

**Low-fat cupuassu goat milk yogurt optimization by just-about-right scale****Otimização de iogurte de leite de cabra de cupuaçu com baixo teor de gordura em uma escala quase certa**

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**ABSTRACT**

Goat milk products have been characterized by unusual consumers with lower acceptance due to their flavor and odor known as goaty. In this context, it was aimed to optimize the cupuassu goat milk yogurt formulation by fat-replaces addition using a Just-about-Right scale (JAR). Five treatments were performed: whole goat milk (W); skimmed goat milk (S); inulin (SI); maltodextrin (SM); and whey protein (SW). The cupuassu goat milk yogurts were evaluated by acceptability index, JAR and penalty analysis. The addition of inulin, maltodextrin and whey protein increase consumer acceptance and purchase intention. However, lower scores were observed for flavor. In Just-about-analyses, caprine flavor and odor were rates as a JAR. All the treatment was penalized as lower cupuassu flavor and odor. These results suggest that the addition of fat-replaces and cupuassu pulp improves the sensory characteristics of skimmed goat milk yogurt.

**Keywords:** skimmed milk, fat replace, goat milk, cupuassu.

**RESUMO**

Os produtos lácteos de cabra têm sido caracterizados com baixa aceitação por consumidores não habituais, isto devido ao sabor e odor característico caprino. Nesse sentido, objetivou-se otimizar a formulação de iogurte de leite de cabra com polpa de cupuaçu por meio da adição de substitutos de gordura por meio da escala do ideal (JAR). Foram realizados cinco tratamentos: leite de cabra integral (W); leite de cabra desnatado (S); inulina (SI); maltodextrina (SM); e whey protein (SW). Os iogurtes de leite de cabra com polpa de cupuaçu foram avaliados pelo índice de aceitabilidade, JAR e análise de penalidade. A adição de inulina, maltodextrina e whey protein aumenta a aceitação por parte dos consumidores, assim como a intenção de compra. No entanto, pontuações mais baixas foram observadas no atributo de sabor. Nas análises de escala do ideal, o sabor e o odor caprino foram avaliados como JAR. Todos os tratamentos foram penalizados com baixa pontuação nos atributos de sabor e odor a cupuaçu. Esses resultados sugerem que a adição de substitutos de gordura e a adição de polpa de cupuaçu incrementa as características sensoriais do iogurte de leite de cabra desnatado.

**Palavras-chave:** leite desnatado, substituto de gordura, leite de cabra, cupuaçu.

**1 INTRODUCTION**

In recent years the concern for a healthy diet has increased, which implies a new challenge in the production of foods with higher consumer acceptance, low cost and better nutritional properties (Dutra & Bolini, 2013). Yogurt is a product of milk fermentation by a genus of lactic acid bacteria, considered a healthy food and is widely used as a vehicle for prebiotics and probiotics (Vianna et al., 2017; Costa et al., 2017). Traditionally, yogurt is produced for cow milk. However, throughout history, other sources of milk have been used, such as goat milk, buffalo milk, camel milk, sheep milk (Lima et al., 2020; Santis et al., 2019). Goat milk is characterized for the higher content of short-chain fatty acids, minerals such as zinc, iron, magnesium and some bioactive compounds as vitamins and proteins of high biological value (Costa et al., 2016; Santis et al., 2019). In this way, goat milk is easier to digest and has lower allergies, such as an allergy to cow milk protein (Mazzaglia et al., 2020). However, due to the higher content of short-chain fatty acids (such as caproic, caprylic, and capric acids), produce a characteristic "goaty" flavor of products derived from goat milk, the main effect of low global acceptance of goat milk products. (Bevilaqua et al., 2020; Costa et al., 2014; 2015a; 2017). Thus, the use of fruit pulp has been promoted to increase the sensorial acceptance of the products (Chollet et al., 2013). Cupuassu (*Theobroma grandiflorum*) is an Amazon native fruit with high technological value due to their high content of fibers such as pectin, due this improves the yogurt instrumental texture (Costa et al., 2015b) and has a distinctive flavor and odor (Ramos et al., 2020; Costa et al., 2016).

However, food sensory and nutritional characteristics are a factor directly related to the commercial success of the product (Costa et al., 2017). Some techniques are used to know the acceptance potential of a new product, which is the acceptance and affective analyses the most used.

Besides, techniques such as the Just-about-right scale (JAR) allow us to know, in detail, the effective level of specific attributes by means of “too enough” and “too much” bipolar measurements (Balthazar et al., 2017; Costa et al., 2017; Li et al., 2014). Thus, the present study aimed to optimize the formulation of cupuassu goat milk yogurt with different fat-replacers (inulin, maltodextrin and whey protein) addition using a JAR.

