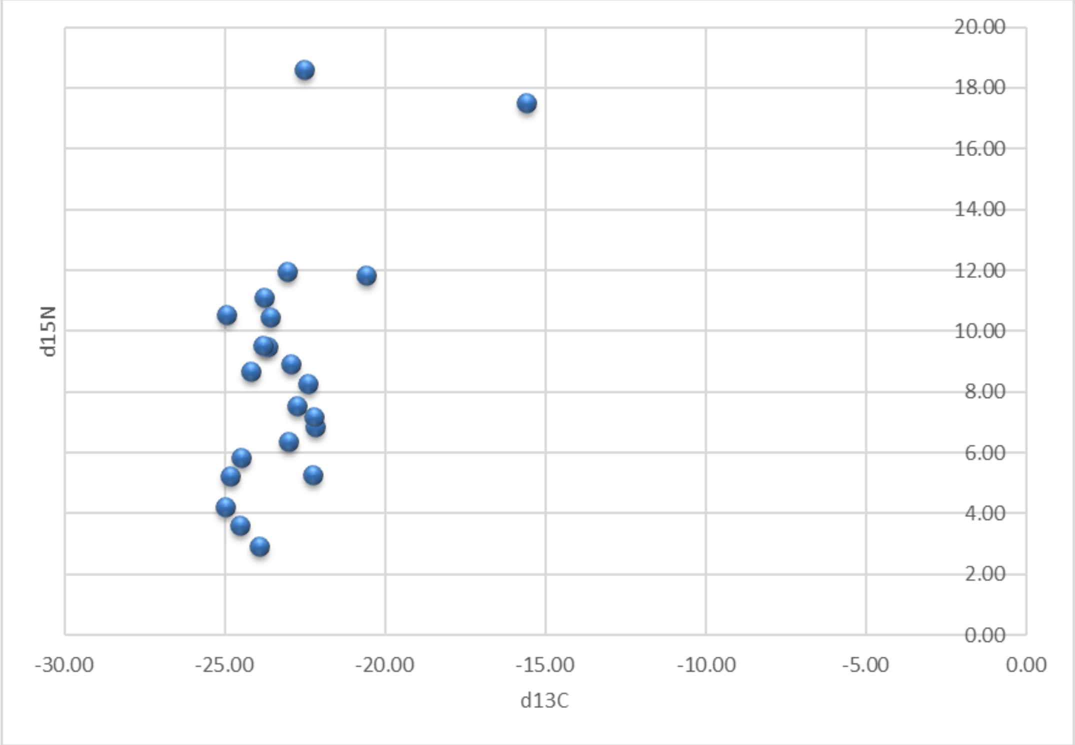
	Delta C		% C		Delta N		% N	
	Average	St Dev	Average	St Dev	Average	St Dev	Average	St Dev
Fish Gel δ raw	-15.24	0.09	43.28	0.44	15.22	0.09	16.72	0.20
Fish Gel δ true	-15.12				15.20			
Fish Gel Reported	***-15.32***		***43.40***		***15.20***		***16.80***	
Cane Measured	-11.85	0.09	39.84	2.21				
Cane Reported	***-11.64***	***+/-0.03***	***42.10***					
Caffine Measured	-27.53	0.12	47.91	1.02	0.83	0.01	27.75	0.70
Caffine Reported	***-27.77***	***+/-0.043***	***49.40***		***1.00***	***+/-0.2***	***28.90***	
N2 Measured					20.39	0.04	20.80	0.15
N2 Reported					***20.30***	***+/-0.2***	***21.21***	

Run Sample Stats

	δ13C	δ15N
Max Uncertainty	0.32	1.04
Min Uncertainty	0.10	0.14

Chart 1 & 2. Scatter plots showing d15N and d13C values from the selected food fragments from Çatalhöyük East and Jarmo





Appendix V:

Table 1: amalgamation of macrobotanical remains from Çatalhöyük East

Table 2: taxonomic identification of plant remains from Jarmo (2012-2014 seasons)

Table 3: frecuency and ubiquity percentages of plant remains from Jarmo

Jarmo seed catalogue

Table 1. Amalgamated macrobotanical data from flotation samples selected for the analysis of food fragments from Çatalhöyük East (excluding Fl.1924, 10634, 11860 and 13382 due to the absence of macrobotanical data available).

Flot	2/4 mm dung ml	2/4mm food frags ml	2/4 mm tubers ml	Fraction	barley grain	barley rachis	glume wheat grain	glume wheat glume bases	free-threshing wheat grain	free-threshing wheat rachis	cereal indeterminate grain	reed culm node	cereal culm node	lentil	pea	chickpea	bitter vetch	pulse indeterminate	weed/wild seed	Cyperaceae	Celtis	nutshell/fruitstone
192	0	0	7	1	0	2	17	565	0	6	8	2	0	1	1	0	1	5	16	11	0	0
516	0	1	0	1	204	1	17	271	17	1	22	0	0	3	5	0	1	5	2061086	17	0	0
639	0	2	1	1	4	8	45	626	0	34	1	2	0	24	0	0	6	5	74	75	2	0
1010	0	0	2	1	0	3	15	328	0	19	5	2	0	1	1	0	0	3	46	57	13	0
2985	0	0	2	1	0	3	10	226	0	10	1	1	0	1	0	0	1	3	58	23	2	0
3099	2	0	2	1	2	1	13	473	0	3	2	1	0	2	0	0	2	4	30	44	5	7
3127, 3133, 3137	4	0	5	0	18	4	65	606	4	14	21	2	0	15	8	1	25	27	1256	452	46	63
3148, 3149 and 3151	1	1	0	0	9	7	96	1776	0	106	17	1	0	64	8	1	2	30	266	144	37	16
3666	0	0	0	1	0	0	92	735	0	4	4	0	0	10	0	0	2	3	1397	64	0	0
5826	0	7	0	0	0	3	4	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0
5859	0	2	1	1	3	3	6	773	11	0	30	1	1	0	1	0	0	1	184	21	19	2
5860	0	0	0	1	2	2	2	58	0	3	4	1	0	2	1	0	0	0	34	4	0	1
6577	9	9	1	0	0	0	33	722	4	42	43	57	1	1	6	0	4	2	192	22	13	3
6939	0	1	0	0.015625	1	0	15	134	0	0	2	20	5	0	0	0	1	1	13	2	0	0
7196	1	1	1	0.015625	5	1	8	17	0	0	26	14	2	0	0	0	0	3	7	11	0	1
7205	0	0	2	0.015625	0	0	3	0	0	0	2	3	0	0	0	0	0	0	4	0	1	0
7558	0	3	1	0.0625	0	0	0	2	0	0	7	0	0	0	0	0	0	1	3	1	0	0
7654	2	3	0	0.5	1	1	3	18	30	0	110	4	0	0	0	0	0	13	238	21	0	0
7807	0	2	0	1	0	0	2	5	0	0	3	1	0	0	0	0	0	3	57	19	0	0
7835	0	0	1	0.125	0	0	0	0	0	0	2	2	0	0	0	0	0	0	2	2	0	0
7857	0	3	0	0.0625	6	0	1	16	0	0	9	0	0	0	2	0	0	1	3	0	0	0

