MANGACHAIA F., et al., 2023. Issue 1, v 1 n°5:1 - 10 mjas, ISSN Online: 2790-2994

Mozambican Journal of Applied Sciences

RESEARCH PAPER

Published: 26 May 2023

https://doi.org/10.53224/mjas.ispg.2025.105

Physical, chemical and sensory quality of goat hamburgers with an increase in textured soy protein.

Fernando Mangachaia[1*], Filipa Madeira[2], Charia Francisco Saíde[2], Quitéria Eduardo Muechumo[2] Dovel Branquinho Ernesto[2], Luisa Crisanto Catangolo[3], Awonenji Steve Chiueteca[3] Ananias Pascoal[4]

[1*]Instituto Superior Politécnico de Manica

[2]Department of Agriculture/ Zootechnics/ Polytechnic Institute of Manica, Campus de Matsinho, Mozambique

[3]Department of Agriculture/ Agriculture Institute of Manica, Mozambique

[4]CIMO-Mountain Research Center, Department of Biology and Biotechnology, Agricultural College of Bragança, Polytechnic Institute of Bragança, Campus Santa Apolónia E, 5301-855, Bragança, Portugal.

OPEN ACCESS

Edited by:
Dr. Custodio R. P. Tacarindua
Mozambique - Instituto Superior Politécnico de Gaza

Reviwed by:
Dr. Raimundo Gamela
Instituto Superior Politécnico de Gaza

Editorial Board
Mozambican Journal of Applied Sciences

Received:
9 March 2022
Accepted:
10 April 2023
Published Online:
26 May 2023

Correspondence:
address:fmangachaia@gmail.com

Citation:
SITOE. T A., et al., 2023

ABSTRACT

This work aimed to study alternatives to enhance meat from adult animals, as a means of developing new products of goat origin with acceptable quality for the local market. For this purpose, an experiment was conducted containing 4 different formulations, namely, Control A with 20% fat from the goat's abdomen, B with 5% textured soy protein, C with 10% textured soy protein and D with 15% of textured soy protein. Afterwards, the samples were submitted to physical-chemical and sensorial quality analyses. The results obtained from the physical-chemical analysis showed significant differences between the samples ($P < 0.05$), the pH reduced from 5.44 to 4.14, fat from 5.03% to 2.57%, moisture from 45.65 to 43.03% there was an increase in protein from 14.89 to 21.30% and there was no significant change with ash. The sensory evaluation made at the consumer's level did not show significant differences regarding flavour taste, aroma, appearance and global acceptance. However, colour and texture showed a significant difference at a significance level of ($P < 0.05$), showing an improvement in the colour of burgers with an increase in textured soy protein.

Keywords: Food science; food quality; food processing; food composition; goat burger and textured soy protein.

INTRODUCTION

The food crisis in developing countries has contributed significantly to hunger and malnutrition. Between 2005 from 2016, the evolution was positive: the number of undernourished people rose from 926 million to 777 million people, corresponding to 14.2% of the world population in 2005 and 10.6% in 2016 (FAO, 2017). In 2017, however, the number of hungry people rose again, with 815 million people in that situation, *ie* 11% of the current world population and 38 million more people than in the previous year (FAO, 2017).

More than half of people suffering from hunger and chronic malnutrition reside in conflict-affected countries, *ie* 489 million (FAO, 2017). In Mozambique, the practice of livestock farming is considered complementary, to survival, especially in regions where agriculture is less secure. Of the livestock activities carried out in the country, poultry and goats are the ones that make the greatest contribution to the nutrition of low-income families, guaranteeing food security, a source of income and also provide the manure that is widely used to fertilize soils for vegetable production. It has been noticed at the level of consumers the preference of younger animals over adult animals for presenting characteristics such as unpleasant odour, texture and specific flavour of the meat.

Studies show that when using soy protein in food, there is moisture retention, which improves the texture, bonding and cohesion of the product, consequently increasing the quality of the final product (MARCINKOWSKI, 2006). Considering that there is a rejection of goat meat from adult and discarded animals due to its odour, specific flavour of the meat, poor appreciation and low commercial value, it was allied to these characteristics that the present work aimed to develop a new product with increased textured soy protein (PTS) to improve the quality of processed meat from adult or cull animals. Aiming to obtain an acceptable product with a less accentuated odour and to analyse the physical-chemical composition of the hamburgers by determining the parameters of humidity, pH, ash, lipids and proteins.

