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Processing and characterization of coalho cheese cream with fish oil

Processamento e caracterização de creme de queijo coalho com óleo de peixe

Abstract

Fish oil is a source of omega 3 that acts in the fight, prevention and/or treatment of chronic diseases. *Coalho* cheese is largely consumed in the Northeastern Brazil, and in the form of cream added with fish oil it becomes a new alternative to consumers. Thus, the aim of this study was to develop and assess *coalho* cheese cream (CCC) formulations added with oregano, with or without fish oil. Firstly, a survey was conducted with 70 cheese consumers, followed by the preparation of three CCC formulations (F1: without fish oil; F2: with 0.54g of fish oil; F3: with 1.08g of fish oil). The CCC formulations (F1, F2 and F3) were analyzed for fungi, total and thermotolerant coliforms, coagulase-positive staphylococci, and *Salmonella sp.;* acceptability and sensory preference were also assessed, as well as the centesimal composition, total phenols, antioxidant activity, pH, total titratable acidity and calories. Taste was the most important factor in the choice of the product, being omega 3 (54.28%) and oregano (57.14%) chosen by the majority of the participants. All formulations were microbiologically safe and had the same acceptability and sensory preference. The acceptability index varied from 7.43 to 8.13. The CCC formulations are in conformity with legislation, are low fat (1.77 to 2.66% of lipids), have high moisture (>55%) and low acidity (3.12 to 3.28g of lactic acid/100g), and have an expressive antioxidant activity and marketing potential (acceptability was >70%). The CCCs are viable for incorporation of fish oil, being an omega-3 source product with functional property.

Keywords: Omega 3. Oregano. Processing. Dairy product

Resumo

O óleo de peixe é fonte de ômega 3, que atua no combate, prevenção e/ou tratamento de doenças crônicas. O queijo coalho é bastante consumido no Nordeste brasileiro, e na forma de creme adicionado de óleo de peixe torna-se uma nova alternativa para o consumidor. Assim, objetivou-se desenvolver e avaliar formulações de creme de queijo coalho (CQQ) com orégano, com ou sem óleo de peixe. Inicialmente, foi realizada uma pesquisa com 70 consumidores de queijo, seguida da elaboração de três formulações de CQQ (F1: sem óleo de peixe; F2: com 0,54g óleo de peixe; F3: com 1,08g de óleo de peixe). Obtidos os CQQs, as formulações (F1, F2 e F3) foram avaliadas no que se refere a: fungos, coliformes totais e termotolerantes, estafilococus coagulase positiva e *Salmonella sp;* aceitação e preferência sensorial; composição centesimal, fenólicos totais, atividade antioxidante, pH, acidez total titulável e valor calórico. O sabor foi o fator mais importante na escolha de um produto, sendo o ômega 3 (54,28%) e o orégano (57,14%) escolhidos pela maioria dos entrevistados. Todas as formulações estavam seguras microbiologicamente e apresentaram a mesma aceitabilidade e preferência sensorial. A aceitabilidade variou entre 7,43 a 8,13.

As formulações de CQQ são de acordo com a legislação, desnatadas (1,77 a 2,66% de lipídios), têm muito alta umidade (≥55%) e baixa acidez (3,12 a 3,28g ácido lácteo/100g), e apresentaram expressiva atividade antioxidante e potencial para comercialização (índice de aceitação ≥70%). Os CQQs são viáveis para incorporação de óleo de peixe, sendo um produto fonte de ômega 3 e que pode apresentar propriedade funcional

Palavras-chave: Ômega 3. Orégano. Processamento. Produto lácteo..

