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Cheese and milk quality of F1 Holstein x Zebu cows fed different levels of banana peel

Marco Túlio Parrela de Melo[1], Vicente Ribeiro Rocha Júnior[1*], Luciana Albuquerque Caldeira[1], Paulo Roberto Silveira Pimentel[1], Sidnei Tavares dos Reis[2] and Diego Lucas Soares de Jesus[2]

*[1]Universidade Estadual de Montes Claros, Avenida Reinaldo Viana, 2630, 39440-000, Janaúba, Minas Gerais, Brazil. [2]Departamento de Zootecnia, Universidade Federal de Sergipe, Aracajú, Sergipe, Brazil. *Author for correspondence. E-mail: vicente.rocha@unimontes.br*

ABSTRACT. This study aimed to evaluate the effects of the inclusion of different levels of sun-dried banana peel in the diet for crossbred cows on the quality of Minas fresh cheese and milk. Diets consisted of 0, 15, 30, 45 and 60% replacement of sorghum silage with banana peel. Ten cows were assigned to two 5 x 5 Latin squares experimental design. Milk samples were taken from each cow and analyzed for composition. Milk was pasteurized for the production of Minas fresh cheese, which was weighed to determine the yield and analyzed for texture, physical and chemical characteristics and consumer acceptance test. Milk urea nitrogen had a quadratic effect with minimum point at 43.76% replacement of silage with banana peel. The remaining items evaluated in the composition of milk and cheese and the consumer acceptance test were not influenced by diets with banana peel. The replacement of up to 60% sorghum silage with banana peel is a viable alternative because it causes no alteration in physical and chemical composition of milk and Minas fresh cheese, as well as consumer acceptance.

Keywords: banana crop, milk processing, by-products.

Qualidade do queijo e do leite de vacas F1 Holandês x Zebu alimentadas com níveis de casca de banana

RESUMO. Objetivou-se avaliar os efeitos dos níveis de inclusão da casca de banana seca ao sol na dieta de vacas mestiças sobre a qualidade do queijo Minas frescal e do leite. As dietas foram constituídas de 0, 15, 30, 45 e 60% de substituição da silagem de sorgo pela casca de banana. Foram utilizadas 10 vacas em um delineamento experimental com dois quadrados latinos 5 x 5. Amostras de leite de cada vaca foram analisadas quanto à composição. O leite foi pasteurizado para fabricação do queijo Minas Frescal, que foi pesado para determinação do rendimento e analisado para textura, características físico-químicas e teste de aceitação geral pelo consumidor. O nitrogênio uréico do leite apresentou efeito quadrático com ponto de mínimo ao nível de 43,76% de substituição da silagem pela casca de banana. Os demais itens avaliados na composição do leite e do queijo, bem como os testes de aceitação geral pelo consumidor, não sofreram influência das dietas com inclusão de casca de banana. A substituição de até 60% da silagem de sorgo por casca de banana pode ser uma alternativa viável, pois não altera a composição físico-química do leite e do queijo Minas Frescal, bem como aceitação deste pelos consumidores.

Palavras-chave: bananicultura, processamento do leite, subprodutos.

Introduction

Minas Frescal cheese is one of the most consumed in the country, and characterized as a semi-fat cheese with very high moisture, consumed by all the layers of the population (Sangaletti et al., 2009). In order to maintain the quality standard in cheese production in the industrial process, in addition to adequate processing, quality of the raw material is fundamental (Cassandro et al., 2008, Sheehan, 2013), which can be influenced, among other factors, by the animal diet (Costa, Fernandes, & Queiroga, 2008, Martins et al., 2012, Aguiar et al., 2013, Nudda et al., 2014, Souza et al., 2015).

In this sense, the use of by-products from agricultural production has been evaluated, since, in addition to having the potential to substitute traditional foods in ruminant feed, due to their adequate nutritional value, they can reduce costs of feeding the herd (Murta et al., 2011, Urbano et al., 2012) and become an alternative route to inappropriate disposal in the environment (Omer, 2009, Ferreira, Costa, & Pasin et al., 2015, Monção et al., 2016).