7860	0	3	1	0.0625	1	1	1	4	0	1	15	1	0	0	0	0	0	1	1	7	0	0
7880	0	0	0	1	4	0	40	0	0	0	8	1	0	0	0	0	0	0	19	1	0	0
7884	0	0	0	1	1	0	1	12	0	2	213	4	0	0	0	0	0	0	5	3	0	4
7928	0	1	0	0.5	0	0	1	3	0	0	6	2	0	0	0	0	0	0	8	1	2	1
7937	0	0	1	1	0	0	1	22	0	0	4	8	0	0	0	0	0	3	6	0	0	31
7947	0	0	0	1	0	0	11	0	0	0	1	1	0	0	0	0	0	0	1	0	0	20
8000	0	1	0	0.0625	4	0	1	13	0	0	7	0	0	0	0	0	0	0	5	2	0	0
8006	0	1	0	1	0	0	0	20	0	0	3	0	0	0	0	0	0	0	1	0	0	1
8017	1	0	0	0.125	5	0	7	12	1	2	8	2	0	2	0	1	0	0	34	108	0	5
8019	0	1	0	0.125	0	0	4	8	0	0	17	5	0	0	0	0	0	0	3	5	0	2
8061	0	1	0	0.125	2	0	5	3	0	0	28	0	0	0	0	0	0	0	2	0	10	0
8123	0	0	0	1	0	0	11	2	0	0	9	0	0	0	0	0	0	0	10	9	0	0
8138	0	2	0	0.25	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
8143	0	0	0	1	0	0	1	15	0	0	1	0	0	0	0	0	0	0	0	0	0	2
8161	0	1	1	1	4	0	5	2	2	0	2	0	0	0	0	0	0	0	14	6	0	0
8183	0	1	0	0.0625	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	5	0
8340	0	0	0	1	4	1	4	7	3	0	10	0	0	0	0	0	0	0	7	1	0	0
8375	1	1	1	0.015625	2	0	0	6	0	0	3	0	0	0	0	0	0	0	1	1	3	0
8456	0	1	0	0.015625	0	0	3	6	0	0	1	0	0	0	0	0	0	0	1	0	0	0
8470	0	8	0	0.0625	2	0	8	0	0	0	3	6	0	0	0	0	0	0	30	2	50	4
8493	1	2	0	0.03125	0	0	0	2	0	0	2	0	0	0	0	0	0	0	4	1	1	2
8641	0	4	4	0.00390625	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	6
8654	0	0	0	0.0625	0	0	0	5	0	0	1	0	0	0	0	0	0	0	0	0	0	0
8946	0	1	0	0.015625	0	2	4	33	0	0	21	0	0	0	0	0	0	0	13	6	0	42
8987	0	1	0	0.125	0	1	0	7	0	0	4	0	0	0	0	0	0	0	1	0	0	0
8994	0	0	0	1	0	0	1	21	0	1	1	0	0	0	0	0	0	0	0	2	0	0
9016	5	16	0	0.125	20	0	3	5	3	0	24	2	4	0	0	0	0	0	78	6	0	14
9018	0	1	0	0.03125	0	1	0	48	0	0	6	3	5	0	0	0	0	0	9	6	4	3
9027	0	0	0	0.0625	0	0	3	4	0	1	5	0	0	1	0	0	0	0	8	0	0	0
9047	0	0	0	1	1	4	1	28	0	4	4	10	0	0	0	0	0	0	19	15	0	0
9053	0	5	0	0.0625	0	1	2	168	1	2	12	6	0	0	0	0	0	1	27	32	0	5
9085	0	0	0	0.03125	1	0	2	14	0	2	5	6	1	0	0	0	0	0	4	28	0	2

9091	0	0	0	0.125	0	1	6	22	0	2	3	0	0	0	0	0	0	0	3	3	3	0
9092	0	2	0	0.5	0	0	1	24	0	0	2	0	0	0	0	0	0	0	1	5	0	0
9229	0	0	0	1	5	0	12	152	0	2	16	1	0	0	0	0	1	1	19	47	0	11
9232	0	3	0	0.015625	3	3	3	96	1	29	29	22	0	0	0	0	0	0	9	0	5	1
9233	0	3	0	0.03125	0	14	3	25	0	16	19	13	0	0	0	0	0	0	9	0	0	1
9258	0	2	4	0.25	3	2	9	110	0	0	31	4	0	0	1	0	0	1	25	24	0	15
9266	0	1	0	0.03125	0	1	0	86	0	3	4	4	0	0	4	0	0	0	4	2	0	3
9395	0	1	0	1	0	1	0	77	1	4	44	2	0	0	0	0	0	2	3	4	1	16
9405	0	9	0	0.0078125	0	0	0	69	0	3	3	2	0	0	0	0	0	0	3	15	1	0
9518	0	3	0	0.25	0	3	17	0	10	19	30	0	0	0	3	0	0	0	6	0	0	0
9520	0	0	0	1	3	3	2	126	0	5	28	0	0	5	0	0	0	20	5	40	0	4
9668	0	1	0	0.5	0	1	1	22	0	3	8	6	0	0	0	0	0	0	9	3	1	0
9669	0	1	0	0.25	0	0	2	31	0	4	9	3	0	0	0	0	0	1	2	2	5	0
9822	0	5	0	0.25	5	4	2	5	0	6	2	5	1	2	0	0	0	2	7	5	0	1
9855	0	2	0	0.125	1	0	2	1	0	4	4	0	2	0	0	0	0	0	13	39	0	0
9868	0	10	0	0.125	2	2	6	9	3	1	56	16	0	3	0	0	0	3	25	71	0	0
9884	0	0	0	0.5	0	1	1	18	0	2	7	1	0	0	0	0	0	0	5	1	0	1
9909	0	0	0	0.03125	0	5	5	139	0	4	8	4	0	0	0	0	0	0	1	0	0	1
9924	0	2	0	1	3	0	3	12	1	2	0	0	5	0	0	2	0	0	2	7	2	0
9954	0	2	0	0.03125	4	0	2	44	0	0	7	2	0	0	0	0	0	0	9	1	0	2
10007	0	0	0	0.125	1	0	2	10	0	0	5	0	1	0	0	0	0	1	18	22	0	1
10009	0	1	1	0.0625	1	0	0	16	0	0	5	0	0	0	0	0	0	0	2	2	0	0
10010	0	1	0	0.03125	5	0	0	2	0	2	3	0	0	0	0	0	0	1	6	0	0	2
10012	0	0	0	0.25	1	0	5	7	0	0	8	0	1	0	0	0	1	1	3	10	0	0
10020	0	0	0	0.03125	4	0	5	6	0	0	1	0	2	0	0	0	0	2	4	0	0	1
10027	0	0	0	1	1	0	4	6	0	0	12	3	0	0	0	0	0	0	0	16	0	2
10028	0	1	0	0.5	5	0	2	3	2	0	4	0	0	2	0	0	0	3	5	20	2	0
10043	0	1	0	0.125	2	0	5	2	0	0	4	0	0	0	0	0	0	6	1	46	0	0
10048	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10051	0	1	0	0.125	5	0	3	5	1	0	0	0	0	0	0	0	0	1	0	18	0	0
10054	0	0	0	0.125	3	0	3	8	0	0	1	0	2	0	0	0	0	2	4	9	0	0
10055	0	1	0	0.0625	2	0	0	5	0	0	4	1	1	0	0	0	0	1	4	13	0	1