INTRODUCTION

The presence of omega-3 fatty acids in human diets plays a vital role in the fight, prevention and/or treatment of chronic diseases[1] such as cardiovascular diseases,[2] cancer, diabetes[3] and neurological diseases.[4] In addition, it enhances immune response, helps in blood clotting[5] and in fighting inflammatory response.[2]

Fatty acids of the ω3-family of nutritional interest include the a-linolenic acid and its derivatives, eicosapentaenoic acid (EPA-C20:5, ω3) and docosahexaenoic acid (DHA-C22:6, ω3).[6] These fatty acids are found in cold water fishes (mackerel, sardine, salmon, herring),[7] with a recommended dietary intake of approximately 1.0 g/day.[8]

The dairy industry has been incorporating ingredients with functional properties into their products aiming to make them healthier and commercially attractive.[9] In Brazil, there are numerous functional foods in the market, including dairy products (milk, goat milk and cheddar cheese) added with omega 3.[10,11]

In the Northeastern Brazil, *coalho* cheese (typical in the region, a firm but very lightweight cheese) is consumed either fresh or cured and has been produced for more than 150 years.[12] According to Normative Instruction no. 30, of June 26, 2001,[13] *coalho* cheese is obtained by milk coagulation with rennet or other suitable coagulation enzymes, and the milk must be whole or standardized at 3% of fat content. Therefore, *coalho* cheese may be a new alternative of ω3-enriched dairy product, considering that it is largely consumed in the Northeastern Brazil and has also conquered new consumers in the Southeast region of the country,[12] being an excellent matrix for addition of fish oil as a source of omega 3 (EPA and DHA).[14]

In addition to ingredients with functional properties, spices and herbs can be added to the cheese, conferring pleasant sensory characteristics to the product and contributing to its preservation as they have bioactive compounds with antioxidant activity.[15,16] Oregano *(Origanum vulgare L.),* for example, is an herb widely used in many cuisines, and has aromatic, antimicrobial and antioxidant properties.[17] The oregano's antioxidant property is related to the presence of phenolic compounds isolated from leaf extracts, particularly the rosmarinic acid.[15] With respect to the antimicrobial activity, it is due to the carvacrol and thymol content present in its composition.[18]

Considering that *coalho* cheese is largely appreciated in the Brazilian Northeast region, from which new products can be produced with alleged functional properties due to the presence of omega-3 fatty acids, this study aimed to develop and assess formulations of *coalho* cheese cream with fish oil and oregano.

MATERIALS AND METHODS

Ethical aspect

This work was previously approved by the Research Ethics Committee of the Federal University of Sergipe in October 9, 2017, with process number n° 2.321.745.

Survey with consumers

A survey was initially conducted with 70 cheese consumers, including students, teachers and employees of the *Universidade Federal de Sergipe* (UFS) [Federal University of Sergipe], aged between 18 and 52 years, of both sexes. The survey consisted of application of a questionnaire containing nine objective multi-choice questions and one subjective question about the consumption of functional foods, cheese consumption, opinion and choice of functional ingredients (dietary fibers, omega 3, lycopene or soy protein) and spices

(parsley, oregano, basil, black pepper or coriander) for the formulation of a novel product, as well as an estimated price to be paid for it

Preparation of cheese cream from *coalho* cheese

The following ingredients were used in the formulations: *in natura* whole milk, milk yeast and a bioprotective yeast *(Rica Nata®),* calcium chloride *(Rica nata®)*, rennet (Bela vista®), salt (Lebre®), dehydrated oregano (Trop), encapsulated fish oil as source of omega-3 fatty acids (Vitaminlife®), each 1-g capsule containing 180mg of EPA and 120mg of DHA, and light milk cream (Camponesa®). Three formulations of cheese cream were prepared, as described in Table 1. Difference between the formulations consists of addition or not of fish oil.

Table 1. Formulation of cheese cream made from *coalho* cheese. São Cristóvão, SE, 2020.

