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Effect of *Palmito* cheese processing on sensory characteristics and degree of liking[1]

Efecto del procesamiento del queso *Palmito* sobre sus características sensoriales y nivel de agrado

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Abstract

Introduction. The production of regional food with local and cultural identity has become an attractive business for small-scale producers because it allows them to market their products highlighting local ingredients and traditional processing that reflects the know-how of each region. One example is *Pasta filata* cheese. **Objective.** To identify sensory characteristics and level of liking for Costa Rican *Pasta filata* cheeses (*Palmito* cheese). **Materials and methods.** The project was carried out at the facilities of the University of Costa Rica, during 2015. Nineteen samples of Costa Rican *Palmito* cheese were used, with fourteen of them being produced by artisanal producers and five by industrial producers. The methodology of Generic Quantitative Descriptive Analysis (QDA) was followed, with ten trained judges defining twenty-one attributes. Agglomerative Hierarchical Clustering (AHC) and Principal Component Analysis (PCA) were conducted to relate the samples to their attributes. Acceptance testing was performed with one hundred consumers. Consumer AHC and external preference mapping were applied to correlate the results of the liking with those of the QDA. **Results.** Significant differences ($p<0,05$) among samples were obtained in the QDA for all attributes. The samples were grouped into three clusters based on similarity attributes. The PCA showed one group, primarily consisting of traditional cheeses, clustered by attributes such as acid and salty flavor, firmness, moisture, and stringy appearance. Another group, corresponding to refrigerated, pasteurized, and unpasteurized cheeses, had a higher intensity of yellow color, greasy texture, softness, and less stringy appearance. A final group, composed of one sample, had a lettuce flavor. **Conclusion.** Through the external preference mapping, it was concluded that consumers like the majority of industrial *Palmito* cheeses, but they prefer traditional ones with characteristics such as stringy and creamy flavor.

Keywords: traditional foods, dairy products, food acceptability.

Resumen

Introducción. La producción de alimentos regionales con identidad local y cultural se ha convertido en un negocio atractivo para los pequeños productores, porque permite que se comercialicen resaltando los ingredientes locales y el procesamiento tradicional que refleja el *know-how* de cada región. El queso de pasta hilada es un ejemplo. **Objetivo.** Identificar las características sensoriales y el nivel de agrado de quesos de *pasta hilada* costarricense (*Palmito*). **Materiales y métodos.** El proyecto se desarrolló en las instalaciones de la Universidad de Costa Rica, durante el 2015. Se utilizaron diecinueve muestras de queso *Palmito* costarricense. Catorce de ellas fueron fabricadas por productores artesanales y cinco por industriales. Se siguió la metodología de análisis descriptivo cuantitativo genérico (QDA) con diez jueces capacitados, que definieron veintiún atributos. Se realizó un análisis de clústeres (AHC) y análisis de componentes principales (PCA) para relacionar las muestras con sus atributos. La prueba de aceptación se realizó con cien consumidores. Se aplicaron técnicas de AHC del consumidor y mapeo preferencial externo para correlacionar los resultados de agrado con los obtenidos en el QDA. **Resultados.** Se obtuvieron diferencias significativas ($p<0,05$) entre muestras en el QDA para todos los atributos. Las muestras se agruparon en tres grupos de acuerdo con la similitud de su atributo. El PCA mostró un grupo, principalmente con quesos tradicionales, agrupados por sabor ácido, salado, firmeza, humedad y apariencia hilada, mientras que otro grupo, correspondiente a quesos almacenados en refrigeración, pasteurizados y sin pasteurizar, tuvieron una mayor intensidad de color amarillo, textura grasienta, suavidad y menor apariencia hilada. Un último grupo, compuesto por una muestra, presentó sabor a lechuga. **Conclusión.** Se concluyó, a través del mapeo preferencial externo, que a los consumidores les gusta la mayoría de los quesos *Palmito* industriales, pero prefieren los tradicionales con características como apariencia hilada y sabor cremoso.

Palabras clave: alimentos tradicionales, productos lácteos, aceptabilidad de los alimentos.

