Perfil sensorial e físico-químico de queijo Minas artesanal produzido na micro-região de Araxá, Brasil

Sensory and physicochemical profile of artisanal Minas cheese produced in the micro-region of Araxá, Brazil

Perfil sensorial y fisicoquímico del queso de Minas artesanal producido en la microrregión de Araxá, Brasil

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Resumo

Este estudo objetivou investigar as características sensoriais típicas dos queijos artesanais produzidos na microrregião de Araxá – MG, por meio da Análise Descritiva Quantitativa (ADQ). O levantamento dos termos descritores da amostra foi realizado por painelistas previamente selecionados. As amostras foram também submetidas ao teste de aceitação sensorial, com provadores não treinados, para analisar os atributos aparência, aroma, textura, sabor e aceitação geral. O teste de aceitação foi realizado em escala hedônica de 9 pontos. A caracterização físico-química dos queijos foi realizada determinando os teores de gordura,

proteína, umidade, cinzas e cloreto de sódio. O perfil de textura também foi obtido por meio de analisador de textura TA.XT2. De acordo com o painel sensorial, os queijos exibiram coloração amarelo palha, com maior tonalidade na casca, alta firmeza e tendência a ser quebradiço, alta umidade, baixa quantidade de olhaduras, aroma característico tendendo a odor forte, sabor com alta acidez, e baixa tendência para o gosto salgado. Os queijos tiveram boa aceitação sensorial pelos provadores não treinados. Houve uma boa relação entre os resultados obtidos para as análises físico–químicas com os já realizados anteriormente na literatura, conseguindo, assim, melhor caracterizar fisicamente e quimicamente o queijo Minas artesanal da região de Araxá. Em relação à análise de textura foram encontrados poucos estudos na literatura que definam o perfil de textura para queijos Minas artesanais o que mostra a importância de encorajarmos mais estudos para melhor investigar as variações do perfil sensorial destes queijos.

Palavras-chave: Queijo minas artesanal; Padrão sensorial; Análises físico-químicas; Análise descritiva quantitativa (ADQ).

Abstract

This study aimed to investigate the typical sensory characteristics of artisanal cheeses produced in the micro-region of Araxá - MG through Quantitative Descriptive Analysis (QDA) since there are few studies on the sensory profile of this type of cheese. The survey of the sample descriptors was carried out by previously selected panelists. The samples were subjected to a sensory acceptance test with untrained panelists to analyze the attributes appearance, aroma, texture, flavor, and overall acceptance. The acceptance test was carried out using a 9-point hedonic scale. The physicochemical characterization of the cheeses was also performed by the determination of fat content, protein, moisture, ash, and sodium chloride levels, as well as the texture profile analysis, using a TA.XT2 texture analyzer. According to the sensory panel, the cheeses exhibited pale-yellow color, which was more prominent in the rind, great firmness, and a tendency to brittleness, high moisture, low number of eyes, characteristic aroma tending to strong odor, excessive acid taste, and low salty taste. The cheeses had good sensory acceptance by the untrained panelists. The physicochemical results corroborated those found in the literature. Regarding the texture profile, few studies have assessed of artisanal Minas cheese, thus further studies should be encouraged to better investigate the changes in the texture profile of the cheeses.

Keywords: Artisanal minas cheese; Sensory pattern; Physicochemical analyses; Quantitative descriptive analysis (QDA).

