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Characterization of creamy sauce made with cryoconcentrated soymilk

Caracterização do molho cremoso elaborado com extrato de soja crioconcentrado

Caracterización de la salsa cremosa preparada con extracto de soja crioconcentrado

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Abstract

Creamy sauces are consumed worldwide and can be formulated using different ingredients, obtaining products with some specific characteristics. The objective of this work was to evaluate the physical-chemical characteristics and sensory acceptance and the hygienic-sanitary conditions of the creamy sauce made with cryoconcentrated soymilk. The cryoconcentrated soymilk, salt, sugar, citric acid, xanthan gum, phosphoric acid and potassium sorbate were homogenized; the soy oil was added slowly with stirring to form the

emulsion. The creamy sauce, made without the addition of eggs, was evaluated for its physical-chemical characteristics, hygienic-sanitary conditions and sensory acceptance. The creamy sauce showed good nutritional characteristics with a higher protein content, lower lipid content and cholesterol free, comparing with commercial mayonnaise. The pH and acidity of the creamy sauce were low. The evaluation of the hygienic-sanitary conditions of the creamy sauce indicated that the product is safe for consumption and meet the specifications of legislation. The microstructure of the creamy sauce was dispersed with highly packaged oil droplets of different sizes and polydispersed. The color of the sauce was light and with a tendency towards green and yellow. Acceptance was satisfactory with 70% approval and the most accepted attributes were color and texture. The purchase intention was over 90%. The formulation of the creamy sauce using the cryoconcentrated soymilk and different ingredients can be modified to improve some characteristics and validity of the product.

Keywords: Emulsion; Soy products; Mayonnaise; Xanthan gum; Sensory acceptance.

Resumo

Os molhos cremosos são consumidos em todo o mundo e podem ser formulados com diferentes ingredientes, obtendo produtos com algumas características específicas. O objetivo deste trabalho foi avaliar as características físico-químicas, a aceitação sensorial e as condições higiênico-sanitárias do molho cremoso feito com extrato de soja crioconcentrado. O extrato de soja crioconcentrado, sal, açúcar, ácido cítrico, goma xantana, ácido fosfórico e sorbato de potássio foram homogeneizados, o óleo de soja foi adicionado devagar sob agitação para formar a emulsão. O molho cremoso, elaborado sem a adição de ovos, foi avaliado pelas características físico-químicas, condições higiênico-sanitárias e aceitação sensorial. O molho cremoso apresentou boas características nutricionais, com maior teor proteico, menor teor lipídico e sem colesterol, comparando com maionese comercial. O pH e a acidez do molho cremoso foram baixos. A avaliação das condições higiênico-sanitárias do molho cremoso indicou que o produto é seguro para o consumo e atenderam às especificações da legislação. A microestrutura do molho cremoso foi dispersa com gotículas de óleo altamente embaladas, de diferentes tamanhos e polidispersas. A cor do molho foi clara e com tendência para o verde e amarelo. A aceitação foi satisfatória com 70% de aprovação e os atributos mais aceitos foram cor e textura. A intenção de compra foi superior a 90%. A formulação do molho cremoso utilizando o extrato de soja crioconcentrado e diferentes ingredientes pode ser modificada para melhorar algumas características e validade do produto.

Palavras-chave: Emulsão; Produtos de soja; Maionese; Goma xantana; Aceitação sensorial.

Resumen

Las salsas cremosas se consumen en todo el mundo y se pueden formular con diferentes ingredientes, obteniendo productos con unas características específicas. El objetivo de este trabajo fue evaluar las características físico-químicas, la aceptación sensorial y las condiciones higiénico-sanitarias de la salsa cremosa elaborada con extracto de soja crioconcentrado. El extracto de soja crioconcentrado, la sal, el azúcar, el ácido cítrico, la goma de xantano, el ácido fosfórico y el sorbato de potasio se homogeneizaron, el aceite de soja se añadió lentamente con agitación para formar la emulsión. La salsa cremosa, elaborada sin la adición de huevos, fue evaluada por sus características físico-químicas, condiciones higiénico-sanitarias y aceptación sensorial. La salsa cremosa mostró buenas características nutricionales, con mayor contenido de proteínas, menor contenido de lípidos y sin colesterol, en comparación con la mayonesa comercial. El pH y la acidez de la salsa cremosa fueron bajos. La evaluación de las condiciones higiénico-sanitarias de la salsa cremosa indicó que el producto es seguro para el consumo y cumplen con las especificaciones de la legislación. La microestructura de la salsa cremosa se dispersó con gotitas de aceite altamente empaquetadas, de diferentes tamaños y polidispersadas. El color de la salsa era claro, verde y amarillo. La aceptación fue satisfactoria con un 70% de aprobación y los atributos más aceptados fueron el color y la textura. La intención de compra fue superior al 90%. La formulación de salsa cremosa a base de extracto de soja crioconcentrado y diferentes ingredientes se puede modificar para mejorar algunas características y validez del producto.