10074	0	1	0	0.0625	4	0	11	22	2	2	2	0	0	1	0	0	0	1	18	48	0	2
10079	0	1	0	0.0625	1	0	8	0	0	0	0	0	0	0	0	0	1	2	10	7	0	0
10255	0	1	0	0.015625	0	16	3	248	0	43	3	12	0	1	0	0	0	2	8	0	0	0
10260	0	5	0	0.0625	1	2	0	240	2	3	9	20	0	1	0	0	0	0	30	9	0	1
10342	0	1	0	1	0	1	14	146	2	5	0	0	0	0	0	0	0	0	1	19	42	0
10507	0	0	0	1	1	2	5	16	1	0	16	0	0	0	1	1	0	2	17	14	42	1
10521	5	1	0	0	0	1	2	5	0	0	0	0	46	0	0	0	0	0	0	3	0	0
10526	0	1	0	0.125	3	0	10	12	5	0	0	0	0	0	0	0	0	1	21	34	0	1
10543	3	2	0	1	8	0	7	1	0	10	0	0	0	0	0	0	0	0	0	99	87	0
10553	0	1	5	0	0	3	6	112	0	3	0	0	2	0	0	0	0	0	0	12	17	0
10563	0	0	0	0.0625	2	0	2	6	0	2	12	0	1	0	0	0	0	4	11	21	0	1
10570	0	1	2	1	7	1	14	6	4	2	0	0	0	0	0	0	0	0	25	16	33	0
10600	0	2	0	0.125	3	4	11	145	0	1	11	12	3	5	1	0	0	1	14	10	0	0
10622	0	1	0	0.0078125	1	0	1	73	0	1	8	0	17	0	0	0	0	0	6	5	0	0
10661	0	1	0	0.0625	3	1	3	14	0	0	12	0	0	0	0	0	0	2	2	4	0	1
10662	0	1	0	0.25	7	2	5	72	0	1	7	0	0	0	0	0	0	1	21	4	0	1
10664	0	1	16	0.125	1	0	0	15	2	0	0	0	1	0	0	0	0	0	0	2	3	0
10675	0	1	0	0.0625	2	0	3	12	2	0	5	0	0	0	0	0	0	1	7	21	0	6
10679	0	0	1	0.125	2	0	9	178	1	0	0	0	0	1	1	0	0	0	0	5	6	0
10681	0	1	0	0.25	1	0	4	15	0	1	8	0	3	0	0	0	1	0	5	2	0	1
10691	0	0	0	1	1	0	13	207	2	2	29	0	0	2	0	0	0	0	3	3	0	1
10720	0	5	2	0.125	4	0	12	31	4	1	0	1	0	0	0	1	0	1	1	29	5	0
10721	0	10	0	0.03125	5	1	15	35	10	1	10	0	0	0	0	0	0	0	147	1	0	3
10742	0	8	0	0.03125	2	0	5	11	2	0	7	0	0	0	0	0	0	1	21	2	0	1
10769	0	0	0	0.5	0	0	2	24	0	0	2	4	1	0	0	0	0	0	0	0	0	1
10770	0	0	0	0.25	0	0	2	66	0	5	3	2	0	0	0	0	0	2	1	1	0	2
10779	0	0	0	1	0	2	12	128	1	1	5	0	0	0	0	0	0	10	75	91	0	19
10798	0	0	1	0	0	1	9	349	5	10	1	3	4	0	0	0	0	7	4	45	5	1
10803	0	0	0	0.25	5	3	0	5	0	3	4	3	5	0	1	0	0	0	27	93	0	0
10804	0	0	0	0.015625	6	0	7	9	2	0	5	2	0	0	1	0	0	0	17	11	0	0
10967	0	6	1	1	15	0	24	6	0	0	0	0	6	0	9	0	1	2	0	0	1	0
11129	0	2	0	1	0	1	1	21	0	0	2	1	0	0	0	0	0	0	0	4	0	1