The use of banana peel in the diet for dairy cows has presented satisfactory results, since it has high content of fermentable carbohydrates in the rumen, especially pectin (10 to 21%), besides ether extract content between 2.0 and 10.9%, crude protein (8.28 to 8.92%), and fatty acid content with a satisfactory profile from the point of view of human health (Emaga, Andrianaivo, Wathelet, Tchango, & Paquot, 2007, Mahopatra, Mishra, & Sutar, 2010, Emaga et al., 2011, Monção et al., 2014, Souza et al., 2016). Banana peel is also rich in flavonoids, such as galocatechin and isocyanidine, substances that have anti-inflammatory and antineoplastic activity. Thus, it can play a role in the prevention of inflammatory processes, dissemination of bacteria and tissue repair in animals (Atzingen et al., 2011).

Thus, sun-dried banana peel has the potential to replace sorghum silage, which is more costly, without affecting the quality and composition of cheese and milk, also contributing to a lower environmental impact of agroindustries that generate this by-product.

Given the above, the goal of this study was to evaluate the effects of including different levels of sun-dried banana peel, replacing the sorghum silage in the diet for F1 Holstein x Zebu cows on the quality of milk and Minas Frescal cheese.

Material and methods

The experiment was conducted at the Experimental Farm of the State University of Montes Claros - Unimontes, located in the municipality of Janaúba, northern state of Minas Gerais. Ten F1 Holstein x Zebu cows with 70 ± 11 days of lactation at the beginning of the experiment were distributed in two simultaneous 5 x 5 Latin squares, each composed of five animals, five treatments and five experimental periods. Five experimental diets were tested: diet with sorghum silage, without the inclusion of banana peel (control); inclusion of 15, 30, 45 and 60% in replacement of sorghum silage. This substitution was made on a dry matter basis. The forage: concentrate ratio in the total dry matter of diets was 70: 30. The experiment lasted 80 days, divided into five periods of 16 days, the first 12 days for adaptation of the animals to the diets and the last four days for data collection and samplings. The diets were formulated to be isoproteic for cows averaging 500 kg body weight and average milk production of 15 kg corrected to 3.5% fat day^{-1} and were fed to the cows twice a day at 7 and 14 hour, in a complete diet system.

Banana peels were obtained from mature fruit of the Prata-Anã cultivar, presenting a dry matter content of 10.32 and 6.25% ether extract. Peels were previously dehydrated by exposure to the sun for 12 ± 3 days. After dehydration, peels were ground in a stationary chopper to particles of 3 to 4 cm and stored in nylon bags in a covered shed.

Foods supplied were weighed on a digital scale and the supply was adjusted so that the leftovers represented 5% of the amount of dry matter supplied. The proportion of the ingredients used in the diets and the chemical composition are listed in Table 1. Cows were kept in individual stalls and milked using a mechanical milking machine twice a day at 8 and 15 hours. The presence of the calf was used to stimulate milk ejection, and after milking, calves remained with the dams to suckle the residual milk for approximately 30 min. In the last four days of each experimental period, milk yields per cow were recorded, which were corrected to 3.5% fat. Also in the last four days of each period, milk samples from each animal were collected twice a day, composing a pool of milk samples of the morning and afternoon milkings, proportionally to the amount produced in the morning and afternoon.

Table 1. Proportion of the ingredients of the experimental diets (%) and chemical composition of diets, on a dry matter basis.