Introduction

Traditional food consumption is a continuous growth market segment. Products manufactured in a given geographical area and produced according to traditional methods, represent strong elements which generate a highly-regarded product by consumers (Fernández-Ferrín et al., 2018). European markets have been supported of the traditional food by policies. Such policies promote standards for a designation under different collective trademarks like Protected Designation Origin (PDO), Protected Geographical Indication (PGI), or Traditional Specialties Guaranteed (TSG) (Dias & Mendes, 2018).

The consumer demand for traditional food derives from opposition to globalization and industrialization in food production and from ethnocentrism movement (Seitz & Roosen, 2015). According to Black (2016) globalization and food industrialization changed the structure of the processing and distribution systems, which has affected many local producers not only because of their inability to compete with large companies, but also due to the technological and financial differences with industries (Black, 2016).

As a solution for the issues of globalization, regional food systems respond to the needs of the ethnocentric consumers, those who prefer to purchase products with a domestic origin from those that are foreign or imported; in order to support the national (or regional) economy, to promote job opportunities and to obtain a product with added value that represents the region in which it is produced (Fernández-Ferrín et al., 2018; Lee et al., 2016).

Food market in Latin America has become more responsive to social norms and values of society. Consumption of regional products, such as coffee, cocoa, cheese, corn, honey and alcoholic beverages, has increased along with the use of collective trademarks (Organization for Economic Co-operation and Development [OECD], 2017). One

of the fastest growing markets in Latin America is dairy, representing around 11% of worldwide milk production (Fariña et al., 2020). Cheese, fluid and powder milk, and yogurt represents the main dairy sale products in the region (De Groot, 2018). Most cheeses consumed in Latin America are produced through rural agribusinesses, therefore this activity represents a high economic impact for small producers (OECD & Food and Agriculture Organization [FAO], 2019).

One of the most popular family of cheeses in Latin America is *pasta filata*. Fresh mozzarella italian cheese is the principal exponent of this family. Its artisan processing is similar to the traditional Oaxaca Mexican cheese, Colombian *Momposino* cheese, *Quesillo* cheese in Nicaragua and Argentina, and the *"arrollado"* cheese, also known as *Palmito*, in Costa Rica (Fuentes et al., 2015; Jimenez-Maroto et al., 2016). Traditional *pasta filata* cheeses in Latin America are associated with handmade products, with a process guided by a cheesemaker, that uses traditional recipes, raw milk, acid whey as a starter and manual kneading of the cheese, which reflects the culture and the know-how of each region (Castro-Castillo et al., 2013).

Variety among processes and the complex structure of cheeses influence sensory characteristics. Even within the same variety of cheese, if steps in the process and storage conditions change, final attributes will be affected (Enab et al., 2012). In Costa Rica there is a lack of information about sensory profile for traditional cheeses. *Palmito* cheese is produced throughout the national territory. For this study, artisan samples were obtained from the area were traditional process of this cheese originated, which may be a limitation of the study.

The objective of this study was to identify the distinguishing sensory features and their impact on the degree of liking of Costa Rican *pasta filata* cheeses (*Palmito* cheese).

Materials and methods

Experimental period and project location

The experimental period of the project was carried out during 2015. The characterization of the *Palmito* cheese process was carried out in Alajuela, Costa Rica. Descriptive analysis and consumer tests took place at the Sensory Analysis Laboratory of the Food Technology Department, University of Costa Rica, San José, Costa Rica.

Samples

Nineteen samples of *Palmito* cheese were used for this study. Fourteen of them were manufactured by artisan producers in San Carlos, Alajuela, and the other five samples were produced by industries in Costa Rica. The artisan cheeses were selected according to: 1) interest and willingness of the producer to participate in the research, 2) ease of communication and logistic to obtain the samples, and 3) cheese volume production. The mapping of artisan producers in San Carlos was carried out through work field. Industrial cheeses were selected according to availability in the market. *Palmito* cheeses processed by artisan producers were coded with letters "QP" and industrial *Palmito* cheeses were coded as "C".