11130	0	1	0	0.0625	2	3	3	141	1	2	5	13	2	0	1	0	0	1	8	5	0	5
11137	0	0	0	1	0	0	8	16	0	0	6	0	1	0	0	0	0	3	3	13	0	7
11162	0	0	0	0.5	2	0	4	72	0	0	2	0	1	0	0	0	0	0	0	16	1	0
11177	0	11	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
11235	0	1	0	1	2	0	2	18	0	0	0	0	0	0	0	0	0	0	2	8	2	0
11239	0	0	0	1	0	0	1	66	0	0	0	0	1	0	0	0	0	1	0	61	10	1
11240	0	0	0	1	8	13	9	707	3	20	0	0	0	3	0	0	0	0	0	30	25	0
11723	0	1	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
11747	0	2	2	0	4	2	0	81	0	0	2	0	0	0	0	0	0	1	0	0	6	1
11750	0	1	1	0	5	2	5	0	0	2	2	1	0	4	3	0	0	0	0	1	10	0
11799	0	0	1	0	2	7	6	134	0	0	0	0	0	1	0	0	0	0	1	0	14	24
11822	0	0	0	0.125	0	0	0	2	1	0	8	0	0	0	0	0	0	0	1	24	0	0
11832	0	0	3	1	3	0	0	3	9	3	0	0	0	0	0	0	0	0	0	3	46	0
11922	0	1	0	0																		1
12021	0	2	0	1	0	0	1	0	0	1	0	0	0	0	1	0	0	1	1	1	2	0
12054	0	0	0	1	0	0	0	10	0	0	0	0	0	1	0	1	0	0	2	0	1	0
12155	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12267	0	1	0	1	4	0	17	14	1	0	1	0	0	0	2	0	0	0	1	7	12	0
12278	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12405	0	2	0	1	3	0	10	42	7	0	4	9	17	0	0	0	0	4	4	2	1	0
12982	0	3	0	0	3	2	3	2	45	0	0	0	0	0	0	1	0	1	0	20	0	0
13012	0	1	0	1	0	0	0	17	1	1	3	0	0	0	0	0	0	0	9	0	0	0
13017	0	1	0	1	1	0	0	0	6	0	0	0	0	1	0	0	0	0	6	0	0	0
13255	0	0	0	1	0	0	3	2	0	1	0	0	0	0	0	0	0	0	0	6	5	1
13511	0	1	0	0	6	0	6	30	4	0	3	3	1	0	0	0	0	0	3	19	9	13
13596	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	3	0	0
13607	0	0	0	1	6	2	4	165	0	0	19	0	0	0	0	0	0	0	11	0	0	0
13617	0	1	0	1	2	1	4	22	1	0	0	0	0	0	0	0	0	0	0	0	0	0
13717	0	1	0	1	146	13	8	0	43	0	0	1	0	1	12	1	4	14	6	0	0	0
13850	0	2	0	1	172	0	24	8	40	0	0	0	0	920	0	6	8	19	81	14	0	1

Table 2. List of total counts of archaeobotanical taxa from Jarmo, seasons 2012-14

2012

	Context/layer	3	4	5	6	7	8	9	10	11	6	7	8	9	10	11	1	2	3	4	5
	Flot no.	6	9, 10	13	16,17	18	20,21	24	29	33,34	14,15,19	18,22	25,26,27	28,30	31,32	35,36,37	1,23	2,3	4,5	7,8	11,12
	Vol. (4463 L)	40	80	40	80	40	77	40	40	80	120	80	120	60	80	120	80	80	67	68	80
Cereals	**Plant part**																				
Hordeum vulgare	grain		1		2													1			
Hordeum cf. *spontaneum*																					
Triticum dicoccum	grain		1		2		1														
	apical end																				
	spikelet forks				9	1										1					
	basal rachis				1																
	glume base				9											3					
Triticum cf. *dicoccum*	grain																				
	spikelet forks		1		2			7		2		4		7	4	3					
	glume base		2	3		7		5		38		13		6	1	3					
	glumes				2	1		2													
Triticum sp.	spikelet forks				5	3															
	culm node																			1	
	basal spikelet fork																				
Triticum dicoccum/monococcum	grain				1																
Triticum aestivum	grain			1																	
Triticum cf. *aestivum*	grain																				
Triticum cf. *temopheevii*	glume base																				
	grain																				
Pulses																					
Lathyrus sativus	seed												4								
cf. Lathyrus sativus	seed					1										1					
Lathyrus cf. *sativus/cicera*	seed															1					
Lens culinaris	seed	3	1		10		2		2	1		2	2	2	5	7	1	1			
	fragments																				
cf. *Lens culinaris*	seed			1	1				2				1		4	1					
Pisum sativum	seed	1				1							1		2						
cf. *Pisum sp.*																					
cf. Lathyrus/Pisum	seed																				
Vicia cf. *faba*	fragments						2						1		2	1					
Vicia cf. *ervilia*	seed		1																		
Vicia sativa	seed	1	1		1		1			2			1			3					
cf. *Vicia* sp.	seed																				1
Fabaceae indeterminate (small)	fragments		3		2						3							7			
Fabaceae indeterminate (large)	fragments					4						5	9								
Fabaceae indeterminate	fragments		2										5	3	4	19			x		

Other edible taxa																					
Linum usitatissimum	whole				1					1					1	1				1	
	fragments																				
Pistacia sp.	wge		1		1							1				1					
Unidentified nutshell	fragments						1			1				1	2	2					
Wild taxa																					
Adonis sp.	grain																			1	
Acacia sp.	grain												1								
cf. Aegilops sp.	fragments																				
	spikelet forks																				
Carex sp.																					
Cyperaceae	fragments																				
cf. Cerastium sp.																					
Galium sp.	seed		1		1					1											1
cf. *Galium* sp.	seed											1									
cf. *Lolium* sp.	seed														1						
Medicago sp.	seed																				
Onobrychis viciifolia	seed																			2	
Schoenoplectus cf. *lacustris*	seed		2	1	1						1										
cf. *Proposis* sp.	seed																				5
Poaceae indeterminate	whole grain	1											1								
Poaceae indeterminate	presence				x																
Thymeleae cf. *passerina*	seed																				
Scirpus sp.	seed																				
Pisum sp.	seed																				
Other																					
Food remains	fragments	1			7			11					7	9	14						
cereal indeterminate	presence						x		x	x		x		x	x	x			x	x	x
indeterminate	presence	x			x			x		x	x		x		x	x				x	x
indeterminate 2	presence												1								
Fabaceae indeterminate	whole																	1			
stem indeterminate	fragments															1					
rodent dropping	presence																				
faunal remains	presence	1																			

