HOW ROYALS FEASTED IN THE COURT OF PEDRO I OF CASTILE: A CONTRIBUTION OF STABLE ISOTOPE STUDY TO MEDIEVAL HISTORY

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Abstract:

Study of the human remains of King Pedro I of Castile (1334-1369), his wife Queen Maria of Padilla (c. 1334-1361), and three other members of his family offered the possibility to investigate the diet of an elite in the medieval Iberian Peninsula by analyzing $\delta^{15}N$ and $\delta^{13}C$ values in collagen samples of their bones. Two medieval archaeological samples were selected for comparative purposes: a Christian sample (n=5) from Palacios de la Sierra (Burgos), and a Muslim sample (n=5) from La Torrecilla (Granada). Results obtained were compared with published data on other medieval populations of the Iberian Peninsula with the aim of improving knowledge on the diet of medieval populations, especially elite groups. Differences in the consumption of C3 and C4 plants were observed between Christians and Muslims, as previously reported. $\delta^{15}N$ values indicated social class differences. The diet of the royal family was characterized by mainly C3 plants and an extremely high animal protein intake characteristic of carnivores. These results are consistent with historical data on the life circumstances of this family.

Keywords:

Pedro I of Castile; stable isotopes; diet; medieval; elite; religion beliefs

1. Introduction

In September 2012, a study was conducted on the contents of boxes from the crypt of the *Virgen de los Reyes* Chapel in Seville Cathedral (Southern Spain) holding the mortal remains of King Pedro I of Castile (1334-1369) (Figure 1), his wife María de Padilla, his son Prince Alfonso, his illegitimate son Juan de Castro, and his stepbrother Fadrique de Castilla. King Pedro was one of the most famous and controversial monarchs of the European Middle Ages. The 14th century was an especially tumultuous period of European history, in which climatic change at the beginning of the Little Ice Age (Fagan, 2000) coincided with poor harvests, famine, the Black Death epidemic, and a social and economic crisis. The kingdom of Castile not only engaged in wars with other peninsular kingdoms but also suffered internal conflicts exacerbated by the disruption of traditional sources of income and changes in power relationships. The situation worsened in 1350 with the death from the bubonic plague of King Alfonso XI, who was succeeded by Pedro I, his legitimate son. King Alfonso had fathered other children with his mistress Leonor de Guzmán, including Enrique, count of Trastámara (later King Enrique II). Enrique became leader of a party that brought together most of the Castilian nobility (Barrios, 2001) in resistance to losses of their privileges and in rebellion against King Pedro (Ladero, 2010; Passolas, 2011), leading to a civil war that became an extension of the Hundred Years' War. King Pedro confronted Enrique in 1367 at the battle of Nájera. The former was supported by an English army commanded by Edward the Black Prince and his brother John of Gaunt, Duke of Lancaster, while Enrique was supported by a French army under Bertrand du Guesclin (Sumption, 2009). The Anglo-Castilian army won the battle, but Enrique fled and King Pedro had insufficient funds to continue paying for the collaboration of the English army. In 1369, at the battle of Montiel, Enrique killed the King in hand-to-hand combat with the aid of a French knight. There are various contemporary chronicles of this event, e.g., by Jean Froissart (online) and López de Ayala (1779). This act ended the legitimate dynasty and put the illegitimate son of Leonor de Guzmán on the throne, starting the Trastámara dynasty. In 1388, the Treaty of Bayonne ended the dynastic rift by unifying the two lines of succession of King Alfonso XI (Valdeón, 2001).

Figure 1. General view of the skeletal remains of King Pedro. Photograph by the authors. Single column.