For trained panel and consumer panel, cheeses were presented unrolled, cut into 5 cm long and served over identical and odorless white porcelain plates. Samples were stored at refrigeration temperature (5 °C) and then allowed to warm to room temperature 15 min. before served (Papetti & Carelli, 2013). In both sensory experiments, the samples were codified with random three-digit numbers and balances to avoid position errors.

Palmito cheese process characterization

Cheese process characterization was obtained through field work, product labels and interviews with producers to identify the main differences among process stages. The obtained information was systematized in a matrix that grouped cheeses according to their similarities.

Descriptive analysis

A panel of ten judges (seven women and three men) with ages from 23 to 30 years old was assembled for this study. Judges were university students and professors who were highly motivated to participate. Generic quantitative descriptive analysis was used to develop the language and methodology for the evaluation of *Palmito* cheese. Twenty-four sessions were intended for the training phase (language development, concept alignment, agreement and reproducibility) and a total of fifteen sessions for the final evaluation stage. Standards applied to define the sensory descriptors were used only for training; these references were not allowed at the evaluation sessions.

Palmito cheeses were evaluated by triplicate, with four samples per one-hour session, four times per week. Rinsing of palate between samples was required, water was provided for this purpose. For sample evaluation, the judges scored each attribute with a continuous unstructured line scale of 10 cm, from low to high intensity. FIZZ software (Biosystemes©) was used to build an automated session and randomize the order of presentation of the samples.

Consumer acceptance test

One hundred consumers evaluated each of the nineteen samples in a randomized and counterbalanced order. All of them were regular consumers of cheese. A ten-point hybrid hedonic scale was used to rate overall acceptability, which consist of a linear ten-point scale with verbal affective labels in the middle and extreme regions, adapted from Villanueva et al. (2005).

Statistical analysis

For descriptive analysis, a three-way analysis of variance (ANOVA) was used to determine significant differences between samples from descriptive analysis. Cheese samples were fixed effect and panelist random effect. If significant difference in means was found ($p<0.05$), Fisher´s LSD multiple mean comparisons were performed. Agglomerative Hierarchical Clustering (AHC) was executed to visualize clustering based on dissimilarity between the samples. Simultaneously, Principal Component Analysis (PCA) was also conducted to correlate attributes with sample clusters.

Agglomerative Hierarchical Clustering (AHC) was performed to determine in which way panelists were grouped according to their liking (Civille & Carr, 2015). Data was analyzed through one-way analysis of variance (ANOVA) for each cluster. If significant differences in means were indicated by the ANOVA ($p<0.05$), Fisher´s LSD multiple mean comparisons were conducted. External preference mapping was performed to correlate the results of descriptive analysis with the results of the acceptance test. Statistical analysis was executed using XLSTAT software (Addinsoft©).

Results

Palmito cheese processing characterization

Three processing stages (heat treatment, acidification and condition of storage) were considered as differentiating factors among Palmito cheese samples. Samples were classified into four categories according to their processing similarities as shown in Table 1.

Table 1. *Palmito* cheese samples classification according to processing similarities. Food Technology Department, University of Costa Rica, San José, Costa Rica. 2015.

Cuadro 1. Clasificación de las muestras de queso *Palmito* según sus similitudes en el procesamiento. Escuela de Tecnología de Alimentos, Universidad de Costa Rica, San José, Costa Rica. 2015.

Category	Sample	Heat Treatment		Acidification			Storage	
		Pasteurized	Non-Pasteurized	Natural fermentation	Use of acid whey	Use of culture	Room temperature water bath	Fridge conditions
A	QP1		X		X		X	
	QP6		X		X		X	
	QP7		X		X		X	
	QP8		X		X		X	
B	QP2		X	X			X	
	QP3		X	X			X	
	QP4		X	X			X	
	QP5		X	X			X	
	QP9		X	X			X	
	QP10		X	X			X	
	QP12		X	X			X	
C	QP11		X	X				X
	QP14		X	X				X
	C4		X			X		X
D	QP13	X			X			X
	C1	X				X		X
	C2	X				X		X
	C3	X				X		X
	C5	X				X		X