Palabras clave: Emulsión; Productos de soja; Mayonese; Goma xantana; Aceptación sensorial.

1. Introduction

Probably mayonnaise is the most widely used cream sauce in the world and traditionally contains egg, vinegar, condiments, and especially oil, between 70 to 80% of the total mass. In Brazil, mayonnaise is defined by the Resolution of the Collegiate Board (RDC No. 276/2005) as “creamy product in the form of a stable emulsion, prepared from vegetable oil (s), water and eggs, which can be added with other ingredients as long as they not disfigure the product” (Brasil, 2005). However, several attempts have been made to replace some mayonnaise ingredients, such as egg yolk, to reduce the cholesterol content, or to

replace the lipid fraction to obtain a creamy sauce with typical sensory characteristics, but with reduced energy value. Therefore, soy derivatives have been highlighted for the preparation of oil-in-water emulsions due to their ability to emulsify and stabilize them, in addition to increasing the protein content and reducing the fat.

Among soy derivatives, the extract has a wide application, as it is a product that is easy to obtain, high nutritional value, ready for consumption and of low cost (Seibel, 2018). In 1999, the Food and Drug Administration (FDA) claimed that foods containing soy proteins, associated with low in saturated fat and cholesterol diets, may reduce the risks of heart disease (FDA, 1999) and thus its consumption started to be encouraged.

Soymilk in liquid or powder form has many applications in the food industry and can be consumed as drinks or as a component of dairy products, such as yoghurts, ice cream and creams (Ribeiro, Andrade, Daniels & Seibel, 2014; Silva, Prudêncio, Felberg, Deliza & Carrão-Panizzi, 2007). However, liquid soymilk has a high percentage of water that can be partially removed by using specific processes and applied for other purposes. Thus, cryoconcentration can be used as a promising and effective means to obtain concentrated liquid foods, as it prevents the loss of quality of the original product. The principle of the cryoconcentration process is based on the total freezing of an aqueous solution, followed by a partial defrosting procedure and the use of a simple gravitational separation (Aider & Halleux, 2009; Petzold, Moreno, Lastra, Rojas & Orellana 2015). The cryoconcentrated product can be used, among other foods, for the preparation of creamy sauces.

In this context, the aim of this work was to elaborate and evaluate the physical-chemical characteristics and sensory acceptance and the hygienic-sanitary conditions of the creamy sauce made with cryoconcentrated soymilk.

2. Methodology

2.1 Elaboration cryoconcentrated soymilk

Soymilk (SM) was obtained as described by Seibel (2018). In this procedure, soy beans were bleached in boiling water 1:3 (g:mL) for 5 min, and soaking for 16h at room temperature. The soaked soy were drained and ground for 5 min in an industrial blender (Metvisa, model LQ15, Brazil) using water at 90 °C in a 1:10 (g:mL) ratio, in relation to unsoaked grains. The soaked and ground soy was placed in polyester bags and centrifuged (Consul centrifuge model Sec Fácil) to obtain the soymilk (SM) and the residue called okara.

The SM was put in rectangular plastic containers (32 cm wide x 45 cm long x 4 cm high), and kept for 24h in the vertical freezer at -18 ºC (Consul, model 280, Brazil). The frozen SM, with a maximum thickness of 1 cm, was ground by hand and packed in polyester bags. These were concentrated by centrifugation (Consul Centrifuge model Sec Fácil) using a rotation of 1,800 rpm until the exit of the SM ends. The semi-concentrated SM obtained, was placed in the containers, frozen and concentrated again. These steps were performed two and three times, until obtaining the cryoconcentrated SM (A, B, C, D, E and F). According to the initial and final content of total soluble solids (ºBrix) of these six batches of SM (Table 2), it was established that batch F was the best for crioconcentration and preparation of creamy sauce. The content of total soluble solids (TSS), expressed in °Brix, was measured in triplicate with a direct reading on the bench refractometer (type Abbe, Instrutherm, model RTA-100).