2014

	Trench	QR1415	QR1415	QR1415	QR1415	QR1415	QR1415	QR1415	QR1415	QR1415	QR1415	QR1415	QR1415	QR1415	QR1415	QR1415	QR1415	QR1415	QR1415
	Context/layer	M3	W3	WME5	WME5	WMES B	B Spit 6	B Spit 6	19	16	17	18	18	10	11	15	15	15	18
	Flot no.	41	42	50	51	61	73	74	193	194	195	196	198	116	127	137	141, 178	143	144
	Vol. (4463 L)	17	20	19	18	20	20	19	20	20	18	17	18	20	20	18	38	18	18
Cereals	**Plant part**																		
Hordeum vulgare	grain						1												
Hordeum cf. *spontaneum*												1							
Triticum dicoccum	grain												1						1
	apical end																		1
	spikelet forks									1									
	basal rachis																		
	glume base																		
Triticum cf. *dicoccum*	grain																		
	spikelet forks																		
	glume base							1		1	1	2							2
	glumes																		
Triticum sp.	spikelet forks																		
	culm node																		
	basal spikelet fork																		
Triticum dicoccum/monococcum	grain																		
Triticum aestivum	grain						1												
Triticum cf. *aestivum*	grain						1												
Triticum cf. *temopheevii*	glume base																		
	grain																		
Pulses																			
Lathyrus sativus	seed																		
cf. Lathyrus sativus	seed																		
Lathyrus cf. *sativus/cicera*	seed																		
Lens culinaris	seed		1						1					1		1		3	1
	fragments																1		2
cf. *Lens culinaris*	seed																		
Pisum sativum	seed																		
cf. *Pisum sp.*																			
cf. Lathyrus/Pisum	seed																		
Vicia cf. *faba*	fragments																		
Vicia cf. *ervilia*	seed																		
Vicia sativa	seed																		
cf. *Vicia* sp.	seed																		
Fabaceae indeterminate (small)	fragments																		
Fabaceae indeterminate (large)	fragments		2	1	1				2			1							
Fabaceae indeterminate	fragments												3						

Other edible taxa																			
Linum usitatissimum	whole							1				1							
	fragments																		
Pistacia sp.	wge																		
Unidentified nutshell	fragments																		
Wild taxa																			
Adonis sp.	grain																		
Acacia sp.	grain																		
cf. Aegilops sp.	fragments																		
	spikelet forks																		
Carex sp.			1																
Cyperaceae	fragments																		
cf. Cerastium sp.						1													
Galium sp.	seed																		
cf. *Galium* sp.	seed																		
cf. *Lolium* sp.	seed																		
Medicago sp.	seed																		
Onobrychis viciifolia	seed																		
Schoenoplectus cf. *lacustris*	seed																		
cf. *Proposis* sp.	seed																		
Poaceae indeterminate	whole grain	1																	
Poaceae indeterminate	presence								0										
Thymeleae cf. *passerina*	seed									1									
Scirpus sp.	seed														1				
Pisum sp.	seed																		
Other																			
Food remains	fragments																6		7
cereal indeterminate	presence		x						4		x								
indeterminate	presence																		
indeterminate 2	presence																		
Fabaceae indeterminate	whole																		
stem indeterminate	fragments																		
rodent dropping	presence																		
faunal remains	presence			1															

2014

	Trench	QR1415	QR1415	QR1415	QR1415	QR1415	QR1415	QR1415	QR1415	QR1415	QR1415	F4/5	E4	EF4	E3/4	EF4	E4	E4	E4	E4	E4	M1415	M1415	M1415	F4-5	EF4	JCM
	Context/layer	11	20	21	17	22	22	22	22	20	20	11	1	2	2	5	9	3	10	?	5B	15	20	11	5	5	21
	Flot no.	148	150	151	158	159	179	180	181	182	184	75	108	133	153	162	167	172	175	183	192	146	160	169, 171	64	155	152
	Vol. (4463 L)	20	20	20	20	18	18	17	18	18	18	19	20	20	20	20	20	15	20	10	20	19	16	30	20	18	21
Cereals	**Plant part**																										
Hordeum vulgare	grain																					1					
Hordeum cf. *spontaneum*																											
Triticum dicoccum	grain																										
	apical end						1																				
	spikelet forks																										
	basal rachis																										
	glume base														2												
Triticum cf. *dicoccum*	grain								1																		
	spikelet forks					2					2								1								
	glume base	1	1			1	1	1		1	3					2			2		1						
	glumes																										
Triticum sp.	spikelet forks																										
	culm node																										
	basal spikelet fork			1																							
Triticum dicoccum/monococcum	grain																										
Triticum aestivum	grain						1																				
Triticum cf. *aestivum*	grain																										
Triticum cf. *temopheevii*	glume base	?1	?1																								
	grain						1																				
Pulses																											
Lathyrus sativus	seed																										
cf. Lathyrus sativus	seed					2													3								
Lathyrus cf. *sativus/cicera*	seed																										4
Lens culinaris	seed	3	1	1	1	4	1	6	2	1			1	1									1				
	fragments	4	1	2																2			1				
cf. *Lens culinaris*	seed																										
Pisum sativum	seed			1		1																					1
cf. *Pisum sp.*								1			1																
cf. Lathyrus/Pisum	seed								2																		
Vicia cf. *faba*	fragments																										
Vicia cf. *ervilia*	seed																										
Vicia sativa	seed			1																							
cf. *Vicia* sp.	seed																										
Fabaceae indeterminate (small)	fragments	2		6						4																	5
Fabaceae indeterminate (large)	fragments			1				2									4	1					1				
Fabaceae indeterminate	fragments					2																					

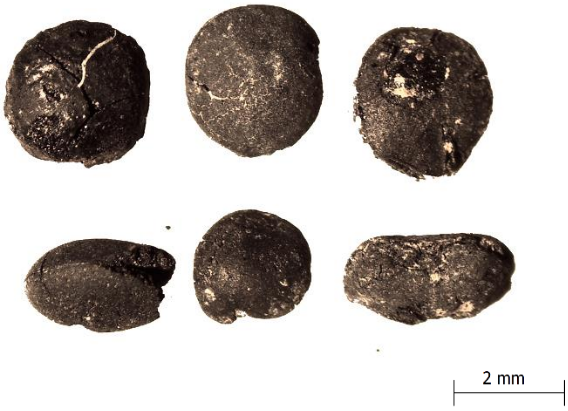
Other edible taxa																											
Linum usitatissimum	whole	2		1			1			1						1											
	fragments			3		1																					7
Pistacia sp.	wge																										
Unidentified nutshell	fragments		1															3									
Wild taxa																											
Adonis sp.	grain																										
Acacia sp.	grain																										
cf. Aegilops sp.	fragments					1																					
	spikelet forks																						1				
Carex sp.																											
Cyperaceae	fragments			1																							
cf. Cerastium sp.																											
Galium sp.	seed												1														
cf. *Galium* sp.	seed																										
cf. *Lolium* sp.	seed																										
Medicago sp.	seed																										
Onobrychis viciifolia	seed																										
Schoenoplectus cf. *lacustris*	seed																										
cf. *Proposis* sp.	seed																										
Poaceae indeterminate	whole grain						2	2																			
Poaceae indeterminate	presence																						2				
Thymeleae cf. *passerina*	seed											1															
Scirpus sp.	seed						1																				
Pisum sp.	seed																		1								
Other																											
Food remains	fragments	16	14			1		12			12								2				8		6	17	10
cereal indeterminate	presence			x																	1			x			
indeterminate	presence																						x				
indeterminate 2	presence																										
Fabaceae indeterminate	whole																										
stem indeterminate	fragments																										
rodent dropping	presence																										
faunal remains	presence																1										

