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Improvement of the healthy properties of a Spanish artisan meat pie maintaining the organoleptic quality

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ABSTRACT

Some artisan products with high fat content, particularly saturated fat, are perceived as unbalanced foods. The “Murcia's meat pie” (MMP) is a Spanish artisan product with ground beef as the main filling ingredient. The aim of this study was to improve the healthy properties of MMP maintaining its original organoleptic quality. Four MMP which were different in the proportion and anatomic location of the cuts of beef were assessed. The MMP most recommended for human consumption was elaborated with ground beef prepared with neck (20 g/100 g) and chuck (80 g/100 g) because of having a lower fat content than the control (37 g/100 g) and the most recommended fatty acid profile. The study showed that a better selection of one or more ingredients can be a valuable strategy for improving the healthy properties of artisan products, without diminishing the sensory attributes. This would allow maintaining the identity, cultural and gastronomic heritage of each country.

1. Introduction

There is general consensus among the different scientific societies and public health organizations about the important role that diet plays in the prevention and treatment of degenerative illnesses. The latest guidelines of the WHO to promote healthy diets include limiting energy intake from fat and reducing saturated fat content of processed foods (WHO, 2003, 2009, 2013). Consumers are becoming more health conscious in their food choices being interested in knowing the nutritional content of foods. Among their main concerns there are the energy value and fat and saturated fat contents in food because of their potential adverse health effects (Brugiapaglia, Lussiana, & Destefanis, 2014; Realini, Guàrdia, Díaz, García-Regueiro, & Arnau, 2015).

Artisan foods are widely recognised as an important part of the nutritional, gastronomic and cultural heritage of different countries. However, many of these artisan products are perceived as nutritionally unbalanced due to their high caloric value and fat content. Murcia's meat pie (MMP) is a Spanish artisan product, typical of the gastronomy of the Region of Murcia, filled with ground beef (GB) as the main ingredient (Ruiz-Cano et al., 2013). Its current caloric value (>300 kcal/100 g), caloric content from fat (50 kcal/100 g) and saturated fat content (45–50 g/100 g total fat) represent an important limitation for its consumption into a balanced diet. The improvement of the healthy properties of artisan foods, through a more adequate selection of one or more of their ingredients, could be an effective strategy to avoid disappearance of some of this type of traditional products.

GB, the main filling ingredient of MMP, is a meat rich in fat and saturated fat (Aldai, Dugan, & Kramer, 2010) and it is perceived for consumers as an unhealthy food (Scollan et al., 2006). It has been demonstrated that GB can be healthier through a better selection of the anatomical location of the cuts (Turk & Smith, 2009).

On the other hand, fat is a key component that affects sensory food attributes. Therefore, a significant reduction of its content in food products should be made carefully, because it could affect their organoleptic characteristics and reduce the overall acceptability (Jiménez-Colmenero, Triki, Herrero, Rodríguez-Salas, & Ruiz-Capillas, 2013; Youssef & Barbut, 2011).

Hence, the aim of this study was to improve the MMP healthy properties, a Spanish artisan meat product, maintaining its excellent and appreciated organoleptic quality. The potential imp-

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rovements investigated in the present study were: a) Reduction of the fat content; b) Modification of the fatty acid profile and fat quality indexes; c) Reduction of the energy value and d) Maintenance of the original sensory attributes of this product.

2. Materials and methods

2.1. Raw materials

Beef meat (fresh post-rigour meat of different cuts of the beef carcass: neck, chuck and thick flank) were kindly provided by a local processor (Faustino y José Damian, S. L., Llano de Brujas, Murcia). Commercial available wheat flour (moisture 13.9 g/100 g, protein 11.8 g/100 g), lard, salt, spices and eggs used in the formulations were purchased from a local market in Murcia (Spain).

All the chemicals and standard reagents used were from Sigma Aldrich (Buchs, Switzerland). Milli-Q system (Milli-Q Corp. Bedford, MA) ultra-pure water was used.

2.2. Formulation and processing of Murcia's meat pie

Four GB samples were prepared with simple mixtures of different cuts of the carcass, in the following proportions: GB1: thick flank 65 g/100 g and neck 35 g/100 g, GB2: thick flank 80 g/100 g and neck 20 g/100 g, GB3: chuck 80 g/100 g and neck 20 g/100 g and GB4: defatted chuck 80 g/100 g and neck 20 g/100 g. The defatted chuck was prepared by removing all subcutaneous fat and intermuscular fat from the muscle. Beef meat mixtures were ground in a 2 cm plate meat grinder (Mainca, Granollers, Spain). The sample GB1 was taken as a reference for being the most commonly used by bakers in the elaboration of MMPs.