MATERIALS AND METHODS

The present research was carried out in the food processing unit of the Higher Polytechnic Institute of Manica (ISPM), located in the administrative post of Matsinho, district of Vanduzi, in the Province of Manica However, this work was carried out in November 2019, with 25 trained tasters randomly chosen within the Institution and about 150 untrained tasters residing in the city of Chimoio, in Manica. Fifteen rustic animals were acquired, with an average age above 5 years, from the district of Bárue in the Province of Manica. Animals are considered refuse, where their market value is extremely low. They were slaughtered at the Chimoio slaughterhouse and transferred to the food laboratory at ISPM, where they were kept at a temperature between 0-5 ºC for seven (7) days. This study is part of the program for the development of new products based on goat meat of local breeds, implemented by Nguni Investments. The study aimed to value meat from adult animals and reduces production costs for low-income families. For the preparation of the hamburgers, the carcasses were previously deboned and cleaned, cut into strips ground into 6mm discs with the fat separately in a multifunctional electric grinder. Textured soy protein (PTS) was hydrated in a ratio of 1 litre of water to 400 grams (g) and after hydration, it was manually pressed to remove excess water and ground in a 5mm disk to obtain a more mass thin and was again weighed in

portions for its increment in the formulations. Different types of hamburger formulations were developed where the inclusion levels of PTS were tested in four treatments, namely, A (0% PTS), B (5% PTS), C (10% PTS) and D (15% PTS). The formulations used in each treatment are listed in Table 1. After obtaining the ground meat and fat, they were weighed in four portions, following the percentage of each formulation, the other ingredients were added, as shown in Table 1. The addition of seasonings (in nature onion, in nature garlic, refining salt, black pepper ground powder, flavouring, meat seasoning, powdered sweet paprika) were weighed and placed in sequence on aluminium paper, powdered milk and red wine to give the product flavour. The goat meat was transferred to a stainless steel basin where the other condiments were added to the homogenization, of the mixture of each formulation. Homogenization was performed by an electric machine for 5 to 10 minutes. After homogenization the mass was involved by adherent paper (polyvinyl chloride) and identified in treatments, then allowed to rest under refrigeration (4 ° C) during the 24-hour period for the healing process. After the rest the dough was heavy in 100g portions and was manually moulded with a manual form for the hamburger, the product was involved in adherent paper identified and frozen at temperature 18 ° C on the glacier, until the chemical and sensory parameters.

Table 1. Formulations used in hamburger processing

	Formulations (%)			
Ingredients	**A 0%**	**B 5%**	**C 10%**	**D 15%**
Goat meat	98,25	93,25	88,25	83,25
Textured soy protein	0,00	5,00	10,00	15,00
Fresh onion	0,18	0,18	0,18	0,18
fresh garlic	0,17	0,17	0,17	0,17
refined salt	0,15	0,15	0,15	0,15
Black pepper powder	0,15	0,15	0,15	0,15
Flavouring	0,20	0,20	0,20	0,20
meat seasoning	0,30	0,30	0,30	0,30
Powdered milk	0,20	0,20	0,20	0,20
Red wine	0,20	0,20	0,20	0,20
sweet paprika powder	0,20	0,20	0,20	0,20
Total	**100,00**	**100,00**	**100,00**	**100,00**

Samples: A= Control formulation (20% fat; 0% PTS); B= Formulation with 5% PTS + 15% fat; C= Formulation with 10% PTS + 10% fat; D= Formulation with 15% PTS + 5% fat.

Physical-chemical analyses (pH, protein, moisture, fat and ash) were performed in ISPM food laboratories and Catholic University of Mozambique, Manica delegation. To this end, food analytical standards of the Adolfo Lutz (2008) Institute were used, and a pH penetration meter from the HANNA instruments brand (HI 99163) was used to determine the pH; a branded oven (Raypa) for humidity determination; a Buchi K-446 mineralizer, using a Buchi

K-415 coupled gas neutralizer and a Buchi K-375 distiller; an extraction unit (BuchiExtractionUnit B-815) to obtain the percentage of total fat and a mulflaNey VULCANTM 3-5.