## 2 MATERIALS AND METHODS

### 2.1 YOGURT PRODUCTION

Cupuassu goat milk yogurts were made at the *Laboratório de Inspeção e Tecnologia de Leite e Derivados* (UFBA – Brazil). In all treatment, 1 % of Thermophilic yogurt culture (YF-L903, Chr. Hansen, Valinhos, Brazil) was used to ferment the UHT goat whole and skimmed milk (Caprilat®, Rio de Janeiro, Brazil) as described to (Costa et al., 2016). For the present study, five treatments were prepared; whole goat milk yogurt (W); skimmed goat milk yogurt (S); skimmed goat milk yogurt with Inulin (5 %; Ingredients & Systems Biotechnology®, São Paulo, SP, Brazil) (SI); skimmed goat milk yogurt with Maltodextrin (5 %; Max Titanium®, São Paulo, SP, Brazil) (SM); and skimmed goat milk yogurt with whey protein (5 %; Optimum Nutrition, Gold Standard) (SW).

In all treatments, sugar (3 %; União®, São Paulo, SP, Brazil) and Cupuassu pulp (10 %, Polpa de Fruta, Macapá, AP, Brazil) were added according to Costa et al. (2017). The ingredients were added before fermentation, being fermented in an oven (BOD) at a temperature of  $43 \pm 1$  °C. Fermentation was interrupted when the pH reached  $4.6 \pm 0.1$  (AOAC, 2001). The beaten yogurts were conditioned in 2 liters glass, stored in a refrigerator ( $4 \pm 1$  °C) until the moment of sensory analysis.

### 2.2 SENSORY ANALYSIS

Sensory analysis was performed at the the *Laboratório de Inspeção e Tecnologia de Leite e Derivados* (LaITLácteos). Overall liking and JAR were carried out with 119 non-habitual consumers randomly recruited; 74 women (62.2 %) and 45 men (37.8 %) ranging from 18 to 69 years old, an average of  $25.8 \pm 7.2$  years old. The samples were served in white polyethylene cups at  $8 \pm 2$  °C, for each yogurt sample coded with three random digits. Potable water and biscuit were used to clean the palate. The consumers evaluated the samples one by one and assessed using a 9-point hedonic scale ranging from 1 (dislike extremely) to 9 (like extremely). The acceptability index (AI) was then calculated for each attribute using Equation (1), where A average score obtained for the product and B is the highest score given to the product by a consumer (Kowaleski et al., 2020):

$$AI (\%) = \frac{A}{B} \times 100 \quad (1)$$

For just-about-right (JAR), consumer rated the same cupuassu goat milk yogurt samples in term for four item to be evaluated: aroma in terms of acid, caprine and cupuassu; flavor in terms of sweet, acid, caprine and cupuassu; color for yellow and green; and texture for consistency, viscosity, firmness and cohesiveness on a 5-point hedonic scale (5 = much more than ideal at 1 = much less than ideal), according to Costa et al. (2017).

### 2.3 STATISTIC DATA

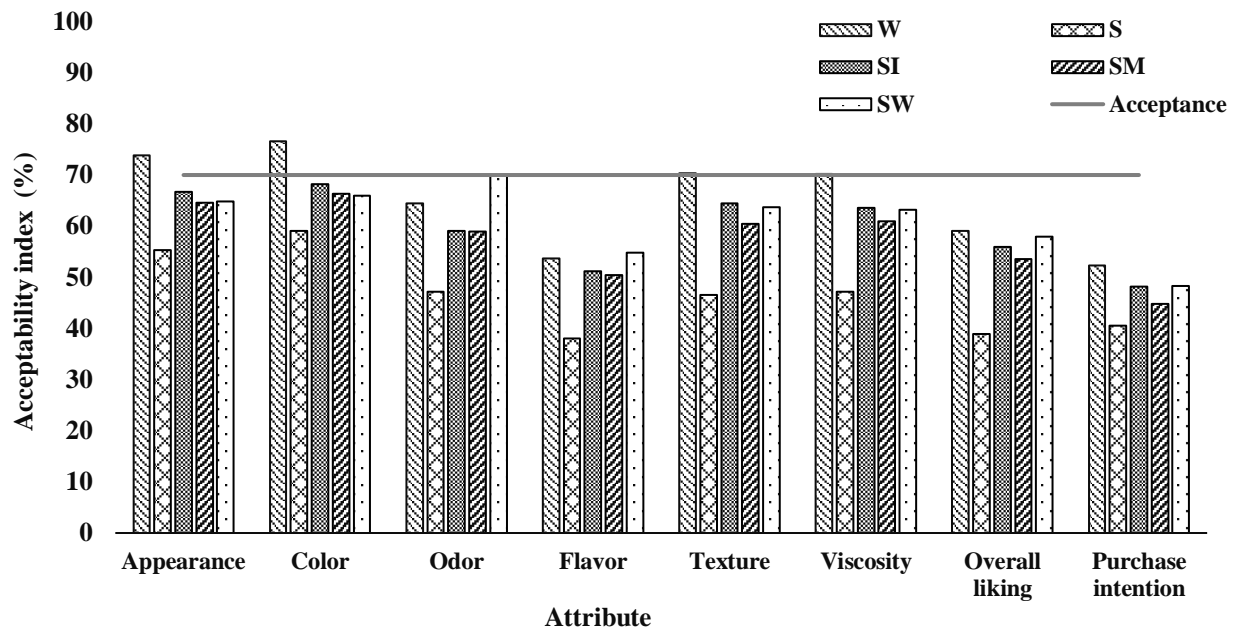
Sensory analysis data was treated by ANOVA (Analysis of Variance). The ANOVA was subjected to Tukey test at  $p < 0.05$ , applied in the XLSTAT (version 2013.2.03) statistical program. For penalty analysis was carried out on JAR data to identify decreases in the overall acceptability where consumers rated the attributes at “too little” or “too much.”