Our study of the health of King Pedro and his family included stable isotope analysis based on bone collagen, which yields information on diet and possible geographic movements (Ambrose, 1993; Schoeninger and Moore, 1992). The most frequent analyses of skeletal remains are based on carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope ratios. Carbon findings reflect the ecosystem and the consumption of type C3 or C4 plants (DeNiro and Epstein, 1978; Van de Merwe, 1982), while nitrogen indicates the position of an individual in the food chain, given that its value in bone collagen is 3-5‰ higher in predator than in prey (Ambrose, 1991; DeNiro and Epstein, 1981; Schoeninger et al., 1983). The consumption of marine products can be estimated according to the combination of nitrogen and carbon values (Richard and Hedges, 1999; Schoeninger and DeNiro, 1984). Because isotope values reflect the diet consumed during a period of several years before death (Hedges et al., 2007), and the diet depends on local ecosystems, changes in these values may suggest possible migrations (Herrscher and Le Bras-Goude, 2010). Dietary variations can also indicate differences in social status (Choy et al., 2015; Pearson et al., 2013; Privat et al., 2002).

The main objectives of this study were to estimate the diet of King Pedro I and his family from isotope analyses, to relate findings to contemporaneous historical information on diet and geographic movements, and to assess the nutritional situation of the Castilian elite of the 14th century. This represents the first isotope analysis conducted in Spain on medieval personages.

2. Material and Methods

Three sources were used in this study: samples from the five historical personages, samples from archeological excavations at two medieval sites of the Iberian Peninsula, and data from other studies on medieval archeological populations of the Iberian Peninsula. We report biographic data on the royal family and an evaluation of their maxillodental status, followed by a description of the study sample sites.

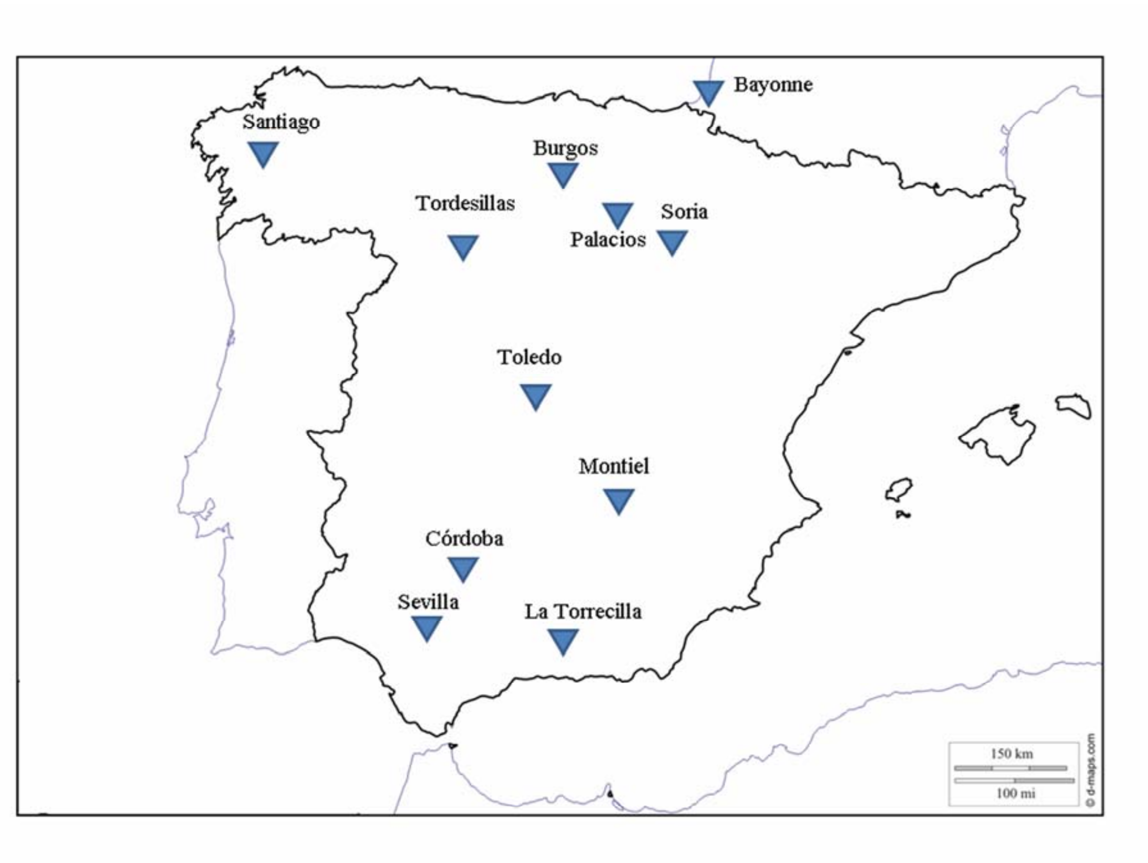

Figure 2. Map depicting the archaeological sites and main cities mentioned in the text. Double column.