Resumen

Este estudio tuvo como objetivo investigar las características sensoriales típicas de los quesos artesanales producidos en la microrregión de Araxá - MG, a través del Análisis Descriptivo Cuantitativo (ADQ). La encuesta de los términos descriptivos de la muestra fue realizada por panelistas previamente seleccionados. Las muestras también fueron sometidas a la prueba de aceptación sensorial, con panelists no entrenados, para analizar los atributos apariencia, aroma, textura, sabor y aceptación general. La prueba de aceptación se realizó en una escala hedónica de 9 puntos. La caracterización físico-química de los quesos se realizó determinando los niveles de grasa, proteína, humedad, cenizas y cloruro de sodio. El perfil de textura también se obtuvo usando un analizador de textura TA.XT2. De acuerdo al panel sensorial, los quesos mostraron color amarillo pajizo, con mayor tonalidad en la corteza, alta firmeza y tendencia a ser quebradizos, alta humedad, baja cantidad de apariencia, aroma característico que tiende a un olor fuerte, sabor con alta acidez y baja tendencia hacia el sabor salado. Los quesos tuvieron una buena aceptación sensorial por parte de los catadores inexpertos. Hubo buena relación entre los resultados obtenidos para los análisis físico-químicos con los ya realizados en la literatura. En cuanto al análisis de textura, se han encontrado pocos estudios en la literatura que definan el perfil de textura del queso artesanal de Minas, lo que demuestra la importancia de impulsar más estudios para investigar mejor las variaciones en el perfil de textura de estos quesos.

Palabras clave: Queso de minas artesanal; Patrón sensorial; Análisis físico-químico; Análisis descriptivo cuantitativo (ADC).

1. Introduction

Artisanal cheeses have been positioned as a diet food for decades due to their nutritional benefits and sensory characteristics. Scientific interest in artisanal cheese also is growing because it represents a source of bacteria with potential health benefits (De la Rosa-Alcaraz, 2020).

The Minas artisanal cheeses are produced only on farms from certified regions, using whole raw milk and endogenous culture starter for its production (Luiz et al., 2017). They represents historical and cultural tradition of the region where it is produced. Minas Gerais stands out as the largest and most important producer of artisanal cheeses in Brazil. Among the 30,000 artisanal cheese producers in the state, about 9,000 belong to the seven traditionally recognized regions (Araxá, Campo das Vertentes, Canastra, Cerrado, Serra do

Salitre, Serro, and Triângulo Mineiro), with an average annual production of 50 thousand tons (Emater, 2018).

Cheese quality depends on several factors, including the manufacturing process, the origin of the raw materials, the total solids of milk, animal breed, and diet, among others. The aroma, flavor, and texture of the cheeses depend on the milk used in the process, the manufacturing process, and the ripening conditions. The ripening time varies with the type of cheese and the region where it is produced, and it is responsible for the sensory and texture characteristics of the cheeses (Perry, 2004).

The sensory evaluation allows assessing various parameters such as appearance, odor, flavor, texture, and consistency, which defines the quality and acceptance of the final product (Meilgaard, Civille & Carr, 2016). The sensory quality and homogeneity of product can be key for the development of an identity of artisanal cheeses from different regions (Ramírez-Rivera et al., 2018).

In this context, the study aimed to investigate the sensory characteristics of artisanal cheeses produced in the micro-region of Araxá, Mina Gerais, Brazil through the Quantitative Descriptive Analysis (QDA). The relevance of the study is the lack of studies in the literature on the sensory profile of artisanal Minas cheese from this region, once cheeses from other producing regions of Minas Gerais have been already characterized for their sensory profile.

2. Materials and Methods

Commercial samples from three different brands of artisanal Minas cheese, produced in the micro-region of Araxá –MG, were acquired in the market of the city of Uberaba - MG. Producers from different cities: Araxá, Campos Altos, and Ibiá were selected to better represent the micro-region under study. The cheeses met the requirements of Brazilian legislation on a minimum ripening period of 14 days.

2.1 Quantitative Descriptive Analysis (QDA)

The samples were subjected to QDA according to Meilgaard, Civille, and Carr (2016). A pre-selection of panelists was carried out with 60 individuals to select 20 individuals to participate in the tests. The 20 pre-selected panelists were subjected to two more selection tests. The first was a blind test that consisted of correctly identifying the odor of the samples. The participants that correctly identified at least 7 of the 10 samples were approved to

participate in the second step. The second step consisted of a triangular test, with 6 repetitions, in which the participants had to sort at least 4 repetitions. Finally, 15 individuals were selected to participate in the group.

QDA was carried out in two sessions. In the first session, two samples of artisanal Minas cheese were evaluated individually and the participants were asked to describe the differences and similarities between the samples. In the second session, the descriptors defined in the first meeting were used to determine the extremes of the sensory scale to define the intensity and characterize the samples. An unstructured linear scale of 9 cm was used.

