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Time-intensity profile and relationship with consumer acceptability of processed cheese spread

Perfil tempo-intensidade e a relação com a aceitabilidade do consumidor de queijos tipo requeijão

Perfil tiempo-intensidad y relación con la aceptabilidad del consumidor del queso tipo "requeijão"

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Abstract
Creamy "requeijão" is the commercially most prominent processed cheese spread in Brazil. The time intensity analysis is important to provide how the flavor behavior is for the consumers during the food ingestion and is used in order to obtain the temporal profile of an attribute in a certain product. In the present study, three different commercial brands, leaders in the market, in their traditional and light versions, were subjected to sensory and instrumental evaluations. Time-intensity analyses and acceptance tests were carried out. After the statistical evaluation, applying ANOVA, the Tukey test (p. 0.05), Partial Least Square (PLS), it was concluded that the consumers preferred products with a more intense cheese flavor and higher adhesiveness, besides expressing a greater acceptance and purchase intention for the product in its traditional version.
Keywords: PLS; Cheese; Sensory; Instrumental; Acceptance.

Resumo
O requeijão cremoso é o queijo processado fundido comercialmente mais conhecido no Brasil. A análise do tempo-intensidade é relevante para fornecer como se comporta o sabor para os consumidores durante a ingestão do alimento e é utilizada para obter o perfil temporal de um atributo em um determinado produto. No presente estudo, três diferentes marcas comerciais, líderes no mercado, em suas versões tradicional e light, foram submetidas a avaliações sensoriais e instrumentais. Análises tempo-intensidade e testes de aceitação foram realizados. Após avaliação estatística, aplicando ANOVA, teste de Tukey (p. 0.05), Partial Least Square (PLS), concluiu-se que os consumidores preferiram produtos com sabor de queijo mais intenso e com maior adesividade, além de expressarem maior aceitação e intenção de compra para o produto em sua versão tradicional.
Palavras-chave: PLS; Queijo; Sensorial; Instrumental; Aceitabilidade.

Resumen
El cremoso "requeijão" es el queso procesado para untar comercialmente más destacado de Brasil. El análisis de intensidad temporal es importante para conocer cómo es el comportamiento del sabor para los consumidores durante la ingestión del alimento y se utiliza para obtener el perfil temporal de un atributo en un determinado producto. En el presente estudio se sometieron a evaluación sensorial e instrumental tres marcas comerciales diferentes, líderes en el mercado, en sus versiones tradicional y light. Se llevaron a cabo análisis de intensidad de tiempo y pruebas de aceptación. Luego de la evaluación estadística, aplicando ANOVA, la prueba de Tukey (p. 0.05), Partial Least Square (PLS), se concluyó que los consumidores prefieren productos con sabor a queso más intenso y mayor adhesividad, además de expresar una mayor aceptación e intención de compra. para el producto en su versión tradicional.
Palabras clave: PLS; Queso; Sensorial; Instrumental; Aceitabilidad.

1. Introduction

"Requeijão cremoso" is a typically Brazilian processed cheese spread, whose consistency allows them to be spread with a knife at room temperature. It is manufactured from raw or pasteurized skimmed milk, with or without the addition of lactic fats (Oliveira, 1986; Silva, 2003;). According to Brasil **(**2004**)**, 47000 tons of this type of processed cheese spread were commercialized in 2007, corresponding to 7.5% of the total cheese production

In the past 30 years has largely been emphasis on control of caloric intake, especially in developed countries (Mistry, 2001). So, the manufacture and available of low fat spread cheese is responsible for the market growth. However, it is normally reported that the mixture and the free-fat dry extract contents are the main factors affecting the hardness of the spread cheese, enabling the elaboration of light "requeijão" with reduced fat and a similar texture to the traditional version (Verma and Gupta, 1981). To date no studies were found that evaluated the effect of the reduced fat on acceptance by consumers of this product.

The quality parameters of a determined group of products can also be established by correlating the results of descriptive sensory tests (trained panelists), affective sensory tests using consumers of the product and instrumental/chemical analyses (Baker *et al*, 1998). This relationship supports the determination of the most well-adapted sensory profiles with respect to product quality for the target market, enabling large companies to establish quality control activities, improve quality and develop new products (Elortondo *et al*, 2007). The Partial Least Square (PLS) is an important tool to make relationship between sensory profile data, instrumental analyses and consumer acceptance (Tenenhaus *et al.*, 2005).

