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Emulsified sausages obtained from mechanically separated meat of yacare caiman (*Caiman yacare*)

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Abstract

This study aimed at the development and characterization of emulsified sausages using mechanically separated meat (MSM) from yacare caiman (*Caiman yacare*). The sausages were formulated using three different treatments containing (in %) 70.0 (T1), 75.0 (T2), or 80.0 (T3) of MSM of yacare and subjected to comprehensive analyses, including chemical composition, physical properties, microbiological safety, and sensory attributes. The proximate composition analysis revealed that moisture was the unique parameter that presented statistical differences between treatments, ranging from 74.94% (T1) to 72.35% (T3). pH and water activity measurements indicated stable and safe products, with high water activity attributed to water incorporation during emulsion formation. Color differences were observed among treatments, potentially linked to formulation, especially the MSM content. The highest average obtained for luminosity was 49.87 for T2, differing statistically ($P > 0.05$) from T1 and T3. Consistent shear force values suggested effective emulsion formation and processing. The microbiological analysis demonstrated the safety of sausages, meeting microbial standards for consumption. Sensory evaluation revealed positive responses to appearance and aroma, while flavor and texture received mixed reviews. Purchase intention scores indicated cautious consumer interest. Thus, further efforts are needed to optimize formulations and processing to enhance consumer sensory attributes to meet consumer preferences and improve acceptance, achieve marketability, and capitalize on the ecological and nutritional benefits of yacare caiman-derived products.

Keywords: emulsified inlaid; carcasses; valorization; food products.

Practical Application: The utilization of yacare offers opportunities for value-added products and ecological sustainability.

1 INTRODUCTION

Rational yacare farming is an activity whose main objective is to obtain high-quality skins, unlike those from animals captured from nature. In Brazil, the breeding of the yacare caiman (*Caiman yacare*) is carried out by several breeders approved by the Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA). The activity commenced with a semi-extensive breeding system for commercial purposes, steadily scaling up production over time. Rational exploitation can be important for the maintenance of the ecological balance of this species in the Brazilian Pantanal Region, reducing predatory hunting (Aleixo et al., 2002; Brasil, 1990; Maciel et al., 2003; Vicente Neto et al., 2010).

In addition, yacare meat is an excellent source of animal protein that can be utilized for human consumption. It presents high biological value, high digestibility, and low cholesterol values and has the technological potential to produce derivative products (Paulino et al., 2011; Romanelli et al., 2002). The captive animals have lower fat content than the wild yacares (Vicente Neto et al., 2006). Sensory studies have attested to the attractive appearance, pleasant taste, and good acceptance of some yacare meat products (Cavenaghi-Altemio et al., 2021; de Souza et al., 2022; Fernandes et al., 2013).

Mechanically separated meat (MSM) is a valuable byproduct derived from the yacare processing that can be obtained for the full utilization of the carcasses. However, the presence of hemopigments renders it more prone to rancidity, as hemoglobin acts as an activator of lipid oxidation (Sánchez-Alonso & Borderías, 2008). Despite its susceptibility, MSM finds utility as a raw material in crafting high-value products targeted at specific market segments, meeting the demand for animal protein. Its application in emulsified sausages, for example, not only enhances meat yield but also aids in reducing processing costs, making it a viable option for optimizing production (Cavenaghi-Altemio et al., 2018; Trindade et al., 2005). Nevertheless, the extensive use of MSM in meat products requires cautious consideration to avoid sensory issues, such as undesirable aromas and texture problems (Trindade et al., 2005).

Sausage is one of the most traditional and commercialized meat products in the world, mainly due to the continuous

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increase in the consumption of hot dogs (Ayo et al., 2008). It is obtained from the emulsion of meat from one or more species of butcher animals, added with ingredients, embedded in natural or artificial wrapping, or by an extrusion process, which is subjected to an appropriate thermal process (Garcia-Santos et al., 2019).

Thus, the aim of this work was to develop formulations of emulsified sausage using MSM of the yacare caiman (*Caiman yacare*) and characterize them through chemical, physical, microbiological, and sensory analyses.

2 MATERIALS AND METHODS

2.1 Mechanically separated meat of yacare carcasses

Yacare carcasses were donated by Caimasul Ltda. (Corumbá, MS, Brazil). They were transported to the Laboratory of Food Technology, Universidade Federal da Grande Dourados, Dourados, MS, Brazil, under refrigerated conditions. The MSM was produced in 3 mm particle size using a meat-bone separator (HT 250, High Tech, Brazil), operating at the inlet of 6°C and the outlet of 10°C (Cavenaghi-Altemio et al., 2020).