Palmito cheeses manufactured by artisan producers were coded with letters "QP" and industrial *Palmito* cheeses were coded as "C". / Quesos *Palmito* elaborados por productores artesanales se codificaron como "QP" y los industriales como "C".
Category A grouped unpasteurized cheeses, which used acid whey as a culture and were stored at room temperature water bath; Category B referred to unpasteurized cheeses, natural fermented, stored at room temperature water bath; Category C incorporated unpasteurized cheeses, natural fermented, stored under fridge conditions; Category D grouped cheeses that were pasteurized, acidified with culture, and stored under fridge conditions. / Categoría A agrupó los quesos no pasteurizados, que utilizaban suero ácido como cultivo y se almacenaban en baño maría a temperatura ambiente; Categoría B se refería a los quesos no pasteurizados, de fermentación natural, almacenados en baño maría a temperatura ambiente; Categoría C incorporó los quesos no pasteurizados, de fermentación natural, almacenados en condiciones de frigorífico; Categoría D agrupaba los quesos pasteurizados, acidificados con cultivo y almacenados en condiciones de frigorífico.

Descriptive analysis

Under consensus of the panelists, seven categories of descriptors were defined in the respective order of evaluation of the samples. As *Palmito* cheese is a *pasta filata* cheese, the trained panelists created a category that encompasses attributes related to yarn. Twenty-one attributes were defined by panel consent and expressed in terms of appearance, aroma, texture (hand and mouth), yarn, taste, and residual taste. Attributes, their definitions and standards are given in Table 2.

Table 2. Sensory attributes, intensity scale and standards used to describe *Palmito* cheese. Food Technology Department, University of Costa Rica, San José, Costa Rica. 2015.

Cuadro 2. Atributos sensoriales, intensidades y definiciones usadas para describir el queso Palmito. Escuela de Tecnología de Alimentos, Universidad de Costa Rica, San José, Costa Rica. 2015.

Attributes	Intensity scale	Definitions/Standards
Yellow color	Pale to dark	Pale: whole milk with 3 % fat. Dark: Gouda cheese.
Creamy aroma	Weak to strong	Weak: skimmed milk with 0 % fat. Strong: diluted sweet cream milk 1:2.
Acid aroma	Weak to strong	Weak: fresh industrial Turrialba cheese. Strong: sour milk.
Lettuce aroma	Weak to strong	Weak: fresh industrial Turrialba cheese. Strong: washed lettuces.
Moist	Low to high	cheese is touched and pressed with the index finger and the thumb; then rub both fingers. Low: bond paper. High: fresh industrial Turrialba cheese.
Greasy	Low to high	Cheese is touched and pressed with the index finger and the thumb; then rub both fingers. Low: bond paper. High: cold butter.
Firmness	Soft to firm	Cheese is touched and pressed with the index finger Soft: tortilla dough. Firm: “Havaiana” beach sandal.
Easiness to tear	Easy to hard	Easy: to cut overcooked cannelloni with the fingers. Hard: to shred a chicken.
Yarn-like appearance	Low to high	Rip the cheese from the center and pull it to the sides. Low: Gouda cheese. High: shredded chicken.
Elasticity	Low to high	Ability to stretch twice the yarns of the cheese in a horizontal way, and to recover to the initial state. Low: shredded chicken. High: gummy worm
Hardness	Soft to hard	Chewing the cheese five times with the molars. Soft: Gouda cheese. Hard: overcooked chicken breast
Greasy mouth feel	Low to high	Chewing the *Palmito* cheese. Low: fresh industrial Turrialba cheese. High: Gouda cheese.
Squeaky mouth feel	Low to high	Produces a sound when chewing. Low: Parmesan cheese. High: semi-hard cheese heated 30 seconds on microwave.
Acid taste	Weak to strong	Weak: fresh industrial Turrialba cheese. Strong: sour milk.
Creamy taste	Weak to strong	Weak: skimmed milk with 0% fat. Strong: diluted sweet cream 1:2 (sweet cream: skimmed milk).
Salty taste	Low to high	Low: fresh industrial Turrialba cheese. High: sour cream with 2 % salt.
Bitter taste	Weak to strong	Weak: fresh industrial Turrialba cheese. Strong: Gouda cheese.
Lettuce taste	Weak to strong	Weak: fresh industrial Turrialba cheese. Strong: washed lettuces.
Milky after taste	Weak to strong	Weak: cheese whey. Strong: whole milk (3 % fat).
Acid after taste	Weak to strong	Weak: cheese whey. Strong: sour cream.
Lettuce after taste	Weak to strong	Weak: fresh industrial Turrialba cheese. Strong: washed lettuces.