Currently time intensity analysis (TI) is another a descriptive sensory technique frequently used to several foods as flavored gelatin ice cream (Cadena & Bolini, 2011), chocolate (Palazzo et al., 2011), sea and land salts (Drake and Drake, 2011) and yerba mate infusions (Calviño et al., 2004).

TI allows for the measurement of a stimulus during a course of time, determining the velocity of perception and duration of such a stimulus. This technique is based on one pre-establish sensory characteristic in the sample evaluated, when, for example, from the association between human perception and computer resources, the time course between the perception of an attribute and its respective intensity is perceived (Bolini & Faria, 1999).

The aim of this study was to investigate the relationship between instrumental parameters (pH, color and texture) and TI sensory analysis of cheese flavor, saltiness and adhesiveness on the acceptance by potencial consumers of creamy "requeijão" traditional and light.

2. Methodology

2.1 Products

The products evaluated in this study were the main "requeijão" brands on the market, purchased in supermarkets in the city of Campinas, SP, Brazil. Six different products were assessed on Table 1. All of the samples were manufactured in multinational industries.

Table 1 - Types of product, manufacturing location and abbreviations for the product evaluated

Type of product / Manufacturing location place	Product abbreviation
Traditional sample (São Paulo, BRAZIL)	TRA1
Light sample (São Paulo, BRAZIL)	LIG1
Traditional sample (São Paulo, BRAZIL)	TRA2
Light sample (São Paulo, BRAZIL)	LIG2
Traditional sample (Minas Gerais BRAZIL)	TRA3
Light sample (Minas Gerais, BRAZIL)	LIG3

Source: Authors.

2.2 Time – intensity analysis

Using TI analysis (Techakriengkrai *et al*, 2004), the six samples of "requeijão cremoso" (Table 1) were performed for salty taste, cheese flavor and adhesiveness by a panel of eight trained judges (2 male and 6 female, ages 18-35 and students from the Food Engineering Faculty at UNICAMP). Candidates were initially screened based on: subjects' discrimination capability to determine global differences in the samples of "requeijão" through the Wald Sequential Analysis using a series of Triangular Difference Tests (Meilgaard *et al*, 2004). In the sequential analysis the values of p0 = 0.45 (maximum acceptable inability), p1 = 0.70 (minimum acceptable ability), and for risks, α=0.05 (probability of accepting a candidate without sensory acuity) and β=0.05 (probability of rejecting a candidate with sensory acuity) were used.

In order to train the panelists some references were used (Table 2), allowing them to sense the maximum intensity that could be perceived for each chosen attribute: salty taste, cheese flavor and adhesiveness. The training procedure consisted to evaluation these three attributes cited in three TI sessions using three sample of commercial "requeijão". This method was using to become familiar the judges with the time-intensity analysis, with the scale that was used and with the attributes evaluated. With the data collected, an ANOVA (Source of Variation: sample and replications) was performed for each panelist and each attribute. Eight individuals showing adequate discriminate power ($_pF_{sample}$ 0.50) and reproducibility ($_pF_{replication}$ 0.05) were selected to participate in the TI analysis (ASTM 1976).

Table 2 - Definition and attribute references to be evaluated in the time - intensity analyses.

Attribute	Definition	Reference standared
Salty taste	Characteristic taste of an aqueous NaCl solution	2.0% aqueous NaCl solution
Cheese flavor	Characteristic flavor of a "polenguinho" cheese	Traditional "requeijão" lactic speciality, manufactured under the brand name of Polengh
Adhesiveness	Strength required to pass the sample from the spoon to the tongue, related to the consistency that could be felt in the mouth (mouth feel).	Caramel sauce used in ice-creams, manufactured under the brand name of Du Porto, served at 10ºC

Source: Authors.

For the sensory evaluation, the selected panelists assessed the six samples of "requeijão", served in teaspoons (4g/portions) and codified with three-digit random numbers, in three repetitions of test. Evaluations were conducted at 20 ± 2°C, in individual booths under incandescent white illumination in a monadic way. Judges were oriented to rinse twice with distilled water for 20s before tasting the next sample.