2.2 Sausages

Sausages were prepared in three different treatments containing (in %) 70.0 (T1), 75.0 (T2), or 80.0 (T3) of MSM of yacare and 20.0 (T1), 15.0 (T2), or 10.0 (T3) of ice (Figure 1). The remaining 10% of the formulations was composed (in %) by: soy protein, 3.8; cassava starch, 1.8; refined sodium chloride, 1.6; spices, 1.3; sodium polyphosphate, 0.45; carrageenan, 0.45; sugar, 0.36; cochineal carmine, 0.18; ascorbic acid, 0.045; and sodium nitrite, 0.015. After being weighed, the ingredients of the formulations were mixed at the maximum temperature of 16°C to stabilize the emulsion. The emulsions were stuffed into cellulose casings with 26 mm diameter and 180 mm length (Viskase, Atibaia, SP, Brazil) and processed with manual inlaid equipment (Picelli, Rio Claro, SP, Brazil). The sausages were cooked for approximately 30 min on low heat until the internal temperature reached 72°C. Then, they received a thermal shock with cold water below 5°C for 10 min. Uncased sausages were dyed with annatto dye, vacuum packed, and stored at refrigerated temperature for further analysis. Additives and condiments were supplied by Conatril Food Industry Ltda. (Rio Claro, SP, Brazil), and casings were donated by Cavenaghi Eireli (Dourados, MS, Brazil).

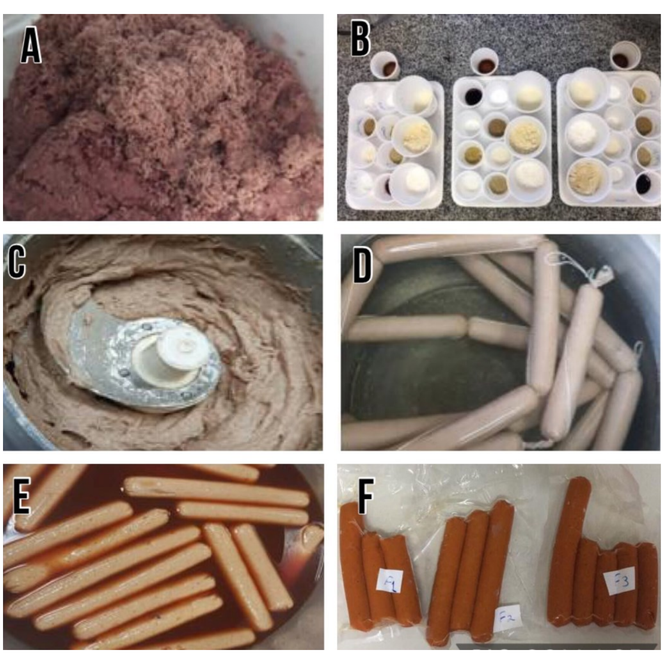

Figure 1. Development of yacare-based sausages. (A) Mechanically separated meat obtained from carcasses. (B) Weighing of the ingredients. (C) Emulsifying the dough. (D) Heat treatment. (E) Dyeing. (F) Final product.

2.3 Chemical analysis

2.3.1 Proximate composition

Moisture, crude protein, and crude ash contents of the sausages were determined in triplicate according to the methods described by AOAC (2012). Moisture was determined by the oven-drying method at 105°C until constant weight (method 950.46B), protein by the Kjeldhal method (method 928.08) using the conversion factor of 6.25, and ash by using the muffle oven technique (method 920.153). The lipid content was obtained in triplicate by the extraction method with cold organic solvent (Bligh & Dyer, 1959). The carbohydrate content was estimated by difference.

2.3.2 Water activity and pH

The water activity of the sausages was determined in triplicate in a hygrometer (Aqualab model CX-2, São José dos Campos, SP, Brazil) at 25°C with 1 g of sample. pH of the sausages was measured in triplicate using a digital pH meter (Hanna Instruments Ltd model HI99163, Bedfordshire, UK) by mixing 25 g of the sample and 10 mL of distilled water, according to the method described elsewhere (Spitzer & Werner, 2002).

