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Market Opportunities and New Sheep Meat Products Produced by Sustainable Farming System

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Abstract

Within the scope of the Open2preserve project in northern Portugal, an integrated assessment has been developed to evaluate the efficiency of pyric herbivory to maintain open landscapes and the farm products' quality of livestock products using it. As a measurement of farm system evaluation, some meat products quality was analysed, particularly meat lamb and some meat processed products as hamburgers, sausages, pâtés, and cured legs from carcasses that come out of PGI or PDO quality brands. Results indicated that lambs produced were in the quality requirements of similar products produced in the region. The processed products would be an interesting alternative for the meat industry and a novelty for

consumers, adding value to carcasses with low commercial price and consumer reduced acceptability.

Keywords: Sheep; meat; physicochemical quality; sensorial quality; market strategies.

INTRODUCTION

European pastoral regions have witnessed a general process of massive depopulation over several decades [1, 2]. The grazing of mountainous areas persists but is in decline, despite support from the European Common Agricultural Policy (CAP), which recognizes the value of local breeds and other agri-environmental practices [3-5]. The abandonment is one facet of the broader trend of rural depopulation, and it is driven by a complex mixture of economic, social, and political factors [6].

From an economic-social point of view, in less-favoured regions of southern Europe, farmers are dropping out of their farms as they grow older. In many cases, they do not have sufficiently interested descendants to maintain their farms, mainly because of harsh living conditions and low income. From a political standpoint, the common agricultural policy (CAP) has been the most important driver of agricultural management and sustainability in the European Union [7]. However, the PAC has zigzagged between divergent, sometimes contradictory goals implemented in a patchwork and inefficient manner [6]. It treats rural development as an individual, agriculture-centric project, ignoring the primary social, political, and economic drivers of land abandonment, as well as the diversity of the rural areas in which they occur [6]. The European small ruminants (i.e., sheep and goats) farming sector contributes to many of the Sustainable Development Goals described by the United Nations (e.g., Economic growth, Sustainability, Climate Action, zero hunger). This sector produces only 6% of meat and 3% of milk production in the European Union. However, it supports 1.5 million farmers, plus members of the food chain, and provides economic and social cohesion for the most disadvantaged and depopulated rural areas [8]. It represents an important share of the total livestock production in some European countries such as Spain, Italy, France, and Greece [8].

However, it is the one that generates the lowest income among the livestock farming systems, and the financial support received is far below that received by other more profitable agricultural sectors. Imports from non-EU countries and excessive restrictions on sheep meat exports from the EU to these countries are also exerting increasing pressure. All these factors together mean that the long-term sustainability of sheep production in the EU on a professional scale is increasingly under threat [9]. On the other hand, these systems in mountain areas are even more at risk; in addition to the above reasons, they face the disappearance of shepherds.

Nowadays, the role of traditional pastoralism in the multifunctionality and quality of the ecosystem services provided by mountain ecosystems is widely recognized at scientific and political levels [10, 11]. However, farmers are not paid for the environmental services they deliver [12]. On the other hand, its key role in protein production using local natural resources [13, 14] has been lost. Growing concerns about the environmental, human health, and animal welfare impacts of meat production and consumption pose a major challenge to the red meat sector and treat the sector as a whole without distinguishing between industrial-landless production systems and those pasture-based livestock farming systems. The build-up narrative

on livestock, climate change, and human diet advocates a drastic reduction or elimination of animal-source foods from global diets due to the large climate impact of livestock compared to cropping systems [15] has been a very negative driving factor leading to increased marketing difficulties and discouraging livestock producers.
On the other hand, extensive livestock systems have often been particularly criticized for their assumed low production efficiency, high per-animal methane emissions, and the large extent of land use change when compared with more intensive systems [15]; while ignoring their positive externalities. The relationship between livestock and the environment is much more complex than the current narrative reveals. Many global assessments do not sufficiently evaluate livestock systems in all their variations in a comprehensive, integrated way [15]. The Open2preserve project fits into this context, and it aims to break with this simplistic view of livestock production.

Open2preserve proposes an approach focused simultaneously on the landscape and the landscape makers, i.e., suggesting a model combining landscape management via pyric herbivory and farm innovation. The goal is to work on the social sustainability of rural territories by developing innovative solutions to keep more people in the primary sector, mainly in extensive livestock production. Mountain areas in the SUDOE region need to improve their farms through the valorisation and differentiation of their products and value chains. The development of livestock products with a quality label, new marketing routes, and new products are good examples that will ensure the profitability of farms and the revitalization of the natural heritage of the territory. In this sense, the present study characterizes the physicochemical and sensorial quality of meat and meat products produced under the flock management conditions in the Open2Preserve assumptions for this area. In addition, the results of the new markets opportunities for these products are also presented.