The TI data was collected using the SCDTI (Time Intensity Data Acquisition System) program, developed in the Laboratory of Sensory Analysis of the Faculty of Food Engineering – UNICAMP (Bolini-Cardello *et al*, 2003). The panelists responded to the intensity of the three selected stimulus (salty taste, cheese flavor and adhesiveness) by using a time-intensity device with a 9 cm hybrid scale anchored in the left and right extremes with the terms "none" and "strong", witch was manipulated by the mouse of a personal computer. The TI curves were constructed with the data generated, with the following parameters: Maximum perceived intensity (I_{max}), Time for maximum intensity (TI_{max}), Total duration time (T_{tot}) and Total area under the curve (Area).

2.3 Affective test

Consumer acceptance tests were carried out with the six samples of "requeijão" in terms of appearance, aroma, flavor, texture and overall impression. Based on Hough *et al*. (2006), for this test 120 consumers of "requeijão" were requested to evaluate each sample, using a non-structured 9 cm scale with anchors ''dislike extremely" and ''like extremely". In the same

analysis, the participants were also asked to report their buying attitude regarding each sample, using a five-point purchasing attitude scale (Meilgaard *et al*. 1999). The samples, in teaspoons (4g/portions) codified with three-digit random numbers, were presented in complete block and the order of presentation of the samples was balanced for the first-order effect according with MacFie *et al*. (1989). Evaluations were conducted at 20 ± 2°C, in individual booths under incandescent white illumination and in a monadic way. Water was provided for palate cleansing before tasting the next sample.

2.4 Instrumental analysis

The six samples of "requeijão" were evaluated three times using three different batches of each one.

2.4.1 Texture analysis

The sample textures were evaluated from the TPA carried out using a universal texturometer TA TX2, SMS – *Stable Micro Systems*. All the experiments were carried out at temperature of 20 ± 2ºC.

A uniaxial compression was performed on 250 ml of "requeijão" jars. The crosshead speed was 1.0mm/s and the cylindrical probe (with 2 cm diameter) compressed to 10.0mm. The same texture analyzer and load cell were used in another research with "requeijão" for the puncture test, fitting a cylindrical probe with a 2 cm diameter to the cell (Rapacci, 1997).

2.4.2 Color Analysis

Color measurements (L* = lightness, a* = redness, b* = yellowness) were determined using a Hunter Lab colorimeter (Color Quest II). Illuminate D65 (6900°K) and 10º standard observer were used (Gigante, 1998).

This instrument was standardized prior to each use by covering the white tile with a swatch of packaging material, using the white (C6299 Hunterlab Color Standard) and gray (C6299G Hunterlab Color Standard) references with a 10 mm quartz cuvette.

The samples were carefully placed in the cuvettes at room temperature to prevent the formation of air bubbles.

2.4.3 pH analysis

The pH measurements were performed with an Ion Analyzer EA 940 pH meter (Orion Expandable, Boston, USA).

2.5 Statistical analysis

The data of the parameters obtained from the TI curves, consumer acceptance test and instrumental analysis were evaluated using the ANOVA and Tukey test for multiple mean comparisons ($p \leq 0.05$). All statistic analyses were performed using SAS version 9.1.3 (SAS Institute, Cary, N.C.).

TI information obtained from the trained panel and instrumental analysis were related to the consumer acceptance data using PLS regression. This statistical analysis carried out using XLSTAT 2006(Addinsoft Inc., Paris, France) software at a 5% significance level.

3. Results and Discussion

3.1 Sensory analysis

According to TI results (Table 3), the cheese flavor mean for sample LIG3 were significantly different ($p<0.05$) from the other means samples for the parameter Imax, with the exception of the traditional version of the same brand (TRA3). The Figure 1 also illustrates that sample LIG3 has the lowest Imax peak. Notwithstanding, the time necessary to reach the TI_{max} was almost the same for all the samples.

Table 3 - Time – intensity means for the parameters: cheese flavor, salty taste and adhesiveness.

