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Development of goat pâté prepared with 'variety meat'

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ABSTRACT

Many edible meat by-products are just as significant sources of essential nutrients as meat itself. The use of blood and liver in the preparation of pâté offers an alternative for the economic exploitation of goat 'variety meat'. Given the scant information on the production of goat pâté, the objectives of this study were to develop a value-added product, goat pâté, processed with variety meat (goat meat trimmings, goat liver and blood) and to determine its physico-chemical parameters and mineral profile. Three formulations, with different percentages of blood and liver, were prepared; formulation A consisted of 21% liver and 9% blood, formulation B contained 15% liver and 15% blood, and formulation C contained 9% liver and 21% blood. As well as the mineral profile (Ca, Na, Fe, Mg, Zn, P, Cu, K, Cr), the physico-chemical parameters of water activity (Aw), pH, colour (CIE $L^*a^*b^*$), moisture, lipid, protein, total carbohydrate and ash were evaluated. All three formulations of goat pâté were in accordance with Brazilian legislation for moisture, protein, lipid and carbohydrate content. Parallel significant differences ($P < 0.05$) were detected for moisture, protein, carbohydrate, iron, phosphorus, magnesium and copper content, and for L^* and a^*, among the three formulations. Pâté C, prepared with the highest amount of blood, was richest in iron and presented the highest redness (a^*). The other parameters examined did not differ with the variations in blood and liver used. The development of new goat products using variety meats offers an option for adding value in the productive sector and makes available an easily assimilated source of iron.

1. Introduction

'Variety meat' is a term used in the meat trade for traditionally edible by-products taken from a part of the animal other than skeletal muscle, i.e. liver, brain, heart, kidney, tripe, stomach, head meat, lips, etc. (Goldstrand, 1988). It has always been promoted as an important source of minerals and vitamins, particularly iron, riboflavin, niacin and vitamin A, and these nutritional benefits have led to a high level of consumption (Anderson, 1988).

While meat is the primary product of the livestock industry and constitutes most of its economic value, the question remains as to how to make more profit by using by-products. This is supported by Bengtsson and Holmqvist (1984) who estimate that 7–12% of the income from a slaughtered animal comes from by-products. Goldstrand (1988) calculates that organs, fatty tissues, bones and blood represent 39, 30 and 35% of the live weight of cattle, pigs and lambs or goats, respectively.

Processed meat products using variety meat, such as *morcilla de Burgos* in Spain (Santos et al., 2003), *cavourmas* in Greece (Arvanitoyannis et al., 2000), *blutwurst* in Germany (Stiebing, 1990), and *morcella de Assar* in Portugal (Roseiro et al., 1998), are quite popular in many European countries.

Costa et al. (2003) examined the interest in goat variety meat and concluded that these by-products could add extra earnings of 57.71% to the carcass value. Kirton et al.

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(1995) and Rosa et al. (2002) propose that studies involving the use of viscera or other by-products as ingredients and flavourings for processed food should be promoted and evaluated. However, scientific information on the quality of goat variety meat and its use in processed products is scarce.

Discussions of the advantages and disadvantages of using variety meat in the human diet have focused mainly on its nutritional value. Santos et al. (2003) report that *morcilla de Burgos*, like other traditional European blood-based products, has a high protein content and is an easily assimilated source of iron. Madruga et al. (2003) have shown that the proximate composition, phosphorus and iron content of goat viscera and blood are close to those of goat meat. So, the use of blood in the human diet may also help to meet nutritional shortcomings. Iron deficiency is a widespread problem, especially in developing countries, and stands out as one of the major global health problems (Guerra et al., 2008). The heme iron present in blood, and its excellent bioavailability when compared to non-heme iron, can help prevent anaemia if blood is included in the diet (Santos, 2007). Including variety meat from the goat carcass in the preparation of processed products, like pâté, offers an alternative use for these by-products, which in Brazil are generally only used in the preparation of a typical goat meat product called *buchada* (Madruga et al., 2007). The objectives of this study were to develop a value-added product, goat pâté, prepared using variety meat (spent goat meat, goat liver and blood) and to determine the physico-chemical parameters and mineral profile of this goat product.

2. Materials and methods

2.1. Preparation of goat pâté

Pâtés were prepared using goat variety meat–blood, liver and meat trimmings – from Saanen and Anglo-Nubian goats aged 18–24 months. The animals were slaughtered after a 16-h period of solid fasting and hydric diet. The animals were suspended by the extremities of their limbs, stunned by cerebral concussion and bled by cutting the jugular vein and carotid artery.