2.2 Formulation of the creamy sauce of cryoconcentrated soymilk

Cryoconcentrated SM was homogenized in a blender (PHILIPS Walita) for 3 min and sieved (40 mesh). In the homogeneous cryoconcentrated SM, all ingredients were added (Table 1) except oil and homogenized again for another 3 min. Then, the oil was added slowly with stirring to form the homogeneous emulsion or, the creamy sauce. This creamy sauce made with F cryoconcentrated SM was packed in polyethylene bottles, sealed with aluminum seals and kept at room temperature. This product was called “creamy sauce of cryoconcentrated SM” and used to carry out analyzes of physicochemical characterization, evaluation of hygienic-sanitary conditions and sensory acceptance.

Table 1 – Ingredients for the formulation of creamy sauce of cryoconcentrated soymilk.

Ingredients	Quantity (g*100g^{-1})
Cryoconcentrated soymilk	59.0 (17.2ºBrix)
Soy oil	38.2
Salt	0.4
Crystal sugar	0.1
Citric acid	0.5
Xanthan gum	1.2
Phosphoric acid	0.3
Potassium sorbate	0.3

Source: Authors.

2.3 Physicochemical characterization of the creamy sauce of cryoconcentrated soymilk

The creamy sauce of cryoconcentrated SM was characterized in terms of chemical composition, pH measurement, total titratable acidity content, water activity, color analysis and microstructures.

Chemical composition of the creamy sauce of cryoconcentrated SM was carried out in triplicate and according to the methods described by AOAC (2016). Moisture content was determined using an oven at 105 °C until constant weight was obtained. The ash level was determined after sample carbonization, followed by muffle incineration at 550 °C. The lipid content was determined by the Soxhlet method using petroleum ether as a solvent for extraction. The protein content was determined by the micro Kjeldahl method (N × 6.25). And the total carbohydrate content was estimated by a difference of 100% minus the moisture, ash, lipid and protein content.

The pH value of the creamy sauce was obtained with the potentiometer with glass electrode in triplicate (Tecnopon, model NT PHM).

The titratable total acidity content of the creamy sauce was determined in triplicate by titration with standardized 0.1 M sodium hydroxide solution and expressed in g of citric acid per 100 mL of sample.

Water activity (aw) of the creamy sauce was determined at 25 °C ± 1 using the electric hygrometer (AQUALAB 4TE, Decagon CX-2, Pullman, Unites States) calibrated with distilled water, in triplicate.

Color analysis of the creamy sauce was performed using a colorimeter (Konica Minolta CR 400s) and the result was expressed according to the CIELAB system (2020). The equipment was calibrated using the calibration plate and the reading was performed in 10 different points of the creamy sauce of cryoconcentrated SM. The coordinates measured were: L*, a* and b*. Where L * is the luminosity, that varies from 0 to 100, being that 0= total black and 100= total white. Value of a+ = color trend to red; value of a- = color trend to green; value of b+ = color trend to yellow and value of b- = color trend to blue.

The microstructure of the creamy sauce were analyzed using an optical microscope (Leica, model MDS50). One drop of each sample, flooded with methylene blue solution, was placed carefully on a lamina microscope slide, covered with a laminula coverslip and observed at 400 times magnification (Liu, Xu and Guo, 2007).

2.4 Evaluation of hygienic-sanitary conditions of the creamy sauce of cryoconcentrated soymilk

The microbiological analyses of the creamy sauce of cryoconcentrated SM were carried out according to RDC nº 331 (Brasil, 2019) and following the methodologies described by Silva et al. (2017). To determine the NMP of coliforms at 45 °C, the multiple tube technique (three series of three tubes) was used, using the Lauryl Sulfate Triptose Broth - LST for the presumptive test (35ºC / 48h) and the Brilliant Green Bile Broths 2% - VB (35ºC / 24-48h) and Escherichia coli Broth - EC (44.5ºC / 24h) for confirmation of coliforms at 35 °C and coliforms at 45 °C, respectively. The results were expressed using the Hoskings table. For *Salmonella* sp. research the ISO 6579 (2007) methodology was adopted. Suspected colonies in the Xylose Lysine Deoxycholate (XLD) and Agar Salmonella Shigella - SSA were subjected to serum agglutination test based on the antigen-antibody reaction, with consequent agglutination of the antigen against the antiserum for polyvalent Salmonella “O” (Brasil, 2001).