Samples	CHEESE FLAVOR				SALTY TASTE				ADHESIVENESS			
	TImax (s)	Area	Ttot (s)	Imax	TImax (s)	Area	Ttot (s)	Imax	TImax (s)	Area	Ttot (s)	Imax
TRA1	12.81 [a]	116.88 [a]	37.63 [a]	6.54 [a]	10.96 [a]	93.71 [a]	34.10 [a]	6.11 [a]	10.18 [a]	67.50 [a]	22.75 [a]	6.04 [a]
LIG1	11.66 [a]	101.05 [ab]	33.10 [ab]	6.32 [a]	11.17 [a]	104.60 [a]	33.59 [a]	5.90 [a]	11.36 [a]	60.97 [a]	20.74 [a]	5.64 [ab]
TRA2	11.85 [a]	99.61 [ab]	32.83 [ab]	6.16 [a]	11.60 [a]	95.10 [a]	34.82 [a]	5.49 [a]	8.58 [a]	62.98 [a]	20.96 [a]	5.35 [b]
LIG2	11.65 [a]	104.93 [ab]	32.77 [ab]	6.05 [a]	10.93 [a]	92.26 [a]	31.29 [a]	5.61 [a]	9.33 [a]	54.65 [a]	21.25 [a]	5.36 [b]
TRA3	12.11 [a]	91.69 [ab]	33.42 [ab]	5.96 [ab]	12.28 [a]	87.46 [a]	29.74 [a]	5.47 [a]	9.03 [a]	50.18 [a]	20.24 [a]	5.19 [b]
LIG3	12.07 [a]	80.13 [b]	29.11 [b]	5.32 [b]	11.42 [a]	85.92 [a]	30.91 [a]	5.39 [a]	10.39 [a]	57.19 [a]	19.95 [a]	5.75 [ab]

Values with different superscripts in the same column are significantly different, p □ 0.05. Source: Authors.

The Table 3 also shows that for the salty taste all the means for all the samples were not significantly different from each other (p □ 0.05) for the four parameters evaluated. Similar behavior amongst the samples for salty taste attribute was showed in the Figure 1, that illustrates the peaks for Imax for the curves of all the brands.

For the adhesiveness attribute, the sample TRA1 had the highest mean for Imax and was therefore significantly (p □ 0.05) more adhesive than the other above mentioned samples (TRA2, LIG2 and TRA3), which presented lower means for Imax. Figure 1 also shows a higher peak for the maximum intensity (Imax) of sample TRA1 as compared to those of samples TRA2, LIG2 and TRA3.

In the results for consumer acceptance (Table 4), the sample LIG2 appearance was the most accepted, but did not differ significantly ($p < 0.05$) from samples LIG1 and TRA2. In contrast, the sample LIG3 differed significantly ($p < 0.05$) from the others, being the worst accepted.

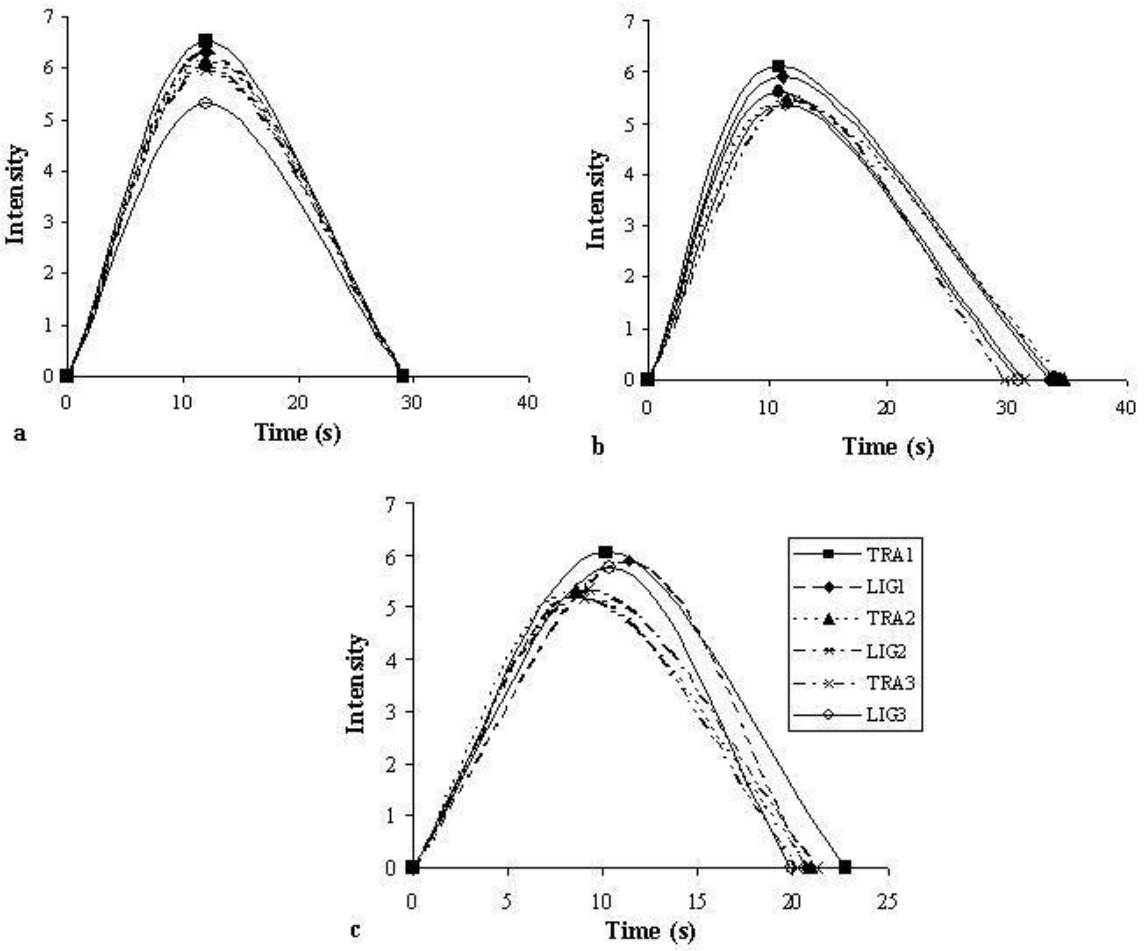
Table 4 – Means for the consumer acceptance.