2.1 Pedro I of Castile

King Pedro I of Castile (*Burgos, 30-08-1334; † Montiel, 23-03-1369)(Figure 2) was a charismatic character who was both loved and hated during his lifetime and corresponded to the prototype romantic hero *par excellence*. Authors such as P. Calderón de la Barca, Voltaire, P. Mérimée, J. Zorrilla or A.C. Doyle have dedicated writings to this figure, and he also appeared as the main character in legends and romances (Cómez, 2006). The 16th century historian Gerónimo de Zurita (from the edition of the writings of Chancellor López de Ayala published in 1779 and comments on these by Gerónimo Zurita) claimed that the king had no diseases and “had good eating and drinking habits, eating little”. The skeleton is incomplete, with taphonomic alterations of the cortex of various bones. The maxilla is preserved with the sockets of all teeth, which were lost *post mortem*, showing no evidence of alveolar resorption.

2.2 María de Padilla

This lady from a noble family (* Astudillo, 1334; † Seville, 1361)(Figure 2) became lover of the king and was the woman most loved by the monarch and bore five of his children. All ancient chroniclers lauded her beauty and her kind and discreet nature, while the romantic literature of the 19th century presented her as a woman with great erotic and sensual appeal. After her death, King Pedro I announced that he had married her in secret and officially declared her as legitimate Queen (López de Ayala, 1779; Ros, 2003). The skeleton is virtually complete and well preserved. Seven teeth are preserved, one with caries, and the rest were lost *post mortem*. There is one fistulation of a possible periapical granuloma (Figure 3) and there are mild plaque deposits. Grade 4 tooth erosion (Smith, 1984) is observed.

Figure 3. Queen María de Padilla: possible periapical granuloma presenting a fistula. Single column.

2.3 Prince Alfonso

The first male son of King Pedro I and María de Padilla (* Tordesillas, 1359) was named heir to the throne and died in Seville in 1362 at the age of three-and-a-half years (López de Ayala, 1779). The skeleton is incomplete but the bone tissue is well preserved. One deciduous molar and the crowns of three unerupted permanent molars are present. His height and development are appropriate for his age, and no indicators of metabolic stress are detected.

2.4 Juan de Castro

Juan de Castro was the son of King Pedro I and the noblewoman Juana de Castro, born in 1355. Although he was considered illegitimate, King Pedro legitimized him in his testament after the death of Prince Alfonso. In 1371, he was imprisoned by order of King Enrique II and sent to the castle of Soria (Figure 2), where he remained confined. Juan de Castro died in Soria in 1405 at the age of 50 (Escolar and Escolar, 2012; Guichot, 1878; López de Ayala, 1779). The skeleton is incomplete (lacking most bones of hands and feet) but well preserved. Six teeth without caries are preserved in maxilla and mandible. Except for one molar, the rest of the teeth were lost *post mortem*. There are no indicators of periodontal disease. Grade 4 dental erosion is observed (Smith, 1984). There are no signs attributable to states of hardship.

2.5 Fadrique de Castilla

He was born in 1333 as the illegitimate son of King Alfonso XI, twin brother of the future King Enrique II and stepbrother of King Pedro I. He always associated with his brother Enrique in confrontations with the legitimate monarch (Barrios, 2001; Escolar and Escolar, 2012). He died in Seville in 1358 at the age of 25, when King Pedro I ordered his death for high treason. According to the chronicle of Chancellor López de Ayala (1779), he received several blows with a mace inflicted by the king's crossbowmen and was finished off with a dagger provided by the monarch himself. There are many missing pieces of the skeleton, including cranium and mandible.