## 3 RESULTADOS E DISCUSSÃO

### 3.1 ACCEPTABILITY INDEX

Acceptability index (AI) values of cupuassu goat milk yogurts are exhibited in figure 1. In general form, the results showed that the addition of inulin, maltodextrin and whey protein improve the cupuassu goat milk yogurt acceptance. In this context, the treatment S demonstrated the lowest values in all the attributes compared with the other samples (SW, SI, SM and SW), this may be due to their low consistency of skimmed cupuassu goat milk yogurt (Costa et al., 2016). According to Vianna et al. (2017) attribute such as appearance and textural have a higher effect on the yogurt acceptability. According to Kowaleski et al. (2020) AI higher or equal to 70 % indicates to the product it was accepted by the consumer. In this way, the treatment W was considered as accepted in the appearance, color and viscosity attribute. The flavor and overall liking attributes obtained values below 70% in all treatments probability due to the goaty flavor (Costa et al., 2014; 2015a), and also the lower familiarity of consumers to this type of product can affect the product acceptance (Costa et al., 2015a; 2017; Mazzaglia et al., 2020). In this study, only the fat replacers addition is not enough to improve the acceptance. In this way, other formulations must be tested to reach 70% acceptance.

Figure 1 - Acceptability index for sensory attributes of different formulations of cupuassu goat milk yogurts.



W = whole goat milk; S = skimmed goat milk; SI = skimmed goat milk with 5 % of inulin; SM = skimmed goat milk with 5 % of Maltodextrin; SW = skimmed goat milk with 5 % of whey protein.

### 3.2 JUST-ABOUT-RIGHT (JAR) PROFILE AND PENALTY ANALYSIS

The JAR scores are presented in Table 1. Acid and goat flavors were considered as JAR in the treatments W, S, SI and SM. However, the SW treatment was considered as less of JAR for acid flavor and odor, this due that original product has a vanilla flavor composition, which increases a sweeter taste for the consumer. This effect can be observed in the flavor attributes, where the SW treatment was rated closer to JAR compared to the other treatments. Thus, the vanilla flavoring addition can be a strategy to increase the attractiveness of these yogurts to unusual consumers.

In all treatments, the cupuassu flavor was considered as less of JAR. Similar results were found by Costa et al. (2017), with study different percentage of cupuassu pulp (5, 10 and 15%) in goat milk yogurt. They were indicating the addition of a higher percentage of cupuassu pulp decrease the caprine flavor in the formulation. However, there was no difference between 10 or 15% of cupuassu pulp. In the present study, it was observed that cupuassu pulp only was enough to reduce caprine flavor and the product rejection by consumers. Nonetheless, when combined with fat replacers the goat milk yogurt presented acid and caprine flavor as ideal. Furthermore, inulin, maltodextrin and whey protein addition increased consistency, viscosity, firmness, and cohesiveness perception. This fact is in agreement with that observed by Costa et al. (2016), who reported that the addition of inulin, maltodextrin and whey protein increases the apparent viscosity of skimmed goat milk yogurt.

Table 1 - Just-about-right (mean  $\pm$  standard deviation) scores for the different formulations of cupuassu goat milk yogurts<sup>1</sup>.