Ingredients	Replacement levels (% DM)				
	0	15	30	45	60
Sorghum silage	70	59.5	49	38.5	28
Banana peel	0	10.5	21	31.5	42
Soybean meal	17.31	17.29	17.27	17.24	17.22
Ground corn	11.73	11.75	11.77	11.8	11.82
Mineral supplement[1]	0.96	0.96	0.96	0.96	0.96
Chemical composition					
Dry matter	50.55	56.26	61.97	67.68	73.39
Mineral matter	6.64	7.33	8.02	8.71	9.4
Organic matter	93.36	92.67	91.98	91.29	90.60
Crude protein	13.65	13.89	14.12	14.35	14.58
[2]NDIN	0.35	0.39	0.43	0.47	0.51
[3]ADIA	0.19	0.21	0.23	0.25	0.27
Ether extract	2.83	3.28	3.74	4.19	4.64
Total carbohydrates	76.87	75.50	74.12	72.75	71.38
[4]NFC	20.70	22.16	23.61	25.07	26.52
[5]NDF	57.30	55.05	52.79	50.54	48.28
[6]NDFcp	56.38	53.55	50.72	47.90	45.07
[7]ADF	30.81	29.75	28.70	27.65	26.59
Lignin	7.51	7.59	7.66	7.74	7.82

[1]Guarantee levels per kg product: calcium (128 g min.) (157 g max), phosphorus (100 g min.), sodium (120 g min.), magnesium (15 g), sulfur (33 g), cobalt (135 mg), copper (2,160 mg), iron (938 mg), iodine (160 mg), manganese (1,800 mg), selenium (34 mg), zinc (5,760 mg), fluorine (1,000 mg); [2]NDIN = neutral detergent insoluble nitrogen; [3]ADIA = acid detergent insoluble nitrogen; [4]NFC = Non-fiber carbohydrates; [5]NDF = Neutral detergent fiber; [6]NDFcp = Neutral detergent fiber corrected for ash and protein0; [7]ADF = Acid detergent fiber.

For determination of physical and chemical characteristics of milk, the following analyses were conducted in triplicate: density at 15ºC, by thermo lacto densimeter Queolne; pH, by digital pH meter Tecnopon; and ashes, by the elimination of organic matter at 550°C. The Bronopol preservative was inserted and homogenized in milk samples, for later referral to the Milk Clinics, a sector of the Animal Science Department, School of Agriculture Luiz de Queiroz, University of São Paulo, located in

Piracicaba, state of São Paulo, Brazil, for determination of contents of fat, protein, lactose and total dry extract (TDE), defatted dry extract (DDE), milk urea nitrogen (MUN), casein, by the infrared method and somatic cell counts (SCC) were determined by the flow cytometry method.

With the milk produced on the last day of each experimental period, Minas Frescal cheese was manufactured in the Laboratory of Technology of Animal Products of Unimontes - Campus Janaúba. The milk from each experimental diet, separately, was weighed, filtered and subjected to slow pasteurization (65°C for 30 min.). Next, milk was cooled to 39°C, temperature at which were added calcium chloride (40 mL 100 L^{-1}) and rennet (30 mL 100 L^{-1}), which was diluted in equal amount of filtered water. After a period of 40 to 60 min., milk coagulated, then the mass was cut with a stainless steel knife into cubes of 1.5 to 2 cm, intercalating the stirring and the rest to promote the desorption. Following drainage of the whey, the mass was put into plastic forms and salted (700 g 100 L^{-1} refined white salt). Cheeses were cooled at 4°C for approximately 12 hours, the next day they were removed from the forms, packed, weighed on a digital scale to determine the yield and reserved for subsequent texture, physical-chemical and sensory analyses. The texture of the cheese samples was determined using a Texturometer - Model TAXT from Stabic Micro Systems, with the aid of a software, directly yielding the cutting force (Kg). It was used a Warner Bratzler cell at a speed 3 mm s^{-1}. Gross yield (kg kg^{-1}) = weight of the formulation (milk + ingredients) (kg) $mass^{-1}$ of cheese after packaging (kg). The yield adjusted for moisture content of the cheese (Lucey & Kelly, 1994) was calculated considering a value of 57% as reference for the moisture of Minas Frescal cheese, according to the equation: Adjusted Yield (L kg^{-1}) = milk volume (L) × (100 - % desired moisture)/(kg cheese x solids content (%).