The GB samples were vacuum-packaged and stored at 0 °C until required for product manufacture. Spices used in the formulation were: ground black pepper (0.4 g/100 g), nutmeg (0.05 g/100 g), garlic powder (0.6 g/100 g), paprika (0.7 g/100 g) and salt (3.2 g/100 g).

The four types of GB were used for the elaboration of the MMPs according with the formulation and processing for the MMP previously described by Ruiz-Cano et al. (2013). The MMPs were elaborated by three artisan bakers from the Bakery Enterprises Association in the Region of Murcia (AREPA). Each type of MMP was elaborated in triplicate.

2.3. Proximate analysis and caloric value estimation

Samples of GB and MMP were analyzed after homogenization for moisture (Method nº 945.15), ash (Method nº 942.05), crude protein (Kjeldahl method, factor = 6.25, Method nº 920.54), and crude fat (Method nº 920.39) contents, according to the AOAC methods (AOAC, 2000; AOAC, 2006).

Total caloric values (kcal) for MMP were estimated on the basis of a 100 g portion using values for protein (×4 kcal/g), carbohydrate (×4 kcal/g) and fat (×9 kcal/g) (Moreiras, Carbajal, Cabrera, & Cuadrado, 2011). Carbohydrate contents were calculated by the difference (meaning 100-the sum of moisture, protein, fat and ash).

2.4. Determination of fatty acid profiles

Fatty acids (FAs) were extracted from 0.5 to 1.0 g of sample, by homogenising in 20 ml of chloroform/methanol (2:1 v/v) in an ultra-tissue disrupter (IKA Ultra-Turrax T25 dig. IKA Werke GmbH & Co. KG/Germany). Total lipids were prepared according to the method of Folch, Lees, and Stanley (1957). Fatty acid methyl esters (FAME) were separated and quantified by gas–liquid chromatography using an SP™ 2560 flexible fused silica capillary column (100 m long, internal diameter of 0.25 mm and film thickness of 0.20 mm) (Supelco 2560 SPTM, Bellefone, PA, USA) in a Hewlett Packard 5890 gas chromatograph (Bellefone, PA, USA).

2.5. Lipids nutritional quality indexes

The data from fatty acids composition analysis were used to determine the nutritional quality of the lipid fraction. The following indexes were calculated:

- Total saturated fatty acids (SFA), monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA).
- Unsaturated fatty acids/saturated fatty acids ratio [(MUFA + PUFA)/SFA] and polyunsaturated fatty acids/saturated fatty acids ratio (PUFA/SFA) (Pérez-Llamas, Martínez, Carbajal, & Zamora, 2012).
- Atherogenicity index (AI) = [(C12:0 + (4 × C14:0) + C16:0)]/(ΣMUFA + Σn−6 + Σn−3) (Ulbricht & Southgate, 1991).
- Thrombogenicity index (TI) = (C14:0 + C16:0 + C18:0)/[(0.5 × ΣMUFA) + (0.5 × Σn−6) + (3 × Σn−3) + (Σn−3/Σn−6)] (Ulbricht & Southgate, 1991).
- Hypocholesterolemic fatty acids/hypercholesterolemic fatty acids ratio (H/H) = [(C18:1n−9 + C18:1n−7 + C18:2n−6 + C18:3n−6 + C18:3n−3 + C20:3n−6 + C20:4n−6 + C20:5n−3 + C22:4n−6 + C22:5n−3 + C22:6n−3)/(C14:0 + C16:0)] (Fernández et al., 2007).

2.6. Sensory evaluation of Murcia's meat pie

A consumer panel consisting of 80 people between 30 and 65 years among the staff of the university was used for the sensory tests. The sensory attributes (colour, appearance, texture, taste, flavour and overall acceptability) were evaluated using a hedonic descriptive scale of nine points (1 = dislike extremely, 9 = like extremely).