Samples	**Appearance [1,2]**	**Aroma [1,2]**	**Flavor [1,2]**	**Texture [1,2]**	**Overall impression [1,2]**
TRA1	5.72 [b]	5.51 [ab]	6.48 [a]	6.17 [ab]	6.26 [a]
LIG1	6.24 [ab]	5.61 [a]	5.89 [ab]	6.35 [a]	6.11 [a]
TRA2	6.37 [a]	5.33 [ab]	5.10 [bc]	5.75 [ab]	5.61 [ab]
LIG2	6.82 [a]	5.43 [ab]	4.62 [c]	6.23 [a]	5.46 [b]
TRA3	5.70 [b]	5.02 [bc]	4.61 [c]	5.53 [bc]	5.04 [b]
LIG3	4.96 [c]	4.55 [c]	3.78 [d]	4.95 [c]	4.28 [c]

[1] Using a 9 cm non-structured scale varying from "disliked extremely" to "liked extremely". [2] Values with different superscripts in the same column were significantly different, $p < 0.05$. Source: Authors.

The sample LIG1 was the most accepted for aroma, but did not differ significantly (p □ 0.05) from samples TRA1, TRA2 and LIG2. Over again, the sample LIG3 differed significantly ($p < 0.05$) from the others being the worst accepted.

Figure 1 - Time – intensity curve parameters for "requeijão": cheese flavor (a), salty taste (b) and adhesiveness (c), used in the statistical analysis.



Source: Authors.

With respect to flavor, sample TRA1 showed the highest means of acceptance, but did not differ from sample LIG1. The lowest mean of acceptance was for sample LIG3, which differed significantly ($p < 0.05$) from the others.

For the attribute texture, there were no significant differences ($p < 0.05$) between the samples TRA1, LIG1, TRA2 and LIG2, these samples all showing the highest score for this attribute. The sample LIG3 was the worst accepted and differed significantly ($p < 0.05$) from the others with exception of the traditional version of the same brand (TRA3).

Thus, except for brand 3, brands 1 and 2 showed the same consumer acceptance for the two forms, providing evidencing of the high quality of light "requeijão" as compared to the traditional product.

Finally, Table 5 shows that brand 1 (TRA1 and LIG1) obtained the best scores for purchasing intention, more than 40% stating they certainly would buy TRA1, and approximately 35% certainly would buy LIG1. The brand 3 (TRA3 and LIG3) obtained the worst scores for purchasing intention, more than 40% stating they certainly would not buy LIG3 and 25% certainly would not buy TRA3. For all the brands the purchasing intention for the traditional versions was higher than for the light version of the same brand.