2.5 Sensory acceptance test of the creamy sauce of cryoconcentrated soymilk

Prior to conducting the sensory acceptance test for the creamy sauce of cryoconcentrated SM, the research project was approved by the Research Ethics Committee,

under CAAE number: 85726317.1.0000.5547. The sensory acceptance test was carried out in individual booths, with 100 untrained volunteer judges, 44% male and 56% female; and 84% aged between 18 and 25 years and 16% aged over 26 years. Initially, the judge carried out the analysis of the creamy sauce of cryoconcentrated SM in the presence of a vehicle, using ¼ of loaf bread, without the edges. Later the judge received another creamy sauce without the vehicle. In both samples, the judges evaluated the attributes of color, aroma, flavor, texture and global acceptance using a hybrid hedonic scale from 0 to 10 points, where ZERO corresponded to "I disliked it extremely" and TEN "I liked it extremely" (Villanueva, Petenate & Silva, 2005). Before conducting the sensory acceptance test, all judges were instructed and informed about how to perform this test and signed the consent form. The test of sensory acceptance of the creamy sauce of cryoconcentrated SM was analyzed using the analysis of variance (ANOVA) and the Student t test at the level of 5% of significance, using the Statistic 10.0 program.

3 Results and discussion

3.1 Cryoconcentrated soymilk

The conditions of cryoconcentration to obtain the SM were established by Paulo, Silva and Seibel (2018), who used two and three cycles of freezing and defrosting and obtained a concentration of about six times in the total soluble solids content of the SM. Therefore, six batches (Table 2) of cryoconcentrated SM (A, B, C, D, E, and F) were elaborated to define the parameters of the initial and final TSS content to formulate the best creamy sauce. It was observed that the initial TSS content of the SM was between 3.0 and 3.2 ºBrix and varied according to the different batches of the SM used. However, after the cryoconcentration of the SM, it was observed that the final TSS content varied from 17.2 to 22.0 ºBrix. This variation was due to the application of cryoconcentration in different stages and possibly due to the process conditions that did not control the freezing speed and complete separation of the products. According to Hernández, Raventós, Auleda & Ibarz (2010) and Nakagawa, Nagahama, Maebashi & Maeda (2010) as the water crystals grow during the nucleation phase, the solutes are expelled to the solid-liquid interface and the efficiency of the solids concentration will depend on crystal purity and ice formation kinetics. Therefore, to make the creamy sauce, the F cryoconcentrated SM with 17.2ºBrix was used. F batch was chosen due to the application of only two stages of cryoconcentration, with less

process time and energy expenditure. In addition, when testing the creamy sauce, it was observed that it showed no differences in visual aspect in relation to the other creamy sauces.

Table 2 – Total soluble solids content in the cryoconcentration of soymilk.

Soymilk	TSS[1] initials (ºBrix)	TSS[1] finals (ºBrix)
A*	3.0	18.0
B	3.1	19.1
C	3.2	19.5
D	3.2	22.0
E	3.2	18.1
F*	3.0	17.2

[1]Total soluble solids. *SM cryoconcentrated in two cycles. Source: Authors.

3.2 Evaluation of the creamy sauce of cryoconcentrated soymilk formulation

For the preparation of the creamy sauce with cryoconcentrated SM several previous tests were carried out with alteration of the ingredients (Table 1) and their respective proportions. Since in all the formulations the oil was used in a smaller amount in relation to the traditional products and there was no addition of egg. However, with the removal of the egg and reduction of the amount of oil in the creamy sauces formulations, problems occurred in the formation and stability of the emulsions, and in the sensory characteristics of texture and flavor. The formulation of the creamy sauce of cryoconcentrated SM was established as shown in Table 1, after Paulo et al. (2018), formulate the creamy sauce and verify good consistency, pH <4.0, better appearance and taste more pleasant to the palate, after 7 days of storage under refrigeration.

The ingredients used to make this creamy sauce are traditionally found in commercial mayonnaise. For the acidification of the sauce, citric acid was used, as it is the most common acid in food and has good flavor acceptance and the phosphoric acid that has the characteristic of lowering the pH and is a middle ground between the pronounced acidity of the fruit (acid citric) and the smoothness of other acids (FIB, 2015). Potassium sorbate was used to assist in

microbiological control, with high efficiency and due to its role in inhibiting mould and yeasts (FIB, 2011). Xanthan gum was used as a thickener due to the reduced pH tolerance in acidic and basic ranges, forming emulsions with excellent stability for a long time. According to Chivero, Gohtani, Yoshii, & Nakamura (2016) the xanthan gum molecules in the emulsion continuous phase prevents the oil droplets to cream since the gravitational lift on the droplets is less than the yield stress of the xanthan weak gel. In addition, xanthan gum, even in low concentration, whose recommendation is 0.7-1.5% (w/v), has a high thickening power for sauces (Lersch, 2008). Campos, Antoniassi, Deliza, Freitas & Felberg (2009) used xanthan gum in the preparation of creamy sauce based on SM and observed that it helped in the stability and consistency of the final product.