For sensory evaluation of the samples, they were carried out in the ISPM cafeteria on the Matsinho campus in the morning from 9:45 am to 12:00 pm, with the 150 participation of untrained tasters, according to Bento *et al.,* (2013). Through the situation lived in the country and in the world the prevention measures against Covid-19 were taken in order to safeguard the health of all participants, observing the disinfection of the hands of judges at the entrance of the cafeteria, the mandatory use of masks and the distancing of 1.5m among tables. An acceptance test was performed to evaluate the degree of acceptance of products and the intention to purchase. The acceptance test was made based on the assessment of the attributes flavour, colour, aroma, texture, appearance and global acceptance, using a hedonic scale (1 to 9) which ranged from 1 "I disliked much" to 9 "I liked very much". Acceptance rate was calculated by dividing the sample score with the highest score and presented in percentage. The purchase attitude was assessed using 1 to 5 scale, where, 1 "certainly would not buy the product" to 5 "certainly would buy the product", according to the methodology quoted by BENTO *et al*. (2013).

The results obtained in the purchase acceptance and intention test were analysed by analysis of variance (ANOVA) and Tukey test for comparison of the means between the samples, the significance level of 5% was used. For data analysis, the statistical program SISVAR version 5.6 (Economic Support - CAPES, CNPq) was used. However, obtaining the frequencies were calculated through Microsoft Excel® 2016 software.

RESULTS AND DISCUSSION

Hamburgers Physical-Chemical Composition

The results obtained in the analysis of variance by the Tukey test at a significance level of 5% show significant differences in at least three parameters analysed between the goat meat-based hamburgers samples, the averages obtained are associated with their respective deviations default (Table 2).

Table 2. Statistical analysis of treatments and their respective averages

	Average of treatments			
Parameters	**A0%**	**B5%**	**C10%**	**D15%**
pH	5.44±0.20^{a}	5.21±0.20^{ab}	4.96±0.20^{b}	4.14±0.20^{c}
Humidity (%)	45.65±1.32^{a}	43.08±1.32^{b}	44.31±1.32^{ab}	44.90±1.32^{ab}
Protein (g / 100g)	14.89±2.06^{d}	16.76±2.06^{c}	19.56±2.06^{b}	21.30±2.06^{a}
Fat (%)	5.03±1.16^{a}	4.90±1.16^{a}	3.02±1.16^{b}	2.57±1.16^{b}
Grey (%)	6.97±2.20^{a}	6.96±2.20^{a}	7.06±2.20^{a}	6.90±2.20^{a}

Caption: Means followed by equal letters on the same line indicate that there were no significant differences between samples (P≥0.05); OV=Overall Average; MSD = Minimum Significant Difference at 5% error level (Tukey's test). Treatments: A= 0% PTS + 20% fat; B5% PTS + 15% fat; C= 10% PTS + 10% fat; D= 15% PTS + 5% fat.

pH values

The pH determinations of goat hamburgers for the studied samples are presented in Table 2, indicating values between 4.14 and 5.44. The results show that there were significant changes between the samples compared to each other by the Tukey test, at the 5% level of significance, however, the meat is not considered DFD (dark, firm and dry: dark, hard and dry), see that the pH was not greater than 6.2 (Ordóñez, 2005), these values are within acceptable standards in the literature, however, with the reduction in the amount of meat and the increase in the levels of textured soy protein, hamburger pH levels. The values found for pH were close to those found for similar meat products as sheep or goat sausages (LEITE *et al.* 2015), foal sausages (LORENZO and FRANCO, 2012) and sheep and goat pâtés (TEIXEIRA *et al*. 2019).