The blood was collected aseptically in a closed system to avoid possible contamination. As soon as collection was complete, 50% of sodium citrate anticoagulant was added, followed by homogenization and cooling at $5 \pm 1\,^{\circ}$C.

The meat trimmings and liver were separated from the carcass and abdominal cavity, respectively, decontaminated by washing with heavily chlorinated water (Kelly et al., 1981), and stored under refrigeration at $5 \pm 1\,^{\circ}$C for 24 h, after which they were used. The decontamination process was meant to reduce bacterial contamination and so improve the general hygiene of the product. Pork fat was purchased from a local butchery.

Three formulations of pâté with varying percentages of liver and blood (Table 1) were studied. Goat pâté was produced as three batches of 5 kg for each formulation. The preparation process followed the standard procedure for the preparation of pâté. The required quantities of blood and liver were cooked in boiling water (100 °C) for 5 min, cooled to room temperature, and used in the preparation of an emulsion. The cooked blood and liver were cut into cubes and placed in the homogenizer (Jamar K-10, São Paulo, Brazil), along with some ice. Homogenization was initiated as soon as possible, salt was added and the process continued for thirty seconds to allow the salt to be incorporated into the mix. Curing salt and stabilizer were added at 15-s intervals. Mixing was continued until the dough reached 16 °C, then the mass was removed from the homogenizer.

At the same time, a meat emulsion was prepared using goat meat trimmings (neck meat), pork fat, cut into 3 cm^3 cubes, and the remaining ingredients. The previously prepared liver and blood emulsion was added,

Table 1
Formulation of goat pâtés prepared with by-products.

Raw materials[a]	Goat pâté formulations (%)		
	A	B	C
Blood	9	15	21
Liver	21	15	9
Lard	30	30	30
Goat meat	20	20	20
Water	20	20	20
Other ingredients[b]			
Stabilizer	0.30	0.30	0.30
Salt (sodium chloride)	2.50	2.50	2.50
Curing salt	0.30	0.30	0.30
Flavour enhancer	0.10	0.10	0.10
Garlic powder	0.15	0.15	0.15
Antioxidant	0.30	0.30	0.30
Ham spice	1.00	1.00	1.00
Soy protein isolate	2.00	2.00	2.00
Cassava starch	1.50	1.50	1.50

[a] Sum of the raw materials constitutes 100% of the pâté formulation.
[b] Percentage added to the formulation of 100%.

with the final mixture remaining in the homogenizer for 4 min until complete emulsification of the mass. The pâté was packed in 300 mL glasses and cooked to an internal temperature of 85 °C (checked using a thermocouple) for 30 min. After cooking, the glasses were cooled to 35 °C in chilled water, followed by refrigerated storage at 4 °C. The analyses were carried out within 8 days.

2.2. Physico-chemical analysis and mineral profile of goat pâté

The physico-chemical characterization of the pâté was carried out by determining colour, pH, water activity (Aw) and proximate composition. Determination of moisture, protein and ash followed the AOAC methodology (locator numbers 39.1.03, 39.1.15 and 39.1.09) (AOAC, 2006). The ether extract was determined following the method of Folch et al. (1957), and total carbohydrates were determined by difference. The measurement of colour, using the parameters L^* (luminosity), a^* (red colour intensity) and b^* (yellow colour intensity), was performed according to Abularach et al. (1998), using a Minolta CR-300 colorimeter (Minolta Co., Osaka, Japan). The following configurations were used: illuminant D65, 8° viewing angle, 10° observer angle and specular included, conforming to the CIE specifications (1986). All physico-chemical determinations of the formulations were performed in triplicate.

Five gram (5.000 ± 0.001 g) samples were weighed into porcelain crucibles for mineral analysis. The samples were incinerated in a furnace at 450 °C for 12 h. The ash was dissolved in 2.5 mL concentrated hydrochloric acid and diluted to 50 mL with deionised water in volumetric flasks (AOAC, 2006).

