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Chemical and sensory quality of sheep liver pâté prepared with 'variety meat'

Qualidade química e sensorial de patê de fígado ovino elaborado com subprodutos comestíveis

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Abstract

Many edible meat by-products produced from sheep slaughter are often wasted but represent excellent sources of many nutrients. The preparation of pâté may be an alternative use for this raw material and may contribute to the development of a sheep sector by offering new products to the consumer market. The objective of this work was to produce and evaluate the quality of sheep pâté made with blood, liver and trimmed meat. The pâté formulation was composed of 12% meat, 25% liver, 13% blood, 20% water and 30% fat, as well as spices and seasoning. The product had high iron content (9.0 mg/100 g). The measured levels of essential amino acids exceeded the recommended values for adults. The sheep liver pâté showed a significant percentage of linoleic acid (16.68%), which is essential to the human body. The pâté produced was in accordance with the requirements of the Brazilian legislation regarding chemical and microbiological parameters, able to be edible, and showed good sensory acceptance. This study suggests that the development of sheep liver pâté is a viable alternative to add value to edible sheep slaughter by-products by generating a product with high nutritional value.
Key words: Meat emulsions, sheep, pâté, quality, edible by-products

Resumo

Subprodutos comestíveis produzidos a partir do abate de ovinos são muitas vezes desperdiçado, mas representam excelentes fontes de muitos nutrientes. A preparação de patê pode ser uma alternativa para utilização desta matéria-prima e pode contribuir para o desenvolvimento do setor da ovinocultura, oferecendo novos produtos para o mercado consumidor. O objetivo deste trabalho foi produzir e avaliar a qualidade de patê ovino feito com fígado, sangue e retraços de carne. A formulação do patê foi composta de 12 % de carne, 25% de fígado, 13 % de sangue, 20% de água e 30% de gordura, bem como especiarias e condimentos. O produto tinha alto teor de ferro (9,0 mg/100 g). Os níveis medidos de aminoácidos essenciais excederam os valores recomendados para adultos. O patê de fígado ovino mostrou uma percentagem significativa de ácido linoleico (16,68%), o que é essencial para o corpo humano. O patê produzido apresentou-se em acordo com as exigências da legislação brasileira sobre parâmetros químicos e microbiológicos, podendo ser consumido, e mostrou boa aceitação sensorial. Este estudo sugere que o desenvolvimento de patê de fígado de ovelha é uma alternativa viável para agregar valor aos subprodutos comestíveis do abate de ovinos, gerando um produto com alto valor nutritivo.
Palavras-chave: Emulsões cárneas, ovino, patê, qualidade, subprodutos comestíveis

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Introduction

The use of alternative sources of protein from the meat industry and its by-products can improve the nutritional status of the population at a low cost, especially in underdeveloped countries (FONTES et al., 2004, MATTOS et al., 2006). Worldwide, iron-deficiency anaemia is the most common nutritional disorder, affecting approximately 3.5 billion people. In Brazil, anaemia is an important endemic deficiency caused mainly by the lack of adequate food, low income and losses from wasted food (MOREIRA-ARAÚJO; ARAÚJO; ARÊAS, 2008). According to Dalmás et al. (2011), blood and liver are sources of high-quality protein and have excellent iron bioavailability, which can be useful in the prevention of anaemia when included in the human diet. In this context, an important task for the meat industry is maximal processing of edible by-products into food products, which favours the reduction of iron losses, increases the diversification of products to the consumer market, and adds an extra gain for the production chain.

Costa, Medeiros and Madruga (2003) reported that the use of goat slaughter by-products can increase income by 57.51 % in relation to the carcass value. Dalmás et al. (2011) reported that the preparation of pâté is an alternative to the conventional use of goat blood and liver. In Europe, blood sausage and liver pâté are traditionally consumed (ESTÉVEZ; VENTANAS; CAVA, 2005, SANTOS et al., 2003).