Three training sessions were carried out, using the answer sheet elaborated according to the group consensus using the three artisanal Minas cheese samples. The results were subjected to analysis of variance (ANOVA) and those with p-value < 0.05 were eliminated from the test. Ten panelists were finally selected for the quantitative descriptive analysis.

Artisanal Minas cheese samples from the Araxá micro-region were analyzed in three replications. After the end of the sensory test, the vertical line marked by the panelist in the answer sheet was converted into a score, by measuring it in centimeters, which corresponded to the perception of each attribute evaluated.

2.2 Sensory acceptance test

For the sensory acceptance test, 66 cheese consumers were recruited. The acceptance test was carried out using a 9-point hedonic scale (Meilgaard, Civille & Carr, 2016). The attributes flavor, color, texture, aroma, and overall acceptance were evaluated.

2.3 Physicochemical characterization

Cheeses were evaluated for pH, moisture, ash, total nitrogen (AOAC, 1995), fat by the Gerber method (British Standards Institution, 1989) and sodium chloride (Castanheira, 2010). All analyses were performed in triplicate.

2.4 Texture profile analysis

The texture profile analysis (TPA) was performed using a TA.XT2 texture analyzer (Stable Micro System, Hasleme, England) and a 35 mm diameter cylindrical aluminum probe (P35). The parameters evaluated were hardness, adhesiveness, cohesiveness, springiness, and

chewiness. The sample preparation was performed according to Mazal et al. (2007). Five cylindrical samples (2 cm in diameter x 2.4 cm height) were maintained under refrigerated conditions (~10ºC) before analysis. The analysis conditions were: pre-test, test, and post-test speeds of 1 mm/s, compression of 10 mm, and contact force of 5 g.

2.5 Statistical analysis

The results were analyzed by analysis of variance (ANOVA) and Tukey's test at a level of 5% significance (Action Stat Pro statistical system- http://www.portalaction.com.br/action-stat-pro).

3. Results and Discussion

3.1 Sensory evaluation (QDA)

A sensory form was developed by the panelists during the QDA to determine the sensory attributes that describe the artisanal Minas cheese. Ten attributes were selected, namely: yellow color, number of eyes, color of the grid, cheese flavor, milk aroma, firmness, moisture, softness, salty taste, and acidity. Each attribute was analyzed in three sessions, and the final sensory panel was made up of eight panelists.

Table 1 shows the mean sensory scores. The lowest average was observed for the attribute number of eyes, in the Cheese 2 (2.8) and the highest average was obtained for the attribute firmness, in Cheese 3 (6.2).

Table 1 - Average sensory scores of the cheese attributes.

|	Cheese 1	Cheese 2	Cheese 3
Yellow color	2.9 ± 1.5^{b}	5.4 ± 1.1^{a}	3.9 ± 1.9^{b}
Number of eyes	3.9 ± 1.7^{b}	2.8 ± 1.6^{b}	5.1 ± 1.7^{a}
Color of the rind	5.0 ± 2.0^{ab}	5.8 ± 0.9^{a}	4.1 ± 2.2^{b}
Cheese flavor	4.1 ± 1.8^{a}	5.0 ± 1.8^{a}	5.0 ± 1.6^{a}
Milk aroma	4.4 ± 1.9^{a}	4.4 ± 1.5^{a}	5.3 ± 1.6^{a}
Firmness	5.2 ± 2.0^{ab}	4.9 ± 1.4^{b}	6.2 ± 1.6^{a}
Moisture	4.0 ± 2.0^{a}	4.4 ± 1.5^{a}	4.0 ± 2.2^{a}
Softness	5.0 ± 1.9^{a}	4.7 ± 1.6^{a}	4.4 ± 2.0^{a}
Salty taste	4.1 ± 2.0^{a}	3.6 ± 2.0^{a}	4.4 ± 1.8^{a}
Acidity	4.8 ± 1.4^{a}	5.2 ± 1.8^{a}	5.3 ± 1.8^{a}

[a, b]Different letters on the same line were statistically different by the Tukey's test ($p < 0.05$). Source: Authors.