Moisture

Moisture is an important parameter for meat juiciness and palatability (SEBRAE, 2016). The results of moisture content differ statistically between the samples ($P < 0.05$), and sample B differs significantly from the other samples, the moisture content observed here ranges from 43.08 to 45.65%, it was verified. If even as the amount of meat was reduced and with successive increase in the levels of PTS, there was water retention in the hamburgers. According to GONSALVES *et al.* (2012), when evaluating the chemical parameters of goat hamburgers, observed that, in relation to moisture content, the hamburgers had an average of 61.5% and TEIXEIRA *et al*. (2019) points 36.6- 48.3 % in sheep and goat pâtés.

Protein

The protein contents of the studied samples differ from each other ($P < 0.05$) resulting in values ranging from 14.86 to 21.30g/100g, these values do not differ much from those reported in the literature and these values are within the Minimum acceptable indication. According to current legislation, hamburgers must have at least 15% protein (BRAZIL, 2000). However, the solubility of meat proteins is the main factor that determines the juiciness properties. The values found for protein were close to those found for similar meat products as sheep or goat pâté (TEIXEIRA *et al*. 2019). The lowest specific amount of carbohydrate that people should consume each day is 130 grams to maintain normal levels of glucose in the brain. The recommended intakes for pregnant and lactating women are higher, at 175 grams and 210 grams per day, respectively. The recommended intake for adult men and women is 0.8 grams of protein per kilogram of body weight. A 70-kilogram woman (about 150 pounds), for example, should eat 56 grams of protein each day (INSTITUTE OF MEDICINE, FOOD AND NUTRITION BOARD, 2005).

Total fat

Fat is essential in the diet for promoting absorption of some vitamins and helping build some tissues. Monounsaturated and polyunsaturated fatty acids reduce blood cholesterol levels and help lower the risk for heart disease. Certain kinds of fats, however, provide no known beneficial role in preventing chronic disease. At the same time, a growing amount of evidence suggests that eating excessive amounts of some of the macronutrients can lead to health problems, including obesity, heart disease, and diabetes, although questions remain about the links between some of the macronutrients and disease. According to the Technical Regulation of Burger Identity and Quality, the values established for fat in the product are

a maximum of 23% and for protein, the minimum value is 15% (BRAZIL, 2000), however, the values of fat differed significantly between samples ($p<0.05$) with a reduction in the amount of meat and an increase in textured soy protein.

Thus, it can be said that the hamburgers made with goat meat met these required requirements, as the fat content ranged from 5.03% to 2.57%. The values found for total fat were close to those found for similar meat products as sheep or goat pâté (TEIXEIRA *et al*. 2019) and sheep or goat sausages (LEITE *et al*. 2015). The reduction in fat content greatly favours consumers with chronic diseases such as cardiovascular disease, diabetes, obesity, stroke and cancer). However, the recommended daily intake values for alpha-linolenic acid, which is an omega-3 fatty acid, and linoleic acid, which is an omega-6 fatty acid. Adult men should get 17 grams of linoleic acid and 1.6 grams of alpha-linolenic acid per day. Adult women should take in 12 grams of linoleic acid and 1.1 grams of alpha-linolenic acid each day (INSTITUTE OF MEDICINE, FOOD AND NUTRITION BOARD, 2005). Anyway, the World Health Organization (WHO) in 2009 Scientific Update on Trans fatty acids suggested that the intake of ruminant TFAs is low enough in most populations and does not constitute a significant risk factor and according to DHAKA *et al*. (2011) ruminant animal products such as meat are rich in essential nutrients which are difficult to obtain from other sources and to ban these foods from the human diet have detrimental effects on population particularly for infants nutrition. The United States Department of Agriculture (USDA) recommending 20-35% energy from total fat (FAO, 2010 and USDA).

Ashes

The vitamins and minerals perform specific functions to meet the body's needs, most of these macronutrients supply energy for daily activity. In Normative Instruction Nº 20, of July 31, 2000, a parameter for the percentage of ash is not mentioned (BRAZIL, 2000). Regarding the ash contents, it was observed that there were no statistically significant differences ($p> 0.05$) between the analysed samples, that is, with and without the addition of textured soy protein (PTS) and with the reduction in the amount of meat, the ash content for the samples was the same, as the mean values obtained ranged from 6.90 to 7.06% statistically indifferent. The values found for ashes were close to those found for similar meat products as sheep or goat sausages (LEITE *et al*. 2015)

Sensory analysis

The analysis of the results of the attributes colour, aroma, texture, appearance and global acceptance of the hamburgers with different levels of textured soy protein is shown in table 1. Of the attributes evaluated in the sensory analysis, differences were observed between treatments ($P\leq 0.05$) in the colour and texture variables (Table 3).