To determine the physical and chemical characteristics of cheese, the following analyses were carried out in triplicate: titratable acidity (ºD), using the phenolphthalein indicator solution (0.1%); pH, by means of digital pH meter Tecnopon; fat percentage content by the Gerber method; protein by the Kjeldahl method; fixed mineral residue by the elimination of organic matter at 550°C; total solids by evaporating water from the sample using an oven at 105°C; the moisture was determined by subtraction of total solids; and water activity (Aw) by means of Aw meter, Aqua Lab®.

The evaluation of cheeses by the untrained panelists was performed through the sensory acceptance test. The sensorial analysis of cheese was performed in five periods, with 30 tasters per period; the samples were coded and cut into cubes weighing 25 g and supplied in disposable cups. Samples with their respective codes were simultaneously served and classified by the tasters to evaluate the general acceptance, assigning the score 1 to the least accepted and 9 to the most accepted. The ordering preference test was also performed.

Data obtained were subjected to analysis of variance, using the software Sisvar (Ferreira, 2011). When significant, the means of treatments were compared by the Dunnet's test and subjected to regression analysis, considering $\alpha = 0.05$.

When significant, data of the cheese acceptance test were subjected to the Friedman test, considering $\alpha = 0.05$. The ordering preference data of the cheese samples were subjected to the analysis of the minimum significant difference (MSD).

Results and discussion

There was no effect of the levels of inclusion of sun-dried banana peel on the diets on milk fat and protein content (Table 2).

Table 2. Physical-chemical composition, somatic cell count (CCS) and milk yield of cows fed increasing levels of banana peel in the diet, with respective regression equations (RE), standard error of the mean (SEM) and values P (Pr > Fc).

Variables	Levels of banana peel							
	0	15	30	45	60	RE	SEM	Pr > Fc
Fat, %	4.73	4.87	4.64	4.61	4.96	$\hat{Y} = 4.76$	0.067	0.6695
Protein, %	3.66	3.63	3.68	3.65	3.73	$\hat{Y} = 3.67$	0.017	0.8244
Lactose, %	4.60	4.49	4.51	4.56	4.57	$\hat{Y} = 4.55$	0.020	0.8249
Ash, %	0.79	0.78	0.76	0.80	0.78	$\hat{Y} = 0.78$	0.005	0.8544
[2]TS, %	14.01	14.20	14.24	14.17	13.92	$\hat{Y} = 14.11$	0.059	0.8464
[3]DDE, %	9.24	9.13	9.25	9.20	9.18	$\hat{Y} = 9.20$	0.022	0.8458
Density, g mL^{-1}	1.03	1.03	1.03	1.03	1.03	$\hat{Y} = 1.03$	0.000	0.5403
pH	6.67	6.67	6.67	6.67	6.70	$\hat{Y} = 6.68$	0.005	0.9331
[4]NUL	19.13	17.15	15.75*	16.76	15.97*	[1]	0.601	0.0325
Casein, % m m^{-1}	2.86	2.84	2.87	2.86	2.88	$\hat{Y} = 2.86$	0.007	0.9974
[5]Casein $Protein^{-1}$	78.02	78.09	77.87	78.25	77.86	$\hat{Y} = 78.02$	0.072	0.9473
CCS	367.6	168.1	100.0	730.6	976.10	$\hat{Y} = 468.48$	167.71	0.5806
[6]PLCG, Kg	16.8	16.39	16.25	16.54	16.49	$\hat{Y} = 16.49$	0.091	0.8812

[1]$\hat{Y} = 19.5912 - 0.171560x + 0.001960x^2$ ($R^2 = 0.8727$), [2]Total Solid Content, [3]Defatted Dry Extract Content, [4]Milk urea nitrogen, [5]% casein in relation to protein, [6]Milk yield corrected to 3.5% fat. *Significantly different by Dunnett's test.