CONTEXT OF THE RESEARCH

The study was carried out in Trás-os-Montes, in Northeast Portugal (Figure 1).

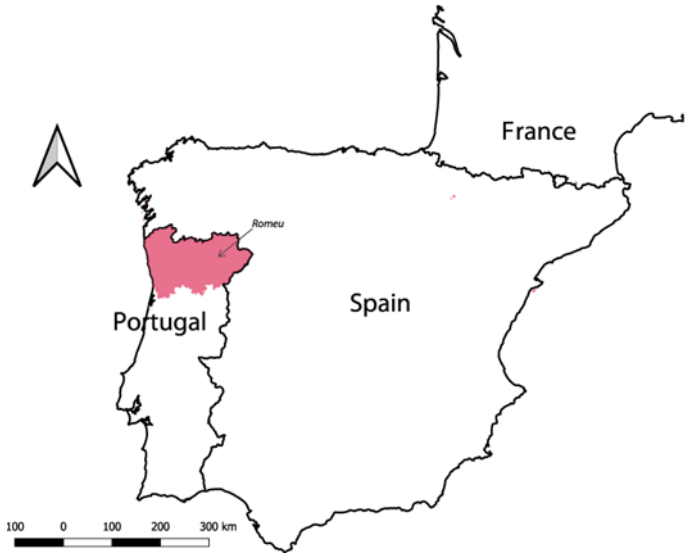

Figure 1. Location of livestock farm in the SUDOE context

The livestock farm is located in the village of Vimieiro, parish of União de Freguesias de Avantos e Romeu, municipality of Mirandela. It is a mountainside area bordered by a stream to the northwest and an olive grove to the south. The location is a Natura 2000 Network Site classified as a Site of Community Importance (SCI PTCON0043 - Romeu, 4,700 ha). This area is in the Mediterranean region, with a Meso-Mediterranean and a dry ombrotype. The average annual temperature is 14.3°C, and the total annual precipitation is 508.6 mm, with a Meso-Mediterranean thermotype and a dry ombrotype (data for 1951-1980) [16].

Regarding the approach of Open2preserve on landscape dynamics', a 4.3 ha plot was dedicated to an experiment to explore pyric herbivory. The vegetation is dominated by an open Mediterranean forest with Portuguese oak (*Quercus faginea*), cork oak (*Quercus suber*), holm oak (Quercus rotundifolia and several shrub species such as *Cytisus scoparius*, *Cytisus m*ultiflorus, *Lavandula stoechas*, *Cistus ladanifer*, with an herbaceous stratum, generally dominated by annual grasses. On this plot, targeted grazing and mechanical clearing practices were combined for maintaining open landscapes, reducing the risk of fire, and thus decreasing the loss of biodiversity associated with them. A local flock of approximately 150 head of sheep of the Churra Galega Bragançana - Branca breed, reared for meat grazing the area. The exploitation regime is extensive, with no planned calving and/or mating seasons. It is conducted by a shepherd hired.

The livestock husbandry system is based on daily grazing circuits over the agro-pastoral landscape. It comprises owned, rented, and borrowed land and the experimental area. The adjacent pasture area comprises about 690 h, including annual (146 ha) and permanent crops (236 ha of olives), grasslands (39.5 ha), shrublands (71.6 ha), and grazed (181ha, mainly cork oak) and ungrazed forests (18.3 ha). Traditionally, unfenced and uncultivated areas can be freely traversed by animals. Then, the flock could cross these free rangeland areas beyond own private areas (mainly grasslands, annual crops for the production of forages, and forest areas; see Fig 2). Grazing circuit duration varies greatly throughout the year and is affected by daylight, maximum daily temperature, and resource availability.