Table 3. Frequency and Ubiquity percentage of plant remains recovered from Jarmo 2012-2014 seasons

Jarmo 2012/14				
Cereals	**Plant part**	**Presence**	**Ubiquity %**	**Frequency %**
Hordeum vulgare	grain	5	6.02	0.83
Hordeum cf. *spontaneum*		1	1.20	0.14
Triticum dicoccum	grain	6	7.23	0.83
	apical end	2	2.41	0.28
	spikelet forks	4	4.82	1.66
	basal rachis	1	1.20	0.14
	glume base	3	3.61	1.94
Triticum cf. *dicoccum*	grain	1	1.20	0.14
	spikelet forks	11	13.25	4.84
	glume base	25	30.12	13.69
	glumes	3	3.61	0.69
Triticum sp.	spikelet forks	2	2.41	1.11
	culm node	1	1.20	0.14
	basal spikelet fork	1	1.20	0.14
Triticum dicoccum/monococcum	grain	1	1.20	0.14
Triticum aestivum	grain	3	3.61	0.41
Triticum cf. *aestivum*	grain	1	1.20	0.14
Triticum cf. *temopheevii*	glume base	2	2.41	0.28
	grain	1	1.20	0.14
Pulses				
Lathyrus sativus	seed	1	1.20	0.55
cf. Lathyrus sativus	seed	4	4.82	0.97
Lathyrus cf. *sativus/cicera*	seed	2	2.41	0.69
Lens culinaris	seed	33	39.76	9.68
	fragments	7	8.43	1.80
cf. *Lens culinaris*	seed	6	7.23	1.38
Pisum sativum	seed	7	8.43	1.11
cf. *Pisum sp.*		2	2.41	0.28
cf. Lathyrus/Pisum	seed	1	1.20	0.28
Vicia cf. *faba*	fragments	4	4.82	0.83
Vicia cf. *ervilia*	seed	1	1.20	0.14
Vicia sativa	seed	8	9.64	1.52
cf. *Vicia* sp.	seed	1	1.20	0.14
Fabaceae indeterminate (small)	fragments	8	9.64	4.43
Fabaceae indeterminate (large)	fragments	13	15.66	4.70
Fabaceae indeterminate	fragments	9	10.84	5.26
Other edible taxa				
Linum usitatissimum	whole	12	14.46	1.80
	fragments	3	3.61	1.52

Pistacia sp.	wge	4	4.82	0.55
Unidentified nutshell	fragments	7	8.43	1.52
Wild taxa				
Adonis sp.	grain	1	1.20	0.14
Acacia sp.	grain	1	1.20	0.14
cf. Aegilops sp.	fragments	1	1.20	0.14
	spikelet forks	1	1.20	0.14
Carex sp.		1	1.20	0.14
Cyperaceae	fragments	1	1.20	0.14
cf. Cerastium sp.		1	1.20	0.14
Galium sp.	seed	5	6.02	0.69
cf. *Galium* sp.	seed	1	1.20	0.14
cf. *Lolium* sp.	seed	1	1.20	0.14
Medicago sp.	seed	0	0.00	0.00
Onobrychis viciifolia	seed	1	1.20	0.28
Schoenoplectus cf. *lacustris*	seed	4	4.82	0.69
cf. *Proposis* sp.	seed	1	1.20	0.69
Poaceae indeterminate	whole grain	5	6.02	0.97
Poaceae indeterminate	presence	3	3.61	0.55
Thymeleae cf. *passerina*	seed	2	2.41	0.28
Scirpus sp.	seed	2	2.41	0.28
Pisum sp.	seed	1	1.20	0.14
Other				
Food remains	fragments	18	21.69	22.13
cereal indeterminate	presence	16	19.28	2.90
indeterminate	presence	11	13.25	1.52
indeterminate 2	presence	1	1.20	0.14
Fabaceae indeterminate	whole	1	1.20	0.14
stem indeterminate	fragments	1	1.20	0.14
rodent dropping	presence	0	0.00	0.00
faunal remains	presence	3	3.61	0.41

Jarmo seed catalogue



Lentils (*Lens culinaris*)

Vetch (*Vicia sativa*)

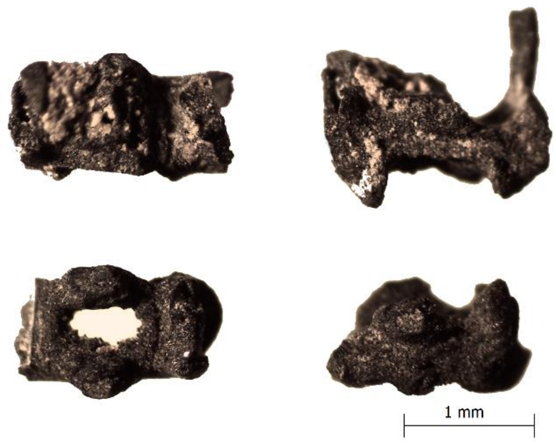
Grass pea (*Lathyrus sativus*)

Flax (*Linum usitatissimum*)

Naked barley (*Hordeum vulgare* var. *nudum*)

Emmer (*Triticum diccocum*)

Free-threshing wheat (*Triticum aestivum*)



Triticum sp. Spikelet forks

Triticum sp. Glume bases

New Type glume wheat (*Triticum* cf. *temopheevii*)

Appendix VI

Table 1: Summary table of the distribution of the analysed food fragments by building and context type from Çatalhöyük East

Table 1. Summary table of the distribution of the analysed food fragments by building and context type from Çatalhöyük East

