

Assessing consumer preference toward Chihuahua cheese and Chihuahua-type cheese

Evaluación de la preferencia del consumidor hacia el queso Chihuahua y el queso tipo Chihuahua

JOSÉ LUIS ALMANZA RUBIO¹, RAÚL EDUARDO OROZCO MENA¹
Y NÉSTOR GUTIÉRREZ MÉNDEZ^{1,2}

Recibido: Agosto 9, 2012

Aceptado: Marzo 23, 2013

Abstract

La carencia de una denominación de origen que proteja al queso Chihuahua ha motivado a las grandes queserías de México y del extranjero a imitar el queso producido por los menonitas. El objetivo de este trabajo fue el de describir las preferencias de los consumidores de la ciudad de Chihuahua en relación al queso Chihuahua y las imitaciones de queso Chihuahua. Se seleccionaron cuatro zonas públicas en diferentes partes de la ciudad de Chihuahua y se utilizaron 88 jueces no entrenados (22 por zona) para realizar las pruebas sensoriales. Se identificó la preferencia y aceptación sensorial del queso Chihuahua y el queso tipo Chihuahua elaborado fuera del estado. En un análisis proximal de las 11 marcas de queso Chihuahua, se encontró que el queso Chihuahua elaborado en el estado de Chihuahua tiene un porcentaje de grasa mayor que las marcas de queso tipo Chihuahua elaborado en otros estados de la república o el importado de otros países. Posteriormente, en una encuesta donde se identificaron las marcas de queso Chihuahua más consumidas por la población de la ciudad de Chihuahua, se encontró que la marca Laurel, una de las marcas elaboradas en Chihuahua, es la más consumida por la población de la ciudad. Los resultados obtenidos de las pruebas sensoriales y de la encuesta de consumo demostraron que sí existe una mayor aceptación por parte de los consumidores hacia los quesos Chihuahua elaborado en el estado de Chihuahua que por los quesos tipo Chihuahua elaborados fuera del estado.

Keywords: queso Chihuahua, evaluación sensorial, aceptación, preferencia, encuesta.

Resumen

The lack of a protected designation of origin for Chihuahua cheese has led large dairy companies in Mexico and abroad to emulate this cheese produced by the Mennonites. The aim of this work was to understand the preferences of consumers from Chihuahua City toward Chihuahua cheese and Chihuahua-like cheeses. Four public areas were selected in different parts of the city of Chihuahua, and 88 untrained judges (22 per zone) were used for sensory testing. Preference and sensory acceptance of Chihuahua cheese and Chihuahua-like cheese made outside the state was determined. A proximate analysis of the 11 brands of Chihuahua cheese, found that Chihuahua cheese produced in the State of Chihuahua has a higher fat percentage than the Chihuahua-like cheese brands produced in other States of the Republic or imported from other countries. Subsequently, a survey, which identified the Chihuahua cheese brands most consumed by the population of the city of Chihuahua, found that the *Laurel* brand, one of the brands produced in Chihuahua, is the most consumed by the population of the city. The sensory testing and consumer survey results showed that there is a greater acceptance by consumers toward Chihuahua cheese produced in the State of Chihuahua than for that made out of the State.

Palabras clave: Chihuahua cheese, sensory study, acceptance, preference, survey.

¹ Universidad Autónoma de Chihuahua, Facultad de Ciencias Químicas. Circuito Universitario, Campus II. Chihuahua, Chih. México.

² Dirección electrónica del autor de correspondencia: ngutierrez@uach.mx.

Introduction

One of the main food industries in Chihuahua, Mexico, is the dairy industry, especially the cheese industry, being the Chihuahua cheese its principal product. In Chihuahua, the cheese factories ranging from small traditional companies to large industrialized factories; producing a wide variety of Chihuahua cheeses, with different characteristics of flavor and texture. However, nowadays the market is slowly saturated with brands of cheese labeled as "Chihuahua cheese" manufactured in the center and south of Mexico, or even imported from other countries like Chile and Uruguay (Gutiérrez-Méndez and Nevárez-Moorillon, 2009).

Chihuahua cheese or Mennonite cheese is one of the most popular and consumed cheeses in Mexico and the Hispanic community in the United States (Tunick *et al.*, 2008). The history of Chihuahua cheese is closely related to the Mennonite communities who migrated from Canada to Chihuahua, Mexico in 1922. The migration of this group of Mennonites brought the development of a cheese similar to Cheddar (Taylor-Hansen, 2005). The cheese of the Mennonites or «Mennonite cheese» gradually gained acceptance among the inhabitants of Chihuahua. After a time, the popularity of this cheese grew and transcended the region of Chihuahua. Consumers from the Center and Southern regions of Mexico identified the Cheese made by the Mennonites as «the Cheese made in Chihuahua» and with time it was known as Chihuahua Cheese (Gutiérrez-Méndez and Nevárez-Moorillon, 2009; NMX-F-738-COFOCALEC, 2011).