2.4 Physical analysis

2.4.1 Instrumental color

The color [CIE L*(lightness), a* (redness), b* (yellowness)] of the sausages was evaluated in triplicate for each treatment using a colorimeter (Minolta Chroma Meter CR 410), with measurements standardized with respect to the white calibration plate. Color differences (Δ) were calculated to have a numerical comparison between the sample and the standard. The total color variation (ΔE) was expressed according to Equation 1:

$$\Delta E^{*} = \sqrt{(\Delta L^{*})^2 + (\Delta a^{*})^2 + (\Delta b^{*})^2}, \quad (1)$$

Where:

ΔL^{*}: variation between lighter and darker (– = darker, + = lighter);

Δa*: variation between green and red (– = greener, + = redder);

Δb*: variation between blue and yellow (– = bluer, + = yellower) (Cavenaghi-Altemio et al., 2021).

2.4.2 Shear force

Texture analysis of the sausages was carried out using a texture analyzer Model TAXTplus (Stable Micro Systems, Surrey, England) calibrated with a standard weight of 5 kg. Samples with 10 mm thickness were kept at 2°C, were equilibrated at room temperature (28–30°C) before analysis, and then placed into the texture analyzer to conduct the cutting/shearing test (speed of 1.0 mm/s and distance of 30 mm) using a Warner-Bratzler (Knife-Guillotine) shear blade (1 mm thick) to determine the shear force (N). A minimum of 10 replicates of each treatment was analyzed.

2.5 Microbiological analysis

Microbiological analyses of the sausages were carried out for thermo-tolerant coliforms at 45°C, *Staphylococcus* positive coagulase, and *Salmonella* sp. in accordance with the methodology described elsewhere (USDA/FSIS, 1998).

2.6 Sensory analysis

Sensory analyses of the sausages were conducted by 43 trained panelists (23 males and 20 females) ranging in age from 20 to 55 years. A 9-point hedonic scale (*9* = like extremely; *1* = dislike extremely) was used for the evaluation of attributes such as color (internal and external), appearance, texture, odor, taste, and overall acceptance. The treatments were heated in microwave ovens for 5 s, and then they were cut transversely to a thickness of 10 mm and served in disposable containers, coded with three-digit random numbers. Purchase intention was evaluated using a 5-point scale, where *5* = certainly would purchase, *4* = probably would purchase, *3* = maybe would purchase / maybe would not purchase, *2* = probably would not purchase, and *1* = certainly would not purchase, which was expressed as the percentage of the total score. The acceptability index (AI) was calculated according to Equation 2. The sample was considered acceptable if the AI was greater than 70% (Cavenaghi-Altemio et al., 2018):

$$AI = \frac{\text{average of the attributed grades}}{\text{maximum attributed grade}} x100 \quad (2)$$

2.7 Statistical analysis

Statistical results were evaluated through analysis of variance (ANOVA) and Tukey's test for comparison of means, at a level of 5% of significance, using the statistical software Statistica 7.0. The sensory attributes and the purchase intention results were analyzed in percentages.

3 RESULTS AND DISCUSSION

3.1 Chemical analysis

3.1.1 Proximate composition

The proximate composition of the yacare meat-based sausages is presented in Table 1. Moisture had a significant difference ($P < 0.05$) between the three treatments, which ranged from 74.94% (T1) to 72.35% (T3), showing the moisture decreased with the increase in the ice content. These values are close to the average moisture content of 71.21% reported for yacare meat sausages added to pork fat (Fernandes et al., 2013). On the other hand, they are much higher than the 59.89–63.90% range observed for sausages containing 82.94 ± 1.00% of yacare meat shavings because of the reduced water content (8.095%) added to obtain the emulsions (Cavenaghi-Altemio et al., 2021). These results underline the importance of a proper balance between water, lipids, proteins, and other ingredients to achieve the desired water retention in the final emulsion. Considering only yacare meat, it was reported elsewhere that the average values for moisture content were 76.06 and 75.27 for different cuts and animal ages (Vicente Neto et al., 2007).

Protein content ranged from 15.82 (T1) to 16.47% (T3), with no significant difference ($P > 0.05$) between the treatments (Table 1). For comparisons, it was previously reported that the protein content for yacare meat sausages added of pork fat was 20.96% (Fernandes et al., 2013), and the values ranged from 25.33 to 27.68% for formulations of cooked sausages elaborated with yacare meat shavings as the main ingredient (Cavenaghi-Altemio et al., 2021). Considering only yacare meat, the protein values were reported between 18.39 and 19.44% for this ingredient (Romanelli et al., 2002).