	Formulations		
Ingredients of *the coalho cheese*	F1	F2	F3
UHT whole milk	1L	1L	1L
Milk yeast	5mL	5mL	5mL
Calcium chloride	0.2g	0.2g	0.2g
Rennet	5g	5g	5g
Salt	1.6g	1.6g	1.6g
Bioprotective yeast	1g	1g	1g
Oregano	0.5g	0.5g	0.5g
Fish oil*	0g	0.54g**	1.08g***
Ingredients of the cheese cream	F1	F2	F3
Coalho cheese	75g	75g	75g
Milk cream	25g	25g	25g

*Values for a 50-g portion. **/*** According to RDC n° 54, of November 12, 2012,[50] for a product to be considered a source of omega 3, it must have at least 40mg** and a maximum of 80mg*** of omega-3 fatty acid. Thus, formulation 2 contains 40mg of omega 3, and formulation 3, 80mg of omega 3, both in a 50-g daily portion.

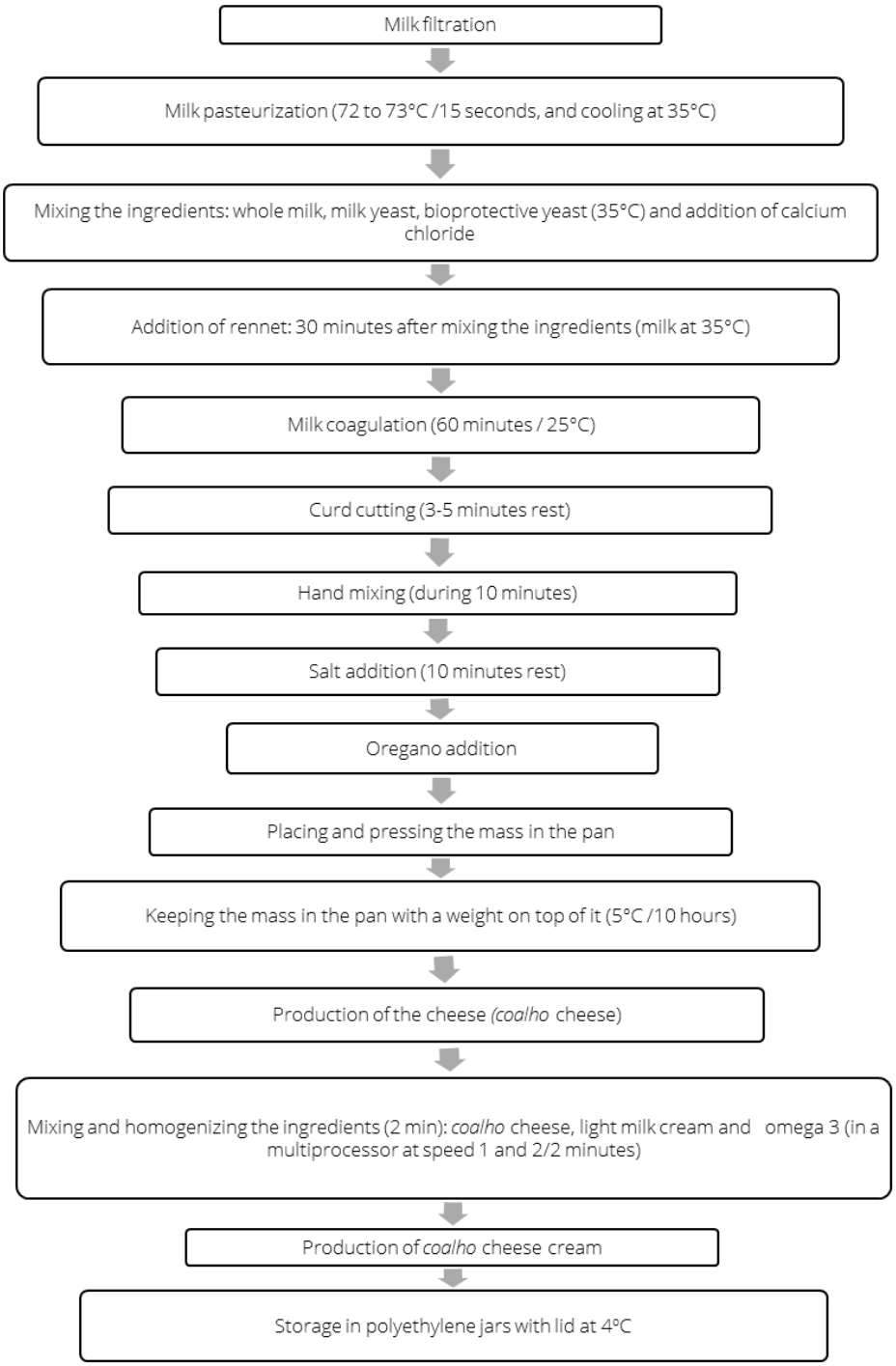
Initially, pretests were carried out without participation of the panelists, aiming to reproduce a cheese cream made from *coalho* cheese with good sensory characteristics.