Table 3. Means of sensory attributes of goat meat hamburgers formulated with different levels of PTS

Sensory attributes	Treatments				**OV**	**MSD**
	A0%	**B5%**	**C10%**	**D15%**		
Flavour (taste)	6.07[a]	6.78[a]	6.93[a]	6.75[a]	6.63	0,96

Colour	5.75[b]	6.89[a]	6.78[a]	6.48[ab]	6.47	0,75
Aroma	6.39[a]	6.53[a]	6.73[a]	6.93[a]	6.64	0,77
Texture	5.89[b]	6.67[ab]	6.96[a]	6.73[a]	6.56	0,78
Appearance	6.40[a]	6.93[a]	6.81[a]	6.92[a]	6.76	0,78
Buy intention	6.54[a]	7.17[a]	7.07[a]	7.04[a]	6.96	0,75
Acceptance (%)	63.89	76,56	75,00	72,05	73,87	

Caption: Means followed by equal letters on the same line indicate that there were no significant differences between samples (P≥0.05);OV=Overall Average;MSD = Minimum Significant Difference at 5% error level (Tukey's test). Treatments: A= 0% PTS + 20% fat;B5% PTS + 15% fat;C= 10% PTS + 10% fat;D= 15% PTS + 5% fat.

From the results illustrated in table 1, it can be seen that for the acceptance test, the proportion between fat and textured soy protein used in formulations A, B, C and D did not significantly influence (P≥0.05) in the results for the other attributes, except for the attribute colour and texture, which was significant. Global acceptance - for the formulations analysed, there were no significant differences (P≥0.05) concerning the global acceptance of the hamburgers added to different levels of PTS, that is, the different levels of PTS added in the preparation of the products did not influence the acceptance response overall before the tasters, who attributed average scores from 6.54 to 7.17, possibly due to the weak sense of the characteristic flavour and aroma of the meat, masked by the increase in PTS. The highest average was assigned to sample B (5% PTS) with 7.17 and the overall average of 6.96 is in the acceptance part of the 9-point hedonic scale. Observing the frequencies of global acceptance in Figure 1.

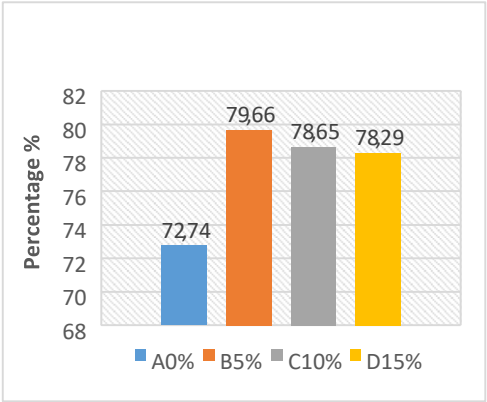

Fig. 1. Global acceptance

It can be seen that for sample B there was a higher percentage of acceptance within the range of 6 to 9 points on the hedonic scale with a percentage sum of 79.66% with a frequency of responses for point 9 "I liked it very much", followed by samples C and D with 78% for both, for sample A which obtained 72.74% respectively according to the frequency of responses in points 6 and 9 "I liked it slightly and I liked it very much" all samples were accepted. According to GONSALVES *et al.* (2012), they evaluated goat hamburgers with added textured soy protein and without textured soy protein and concluded that goat hamburger with added PTS is not well-accepted sensory, due to rejection by PTS. The opposite result to the one found in this work. In the study by PAULOS (2012) and CARVALHO (2015), for the attribute global quality, consumers did not attribute differences (p>0.05) between

the samples. The result was very positive, as it demonstrated that replacing different levels of fat and meat with hydrated wheat fibre did not harm the sensory acceptance of the hamburgers as a whole. To be accepted for its sensory properties, a product must obtain a minimum acceptability index of 70% on the hedonic scale, which corresponds to a value of 7.0 (TEIXEIRA *et al*. 1987).