2.6 Archeological samples

The first archeological sample is from the necropolis of Palacios de la Sierra (Burgos) (Figure 2). It was excavated by A. del Castillo, who found more than 400 tombs in a very poor state of preservation. Most are individual tombs excavated in the rock and closed by stone slabs, although there are some sarcophaguses. They have been dated by typology between the 11th and 13th centuries. The population of Palacios de la Sierra appears to have been mainly dedicated to agriculture, stockbreeding, and crafts (Andrío, 1997), and its standard of living was slightly higher than that of other medieval populations in the area (Maroto, 2004).

The second sample comes from the Muslim necropolis of La Torrecilla (Arenas del Rey, Granada) (Figure 2), excavated by A. Arribas and M. Riu. It includes 139 tombs with very modest stone structures or simple pits in the ground. C-14 studies dated it between the 13th and 15th century. The cemetery served a relatively poor and isolated rural population that would have mainly depended on agriculture (Souich, 1979; 1982).

Ten samples from the ribs of male adults (5 from Palacios and 5 from Torrecilla) were selected for isotope analysis.

2.7 Analytical methods

With the authorization of the Hon. Canonry of Seville Cathedral, a small bone sample was taken from the five historical personages whose remains are preserved in the crypt of the Royal Chapel. Isotope analyses were conducted following the routine procedures of the Stable Isotope Biogeochemistry Laboratory of the Andalusian

Institute of Earth Sciences, using the bone collagen extraction protocol proposed by Bocherens et al. (1991, 1997).

3. Results and Discussion

3.1 The diet of the Royal Family and other medieval populations

Table 1 lists the results of the analysis of the samples from the members of the Royal Family in Seville, while Table 2 exhibits the results for the samples obtained from individuals in Palacios de la Sierra and La Torrecilla. The atomic C:N ratio of the samples fell within the range of 2.9-3.6 recommended by DeNiro (1985). Table 3 displays the values published for other medieval populations in the Iberian Peninsula.

Table 1

Individual	Bone	Sex	$\delta^{15}N$ ‰ AIR	$\delta^{13}C$ ‰ V-PDB
Pedro (King)	Metatarsal	male	12.9	-18.4
María (Queen)	Metatarsal	female	13.8	-18.5
Alfonso (Prince)	Rib	male	15.6	-18.0
Juan	Rib	male	11.9	-19.3
Fadrique	Rib	male	12.1	-18.6

Samples and isotopic values from the members of the Royal Family

Table 2

Palacios de la Sierra (Burgos)

Individual	Sex	$\delta^{15}N$ ‰ AIR	$\delta^{13}C$ ‰ V-PDB
T-15	male	10.6	-18.6
T-161	male	9.7	-20.3
T-276	male	9.8	-18.5
T-407	male	6.8	-18.7
T-506	male	10	-18.2

La Torrecilla (Arenas del Rey, Granada)

Individual	Sex	$\delta^{15}N$ ‰ AIR	$\delta^{13}C$ ‰ V-PDB
T-30	male	11.7	-17.7
T-111	male	10.3	-11.9
T-118	male	9.4	-14.2
T-152	male	9.7	-13.6
T-158	male	9.8	-14.8

Samples and isotopic values from individuals in Palacios de la Sierra and La Torrecilla

Table 3

Site	Chronology	δ^{15}N ‰ AIR	δ^{13}C ‰ V-PDB	Source
Dulantzi	6th to 10th	9.2 ±1.2	-19.8 ± 1.4	(Quirós et al., 2013)
Zaballa	10th to 15th	9.0 ± 0.8	-19.8 ± 0.7	(Lubritto et al., 2013)
Treviño	12th to 14th	9.6 ± 1.2	-19.6 ± 0.7	(Lubritto et al., 2013)
Jaca	13th to 15th	9.9 ± 0.9	-18.3 ± 1.2	(Mundee, 2009)
Valencia	10th to 13th	11.5 ± 1.4	-17.7 ± 1.3	(Mundee, 2010)
Benipeixcar	13th to 16th	10.7 ± 0.6	-16.4 ± 0.9	(estimated from Alexander et al., 2015)
Gandía	13th to 16th	10.2 ± 0.8	-17.2 ± 1.0	(estimated from Alexander et al., 2015)
Palacios	11th to 13th	9.4 ± 1.5	-18.8 ± 0.8	(present study)
Torrecilla	13th to 15th	10.2 ± 0.9	-14.4 ± 2.1	(present study)

Mean isotopic values in Medieval Iberian Archeological samples.