Lipid content also did not show a significant difference ($P > 0.05$) between the treatments, achieving 4.32, 4.40, and 4.33%, for T1, T2, and T3, respectively (Table 2). Again, for comparisons, it presents the 3.67% lipid content reported for yacare meat sausages added of pork fat (Fernandes et al., 2013) and

Table 1. Proximate composition of sausages obtained from mechanically separated meat (MSM) of yacare Caiman (*Caiman yacare*) according to treatments T1, T2, and T3.

Composition (%)	T1	T2	T3
Moisture	$74.94^{a} \pm 0.01$	$73.19^{b} \pm 0.02$	$72.35^{c} \pm 0.05$
Protein	$16.11^{a} \pm 0.47$ (64.3 ± 1.0)	$15.82^{a} \pm 0.12$ (59.0 ± 0.2)	$16.47^{a} \pm 0.02$ (59.6 ± 0.1)
Lipids	$4.32^{a} \pm 0.24$ (17.2 ± 0.5)	$4.40^{a} \pm 0.18$ (16.4 ± 0.3)	$4.33^{a} \pm 0.01$ (15.7 ± 0.0)
Ash	$2.56^{a} \pm 0.05$ (10.2 ± 0.1)	$9.47^{a} \pm 0.02$ (9.2 ± 0.0)	$2.43^{a} \pm 0.01$ (8.8 ± 0.0)
Carbohydrates	2.07 (8.3 ± 1.5)	4.12 (15.4 ± 0.6)	4.42 (16.0 ± 0.1)

Values in parentheses are on a dry basis. Values (means ± standard deviations) with the same superscript letter in the same row do not differ statistically at $p > 0.05$. T1, T2, and T3 are in accordance with methodology.

the 1.69–5.36% range obtained for yacare meat-based sausages (Cavenaghi-Altemio et al., 2021). All these values are close to the average lipid content of 3.94% obtained elsewhere for yacare carcasses (Fernandes et al., 2015).

Ash content also had no significant difference ($P > 0.05$) between the treatments and ranged from 2.43 to 2.56%, with similar values due to the similarity of proportion in the formulations in relation to ingredients that contain higher mineral contents. Ash content of 3.92% was obtained for yacare meat sausages added of pork fat (Fernandes et al., 2013), and values ranged from 4.50% to 4.62% for yacare meat-based sausages (Cavenaghi-Altemio et al., 2021). These differences may be related to differences mainly due to the addition of condiments and salts with inorganic residues (Cavenaghi-Altemio et al., 2013; Cavenaghi-Altemio et al., 2021) because the ash content of the yacare meat itself, which is the main ingredient of the sausages, is very reduced. Some values of ash reported in the literature for yacare meat are 1.00–1.05% (Romanelli et al., 2002), 0.70–0.95% (Vicente Neto et al., 2007), 1.19% (Fernandes et al., 2015), and 1.2–1.4% (Fernandes et al., 2017).

Finally, the carbohydrate content observed by difference for T1, T2, and T3 was 2.07, 4.11, and 4.42%, respectively (Table 2), with the cassava starch and the sugars the ingredients that mainly contributed to it. The contribution of carbohydrates from the yacare itself is irrisory (0.07%) (Fernandes et al., 2015). Another study reported carbohydrates ranging from 0.58 to 8.51% in yacare sausages. The authors associated the increase in the carbohydrate content with the inulin concentration added to each specific formulation so that the greater the amount of inulin, the greater the carbohydrate content in the sausage formulation (Cavenaghi-Altemio et al., 2021).

The composition of sausages inherently relies on the composition and content of each ingredient and their constituents (Cavenaghi-Altemio et al., 2022). Among these constituents, protein content emerges as an essential factor influencing the emulsion's water-holding capacity in sausage production. A reduced protein content within the emulsion can enhance its ability to retain water. This is due to the stabilizing role of proteins at the water–oil interface, which hinders droplet coalescence. Conversely, higher protein levels tend to bind more water, thereby restricting free water and reducing the overall water-holding capacity (Cavenaghi-Altemio et al., 2021). This phenomenon occurs because water becomes more tightly associated with proteins, consequently affecting the fluidity of the emulsion.