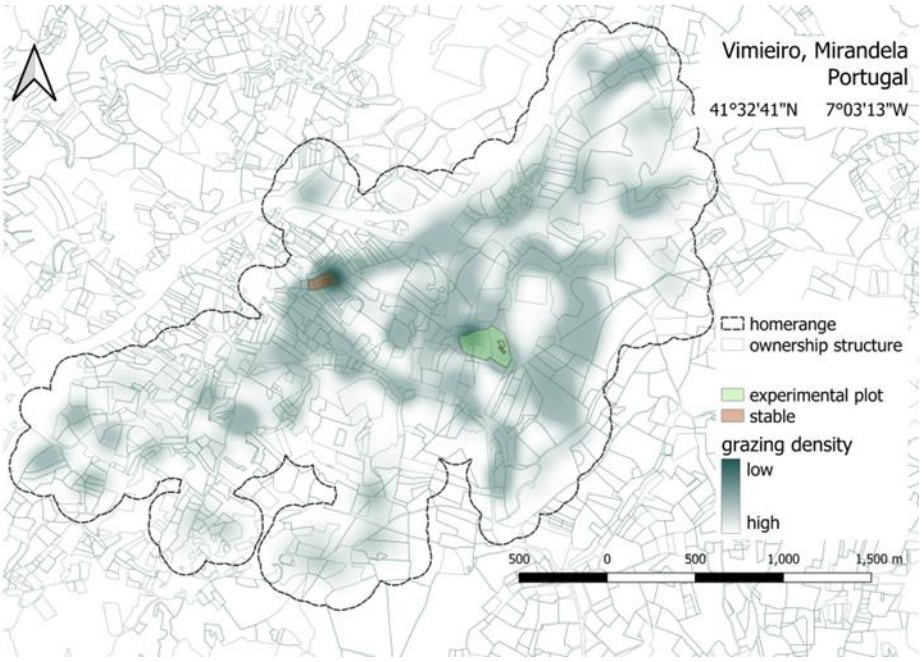

Figure 2. Grazing area of herd.

PHYSICOCHEMICAL CHARACTERIZATION OF THE PRODUCTS STUDIED

Lamb Carcasses

Twelve lamb carcasses around 9-14 kg body weight, corresponding to 5-7 kg carcass weight, according to the specifications for lamb carcasses with protected origin designation [17] were analysed. The pH and meat CIELAB colour coordinates (L* brightness, a* redness and b* yellowness) as well the shear force was measured. The left side of each carcass was divided into eight standard joints: leg, chump, loin, ribs, anterior ribs, shoulder, breast, and neck and each joint was dissected into lean, subcutaneous fat, intermuscular fat, bone, and remainder, according to previous descriptions [18]. The pH of the carcasses after 24h refrigerated at 4ºC was 5.6, the colour coordinates were (L* 41.2, a* 15.9 and b* 9.1) and the shear force was 5.1 Kgf/cm^2. These are the referenced colour and shear force characteristically of light lambs produced in sheep Mediterranean systems [19-22]. The carcass joints % are shown in Table 1 and considering the leg, chump, loin and shoulder as 1st category, the carcasses presented a high % for these pieces, 25.7, 9.1, 10.8 and 20.8% respectively. The lean percentage was 61.9 % ± 0.23, the carcass fat 18.9% ± 0.31 and the bone % 17.9 ± 0.15. The values for carcass composition are within the values for this type of carcasses according to the previously mentioned literature. The lamb carcasses produced were of a quality that complied with the standards set by the PDO product specification and are within the consumer's preferences for this light carcass characteristic of Southern Europe.

Table 1. Percentage of lamb carcass joints

Carcass Joint	Mean±SD
Leg	25.7±0.8
Chump	9.1±1.6
Loin	10.8±0.4
Ribs	5.9±0.5

Anterior Ribs	6.6±0.9
Shoulder	20.8±0.8
Breast	11.0±1.1
Neck	**10.1±0.9**

Fresh Sausages

Lorem The meat of 12 adult ewes ageing more than 7 years old with an average carcass weight of 25 kg was used to process fresh sausages. The carcasses were firstly deboned and cleaned from nerves, tendons, and connective tissue. Sausages were processed according to the methodology previously described [23]. The raw meat was mixed and minced with 10% of pork belly of Bísaro, a local breed, and the ingredients: salt, garlic, peppers, bay leaves, and water. The mixture was stuffed into 34-46 mm pork casings and stabilized in a chamber with controlled temperature and moisture. Sausages were vacuum packaged and stored in a refrigerator at 4°C. Three samples from each of the threes lots fabricated were randomly taken for chemical analysis and the data were shown in Table 2. The values of aw as well the moisture and pH are within the expected values for this type of fresh meat product. The most abundant fatty acid was the C18:1n9c followed by the C16:0, the C18:0, and the C18:2n6c. The unsaturated fat corresponds to the main fat fraction present, 56.7%, being a product similar to those previously mentioned [23-26]. This fresh sheep sausage is an interesting meat product manufactured with meat from animals with very low commercial value.