There was no significant difference (p=0.798), there was a lack of adjustment and in the application of the analysis of variance, it was obtained a coefficient of determination adjusted exactly as in the other attributes analysed. The factors that affect the acceptability of goat meat are the factors that affect the consumer's reaction to liking or not the meat are appearance, tenderness, juiciness and flavour, and these aspects can vary depending on age, sex. Breed beyond feeding animals (SAÑUDO, 1991) and (LIMA, 2009).

Buy intention and acceptance - The purchase attitude test is used to assess the global acceptance of the product, that is, the product as a whole, or also to assess the acceptance of product attributes (FERREIRA *et al*. 2000). For purchase intent, As shown in figure 2.

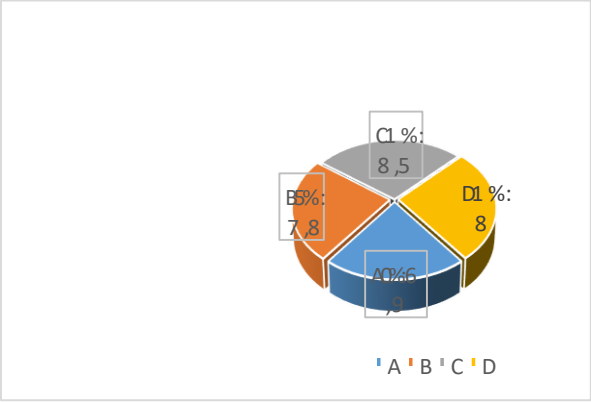

Fig. 2. Buy intention

Formulations C and D obtained higher percentages of acceptance 86.56% (n=55) and 84% (n=53) the judges attested that "they would probably buy the product" concerning treatments B and A they obtained 76.8% (n=49) and 65.93% (n=42). SEABRA *et al*. (2002), conducting research with sheep meat hamburgers, replacing the fat with cassava starch and oat flour, found no significant difference between the samples, both for global acceptance of the product and for purchase attitude.

CONCLUSION

With the accomplishment of the present work in agreement with the patent objectives, it is concluded that the production of goat hamburgers with an increment of different levels of textured soy protein presented, in general, acceptable levels for all analysed parameters for healthy human consumption and following literature recommendations. However, the increase in PTS increased the quality of the final product, raising the protein levels from 14.89 to 21.30% and reduced the fat content from 5.05 to 2.57%, making it important for consumers with chronic illnesses. High ash levels indicate that these hamburgers are rich in minerals.

REFERENCES

BENTO, R. A., ANDRADE, S. A. C., SILVA, A. M., ARAÚJO, D. Análise sensorial de alimentos, Colégio Agrícola Dom Agostinho Ikas, 2013.

(CODAI) da Universidade Federal Rural de Pernambuco (UFRPE), Universidade Federal do Rio Grande do Norte (UFRN) e -Tec Brasil, Recife, 142, 2013.

Ministério da Agricultura e do Abastecimento. Regulamento técnico de identidade e qualidade de

hambúrguer; Instrução Normativa nº 20, de 31/07/2000. Diário Oficial da República Federativa do Brasil, Brasília, 31/07/2000, p. 7-9, Brazil. 2000.

CARVALHO, L. T. Parâmetros tecnológicos, aceitação sensorial e sensação de saciedade apos consumo de hambúrguer bovino com adição de fibra de trigo e teor de gordura reduzido, Dissertação (Mestrado) – Faculdade de Zootecnia e Engenharia de Alimentos, Universidade de São Paulo, Pirassununga, 2015.

DHAKA, V., GULIA, N., AHLAWAT, K.S., KHATKAR, S. Trans fats – sources, health risks and alternative approach – a review. Journal of Food Science and Technology, 48, 534–541, 2011.

Food and Agriculture Organization of the United Nations (FAO). Fat and fatty acid requirements for adults. In: Fats and Fatty Acids in Human Nutrition. Rome, Italy, pp. 55–62.

FAO. 2017.

FERREIRA, V. L. P. Análise sensorial: testes discriminativos e afetivos. Campinas: SBTA, 127, 2000.