According to the Mexican Norm, Chihuahua cheese is defined as...«the product obtained from pasteurized whole cow's milk subjected to coagulation, draining, fermentation, salted, pressed and aged for a minimum of seven days at controlled room temperature and humidity, without any use of fats or proteins strange to milk»... (NMX-F-738-COFOCALEC, 2011). Chihuahua cheese color is yellow, and when it becomes ripe turns to a golden yellow. Its consistency is semi-hard and sliceable, and its sensory characteristics are similar to that of a one month aged Cheddar; although rheological analysis suggests it is more alike to fresh Colby cheese (Gutiérrez-Méndez and Nevárez-

Moorillon, 2009; Villegas, 2003). The growing demand of this cheese and the lack of origin denomination have motivated the introduction of Chihuahua-like cheeses in the national market. In the market, it is possible to identify types of Chihuahua cheese like: a) the traditional cheese made by the Mennonites, b) the cheese made in Chihuahua by producers who do not belong to the Mennonite community, c) the cheese labeled as «Chihuahua cheese» made outside the State of Chihuahua, d) and the cheese labeled as «Chihuahua cheese» imported from other countries. These imitations of the Mennonite cheese are mainly produced in central and southern states of Mexico, but some brands are also imported from Chile and Uruguay (Gutiérrez-Méndez and Nevárez-Moorillon, 2009; Tunick *et al.*, 2008).

Strictly speaking there is not a clear definition of the sensory and texture characteristics of the Chihuahua cheese. However, the perception of the consumer in Chihuahua is that the cheeses produced by Mennonites have a different flavor and texture than those cheeses produced in the center and south of Mexico, or the cheese imported from Uruguay and Chile. Chihuahua is a semi-arid State and due to the lack of vegetation, the cattle are fed with alfalfa, corn semolina and the Mennonites from Chihuahua also feed their cattle with oats (personal communication with Mennonite farmers). The cattle diet modifies the chemical composition of the milk, and hence the sensory properties of this. The milk produced from cows fed with pasture has different fatty acid composition and volatile compounds than the milk from cows fed

with grains (Buchin *et al.*, 1998; Tornambé *et al.*, 2006). The aim of this work was to understand the preferences of consumers from Chihuahua City toward Chihuahua cheese and Chihuahua-like cheeses.

Materials and Methods

Chihuahua cheese samples. Eleven brands of Chihuahua and Chihuahua-type cheese were used in this study. The samples included cheese brands manufactured in Chihuahua State (six brands), Mexico State (two brands) and brands imported from Chile (one brand) and Uruguay (two brands) labeled as Chihuahua cheese (see Table 1). The cheese samples were purchased in local markets and kept in their original packaging at 4 °C before their compositional and sensory analysis.

Table 1. Brands of Chihuahua and Chihuahua-type cheese used in the sensory study.

Brand	Origen	
	Country	State
Lala	Chile	
Esmeralda	Uruguay	
Soriana	Uruguay	
La Villita	Mexico	Mexico State
Alpura	Mexico	Mexico State
Sierra verde	Mexico	Chihuahua
Laurel	Mexico	Chihuahua
Los pinos	Mexico	Chihuahua
Campo Holandés	Mexico	Chihuahua
Rueda (without brand)	Mexico	Chihuahua
Sello dorado (analogue cheese)	Mexico	Chihuahua

Compositional analysis of Chihuahua cheese. Compositional analysis was carried out three times to each brand of Chihuahua and Chihuahua-type cheese. The determination of

moisture content and ash were performed by the method of AOAC (1998) 926.08 and AOAC 945.46 respectively. The salt content of each sample was determined with a saltmeter (Atago ES-421). The quantification of fat was performed according to the Mexican Norm NMX-F-710-2005 (NMX-F-710-COFOCALEC, 2005). Protein determination was measured by the Micro-Kjeldahl method AOAC 991.22. pH of the cheeses was determined using a potentiometer. Additionally, all cheese samples were subject to evaluation of alkaline phosphatase activity (to determine if the cheeses were made from unpasteurized milk), with a commercial kit LACTO-ZYMA (Hycel Reactivos Químicos, Mexico). Data collected from the compositional analysis were subject to statistical analysis by one-way ANOVA and Tukey's multiple means comparisons using the software Minitab 16 (Minitab Inc., 2010).