All ingredients were weighted in a semi-analytical scale (OhausAdventurer, ARC120). The *in natura* whole milk was filtered in a stainless-steel sieve (20cm), then pasteurized in water bath (72 to 75°C/15 seconds) and cooled in ice bath to 35°C. Subsequently, all ingredients were weighted in a semi-analytical scale (OhausAdventurer, ARC120). To the pasteurized whole milk (35°C), the milk yeast, the bioprotective yeast and calcium chloride were added and then mixed, and afterwards the rennet was added. This mixture was left to rest for 60 minutes at 25°C; afterwards, with the aid of a polyethylene spatula, crosswise cuts were made, left to rest (3 to 5 minutes), and then was manually stirred with the same spatula (10 minutes) to provide better straining of the curd. Salt was added, mixed and left to rest (10 minutes), followed by addition of oregano and then hand mixed. The resulting mass was placed in rectangular loaf pans (1Kg) and then pressed to remove

the whey from the curd. The mass in the pans stayed under refrigeration (5°C for 10h) with a weight on the top. After obtaining the *coalho* cheese, the cream was then prepared by mixing the ingredients (*coalho* cheese, light milk cream and fish oil) in a multiprocessor (speed 2/2 minutes). The *coalho* cheese cream was put into polyethylene jars with lid (500g) and remained under refrigeration (4°C) until the time of assessments.

It was decided to add fish oil in the final stage of preparation of the *coalho* cheese cream. Literature reports that adding fish oil before straining the whey from the curd may have the inconvenience of losing this oil, as whey comprises 85-95% of total milk volume.[19] Figure 1 illustrates the process flowchart of preparation of the *coalho* cheese cream.

Figure 1. Flowchart of the process of elaboration of rennet cheese cream with oregano and omega 3.



Microbiological analysis

Prior to the sensory evaluation, 200g-samples of each formulation of the *coalho* cheese cream were forwarded to the *Laboratório de Microbiologia de Alimentos do Departamento de Nutrição* [Laboratory of Food Microbiology of the Department of Nutrition) of UFS, Campus São Cristóvão, SE. The following microbiological analyses were performed: enumeration of molds and yeasts, total and thermotolerant coliforms, coagulase-positive staphylococci, and *Salmonella sp*. Analysis. [20]

Sensory analysis

The sensory evaluation of the three formulations of *coalho* cheese cream (F1, F2 and F3) was performed by 70 untrained panelists (18 to 50 years old), of both sexes, in individual booths under white light. Before tasting, the participants filled out a form with their personal information and questions related to *coalho* cheese cream (allergy or food intolerance, if they like it or not, frequency of consumption, importance of functional foods). Subsequently, they were instructed to read and sign the free and informed consent form before performing the sensory analysis.

Approximately 20g of each sample were served at 5°C in polyethylene cups coded with three-digit numbers, which were presented simultaneously and randomly to the participants. Each sample was evaluated regarding preference (ranking method), acceptability (hedonic scale) and purchase intention.