3.3 Physicochemical and instrumental characterization of the creamy sauce of cryoconcentrated soymilk

In the chemical composition of the creamy sauce of cryoconcentrated SM (Table 3), it was observed that the product has a predominance of water content with 51.62 ± 0.12%, followed by 38.03 ± 2.03% of lipids. In addition, it is noteworthy that the protein content was 2.61 ± 0.41%. The content of these constituents comes from the cryoconcentrated SM and the oil added in the formulation. A mayonnaise with different percentages of gum as an emulsifier was prepared by Cornelia, Siratantri and Prawita, (2015), the product presented a chemical composition distinct from the present work, with lower moisture content (32.38%), proteins (0.16%) and ashes (0.72%) and higher lipid content (60.36%) and carbohydrates (6.54%), due the different ingredients used in formulations.

Table 3 – Chemical composition of creamy sauce of cryoconcentrated soymilk.

Chemical Composition	Content** (g*100g^{-1})
Moisture	51.62 ± 0.12
Ashes	1.59 ± 0.02
Proteins	2.61 ± 0.41
Lipids	38.03 ± 2.03
Carbohydrates*	6.15

*Calculated by difference. ** Means and standard deviation of three samples. Source: Authors.

The incorporation of cryoconcentrated SM in the creamy sauce was advantageous to reduce the lipid content, when compared to the traditional mayonnaise. The traditional product is a semi-solid emulsion and contains 70 to 80% oil in water (Nikzade, Tehrani & Tarzjan, 2012). Hellmann's commercial mayonnaise, is a regular product and leader in the Brazilian market, with a 32.89% lipid and 6.59% carbohydrate content on its label, whose contents are close to the creamy sauce of cryoconcentrated SM (Table 3). The formulation and the amount of proteins in this creamy sauce were nutritionally benefic in relation to commercial mayonnaise, due to the higher protein content (2.61 ± 0.41%) and there was no addition of egg, therefore, it is cholesterol free. According to IMeN (2011), a 100g portion of commercial mayonnaise contains only 0.73g of proteins and pasteurized eggs.

The chemical composition, especially lipid content, affects stability of the emulsions. In traditional mayonnaise the stabilization of the oil-water interface is mainly due to the granular micro-particles formed from the phosphoprotein and coalesced low-density lipoprotein constituents of egg yolk; in this high-lipid product, the granules keep the oil droplets well separated and prevent coalescence (Di Mattia et al., 2015). Chivero et al. (2016) needed 60% oil to stabilize emulsions without eggs and with different emulsifiers.

In the creamy sauce of cryoconcentrated SM made without egg and reduced fat, the stability is due the interaction of the soy proteins and xanthan gum. Proteins have hydrophilic and hydrophobic regions in the same molecule, reducing surface tension at the interface and the xanthan gum has high viscosity. Thus, the active surface of the protein-polysaccharide complex increases the viscosity of the aqueous phase immediately adjacent to the emulsion interface, contributing to the stability of the creamy sauce.

To evaluate the quality of the creamy sauce of cryoconcentrated SM in relation to the development of microorganisms, the pH value, acidity content and Aw were determined (Table 4). The pH value (3.98) of the creamy sauce was less than 4.0 and therefore, it is within the microbiological safety values, according to industrial procedures.

The low acidity of the creamy sauce cryoconcentrated SM, of 2.10 ± 0.02%, came from the citric and phosphoric acids used in the formulation (Table 1) and these represented 0.8% of the total composition of the ingredients. According to Izidoro, Scheer, Negre, Haminiuk & Sierakowski (2008) an emulsion stabilized with green banana pulp and acidified with 4% vinegar had an acidity content of 3.09 to 3.33% and was higher than the creamy sauce (Table 4). However, Mendes, Formigoni, Santos, Rodrigues & Madrona (2016) used 7.47% of lemon as an acidifier in the formulation of mayonnaise developed based on coconut oil and obtained an acidity content of only 0.49% and pH of 4.40.