Table 5 - Means for purchasing intention for the "requeijão".

Samples	TRA1	LIG1	TRA2	LIG2	TRA3	LIG3
I would certainly not buy this product	7,63%	9,32%	12,71%	15,25%	21,19%	36,44%
I would probably not buy this product	10,17%	13,56%	17,80%	21,19%	16,95%	26,27%
I´m not sure if I would buy this product or not	15,25%	19,49%	26,27%	27,97%	27,12%	17,80%
I would probably buy this product	31,36%	28,81%	23,73%	19,49%	22,03%	12,71%
I would certainly buy this product	35,59%	28,81%	19,49%	16,10%	12,71%	6,78%

Source: Authors.

3.2 Instrumental Analysis

The results for luminosity (L), redness (a*) and yellowness (b*) of the samples are presented in Table 6. The parameters b* were significantly different (p □ 0.05) for the brand 3 (TRA3 and LIG3). These samples were more yellow than the other samples, which could have contributed to their reduced acceptance by the consumers with respect to appearance.

Table 6 – Means for color and texture parameters of the "requeijão" samples.

Samples	L	a*	b*	pH	Hardness	Adhesiveness	Springiness	Cohesiveness
TRA1	88.27□ 0.58 [a]	0.45□0.05 [a]	11.34□0.18 [b]	5.82□0.02 [b]	5.18□0.49 [a]	-0.30□0.29 [a]	0.93□0.0 [abc]	0.58□0.04 [c]
LIG1	88.09□ 0.16 [a]	0.30□0.02 [a]	11.39□0.42 [b]	5.72□0.01 [c]	0.55□0.16 [b]	-0.23□0.05 [a]	0.92□0.03 [bc]	0.61□0.03 [bc]
TRA2	88.81□0.21 [a]	0.31□0.02 [a]	10.86□0.04 [b]	6.04□0.00 [a]	0.34□0.65 [b]	-0.17□0.07 [a]	0.91□0.02 [c]	0.56□0.05 [c]
LIG2	87.81□1.06 [a]	0.23□0.00 [a]	11.15□0.16 [b]	6.01□0.03 [a]	0.35□0.39 [b]	-0.21□0.14 [a]	0.95□0.02 [abc]	0.60□0.02 [bc]
TRA3	87.45□0.34 [ab]	-0.23□0.01 [a]	13.84□0.12 [a]	5.98□0.03 [a]	0.24□0.04 [b]	-0.10□0.04 [a]	0.98□0.01 [a]	0.68□0.03 [ab]
LIG3	85.74□0.33 [b]	-0.99□0.01 [b]	15.21□0.06 [a]	5.73□0.03 [c]	0.31□0.10 [b]	-0.18□0.11 [a]	0.97□0.02 [ab]	0.71□0.01 [a]

[1] Values with different superscripts in the same column are significantly different, $p < 0.05$. Source: Authors.

With respect to texture, the sample TRA1 was significantly firmer (p □ 0.05) and received the highest scores for overall impression in acceptance test. In the other hand, the sample LIG3 presented a greater value for the parameter cohesiveness, but did not differ significantly (p □ 0.05) from its traditional version (TRA3) and both presented the lowest scores for consumer acceptance for the attribute of texture.

According to Guinard and Mazzucchelli (1996), the food texture is important as a quality indicator that consumers use to accept or reject a food product. The relationship between sensory and instrumental texture measurements of natural and processed cheeses was studied by Drake *et al* (1999). The instrumental measurements studied included the texture profile analysis (TPA) and some fundamental rheological tests, but TPA was better at predicting sensory attributes when the cheeses were divided into two groups, natural and processed. In this study the samples that showed highest hardness and adhesiveness were, in general, the best accepted. Garruti *et al* (2003) found the same results, when studying the sensory profile of four commercial brands of "requeijão", observing that the consumers preferred more consistent samples.