Significant differences statistically (p<0,05) were observed in the samples differentiated by panelist based on the twenty-one attributes evaluated. Samples were clustered into three groups according to their similarity; cluster T, M and L. Cluster T comprised 52.63 % of the evaluated samples, represented by A and most B cheeses (Table 1). Cluster M included 42.10 % of the samples, which were cheeses from the categories C and most of D, and sample QP12, from B category (Table 1). The L conglomerate was the smallest (5.25 %), and it was represented only by the sample C3, from D category (Table 1).

The PCA shown in Figure 1 accounted for 76.17 % of the sample variance with F1 and F2 axis, which explained 52.94 % and 23.23 %, respectively. The negative section of the F1 axis enclosed attributes that described most of cluster T cheeses, which presented acid aroma and taste, salty taste, high firmness, moisture, and yarn appearance. The positive section of F1 axis aligned the attributes that described conglomerate M, such as greasy texture, yellow appearance, cream aroma, and milk aftertaste. The L cluster presented characteristics related to Lettuce attribute in the positive section of the F1 axis. On the other hand, F2 positive axis explained bitter flavor presented in some cheeses of the T cluster and L cluster.

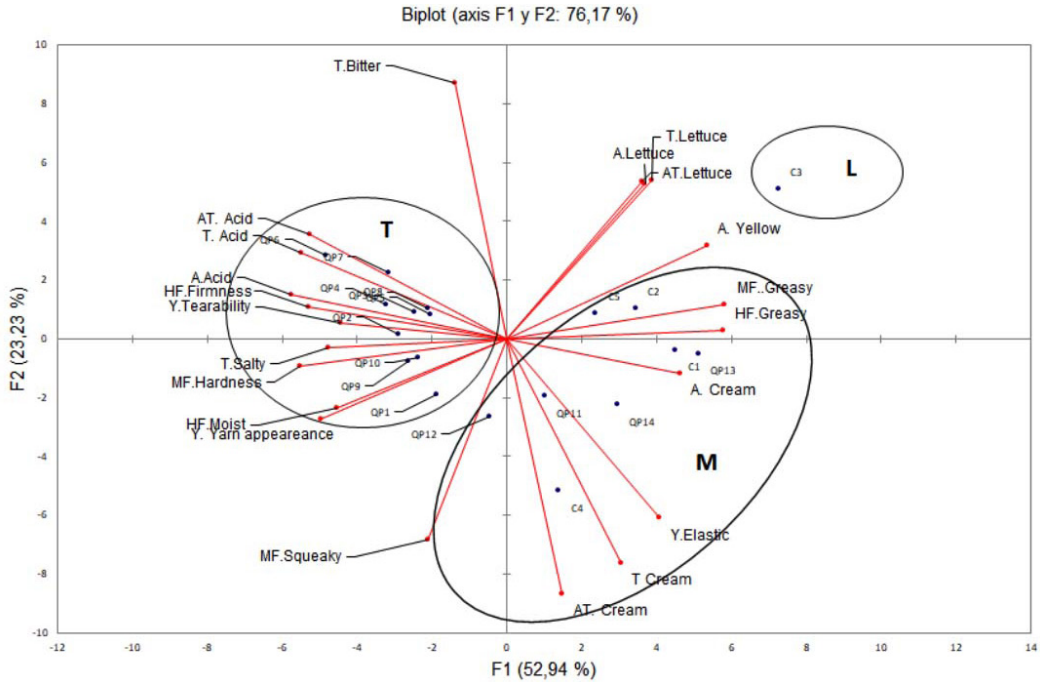

Figure 1. Principal component analysis (PCA) biplot of sensory attributes of *Palmito* cheese samples. Clusters are represented by T, M & L letters. Food Technology Department, University of Costa Rica, San José, Costa Rica. 2015.