2.7. Statistical analysis

The results were expressed as mean ± standard deviation (SD). The normality of the variables was confirmed by the Shapiro–Wilk test and homogeneity of variance by the Levene test. Statistical differences among the groups were assessed by one-way ANOVA analyses, followed by the Bonferroni or Games Howell test, depending on the homogeneity of the variables. The level of significance was set at $p < 0.05$ for all analyses. All data were analyzed by the computer application SPSS for Windows® (version 19.0, SPSS Inc., Chicago, USA).

3. Results

Table 1 shows the proximate chemical composition of the four types of GB tested. Comparatively, GB3 and GB4 showed significantly lower fat content ($p < 0.05$) and higher moisture and protein ($p < 0.05$) that GB1 and GB2.

The fatty acid profile of the four analyzed GB is shown in Table 2. In all cases, the quantitatively most important FAs were palmitic (C16:0), stearic (C18:0) and oleic (C18:1n−9). The content of linoleic acid (C18:2n−6) and arachidonic (C20:4n−6) were found higher in GB3. The contents of *trans*-FA of the four types of GB ranged from 0.83 to 1.52 g/100 g total FAs. Comparatively, GB3 presented lower proportion of SFA ($p < 0.05$) and higher of MUFA ($p < 0.05$) among the four types of GB. The proportion of PUFA was significantly lower in the GB1 and GB4 comparatively with GB2 and GB3 ($p < 0.05$).

Table 1
Proximate composition of the four ground beef (GB)[a].

Components (g/100 g)	Samples[b]			
	GB1	GB2	GB3	GB4
Moisture	54.87 ± 0.46[a]	63.22 ± 0.62[b]	67.66 ± 0.85[c]	71.96 ± 0.33[d]
Ash	1.50 ± 0.02[a]	1.03 ± 0.02[b]	1.04 ± 0.02[b]	0.96 ± 0.03[b]
Protein	14.08 ± 0.94[a]	16.82 ± 0.02[b]	18.57 ± 0.66[c]	19.04 ± 0.30[c]
Fat	28.17 ± 0.40[a]	19.71 ± 0.66[b]	13.12 ± 0.27[c]	8.76 ± 0.52[d]
Protein/Fat ratio	0.50	0.85	1.41	2.17

[a] Values are means of four replicates ± standard deviation (SD).
[b] Different superscript letters within each row indicate significant differences among samples ($p < 0.05$).

Table 2
Fatty acid profile (main groups and ratios) for the four ground beef (GB)[a].

Fatty acids (g/100 g total FAs)	Samples[b]			
	GB1	GB2	GB3	GB4
Myristic acid (C14:0)	4.86 ± 0.04	3.18 ± 0.04	2.21 ± 0.57	4.47 ± 0.23
Palmitic acid (C16:0)	30.98 ± 0.01	30.19 ± 0.11	23.88 ± 0.92	30.34 ± 0.13
Palmitoleic acid (C16:1)	4.13 ± 0.01	2.96 ± 0.01	3.68 ± 0.48	4.36 ± 0.37
Stearic acid (C18:0)	17.66 ± 0.08	16.58 ± 0.27	12.17 ± 0.99	18.07 ± 1.20
Elaidic acid (C18:1 *trans*-9)	0.83 ± 0.15	1.52 ± 0.11	0.87 ± 0.13	1.39 ± 0.27
Vaccenic acid (C18:1n−7)	1.57 ± 0.01	1.78 ± 0.06	2.16 ± 0.14	1.80 ± 0.24
Oleic acid (C18:1n − 9)	36.59 ± 0.03	32.73 ± 0.25	41.75 ± 0.83	34.16 ± 1.27
Linoleic acid (C18:2n−6)	2.59 ± 0.01	9.56 ± 0.05	10.74 ± 1.57	3.72 ± 0.35
α-linolenic acid (C18:3n−3)	0.23 ± 0.01	0.28 ± 0.40	0.12 ± 0.18	0.16 ± 0.07
Arachidic acid (C20:0)	0.13 ± 0.01	0.17 ± 0.01	0.12 ± 0.18	0.22 ± 0.01
Eicosanoic acid (C20:1n−9)	0.19 ± 0.01	0.27 ± 0.04	0.12 ± 0.17	0.14 ± 0.01
Arachidonic (C20:4n−6)	0.10 ± 0.01	0.33 ± 0.01	1.79 ± 0.45	0.66 ± 0.15
Σ SFA	53.64 ± 0.11[a]	50.14 ± 0.35[a]	38.45 ± 0.25[b]	53.12 ± 1.09[a]
Σ MUFA	42.49 ± 0.01[a]	37.75 ± 0.25[b]	47.84 ± 1.51[ab]	40.47 ± 1.89[ab]
Σ PUFA	3.86 ± 0.13[a]	12.10 ± 0.61[b]	13.70 ± 1.76[ab]	6.39 ± 0.80[a]

SFA: saturated fatty acids. MUFA: monounsaturated fatty acids. PUFA: polyunsaturated fatty acids.
[a] Values are means of four replicates ± standard deviation (SD).
[b] Different superscript letters within each row indicate significant differences among samples ($p < 0.05$).

