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Formulation of functional instant pumpkin cream soup with moringa leaves as nutritional support for breastfeeding mothers

Formulasi sup krim instan fungsional dari labu kuning dengan daun kelor untuk pemenuhan gizi ibu menyusui

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Abstract

The exclusive breastfeeding rate has declined, partly due to mothers' perceptions of inadequate breast milk production. Optimal nutrition is crucial to enhance breast milk production. This study aimed to develop instant pumpkin cream soup with moringa leaves, which contains beta-carotene, flavonoids, and phenols as galactagogues and supports meeting the nutritional needs of breastfeeding mothers. Conducted from January to April 2024 in Bogor, West Java, the study used a Randomized Design (CRD) with moringa leaf concentrations of 1%, 2%, and 3%. A sensory evaluation by 35 semi-trained panelists indicated that the highest moringa concentration (F3) achieved the best taste, consistency, and overall acceptability scores. Statistical analysis revealed significant differences in moisture and protein contents between fresh and instant cream soups (p<0,05). The selected formula contained 0,22 mg/g iron, antioxidant activity (IC50:167,79 ppm), 50,95 mg GAE/g total phenols, 20,33 mg QE/g total flavonoids, and 40,50 mcg/g beta-carotene, with a protein digestibility of 43,57%. One serving (25 g) of cream soup provided 5% of the Recommended Dietary Allowance (RDA) for breastfeeding mothers. In conclusion, cream soup formula with 3% moringa leaves was the most preferred, containing nutrients and antioxidants that support increased breast milk production and meet the nutritional needs of breastfeeding mothers.

Keywords: Antioxidant activity, beta-carotene, galactagogue, protein digestibility, sensory evaluation

Abstrak

Tingkat pemberian ASI eksklusif menurun, salah satunya disebabkan oleh persepsi ibu bahwa produksi ASI tidak mencukupi. Pemenuhan gizi yang optimal penting untuk mendukung produksi ASI. Penelitian bertujuan mengembangkan sup krim instan labu kuning dengan daun kelor, yang mengandung beta-karoten, flavonoid, dan fenol sebagai galaktagogum serta mendukung pemenuhan gizi ibu menyusui. Penelitian dilakukan pada Januari-April 2024 di Bogor, Jawa Barat, menggunakan Rancangan Acak Lengkap (RAL) dengan perlakuan penambahan daun kelor pada konsentrasi 1%, 2%, dan 3%. Evaluasi sensori oleh 35 panelis semi-terlatih menunjukkan bahwa formula dengan konsentrasi daun kelor tertinggi (F3) memperoleh skor terbaik pada aspek rasa, kekentalan, dan penerimaan keseluruhan. Analisis statistik dengan Paired Sample T-test. Hasil menunjukkan perbedaan signifikan pada kandungan air dan protein antara sup krim segar dan instan (p<0,05). Formula sup krim terpilih mengandung 0,22 mg/g zat besi, aktivitas antioksidan (IC50: 167,79 ppm), 50,95 mg GAE/g total phenol, 20,33 mg QE/g total flavonoid, 40,50 mcg/g beta-karoten, dan daya cerna protein sebesar 43,57%. Satu takaran saji (25 g) sup krim dapat memenuhi 5% Angka Kecukupan Gizi (AKG) untuk ibu menyusui. Kesimpulan, formula sup krim dengan 3% daun kelor paling disukai serta mengandung zat gizi dan antioksidan yang berpotensi mendukung peningkatan produksi ASI dan membantu memenuhi kebutuhan gizi ibu menyusui.

Kata Kunci: Aktivitas antioksidan, beta-karoten, daya cerna protein, evaluasi sensori, galaktagogum

Introduction

The World Health Assembly has established a global target to increase the prevalence of exclusive breastfeeding among infants under six months of age to at least 50% by 2025. However, current data indicate that approximately 60% of the infants in this age group are not exclusively breastfed. Alarmingly, this figure has shown minimal improvement over the past two decades, underscoring the persistent challenges in promoting exclusive breastfeeding practices globally (WHO, 2023). In Indonesia, the right of a newborn to exclusively breastfeed for the first six months is legally recognized under the Government Regulation on Health No. 17 of 2023. However, recent data from the Indonesian Nutrition Status Survey (INSS) reveal a significant decline in exclusive breastfeeding rates, dropping from 31,5% in 2021 to 16,7% in 2022 (Kementerian Kesehatan, 2022). Low breastfeeding rates are often attributed to mothers' perceptions of insufficient milk production and breast or nipple pain (Morrison et al., 2019).