Sensory study. Affective tests were used to rate the acceptance of consumers toward different samples of Chihuahua cheese. The study was conducted in four different locations of Chihuahua City where many potential consumers congregate (two supermarkets, one church, and a public park). In order to avoid sensorial fatigue due to the large number of samples (eleven different brands of cheese), an incomplete balanced block design was used to distribute the combinations of brands and consumers (Meilgaard *et al.* 1999). According to this design, twenty-two consumers participated by location, every consumer evaluated only three samples, and each brand of cheese was evaluated six times by location. In total, 88 consumers participated in the sensory study, and each brand was assessed 24 times by different consumers.

Before the probe, the cheeses were cut in cubes of 1 cm, stored in hermetic plastic containers, and transported in coolers to the locations where the sensory tests were conducted. Each consumer assessed the texture and flavor of three cheese samples by an acceptance test using a 9 cm none structured

hedonic scale (Meilgaard *et al.*, 1999). Data collected were analyzed as an incomplete balanced block design (judges were considered as blocks) using the software Minitab 16 (Minitab Inc., 2010).

Consumer preference survey. Direct inquiries were applied face-to-face to 100 consumers from Chihuahua City as described by Meilgaard *et al.* (1999). Each respondent was supplied with a list containing 66 names of the Chihuahua cheese brands marketing in Chihuahua City. The consumers were asked to select from the list, the brand or brands of Chihuahua cheese most consumed. Data were collected in public places during the summer of 2011.

Results and Discussion

Composition of Chihuahua and Chihuahua-type cheeses. The cheese samples analyzed showed differences in their gross composition. The brand with the lowest moisture content was the «*Rueda cheese*» (Table 2). The low moisture content of Rueda cheese (or Chihuahua cheese manufactured with unpasteurized milk) has been reported by other authors like VanHekken *et al.* (2006) and Tunik *et al.* (2008). *Rueda cheese* is the original Mennonite cheese (without any specific brand) manufactured in small-scale using unpasteurized milk. In this study, only Rueda cheese was positive to phosphatase alkaline test, indicating that it was manufactured with unpasteurized milk. This traditional Mennonite cheese has a round shape like a wheel (*rueda* in Spanish), and its surface contains the blanket used during the molding of the cheese; although some producers also wrap the cheese surface with wax. In contrast, the Chihuahua cheese manufactured in large scale with pasteurized milk is vacuum packed using plastic bags with low moisture permeability. Whereas Rueda cheese is not packaged in plastic bags and thus the surface of the cheese becomes more dry after the first weeks of storage due to the low relative humidity in Chihuahua State.

The most evident differences in the composition of the cheese brands were the fat content and the fat protein proportion (see Table 2). The cheeses manufactured in Chihuahua State had more fat and a higher proportion of fat-protein than the cheeses not manufactured in Chihuahua (see Table 2). The fat content affects the rheology and texture of the cheese but produced a limited effect on taste and aroma (Guinee and McSweeney, 2006). The aroma perception decreases in the foods with more fat, because the lipophilic odorant molecules prefer to reside in the oil phase of the food matrix (Reineccius, 2006). Nevertheless, during the ripening of the cheese, fatty acids are released from triacylglycerols by the action of lipases. The fatty acids, in particular, the short-chain acids like butyric, caproic and caprylic contribute significantly to the flavor of the cheese (Fox and McSweeney, 1998). Recent evidence from animals suggests that there are specific lingual receptors for fatty acids (Taylor and Roberts, 2004). However, the sensory threshold of fatty acids may vary depending of each fatty acid and the composition of the food matrix. In milk, butyric acid (4:0) has a threshold of 46.1 ppm, whereas caprylic (6:0), capric (8:0) and palmitic (16:0) acids have a threshold of 30.4, 22.5 and 244.5 (Fox and McSweeney, 1998).