No significant differences were observed in six of ten attributes studied (cheese flavor, milk aroma, moisture, softness, salty taste, and acidity), while Cheese 2 was significantly different from the other samples for the attribute yellow color. A similar result was observed in the attribute number of eyes, once Cheese 3 differed statistically from Cheese 1 and Cheese 2. For the attribute color of the rind, significant differences were observed between Cheese 2 and Cheese 3, with no differences from Cheese 1, which was also observed for the attribute.

As the application of dyes in this cheese is not allowed, it is believed that the variation in the yellow color intensity of the cheeses studied as well as the variation in the color of the rind of these cheeses is linked to the ripening time or period of the year that the cheeses were produced. One of the two main causes for the appearance of cheeses is the presence of contaminating microorganisms in the raw material, and/or "*pingo*" (fermented whey collected from the cheese production on the previous day), that is, due to hygiene failures during cheese making. The second main cause is the cutting of the curd into very large and irregular grains, resulting in whey retention and with manual pressing the curd of cheese does not compact, forming mechanical eyes on the periphery and interior of the cheese (Furtado, 2011).

The sensory profile of the cheeses of this study is shown in Figure 1.

Figure 1 - Graphical representation of the results of the Quantitative Descriptive Analysis of the cheese samples.
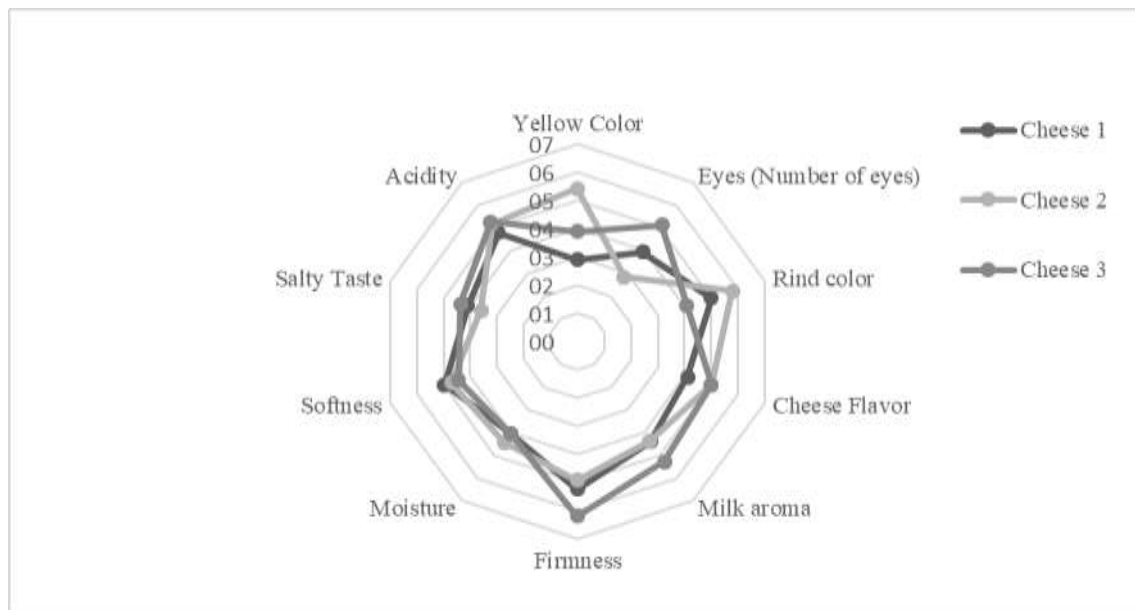
Source: Authors.

As can be seen in Figure 1, all cheeses exhibited a similar sensory profile, which is a satisfactory result, as it shows standardization of the cheeses from the Araxá micro-region, even though they were produced in different municipalities. Due to the similarity observed, it seems that these cheeses were at the same ripening intensity when they were purchased at the sales points, as apparently the cheeses were not in a very advanced ripening stage.

