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Sheep meat fermented sausages from disposal animals with inclusion of swine meat and fat

Embutidos fermentados de carne ovina oriunda de animais de descarte com inclusão de carne e gordura suína

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Abstract

The supply chain of the sheep industry is faced with the problem of marketing the meat of disposal animals that do not have the appropriate organoleptic characteristics required by the consumer market of meat *in natura*, being one of the alternatives to its use the manufacture of fermented sausages. The present work aims to evaluate the influence of different proportions of swine meat and fat on sheep meat fermented sausages coming from disposal animals. To this end, it were used four different proportions of ovine:swine meat (100:0; 66:33; 33:66 and 0:100%); and three different levels of addition of pork fat (5; 10 and 15%). Salamis with 66% sheep meat and 15% pork fat stood out, having the best averages in the sensory evaluation on several issues evaluated in this study.

Additional keywords: salami; sensory; sheep industry.

Resumo

A cadeia produtiva da ovinocultura depara-se com a problemática da comercialização da carne de animais de descarte, que não apresentam as características organolépticas adequadas e exigidas pelo mercado consumidor de carne *in natura*, sendo que uma das alternativas para sua utilização é a fabricação de embutidos fermentados. Com o presente trabalho, objetiva-se avaliar a influência de diferentes proporções de carne e gordura suína em embutidos fermentados de carne ovina, oriunda de animais de descarte. Para tal, foram utilizados quatro diferentes proporções de carne ovina: suína (100:0; 66:33; 33:66 e 0:100%); e três diferentes níveis de acréscimo de gordura suína (5; 10 e 15%). Em destaque, os salames com 66% de carne ovina e 15% de gordura suína apresentaram as melhores médias na avaliação sensorial em vários quesitos avaliados neste estudo.

Palavras-chave adicionais: ovinocultura; salame; sensorial.

Introduction

Brazil presents sheep herd of 17,380,581 million head, with an increase of 3.4% of the effective number in 2010 compared to 2009. Out of this effective number, the Northeast region holds 56.7%, followed by the South region, with 28.1% of the entire national total. Having as highlight the increase recorded for the Midwest region of the country, which showed 12.4% increase, especially for the state of Mato Grosso, which had an increase of 24.1% in 2010, whose effective number has surpassed Mato Grosso do Sul, hitherto the most representative state in sheep production in this region (IBGE, 2010; IBGE, 2009).

Associated with this growth, changes need to occur so as to influence the marketing of products obtained from creating, such modifications are fixed to points of the supply chain like management, herd breeding, nutrition and health in order to obtain meat with the qualities required by the consumer.

Nonetheless, the market is not only supplied

with animals from creations with low technological level, but also with older animals even coming from intensive systems due to the disposal of matrices and breeders. Thus, it is necessary to look for alternatives that add value to meat from animals that do not conform to the sensory parameters required by consumers, one alternative would be to use the meat for the production of processed products.

Among these, the production of fermented sausages, like salami, has shown a great alternative by presenting facilities in obtaining the remaining ingredients with affordable prices and of easy fabrication, and because it is an easily consumed product, for being disseminated in the market for a long time. It is cited by Madruga & Fioreze (2003) as a product that adds value and enables the growth and development of the products industrialization, leading to higher generation of profits and jobs.

In view of the problems faced by the supply chain of the sheep industry, this work was done in an attempt to obtain information on the processing of

fermented sausages with sheep meat coming from disposal animals, with different levels of swine meat and fat, for the obtaining of a fermented processed that has commercial feasibility.

Material and methods

The project was developed at the Federal University of Mato Grosso, Sinop Campus. The processings and the physicochemical and sensory evaluations were performed at the Animal Products Technology Laboratory (TPOA) from the same institution. The sheep meat used for the preparation of the sausage products was acquired from a local breeder in the form of frozen cuts of disposal sheep; swine meat and fat were also acquired in the local market.

In the preparation of the sausage cuts, it were used four different proportions of ovine:swine meat: 100:0; 66:33, 33:66 and 0:100, respectively, and three levels of added pork fat: 5, 10 and 15% in the four proportions used.