Table 3 shows the proximate chemical composition of the four types of MMP analyzed, elaborated with the different GB types. The MMP1 presented significantly lower moisture and protein contents ($p < 0.05$), whereas MMP3 and MMP4 showed the lowest fat content ($p < 0.05$). The MMP2 presented the significantly highest fat value ($p < 0.05$). The caloric value of the four types of MMP studied differs significantly among them and ranged between 250 and 312 kcal/100 g product.

Fatty acid profiles in the four types of MMP assessed are shown in Table 4. The quantitatively most important FAs were C16:0 and C18:0 among the SFA, and C18:1n−9 between the MUFA. The results for the four types of MMP were consistent with those obtained for the corresponding GB used in their elaboration. The MMP3 showed the lowest content of C16:0 and C18:0 and the highest one of C18:1n−9. It was not detected any *trans*-FA content in the four types of MMP. The essential fatty acid C18:2n−6 was found in higher proportion in MMP3 than in MMP4, and it was two times higher than in MMP1 and MMP2. Our results show that the sums of the 3 families of FAs followed similar trends to those found in the corresponding types of GB used in their elaboration. Comparatively, MMP3 showed the lowest proportion of SFA and the highest of MUFA and PUFA.

The fat quality was evaluated through the relationships between the three families of fatty acids (Fig. 1). Comparatively, the highest values of (MUFA + PUFA)/SFA and PUFA/SFA were obtained in MMP3 and MMP4.

Fig. 1 also provides information about the fat quality from the four MMP through different indexes: AI, TI and H/H. These values differed significantly between the four MMP due to the type of GB used in their preparation. Comparatively, the MMP3 and MMP4 showed the lowest values of AI and IT and the highest of H/H.

The sensory analysis results of the four MMP analyzed are presented in Fig. 2. On a scale of 1–9, all samples obtained an overall acceptability over 7. Any significant differences between the

Table 3
Proximate composition of the four Murcia's meat pies (MMP)[a].

Components (g/100 g)	Samples[b]			
	MMP1	MMP2	MMP3	MMP4
Moisture	40.80 ± 0.09[a]	43.22 ± 0.07[b]	45.05 ± 0.11[c]	49.23 ± 0.64[d]
Ash	3.13 ± 0.01[a]	2.01 ± 0.03[b]	1.66 ± 0.16[b]	2.08 ± 0.03[b]
Protein	9.97 ± 0.01[a]	10.69 ± 0.15[b]	11.42 ± 0.16[c]	11.36 ± 0.16[c]
Fat	17.56 ± 0.21[a]	18.28 ± 0.10[b]	10.97 ± 0.08[c]	11.05 ± 0.38[c]
Carbohydrate[c]	28.53 ± 0.31[a]	25.79 ± 0.13[b]	30.89 ± 0.45[c]	26.26 ± 0.94[b]
Caloric value (kcal)	312 ± 1[a]	310 ± 1[a]	267 ± 1[b]	250 ± 1[c]

[a] Values are means of four replicates ± standard deviation (SD).
[b] Different superscript letters within each row indicate significant differences among samples ($p < 0.05$).
[c] By difference as 100 − (moisture + protein + ash + fat).

Table 4
Fatty acid profile (main groups and ratios) for the four Murcia's meat pies (MMP)[a].