The δ^{15}N (AIR) values of the Royal Family are very high and denote a very rich diet in animal proteins. The δ^{13}C (V-PDB) values indicate the consumption of C3 plants (Ambrose, 1993; Schoeninger and DeNiro, 1984). As expected, the δ^{15}N values of all of the members of the royals under study are much higher than the mean values observed in the other published medieval populations (Figure 4), in agreement with contemporaneous accounts of the diet of the Castilian nobility. The δ^{15}N value is lower for Juan de Castro than for the other members of the Royal Family, who spent most of his life as a prisoner in Soria castle, where his diet would reflect his elite status but would have been poorer than provided in the court.

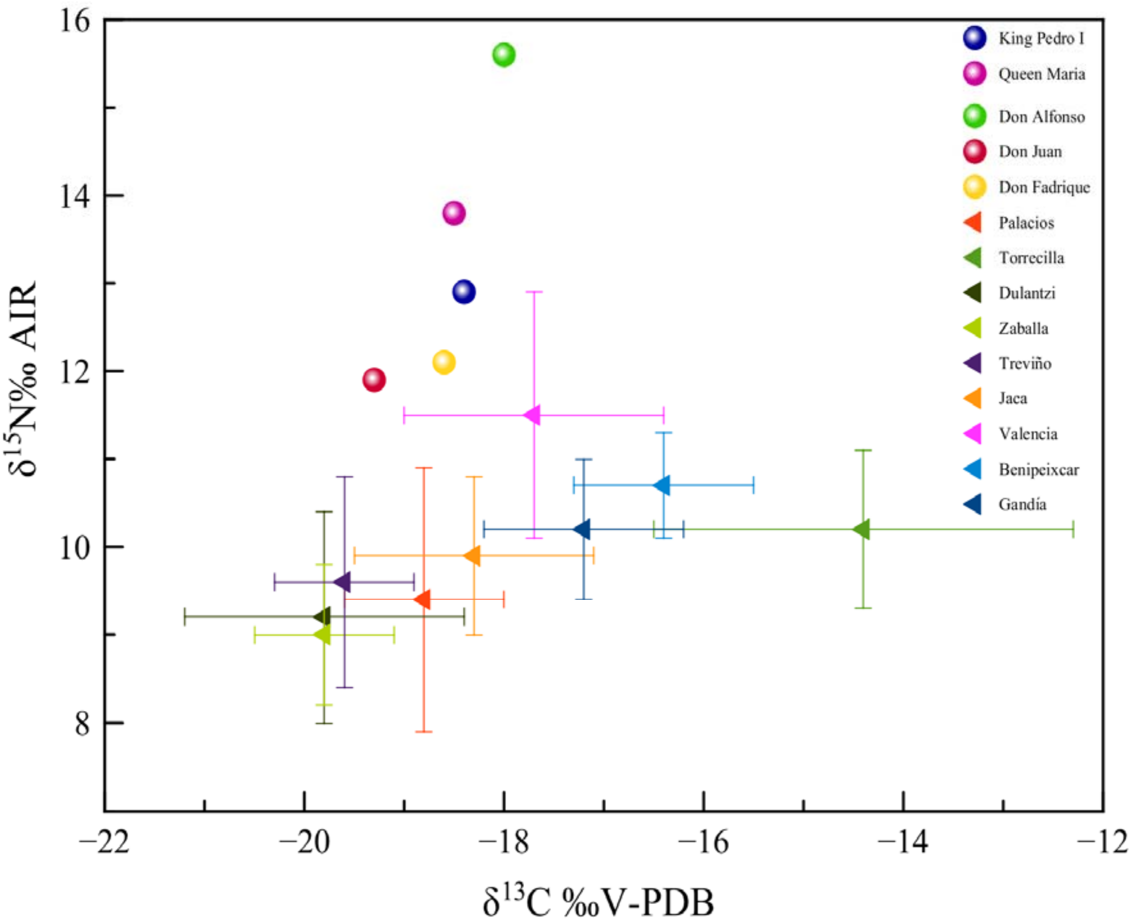

Figure 4. Scatter plot of values in each member of the Royal Family and mean values in other medieval populations in the Iberian Peninsula. Double column.