Table 4 - Physicochemical and color analysis of creamy sauce of cryoconcentrated soymilk

Physicochemical and color analysis	**Measures[1]**
pH	3.98 ± 0.01
Acidity (mg*100g^{-1})	2.10 ± 0.02
Water activity (Aw)	0.9841 ± 0.0001
L*	83.52 ± 1.11
a*	-6.57± 0.08
b*	16.62±0.28

[1]Means and standard deviation of three samples for physicochemical analysis and of 10 samples for the color analysis. Source: Authors.

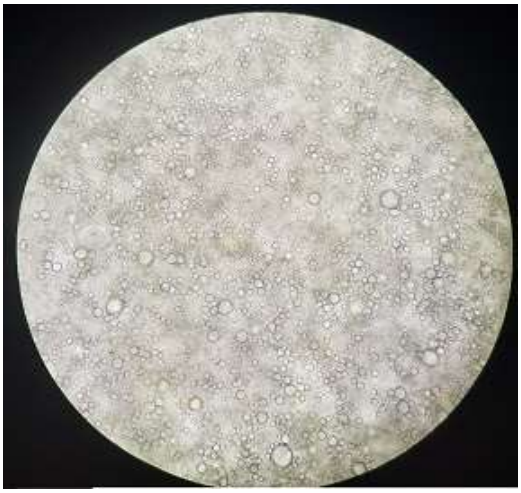
The water activity of 0.9841 ± 0.0001 indicates that the creamy sauce is a perishable food, since most water molecules are not chemically or physically weakly linked, which can be used in chemical and enzymatic reactions, and also in the development of microorganisms. Mayonnaise, according to Chirife, Vigo, Gómez, & Favetto (1989), is a product that normally contains high water content (0.93 to 0.95%) in its composition. However, the combination of high water activity and low pH (<4.1) can inhibit the growth of yeasts and lactobacilli in food (Ma and Boye, 2013). Cornelia, et al. (2015) when making a mayonnaise with different percentages of gum as an emulsifier, found a lower Aw (0.72) than the present creamy sauce, due the interaction of the ingredients.

The color of a food product is one of the most important attributes that can influence its appearance and acceptability, with traditional mayonnaise having a bright yellow color. The color parameter of the creamy sauce of the cryoconcentrated SM measured by luminosity (L*) varied between 81.96 and 84.44, being closer to a total white and, therefore, it was characterized as light. The value of parameter a* was between -6.43 and -6.67 and represents a tendency towards green color, while the value of parameter b* was between 16.07 and 16.86 and presents a tendency towards yellow color (Table 4). The color analysis of the emulsion stabilized with green banana pulp showed parameters a* and b* with a greater tendency for yellow and red due to the content of the banana pulp used (Izidoro et al. 2008). Light mayonnaise with protein and pectin microparticles developed by Chang et al., (2017) showed higher luminosity (87.24 and 94.64) and lower values of a* (-0.18 and -1.10) also indicating a

trend towards green color, and the parameter b* (15.27 and 22.55) a tendency towards yellow color.

The microstructure of the creamy sauce of the cryoconcentrated SM was carried out to evaluate the formation of the oil-in-water emulsion of the emulsified systems (Figure 1). The image shows a dispersed structure, characterized by the presence of highly packaged oil droplets of different sizes and polydispersed. Giacintucci, Mattia, Sacchetti, Neri & Pittia (2016) evaluated the effect of natural and artificial phenolic extracts on the physical properties and stability of mayonnaise. They observed that the extracts significantly influenced the degree of dispersion of the emulsions, compromising the microstructure, flow behavior and product stability. According to Nikzade, et al. (2012) low-fat mayonnaise may have a wide variety of microstructures depending on production conditions and composition, which can drastically interfere with the viscosity of emulsions.

Figure 1 – Microstructure of creamy sauce of cryoconcentrated soymilk.



Source: Authors.

Mun et al. (2009) described that factors such as types of emulsion agents, stability, droplet size, oil concentration and viscosity of the aqueous phase are important parameters to determine the microstructure of mayonnaise. Mayonnaise consists of oil droplets dispersed in an aqueous medium, whose characteristics can vary widely according to the formulation and ingredients used that may interfere in the microstructure of the same. In the emulsions development by Quintana, Franco and Garcia-Zapateiro (2015) the microstructure showed significant differences in distribution and droplet size according to the protein concentration and velocity of emulsification. As the protein concentration increased, a better size

distribution of droplets was observed, due to the fact that proteins play an important role in the stability of emulsions.