Dormond, Boshini, and Rojas-Bourriilón (1998), in two experiments that evaluated the inclusion of 14 and 21 kg of banana peel at the initial and intermediate stages of lactation of Jersey cows, found fat levels of 4.21 and 4.22%, respectively. The values found in the present study are within the normal range for milk fat, which can vary from 1.5 to 7%, with an average of 3.5% (Simili & Lima, 2007). The level of production of the cows, their genetics and forage: concentrate ratio of the diet

(70: 30), may help to explain the high fat content of milk. According to Reis et al. (2012), the production is related to the dilution effect, while the genetics of crossbred dairy cows influence the production of milk with higher fat content.

As for milk protein content, Dormond et al. (1998) also evaluated the inclusion of banana peel in the diet for Jersey cows in initial and intermediate lactation, and reported average values of 3.48 and 3.52%, respectively. The value found in this study (3.67%) is above the minimum recommended by current legislation, which is of the order of 2.9%.

Casein and its percentage in milk protein were also not influenced by the inclusion of banana peel (Table 2). Similar results were verified by Freitas Júnior et al. (2010), who also found no difference for casein and casein in percentage of crude protein, obtaining average values of 2.21 and 78.26%, respectively, when supplemented the diet of cows in middle lactation, with different sources of fat. The fact that this milk protein fraction remained stable between treatments indicates that there was no influence of the diets on the protein metabolism of the mammary gland (Gandra et al., 2010).

Additionally, these results indicate that diets containing banana peel can provide adequate levels of energy and degradable protein in the rumen for microbial protein synthesis, providing metabolizable protein, especially in relation to the most limiting amino acids for cattle such as lysine and methionine, which favors the protein synthesis of milk (Ribeiro, Lopes, Gama, Morenz, & Rodriguez, 2014).

Lactose content did not differ between diets. This was expected considering that this nutrient undergoes few changes with the alteration of the diet, but has relevant function as an osmotic component of milk. Total milk solids were also not influenced by diets (Table 2). The variation in total solids content is highly dependent on variations in fat and protein content, since these components present the highest variation response to diet, mainly fat (Reis et al., 2012). In this sense, it was expected that this component would not be altered by the diets, in consonance with the fat and protein contents found in the present work.

The percentages of ash and defatted dry extract also were not influenced by the inclusion of banana peel in the diet for cows. The value of DDE is above the legal minimum limit of 8.4%. In the present study, density followed the standards of quality inspection of milk without significant difference (Table 2).

Milk urea nitrogen presented a quadratic effect, with minimum values observed when sorghum silage was replaced by up to 43.76%. Diets containing 30 and 60% banana peel replacing sorghum silage were different from the control diet, presenting lower levels of MUN in relation to this diet. A possible explanation for these results may be related to the presence of tannins in banana peel, reported by Emaga, Andrianaivo, Wathelet, Tchango, and Paquot (2007). Some studies (Min, Attwood, Mcnabb, Molan, & Barry, 2005, Toral, Herváz, Bichi, Belenguer, & Frutos, 2011) suggest that the tannins present in foods may influence the degradability of protein in the rumen, which, in turn, may contribute to lower release of ammonia and, consequently, to alter urea nitrogen concentrations in plasma (PUN). Moreover, the increased availability of non-fiber carbohydrates (Table 1) in banana peel diets may have favored the use of degraded nitrogen in the rumen, improving the efficiency of microbial protein synthesis, reducing PUN and MUN.

According to Galvão Júnior et al. (2010), milk urea nitrogen is an important indicator of protein nutritional status as well as for determining the efficiency of nitrogen use by the ruminant animal and is directly related to PUN, which, in turn, is influenced by several factors, including the crude protein and the protein: energy ratio of the diet. According to Roseler, Ferguson, Sniffen, and Herrema (1993), the mean value of MUN should be between 12-18 mg dL^{-1}, and mean values above 16 mg dL^{-1} would indicate excess protein in the diet, deficiency in non-fiber carbohydrate fermentation and/or imbalance between the availability of energy and nitrogen in the rumen.