Flot	Unit	Level	Period	Space	Building	Area	Context type	Wheat	Barley	Indet. Cereal	Pulses	Tuber	Wild mustard	Other	Matrix type
192	1074	South L	Early	115	none	South	Outdoor midden			x				x	3
516	1442	North G	Middle	187	1	North	Occupation layer								1
639	1835	South K	Early	116	2	South	bin fill								3
1010	2346	South L	Early	151	4	South	Indoor fire installation			x					1
1924	3600	South L	Early	115	none	South	Open fire outdoor	x							3
2985	4917	South L	Early	173	6	South	bin fill	x		x					3
3099.1	4937	South L	Early	173	6	South	Indoor fire installation	x			x				3
3099.2	4937	South L	Early	173	6	South	Indoor fire installation	x					x		3
3133	4866	South G	Early	181	none	South	Outdoor midden			x					3
3148	4869	South G	Early	181	none	South	Outdoor midden	x		x					3
3151	4869	South G	Early	181	none	South	Outdoor midden		x						3
3666	5302	South G	Early	181	none	South	Outdoor midden	x							2
5826.1	10240	North J	Late	237	47	North	Indoor fire installation	x							4
5826.2	10240	North J	Late	237	47	North	Indoor fire installation	x							2
5859	10081	North H	Late	238	45	North	Occupation layer	x							1
5860	7948	North G	Middle	100	49	North	Indoor fire installation	x		x					3
6577	13107	North I	Late	279	none	North	Outdoor midden	x	x	x					3
6939	13183	North I	Late	279	none	North	Outdoor midden	x	x	x					3
7196	14186	North I	Late	279	none	North	Outdoor midden	x							3
7205	14179	North I	Late	279	none	North	Outdoor midden	x	x	x					4
7558.1	15724	South Q	Late	299/305	none	South	Outdoor midden	x							1
7558.2	15724	South Q	Late	299/305	none	South	Outdoor midden	x							3
7654	15749	South P	Late	427	none	South	Outdoor midden	x	x						2
7807	16224	South P	Late	371	none	South	Outdoor midden	x		x					3
7835	16246	South Q	Late	299/305	none	South	Outdoor midden	x	x	x					4
7857	16279	South P	Late	328	75	South	Indoor fire installation	x		x					2
7860.1	16507	South S	Late	319	none	South	Outdoor midden	x		x					3
7860.2	16507	South S	Late	319	none	South	Outdoor midden	x		x					4
7880	16505	South P	Late	333	none	South	outdoor ovens area	x	x						3

7884	16518	South P	Late	333	none	South	outdoor ovens area	x							1
7937	14472	North G	Middle	100	49	North	Occupation layer			x					2
7947.1	14468	North G	Middle	100	49	North	Occupation layer		x						3,4
7947.2	14468	North G	Middle	100	49	North	Occupation layer	x							1
8000	16548	South P	Late	333	none	South	outdoor ovens area			x		x			3
8006	14496	North G	Middle	100	49	North	Occupation layer	x			x				3
8017	16715	North G	Middle	60	none	North	Outdoor midden	x		x					4
8019	16570	South P	Late	333	none	South	outdoor ovens area	x							2
8061	16543	South P	Late	333	none	South	outdoor ovens area	x							3
8123	16595	South P	Late	333	none	South	outdoor ovens area	x							2
8143	14469	North G	Middle	100	49	North	Occupation layer	x							3
8161	17027	South R	Late	339	none	South	Outdoor midden	x							2
8183	17039	South R	Late	339	none	South	Outdoor midden	x	x						3
8340	17081	South Q	Late	299/305	none	South	Outdoor midden	x	x	x					3
8375	17308	South Q	Late	299/305	none	South	Outdoor midden	x							3
8456	16484	North G	Middle	336	77	North	Occupation layer			x					3
8470	17339	South P	Late	333	none	South	outdoor ovens area	x		x					1
8493	16493	North G	Middle	336	77	North	Occupation layer								3
8641	17525	North G	Middle	336	77	North	Occupation layer					x			4
8654	17527	North G	Middle	336	77	North	Occupation layer		x	x					4
8946	18511	South P	Late	344	none	South	Outdoor midden	x	x						1
8987	18441	South O	Middle	137	76	South	Burial			x					4
8994	18565	South O	Middle	134	79	South	between walls	x							3
9016	18194	South P	Late	372	none	South	Open fire outdoor	x	x	x					2
9018	18537	South P	Late	344	none	South	Outdoor midden	x	x	x					2
9027	18548	South P	Late	344	none	South	Outdoor midden	x							3
9047	18608	South P	Late	369	none	South	Outdoor midden		x	x					3
9053	18609	South P	Late	369	none	South	Outdoor midden								1
9085.1	18616	South P/South O	Late	374	87	South	Occupation layer								3
9085.2	18616	South P/South O	Late	374	87	South	Occupation layer	x							2

9091.1	18489	South O	Middle	137	76	South	Burial				x				1
9091.2	18489	South O	Middle	137	76	South	Burial			x					2
9092	18465	South O	Middle	137	76	South	Burial	x	x	x					4
9229	19044	North G	Middle	336	77	North	Burial								3
9232.1	19115	South P	Late	344	none	South	Outdoor midden	x		x					3
9232.2	19115	South P	Late	344	none	South	Outdoor midden		x	x					3
9233	19114	South P	Late	344	none	South	Outdoor midden		x	x					3
9258	18953	South O	Middle	135	80	South	Indoor fire installation			x					2
9266	19128	South P	Late	344	none	South	Outdoor midden		x			x			3
9395	19344	South N	Middle	460	none	South	Outdoor midden	x		x					3
9405.1	19349	South N	Middle	459	none	South	Outdoor midden			x					3
9405.2	19349	South N	Middle	459	none	South	Outdoor midden	x			x				4
9518	19603	South O	Middle	469/365	97	South	bin fill			x					1
9520.1	19295	North G	Middle	336	77	North	Burial			x					3
9520.2	19295	North G	Middle	336	77	North	Burial			x					2
9668	19243	South O	Middle	469/365	97	South	Occupation layer	x		x					3
9669.1	18782	South N	Middle	379	89	South	Occupation layer	x		x					3,4
9669.2	18782	South N	Middle	379	89	South	Occupation layer	x		x					3
9822	20140	TP U	Final-T	495	110 (b.5)	TPC	Occupation layer		x						4
9855	20149	TP U	Final-T	496	none	TPC	Occupation layer		x	x					4
9868	20154	TP U	Final-T	496	none	TPC	Occupation layer								4
9884	20428	North H	Late	77/76	129	North	Burial		x						4
9924.1	20215	TP Q	Final	491	115	TPC	Outdoor midden	x							3
9924.2	20215	TP Q	Final	491	115	TPC	Outdoor midden	x		x					4
9954	20232	TP Q	Final	491	115	TPC	Outdoor midden	x							3
10007	20507	TP Q	Final	491	115	TPC	Occupation layer	x		x					1
10009	20511	TP Q	Final	491	115	TPC	Occupation layer	x		x					4
10010	20249	TPC Post-Chalcolithic	Final-T	484	none	TPC	Occupation layer			x					4
10012	20261	TPC Post-Chalcolithic	Final-T	484	none	TPC	Occupation layer			x					3
10020	20255	TPC Neolithic	Final	495	none	TPC	Occupation layer			x					2