Pâté is a cooked product with important gastronomic traditions and greatly appreciated sensory properties that is consumed in many countries (ECHARTE et al., 2004, VOSSEN et al., 2012). Studies have demonstrated the use of liver from different animal species such as pig (ESTEVÉZ et al., 2007, 2004; ECHARTE et al., 2004, D'ARRIGO et al., 2004), ostrich (FERNÁNDEZ-LÓPEZ et al., 2004), duck (ABU-SALEM; ABOU-ARAB, 2010), fish (AQUERRETA et al., 2002), chicken (ABU-SALEM; ABOU-ARAB, 2010, POLAK et al., 2011) and goat (DALMÁS et al., 2011) in the preparation of pâté, which highlights their nutritional and sensory properties. Given the above information and due to the scarcity of studies on the use of edible sheep slaughter by-products in the development of new products, particularly pâté, the aim of this work was to produce a pâté made with sheep blood, liver and meat trimmings and to determine its physicochemical, microbiological and sensory characteristics.

Material and methods

Preparation of sheep liver pâté

The basic formulation of pâté (Table 1) resulted from preliminary studies where varying concentrations of blood, liver and meat trimmings of sheep slaughtered between the ages of 18 and 24 months were considered to have better sensory acceptance. The drafting of the sheep liver pâté followed the methodology used by Dalmás et al. (2011) and was performed in triplicate.

Table 1. Formulation of pâté prepared with sheep slaughter by-products.

Raw Materials [1]	Formulation in %	Formulation in g/5 kg
Blood	13	650
Liver	25	1250
Meat trimmings	12	600
Fat	30	1500
Water	20	1000
Ingredients [2]		
Stabilizer	0.4	20
Salt (Sodium chloride)	1.5	75
Curing salt (Nitrite)	0.3	15
Flavour enhancer	0.1	05
Powder garlic	0.1	05
Ham seasoning	1.0	50
Antioxidant	0.4	20
Soybean protein	2.0	100
Manioc starch	1.5	75

[1] Sum of raw materials accounted for 100 % of the pâté formulation;
[2] Percentage added to the formulation of 100 %.
Source: Elaboration of the authors.

Physicochemical characterization and profile of minerals, amino acids and fatty acids

Moisture, ash, protein, nitrite and starch contents were determined using parameters described by AOAC (2000). The ether extract was characterised according to Folch, Less and Stanley (1957). The cholesterol content was measured according to methodology proposed by Bragagnolo and Rodriguez-Amaya (1997). A high resolution liquid chromatography instrument (VARIAN, Waters 2690, California, USA) with an INESTISIL C18 column (4.6 mm x 150 mm x 5 mm) was employed for the determination of the cholesterol content in the samples. An isocratic elution of acetonitrile and isopropanol (60:40) with a constant flow rate of 1 mL/min was used as the mobile phase. The detection of total cholesterol occurred in a UV-VIS detector (PDA 330) set at 210 nm. The chromatographic separation was performed at 30 °C with a run time of 10 min.

The water activity was measured according to parameters described by AOAC (2000) using a DECAGON apparatus (PAWKIT series P04266, São Paulo, Brazil). The pH was determined using a digital pH meter (DIGIMED, model pH 300M, São Paulo, Brazil) equipped with a glass electrode and the measurements were taken according to parameters described by AOAC (2000).

The colour parameters (L*, a*, b*) of the sheep liver pâté was determined according to the methodology described by Abularach, Rocha and Felício (1998) using a digital Minolta colorimeter (Model CR-300, Minolta, Osaka, Japan).

The determination of minerals (P, K, Ca, Na, Mg, Cu, Cr, Zn and Fe) was performed by plasma emission spectroscopy (BAIRS ICP-OES 2000, Massachusetts, USA) equipped with a 40 MHz radio frequency source, a peristaltic pump and a spray chamber, which is in accordance with methodology described by Dalmás et al. (2011). The amino acid profile, using methodology by White, Hart and Fry (1986), was determined on a sample previously hydrolysed in 6N bidistilled hydrochloric acid, followed by the pre-column derivatisation of the free amino acids with phenylisothiocyanate (PITC). The separation of the phenylthiocarbamyl

amino acid derivatives (PTC-aa) was performed by liquid chromatography (VARIAN, Waters 2690, California, USA).