Fatty acid (g/100 g total FAs)	Samples[b]			
	MMP1	MMP2	MMP3	MMP4
Myristic acid (C14:0)	3.97 ± 0.11	3.22 ± 0.06	1.51 ± 0.01	2.41 ± 0.07
Palmitic acid (C16:0)	31.28 ± 0.83	30.50 ± 0.15	24.47 ± 0.01	29.97 ± 0.10
Palmitoleic acid (C16:1)	2.95 ± 0.05	2.90 ± 0.04	2.17 ± 0.01	2.52 ± 0.03
Stearic acid (C18:0)	17.04 ± 0.01	17.02 ± 0.02	9.02 ± 0.05	16.36 ± 0.05
Elaidic acid (C18:1*trans*-9)	n.d.	n.d.	n.d.	n.d.
Vaccenic acid (C18:1n−7)	1.77 ± 0.10	1.79 ± 0.05	2.12 ± 0.02	1.94 ± 0.01
Oleic acid (C18:1n−9)	32.89 ± 0.80	32.99 ± 0.02	36.98 ± 0.14	32.48 ± 0.02
Linoleic acid (C18:2n−6)	8.35 ± 0.09	9.81 ± 0.14	18.45 ± 0.03	12.19 ± 0.14
α-linolenic acid (C18:3n−3)	0.58 ± 0.07	0.61 ± 0.01	0.89 ± 0.01	0.70 ± 0.01
Arachidic acid (C20:0)	0.17 ± 0.01	0.08 ± 0.12	0.00 ± 0.00	0.18 ± 0.01
Eicosanoic acid (C20:1n−9)	0.33 ± 0.01	0.32 ± 0.01	0.57 ± 0.01	0.37 ± 0.01
Arachidonic acid (C20:4n−6)	0.26 ± 0.01	0.34 ± 0.01	0.60 ± 0.01	0.42 ± 0.01
Σ SFA	52.46 ± 0.92^{a}	50.82 ± 0.34^{b}	35.01 ± 0.08^{c}	48.93 ± 0.11^{d}
Σ MUFA	37.95 ± 0.86^{a}	37.99 ± 0.04^{a}	41.85 ± 0.17^{b}	37.33 ± 0.03^{a}
Σ PUFA	9.59 ± 0.06^{a}	11.18 ± 0.31^{b}	20.70 ± 0.19^{c}	13.72 ± 0.15^{d}

SFA: saturated fatty acids. MUFA: monounsaturated fatty acids. PUFA: polyunsaturated fatty acids. n.d.: not detected.
[a] Values are means of four replicates ± standard deviation (SD).
[b] Different superscript letters within each row indicate significant differences among samples ($p < 0.05$).

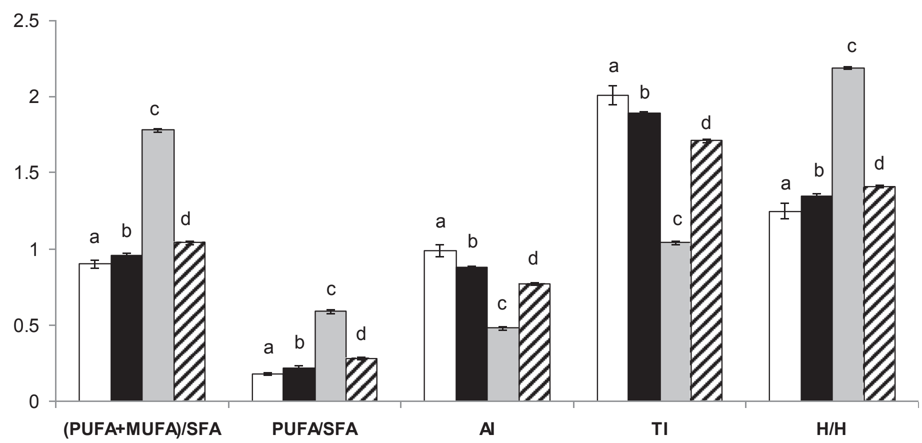

Fig. 1. Nutritional quality indexes of the lipid in the four Murcia's meat pies (MMP). White bars: MMP1; black bars: MMP2; grey bars: MMP3; striped bars: MMP4; SFA: saturated fatty acids; MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids; AI: atherogenicity index; TI: thrombogenicity index; H/H: fatty acids hypocholesterolemic/hypercholesterolemic ratio. Values reported are mean values and standard deviations. Bars with the same letter are not significantly different ($p < 0.05$).