Treatments	Flavor			
	Sweet	Acid	Caprine	Cupuassu
W	2.39 $\pm$ 0.90 <sup>b</sup>	3.5 $\pm$ 0.90 <sup>a</sup>	3.41 $\pm$ 1.03 <sup>b</sup>	2.79 $\pm$ 1.03 <sup>a</sup>
S	1.9 $\pm$ 0.77 <sup>c</sup>	3.7 $\pm$ 1.12 <sup>a</sup>	3.82 $\pm$ 1.12 <sup>a</sup>	2.39 $\pm$ 1.15 <sup>b</sup>
SI	2.35 $\pm$ 0.75 <sup>b</sup>	3.41 $\pm$ 0.82 <sup>a</sup>	3.43 $\pm$ 1.08 <sup>b</sup>	2.71 $\pm$ 0.96 <sup>ab</sup>
SM	2.33 $\pm$ 0.81 <sup>b</sup>	3.42 $\pm$ 0.93 <sup>a</sup>	3.49 $\pm$ 1.05 <sup>ab</sup>	2.81 $\pm$ 0.96 <sup>a</sup>
SW	2.96 $\pm$ 0.97 <sup>a</sup>	2.99 $\pm$ 0.74 <sup>b</sup>	3.35 $\pm$ 0.95 <sup>b</sup>	2.36 $\pm$ 1.02 <sup>b</sup>
Treatments	Texture			
	Consistency	Viscosity	Firmness	Cohesiveness
W	3.04 $\pm$ 0.80 <sup>a</sup>	3.03 $\pm$ 0.79 <sup>a</sup>	2.92 $\pm$ 0.86 <sup>a</sup>	2.84 $\pm$ 0.75 <sup>a</sup>
S	2.13 $\pm$ 0.79 <sup>c</sup>	2.24 $\pm$ 0.87 <sup>c</sup>	1.98 $\pm$ 0.74 <sup>c</sup>	2.18 $\pm$ 0.77 <sup>b</sup>
SI	2.64 $\pm$ 0.74 <sup>b</sup>	2.74 $\pm$ 0.81 <sup>b</sup>	2.55 $\pm$ 0.81 <sup>b</sup>	2.65 $\pm$ 0.80 <sup>a</sup>
SM	2.52 $\pm$ 0.82 <sup>b</sup>	2.64 $\pm$ 0.79 <sup>b</sup>	2.48 $\pm$ 0.76 <sup>b</sup>	2.7 $\pm$ 0.82 <sup>a</sup>
SW	2.56 $\pm$ 0.74 <sup>b</sup>	2.64 $\pm$ 0.76 <sup>b</sup>	2.46 $\pm$ 0.75 <sup>b</sup>	2.63 $\pm$ 0.72 <sup>a</sup>
Treatments	Odor		Color	
	Acid	Caprine	Yellow	Green
W	3.28 $\pm$ 0.79 <sup>b</sup>	3.29 $\pm$ 0.89 <sup>b</sup>	2.79 $\pm$ 0.70 <sup>b</sup>	2.69 $\pm$ 0.76 <sup>a</sup>
S	3.59 $\pm$ 1.09 <sup>a</sup>	3.76 $\pm$ 1.19 <sup>a</sup>	3.02 $\pm$ 0.84 <sup>ab</sup>	2.95 $\pm$ 0.85 <sup>a</sup>
SI	3.37 $\pm$ 0.82 <sup>ab</sup>	3.38 $\pm$ 1.08 <sup>b</sup>	3.14 $\pm$ 0.65 <sup>a</sup>	2.92 $\pm$ 0.68 <sup>a</sup>
SM	3.37 $\pm$ 0.88 <sup>ab</sup>	3.46 $\pm$ 0.96 <sup>ab</sup>	3.1 $\pm$ 0.83 <sup>a</sup>	2.93 $\pm$ 0.88 <sup>a</sup>
SW	2.92 $\pm$ 0.73 <sup>c</sup>	3.17 $\pm$ 0.91 <sup>b</sup>	3.21 $\pm$ 0.81 <sup>a</sup>	2.83 $\pm$ 0.74 <sup>a</sup>

<sup>a-d</sup> Different lowercase superscripts indicate significant differences among treatment,  $P < 0.05$ . W = whole goat milk; S = skimmed goat milk; SI = skimmed goat milk with 5 % of inulin; SM = skimmed goat milk with 5 % of Maltodextrin; SW = skimmed goat milk with 5 % of whey protein. <sup>1</sup>All JAR attributes were evaluated in a structured 5-point hedonic scale.