The characterisation of the fatty acids present in the lipid extract was obtained using the method of Folch, Less and Stanley (1957) and was performed as the methodology described by Hartman and Lago (1973). The identification and quantification of fatty acid esters was performed by gas chromatography (VARIAN, 430-GC, California, USA) coupled with an FID detector and a fused silica capillary column (CP WAX 52 CB, VARIAN) with film thickness dimensions of 60 m x 0.25 mm and 0.25 µm. Helium was used as the carrier gas (1 ml/min flow rate). The initial oven temperature was 100 °C and was programmed to reach 240°C by increasing 2.5 °C per minute for 20 minutes. The injector and detector temperatures were maintained at 250 °C and 260 °C, respectively. The chromatograms were recorded with the Galaxie Chromatography Data System software. The fatty acids were identified by comparison of the retention time of corresponding methyl esters of samples using the Supelco ME19-Kit standards (Fatty Acid Methyl Esters C6-C22). The fatty acid results were quantified using the standardisation of areas for the methyl esters and expressed as an area percentage.

Sensory evaluation

Before consumption by panelists, pâté samples were submitted to microbiological analysis, taking for the most probable number of thermotolerant coliforms, counts of coagulase-positive Staphylococcus (APHA, 2001), sulphite-reducing Clostridium (BRASIL, 2001) and *Salmonella* sp. (FDA, 2011).

The sensory analysis was performed by 60 untrained panelists, selected for being consumers of pâté or/and sheep-derived products or/and products made with blood and viscera. About 2 g of sheep liver pâté was served approximately 10 °C spread on bread slices, which average 2.5 cm^2.

Panelists were asked to taste the samples for evaluation of attributes aroma, colour, flavour, texture and overall impression, using the nine-point hedonic scale as follows: 1 = disliked extremely, 5 = neither liked / or disliked, and 9 = liked extremely. For the purchase intention test, a five-point structured scale was used, where 1 = Certainly would buy, 3 = Maybe would buy / may would not buy and 5 = Certainly would not buy. The sensory tests were performed according to methodology proposed by Meilgaard, Civille and Carr (1991), after approval by the Ethics Research Center of Health Sciences, Federal University of Paraíba (n. 0218/11).

Results and Discussion

Physicochemical quality, minerals, amino acids and fatty acids profile of sheep liver pâté

The physicochemical characterisation of pâté made with edible sheep slaughter by-products is shown in Table 2. The results are in accordance with the limits set by Brazilian legislation (BRASIL, 2000), which recommends a maximum content of 70 % moisture, 32 % fat and 10 % total carbohydrates with a minimum content of 8 % protein.

The ash content (3.72 g/100 g) of sheep liver pâté was similar to values reported by Dalmás et al. (2011) in pâté made with goat blood, liver and meat (3.13 g/100 g). However, sheep liver pâté showed mineral values higher than those reported by Estévez et al. (2007) and Echarte et al. (2004) in pig liver pâté that likely resulted from the use of sheep blood and liver, which are considered a good source of minerals (ANDERSON, 1988, FONTES et al., 2004).

Table 2. Mean and standard deviation of physicochemical characterization of sheep liver pâté, goat pâté, liver pâté and lamb meat.