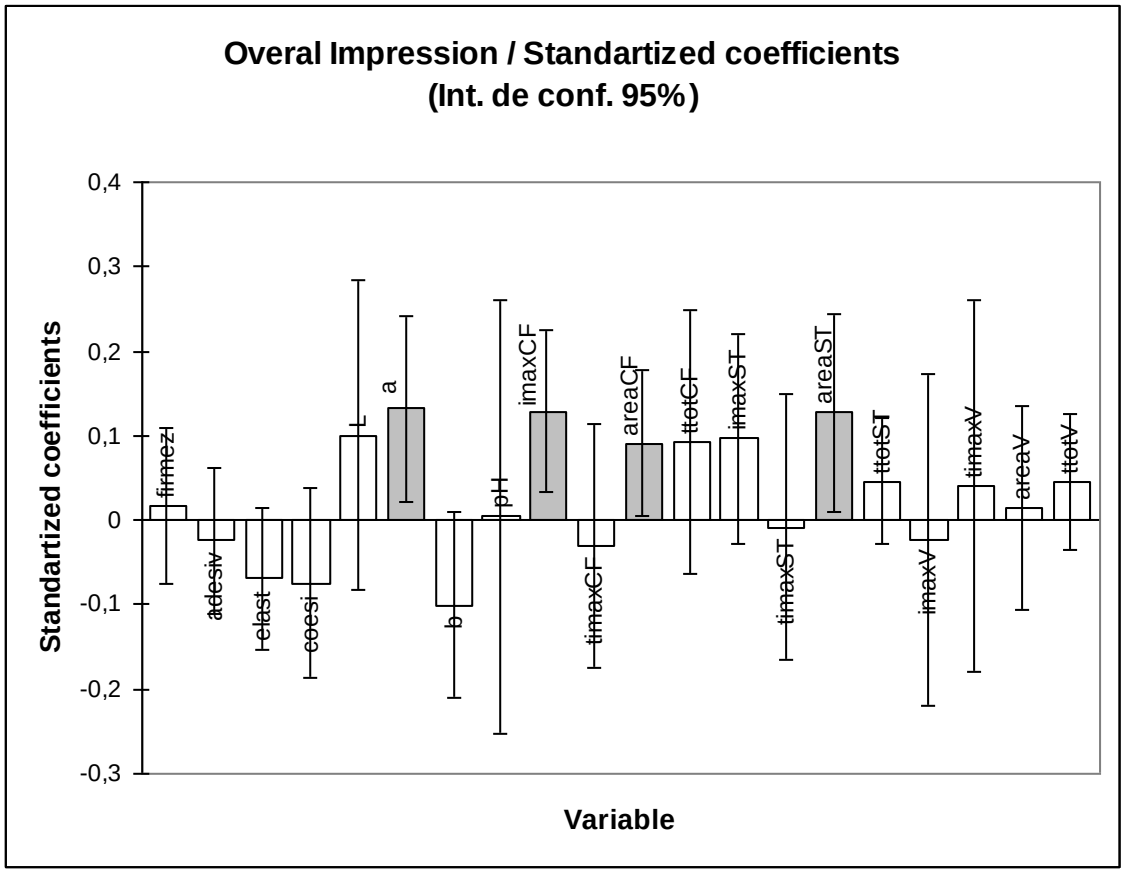
For cheddar cheese, Bryant *et al* (1995) concluded that when the fat content of the cheese decreased, the hardness and springiness increased and adhesiveness and cohesiveness decreased. However, for "requeijão", only hardness demonstrated this behavior.

Is important to observe that the high standard deviations among TPA parameters (hardness and adhesiveness) of the "requeijão" samples showed in the Table 6, probably occurred because were evaluated three different batches of each one sample. Showed that the quality control of the industries could be improved.

3.3 PLS Regression

The Figure 2 represents the results of the standardized coefficient taking as dependent variable overall impression and the independent variables, represented as bars, with minimum and maximum values and with yours standard deviation, with 95% of confidence.

Figure 2 - Indication of significant characteristics of "requeijão" samples with positive or negative importance in overall impression for the consumers.