3.2 pH and water activity

The average pH values ranged from 5.53 to 5.89, with no difference ($P > 0.05$) between treatments (Table 3). Very close ranges (5.5–5.7 and 5.53–5.61) were reported elsewhere for yacare meat (Taboga et al., 2003; Vicente Neto et al., 2007) and yacare sausages (Cavenaghi-Altemio et al., 2021), respectively. These results indicate that the meat itself, particularly its natural components, is the main ingredient related to the pH of the sausage. In this case, it decreases after slaughtering (Cossu et al., 2007) due to the lactic acid released from the muscle cells. After slaughter, the muscle cells continue to respire for a short period, leading to the breakdown of glycogen into lactic acid. This accumulation of lactic acid lowers the pH of the meat, which is consequently maintained in the sausage. Additionally, other meat components, such as phosphates and nucleotides, can also play a role in affecting the pH. Furthermore, the use of curing agents, such as sodium nitrite, also impacts the final pH of the sausage by creating a more acidic environment, which contributes to the overall stability and safety of the sausage.

The average water activity (aw) was 0.98 for all treatments (Table 3). Other studies with yacare sausages reported an average aw of 0.97 (Fernandes et al., 2013) and values ranged from 0.951 to 0.960 for this parameter (Cavenaghi-Altemio et al., 2021). Using these two previous studies for comparison, a correlation between aw, moisture, and protein can be clearly observed. Thus, the lower the protein content, the higher the water activity and moisture content of the sausages.

Table 2. pH, water activity (aw), instrumental color, and shear strength of sausages obtained from mechanically separated meat (MSM) of yacare Caiman (*Caiman yacare*) according to treatments T1, T2, and T3.

Determination	T1	T2	T3
pH	$5.89^{a} \pm 0.10$	$5.53^{a} \pm 0.22$	$5.83^{a} \pm 0.08$
aw	$0.98^{a} \pm 0.01$	$0.98^{a} \pm 0.01$	$0.98^{a} \pm 0.02$
L^*	$48.97^{b} \pm 0.16$	$49.87^{a} \pm 0.13$	$46.75^{c} \pm 0.17$
a^*	$12.09^{a} \pm 0.16$	$13.39^{b} \pm 0.37$	$13.58^{b} \pm 0.05$
b^*	$7.91^{b} \pm 0.15$	$8.53^{a} \pm 0.26$	$8.10^{a} \pm 0.17$
Shear strength (N)	$7.56^{a} \pm 0.86$	$7.12^{a} \pm 0.38$	$7.65^{a} \pm 0.87$

Values (means ± standard deviations) with the same superscript letter in the same row do not differ statistically at $p > 0.05$; L*: lightness; a*: redness, b*: yellowness; T1, T2, and T3 are in accordance with methodology.

Table 3. Microbiological evaluation of sausages obtained from mechanically separated meat (MSM) of yacare Caiman (*Caiman yacare*) according to treatments T1, T2, and T3.

Microbiological analysis	**T1**	**T2**	**T3**
Thermotolerant coliforms at 45°C	$< 1.0 \times 10^2$ C FU/g	$< 1.0 \times 10^2$ CFU/g	$< 1.0 \times 10^2$ CFU/g
CPSA	$< 1.0 \times 10^2$ CFU/g	$< 1.0 \times 10^2$ CFU/g	$< 1.0 \times 10^2$ CFU/g
Salmonella sp.	Absence in 25 g	Absence in 25 g	Absence in 25 g

CFU: counting forming units; CPSA: coagulase-positive *Staphylococcus aureus*; T1, T2, and T3 are in accordance with methodology.

The high aw of sausages is mostly related to the nature and composition of the raw materials. Despite the MSM may facilitate the incorporation of water during the formation of the emulsion due to its high moisture content, the added water (ice) should be considered in excess taking into account the utilized formulations. Moreover, the high aw may favor the growth of microorganisms, but the addition of preservatives, e.g., sodium nitrite, and the storage at low temperature can help to prevent microbial activity (Gómez et al., 2020).

3.3 Physical analysis

3.3.1 Instrumental color

Regarding the instrumental color, the treatments differed from each other ($p < 0.05$) for the L* parameter. The highest average obtained for this parameter was 49.87 for T2, differing statistically ($P > 0.05$) from T1 and T3. L* values ranging from 54.01 to 56.02 were reported for yacare meat (Rodrigues et al., 2007), indicating that the other ingredients are also responsible for the luminosity. Literature mentioned L* values between 57.24 and 59.69 for yacare sausages, which also differed from the values observed for the meat (Cavenaghi-Altemio et al., 2021).