10027	20187	TP W	Final-T	498	none	TPC	Occupation layer	x	x	x					3
10028	20260	TP U	Final-T	496	none	TPC	Occupation layer	x	x	x					4
10043	20184	TP U	Final-T	496	none	TPC	Occupation layer			x					4
10051	20168	TP W	Final-T	498	none	TPC	Occupation layer	x	x	x					3
10054	20254	TP N	Late	486	110 (B.5)	TPC	Occupation layer	x		x					4
10055	20168	TP W	Final-T	498	none	TPC	Burial		x	x					3
10074	20189	TP U	Final-T	496	none	TPC	Occupation layer	x		x					3
10079	20192	TP U	Final-T	495	none	TPC	Occupation layer	x	x	x					4
10255	20488	North G	Middle	87	114	North	Occupation layer	x							3
10260	19570	North G	Middle	87	114	North	Occupation layer								3
10342.1	20625	North G	Middle	336	77	North	Burial	x							3
10342.2	20625	North G	Middle	336	77	North	Burial	x		x					4
10521	20961	North G	Middle	87	114	North	Occupation layer	x		x					3,4
10526	30288	TPC Post-Chalcolithic	Final-T	598	none	TPC	Occupation layer	x	x						4
10543	30274	TP U	Final-T	509	120	TPC	Occupation layer			x					3
10553	20686	North G	Middle	336	77	North	Burial	x	x						3
10563	30285	TPC Post-Chalcolithic	Final-T	507	none	TPC	Occupation layer			x					3
10570	30271	TP Q	Final	506	none	TPC	Occupation layer								3
10600	20988	North F	Middle	511	132	North	Occupation layer								1
10622	30547	North F	Middle	512	119	North	Occupation layer	x			x				4
10634	20989	North G	Middle	336	77	North	Burial	x		x					4
10661	30738	TP M	Late	514	121	TPC	Occupation layer	x							4
10662	30614	South H	Early	510	118	South	Occupation layer								4
10664	30615	South H	Early	510	118	South	Occupation layer	x				x			4
10675	30745	TPC Post-Chalcolithic	Final-T	508	none	TPC	Occupation layer	x							4
10679	19379	South M	Middle	470	none	South	Occupation layer	x							3
10681	30747	TP N	Late	485	110	TPC	Occupation layer	x							1
10691	19879	South N	Middle	379	89	South	Burial			x					2
10720	30757	TP M	Late	514	121	TPC	Occupation layer	x		x					4
10721	30761	TP M	Late	514	121	TPC	Occupation layer	x		x					4

10742	30778	TP M	Late	514	121	TPC	Occupation layer		x	x					3
10769	30561	North G	Middle	87	114	North	Occupation layer	x		x					3
10770	30503	North G	Middle	94	52	North	Burial			x	x				3
10779	30626	South H	Early	510	118	South	Occupation layer			x					3
10798	30106	North F	Middle	512/513	119	North	Occupation layer	x		x	x				3
10803	30732	TP R	Final-T	519	none	TPC	Outdoor midden	x							1
10804	30806	TP M	Late	514	121	TPC	Occupation layer	x		x					3
10967	30870	TPC Neolithic	Final	648	none	TPC	Outdoor midden		x	x					4
11129	21117	North G	Middle	527	113	North	between walls	x		x					3
11130	21108	North G	Middle	527	113	North	between walls	x							3
11137	21109	North G	Middle	527	113	North	between walls		x	x	x				4
11162	21140	North G	Middle	527	113	North	Occupation layer	x							3
11177	30436	TP W	Final-T	528	none	TPC	Burial		x						3
11235	30364	South L	Early	236	43	South	Occupation layer	x			x				3
11239	22032	North G	Middle	488	none	North	Outdoor midden	x			x				4
11240	21170	North G	Middle	87	114	North	Occupation layer	x			x				4
11723	21061	TP U	Final-T	495	none	TPC	Indoor fire installation	x							3
11747	21645	North G	Middle	490	none	North	Outdoor midden			x					1
11750	21659	North G	Middle	490	none	North	Outdoor midden	x							3
11799	21661	North G	Middle	489	none	North	Outdoor midden	x		x					2
11822	21089	TP U	Final-T	495	none	TPC	Occupation layer	x							4
11832	21095	TP M	Late	493	122	TPC	Occupation layer	x	x						3
11860	21051	TP U	Final-T	495	none	TPC	Occupation layer			x					4
11922	22709	TP M	Late	493	122	TPC	bin fill	x		x					4
12021	22764	TP M	Late	639	150	TPC	Occupation layer	x		x					1
12054	21964	South N	Middle	379	89	South	Occupation layer	x							4
12155.1	22834	TP N	Late	420	none	GDN	Outdoor midden			x					3
12155.2	22834	TP N	Late	420	none	GDN	Outdoor midden	x							4
12267	31353	TP M	Late	639	150	TPC	Occupation layer								1
12278.1	22850	TP N	Late	420	none	GDN	Outdoor midden	x							1

12278.2	22850	TP N	Late	420	none	GDN	Outdoor midden		x	x					4
12405	21038	TP M	Late	597	150	TPC	Outdoor midden	x							3
12982	20761	TP M	Late	594	150	TPC	Pot fill	x							4
13012	30888	TP M	Late	594	150	TPC	Occupation layer	x							3
13017	20798	TP M	Late	594	150	TPC	Occupation layer	x							1
13255	23216	South I	Early	620	none	South	Occupation layer	x		x					3
13511	31894	TP M	Late	594	150	TPC	Occupation layer	x							4
13596.1	20766	TP M	Late	594	150	TPC	Occupation layer			x					4
13596.2	20766	TP M	Late	594	150	TPC	Occupation layer	x							3
13607	23700	TP M	Late	594	150	TPC	bin fill	x							3
13617	23717	TP N	Late	585	none	TPC	Occupation layer	x							4
13717.1	23778	TP M	Late	515	166	TPC	Occupation layer			x					4
13717.2	23778	TP M	Late	515	166	TPC	Occupation layer	x							4
13850	32803	TP M	Late	637	150	TPC	Occupation layer								1
13882	23993	TP M	Late	639	150	TPC	Occupation layer								2,3