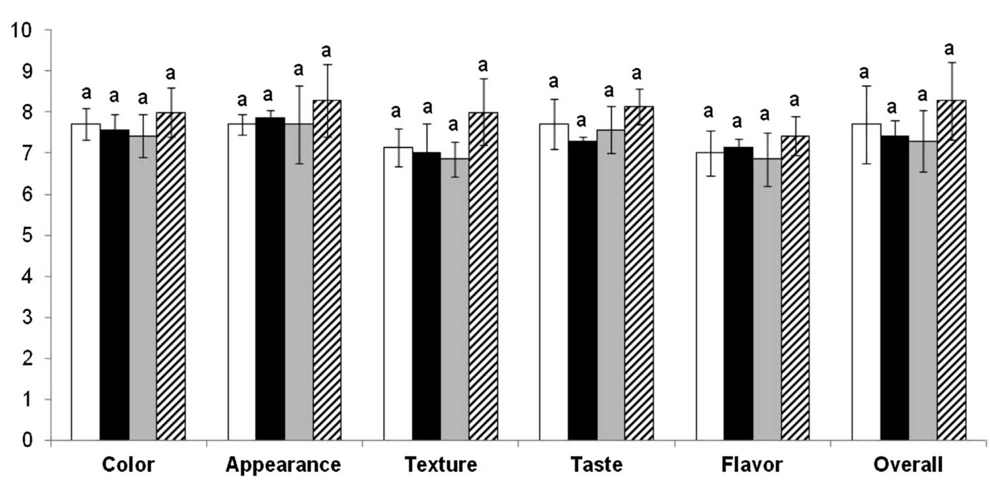

Fig. 2. Sensorial attributes and overall acceptability (OA) in the four Murcia's meat pies (MMP). White bars: MMP1; black bars: MMP2; grey bars: MMP3; striped bars: MMP4. Values reported are mean values and standard deviations. Bars with the same letter are not significantly different ($p < 0.05$).

sensory attributes among the four MMP (colour, appearance, texture, taste and flavour) were observed.

4. Discussion

On one hand, it is of great interest to maintain or regain the gastronomic culture of each country. On the other hand, and given the important implications that diet has on health, there is a growing consumers' concern about composition of foods, particularly energy value and fat content (Brugiapaglia et al., 2014). This study has considered both aspects, with the objective of improving their healthy properties maintaining the organoleptic attributes of an artisan product, typical of the gastronomy of the Region of Murcia (Spain).

The analysis shows that the nutritional composition varied widely among the four types of GB tested GB, depending on the anatomical location (GB3 *vs.* GB2) and on of the proportion (GB1 *vs.* GB2) of the cuts of the carcass. The four types of GB are an excellent protein source (14–19 g/100 g). The protein contents of the GB2, GB3 and GB4 were higher than those reported in other GB obtained from a mixture of lean meat 80 g/100 g and fat meat 20 g/100 g (protein 15 g/100 g) (USDA, 2011). The protein/fat ratios obtained in GB3 and GB4 (1.41 and 2.17, respectively) were higher than those of GB1 and GB2 (0.50 and 0.85, respectively), which would make the first ones the most recommended for consumption from the point of view of human health.

The study shows that not only the total fat amount but also the ratios of fatty acid families vary significantly with the proportion and anatomical location of the cuts of the carcass. These results are consistent with those described by Turk and Smith (2009), who demonstrated the existence of substantial differences in the fatty acid composition among depot sites throughout a beef carcase.

The GB with the highest percentage of neck showed the highest proportion of SFA and the lowest of unsaturated fatty acids (UFA) (GB1 *vs.* GB2). For a given proportion of neck, flank presented higher proportion of SFA and lower of MUFA than chuck (GB2 *vs.* GB3). These results are due to the fact that the cuts containing higher content of external fat are also those with higher SFA content (Schönfeldt, Naudé, & Boshoff, 2010). Thus, carcass cuts ranked from highest to lowest content of external fat and SFA are: neck> flank> chuck; and the GB types most recommended for human consumption would be in the following order: GB3> GB2> GB1.

The GB4 was prepared with the same proportions of neck and chuck than GB3 (20 and 80 g/100 g, respectively), but with previously defatted chuck. The FA profile analysis shows statistically significant differences between both types of GB. The GB4 showed higher percentages of SFA and lower of MUFA and PUFA than GB3. These findings confirm that the neck fat (richer in SFA) is the one that substantially contributes to the FAs profile in GB4. Among the four types of GB analyzed, the GB3 would be the most recommendable, because it has a lower fat content compared to GB1 and GB2, and is a more recommendable FAs profile than GB4. Furthermore, GB3 showed the highest values of the two essential fatty acids (C18:2n−6 and C18:3n−3) and C18:1n−9. This richness in UFA may provide an additional benefit for cardiovascular health. In fact, it has been reported that an adequate intake of both n−6 and n−3 fatty acids is essential for good health and low rates of cardiovascular disease and type 2 diabetes (Willet, 2007). In addition, various health effects have been attributed to the C18:1n−9, such as lowering plasma cholesterol concentration, beneficial effects on blood pressure and reducing risk of myocardial infarction, among others (Dalay, Abbott, Doyle, Nader, & Larson, 2010).