T1 presented a lower a* value (redness), differing from T2 and T3 that they did not show a significant difference ($P < 0.05$) between them. For the parameter b* (yellowness), T1 had also a lower value, differing from T2 and T3 that they did not show a significant difference ($P < 0.05$) between them (Table 3). For comparisons, lower values of chroma a* (from 4.93 to 6.08) and chroma b* (10.29 to 11.79) were reported elsewhere for yacare sausages (Cavenaghi-Altemio et al., 2021). These authors observed that small differences in the size of the meat fragments used to elaborate the sausages could have occurred during processing, affecting the color parameters. Thus, it is probable that the use of MSM instead of meat shavings had also affected the color, especially by increasing a* value (Miller et al., 2021). Moreover, the higher the MSM content, the lower the chroma b* (Oliveira Filho et al., 2010), which explains the higher b* value observed for T1 (Table 3). However, it must be underlined that all other ingredients contribute to the color parameters, making it difficult to compare with data from the literature because of the different formulations.

3.3.2 Shear force

There was no significant difference ($P > 0.05$) between the treatments for shear force (SF), ranging from 7.12 to 7.65 N (Table 3). These values are lower than the interval between 13.33 and 18.01 N reported for three formulations of yacare meat-based sausages (Cavenaghi-Altemio et al., 2021) and the 17.65 N of hardness for mortadella made with *Caiman yacare* meat (de Souza et al., 2022). It was expected, as the use of MSM can lead to textural softness due to the lack of muscle structure resulting from the high pressures utilized in their obtainment (Miller et al., 2021).

3.4 Microbiological analysis

To evaluate the microbiological quality of the emulsified sausages made from MSM of yacare and guarantee the food safety of the panelists during the sensory analysis, microbiological evaluations were carried out for total coliforms, coagulase-positive staphylococci, and *Salmonella* sp. (Table 3). All samples met the legal standards for sausage from meat from butcher's animals, as the legislation does not cover yacare meat. Thus, sensory analysis was accomplished for acceptance and purchase intention. This microbial monitoring is important because the presence of *S. aureus* and even *Salmonella* sp. was previously reported for yacare meat, and the product was classified as unsuitable for consumption due to the lack of hygienic-sanitary conditions of the animal's captivity and/or slaughter line (Hoffman & Romanelli, 1998).

3.5 Sensory analysis

Sensory analysis panelists were categorized by gender (Figure 2A) and age (Figure 2B). Based on the average scores, the three treatments ranged from "like it slightly" and "like it moderately" for internal and external colors, appearance, aroma, and texture (Table 4). The exception was the texture of T2, ranked as "neither like nor dislike." For taste, T1, T2, and T3 received average grades for "neither like nor dislike." The overall acceptance ranged from "like slightly" to "like moderately" for all treatments evaluated (Table 4). The AIs ranged from 59.7% to 81.9% across all the sensory attributes. The best grades were obtained for color (internal and external), appearance, and aroma, with scores above 70% for all treatments. However, texture, taste, and overall acceptance received scores above this value (Table 4), which is considered the minimum value to accept a product (Stone & Sidel, 2004). Thus, in general, the results obtained here indicate that the emulsified sausages made with MSM of yacare did not have a good acceptance. AIs ranging from 68.67 to 87.11% were reported elsewhere for cooked sausages elaborated with yacare meat shavings (Cavenaghi-Altemio et al., 2021).

Here, the differences in the MSM content in the treatments did not influence the sensory parameters, as there was no

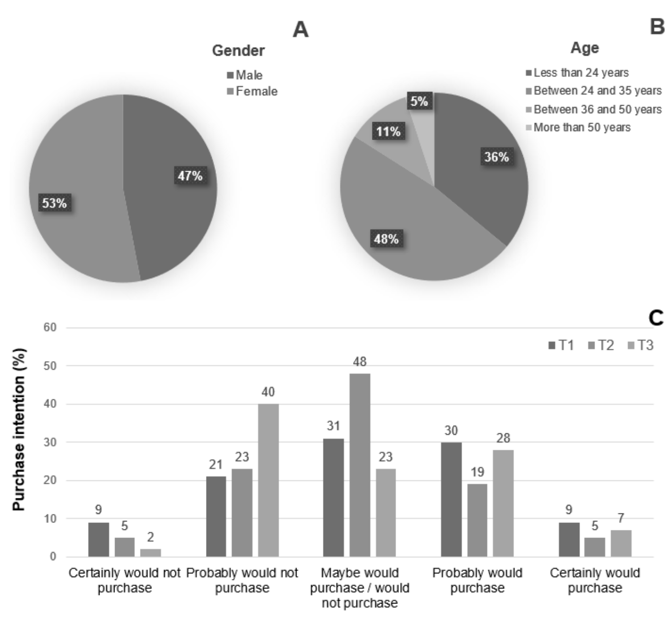

Figure 2. (A) Gender, (B) age, and (C) purchase intention of yacare-based sausages of the panelists from the sensory analysis. T1, T2, and T3 are in accordance with methodology.