The isotope values for the Royal Family suggest a luxurious diet featuring the consumption of game meats. The occasional consumption of freshwater and/or marine fish cannot be ruled out, consistent with Catholic dietary conventions. The $\delta^{13}C$ values denote C3 plant intake, which would in part correspond to the consumption of bread prepared with wheat, only available to more prosperous individuals (García Marsilla, 2013; García Sánchez, 1996). A dietary study of the Medici Grand Dukes of Florence (16^{th}-17^{th} century AD) and the Aragonese Princes of Naples (15^{th}-17^{th} century AD) published by Fornaciari (2008) revealed very high $\delta^{15}N$ values (carnivore levels) in both royal groups, explained by a highly meat-rich diet, with $\delta^{13}C$ values that would correspond to fish intake, especially those of the Aragonese Princes. Other dietary studies in medieval and post-medieval England reported higher $\delta^{15}N$ values in samples from monks and aristocrats than in those from villagers (Müldner and Richards, 2005; Müldner and Richards, 2007a,b).

The $\delta^{13}C$ values are similar among inhabitants of Palacios de la Sierra and are typical of the consumption of C3 plants. The average $\delta^{13}C$ value is intermediate between values in samples from Jaca (Mundee, 2009) and those from Dulantzi (Quirós et al., 2013), Treviño (Lubritto et al., 2013), and Zaballa (Lubritto et al., 2013), which are all geographically close to Palacios de la Sierra. The $\delta^{15}N$ values are more variable, being considerably lower in one of the inhabitants of Palacios de la Sierra. The mean $\delta^{15}N$ value is similar between Palacios de la Sierra and the aforementioned populations, which are all from the north of the Iberian Peninsula. The authors considered the values obtained in Dulantzi, Zaballa, and Treviño to be typical of the elite, with a higher protein consumption than in medieval peasant populations in Spain (Lubritto et al., 2013; Quirós, 2013; Quirós et al., 2013). However, these "elite" values are appreciably lower than those observed in the Royal Family members. The $\delta^{15}N$ value for Jaca, a very important city at the time, was also related to a high animal protein intake, possibly from the consumption of freshwater fish (Mundee, 2009), although it is much lower than in the Royal Family. The variety of values in Palacios de la Sierra suggests the presence of different social classes in this population center. At any rate, the strong class inequalities in medieval Castilian society are evidenced by the diets of the rich *versus* poor and nobility *versus* peasantry (De Castro, 1996) and by the distribution of isotope values among these populations. In all of these, the $\delta^{13}C$ values denote consumption of C3 plants, although results in four individuals from Jaca suggest the consumption of C4 plants or of animals fed with the latter, which may explain the less negative values observed (Mundee, 2009). The mean $\delta^{15}N$ value is lower in the individuals from Palacios de la Sierra than in those from the other medieval populations compared, which are all from the Valencia region, but the main difference is in $\delta^{13}C$ results. The populations of Valencia city (Mundee, 2010), Santa María de Gandía, and Benipeixcar (Alexander et al., 2015) indicate a high consumption of animal proteins, and the $\delta^{13}C$ values denote consumption of C4 plants or of animals fed with these (Mundee, 2010; Alexander et al., 2015). Gandía and Benipeixcar are contemporary, although with different religions (Christian and Muslim, respectively), and the authors (Alexander et al., 2015) attributed the significant differences observed in $\delta^{13}C$ values to the consumption of C3 plants by Christians and C4 plants by Muslims. Valencia city, although Muslim at the time, was a very important urban center and as such may have enjoyed a rich and varied diet, yielding elevated $\delta^{15}N$ values and more negative $\delta^{13}C$ values (Alexander et al., 2015).