Formulations preference was assessed according to the ranking method.[21] Acceptability was determined by a nine-point hedonic scale relating to odor, texture, taste, color and overall impression. The purchase intention scale ranged from one to five.[21] The Acceptability Index (AI) was evaluated by the expression AI (%) = A x 100 / B, where A = average grade obtained for the product and B = maximum grade given to the product. An AI with good acceptability is considered as > 70%.[22]

Chemical and physicochemical characterization

After the sensory evaluation, chemical and physicochemical analyses of the three formulations of *coalho* cheese cream were performed (in the Laboratory of Foods Analysis of the Department of Nutrition, Federal University of Sergipe, Campus São Cristóvão). The following analytical parameters were adopted: moisture, protein, lipids, ash, pH and total titratable acidity (TTA). The analyses were performed in triplicate and according to the analytical standards of the Adolf Lutz Institute.[23] In addition, through difference calculations, total carbohydrates were determined.[24] Total energy values were estimated according to the following Atwater conversion factors: 4kcal/g for proteins and carbohydrates; and 9kcal/g for lipids.[25]

To determine total phenols, DPPH (2,2- difenil-1-picril-hidrazil), FRAP (Ferric reducing antioxidant power) and TBARS (Thiobarbituric acid reactive substances), sample extracts of 1 g of *coalho* cheese cream were diluted in methanol solution (8:2 methanol/ water). Total phenols obtained were expressed in ugEq of gallic acid/100g of sample,[26] and the antioxidant capacity of the cheese cream was determined using the DPPH (radical 2,2-diphenyl-1-picrylhydrazyl) radical sequestration method and expressed in mg of Trolox Eq/ 100g of sample,[27] and the ferric reducing capacity (FRAP) was expressed in pM of ferric sulfate/100g of sample.[28] Lipid peroxides were also determined by TBARS, following the method of Ohkawa et al.,[29] expressed in mg of malonaldehyde/100 g of sample.

Statistical analysis

Using the IBM SPSS software, version 21 (2012), the data was subjected to analysis of variance for repeated measures to verify homogeneity of variance means. The means that were homogenous ($p>0.05$) were analyzed by the Tukey's test. P-values below 0.05 were considered significant. The results of sensory preference for the *coalho* cheese cream formulations were analyzed by the Friedman's test, through which the sums of the ranks of formulations of *coalho* cheese cream are compared with the critical absolute value of the sum of the ranks (minimum significant difference) to establish a significant preference at 5% probability obtained in a specific table.[21]

RESULTS AND DISCUSSION

Consumer survey

In the consumer survey, it was found that 95.71% liked cheese, and 78.57% consumed it. Regarding the most important characteristics of a product, 77.14% responded that it was taste. With respect to the consumption of healthy foods, 82.86% responded that they had the habit of eating healthy foods.

Omega 3 was the ingredient chosen by the majority of the participants (54.28%) to give functional claim to *coalho* cheese cream, followed by dietary fibers (40%), lycopene (2.86%) and soy protein (2.86%). Regarding spices, oregano was chosen by the majority of consumers (57.14%), followed by basil (17.14%), coriander (15.71%) and parsley (4.29), and there were participants who did not choose any of the alternatives (5.72%).

Microbiological analysis

The regulation RDC n° 12[30] sets out for high-moisture *coalho* cheese (>55%) added with herbs a count of thermotolerant coliforms of up to 10^2 CFU/g, coagulase-positive staphylococci up to 10^3 CFU/g and absence of *Salmonella sp* in 25g of cheese. The three formulations analyzed indicated absence of positive tubes of thermotolerant coliforms and typical colonies of coagulase-positive staphylococci and *Salmonella sp.* Thus, the *coalho* cheese cream served to the panelists in the sensory analysis was microbiologically safe.

Sensory evaluation

Sensory acceptability and purchase intention

The sensory acceptability of the three formulations of *coalho* cheese cream is shown in Table 2.