3.4 Evaluation of hygienic-sanitary conditions of creamy sauce of cryoconcentrated soymilk

Microbiological analyses of the creamy sauce of the cryoconcentrated SM showed thermotolerant coliforms count ≤ 3 MPN / g and absence of *Salmonella* sp.. Consequently, the results indicate that the formulated product is in accordance with the standard established by the legislation, which establishes the maximum tolerance of 10 MPN / g for coliforms at 45 °C and absence of *Salmonella* sp. in 25 g of the product (Brasil, 2001). The chemical composition of the creamy sauce (Table 3) shows that there is a good source of nutrients for microbial growth. However, its acid pH (3.98 ± 0.01) and the presence of salt and sugars dissolved in the aqueous phase, limit contamination by microorganisms. According to Jay, Loessner and Golden, (2005) the main microorganisms involved in the deterioration of mayonnaise are yeasts, especially of the *Saccharomyces* genus. While lactic bacteria can grow on the product's surface and some molds can grow in the region where the oxygen concentration is highest. In addition, the growth of these microorganisms can cause a separation of the mayonnaise phases with the formation of gas bubbles and unpleasant odors and flavors.

3.5 Sensory acceptance test of the creamy sauce of cryoconcentrated soymilk

The attributes of the sensory acceptance test of the creamy sauce (Table 5) were measured by the degree of acceptance, using the hedonic scale between 'I disliked it extremely' and 'I liked it extremely'. In this measure using the vehicle (loaf bread), the highest acceptance of the creamy sauce was observed in the characteristics of color (8.24), followed by texture (7.34), aroma (7.29), global acceptance (7.19) and flavor (7.02). All these values corresponded, in the hedonic scale used, to the degree of acceptance between ‘I liked it a lot’ and ‘I liked it moderately’ of the creamy sauce of cryoconcentrated SM.

Table 5 – Sensory acceptance test of creamy sauce of cryoconcentrated soymilk.

Attributes	Presence of vehicle	Absence of vehicle
Aroma	7.29 ± 1.95[a]	6.93 ± 2.21[a]
Color	8.24 ± 1.68[a]	7.61 ± 2.24[b]
Flavor	7.02 ± 2.47[a]	5.69 ± 2.93[b]
Texture	7.34 ± 2.26[a]	6.94 ± 2.39[a]
Global Acceptance	7.19 ± 2.27[a]	6.48 ± 2.41[b]

Means on the same line, followed by the same letter, do not differ significantly by Student's t test. Evaluation with a hedonic scale of 10 points. Source: Authors.

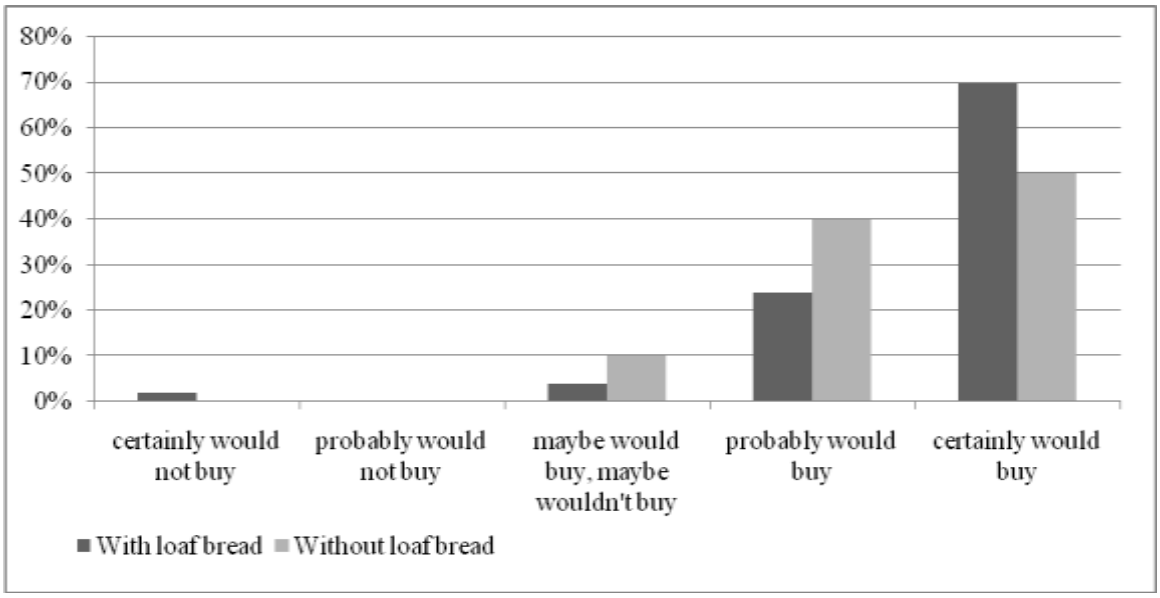
In the sensory acceptance test of the creamy sauce without the vehicle, the averages attributed for the color (7.61), texture (6.94), aroma (6.93) and global acceptance (6.48) corresponded, on the scale used, “I liked it a lot” and “I liked it moderately”, but the value for the flavor attribute (5.69), represented “I didn't like or disliked it”. Thus, the incorporation of cryoconcentrated SM in the sauce formulation, due to its astringent characteristics and residual flavor, may have influenced the evaluation of the lowest score for the flavor attribute, as at that moment the judges tasted the pure sauce, without interaction of other flavors. However, the results indicate that the judges in the evaluation forms did not mention the decrease in the amount of oil and the insertion of cryoconcentrated SM present favorable scores in the other sensory attributes of the product, and the residual flavor of the soybean. Di Mattia et al., (2015) mentioned the influence of ingredients on sensory responses when evaluating mayonnaises made with extra virgin olive oil, where judges perceived the attributes bitter, spicy and astringent.