The additives used were similar for all treatments, being used a ready prepared of the brand 'Condimentos Global para Salame SB#70', used according to the manufacturer's recommendations, whose composition had: 67.5% salt, maltodextrin, stabilizer INS-4521, flavor enhancer INS-621, antioxidant INS-316, natural spices, preservative INS-250 and 251 and natural aroma of spices.

The milling was carried out in CAF® model machine with 6 mm mesh screen, being the sheep and swine meat milled twice and the fat only once. It was held manual mixing until obtaining a mass that had uniform appearance, being it embedded in dried beef tripe, previously moistened, with the aid of the same equipment used for milling.

Maturation was held in BOD chamber Solab SL 200/334 model and lasted 15 days. The salamis suffered pre-maturation at 5 °C for 24 hours in an oven, starting the fermentation process; in the first 24 hours the salamis were maintained between 22 and 23 °C with 85% relative humidity (RH); on the second day the temperature was maintained from 18 to 20 °C and 80% RH and from the third day to the fifteenth day the temperature was maintained between 12 and 15 °C with RH between 70 and 80%.

After the maturation of the products at 15 days, the sensory test was conducted with the participation of 41 selected and untrained assessors. Of these, 21 evaluated the proportion of ovine:swine meat, and 20 the influence of three different pork fat levels in the sensory quality of the produced sausage.

Participants were selected from a questionnaire with open and closed questions on meat consumption and habits like smoking and drinking. The aim was to evaluate the consumption of meat, the most consumed types, the frequency of consumption of sausages, and the presence of lifestyle habits that could bring harm to the taste buds and thus interfere with the tasting of the products. Those selected had

meat consumption rate superior than three times a week - being the sheep meat, on a scale of preference of the meat type consumed, among the top five, and the frequency of consumption of sausages equal or superior than three times a week - and were non-smokers.

The sensory test was performed in the food technology laboratory, during the morning commute between 8 h 30 min and 11 h 30 min. The tasters received, in medium-sized tray, the salami slices according to the treatment that they would assess, the slices were placed in the tray below its numbering, which was drawn up with four random numbers, but not repeated. It was provided sparkling mineral water so that the tasters could clear the taste buds before tasting and between samples to avoid flavor interference.

The evaluators were given an evaluation form of the products in unstructured scale ranging from "very bad" to "very good" for the appearance, flavor and overall acceptability questions; for the succulence question, it varied from "dry" to "succulent"; for chewiness, it ranged from "hard to swallow" to "easy to swallow"; and for the softness question, it ranged from "extremely hard" to "extremely soft".

For physicochemical analysis, samples were randomly collected, consisting of three sub-samples of salami per treatment. Salamis were crushed so that there was a homogeneous mixture of the sample, analyzes were performed in duplicate. The moisture was analyzed by the final drying method that consists in drying at oven for 16 hours at 105 °C (Silva & Queiroz, 2002).

The pH, chlorides (amount of salts) and ashes were obtained through electrometric methods, volumetry and incineration waste, respectively (Instituto Adolfo Lutz, 2008). To determine the ether extract, it was used Randall procedure according to Detmann et al. (2012), which consists of the complete immersion of the cartridges with the sample in petroleum ether heated for four hours. The crude protein values were determined by micro-Kjeldahl method, which consists of three steps: digestion in sulfuric acid (H₂SO₄) at 400 °C, distillation and titration with hydrochloric acid (HCl) (Brasil, 1981).

Instrumental color analysis was performed using a digital Minolta colorimeter reading the parameters L* (lightness), a* (red/green intensity) and b* (yellow/blue intensity). It was also evaluated the texture by shear force through Warner Bratzler Shear Force method, in texturometer model TA. XTPlus Texture Analyzer.

The data of physicochemical analyzes were evaluated in a factorial design (4 ovine:swine meat ratios and 3 proportions of added fat) by the PROC GLM program of SAS 9.0 (SAS, 2002), in the sensory analysis the taster was included as a block, being the averages subjected to analysis of variance and compared by Tukey test (P<0,05).

Results and discussions

The sheep meat is a protein source similar to other species, however, its consumption is restricted due to factors involving since the supply chain, price, supply availability and also the qualitative aspects (Pelegrini et al., 2008). The same author highlights the meat of old or disposal sheep, without ideal conditions for *in natura* consumption, mainly due to the non-standardization of the carcasses and inadequate hygienic-sanitary conditions of slaughtering, which hinders the marketing.