Table 2. Physicochemical composition of fresh sheep sausages

	Mean ± SE
aw	0.93±0.002
pH	5.92±0.011
Moisture (%)	59.9±0.18
Protein (%)	17.8±0.08
Total Fat (%)	20.1±0.4
Fatty Acids profile (expressed in g/100g fatty acids)	
C 14:0	2.07±0.03
C 16:0	22.95±0.15
C 16:1	2.14±0.11
C17:0	1.00±0.01
C 17:1	0.51±0.01
C 18:0	16.51±0.21
C 18:1n9t	0.55±0.14
C 18:1n9c	41.28±0.29
C18:1n11t	1.64±0.18
C18:1n7c	1.66±0.16
C18:2n6c	6.62±0.46
C18:3n3c	0.75±0.02
C20:0	0.18±0.01
C20:1n9	0.55±0.02
SFA	43.30±0.32

MUFA	48.48±0.34
PUFA	8.22±0.47
MUFA+PUFA	56.70
PUFA/SFA	0.19±0.01
PUFA-n3	1.07±0.08
PUFA-n6	7.47±0.12
PUFA-n6/n3	7.08±0.42

SFA - saturated fatty acids; MUFA – monounsaturated fatty acids; PUFA – Polyunsaturated fatty acids; PUFA n-3 sum of PUFAS of n-3 series; PUFA n-6 sum of PUFA n-6 series

Pâtés

For the manufacture of pâtés, lean meat trimmings from sheep carcasses from Churra Bragançana were used, incorporating two different sources of fat — a DOP olive oil (Azeite Transmonstano) and a pork belly of a local breed (Bísaro) — with two levels of added fat (10% and 30%). Meat was boiled for 60 minutes and after was mincing and missing with pork belly or olive oil and the ingredients (water, milk, and Mix-088 Paté Bueton). Two replications of each pâté were manufactured, and three samples of each replication were randomly selected to physicochemical analysis in triplicate. Table 3 shows the predicted values for the effect of fat source on physicochemical characteristics of the three pâtés. Pâtés with added pork belly fat had a slightly higher percentage of protein than those with olive oil, with % fat not being significant despite a trend towards a higher fat content for those with olive oil. These results are very close to those found by other authors [27-30] for similar products by goat meat. Pâtés with olive oil show lower palmitic and stearic fatty acids content than those with fat pork belly, resulting in products with lower saturated fat and higher unsaturated fat contents. These results were expected given the different origin of the incorporated fat sources, olive oil in contrast to fat pork. Despite the reduced amount of elaidic acid (C 18:1n9t) present, there were differences between the different pâtés, with those that incorporated olive oil having a lower content of this trans fatty acid. The PUFA/SFA ratio varying between 0.38 and 0.20 g/100 g of fatty acids are within the values recommended by FAO [31]. The observed n-6/n-3 ratios ranging from 5.6 to 8.06 are higher than the ratio recommended [32]. which does not exceed 4 even though according to WHO [33] based on both the scientific evidence and conceptual limitations, there is no compelling scientific rationale for the recommendation of a specific ratio of n-6 to n-3 fatty acids or Linoleic acid (LA) to Alpha-linolenic acid (ALA). In fact, according to the most important food recommendations, the P/S and n-6/n-3 ratios show that sheep pâtés are balanced fatty products and an interesting way of using meat to reach new consumer markets such as Kosher and Halal since one of the products is pork-free.

Table 3. Physicochemical composition of sheep pâtés

	10% Pork fat	**30% Pork fat**	**10% Olive oil.**	**30% Olive oil**	**SE**	**F**
pH	6.2	6.1	6.0	5.2	0.02	ns
Dry Matter (%)	41.35	41.75	46.10	48.26	1.57	ns
Protein (%)	24.44[a]	23.46[a]	20.69[b]	21.05[b]	0.59	**
Total Fat (%)	13.40	14.16	15.27	17.01	1.2	ns
Fatty Acids profile[1] (expressed in g/100g fatty acids)						