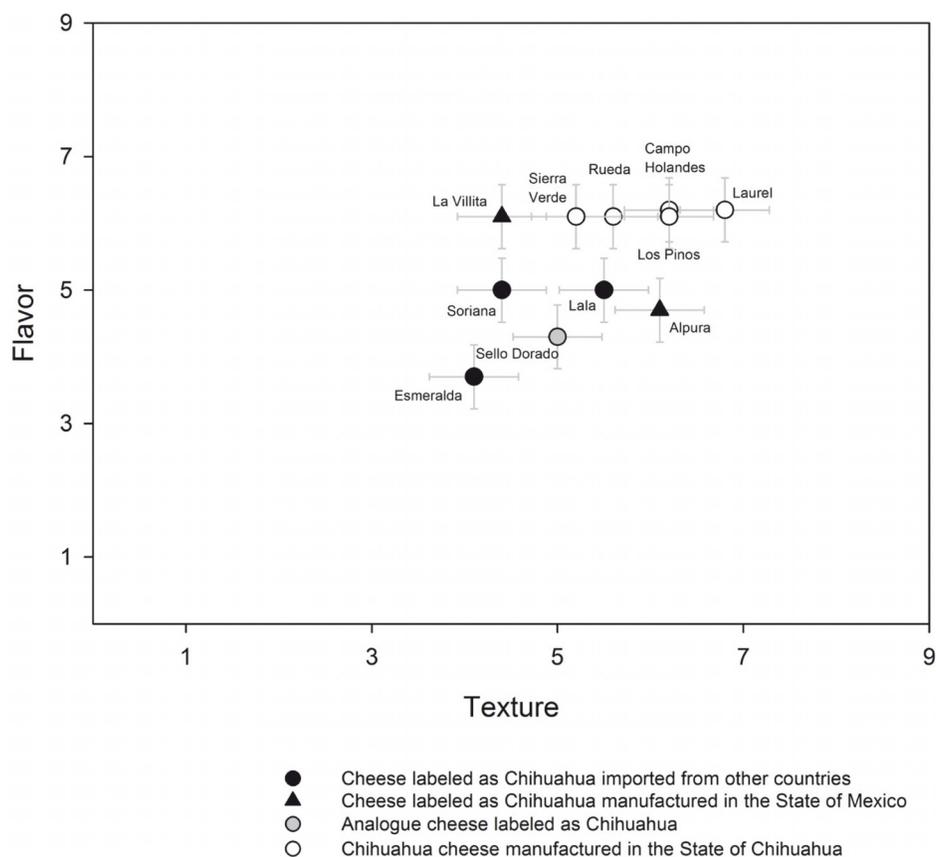
Variations in bovine milk fat composition (type and proportion of the fatty acids) are attributable to different factors, including the feeding of the cattle, like the proportion of forage (Palmquist and Jensen, 2008). The Mennonites settled in Chihuahua State, fed their cattle with a mixture of oats and forage (personal communication with Mennonite farmers from Chihuahua), whereas in the Center and Southern of Mexico, the milk cows are fed mainly with forage. For this reason, the milk from the Mennonite farms might contain different types of fatty acids, comparing with the milk from dairy cattle of the Center and Southern regions of Mexico.

Sensory evaluation. The 88 participants of the sensory study had a range of ages between 12 - 64 years old, with mean of 32 years old

(first quartile = 20, median = 27, third quartile = 43). All the participants expressed to be regular consumers of Chihuahua cheese. The 23% of the panel stated that they consumed Chihuahua cheese every day; whereas 20% consumed Chihuahua cheese once a week, and 19% three times a week. According to the statistical analysis, the consumers observed a significant difference in the flavor and texture of Chihuahua cheese brands.

(declared on the label of the cheese) with similar gross composition of regular Chihuahua cheese (Table 2). In this study, the panel gave low scores in flavor and texture to the analogue cheese, even without knowing that they were assessing an analogue cheese. Analogue cheese products replace the milk fat and non-fat milk solids by caseinates and vegetable oils. The price in the market of these cheese imitations is lower than real cheeses, because of the low cost of

Figure 1. Sensorial perception of Chihuahua City consumers toward different brands of Chihuahua cheese and Chihuahua-type cheese.



The cheeses perceived as the worst in flavor and texture were the brands *Esmeralda* and *Sello Dorado* (Figure 1). The brand *Esmeralda* (imported from Uruguay) presented the highest moisture and the lowest fat content (Table 2), producing a flavor and texture unusual for Chihuahua cheese. On the other hand, the brand *Sello Dorado* is an analogue cheese

vegetable oils and caseinates. However, the flavor of analogue cheeses cannot approach the flavor of a real cheese. The texture of an imitation cheese may also differ to the real cheeses due to the physicochemical characteristics of the vegetable oils, and the way the fat and protein are distributed in the cheese matrix (Bachman, 2001; Guinee, Caric, and Kaláb, 2004).

Table 2. Compositional analysis of the Chihuahua and Chihuahua-type cheese used for the sensory analysis.