The huge advantage of using the disposal sheep meat in salami production is not only linked to the aggregate value correlated with the organoleptic characteristics obtained with this technique, but must be added to its wide spread in the market since this product is closely related to the process of colonizing of different regions of Brazil.

The fermentation process was initially used to conserve plant and animal foods. Notwithstanding, with the emergence of other conservation processes, such as sterilization and the use of the cold chain, fermentation lost its importance as preservation method in industrialized countries and became an independent class of foodstuff, for ensuring peculiar characteristics of flavor, aroma and texture (Caplice & Fitzgerald, 1999).

According to Terra (2003), among the various sensory characteristics of salami, aroma and color are key factors at the time of purchase of the product by the consumer. In this study, no difference was observed for the aroma in products with 33, 66 and 100% sheep meat contents, showing that the greater inclusion of this did not impair the acceptance of the product. The inclusion of up to 66% of sheep meat did not differ from the treatment that did not receive sheep meat, and such fact can be attributed to the action of enzymes produced by microorganisms that can produce volatile compounds that alter the odor, thus masking the meat aroma of older animals, as quoted by Carpiné et al. (2010), where some strains of lactic bacteria of fermented meat products synthesize proteases and lipases, promoting desirable changes in the aroma and texture of the products. Table 1 shows the results of the sensory evaluation.

Even with the occurrence of an increase in the average of the grades given to the aroma, according to the addition of pork fat, there was no difference between them, and a possible cause can be due to the enzymatic action of some microorganisms as mentioned above, or the inclusion of up to 15% fat may not be sufficient to cause consumer noticeable difference. This is in agreement with the literature, since Nassu et al. (2002) mentions that in the preparation of fermented sausage with goat meat with 20% pork fat, the highest grades regarding the general acceptance were obtained.

In works of Nassu et al. (2002) and Nassu

(1999), evaluating the interference of adding pork fat in fermented sausages of goat meat in the amounts of 5, 10 and 20%, no difference was observed in the averages for appearance, aroma, flavor, texture and overall acceptability, which also corresponds to the observed in this study with values of 5, 10 and 15% inclusion of pork fat.

Noting the means presented in Table 1, the inclusion value of 66% sheep meat had the highest averages in the categories of appearance, aroma, flavor, succulence, chewiness and overall acceptability. François et al. (2009) reports that adding 75% disposal sheep meat in the sausages formulation without damaging the sensory characteristics is possible. Not only in the preparation of salamis, but it is observed that the use of sheep meat above 66% achieved good acceptance by the evaluator in work of Guerra et al. (2012), with the preparation of mortadella with 70% sheep meat getting the highest means for general acceptability. Table 2 presents the unfolding of the interaction that took place between the averages for meat and fat.

Possible cause of this interaction and more easily observed when evaluating Table 3 values, as there is increase in the pork fat percentage in the composition there is a salami whitening trend, this situation making its appearance different from the coloration commonly found in salamis both for sheep meat and cattle meat, tending to present a coloration close to the meat *in natura*.

It should be noted that the acceptance by the tasters is the result of the sum of several criteria, which may be divided into two groups, the first one grouping those that carry the idea of sweet or savory without being tasted, taking as an example the aroma, color and appearance, which has a strong relationship with color. The second group is represented by the flavor, softness, chewiness and succulence, this group represents characteristics that favor the permanence of the consumption of this product. Table 3 presents the results for color analysis.

Treatment with 66% sheep meat had lower average than treatment with 0% sheep meat for appearance. When observed the same treatment by comparing this datum to the information presented in Table 3, it differs from the treatments with 33 and 0% sheep meat to the L* value. The a* value differs from the treatment with 0% sheep meat, yet the b* value shows no difference between the treatments with L* and a* values. It is apparent that with the use of 66% and 100% sheep meat, salamis with an intermediate brightness were obtained, showing the quality of the product produced, which can be an important and critical feature of the consumer's choice at the time of purchase. Treatment with 66% sheep meat presented a coloring with more reddish hue, being its a* value with an average higher than the other treatments, which is in line, since the largest sheep meat content may have influenced this feature.