Table 4. Sensory analysis of sausages obtained from mechanically separated meat (MSM) of yacare Caiman (*Caiman yacare*) according to treatments T1, T2, and T3.

Attributes	T1	T2	T3
Color (internal)	6.98ª ± 1.42 (77.6)	6.74ª ± 1.54 (74.9)	7.23ª ± 1.41 (80.3)
Color (external)	7.01ª ± 1.44 (77.9)	6.84ª ± 1.40 (76.0)	7.37ª ± 1.27 (81.9)
Appearance	7.28ª ± 1.24 (80.9)	6.60ª ± 1.38 (73.3)	7.30ª ± 1.06 (81.1)
Texture	6.00ª ± 1.73 (66.7)	5.70ª ± 1.66 (63.3)	6.02ª ± 1.61 (66.9)
Aroma	6.35ª ± 1.96 (70.6)	6.51ª ± 1.79 (72.3)	6.53ª ± 1.70 (72.6)
Taste	5.37ª ± 2.17 (59.7)	5.79ª ± 1.73 (64.3)	5.84ª ± 1.93 (64.9)
Overall acceptance	5.91ª ± 1.76 (65.7)	6.16ª ± 1.48 (68.5)	6.07ª ± 1.53 (67.5)

Values (means ± standard deviations) with the same superscript letter in the same column do not differ statistically at $p > 0.05$. Values in parentheses are referred to as the acceptance indexes. T1, T2, and T3 are in accordance with methodology.

significant difference ($P > 0.05$) in any of the attributes evaluated. Nevertheless, in comparison with other previous works using other sources of yacare meat, it is much more probable that the MSM has negatively influenced taste and texture. The increase in the amount of MSM in meat products is usually accompanied by an increase in the scores for softness and sandiness and a decrease in elasticity and cohesiveness. The replacement of manually deboned meat by MSM was reported to cause perceptible sensory changes in the texture characteristics of meat products (de Freitas et al., 2002) while the increase in MSM was related to the decrease in the AI of sausages (Lago et al., 2017).

Figure 2C shows the purchase intention for each treatment. The average scores assigned to the purchase intention parameter were 3.09, 2.95, and 2.98 for T1, T2, and T3, respectively. On the 5-point hedonic scale, this region corresponds to "maybe would purchase, maybe would not purchase" the product. T1 had the highest AI, with 39%, followed by T3 with 35% and T2 with 23%, respectively. Based on that, none of the treatments would be accepted by consumers (Stone & Sidel, 2004).

4 CONCLUSION

This study encompassed the evaluation of various aspects related to the development and characterization of emulsified sausages obtained from MSM of yacare caiman (*Caiman yacare*), including the processing, the chemical composition, the physical properties, the microbiological safety, and the sensory attributes. The proximate composition analysis revealed that sausage moisture was the unique parameter that presented statistical differences between treatments. The pH and water activity measurements demonstrated the stability and safety of the sausages. The utilization of MSM allowed for water incorporation during emulsion formation, contributing to the high water activity observed. Differences in color were likely attributed to variations in formulation ingredients and especially the MSM content. Shear force values indicated consistency in texture across treatments, potentially indicating efficient emulsion formation and processing. Microbiological analysis ensured the safety of the sausages for consumption, meeting the required standards for the evaluated microbial indicators. Sensory evaluation showed favorable responses for appearance and aroma, while other attributes such as flavor and texture garnered mixed reviews. Purchase intention scores indicated cautious interest among potential consumers. Thus, while the utilization of yacare MSM presents opportunities for value-added product development and ecological sustainability, sensory attributes remain a critical consideration for consumer acceptance. Further refinement of formulations and processing techniques could potentially enhance the overall sensory experience to meet consumer preferences and expectations and achieve the marketability of these novel sausages.

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