C 14:0	2.11[a]	1.94[a]	0.97[b]	0.50[b]	0.07	*
C 16:0	22.26[a]	24.76[a]	15.86[b]	14.79[b]	1.21	**
C 16:1n-7	1.38[b]	1.77[a]	0.85[c]	0.73[c]	0.11	**
C17:0	1.01[a]	0.93[ab]	0.53[bc]	0.33[c]	0.11	*
C 18:0	16.27a	17.16[a]	8.61[b]	7.08[b]	1.42	**
C 18:1n9t	1.80	1.52	0.82	0.36	0.22	*
C 18:1n9c	45.23[a]	39.79[a]	62.18[b]	66.01[b]	3.12	**
C18:1n11t	1.80[a]	1.52[ab]	0.82[bc]	0.36[c]	0.21	*
C18:2n6c	6.28	7.98	7.08	7.41	0.41	ns
SFA	42.57[a]	45.97[a]	26.79[b]	23.45[b]	2.96	**
MUFA	49.29[a]	44.10[a]	64.54[b]	67.66[b]	2.82	**
PUFA	8.24	10.01	8.80	8.97	0.44	ns
MUFA+PUFA	57.50[a]	54.12[a]	73.34[b]	76.63[b]	3.00	**
PUFA/SFA	0.20[a]	0.22[a]	0.33[b]	0.38[b]	0.02	*
PUFA-n3	1.25	1.13	1.43	1.30	0.10	ns
PUFA-n6	6.90	8.84	7.36	7.67	0.42	ns
PUFA-n6/n3	5.60	8.06	5.19	5.91	0.66	ns

[1]Only the fatty acids with more than 1g/100g; SFA - saturated fatty acids; MUFA – monounsaturated fatty acids; PUFA – Polyunsaturated fatty acids; NS no significant; a≠b * P ≤ 0.05; ** P ≤ 0.01; *** P ≤ 0.001; PUFA n-3 sum of PUFAS of n-3 series; PUFA n-6 sum of PUFA n-6 serie

Cured Legs

Eight ewes slaughtered at the end of the reproductive phase were used to manufacture cured legs. The data follow the methodology of the study within the scope of BISOVICAP [34] project and the work previously published [35] and now replicated with a small part of culled ewes of the experimental flock. The objective, as previously mentioned by the cited authors, was to add value to the meat of discarded animals by processing it as dry-cured or smoked products. The legs were dry salted with coarse marine salt for a period corresponding to 1 day of salting for each 1 of the raw pieces. After that were washed and cleaned, removing the excess of the salt at the surface and hanging in a refrigerated room for 1 day to stabilize the product. Then the legs were rubbed with a mixture of olive oil and red pepper paste and hung for 1 to 2 months to air dry in a room with controlled temperature and humidity. Table 4 shows the physical characteristics at the three stages of the curing process. The pH and aw observed and as indicators of the shelf life of cured products are within the values that guarantee the stability of the product, preventing its deterioration and promoting safety.

Table 4. Physical characteristics of sheep cured legs at the three stages of curing process.

	Sheep cured legs
pH slaughter	6.6±0.02
pH 24 h	5.6±0.01
pH ripening	5.5±0.03
aw slaughter	0.97±0.01
aw salting	0.91±0.00
aw ripening	0.86±0.01

The values of protein and fat contents as well the lipid oxidation expressed as TBARS (mg of malonaldehyde/kg of sample) were shown in Table 5. After the curing process, cured sheep's legs have a high percentage of protein that has almost doubled while maintaining low fat content. In fact, the low cholesterol content associated with a slight reduction in saturated and monounsaturated fat with a slight increase in polyunsaturated fat makes it a product with a balanced PUFA/SFA ratio within the limits recommended [36] above 0.4–0.5. TBARS value indicating the lipidic oxidation is much lower than the value of 2 mg of MDA/Kg which is the upper limit of rancidity indicated [37] for consumer acceptability.

Table 5. Protein, collagen, fat percentages and TBAR of sheep cured legs

	Sheep cured legs		**F**
	Raw product	**Final product**	
Protein (%)	18.16±0.08^{a}	38.4±0.51^{b}	***
Collagen (%)	1.35±0.09^{b}	1.45±0.16^{b}	ns
Cholesterol (%)		4.5±0.45	
FAT (%)	8.70±0.40	7.92±1.02	ns
SFA	44.92±0.32	43.22a±0.45	ns
MUFA	49.33±0.38^{a}	47.59±0.42^{b}	*
PUFA	5.34±0.69^{a}	8.98±0.30^{b}	**
PUFA/SFA	0.12±0.01^{a}	0.21±0.00^{b}	*
TBARS	na	0.51±0.03	