Table 1 - Mean values of sensory evaluation tests of sheep meat fermented sausages with different proportions of pork and lard.⁽¹⁾

Variables	Mean	Sheep Meat (%)				Amount of Fat (%)			P		
		0	33	66	100	05	10	15	Meat	Fat	Interaction
Appearance	5.58	6.29a±0.37	4.86ab±0.44	6.03ab±0.44	4.59b±0.44	5.47±0.37	5.48±0.37	5.38±0.37	0.01	0.98	0.04
Aroma	5.73	6.76a±0.34	5.06b±0.41	5.82ab±0.41	4.50b±0.41	5.50±0.34	5.54±0.34	5.57±0.34	0.0008	0.99	0.84
Flavor	5.79	6.73a±0.37	4.67b±0.44	6.29ac±0.44	5.07bc±0.44	5.66±0.36	5.92±0.36	5.49±0.36	0.017	0.68	0.70
Softness	3.21	4.00a±0.48	3.21±0.57	2.80±0.57	2.22±0.57	3.09±0.49	3.33±0.49	2.75±0.49	0.13	0.66	0.88
Succulence	5.23	4.89a±0.46	5.02±0.54	5.54±0.54	5.14±0.54	4.90±0.45	4.91±0.45	5.63±0.45	0.82	0.39	0.81
Chewiness	5.70	5.32a±0.35	5.06±0.42	6.10±0.42	5.87±0.42	5.35±0.35	5.34±0.35	6.06±0.35	0.21	0.21	0.27
Overall acceptability	5.80	5.59a±0.38	5.07±0.45	6.40±0.45	5.00±0.45	5.60±0.38	5.63±0.38	5.32±0.38	0.08	0.78	0.77

⁽¹⁾ Means followed by different letters in the line differ by Tukey test (P<0.05).

Table 2 - Unfolding of the interaction in the sensory analysis.⁽¹⁾

Fat (%)	Sheep Meat (%)			
	0	33	66	100
05	6.03 Aa±0.65	4.37Aa±0.73	6.29Aa±0.73	5.19Aa±0.73
10	6.05 Aa±0.65	4.47Aa±0.73	5.57Aa±0.73	5.85Aa±0.73
15	6.78 Aa±0.65	5.75Aa±0.73	6.25Aa±0.73	2.75Ab±0.73

⁽¹⁾ Means followed by different letters, uppercase in the columns and lowercase in the lines, differ by Tukey test (P<0.05).

Table 3 - Color analysis results for the different proportions of ovine and swine meat and pork fat contents.⁽¹⁾

Variables	Mean	Sheep meat (%)				Pork fat (%)		
		0	33	66	100	05	10	15
L*	46.02	40.54a±0.77	45.34b±0.77	48.69c±0.77	49.52c±0.77	44.29±0.67	45.5±0.67	48.28b±0.67
a*	16.12	15.09a±0.56	15.81ab±0.56	17.81b±0.56	15.77ab±0.56	15.82±0.48	16.33±0.48	16.21±0.48
b*	10.13	10.31±0.57	9.95±0.57	10.93±0.57	9.35±0.57	9.79±0.49	9.41±0.49	11.20±0.49

⁽¹⁾ Means followed by different letters in the line differ by Tukey test (P<0.05).

When compared these values with the values obtained for lamb meat in the work of Zeola et al. (2007), who found L^* values between 39.74 and 39.94; a^* values between 15.33 and 16.58 and b^* values from 1.28 to 2.33, in three different muscles in sheep of the breed Morada Nova, only treatment with 33% sheep meat showed the a^* value between the values found in the mentioned work, other treatments with sheep meat showed higher values, with emphasis on the b^* values that were much higher. These information show that these values can be influenced by race, age and nutrition.

It should be noted the disproportionality to the b^* variable, which is related to the intensity of yellow between the lamb meat with salamis receiving the sheep meat. Being noted that this variable increases according to the inclusion of sheep meat in the salami. The content of 66% of sheep meat had the highest b^* value, being a meat with greater yellow intensity, which comes to present the idea of old meat, and even with this value being very different when compared to lamb meat, in salami acceptance, inclusion of 66% sheep meat received the highest average. This shows the importance of converting the meat of old or disposal sheep in fermented products by masking features such as the color of the meat, which would cause the rejection of the *in natura* consumption.