Figura 1. Biplot del análisis de componentes principales (PCA) de los atributos sensoriales de las muestras de queso *Palmito*. Aglomeraciones son representadas por las letras T, M y L. Escuela de Tecnología de Alimentos, Universidad de Costa Rica, San José, Costa Rica. 2015.

Consumer acceptance test

Agglomerative hierarchical clustering was conducted to determine consumer segmentation towards liking of the *Palmito* cheeses. Four clusters were found, G1 grouped 43 % of total consumers, being the most representative

segment, G2 grouped 20 %, G4 21 % and the smallest group was G3 with 16 % of the consumers. All groups presented significant differences (p<0,0001) in liking. Figure 2 shows external preference mapping in which consumer acceptance test for each cluster is correlated with the attributes obtained by the descriptive analysis.

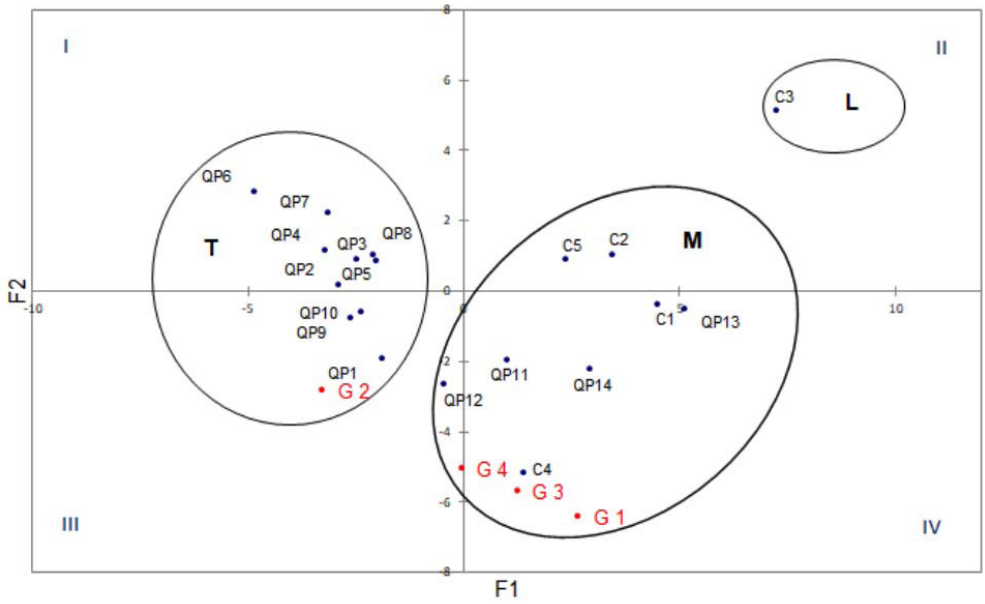

Figure 2. External Preferential Mapping to elucidate the liking drivers in the nineteen *Palmito* cheese samples. G1 (43 consumers), G2 (20 consumers), G3 (16 consumers), G4 (21 consumers). Food Technology Department, University of Costa Rica, San José, Costa Rica. 2015.

Figura 2. Mapeo preferencial externo para elucidar atributos de alto agrado en las diecinueve muestras de queso *Palmito*. G1 (43 consumidores), G2 (20 consumidores), G3 (16 consumidores), G4 (21 consumidores). Escuela de Tecnología de Alimentos, Universidad de Costa Rica, San José, Costa Rica. 2015.