The quantification of mineral elements (Na, K, Ca, Mg, Fe, Zn, Cu, Cr and P) was performed by inductively coupled plasma-optical emission spectroscopy (ICP-OES), using a Baird ICP 2000 (Massachusetts, USA), equipped with a radio frequency source of 40 MHz, a peristaltic pump, a spraying chamber and a concentric spray nebulizer. The system was totally controlled by ICP software using 99.996% liquid argon as plasma gas (Air Liquid, SP, Brazil). Operating conditions of the ICP-OES equipment were: reflected power, 900 W; spray flow, 0.9 L min^{-1}; auxiliary argon flow, 1.5 L min^{-1}; main argon flow, 15 L min^{-1}; background correction, 3 points; integration and reading time, 3 s; replicate number, 3; height of vertical observation, 19 mm; nebulizer pressure, 3 bar and radial torch configuration. The operating wavelengths were: Ca, 317.933 nm; Cu, 324.754 nm; Fe, 259.940 nm; K, 766.491 nm; Mg, 280.270 nm; Na, 589.592 nm; P, 213.618 nm; and Zn, 206.200 nm. Stock solutions at 10,000 mg L^{-1} for Ca, K, Mg, Na (Titrisol, Merck) and P (Qhemis High Purity) and at 1000 mg L^{-1} for Cu, Cr, Fe and Zn (Merck) were used for preparing the standard solutions in 5% HCl, v/v. The concentration ranges of the standard solutions were: 0.01 to 10 mg kg^{-1} of Cu, Cr, Fe and Zn; 0.41 to 410 mg kg^{-1} of Ca and Na; 0.61 to 610 mg kg^{-1} of K and P; and 0.145 to 145 mg kg^{-1} of Mg.

Data were submitted to analysis of variance and the means were compared by the *F* test for a completely randomized design in a 3×1 factorial

Table 2
Physico-chemical quality (mean and standard deviation) of goat pâtés prepared with by-products.

Parameters	Goat pâté formulations		
	A	B	C
Moisture (g/100 g)	54.93[a] ± 0.51	53.57[b] ± 0.12	54.82[a] ± 0.38
Ash (g/100 g)	3.13 ± 0.51	2.99 ± 0.12	3.21 ± 0.38
Lipids (g/100 g)	22.67 ± 0.07	24.33 ± 0.00	23.68 ± 0.11
Protein (g/100 g)	14.74 ± 0.07	14.94 ± 0.00	14.90 ± 0.11
Carbohydrates (g/100 g)	4.53[a] ± 0.00	4.17[a] ± 0.00	3.39[b] ± 0.00
Acidity	4.50 ± 0.28	2.99 ± 0.12	3.21 ± 0.38
pH	6.78 ± 0.08	6.74 ± 0.01	6.74 ± 0.01
Aw	0.97 ± 0.00	0.96 ± 0.00	0.97 ± 0.00
L^*	49.31[a] ± 0.29	45.78[b] ± 1.23	41.55[c] ± 0.28
a^*	13.98[b] ± 0.23	14.37[b] ± 0.30	15.51[a] ± 0.03
b^*	13.91 ± 1.46	12.58 ± 0.19	11.83 ± 0.30

Different letters in the same row indicate statistical differences at 5% probability in Tukey's test.

arrangement (three formulations), having three replicates. Differences in means among treatments were evaluated for significance using the General Linear model of the SAS program (SAS, 1996).

3. Results and discussion

The results obtained from the physico-chemical characterization of the goat pâtés are presented in Table 2. The three formulations were found to comply with Brazilian legislation (Brazil, 2000) relating to the values for moisture, proteins, total lipids and carbohydrates. The legislation recommends that a pâté formulation should consist of 70% moisture at the most, and for levels exceeding 60% pasteurization of the product is mandatory. Lower values were obtained for the three formulations examined in this research (less than 55%). Similar data were observed for total carbohydrates and lipids, where legislation recommends maximum values of 32% and 10%, respectively. The legislation recommends a minimum of 8% protein in the formulation, and values greater than this (15%) were obtained from all three formulations of goat pâté.

Only the values for moisture, L^* and a^*, showed significant differences ($P < 0.05$) among the formulations, while the different levels of blood and liver used did not affect any of the other values.

Pinho et al. (1998), studying 15 brands of bovine liver pâté on sale in Portugal, report moisture content levels of 53.4%, which are similar to the present study. The same authors report values of 11.8% for protein, 29.4% for lipids and 2.6% for ash. In comparison to bovine pâté, our goat pâté presented higher values for ash and protein, and lower values for lipids, showing that the pâté prepared with goat variety meat had different nutritional qualities compared to traditional bovine liver pâtés. The high protein content together with the low concentration of fat in the goat pâté could have consumer appeal, since the consumer market is avid for healthier and low-fat meat products (Rhee, 1992).