Based on this, the diets of cows fed with increasing levels of banana peel replacing sorghum silage did not influence the fat and protein contents, which are predominant nutrients in total solids of milk and, therefore, fundamental in maintaining its quality. The reductions in MUN levels in diets containing banana peel indicate a higher efficiency in the use of dietary nitrogen and, consequently, lower nitrogen excretion favoring the environment (Santos, Kazama, Kazama, & Petit, 2010). This added to the fact that the by-product when used is not discarded fresh in the environment, characterizes it as having great sustainable potential in the substitution of traditional foods.

Aiming to evaluate the quality of milk, somatic cell count (SCC) was analyzed, with a mean value of 468,000 cells mL^{-1} (Table 2). No difference was detected between the levels of inclusion of banana peel in the diet. The results are in accordance with the Normative Instruction 62 for refrigerated raw milk. SCC was also considered as intermediate, as described by Andreatta et al. (2009). Somatic cell counts may indicate *S. aureus* contamination and therefore indicate subclinical mastitis. Studies also reveal the influence of this parameter on milk components, especially protein fractions, and may influence the yield of dairy products (Zafalon, Nader Filho, Carvalho, & Lima, 2008, Andreatta et al., 2009). In the present study, however, there was no influence on milk constituents, which presented normal concentrations.

The physical and chemical composition of the Minas Frescal cheese did not present differences for fat, protein, total solids (TS), moisture and fixed mineral residue (FMR), between diets containing increasing levels of banana peel (Table 3).

Table 3. Physical and chemical composition, gross yield and yield adjusted for the moisture content of the Minas Frescal cheese produced with milk from F1 Holstein x Zebu cows fed increasing levels of banana peel in the diet, with respective means, regression equations (RE), standard error of the mean (SEM) and real values of p (Pr > Fc).

Variables	Levels of banana peel							
	0	15	30	45	60	RE	SEM	Pr > Fc
Moisture, %	64.07	64.67	64.61	64.63	64.37	$\hat{Y}$ = 64.47	0.113	0.9973
[1]TSC, %	35.93	35.33	35.39	35.37	35.63	$\hat{Y}$ = 35.53	0.113	0.9973
Fat, % TSC	35.20	27.86	36.16	34.54	31.39	$\hat{Y}$ = 33.03	1.520	0.7200
Protein, % TSC	36.59	42.56	39.55	38.57	36.61	$\hat{Y}$ = 38.77	1.105	0.6546
[2]RMF, % TSC	7.97	8.57	8.48	8.45	8.20	$\hat{Y}$ = 8.33	0.110	0.8592
Titratable acidity, %	0.05	0.05	0.05	0.05	0.05	$\hat{Y}$ = 0.05	0.001	0.9702
pH	6.45	6.60	6.60	6.61	6.65	$\hat{Y}$ = 6.58	0.035	0.1592
Texture, Kg	0.41	0.47	0.60	0.50	0.35	$\hat{Y}$ = 0.47	0.042	0.5869
[3]Wa	0.94	0.94	1.02	0.95	0.95	$\hat{Y}$ = 0.96	0.016	0.3430
[4]GY, $kg\ kg^{-1}$	2.95	2.90	2.88	2.89	2.89	$\hat{Y}$ = 2.90	0.012	0.9986
[5]YA, $kg\ kg^{-1}$	1.86	1.80	1.80	1.79	1.81	$\hat{Y}$ = 1.81	0.013	0.9940

*Significantly different from the control by Dunnett's test. [1]Total Solid Content, [2]Fixed Mineral Residue, [3]Water activity, [4]Gross yield, [5]Yield adjusted for moisture of the cheese.

Regarding the moisture of the cheeses, the results are consistent with current legislation that classifies the Minas Frescal cheese as very high moisture, that is, moisture of not less than 55%. It was observed an average value of 64.47% moisture for the cheeses obtained in this study (Table 3). Total dry extract was 35.53%, on average. Martins et al. (2012) registered an average value of 43% TSC in the Minas Frescal cheese of cows fed different forage foods.

There was no influence of the diets on the crude protein of cheese (Table 3). The Minas cheese protein can vary up to 40%, proving that the cheeses produced in this study are within the norms of identity and quality of cheeses in Brazil.