For the assessment of fat contents and their interference in color and relating it to the appearance, it is observed that the level of 10% fat had the highest average for a^* , and in the appearance question this inclusion also achieved the highest average. This was also observed in works of Guerra et al. (2012), with the elaboration of mortadella with sheep meat and pork fat, the highest averages of a^* were obtained with the use of 90% sheep meat and 10% pork fat, and for the sensory evaluation this treatment received the highest average for appearance.

Evaluating the meat content, there was no difference for softness, chewiness and succulence. François et al. (2009), evaluating different proportions of swine and disposal sheep meat on the physico-chemical and sensory properties in salamis, observed that the treatments with 15, 35, 55 and 75% sheep meat did not differ in the sensory evaluation for flavor, only the treatment with 15% sheep meat differed from the control treatment, receiving the highest average.

For flavor, among the salamis that received sheep meat, the inclusion of 66% had the highest average, being this situation contradictory between studies, which may be related to the individual taste of the tasters. The same author cites in his work that the addition of 75% of sheep meat in salamis is capable of use without damaging the sensory evaluation.

Zeola et al. (2012) evaluated the model of production and the inclusion of pork fat in qualitative and sensory parameters of hamburger with sheep meat, coming from lambs of the breed Ile de France, and did not observe differences for softness and flavor in hamburger with 66.3 and 76.3% sheep meat with

the addition of 20 and 30% pork fat, respectively. These comparatives remain similar to data found even to the treatments of fat inclusion, showing that this kind of sausage supports a greater increase in fat compared to salami, and that values above 20% tend to cause visible changes in these characteristics, this distinction may be attributed to the fact that the salami tends to be consumed without performing of baking or frying as occurs with the hamburger.

Softness shows relation with chewiness and both characteristics showed no difference between their averages, being remarkable their affinity for both the inclusion of sheep meat and pork fat. The inclusion of 100% sheep meat has shown to be the most difficult to be swallowed, and of 66%, the easier one, being its average higher than the 0% sheep meat. Looking at the values in Table 3 for texture analysis, the inclusion of 66% sheep meat had an average lower than the treatment with 0% sheep meat. Even with the inclusion of 100% sheep meat having the lowest average for this analysis, when observing the loss of water, treatment with 100% sheep meat had the greatest loss during maturation. This demonstrates the influence of the loss of water to the characteristics of softness and chewiness. In Table 4 are shown the values of the physico-chemical analysis of sausages.

Reis & Soares (1998) found weight losses from 38.3 to 43.7% in colonial salami processed with the swine:ovine meat ratio of 70:30, at 30 days after the embedding. In the sensory evaluation performed by the same author, the salami which had the highest weight loss (43.7%) received the lowest average for texture. This situation was observed for the treatment with 100% sheep meat, which had the highest loss of water receiving the lowest average for chewiness and softness.

In works carried out by François et al. (2009), it were found the greatest weight losses in the control treatment (100% pork) and in the treatment with 55% sheep meat, in the sensory evaluation for texture, the control treatment obtained the lowest average, being accompanied with close average, for the inclusion of 75% sheep meat. It can be observed that the sheep meat inclusion content ended up being a second point to be noted in the evaluation of this characteristic. This result was also accompanied in this work for the softness grades, still being observed that with increasing inclusion of sheep meat and water loss, there was negative relationship to the softness grades.

When compared to the pork fat inclusion, there was no significant difference, nonetheless the inclusion of 10% pork fat had the highest loss of water, and the 15% content showed the lowest, this situation presented itself similar to the inclusion of sheep meat, the greater inclusion of fat was accompanied with the highest averages of water loss, the treatment with 15% pork fat differing from the other treatments.