Tabela 2. Aceitação sensorial e intenção de compra de formulações de creme de queijo coalho. São Cristóvão, SE, 202

Sensory attributes	Formulations		
	F1*	F2*	F3*
Odor	7.56±1.43[a]	7.59±1.35[a]	7.58±1.40[a]
Texture	7.77±1.34[a]	7.54±1.56[a]	7.60±1.34[a]
Taste	7.83±1.25[a]	7.43±1.69[a]	7.47±1.39[a]
Color	8.13±1.01[a]	8.06±0.99[a]	7.87±1.13[a]
Overall impression	7.86±1.05[a]	7.61±1.33[a]	7.61±1.25[a]
Purchase intention	3.57±1.16[a]	3.43±1.30[a]	3.36±1.33[a]

*Means and standard deviation (SD). Different letters in rows indicate significant difference by Tukey's test ($p<0.05$). F1 (Formulation 1): without fish oil; F2 (Formulation 2): with 0.54g of fish oil; F3 (Formulation 3): with 1.08g of fish oil.

It can be seen that there was no significant difference ($p>0.05$) between the formulations, i.e., they had the same sensory acceptability for all attributes assessed. It can be seen that the addition of different concentrations of fish oil did not have an influence on the acceptability of all formulations. With respect to hedonic scale, the scores varied from "like it moderately" (7.43) to "like it very much" (8.13).

Comparing the sensory acceptability observed in fresh goat cheese added with different concentrations of fish oil (60, 80 and 100g of fish oil/ 3600g of goat milk), with 127mg of EPA + DHA/28g in fish oil, it was found that appearance, color and odor were the same for all three cheese formulations, showing that the cheese formulations with fish oil are as acceptable as the cheese formulation without fish oil. However, the cheese cream without fish oil was significantly higher ($p<0.05$) with respect to texture (creaminess), taste and overall acceptability when compared with the cheeses with fish oil (Table 2).

When correlating the proposed *coalho* cheese cream with oregano of this study with *minas frescal* goat milk cheese (spiced with garlic, oregano and hot pepper), as proposed by Queiroga et al.,[31] the sensory acceptability was influenced by the kind of spice added, hot pepper being the only one that significantly changed the sensory characteristics of *minas frescal* goat cheese. In addition to oregano, essential oregano oil was added to the cheese due to its antioxidant and antimicrobial action, compared with the study conducted by Rezende,[32] who made artisanal *minas* cheese formulations with chitosan and oregano essential oil, and found that the addition of oregano essential oil did not change the cheese organoleptic characteristics.

The acceptability indices (AI) related to the sensory attributes of the formulations were, respectively, 86.98%, 84.96% and 84.74%. We can say that the three formulations showed potential for consumption considering that the results for the different attributes were over 70%.[22]

Preference

There was no significant difference in preference between the formulations tested, which indicates that the addition of fish oil as a source of omega 3 did not interfere with the sensory preference of the cheese creams tasted by the panelists.

Chemical and physicochemical characterization

Table 3 shows that there was significant difference ($p<0.05$) for ash, protein, pH, total phenols and DPPH in the three formulations of *coalho* cheese cream.

Table 3. Chemical and physicochemical characteristics of formulations of coalho cheese cream. São Cristóvão, SE, 2020.

	Formulations		
Characteristics #	F1	F2*	F3*
Moisture	64.48±2.02^{a}	65.79±0.18^{a}	64.57±0.79^{a}
Ash	2.86±0.03^{b}	2.99±0.02^{a}	2.86±0.05^{b}
Proteins	20.86±1.53^{ab}	19.71 ±1.49^{b}	22.87±0.39^{a}
Lipids	1.77±0.54^{a}	2.29±0.58^{a}	2.66±1.01^{a}
Carbohydrates	15.24±11.43^{a}	14.13±9.98^{a}	12.74±10.91^{a}
Energy	139.46±10.54^{a}	136.32±2.56^{a}	143.56±4.52^{a}
TTA	3.12±0.89^{a}	3.28±0.08^{a}	3.22±0.20^{a}
pH	6.12±0.15^{b}	6.24±0.02^{ab}	6.29±0.02^{a}

Table 3. Chemical and physicochemical characteristics of formulations of coalho cheese cream. São Cristóvão, SE, 2020. (Continues).