In La Torrecilla, all individuals except for T-30 show similar isotope values. T-30 shows a very high $\delta^{15}N$ value and much more negative $\delta^{13}C$ value, suggesting a very different diet. This individual was probably a foreigner or had been living in the location for a very short time. This finding highlights the need to conduct further analyses with larger samples to determine the socioeconomic context of this necropolis. The $\delta^{15}N$ values do not appreciably differ from those of the other populations cited here and indicate a diet rich in animal proteins. However, the $\delta^{13}C$ values do differ from those of the other populations, being highly less negative and indicating a greater consumption of C4 plants and/or C4 plant-fed animals. Although the population of La Torrecilla is considered to be mainly formed by poor peasants (Souich, 1982), who would have a diet largely based on cereals and legumes (García Sánchez, 1983; 1996), rural inhabitants could frequently ensure a supply of proteins by breeding rabbits and poultry (De Castro, 1996) and, in some cases, a supply of milk from their goats and/or sheep. Another source of proteins for poorer populations was fish, which was not highly regarded by the Muslim elites (De Castro, 1996; García Sánchez, 1996). La Torrecilla is only a few kilometers away from the sea, giving its inhabitants ready access to fish consumption (De Castro, 1996).

Historical data are consistent with these findings of a greater major consumption of C3 plants in Christian populations, mainly in the North, and of C4 plants in Muslim populations. C4 plants introduced by Arabs into the Iberian Peninsula included sugarcane (in the 10^{th} century), maze (documented in the 11^{th} century), sorghum, and millet (documented in the 13^{th} century) (De Castro, 1996; Hernández and García, 1998). The Castilian populations considered here would have lived before these changes or too far from al-Andalus to accept these “foreign” crops, which were considered poor for bread-making or more suitable as cattle food (García Marsilla, 2013; García Sánchez, 1996). On the other hand, the use of sugarcane in medicines did spread throughout the Peninsula, especially in the 15^{th} century (García Marsilla, 2013). Although bread made with wheat was the preferred type in Al-Andalus, it was an expensive luxury only available to the most privileged classes (García Sánchez, 1983; 1996). Bread consumed by poorer classes or in times of shortage was prepared with rye, millet, sorghum, or maze, and is considered of low nutritional value (García Sánchez, 1996; Hernández and García, 1998). Hence, the prosperous urban population of Valencia (Mundee, 2010) shows more negative $\delta^{13}C$ values due to the consumption of C3 cereals, such as wheat or barley, whereas the poor rural inhabitants of La Torrecilla exhibit less negative $\delta^{13}C$ values. Mundee (2010) described a European North-South gradient in $\delta^{13}C$ values from more to less negative. It should be taken into account that C4 plants require a warm (more Southern) climate and that these environmental conditions influence $\delta^{13}C$ values (Goude, 2012; Herrscher and Le Bras-Goude, 2010). This may explain the similarity in isotope values between the Christian population of Gandía, who would presumably have a greater intake of C3 plants (Alexander et al., 2015), and the other Muslim populations in the South of the Peninsula, who lived in more arid areas.

3.2 Health and travels of Royal Family members

Consistent with the isotope findings, the skeletal remains of King Pedro and especially those of his son Juan de Castro indicate that they had good oral health. Thus, Juan de Castro had only lost one tooth at the age of 50, with no signs of periodontal disease. It was reported at the time that Pedro I never suffered from toothache (Zurita, 1779). The low grade of dental erosion observed in Juan de Castro and Queen María suggests a diet with no abrasive components. However, although Queen María also has an elevated $\delta^{15}N$ value, there are signs of caries and infection, which may be related to her delivery of five children, and some sources describe her health as delicate (Ros, 2003). According to the Chronicle of Chancellor López de Ayala (1779), the queen died *of her condition*, which rules out a sudden death. At the time, puerperal women and the infirm were recommended by physicians to consume chicken, white bread, wine, hen broth, eggs (García Marsilla, 2013), dried fruits and sweets (De Castro, 1996). Such a diet would explain both her high $\delta^{15}N$ value and the presence of oral disease. As noted above, although sugarcane consumption did not extend to Christian kingdoms of the Iberian Peninsula until sometime after its first introduction in the 10th century, it was used in sweets and medicines that the queen may have consumed (De Castro, 1996).