Table 4: Results of physicochemical analyzes of sheep meat sausages with different proportions of pork and lard. ⁽¹⁾

Variables	Mean	Sheep Meat (%)					Pork Fat (%)		
		0	33	66	100	05	10	15	
Loss of Water (%)	56.57	52.98a±1.01	54.87±1.01	57.37b±1.01	61.07b±1.01	53.79±0.87	55.02±0.87	60.91b±0.87	
Dry Matter (%)	67.81	68.36a±0.23	68.66±0.23	68.06±0.23	66.16b±0.23	67.34±0.20	69.37b±0.20	66.73±0.20	
Ash (%)	6.08	6.36ab±0.23	5.81ab±0.23	5.59ab±0.23	6.55a±0.23	6.12±0.36	6.28±0.36	5.84±0.36	
pH	6.10	5.96a±0.04	6.03±0.04	6.00±0.04	6.38b±0.04	6.03±0.56	6.19b±0.56	6.07ab±0.56	
Ether extract (%)	53.10	50.67a±0.65	51.48ab±0.65	53.41b±0.65	56.87c±0.65	51.05±0.65	53.33b±0.65	54.94b±0.65	
Chlorides (%)	5.37	5.64a±0.21	5.35±0.21	5.01±0.21	5.48±0.21	5.47±0.14	5.63±0.14	5.00±0.14	
Crude Protein (%)	11.60	13.49a±1.01	14.03ab±1.01	11.69ac±1.01	7.20d±1.01	12.55±0.87	11.87±0.87	10.40±0.87	
Texture (kgf)	8.20	10.38a±1.04	10.74±1.04	6.12ab±1.04	5.56b±1.04	9.87±0.90	8.12±0.90	6.61±0.90	

⁽¹⁾ Means followed by different letters in the line differ by Tukey test (P<0.05).

Pinheiro et al. (2008), evaluating sensory characteristics of sheep meat in the categories of castrated and uncastrated lamb and sheep, in the category of softness, correlated values obtained in the shear test with the grades of the sensory evaluation, observing that the sheep meat received the lowest scores for softness, in the same experiment this was the only variable that showed a significant difference.

For texture, it was expected that an increase in the sheep meat content would obtain the highest values, because the meat used comes from disposal animals, as this category has lower meat softness due to the lower solubility of the collagen. Notwithstanding, when seen in Table 4, this situation showed to be reverse. As previously mentioned, the valorization of ovine meat cuts is associated with the amount of muscle, and with advancing age of the animal occurs a reduction of muscle content and increased fat content, which may also have influenced the texture of products. For values of crude protein occurs that the increase in the inclusion of sheep meat is accompanied by protein reduction, the ether extract values behave in a contrary manner, with increasing addition of meat there is an increase in the contents of this variable, being also possible its influence on the texture of the products.

The reduction in crude protein with an increase in pork fat inclusion has also been reported in studies of Nassu et al. (2002) evaluating the influence of inclusion of 5; 10 and 20% pork fat on the physico-chemical characteristics of salami with goat meat. In studies of Guerra et al. (2012), with the use of sheep meat for manufacturing mortadella, the protein was also reduced with the increase of fat in the composition of mortadella.

When assessed the values for pH, in Table 4, only the treatment with 100% sheep meat differed with the other treatments. This situation may be related to the fact that one of the causes of this treatment has obtained the lowest average score for the aroma, according to Silva Sobrinho et al. (2005), pH between 5.5 and 5.8 is normal for sheep meat, this treatment presented pH value above the quoted as normal, the other treatments also had values above what was quoted to this meat. The relationship between pH and aroma and taste of the sheep meat is related to the production of sulfur compounds in meat with high final pH, which are responsible for undesirable odors and flavors (Costa et al., 2009). Observing the pH values and relating them to the averages for flavor and aroma to the treatments that received sheep meat, it is remarkable that the inclusion of 66% sheep meat had the lowest final pH and the highest averages for aroma and flavor.

Conclusions

The inclusion of up to 66% sheep meat in the present study did not demonstrate a negative influence on the sensory evaluation, obtaining good overall acceptance by the evaluators, demonstrating its possi-

ble use for the production of salamis. Showing the great potential of use of the meat of disposal animals for the manufacture of fermented sausages.

With regard to the inclusion of pork fat in salamis, the 15% fat content had no negative influence on the organoleptic factors and on the acceptance, thus this content can be used for the production of salamis.

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