Parameters	Sheep liver Pâté	Goat Pâté[1]	Liver Pâté[2]	Lamb Meat[3]
Moisture (g/100g)	54.81 ± 0.28	54.93 ± 0.51	53.90	81.06
Ash (g/100g)	3.72 ± 0.08	3.13 ± 0.51	NR	NR
Protein (g/100g)	15.10 ± 0.22	14.74 ± 0.07	14.20	14.07
Lipids (g/100g)	23.90 ± 0.06	22.67 ± 0.07	28.00	3.41
Cholesterol (mg/100g)	115.08 ± 0.20	NR	255.00	36
Starch (g/100g)	1.45 ± 0.03	4.53 ± 0.00	1.5	NR
Nitrite (mg/kg)	2.20 ± 0.09	NR	NR	NR
pH	7.25 ± 0.04	6.78 ± 0.08	NR	NR
Aw	0.97 ± 0.00	0.97 ± 0.00	NR	NR
*L**	42.59 ± 0.13	49.31 ± 0.29	63.99 ± 0.63	NR
*a**	18.37 ± 0.25	13.98 ± 0.23	10.23 ± 0.38	NR
*b**	13.78 ± 0.06	13.91 ± 1.46	13.93 ± 0.27	NR
Minerals Profile				
Calcium (mg/100g)	9.40 ± 0.10	10.8 ± 0.50	70	7
Copper (mg/100g)	1.15 ± 0.04	1.63 ± 0.03	NR	NR
Iron (mg/100g)	9.00 ± 0.20	6.48 ± 0.09	5.50	1.19
Phosphorus (mg/100g)	306 ± 8.00	249 ± 6.00	200	104
Potassium (mg/100g)	204 ± 5.00	204 ± 2.00	138	193
Sodium (mg/100g)	1337 ± 10.0	956 ± 28.00	697	43
Magnesium (mg/100g)	15.8 ± 0.20	19.7 ± 1.60	13	13
Zinc (mg/100g)	1.84 ± 0.02	2.27 ± 0.04	2.85	2.43

[1] Adapted from Dalmás et al. (2011);
[2,3] (USDA 2012a, 2012b);
NR: Not referenced.
Source: Elaboration of the authors.

In addition, sheep liver pâté has higher protein (15.10 g/100 g) and lower lipid content (23.90 g/100 g) when compared to values reported for pork liver pâté [10.39 g/100 g and 32.58 g/100 g (ESTÉVEZ et al., 2004), 13.0 g/100 g and 25.79 g/100 g (ESTÉVEZ; VENTANAS; CAVA, 2005), 9.93 g/100 g and 26.28 g/100 g (ECHARTE et al., 2004), respectively] and fish pâté [12.97 g/100 g and 29.01 g/100 g (AQUERRETA et al. 2002) and 9.85 g/100 g and 24.86 g/100 g (MINOZZO; WASZCZYNSKYJ; BOSCOLO 2010), respectively]. The addition of liver and blood to the formulation can also justify the high protein content. Anderson (1988) characterised viscera and found 20.99 g/100 g of protein for lamb liver. The lamb is a young sheep (MADRUGA et al. 2007). Blood is considered a protein source of high commercial value with functional properties suitable for the preparation of emulsified products (SILVA; SILVESTRE, 2003).

The cholesterol content of sheep liver pâté (115 mg/100 g) was lower than that commonly found in literature for this type of product (255 mg/100 g), according to Echarte et al. (2004); however, it was higher than values reported by the same author for pig liver pâté (77.6 to 102 mg/100 g). This fact can be attributed to the use of sheep liver in the formulation because according to Anderson (1988), the cholesterol content (370 mg/100 g) of sheep liver was higher than that of lamb meat (66 mg/100 g) as reported by Madruga (2009).

Given the increasing search for healthier food products, high cholesterol content is considered the most important disadvantage in meat products (ECHARTE et al., 2004). Thus, great efforts have been made to improve the quality of these products. To this end, the sheep liver pâté meets consumer demand as a product with lower cholesterol

content when considering the remaining liver pâtés traditionally marketed.

The residual nitrite content (2.20 mg/kg) was lower than values established by Brazilian law (BRASIL, 1998), which recommends a maximum of 15 mg/kg of product. Sheep liver pâté has a residual nitrite content within the range reported by Pinho et al. (1998) for 15 brands of pig and poultry liver pâté, which ranged from 1.07 to 5.2 mg/kg. Doolaege et al. (2012) reported that the controlled use, in addition to the low residual nitrite concentration, reduced the risk of formation of nitrosamines, making nitrite safe for application in meat products.