The GB type affected significantly the energy value, fat content and the fat quality of this product. The MMP2 made with GB2 (cuts of same anatomical location but different proportion than GB1), did not reduce the fat content or energy value of the product compared with MMP1. Only a slight improvement was observed in the fat quality, due to the partial replacement of the neck by the flank. The most substantial differences among MMPs were found by the different anatomical location of the cut of the carcass. The MMP3 and MMP4 showed a fat content of around 37 g/100 g lower than MMP1. Furthermore, the quality of the fat was improved, as evidenced by the values of the ratios of the FAs families.

The ratios (MUFA + PUFA)/SFA and PUFA/SFA have been described as one of the main parameters for assessing the nutritional quality of the lipid fraction in foods (López-López et al., 2009). The highest values of both ratios were obtained in MMP3. The atherogenic and thrombogenic indexes indicate the potential ability of foods to produce cardiovascular diseases (Ulbricht & Southgate, 1991). Thus, fat with low values of these indexes can inhibit platelet aggregation and reduce plasma concentrations of triglycerides, cholesterol and phospholipids, preventing the occurrence of cardiovascular diseases (Turan, Sonmez, & Kaya, 2007). The MMP3 is the one that showed the lowest values of these indexes among the four MMPs. The highest index value H/H was found in the MMP3. Higher values of this index, which is related to cholesterol metabolism, are considered more beneficial for cardiovascular health (Fernandes et al., 2014).

Obesity has been called “the epidemic of the century” and has become a serious public health problem. This has contributed to the raise of consumer concern for the energy value of foods and to a current tendency of consumers to select foods with a lower caloric value. The MMP4 and MMP3 represented a significant reduction of 14 and 20 kcal/100 g, respectively, in the total caloric value in comparison with the reference MMP (MMP1). Furthermore, the contribution of fats to the total caloric value is considered as a valuable criterion for the evaluation of foods and their inclusion in a balanced diet (Jiménez-Colmenero, 2000). This contribution varies substantially among the four MMPs tested: 50.6 (MMP1), 53.1 (MMP2), 36.8 (MMP3) and 39.8 kcal/100 g (MMP4). According to these data, the MMP3 is the most recommendable to be incorporated into a balanced diet.

The study shows that all tested MMPs have high overall consumer acceptability (7.29–8.28 on a scale of 1–9). It has been described that the fat content of foods has a major effect on several sensory characteristics (Jiménez-Colmenero, 2000; Schmiele, Mascarenhas, Barretto, & Pollonio, 2015). It has been also suggested that fats increase the flavour and aroma of meat products (Ruusunen et al., 2005; Tobin, O'Sullivan, Hamill, & Kerry, 2012). In the MMP3 and MMP4, a significant reduction occurs in the fat content (37%) together with significant variations in the FAs profile compared to the reference MMP. However, none of the sensory attributes (colour, appearance, texture, taste and flavour) were significantly different among the four types of MMPs tested. This finding is in agreement with that of Poyato, Astiasaran, Barriuso, and Ansorena (2015) who indicated that the level of fat can be reduced without any marked decrease in consumer acceptability. In this study, the use of other ingredients such as ground black pepper, nutmeg, garlic, paprika, and salt could mask the effect caused by the reduction in the fat content on the sensory properties. To our knowledge this is the first study to improve the MMP healthy properties without reducing its sensory attributes.

From the results, it can be concluded that the MMP3, made with GB3 (neck 20 g/100 g and chuck 80 g/100 g) is the one among the four tested, offering the most beneficial properties for human health, because of presenting lower fat, more recommended FAs profile and lower energy value. This study shows that through a better selection of one or more of its ingredients, the healthy properties of artisan foods can be improved, without a significant reduction in their original sensory properties. These improvements in artisan foods can contribute undoubtedly to keep traditional foods and avoid the loss of the cultural and gastronomic heritage of a region or country.

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