Discussion

Conglomerate T encloses most of the traditional cheeses, which present acid aroma and taste, salty taste, high firmness, moisture, and yarn-like appearance, as it is shown on the negative section of the F1 axis, PCA (Figure 1). It was expected that reactions as lipolysis, proteolysis, metabolism of lactose and citrate took place in cheeses belonging to the T cluster, which were stored at room temperature in chlorinated water, giving as a result acid aroma and flavor.

Likewise, low acid intensities presented in the M cluster can be explained by the storage under fridge conditions, in which refrigeration acts as a retardant of enzymatic activity and microorganism action (Ramírez-Nolla & Vélez-Ruíz, 2012). As a result, storage conditions affect the acid attributes of *Palmito* cheeses. On the other hand, there were no significant differences between pasteurized and unpasteurized refrigerated samples; therefore, acid characteristics are not related to the pasteurization stage.

Cheeses of the T cluster presented higher intensities of salty flavor than the other conglomerates. Salty flavor is related directly with the amount of salt added to the cheeses. In the artisan process of fresh cheese, salting has two purposes, besides providing flavor to the product, it has a preservative function (Bae et al., 2017). As it is

presented in Figure 1, it was expected that cheeses stored at room temperature with chlorinated water present higher intensities of salty flavor than cheeses stored on refrigeration conditions, since additional salt is not required to extend product shelf life. Higher content of salt also increases firmness characteristics due to dehydration during storage conditions (Maldonado et al., 2013), as is shown on T cheeses.

Most of the traditional cheeses had more humidity, firmness and tearability, while most of industrial cheeses (pasteurized cheeses of M conglomerate) presented more greasy texture, softness and a low yarn-like appearance. The research made by Jana and Tagalpallewar (2017) demonstrated that cheeses made with pasteurized milk lost more moisture during the first days of storage than cheeses made with raw milk, since its protein matrix was more open, porous and with irregular spaces that favored the exit of water. Also, this loss of moisture causes the concentration of the fat content on the surface of the cheese, decreases the firmness of the product, blurs the yarn-like appearance, and makes the cheese easy to tear, which explains the results observed in Figure 1.

Firmness in *pasta filata* cheese is also influenced by the stage of acidification. If acidification is below pH of 5,2 the curd starts to lose fat excessively and cheese becomes harder and sourer (Onipchenko, 2012). Most of the artisan *Palmito* cheese producers extend the period of acidification for 4-5 h; usually not having instruments to control pH. It can be hypothesized that artisan conditions for acidification may be longer than it is required for the product and it could be affecting sensory characteristics of the cheese.

According to Ramírez-Nolla and Vélez-Ruíz (2012), yarn-like is produced during kneading and melting of the curd due to a re-arrangement of caseins molecules that align proteins into threads. Kneading process requires dexterity and experience in order to have the appropriate texture of pasta filata. Consequently, it is expected that traditional cheeses (T conglomerate), present higher intensities of yarn-like appearance and tearability attributes, due to its manual process that remounts to years of experience.

The M conglomerate was located opposite to the T cluster, in the positive section of the F1 axis (Figure 1). As a consequence, these cheeses are softer and less acidic. Most of the industrial cheeses of this group present a major intensity of greasy texture and yellow color, while traditional cheeses of this conglomerate are characterized by presenting cream aroma and milk after taste.

Most industrial cheeses of the M conglomerate presented higher scores of greasy textures influenced by pasteurization as it is mentioned before, but also it is related with a high milk fat content and with storage. During storage, proteolysis and lipolysis reaction occurs. The breakdown of casein during proteolysis allows the fat globules to be released out of the protein matrix and subsequently bind to the surface, causing oily sensation (Onipchenko, 2012).

Yellow appearance in most of the industrial cheeses can be attributed to a ripening process during storage. These cheeses are stored at vacuum and refrigerated with a shelf life up to 20 to 40 days, while traditional cheeses are stored maximum two weeks after they are produced. Fresh cheeses release whey that is reabsorbed during the first days of ripening, what provokes rearrangements on casein molecules and decreases its ability to reflect white light (Barać, et al., 2021). During ripening, proteolysis reactions occur, and casein becomes more soluble and less white (Nedomová et al., 2017).