Sheep liver pâté is a product with high Aw (0.97) and pH close to neutral (7.25), which characterises it as a product susceptible to microbiological changes. Similar behaviour was reported by Minozzo, Waszczynskyj and Boscolo (2010), indicating that these values make the product suitable for the development of pathogenic bacteria. Thus, packing the product in suitable packaging and storing under refrigerated conditions became necessary.

Colour is a quality attribute that directly influences the acceptability of meat products. Consequently, Stiebing (1990) recommends that the red colour intensity (a^*) should have values above 20 to provide acceptable colour in blood meat products with added nitrite. The red intensity (a^*) of sheep liver pâté is close to this limit with a value of 18.37. Lightness (L^*) is another important parameter of meat products with added blood because the higher the blood concentration in the final product, the lower the brightness (L^*), which thus reduces product attractiveness (Dalmás et al., 2011). This parameter can be justified by the high concentration of heme pigments present in blood, which are transformed into dark compounds by heat treatment (FONTES et al., 2004). All colour parameters (L^*, a^* and b^*) of sheep liver pâté were similar to values found by Dalmás et al. (2011) for goat pâté.

Sheep pâté had high potassium, phosphorus, magnesium and iron content, and significant contents of these minerals was reported by Abd El-aal and Suliman (2008) in lamb meat. The nutritional quality of sheep pâté, in regards to the iron content (9 mg/100 g), is related to the use of liver and blood in the formulation, which increased the iron content by approximately 7 times the iron content of meat. Anderson (1988) studied the mineral composition of lamb organs and found higher iron values for the liver (7.47 mg/100 g) compared to meat (1.3 mg/100 g). Dalmás et al. (2011) reported that increasing the blood level resulted in increased iron content (6.46 to 9.99 mg/100 g) when developing goat pâté with added blood and liver. Moreira-Araujo, Araújo and Arêas (2008) and Dalmás et al. (2011) reported that iron from animal sources has excellent bioavailability, which makes it suitable for use in programs to control anaemia through the development of food products.

Likewise, zinc absorption is higher in animal protein-rich sources than in vegetal food (WILLIAMS, 2007). Unlike sodium, the zinc, calcium and copper contents are lower than values reported by Dalmás et al. (2011) for goat pâté. The high sodium concentration in sheep liver pâté is attributed to the addition of sodium chloride and sodium nitrite to the formulation.

The amino acid profile of sheep liver pâté (Table 3) exceeded the recommended values for adults (FAO, 2007) for liver pâté and lamb meat (USDA, 2012b, 2012c). In addition, based on the chemical score (PIRES et al., 2006), the sheep liver pâté showed no amino acid deficiencies; thus, it is a product regarded as a source of protein of high nutritional value. The content of essential amino acids in sheep liver pâté accounted for 53.80 % of the total content, which indicates that this meat product is an excellent source of leucine, valine and histidine. For non-essential amino acids, it also showed high levels of aspartic and glutamic acids.

Table 3. Amino acids profile (mg / g protein) of sheep liver pâté, FAO standard, amino acids, liver pâté and lamb meat scores.

Amino acids	Sheep liver pâté	FAO standard[1]	Amino acids score[2]	Liver pâté[3]	Lamb meat[4]
Essential					
Phenylalanine	56.95	38	1.50	40.99	40.70
Histidine	74.17	15	4.94	20.99	31.64
Isoleucine	52.20	30	1.74	39.01	48.25
Leucine	112.58	59	1.91	73.94	77.78
Lysine	47.68	45	1.06	59.01	88.29
Methionine	48.1	22	2.19	20.00	25.67
Threonina	64.2	23	2.79	40.00	42.81
Valine	82.12	39	2.11	50.09	53.93
Non-essential					
Alanine	80.13	NR	NR	67.04	60.15
Arginine	40.40	NR	NR	63.03	59.42
Aspartic acid	139.07	NR	NR	81.90	87.98
Glutamic acid	179.47	NR	NR	134.09	145.05
Glicine	66.89	NR	NR	95.99	48.85
Proline	19.21	NR	NR	70.07	41.91
Serine	57.62	NR	NR	41.90	37.18
Tyrosine	44.37	NR	NR	31.97	33.58

[1]Estimated amino acid requirement (adults). Standard protein reference FAO / WHO / ONU (2007);
[2]Amino acid score (mg/g protein sample) / (mg/g protein standard FAO / WHO);
[3]USDA (2012b);
[4]USDA (2012c);
NR: Not referenced.
Source: Elaboration of the authors.