The inclusion of banana peel in the diet for cows did not influence the fat content of cheese (Table 3). The cheeses produced in this study were classified as semi-fatty, as they have between 25 and 44.9% fat in the total dry extract and, therefore, are within the standards required by current legislation.

The studied diets confer, on average, 8.33% fixed mineral residue in the TSC of the Minas Frescal cheeses. On the other hand, Martins et al. (2012) verified an average of 5.57% when evaluated different forages in the diet of crossbred dairy cows and Alves, Gemal, Cortez, Franco, and Mano (2011) recorded an average of 4.1% ash in Minas Frescal cheese.

Figueiredo et al. (2015) evaluated characteristics of the artisanal Minas Frescal cheese in different months of the year and reported pH values, ranging from 4.69 to 5.31, thus below those reported in this experiment. Conversely, Andreatta et al. (2009), who followed the same industrial process of this experiment, found average values ranging from 6.67 to 6.74, when evaluated cheeses from milk with different concentrations of somatic cells, which are consistent with the results of the present study. The values of titratable acidity, pH, texture and water activity were not influenced by the diets. The high moisture of the cheeses produced corroborates the average value found for water activity (0.96) (Table 3).

The diets did not influence the texture of the Minas Frescal cheese, allowing to assume that the cheese produced with milk of F1 Holstein x Zebu cows fed diets containing increasing levels of sun-dried banana peel is considered soft (Souza et al., 2015) (Table 3).

Gross yield and yield adjusted for the moisture content of Minas Frescal cheese were not influenced by the diets of the cows. Milk composition has a direct influence on the yield, in which the content of fats and proteins are fundamental in this question. Protein content and, more specifically, the ratio between casein and total protein of milk plays a decisive role in yield. Considering the high levels of casein and percentage of casein in relation to the total protein in milk obtained in the present study, it is suggested that they influenced the high yields obtained besides the high moisture content reported for Minas Frescal cheese.

No differences were detected for the acceptance test, using a nine-point hedonic scale. The overall means of the treatments remained close to the score 7 corresponding to 'moderately liked' (Table 4), indicating that the results are satisfactory for the general acceptance test.

The ordering preference test (Table 5) evidenced no preference between the treatments, indicating that the product did not suffer organoleptic changes perceptible to the tasters.

Table 4. Results of the consumer acceptance test in the sensory analysis of the Minas Frescal cheese produced with milk of F1 Holstein x Zebu cows fed increasing levels of banana peel in the diet, with respective mean values, and real values of p.

Variables	Levels of banana peel						
	0	15	30	45	60	Median	Pr > Fc
Aspect	7.17[a]	7.35[a]	7.06[a]	7.13[a]	7.07[a]	7.13	0.6067
Consistence	6.93[a]	6.94[a]	6.66[a]	6.59[a]	6.72[a]	6.72	0.9103
Flavor	6.79[a]	7.21[a]	7.04[a]	6.72[a]	6.89[a]	6.89	0.5139
[1]IG	6.91[a]	7.09[a]	6.96[a]	6.93[a]	6.93[a]	6.93	0.5345
[2]N	150	150	150	150	150	150	-

Mean values followed by different letters, in the same row, are significantly different by Friedman's test ($p < 0.05$). [1]Global Impression, [2]Number of tasters.

Table 5. Result of the ordering preference test of treatments in the sensory analysis of Minas Frescal cheese produced with milk of F1 Holstein x Zebu cows fed increasing levels of banana peel replacing sorghum silage in the diet.

	Levels of banana peel				
	0	15	30	45	60
Sum of orders	282[a]	320[a]	332[a]	290[a]	278[a]
[2]N	100	100	100	100	100

Total values followed by different letters, in the same row, are significantly different ($p < 0.05$) when evaluated the minimum significant difference; [2]Number of tasters.

Conclusion

The replacement of up to 60% sorghum silage with banana peel may be a viable alternative, as brings no changes to the physical and chemical composition of milk and the Minas Frescal cheese, as well as their acceptance by consumers.

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