Origen	Brand	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Proportion fat - protein	pH	Salt
Cheese manufactured in Chihuahua State, Mexico	Campo Holandés	41.7 ^{ab}	3.6 ^{cd}	27.3 ^a	25.07 ^{abc}	1.09	5.82 ^{bc}	0.82 ^{cde}
	Rueda	38.6 ^d	3.4 ^{cde}	27.3 ^a	26.7 ^a	1.02	5.54 ^e	0.51 ^g
	Laurel	39.0 ^{cd}	3.4 ^{cde}	26.6 ^{ab}	22.6 ^{cd}	1.18	5.52 ^{ef}	0.83 ^{cd}
	Los Pinos	41.1b ^c	4.2 ^b	25.6 ^{ab}	26.02 ^{ab}	0.99	5.88 ^b	1.02 ^{ab}
	Sierra Verde	41.9 ^{ab}	3.2 ^{de}	27.3 ^a	23.5 ^{bcd}	1.16	5.46 ^f	0.69 ^{ef}
Analogue Chihuahua-type cheese	Sello Dorado	40.2 ^{bcd}	3.1 ^e	19.3 ^d	22.7 ^{cd}	0.85	5.81 ^c	0.81 ^{de}
Chihuahua-type cheese manufactured in Mexico State, Mexico	Alpura	40.8 ^{bcd}	3.4 ^{cde}	26.6 ^{ab}	21.6 ^d	1.23	5.49 ^{ef}	0.63 ^{fg}
	La Villita	43.8 ^a	3.7 ^c	22.3 ^{cd}	24.1 ^{bc}	0.92	5.38 ^g	1.15 ^a
Chihuahua-type cheese imported from Chile	Lala	41.8 ^{ab}	5.1 ^a	21.6 ^{cd}	25.7 ^{abc}	0.84	5.66 ^d	1.05 ^{ab}
Chihuahua-type cheese imported from Uruguay	Esmeralda	42.4 ^{ab}	3.6 ^{cd}	21.6 ^{cd}	27.06 ^a	0.80	5.7 ^d	0.95 ^{bc}
	Soriana	40.6 ^{bcd}	4.1 ^b	24.0 ^{bc}	25.4 ^{ab}	0.94	5.96 ^a	1.13 ^a
Standar error		0.479	0.075	0.635	0.485		0.012	0.027
Reference								
Van Hekken and Farkye, 2003		41-45	-	21-30	22-26	-	5.0-5.3	1.4-2.4
Van Hekken <i>et al.</i> 2006 ¹		37-41	-	30-36	24-29	-	-	-
Van Hekken <i>et al.</i> 2006 ²		39-45	-	30-35	24-28	-	-	1-1.5
Tunick <i>et al.</i> 2008 ^{1,2}		36-44	-	30-34	23-27	-	4.8-5.21	1-1.5
Diaz-Cinco <i>et al.</i> 1992		41.9	-	21.2	26.4	-	-	-
Mexican Norm NMX-F-738-COFOCALEC-2011		≤ 45		≥ 28	≥ 23		5.0-5.5	≥ 3
Cheddar cheese (Fox and McSweene, 1998)		36		34.4	25.5	-	5.4	-

a,b,c,d Values followed by superscripts with different letters in the same column are significantly different (P>0.05); repetitions by treatment (n) = 3.

(-) data not reported by the authors.

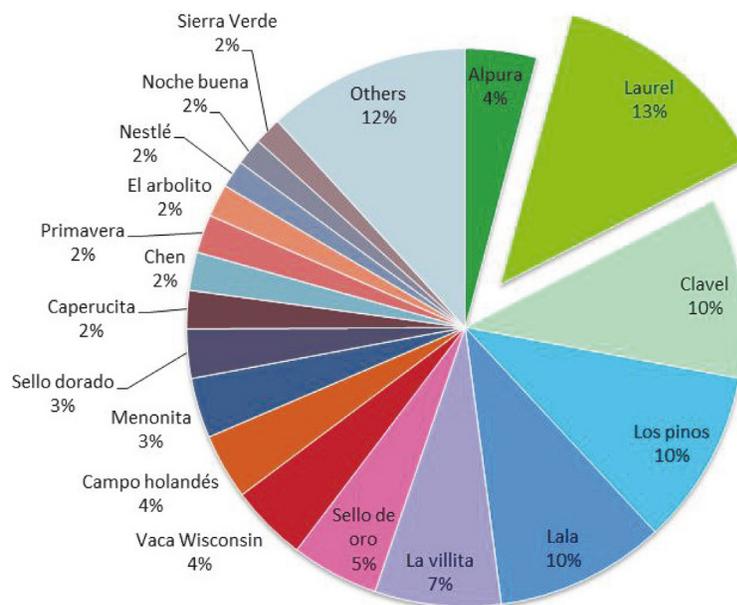
¹ Samples of Chihuahua cheese manufactured with unpasteurized milk in Cuauhtemoc, Chihuahua, Mexico.

² Samples of Chihuahua cheese manufactured with pasteurized milk in Cuauhtemoc, Chihuahua, Mexico.