When comparing the sensory acceptance tests of the creamy sauce with the presence and absence of vehicle to accompany the samples, it was observed that there was a difference in the attributes of color, flavor and global acceptance. Being that the sauces accompanied by the loaf bread, had a higher score in the evaluated attributes, that is, the acceptability by the judges was better. For the adoption of a vehicle, for affective evaluations of a product, it is considered that the food must be the most frequently used for the consumption of the elaborated product. The sensory evaluation of acceptance of mayonnaise enriched with rosemary, without and with the use of a vehicle, showed higher values when using the vehicle, obtaining a higher score for the texture (7.25), followed by the flavor (6.78) (Salgado,

Carrer & Danieli, 2006). Campos et al. (2009) used a vehicle for sensory evaluation of a soymilk creamy sauce and obtained attributes similar to the present work, whose grades attributed were 7.1 to the texture and 6.9 to the flavor.

The purchase intention of the creamy sauce of cryoconcentrated SM with the presence and absence of vehicles is shown in Figure 2. It was observed that more than 90% of the judges would certainly or probably buy the product, with 28% of mayonnaise consumers daily. The product was mostly well accepted, which can be considered a promising result, as it is a healthy food, by reducing the oil content and adding the soymilk, which has functional properties, beneficial to health. Campos et al. (2009), obtained inferior results when analyzing the purchase intention of emulsions stabilized with green banana pulp, where 75% of the judges would buy the product, of which 45% would probably buy and 30% would certainly buy, but 20% would have doubts if they would buy or wouldn't buy and 5% probably wouldn't buy the product.

Figure 2 - Purchase intention of creamy sauce of cryoconcentrated soymilk.



Source: Authors.

In the evaluation forms, the judges comment about the texture and flavor of the creamy sauce of cryoconcentrated SM. They suggested that the texture should be more viscous, the taste was acidic and the product should be closer to that of the mayonnaise available on the market. Campos et al. (2009) received similar comments, where the following aspects were mentioned: little seasoning, little salt, very acid, color and flavor unpleasant, with the characteristics being pointed out as “disgusted” by the judges.

In order to improve the texture, it would be necessary to increase the product's viscosity, which could be done by increasing hydrocolloids in the formulation. The flavor can be improved by adding flavorings in the formulation and also can replace the antifungal, as it interferes with the palatability of the product. Furthermore, commercial mayonnaise has a greater variety of food additives, which together guarantee the desirable characteristics: formation of emulsion, stability, acidity, texture and flavor for the final product.

4. Conclusions

The creamy sauce of cryoconcentrated soymilk made without egg and less oil quantity, it had good nutritional characteristics with higher protein content, lower lipid content and cholesterol free. The creamy sauce has acidic pH e low titratable total acidity content. The instrumental analyses showed that the product has high water activity, it is a light food, green and yellow color. The microstructure of the creamy sauce showed an emulsion well done, with dispersed structure with highly packed oil droplets of different sizes and polydispersed. The microbiological analyses of the creamy sauce of cryoconcentrated SM to evaluation of the hygienic-sanitary conditions of the creamy sauce indicated that the product is safe for consumption and complied with the legislation. The acceptance of the creamy sauce was satisfactory with 70% approval, and the most accepted attributes were color and texture. The purchase intention was over 90%. The formulation of the creamy sauce using the cryoconcentrated SM and different ingredients can be modified to improve the flavor, stability and validity of the product.

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