The amino acid composition of sheep liver pâté can be credited to the use of blood, liver and sheep meat in the formulation. According to Gorbatov (1988), isoleucine and methionine deficiencies in the blood can be overcome by the combination of the meat with blood, thus maintaining adequate amounts of essential and nonessential amino acids. Anderson (1988) evaluated the amino acid composition in the viscera of lamb, which highlighted the high biological value due to the presence of all essential amino acids and revealed that the viscera has similar values to lamb meat.

Sheep liver pâté has a high percentage of monounsaturated fatty acids (42.31 %) with mainly oleic acid (Table 4), which is distinguished for its high concentration in sheep meat and pork fat (BRAGAGNOLO; RODRIGUEZ-AMAYA, 2002, PELEGRINI et al. 2007). Linoleic acid (C18:2) stood out among the polyunsaturated fatty acids at 16.68 %. Estévez et al. (2004) reported a lower percentage of polyunsaturated fatty acids for pig liver pâté, especially in relation to the linoleic acid concentration (7.71 % to 12.54 %). Anderson (1988) indicates that lamb organs have higher polyunsaturated fatty acid levels compared to those of fresh lamb meat, especially heart (15.85 %), kidney (20.83 %) and liver (23.57 %). Linoleic acid is considered essential to the human body due to its specific physiological functions like being a requisite compound in the tissue that makes up the central nervous system, and it also plays a role in the prevention of cardiovascular, autoimmune and inflammatory diseases (THAUTWEIN, 2001).

Table 4. Fatty acid profile of sheep liver pâté, pig liver pate and lamb meat.

Fatty acid (%)[1]	Sheep liver Pâté	Pig liver Pâté[2]	Lamb meat[3]
SFA	40.80	35.42	39.81
C14:0 Myristic	1.58 ± 0.01	1.12 ± 0.01	3.01
C16:0 Palmitic	25.27 ± 0.13	21.67 ± 0.07	22.92
C18:0 Stearic	12.03 ± 0.06	11.99 ± 0.02	13.88
C20:0 Arachidonic	1.00 ± 0.01	0.21 ± 0.04	1.16
C22:0 Behenic	0.39 ± 0.05	NR	NR
C24:0 Tetracosanoic	0.53 ± 0.00	NR	NR
MUFA	42.31	52.55	25.23
C14:1 cis-9-tetradecenoic	0.03 ± 0.00	NR	NR
C16:1 Palmitoleic	0.42 ± 0.00	2.22 ± 0.01	3.47
C18:1 Oleic	41.86 ± 0.18	48.50 ± 0.07	21.76
PUFA	16.88	10.05	3.94
C18:2 Linoleic	16.68 ± 0.07	10.01 ± 0.08	2.32
C18:3 Linolenic	0.20 ± 0.04	0.04 ± 0.00	1.62

[1]SFA - Sum of saturated fatty acids, MUFA: Sum of monounsaturated fatty acids, PUFA: Sum of polyunsaturated fatty acids.
[2]Adapted from Estévez et al. (2004);
[3]Adapted from Madruga (2009);
NR: Not referenced.
Source: Elaboration of the authors.