Significance: ns: not significant; a≠b * P≤0.05; ** P≤0.01; *** P≤0.001; na – not available

SENSORIAL CHARACTERIZATION OF THE PRODUCTS STUDIED

Fresh Sausages

Fresh sausages were made from Churra Galega Bragançana ewes' meat. Ewes were between 5 and 7 years old, with an average of 20 kg carcass weight. Previous study was previously presented [38]. The effect of paprika use was evaluated. Evaluations about sensory characteristics were made by a taste panel and by a consumers panel. Both panels used a 10 cm, continuous scale. The use of paprika caused an increase in spiciness, as expected, but also in flavour intensity, at the same time sweetness decreased. Globally, both types of fresh sausages, with and without paprika presented median to low values for all sensory attributes. The highest values were for juiciness which can be an indication that this type of product presents pleasant sensory characteristics.

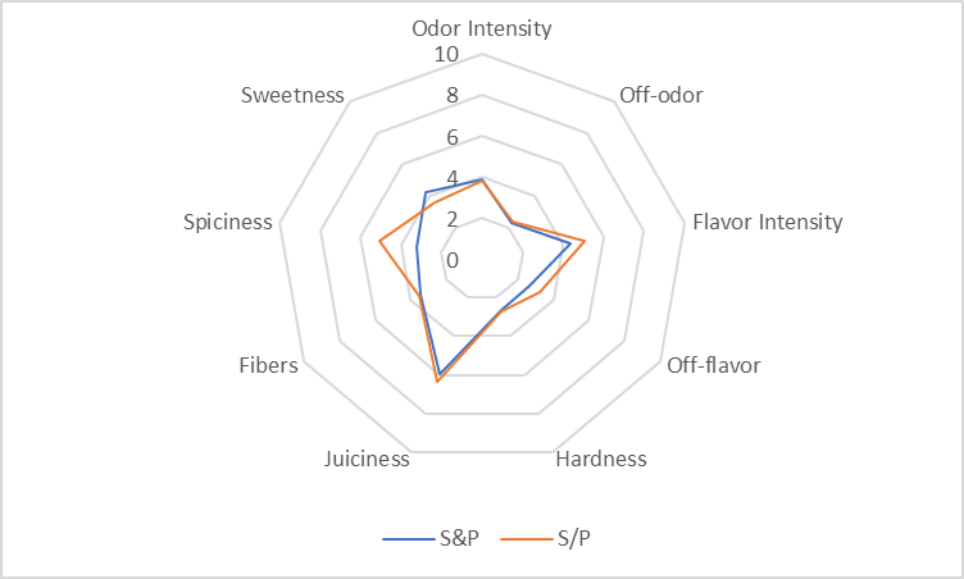

Figure 3: Sensory profile of fresh sausages made with ewes' meat, with (S&P) and without (S/P) paprika

The consumers' panel did not show any preference for the different types of sausages. Global acceptability was around 6/10 for both types of fresh sausages. This means that all types of sausages can have market opportunities. Fat levels in fresh sausages affected the overall acceptability by consumers in fresh sausages made with sheep meat [23]. Sausages with 10% fat had the highest value of acceptability followed by 30% and the least accepted 0% of fat addition.

Pâtés

Pâtés were manufactured with meat trimmings of sheep carcasses. Churra Galega Bragançana ewes aged between 5 and 7 years old, with an average carcass weight of 20kg were used. Different fat sources and percentages were tested: SOO1 (sheep olive oil 10%), SOO3 (sheep olive oil 30%), SPB1 (sheep pork backfat 10%), SPB3 (sheep pork backfat 30%). Sensory evaluation was done by both a trained taste panel to study objective characteristics, and a consumers' panel to test pâtés preferences. A structured but unnumbered scale of 10 cm, with the extremes representing either the minimum (no sensation) or maximum (extremely intense sensation) was used. Previous study was presented [39].