According to the results of QDA, the cheeses were straw-yellow, which was more prominent in the rind, with higher firmness and tendency to brittleness, high moisture, low number of eyes, and characteristic aroma tending to a strong odor, high acidity, with a tendency to be smooth and low salty taste.

Rezende (2014) used the MQDA method (modified quantitative descriptive analysis) to characterize the artisanal Minas cheese from Campo das Vertentes and reported a high coefficient of variation for all sensory attributes, such as overall appearance, straw-yellow color, and open texture due to the high bacteria counts, as well as strong aroma, and flavor masked by the excess of salt, which was highlighted by the panelists.

Arantes et al. (2019) also used multiple factor analysis (MFA) to study the sensory profile of artisanal Minas cheese from the micro-region of Araxá, purchased in the cities of Araxá, Ibiá, and Sacramento. The authors reported that the samples were strongly associated with the sensory attributes soft, light yellow color, brittleness, salty taste, and acid taste, with

no association with the atributes pale yellow rind, buttery flavor, creamy texture, bitter taste, and sweet taste.

When comparing the two studies on artisanal Minas cheese from the Araxá micro-region, we can state that both methods have achieved similar results, thus providing a better perception of the sensory profile of the cheeses from this region.

3.2 Sensory acceptance

The results of the sensory acceptance with untrained consumers of cheese are shown in Table 2.

Table 2 - Average scores of the sensory acceptance test.

	Cheese 1	Cheese 2	Cheese 3
Appearance	7.0 ± 1.4^b	8.2 ± 0.8^a	7.8 ± 1.2^a
Aroma	6.4 ± 2.0^b	7.4 ± 1.5^a	6.9 ± 1.5^{ab}
Flavor	5.7 ± 2.0^b	8.3 ± 0.9^a	5.9 ± 2.4^b
Texture	6.5 ± 1.6^b	8.2 ± 0.8^a	7.0 ± 1.6^b
Overall acceptance	5.9 ± 1.8^b	8.1 ± 0.8^a	6.4 ± 1.7^b

[a, b]Different letters on the same line indicate statistically different means by the `s test ($p < 0.05$). Structured hedonic scale of nine points (1 = disliked extremely, 2 = disliked very much, 3 = disliked moderately, 4 = disliked slightly, 5 = neither liked nor disliked, 6 = liked slightly, 7 = liked moderately, 8 = liked very much and 9 = liked extremely). Source: Authors.

Cheese 2 was different from Cheese 1 for all the attributes studied. No differences were observed between Cheese 3 and Cheese 2 for the attributes appearance and aroma and between Cheese 3 and Cheese 1 for aroma, flavor, texture, and overall acceptance. The sensory scores ranged from neither liked nor disliked (5) and liked very much (8) for all attributes, and appearance was the attribute most appreciated by the participants.

Cheese 2 was the most accepted since it obtained the highest scores for all attributes studied, followed by Cheese 3 and Cheese 1.

The greater acceptance of Cheese 2 may be associated with the attributes yellow color, presence of eyes, and color of the rind, once significant differences were observed for these attributes in the QDA of the samples. In addition, Cheese 2 presented a more prominent yellow color and color of the rind, and a lower number of eyes when compared to the other samples, which may have contributed to its greater sensory acceptance.

According to Dutcosky (2013), for an attribute to be accepted, more than 50% of the scores for that attribute must be equal to or greater than 6 (I slightly liked it). Considering these factors, Figure 2 shows the scores equal to or greater than 6 given by the panelists in the sensory evaluation of the cheeses.