The M cluster is characterized by its cream attributes which are associated with the sweet taste of the milk due to lactose content and related to cattle feed. Results on the PCA show an inverse association between acid and cream characteristics, cheeses with higher scores of cream presented lower scores of acidities (Figure 1). This perception could be affected by a masking effect; according to Shepard et al. (2013) intense acid flavors can mask other flavors that are present on a product. Therefore, product storage under fridge conditions may delay acid production and enhance the perception of cream characteristics that could be masked by acid flavors.

The L cluster, composed only by the C3 cheese, presented characteristics related to lettuce attributes in the positive section of the F1 component. According to Ishler and Roberts (2016) strange flavors and aromas are not related to milk, neither cheese, they are often associated with excessive use of sanitizing agents for equipment and utensils.

The positive section of the F2 component of the PCA encloses bitter flavor (Figure 1). Some cheeses of the T cluster and C3 from the L cluster presented this attribute. During processing and storage of fresh cheeses, low molecular weight peptides are formed derived from casein β and produce bitter flavors. Results did not show a trend that could associate bitterness with the process and storage conditions. Authors mention that other variables that could affect bitterness are cattle feeding, enzymes, high heat treatments, high fat content of milk, excess of rennet, whey or cultures (Lepesioti et al., 2021; Oštarić et al., 2022; Ozcan & Eren-Vapur, 2013).

The negative section of the F2 axis explains attributes like squeaky texture and elastic. Squeaky texture is related with greasy texture. According to Ningtyas et al. (2017) cheeses with high fat content have a protein matrix with fat globules interspersed; therefore, cheeses with low fat content has fewer fat globules within the protein net, providing firmness, rubber and squeaky texture. Results show that D cheeses from M conglomerate present lower scores of squeakiness, resulting in soft, less humid, and high greasy texture cheeses.

No tendency was observed among the samples for the elastic attribute; therefore, it was considered that none of the evaluated stages of the process causes differences that could reflect the elasticity perceived at touch level.

By comparing PCA with preference mapping (Figure 2), the drivers of liking obtained for G1, G3, and G4 were cream aroma and taste and milk aftertaste, which are associated with product storage in fridge conditions in order to avoid masking flavors by acid attributes. QP11, QP13 and QP14 traditional *Palmito* cheeses and C1 and C4 industrial *Palmito* cheeses were in the fourth quadrant in which conglomerates G1, G3, G4 were located.

Consumers of the Cluster G2 prefered cheeses located in the third quadrant such as QP1, QP9, QP10 and QP12 (Figure 2). This segment of consumers had more affinity for traditional cheeses over industrial cheeses and prefered characteristics such as moisture, yarn-like appearance, hardness and salty flavor, which are associated to non-pasteurized product, dexterity and experience in kneading and molding, low fat content of milk, acidification at pH<5,2 and high salt concentration.

Drivers of dislike can also be shown in external preference mapping. On the first quadrant were located the less pleased traditional cheeses QP4, QP5, QP6, QP7 and QP8 presented acid aroma and taste. These characteristics are associated to the use of acid whey in acidification and the effect of storage conditions (water bath at room temperature) due to microbiological and enzymatic reactions as it was previously discussed. Another driver of dislike by all consumers was lettuce aroma, taste and aftertaste presented in C3 cheese, it could be influenced by residual cleaning agents present on equipment and utensils.

Conclusion

Twenty-one attributes were identified as sensory features of *Palmito* cheeses. Most of traditional cheeses, enclosed by conglomerate T, were grouped by their similarity in acid aroma and taste, salty taste, high firmness, moisture, and yarn appearance; while most of industrial cheeses were clustered in a conglomerate M by their similarity on greasy texture, yellow appearance, cream aroma, and milk aftertaste.

Consumers liked most of the industrial *Palmito* cheeses, but they prefered those traditional cheeses with yarn characteristics and cream flavor. According to this study, these characteristics can be obtained by the use of raw milk, an artisan process with refrigerated storage.

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