Sensory analysis

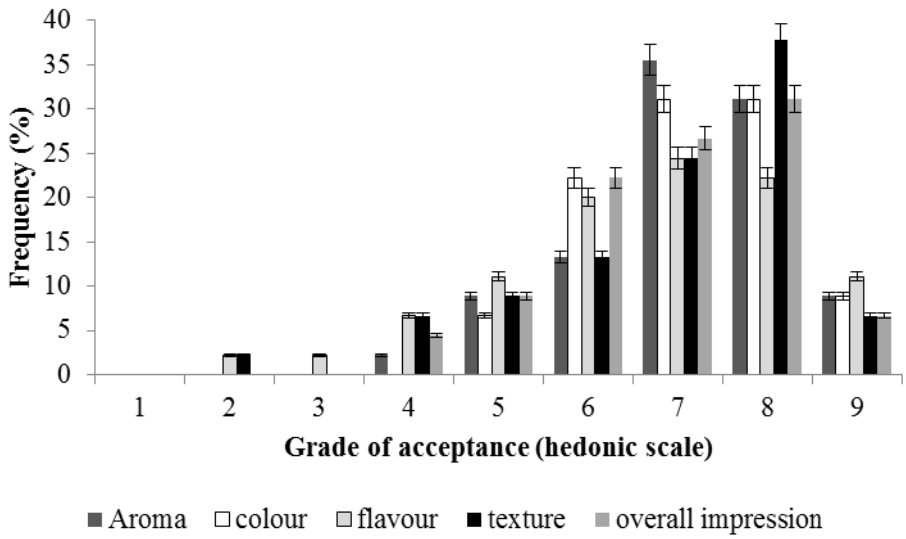
The microbiological evaluation showed microorganism counts below limits established by legislation (BRASIL, 2001) for sulphite-reducing *Clostridium* (<100 CFU / g), coagulase-positive Staphylococcus (<100 CFU / g) and thermotolerant coliforms (<3.0 MPN / g) in addition to the absence of *Salmonella* sp.; therefore, the sheep liver pâté was deemed suitable for human consumption. Guerra et al. (2011) found similar results when preparing sausage with disposed goat meat. The excellent microbiological quality of the sheep liver pâté was a result of the combined effects of heat treatment to eliminate vegetative forms (SANTOS et al., 2005), the use of salt (NaCl) to reduce water activity and inhibit the growth of microorganisms (HONIKEL, 2008), and the addition of nitrite to inhibit the growth of anaerobic bacteria, particularly *Clostridium botulinum*, as well as the growth of spores (SEBRANEK; BACUS, 2007). In addition to these factors, applications of Good Manufacturing Practices - GMP involving the quality of the raw material, hygienic processing conditions and cold storage were essential for the microbiological safety of the product.

The sheep liver pâté was positively evaluated in the acceptance test. This pâté received flavour scores corresponding to liked slightly (6.6) and aroma, colour and texture scores corresponding to liked moderately (7.1). The overall impression received a favourable score of 6.9. Regarding the purchase intention test, the average score received was 3.8 points, which corresponded to 58 % (score 4 and 5) of the panellists that would buy the product, 22% (score 3) indicated doubt whether to buy or not and only 20% rejected the product (score 1 and 2). Guerra et al. (2011) reported similar results, indicating good acceptance, with scores ranging from 6 to 7.6 for the acceptance test and from 3.5 to 3.8 for the purchase intention test of goat mortadella prepared with different fat concentrations.

The frequency histogram of aroma, colour, flavour and texture attributes along with the overall appearance of the sheep liver pâté is shown in Figure 1. A trend of higher scores between 6 and 8 for all attributes was observed, with colour showing

the highest acceptance index (84%) and flavour with the lowest acceptance index (66%). The highest flavour rejection was attributed to the strong flavour as reported by spontaneous comments from panellists. Aquarreta et al. (2002) indicated similar assessments for the same attribute, which was considered very strong in pâté made with tuna liver.

Figure 1. Histogram of frequency of scores assigned to attributes aroma, colour, flavour, texture and overall impression of sheep liver pâté evaluated in the acceptance test.



Source: Elaboration of the authors.

Conclusion

The characterisation of sheep liver pâté showed significant content of essential amino acids, protein, iron and linoleic acid in addition to good sensory acceptability. Therefore, the preparation of sheep liver pâté is a viable alternative to add value to sheep blood and liver that results in a product with high nutritional quality.

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