Figure 2 - Acceptance scores for the sensory attributes of the cheeses.
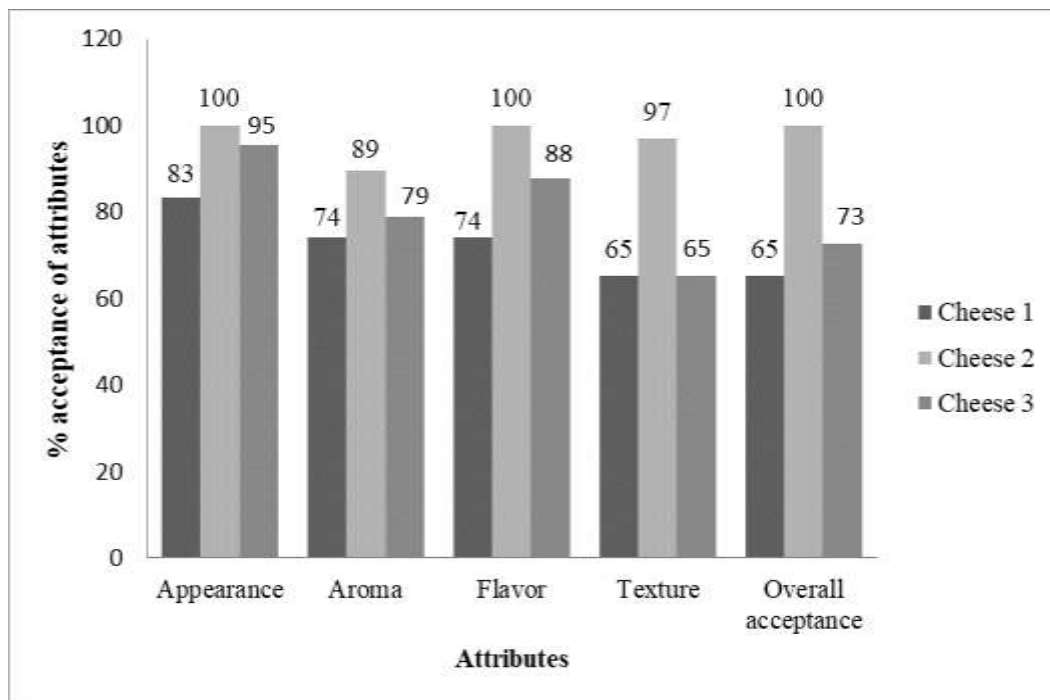
Source: Authors.

As shown in Figure 2, all cheeses presented the minimum scores required for a sample to be considered acceptable. As reported by Dutcosky (2013), to be well accepted in the consumer market, a product must present an acceptance index above 70%. The Figure 2 shows that Cheese 1 and Cheese 3 did not reach the minimum percentage for the attribute flavor to be considered acceptable in the consumer market, which was observed for Cheese 1 for the overall impression.

These results were expected, once the consumer has a habit of consuming fresh cheeses rather than ripened cheeses. In addition, despite the centuries-old tradition of cheese, it is little consumed alone, being more used as an ingredient in several dishes (Rezende, 2014).

The other attributes were accepted by more than 72% of the participants, therefore with good overall acceptance.

Rezende (2014) reported scores similar to this study for artisanal Minas cheese from the Campo das Vertentes micro-region, from different ripening periods. Cheeses with 10 days of ripening had better acceptance scores, ranging from moderately liked (7) to liked very much (8) on the hedonic scale, while cheeses with 20 and 30 days of ripening did not differ from each other ($p > 0.05$), with scores of slightly liked (6)

Fernandes (2018) compared artisanal Minas cheese from the Campo das Vertentes micro-region with cheeses produced in industrial scale using pasteurized milk. The author reported no statistical difference in the acceptance tests between artisanal and industrial treatments, with a significant difference observed between the ripening times of each treatment. In this study, the scores varied on the hedonic scale from "7 - liked moderately" to "8 - liked very much" at 20, 40, and 60 days of ripening, and the ripening period of 20 days received the best scores.

3.3 Physicochemical characterization

The results of the physicochemical characterization of the cheeses are shown in Table 3.

Table 3 - Physicochemical characteristics of the cheeses.