All the cheese brands imported from other countries (*Soriana*, *Lala* and *Esmeralda*) had flavor scores below five, considering nine the maximum value. In contrast, all the cheese brands manufactured in Chihuahua State obtained flavor scores higher than five (see Figure 1). The consumers, with the exception of the brands *Lala* and *Alpura*; also poorly rated the Chihuahua-type cheeses in texture whereas the Chihuahua cheese (manufactured in Chihuahua State) got scores higher than five. Consumers considered that the cheese brand Laurel was the best in flavor and texture (Figure 1). The cheese rated as the best in flavor and

texture, was the sample that met the consumer expectations about how Chihuahua cheese should taste. The brand *Laurel* is produced by one of the oldest cheese factories of the Mennonite community settled in Chihuahua State. The cheese Laurel was at first like a traditional *Rueda cheese*, manufactured with unpasteurized milk and coated with beeswax. Today, this cheese is manufactured in large scale using pasteurized milk and vacuum packed in plastic bags. The success of this cheese in the market was due to keeping its flavor similar to the traditional *Rueda cheese*.

Figure 2. Consumer preference of Chihuahua cheese brands in Chihuahua City. Data collected through face to face inquiries applied to one hundred of consumers.



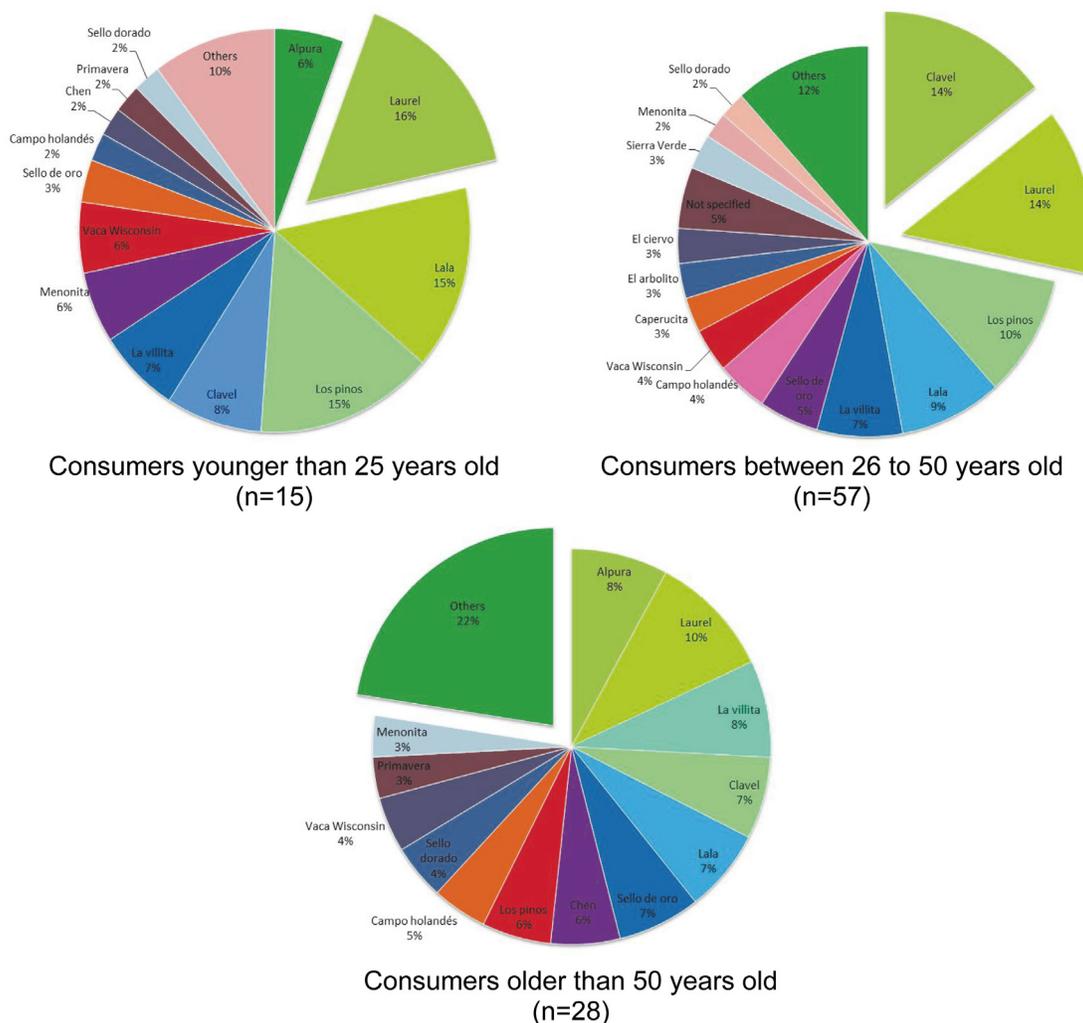
Consumer preference survey. A total of 100 consumers were surveyed (38 males and 62 females) with an age range between 17 - 89 years old, with mean of 41 years old (first quartile = 29.25, median = 41, third quartile = 52.75). All the participants expressed to be regular purchasers of Chihuahua cheese. Consumers surveyed included students living alone or with roommates, providers for small family (2-3 family members), and providers for medium families (4-6 family members). Consumer behavior is a complex issue; consumers tend to take several factors into account when it comes to purchasing a dairy product. Aside from sensory preferences, there is also a significant relationship between availability, packaging, advertisement, and price of dairy products; and consumer behavior in buying dairy products (Manafzadeha *et al.*, 2012).