	Formulations		
Characteristics #	F1	F2*	F3*
Total phenols	1.43±0.38[b]	4.10±0.90[a]	4.02±0.38[a]
DPPH	9.41±0.32[b]	11.37±0.89[a]	7.72±0.98[c]
FRAP	604.56±44.43[a]	543.06±59.37[a]	576.69±38.24[a]
TBARS	26.02±3.43[a]	27.26±1.22[a]	30.86±0.59[a]

Means and standard deviation (SD). Different letters in rows indicate significant difference by the Tukey's test ($p<0.05$). F1 (Formulation 1): without fish oil; F2 (Formulation 2): with 0.54g of fish oil; F3 (Formulation 3): with 1.08g of fish oil. # Moisture, proteins, lipids and ash, all of them expressed in g/100g of sample; Total titratable acidity (TTA) expressed in %; lactic acid /100g of sample; total carbohydrates expressed in %, and energy expressed in kcal/100g. Phenols expressed in ugEq of gallic acid/100g of sample; DPPH was expressed in mg of Trolox Eq/100g of sample; FRAP values were expressed in ppm of ferric sulfate/100 g of sample; TBARS were expressed in mg of malonaldehyde /100 g of sample.

With respect to the parameters assessed, it can be seen that moisture is the major component of the *coalho* cheese cream (64.48 to 65.79%), similar to the moisture of the "very high moisture" content of *coalho* cheese, above 55%.[30] Similar result was found in creamy cheeses with and without probiotics *(Lactobacillus paracasei),* which exhibited moisture ranging from 64.80 to 67.36%, respectively.[33]

The percentage of ash in the *coalho* cheese cream sample ranged from 2.86 and 2.99, being higher in formulation 2 (2.99) and equal to formulations 1 (2.86) and 3 (2.86), as shown in Table 3. Ash composition represents the amount of mineral substances present in foods and is considered as a measure of quality.[34] Furthermore, ash content plays a major role in the final texture of cheeses[35] because calcium forms a structure and acts as a bonding element, forming the cheese mass.[36] However, Oliveira[37] assessed a fresh cheese cream and observed ash values (1.39 to 1.73) lower than those found in this study, which can be due to the ultrafiltration step performed.

The protein values found in the *coalho* cheese cream represent the second major component, and formulation 1 (20.86g) did not differ significantly ($p>0.05$) from the other ones (Table 3). According to Brazilian legislation,[38] the recommended daily intake (RDI) of proteins for an adult is 50g. Taking this into consideration, 100g of *coalho* cheese cream supply 19.71g to 22.87g of protein, which is a significant quantity of this nutrient. However, the protein value found in the *coalho* cheese cream (Table 3) was lower than the one found by Silva et al.[39] (26.93 to 29.63) in *coalho* cheese, which can be due to the addition of milk cream to the cheese cream formulation with a consequent dilution of the product. Cheeses in general have proteins of high biological value, with percentages varying from 5 to 25g of protein /100g of cheese.[40]

The lipid content (1.77 to 2.66%) found in the formulations of *coalho* cheese cream (Table 3), taking as reference cheese regulatory legislation,[41] ranks the formulations as a fat-low product because they showed less than 10% of lipids. Thus, lipid concentrations in the formulations of *coalho* cheese cream is low, if we compare it to the contents found in other studies with cheese in the form of cream, which reported 10 to 12.33,[37] 21.28 to 28.27%,[42] and 9.06 to 9.36%.[33] Intake of saturated and trans fats raises the plasma LDL cholesterol and increases the risk of cardiovascular problems.[43] On the other hand, according to legislation,[44] intake of omega-3 fatty acids helps maintain healthy levels of triglycerides. Thus, *coalho* cheese cream with oregano and omega 3 is a healthy choice of dairy product for people with dyslipidemias and those who aim to maintain a healthy diet due to its low-fat content associated with a functional compound, the omega-3 fatty acid.