Each sample was evaluated for appearance (pâté colour, from rose to brown, cohesiveness, appearance of loose or bonded particles, from little to very cohesive, homogeneity or uniformity of the mixture, from little to very homogeneous), aroma intensity (global intensity of aroma associated to pâté, from little to very intense), taste intensity (global intensity of taste associated to pâté, from little to very intense), and texture (cohesiveness, bonding feeling in the mouth pressing the tongue against the palate of the pâté paste, from little to very cohesive, adhesiveness, adherence of the sample, without chewing, to the palate after being pressed with the tongue, little to very adhesive, fatness, sensation of fat particles in the mouth, little to very fat, juiciness, impression of lubrication of the sample during chewing, little to very juicy) using the Quantitative Descriptive method according to the Portuguese Standards. Results obtained

by a Generalised Procrustes Analysis (GPA) show that 92.5% of the total variability was explained by only 2 factors. A clear distinction between samples is observed. Pâtés with 10% fat, either pork or olive oil, were close in their evaluation and had the highest values for colour (ApCol). Sheep meat pâtés with 30% pork backfat presented the highest values for aroma intensity (ArI), and cohesiveness, apparent (ApC) and texture (TeC). Sheep meat pâtés with 30% olive oil presented the highest taste intensity (TaI) and mouth perceived fatness (TeF).

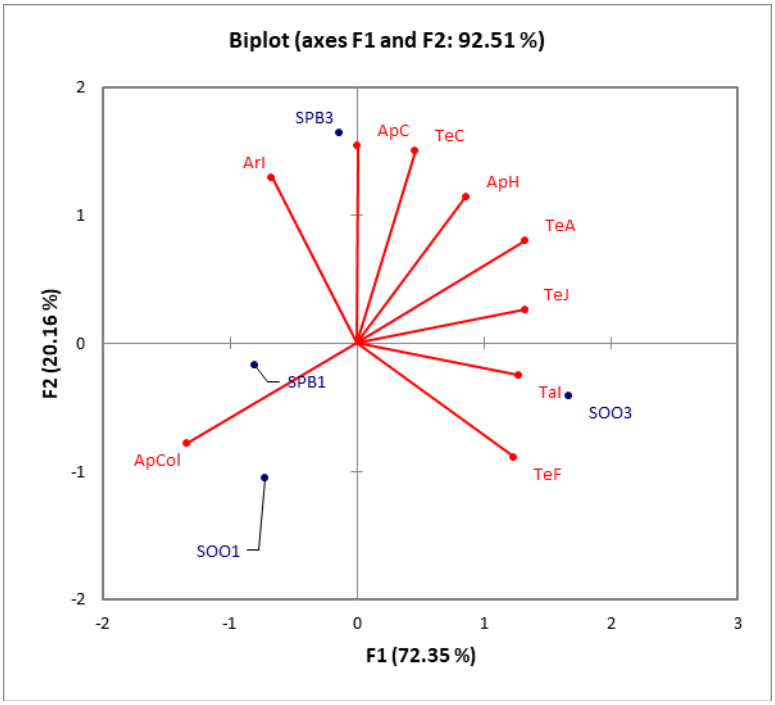

Figure 4: Consensus configuration: joint representation of the correlation between sensory traits and F1 and F2 and pâtés coordinates for sensory analysis. F1 = first principal component of generalized Procrustes analysis (GPA); F2 = second principal component of GPA

SPB1 (Sheep + 10% pork belly); SPB3 (Sheep + 30% pork belly); SOO1 (Sheep + 10% olive oil); SOO2 (Sheep + 30% olive oil). ApCol: colour, ApC: apparent cohesiveness, ApH: homogeneity, ArI: aroma intensity, TaI: taste intensity, TeC: cohesiveness as texture, TeA: adhesiveness, TeF: fatness, TeJ: juiciness

Data from consumers was statistically analysed by a one-way ANOVA. No significant differences ($P>0.05$) were reported by consumers concerning sheep meat pâtés produced with different levels of pork backfat or olive oil. Mean values ranged between 6.5 for SOO1 and 7.0 for SOO3.

Cured Legs

Sensory characteristics of 14 Churra Galega Bragançana ewes cured legs were evaluated by a taste panel. Previous study was made [40]. Appearance, odour, texture, and flavour attributes were evaluated using a 10-cm continuous, unstructured and anchored at the ends scale. The left anchor corresponded to the lowest intensity and the right anchor to the higher intensity of the respective attribute. A Characterization of the Products procedure was performed to compare cured legs with 7 and 8 months of ripening time. Only 2 in 19 attributes presented a

significant (p-value <0,05) discriminant power, meaning they were significantly different between both ripening times. Cured legs with 8 months ripening time were brighter and presented higher acid aroma than the ones with 7 months of ripening time. Globally, all attributes presented median to small values in both treatments, meaning that this type of product can please consumers less used to particular and intense old sheep odours or flavours. An overall acceptability of 7.4/10 and 100% buying willingness for sheep cured legs from a consumers' panel constituted locally was registered [35].