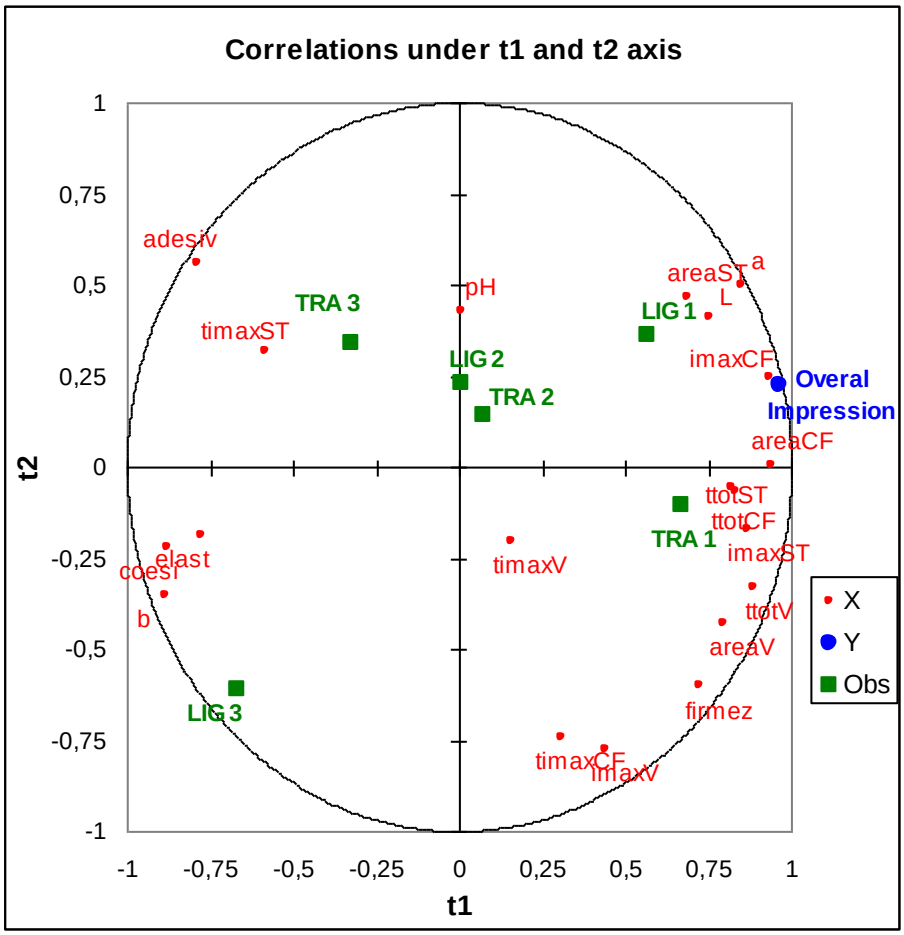
Source: Authors.

The variables facing up with standard deviation within the limits of the bar (gray bars) contribute significantly ($p<0.05$) positively to the acceptance of consumers. Therefore, the parameter of color a*, Imax and Area of cheese flavor and the Area of salty taste are predictive variables of importance, because it is evidenced that contribute positively to the acceptance of samples of “requeijão”.

Wendin (2000) evaluated a TI study with cream cheese for sourness, saltiness and fatty-creamy attributes and fatty-creamy showed the biggest differentiation between the samples. In this research, in the TI analysis for the “requeijão”, the cheese flavor was the best sensorial descriptor to characterize the samples, correlating positively (p=5%) with the acceptance of them.

The Figure 3 shows that the samples LIG1 and TRA1 are the most accepted because they have the variables that contribute positively with more intensity, and is located near to them, as well as the point that represent the overall impression.

Figure 3 - Correlation circle of the products, characteristics (T-I and instrumental parameters) and overall impression of consumers.



LIG2 and TRA2 are located a little distant of the overall impression, followed by TRA3. The sample LIG3 is located more distant, showing that sample is the less accepted by consumers, exactly for having with less intensity on the attributes that contributed positively to the acceptance of "requeijão". Though TRA2 and LIG2 are located close to the variables pH and T_{imax} of adhesiveness while TRA3 are close to T_{imax} of salty taste and LIG3 are near to springiness and cohesiveness, presenting the respective variables with more intensity, these do not influenced the acceptance significantly. Source: Authors.

4. Conclusion

With this study is possible to conclude that the "requeijão" is better accepted by the consumers as soon as more intensity of cheese flavor, hardness and less intensity of color yellow (b*) are observed. The TRA1 was the most accepted sample and demonstrated all this above characteristics. Additionally, for the same brand of "requeijão" is important to observe that in general the traditional version was better accepted than your light version. This analysis is different from the conventional descriptive analysis because it allows the verification of changes in the perception of a product's attribute over time. The sensory results showed in this study should be useful to researchers and product developers who are using fat substitutes in food, especially in spread cheese. Thus, future researches could use some parameters to development or improved our products.

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