	Cheese 1	Cheese 2	Cheese 3
pH	4.63 ± 0.04^b	4.81 ± 0.02^a	4.82 ± 0.05^a
Moisture (%)	54.8 ± 0.6^a	53.9 ± 0.2^b	55.7 ± 0.3^a
Fat (%)	27.8 ± 1.4^a	27.0 ± 2.3^a	28.8 ± 2.8^a
Crude protein (%)	23.7 ± 0.6^a	22.7 ± 0.8^a	23.1 ± 0.3^a
Ash (%)	3.01 ± 0.05^c	3.69 ± 0.04^a	3.33 ± 0.14^b
NaCl (%)	0.93 ± 0.09^b	1.30 ± 0.03^a	0.99 ± 0.06^b

[a, b]Different letters on the same line indicate statistically different means by the Tukey's test ($p < 0.05$). Crude protein = total nitrogen x 6.38. Source: Authors.

No significant differences were observed for fat and protein contents among the cheeses. Araújo (2004) obtained similar fat values for artisanal Minas cheese from the Araxá micro-region, which varied from 23 to 35%. In contrast, Sales (2015) investigated the physicochemical parameters of artisanal Minas cheese from the Araxá micro-region, and reported a mean protein level of 24.67% in the rainy season, within 14 days of ripening, which was similar to those found in this study.

Significant differences were observed for the ash contents of the cheeses, which was also observed by Vale (2018), who studied the effect of the type of culture on the

characteristics of artisanal Minas cheese from the Serro region ripened under controlled conditions. The author reported an average of 3.24% ash in the cheeses produced with the use of "*pingo*", with no changes during the ripening period.

Regarding the moisture levels, only Cheese 2 differed statistically from Cheese 1 and Cheese 3. According to the Brazilian legislation (IMA), artisanal Minas cheese should have a moisture content of less than 45.9% (Minas Gerais, 2008), thus the samples of this study are outside the standard established by law. These results were in accordance with the sensory data (QDA), once the panelists reported higher moisture levels in all cheeses, with scores of 4.0, 4.4, and 4.0 for Cheese 1, Cheese 2, and Cheese 3, respectively.

Silva, Tunes and Cunha (2012) carried out a physicochemical evaluation of fresh and ripened artisanal Minas cheese in the city of Uberaba - MG, and reported moisture content of 47.24% in the fresh cheese, which is higher than the levels required by the Brazilian legislation.

Araújo (2004) also studied the physicochemical parameters of artisanal Minas cheese from the Araxá micro-region, and reported moisture values from 39 to 49.5%, with an estimated average of 45.05%, which is in accordance with the legislation, which classifies the cheese as a medium-moisture cheese.

These differences demonstrate a lack of standardization in the cheese production processes. Several factors contribute to the change in the moisture of the cheeses, such as coagulation temperature, amount of coagulating agent, cutting, stirring, salting steps, and ripening conditions (Araújo, 2004), which can explain the moisture contents observed for the cheeses from the Araxá micro-region.

Regarding the pH, a significant difference was observed only for Cheese 1 when compared with Cheese 2 and Cheese 3, with pH values of 4.81, 4.81, and 4.82, respectively. This result is consistent with those of the quantitative descriptive analysis (QDA), once the average scores for the attribute acidity classified Cheese 1 as a high-acid cheese. The average pH value of these samples was 4.75, which may have increased the perceived acidity by the panelists.

On the other hand, Sudre (2018) obtained an average pH value of 5.24 in artisanal Minas cheese from Serro, demonstrating that the location of the manufacturing process interferes with the pH value of the product.

Regarding the sodium chloride levels, a significant difference was observed only for Cheese 2 when compared with the other cheeses, which was the most accepted cheese in the sensory tests.

In the results of QDA, the attribute salty taste obtained scores slightly below the average of the scale used, with no statistical difference between the results, with scores of 4.1, 3.6 and 4.36 for Cheese 1, Cheese 2, and Cheese 3, respectively. Thus, panelists did not report the artisanal Minas cheese from the micro-region of Araxá as being a very salty cheese. The results of QDA corroborated those found in the physicochemical analyses, once the samples presented on average 1.07% salt content, which is considered low value. The salt content (w/w) of cheese varies from 0.7% to 6% depending on the type of cheese, and cheeses with NaCl levels above 2.61% (w/w) are considered to have a high salt level (Moreno, 2013). Vale (2018) reported higher sodium chloride levels than those found in this study for artisanal Minas cheese from Serro, with an average value of 1.41% NaCl.