Carbohydrates (12.74 to 15.24%) represent the third major component of the formulations (Table 3). Similar carbohydrate values (14.9 and 15.20%) were observed in creamy fresh cheese.[42]

Concerning energy content, the formulations exhibited between 136.32 to 143.56 kcal/100g of coalho cheese cream (Table 3). Thus, the calorie values are below the values reported by Petrovic et al.,[45] who demonstrated that for each 100g of cheese cream there are 242 kilocalories, which may be associated with the lower lipid content of the *coalho* cheese cream developed in this study (Table 3).

The titratable acidity values are between 3.12 to 3.28g of lactic acid /100g (Table 3). According to Freitas Filho et al.,[46] the titratable acidity of cheese samples does not always follow the pH variations, and salt also has an influence on this variation. PH did not differ in formulations 2 (6.24) and 3 (6.29), but in formulation 1 (6.12), showing that the higher the addition of omega 3 to the cheese cream, the higher the pH value (Table 3). Cheese cream is considered fresh,[39] being a product of low acidity (pH>4.5), which favors the proliferation of bacteria, which can be pathogenic and/or deteriorating.[47] Due to these conditions, cultures of bioprotective bacteria were added to the formulations, as described earlier in Materials and Methods (Figure 1).

The total phenols content did not differ statistically ($p>0.05$) in formulations 2 (4.10) and 3 (4.02), but was higher if compared with formulation 1 (1.43), as shown in Table 3. Phenolic compounds are very effective in the prevention of lipid oxidation, which is due to the sequestration of free radical and metals chelation.[48,49] Although the total phenols content has been the same in formulations 2 and 3, it did not have an effect on iron reduction (FRAP) and on lipid peroxidation (TBARS) in the *coalho* cheese cream, considering that the mean values in these analyses were not different ($p>0.05$) for the three formulations (Table 3), which cannot be seen in the analysis of DPPH radical scavenging. The FRAP method consists of determining iron reduction in biological fluid and water solutions of pure compounds.[50] TBARS are used as an indicator of lipid peroxidation, quantifying malonaldehyde, which is one of the main products formed during the oxidation process.[51]

With respect to TBARS levels (26.02 to 30.86mg of malonaldehyde/100g of *coalho* cheese cream) observed in the formulations (Table 3), they were higher than the TBARS found in goat milk cheese (0.9mg of malonaldehyde / 100g of cheese),[11] suggesting that the combined use of vacuum packaging with addition of fish oil before forming the curd may have had a protective effect by trapping the oil within the curd, since there is a possible protein-lipid protective interaction.

CONCLUSION

The three formulations of *coalho* cheese cream that were proposed in this study had good acceptability and sensory preference; furthermore, the acceptability index showed that the formulations have market potential.

With respect to the chemical and physicochemical characteristics, although there was significant variation in some parameters assessed in the *coalho* cheese cream formulations, it was observed that the farthest means are associated with the contents of total phenols, and the formulations with fish oil as source of omega 3 were the ones that exhibited the largest quantity of these compounds.

Given the characteristics shown by the formulations of *coalho* cheese cream added with omega 3 and oregano, it could be seen that they are commercially viable and attractive to consumers, as the *coalho* cheese cream is a novel product that can have functional property, is low-fat and has expressive antioxidant activity.

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Contributors

Santos LVN contributed to the design and conduction of the experiment, to data computation and interpretation, and wrote the manuscript. Ferreira IM conducted the microbiological analyses (chemical and physicochemical) and contributed to data interpretation. Oliveira e Silva AM contributed to the interpretation of chemical and physicochemical analyses and interpretation of data. Carvalho MG contributed to the planning of the experiment, to the performance of sensory analysis, interpretation of all data and in writing the manuscript.

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