GONSALVES, H. R. O., MONTE, A. L. S., SOUZA, G. C., GONSALVES, H. E. O., COELHO, J. L. S. Hamburguer caprino – parâmetros químico, microbiológico e sensorial, ACSA – Agropecuária. Científica no Semi-Árido, 8, 60-66, 2012

Institute of Medicine, Food and Nutrition Board. Dietary Reference Intakes for Energy,

Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients). National Academy Press, Washington, DC, 2005.

Instituto Adolfo Lutz. Métodos físico-químicos para análise de alimentos, coordenadores

Odair Zenebon, NeusSadoccoPascuet e Paulo Tiglea - São Paulo: Instituto Adolfo Lutz, 279 – 320, 2008.

LEITE, A., RODRIGUES, S., PEREIRA, E., PAULOS, K., OLIVEIRA, A. F., LORENZO, J. M., TEIXEIRA, A. Physicochemical properties, fatty acid profile and sensory characteristics of sheep and goat meat sausages manufactured with different pork fat levels. Meat Science.105, 114–120, 2015.

LIMA, M. L. Aceitabilidade da carne caprina no hábito alimentar e percepção sobre o impacto ambiental na produção de caprinos no Nordeste entre estudantes Universitários, Dissertação (Mestrado), Universidade do Rio Grande do Norte, Natal, Rio Grande do Norte, 2009.

LORENZO, J. M., FRANCO, D. Fat effect on Physico-chemical, microbial and textural changes through the manufacture of dry-cured foal sausage lipolysis, proteolysis and sensory properties. Meat Science, 92 704–714, 2012.

MARCINKOWSKI, E. A. Estudo da cinética de secagem, curva de sorção e predição de propriedades termodinâmicas de proteína texturizada de soja. 127f. Dissertação de mestrado. Universidade Federal do Rio Grande do Sul. Porto Alegre, 2006.

ORDÓÑEZ, J. A. Tecnologia De Alimentos – Alimentos De Origem Animal. Porto Alegre, 2005.

PAULOS, K. V. F. Qualidade sensorial de salsichas frescas de carne de ovinos e caprinos.

Tese de mestrado, Instituto Politécnico de Bragança, 2012.

SAÑUDO, C. La calidad organoléptica de la carne com especial referência a la especie ovina: factores que la determinan, métodos de medida y causas de variación. Curso internacional de Producción Ovina. SIA, Zaragoza, 1991.

SEABRA, L. M., ZAPATA, J. F. F., NOGUEIRA, C. M., DANTAS, M. A., ALMEIDA, R. B. Fécula de mandioca e farinha de aveia como substituinte de gordura na formulação de hambúrguer de carne ovina. Ciência e Tecnologia de Alimentos, 22, 245- 248, 2002.

Serviço Brasileiro de Apoio as Micro e Pequenas Empresas (SEBRAE). Serviço Brasileiro de Apoio as Micro e Pequenas Empresas, 2016.

TEIXEIRA, A., ALMEIDA, S., PEREIRA, E., MANGACHAIA, F., RODRIGUES, S. Physicochemical characteristics of sheep and goat pâtés. Differences between fat sources and proportions. Heliyon 5, e02119, 2019.

TEIXEIRA, E., MEINERT, E. M., BARBETTA, P. A. Análise Sensorial de Alimentos.
Florianópolis: UFSC, 1987.

USDA Economic Research Service. Food Availability (Per Capita) Data System. *http://www.ers.usda.gov/dataproducts/foodavailability%28percapita%29datasystem/.aspx#..*

VBxHpBYXI3M (accessed 06 September 2021).

World Health Organization (WHO). Diet, Nutrition and the Prevention of Chronic Diseases. World Health Organ Tech Rep Ser 2003, 916 (i_viii), 1_149 back cover, PMID: 12768890, 2003.

World Health Organization (WHO). Interim Summary of Conclusions and Dietary Recommendations on Total Fat & Fatty Acids. From the Joint FAO/WHO Expert Consultation on Fats and Fatty Acids in Human Nutrition, 10-14 November 2008.WHO, Geneva. *http://www.who.int/nutrition/topics/FFA_summary_rec_conclusion.pdf*.