Table 2 shows the percentages of consumers and the mean drop of the attributes that were penalized in this study. The addition of inulin, maltodextrin and whey protein decreasing sweet, acid and goat flavor, goat and acid odor, as well as increased texture attributes (consistency, viscosity, firmness and cohesion). Thus, the S treatment was penalized by a higher percentage of consumers, in the texture attributes, such as too little compared to the other treatments. Nevertheless, these effects were not observed in the W treatment, where whole goat milk was used. All treatments were penalized for too much goat flavor and odor, as well as for too little consistency, viscosity, firmness and cohesion. The W, S, SI and SM treatments were considered too much in acid flavor and odor. In addition, all treatments were penalized for too little sweet flavor. However, in the SW treatment, it was obtaining a percentage greater than 20% in both too little and too much penalties, which could indicate that in the present study were groups of consumers with different tastes (Fernández et al., 2018). Taste of cupuassu was penalized as too little in all treatments. Similar results have been finding by Costa et al. (2017).

Tabla 2 - Análisis de penalización de la puntuación de la escala de lo ideal (JAR) de las diferentes formulaciones de yogur de copoazú a base de leche de cabra.

Treatments	Flavor							
	Sweet		Acid		Caprine		Cupuassu	
	Too little	Too much	Too little	Too much	Too little	Too much	Too little	Too much
WCTL	54.62 <sup>a</sup> (0.96) <sup>b</sup>	—	—	43.70 (1.44)	—	42.02 (1.58)	39.50 (1.11)	—
SCTL	76.47 (1.13)	—	—	63.03 (1.27)	—	68.07 (1.58)	59.66 (1.51)	—
SINU	55.46 (1.27)	—	—	42.02 (1.35)	—	46.22 (2.45)	39.50 (1.70)	—
SMAL	58.82 (1.08)	—	—	40.34 (0.80)	—	50.42 (1.44)	32.77 (1.00)	—
SWHE	26.89 (2.10)	24.37 (0.53)	—	—	—	41.18 (1.52)	57.98 (0.97)	—
Treatments	Texture							
	Consistency		Viscosity		Firmness		Cohesiveness	
	Too little	Too much	Too little	Too much	Too little	Too much	Too little	Too much
WCTL	—	—	—	—	30.25 (0.75)	—	27.73 (1.60)	—
SCTL	68.91 (1.21)	—	63.03 (1.61)	—	77.31 (1.04)	—	66.39 (1.60)	—
SINU	42.02 (0.79)	—	36.13 (1.22)	—	47.06 (0.24)	—	40.34 (1.14)	—
SMAL	47.06 (1.03)	—	40.34 (0.86)	—	49.58 (0.63)	—	33.61 (0.96)	—
SWHE	47.06 (1.34)	—	40.34 (0.90)	—	52.94 (0.54)	—	39.50 (1.29)	—
Treatments	Odor				Color			
	Acid		Caprine		Yellow		Green	
	Too little	Too much	Too little	Too much	Too little	Too much	Too little	Too much
WCTL	—	31.09 (1.96)	—	31.09 (1.32)	23.53 (1.09)	—	25.21 (0.95)	—
SCTL	—	53.78 (1.11)	—	61.34 (1.74)	21.01 (1.33)	—	21.85 (0.90)	22.69 (0.52)
SINU	—	38.66 (1.37)	—	44.54 (1.80)	—	20.17 (0.46)	—	—
SMAL	—	36.13 (1.13)	—	45.38 (1.19)	—	24.37 (1.35)	21.01 (1.53)	—
SWHE	—	—	—	26.05 (1.47)	—	32.77 (0.63)	24.37 (0.64)	—

— Indicates that less than 20% of consumer selected the corresponding JAR category. W = whole goat milk; S = skimmed goat milk; SI = skimmed goat milk with 5 % of inulin; SM = skimmed goat milk with 5 % of Maltodextrin; SW = skimmed goat milk with 5 % of whey protein. <sup>a</sup> Percentage of consumers who found each treatment to be too little or too much for JAR Flavor, texture, odor and color. <sup>b</sup> the number in parentheses is the change in the mean compared with the consumer response score to overall acceptability.

**4 CONCLUSIONS**

The fat substitute addition (inulin, maltodextrin and whey protein) increases the overall acceptance and the purchase intention by the consumer and could be used as a technological strategy in the production of low-fat cupuassu goat milk yogurt. Therefore, the addition of cupuassu and fat substitutes decreases the characteristic flavor and odor of goat milk in all treatments. Consequently, in the JAR analysis, consumers' perception of low cupuassu flavor was observed by consumers in all treatments, indicating an increase in the cupuassu concentration for future studies. In addition, consistency, firmness and cohesiveness increased with the addition of fat substitutes

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