Among the Royal Family members studied, the highest $\delta^{15}N$ value is shown by Prince Alfonso, who died at the age of three-and-a-half, so that this value would correspond to his whole life, including *in utero* (Beaumont et al., 2015; Hedges et al., 2007; Katzenberg et al., 1996). At birth, he would have had an equally high $\delta^{15}N$ value to that of his mother, Queen María, and this would have been further raised during breastfeeding, likely provided by a nursing maid as was the royal custom. Queen María died one year before the death of her son, who became the only legitimate male heir of King Pedro. The prince would presumably have received the diet then considered optimal for good health, including hen broths (De Castro, 1996), and the breastfeeding may have been relatively prolonged. There is a slight $\delta^{13}C$ enrichment in breastfed children (Fuller et al., 2006), and the Prince has the least negative value of all of the family members studied. No *cribra orbitalia*, enamel hypoplasia, or growth retardation were observed, indicating the absence of deficiency-related diseases (Beaumont et al., 2015; Katzenberg et al., 1996).

There have been recent advances in the study of geographic movements based on stable isotope analyses (e.g., the study of King Richard III of England by Lamb et al., 2014). However, it was only possible to determine the values displayed in Table 1, due to the state of preservation of the skeletal material and the scant amount available for this purpose. The contemporaneous Chronicle of Chancellor López de Ayala (1779) provides ample information on the movements of King Pedro during the 20 years of his reign. Although the city where he lived longest was Seville, there was no capital city at the time and the Court was itinerant. Pedro continuously traveled relatively long distant places, having horses ready for him at fixed locations, and he was the first Castilian monarch to embark in the Spanish Navy (Escolar and Escolar, 2012). During the last five years of his life, to which the isotope values obtained would correspond (Hedges et al., 2007), his kingdom was racked by civil war. In 1366, according to López de Ayala, he went to Burgos, Toledo, Seville, and Santiago de Compostela and travelled by sea to Bayonne (France) for a meeting with Edward the Black Prince (Figure 2). In 1367, he returned to Castile by land and went to Álava, Logroño, Nájera (where the battle of the same name took place), Burgos, Toledo, Córdoba, and Seville. In 1368, he was mainly in Seville and during the first months of 1369 he went from Seville to Toledo and ended his days in Montiel. Queen María accompanied the monarch on his trips with the court but spent most time in Tordesillas and Seville, where she died eight years earlier than her husband. The similarity of their $\delta^{13}C$ values (-18.4‰ and -18.5‰, respectively) is consistent with their residence together for a large part of the last years of their lives. Few data are available on Fadrique, who also died in Seville but spent most of his life in the Castilian provinces of La Mancha as Master of the Order of Santiago, a military post (López de Ayala, 1779). His $\delta^{13}C$ value (-18.6‰) is only slightly different from the above values, suggesting that he spent a certain time in the Court. Prince Alfonso lived between Tordesillas and Seville, but his death at a young age means that his values are not comparable with those of the adults. The most distinct value (-19.3‰) is shown by Juan de Castro, who spent most of his life confined as political prisoner in the castle of Soria, a city in the north of Castile with a different climate to that of Andalusia.

4. Conclusions

The $\delta^{15}N$ values in the members of the royal family are very high, similar to those of carnivore animals, and denote a diet very rich in animal proteins. They are much higher than those of other medieval populations considered elite. The stable isotope values obtained would reflect the superior and more varied diet available to elites and to urban versus rural populations, although further research in wider samples is required on the effects of social class. The isotope analysis results are in agreement with reports of the preferential consumption of C3 plants by Christians and of C4 plants or C4 fed animals by Muslims. Environmental differences would also influence the diet, with the climate being colder and wetter in the North and warmer and drier in the South. The very negative $\delta^{13}C$ values of the Royal Family indicate the exclusive consumption of C3 plants, which were more highly valued, and are consistent with their places of residence towards the end of their lives. The dietary information yielded by isotope analysis is consistent with skeletal indications of the oral health of these historical individuals and with contemporaneous reports on their dietary habits and health status.

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