The consumer survey showed Laurel cheese to be the Chihuahua cheese brand most preferred by consumers (13%). Other high-ranking brands included Clavel (10%) and Los pinos (10%) both of which are made in the State

of Chihuahua. Cheeses made outside the State of Chihuahua received a low consumer preference; except for Lala (10%) a brand imported from Chile by one of the most prominent and well recognized brands in Mexico. Overall, 78% of consumers indicated that they preferred cheese brands with made inside the State of Chihuahua, while only 22% preferred brands of cheese made outside the State of Chihuahua (Figure 2).

Consumers younger than 25 years old expressed a buying preference for Laurel, Lala and Los pinos. These 3 brands, two of which are from the State of Chihuahua had an overall preference of 46%. Consumers between the ages of 26 and 50 showed a preference for the Laurel (Chihuahua), Clavel (Chihuahua), Los pinos (Chihuahua), Lala (Chile) and La villita (Mexico) brands, with a an overall preference of 54%. Consumers older than 50 years did not show much difference between percentages with the «others» section having the most preference (Figure 3).

Figure 3. Consumer preference of Chihuahua cheese brands according their age. Data collected through face to face inquiries applied to consumers from Chihuahua City.



According to these results, *Laurel*, *Clavel*, *Los pinos* and *Lala* are the most consumed cheese brands in Chihuahua City; from these, only *Lala* is produced outside the state of Chihuahua (Chile). None the less, it can also be argued that consumers can be influenced by marketing; as seen with the *Lala* brand, which even though it received an intermediate score in the sensory study, still happens to be one of the most consumed brands. This is probably because *Lala* is a largely known dairy brand in Mexico, and people may be buying the brand for its prestige and not the cheese for its sensory properties.

Conclusion

The compositional analysis of different brands of Chihuahua and Chihuahua-type cheeses showed that cheese made inside the state of Chihuahua had higher fat content than those made outside of the state. The average consumer from Chihuahua city preferred the cheese made inside the state of Chihuahua. According to the sensory evaluation (using blind samples), the cheese brands *Laurel*, *Campo Holandes* and *Los pinos* obtained the highest scores in flavor and texture. Additionally, consumers perceived remarkable differences in

flavor and texture between the analogue cheese and the cheeses made with whole milk. On the other hand, from the results of the surveys applied face-to-face to one hundred of consumers from Chihuahua City the brands *Laurel*, *Clavel*, *Los pinos* and *Lala* were considered as the most preferred and consumed.