3.4 Texture profile

The results of the texture profile analysis of the cheeses are presented in Table 4.

Table 4 - Texture profile of cheeses.

	Cheese 1	Cheese 2	Cheese 3
Hardness (N)	64.2 ± 15.3^b	81.2 ± 5.6^a	81.8 ± 6.1^a
Adhesiveness (g.s)	151.4 ± 115.3^a	146.9 ± 55.1^a	246.8 ± 56.4^a
Springiness (mm)	6.30 ± 1.28^a	7.38 ± 0.28^a	4.62 ± 0.79^b
Cohesiveness	0.217 ± 0.037^b	0.518 ± 0.070^a	0.178 ± 0.031^b
Chewiness	941.3 ± 499.9^b	3188.5 ± 671.5^a	685.2 ± 158.2^b

[a, b]Different letters on the same line indicate statistically different means by the Tukey's test ($p < 0.05$). Source: Authors.

A significant difference was observed only for the parameter adhesiveness of the cheeses. Viana (2014) evaluated the shelf life of mozzarella pizza cheese, and obtained results similar to this study, with values of 142.16 and 220.18 g.s, at 60 and 120 days of storage, respectively.

Significant differences were observed between the samples for all the other texture parameters. Concerning the parameter hardness, a significant difference was observed only for Cheese 1, when compared to the other samples.

Fernandes (2018) compared artisanal Minas cheese from the Campo das Vertentes micro-region with cheeses produced in an industrial scale using pasteurized milk, and found no statistical difference in hardness, with differences only in the ripening time. The author

reported the highest hardness values of 18.156 N and 11.202 N for the industrial cheese and artisanal cheese, respectively, within 60 days of ripening, which was lower than those found in this study.

Concerning the springiness, differences were observed (p> 0.05) for Cheese 3 when compared to the other samples. Sobral et al. (2019) obtained springiness values similar to those of this study. After 15 days of ripening, values around 6 mm were obtained, which a decrease throughout the storage, and an increase at the end of the ripening period (after 60 days). This phenomenon may be due to proteolysis, responsible for the springiness, texture, and formation of compounds that characterize the flavor and aroma of cheese (Fox et al., 2004).

For the parameter cohesiveness, a significant difference was observed for Cheese 2 when compared to Cheese 1 and Cheese 3.

Fernandes (2018) compared artisanal Minas cheese from the Campo das Vertentes micro-region with cheese produced in an industrial scale using pasteurized milk and obtained a cohesiveness value of 0.507 in artisanal cheeses with 20 days of ripening, similar to those found in this study. In addition, the author reported a reduction in cohesiveness during ripening, probably due to the moisture loss in the cheeses over time.

Concerning the chewiness of the cheeses, a significant difference was observed for Cheese 2 when compared to Cheese 1 and Cheese 3. Viana (2014) found higher chewiness values in mozzarella pizza cheese when compared with this study, with values of 1188.65 and 1590.8 at 0 and 60 days of storage, respectively, with a decrease after 90 days of storage (1290.97). According to the author, the initial increase, up to 30 days, and the reduction during the storage, was due to the increase in proteolysis over time.

4. Conclusion

The QDA was effective to characterize and establish the sensory profile of artisanal cheeses from the micro-region of Araxá. The cheeses were characterized as straw yellow, which was more evident in the rind, high firmness, and a tendency to brittleness. Despite its high firmness, the cheeses presented high moisture contents, with a low number of eyes. The cheeses exhibited strong characteristic aroma, high acid taste, and low salty taste. In general, the products had good sensory acceptance by the untrained consumers.

The physicochemical results were similar to those reported in the literature, which allowed for a better physicochemical characterization of artisanal Minas cheese from the

Araxá micro-region. Although the texture profile of the cheeses has been evaluated, the comparison of the results with other cheeses is not possible, due to the different manufacturing practices that directly affect the texture of the cheeses. Therefore, further studies should be encouraged to better investigate variations in the sensory profile of cheeses from this region.

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