Table 6: Ordered sensory attributes from the highest discriminatory power to the lowest. Means, test values and p-values.

Descriptor	Sheep8mo	Sheep7mo	Test values	p-values
Brightness	5.33	4.69	2.69	0.004
Acid aroma	3.56	2.89	1.72	0.042
Marbling	3.79	4.23	1.60	0.054
Rancid aroma	3.99	3.27	1.19	0.116
Yellow appearance	5.07	4.40	0.93	0.177
Meat aroma	5.60	5.17	0.87	0.191
Aroma intensity	5.82	5.34	0.85	0.198
Meat taste	5.31	4.70	0.84	0.200
Rancid taste	3.84	3.13	0.74	0.229
Hardness	4.30	3.92	0.69	0.246
Salty taste	4.54	3.92	0.65	0.257
Juiciness	6.51	6.76	0.63	0.263
Acid taste	4.01	3.55	0.27	0.394
Sweet intensity	3.67	4.09	0.25	0.402
Taste intensity	5.96	6.25	0.16	0.436
Taste persistence	5.77	6.15	0.07	0.472
Stringiness	4.98	4.83	-0.26	0.603
Red appearance	5.07	5.19	-0.69	0.755
Sweet taste	3.84	3.81	-1.06	0.855

Besides the mentioned products, also hamburgers can be a different way to valorise sheep meat [41].

Market Opportunities

According to the endogenous development approach [42], resources are constructed, not just inherited: they are produced and reproduced through social and economic interaction. Meat is the main product of this sheep production system and its main source of income for farmers and has a high impact on the value generated along the productive chain. The market strategy intends to address the commercialization constraint faced by farmers, promoting lamb

consumption and adapting the supply of meat products to consumer profiles and habits. The strategy is based on creating more market opportunities by offering to consumers: - lamb in differentiated and better-valued carcass joints, smaller, vacuum packaged, with cooking instructions, more adequate to modern families and diversifying consumer choice options; - Processing the meat from carcasses out of the quality labels (PDO or IGP) and offering new products, such as hamburgers, meatballs, pates, and different cut pieces, pre-cooked and packed in a culinary bag and traditional or contemporary recipes. Commercial cuts derived from carcass cutting have different prices. High-value commercial cuts can be sold fresh, but lower value cuts have limited or no profit margin, making them suitable for developing new meat products to increase their retail value. This strategy allies this matter with the concern around the quality of processed meat products by developing healthy meat products.

The development strategy of healthy meat products is based on the quality aspects and its impacts on human health based on the increasing trending of the consumption of fast food but also in the substantial awareness of today's consumers regarding the food ingested. In fact, the modern lifestyle with lack of time to prepare lengthy meals, together with the increasingly fast pace of life and its pleasant taste, determine the high acceptance of this type of new meat products, especially by young people. On the other hand, most of these processed meat products were made seeking to reduce total fat levels or even modify their lipid profile, reducing the content of saturated fat and cholesterol that are usually associated with obesity and the development of cardiovascular diseases. The reformulation of healthy meat products maximizes the economic benefits for farmers, industry, and partners that may be involved. The use of commercial cuts with lower value as a source of lean meat allows revaluing these pieces, making them less perishable and significantly increasing the economic profit margin. In this context, the increase of direct income through the valorisation of final meat products improving the social recognition and the shepherds' remuneration of the intangible services offered can help attract young people and improve the attractiveness of these territories.

CONCLUSIONS

The lamb carcasses produced were of a quality that complied with the standards set by the PDO product specification and are within the consumer's preferences for this light carcass characteristic of Southern Europe.

While heavy carcasses and their meat can be refused by some consumers due to their intense sensory characteristics, the production of transformed sheep meat products such as pâtés, fresh sausages, or dry-cured legs confers more discreet attributes to them which will please a wider range of consumers.

Processing meat of carcasses out of the quality labels is an interesting way to give added-value to these meats with very low commercial value and consumer acceptance and provide an interesting income increase to sheep producers on the one hand and promote food processing industries by diversifying their production.

The different strategies developed to add value to meat products are a new challenge to integrated meat production and especially for the marginal mountain areas where production options are scarce with several barriers to market access. They essentially aim to support the

marketing and valorisation of sheep meat, promoting the consumption of lambs, and the offer of processed meat products that adapt to the profile and current consumption habits.

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