References

- AOAC. 1998. *Official Methods of Analysis. Chapter 33* (16 ed.). Washington D.C. USA: Association of Official Analytical Chemists.
- BACHMAN, H.-P. 2001. Cheese analogues: a review. *International Dairy Journal*, 11, 505–515.
- BUCHIN, S., V. Delague, G. Duboz, J. L. Berdague, E. Beuvier, S. Pochet, and R. Grappin. 1998. Influence of Pasteurization and Fat Composition of Milk on the Volatile Compounds and Flavor Characteristics of a Semi-hard Cheese. *Journal of dairy science*, 81(12), 3097–3108.
- FOX, P. F., and P. L. McSweeney. 1998. *Dairy chemistry and biochemistry* (1st ed.). New York: Blackie Academic and Professional.
- GUINEE, T. P., and P. L. McSweeney. 2006. Significance of milk fat in cheese. In P. F. Fox & P. L. McSweeney (Eds.), *Advanced Dairy Chemistry* (Vol. 2, pp. 377–440). New York: Springer.
- GUINEE, T. P., M. Caric, and M. Kaláb. 2004. Pasteurized processed cheese and substitute/imitation cheese products. In P. F. Fox, P. L. McSweeney, T. M. Cogan, & T. P. Guinee (Eds.), *Cheese chemistry, physics and microbiology* 2:434). London UK: Elsevier Academic Press.
- GUTIÉRREZ-MÉNDEZ, N., and G. V. Nevárez-Moorillon. 2009. Chihuahua cheese: the history of a mexican cheese. *Carnilac Industrial*, 24(5), 27–34.
- MANAFZADEHA, Z., A. Ghafarloob, M. C. Sayadanc, J. S. Sendi, S. Elahi, S. Hosseinzadeh and N. Janati. 2012. Does marketing mix have effect on consumers behavior of dairy products? *Journal of Basic and Applied Scientific Research*, 2(6), 5823–5827.
- MEILGAARD, M., G. V. Civille, and B. T. Carr. 1999. *Sensory evaluation techniques*. Boca Raton Florida: CRC Press.
- NMX-F-710-COFOCALEC. *NMX-F-710-COFOCALEC-2005 Sistema producto leche -alimentos – lácteos – determinación de grasa en quesos – método de prueba* (p. 9). Mexico: Diario Oficial de la Federación.
- NMX-F-738-COFOCALEC. *Sistema producto leche - alimentos - lácteos - queso Chihuahua - denominación, especificaciones y métodos de prueba.*, NMX-F-738-COFOCALEC. Mexico: Diario Oficial de la Federación.
- PALMQUIST, D. P., and R. G. Jensen. 2008. Fatty acids in milk fat. In C. K. Chow (Ed.), *Fatty acids in Food and their Health Implications* (pp. 109–126). Boca Raton FL: CRC Press.
- REINECCIUS, G. 2006. *Flavor chemistry and Technology*. Boca Raton FL: Taylor and Francis Group.
- TAYLOR, A. J., and D. D. Roberts. 2004. *Flavor Perception*. Ames, Iowa: Blackwell Publishing Ltd.
- TAYLOR-HANSEN, L. D. 2005. Las migraciones menonitas al norte de México entre 1922 y 1940. *Migraciones Internacionales*, 3(1), 5–31.
- TORNAMBÉ, G., A. Comu, P. Pradel, N. Kondjoyan, A. P. Carnat, M. Petit, and B. Martin. 2006. Change in terpene content in milk from pasture-fed cows. *Journal of dairy science*, 6, 2309–2319.
- TUNICK, M. H., D. L. VanHekken, F. J. Molina-Corral, P. M. Tomasula, J. Call, J. Luchansky, and A. A. Gardea. 2008. Queso Chihuahua: manufacturing procedures, composition, protein profiles, and microbiology. *International Journal of Dairy Technology*, 61, 62–69.
- VANHEKKEK, D. L., M. A. Drake, F. J. Molina-Corral, V. M. Guerrero-Prieto, and A. A. Gardea. 2006. Mexican Chihuahua cheese: sensory profiles of young cheese. *Journal of dairy science*, 89, 3729–3738.
- VILLEGAS, A. 2003. *Los quesos Mexicanos* (2nd ed.). Estado de México, México: Universidad Autónoma de Chihuahua. 

Este artículo es citado así:

Almanza-Rubio, J. L., R. E. Orozco-Mena y N. Gutiérrez-Méndez. 2013: *Assessing consumer preference toward Chihuahua cheese and Chihuahua-type cheese*. *TECNOCENCIA Chihuahua* 7(3): 123-131.

Resúmenes curriculares de autor y coautores

JOSÉ LUIS ALMANZA RUBIO. Cursó la carrera de Ingeniero Químico en la Facultad de Ciencias Químicas de la Universidad Autónoma de Chihuahua. Se encuentra cursando la Maestría en Ciencia y Tecnología de los Alimentos en la misma facultad.

RAÚL EDUARDO OROZCO MENA. Cursó la carrera de Ingeniero Químico en la Facultad de Ciencias Químicas de la Universidad Autónoma de Chihuahua. Se encuentra cursando la Maestría en Ciencia y Tecnología de los Alimentos en la misma facultad.

NÉSTOR GUTIÉRREZ MÉNDEZ: Ingeniero Agroindustrial por la Universidad Autónoma del Estado de Hidalgo (UAEH), con maestría en Ciencia y Tecnología de Alimentos por la Universidad Autónoma de Chihuahua (UACH) y doctorado en Ciencia de los Alimentos por el Centro de Investigación en Alimentación y Desarrollo (CIAD). Actualmente se desempeña como profesor investigador en la Facultad de Ciencias Químicas de la Universidad Autónoma de Chihuahua. Participa en los programas de licenciatura y en el posgrado en Ciencia y Tecnología de Alimentos. Ha sido ganador en dos ocasiones del Premio Nacional en Ciencia y Tecnología de Alimentos y actualmente miembro del Sistema Nacional de Investigadores, Nivel I.