Table 2 shows that the pâtés with higher percentages of blood presented lower values of L^* (luminosity), and therefore were of a darker colour. The formulation with 21% added blood (C) was the one with the lowest average value for this parameter (41.55). Luminosity characterizes the degree of colour clarity ranging from black to white, indicating whether the colours are light or dark. Ferreira et al. (1994) concluded that this is the most informative parameter for the colour of a sample. Similar behaviour was observed for the a^* parameter, which is related to the redness of the goat pâté; the formulation with the highest added blood showed the highest a^* value (15.51), which is significantly different ($P < 0.050$) from the others.

As expected, the lowest values for luminosity (L^*) and the highest values for the intensity of the red colour a^* were found in the formulation with a highest proportion of blood, formulation C, which is explained by the concentration of pigments (haemoglobin and its derivatives) present in blood (Fontes et al., 2004).

The mineral profiles (Table 3) showed higher percentages of sodium, iron, magnesium, phosphorus and copper in goat pâté compared to goat meat. The percentages of iron increased with the addition of blood to the formulation, the highest amount was detected in formulation C. This resulted from the fact that both blood and liver contain high amounts of iron, 300 ppm and 26 ppm, respectively (Gorbatov, 1988).

Santos (2007), studying the use of different amounts of blood in the preparation of mortadella, reported that increasing blood levels resulted in a significant increase in the iron content of the product. High iron values were also found in sausages prepared with higher concentrations of blood (Herrera, 2006).

On the other hand, higher concentrations of magnesium, phosphorus and copper were found in the goat pâté with the highest concentration of liver, i.e. formulation A. Casey et al. (2003), reporting on the mineral composition of goat liver, give values of 188.5 mg/100 g, 263.9 mg/100 g and 8.3 mg/100 g for potassium, phosphorus and copper, respectively. These values were reflected in the goat pâté.

Sodium concentrations were higher in the goat pâté compared to the raw material, i.e. blood, liver and goat meat (Anderson, 1988), because of the addition of sodium chloride and curing salt during the preparation of the pâté. The high levels of iron in the goat pâté highlight the fact that the use of goats' blood and liver in its preparation make it an option for a processed meat product that can be used to reduce the incidence of iron-deficiency anaemia.

Table 3
Mineral profile (mean and standard deviation) of goat pâtés prepared with by-products.

Elements	Goat pâté formulations[a]			Goat meat[b]
	A	B	C	
Ca (mg 100 g^{-1})	10.8 ± 0.50	10.6 ± 0.70	11.0 ± 0.40	13
Na (mg 100 g^{-1})	956 ± 28.00	946 ± 24.00	954 ± 26.0	82
Fe (mg 100 g^{-1})	6.48^{c} ± 0.09	7.92^{b} ± 0.21	9.99^{a} ± 0.14	2.8
Mg (mg 100 g^{-1})	19.7^{a} ± 1.60	16.9^{b} ± 1.30	18.3^{a} ± 1.30	0.04
Zn (mg 100 g^{-1})	2.27 ± 0.04	2.17 ± 0.05	2.13 ± 0.02	4
P (mg 100 g^{-1})	249^{a} ± 6.00	224^{b} ± 2.00	225^{b} ± 5.00	180
Cu (mg 100 g^{-1})	1.63^{a} ± 0.03	1.15^{b} ± 0.04	0.71^{c} ± 0.02	0.26
K (mg 100 g^{-1})	204 ± 2.00	197 ± 3.00	190 ± 4.00	385
Cr (mg 100 g^{-1})	nd <0.02	nd <0.02	nd <0.02	nr

Different letters in the same row indicate statistical differences at 5% probability in Tukey's test.
[a] nd: not detected, above LOD.
[b] USDA Nutrient Database for Standard Reference (available in 06/08/2010); nr – not reported.

4. Conclusion

The physico-chemical characterization of the goat pâtés showed that the three formulations were significantly different for the parameters moisture, L^* and a^*. The goat pâté with the higher percentage of added blood presented higher values for iron and a^*, and was therefore darker in colour. The use of blood and liver in the preparation of goat pâté offers a viable alternative to the rational use of variety meat, generating products with physico-chemical characteristics that comply with legislative recommendations and the desired nutritional quality.

Conflict of interest

None of the authors (P.S. Dalmás, T.K.A. Bezerra, M.A. Morgano, R.F. Milani, M.S. Madruga) has a financial or personal relationship with other people or organisations that could inappropriately influence or bias the paper entitled "Manuscript Title: Development of goat pâté prepared with 'variety meat'.

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