Exclusive breastfeeding offers well-documented health benefits to both infants and mothers. Breast milk reduces the risk of morbidity in infants with diarrhea, respiratory infections, and otitis media (middle ear inflammation). It also lowers the likelihood of obesity and diabetes later in life and supports cognitive development. For mothers, breastfeeding has been shown to reduce the risk of breast cancer, ovarian cancer, and type 2 diabetes (Victora et al., 2016). Nonetheless, the consequences of suboptimal breastfeeding are severe, with a global study across 130 countries estimating that inadequate breastfeeding contributes to approximately 600.000 child deaths annually due to pneumonia and diarrhea (Walters et al., 2019).

One approach to increasing breast milk production is herbal galactagogue therapy, which can enhance prolactin levels (Westfall, 2003). Galactagogues, including pharmaceuticals, foods, or herbal supplements, stimulate the adenohypophysis or inhibit hormones that suppress prolactin production (Khairani et al., 2021).One of the galactagogues already known in Indonesia is Moringa (*Moringa oleifera*) leaves, which contain flavonoids and polyphenols. These substances are associated with increased prolactin and oxytocin hormones, which play a role in milk production (Rotella et al., 2023). Moringa leaves show potential as a herbal galactagogue, significantly increasing breast milk volume and supporting infant weight gain by elevating prolactin levels (Raguindin et al., 2014).

Pumpkin is a vegetable that is beneficial for health and is rich in phenolic compounds, flavonoids, and vitamins (Assous et al., 2014). Pumpkin, which is rich in beta-carotene and a precursor of vitamin A synthesis, is excellent for breastfeeding mothers to consume. Breastfeeding mothers require an additional 350 RE of vitamin A more than non-breastfeeding women do to support breast milk production for their babies. Hence, breastfeeding mothers are vulnerable to vitamin A deficiency (VAD) (Kementerian Kesehatan RI, 2019).

While extensive research has been conducted on supportive foods for breastfeeding mothers, there is still a lack of studies examining the combination of pumpkin and moringa leaves in instant food formulations, particularly in the form of cream soup. Pumpkin-based instant cream soup has the potential to serve as a nutritious snack or supplementary dish for breastfeeding mothers, enriched with Moringa leaves that contain bioactive compounds such as galactagogues (Rotella et al., 2023).

Instant cream soup is a practical and affordable snack with a stable taste over a storage period of 6-12 months, making it popular in modern society (Dhiman et al., 2017). Developing pumpkin cream soup with moringa leaves is important because of the nutritional benefits of both ingredients, which are rich in bioactive compounds, and their potential to support breast milk production in nursing mothers. The objective of this study is to analyze the organoleptic value, physical properties, proximate nutritional content, iron content, antioxidant activity, beta-carotene, total phenol, flavonoid, and protein digestibility of instant pumpkin cream soup with Moringa leaves for breastfeeding mothers

Methods

This research was conducted using a completely randomized (CRD) design. The treatment given was the difference in additional ingredients for making instant cream soup in the form of moringa leaf addition (1%, 2%, and 3% of the total cream soup composition) to the instant cream soup formulation. Each treatment was tested twice and analyzed in duplicate to ensure the accuracy and reliability of the results. The amount of Moringa leaves that significantly affects breast milk production, as stated by (Renityas, 2018), is 800 mg of Moringa extract administered once per day, and according to (Sulistiawati et al., 2017), 250 mg of Moringa extract administered twice per day. Based on these dosages, the extract amounts were converted into fresh moringa leaves for human consumption, equivalent to approximately 1,9–2 g of fresh leaves per day. Moringa leaves were added to 210 g of cream soup, starting with 2 g in F1 (1,0%), 4 g in F2 (2%), and 6 g in F3 (3%).

This research was conducted in January–June 2024. The preparation of instant cream soup formula was performed at the Food Experiment Laboratory, and organoleptic data collection on semi-trained panelists was performed at the Organoleptic Laboratory of the Department of Public Nutrition, Faculty of Human Ecology, IPB. A drum dryer was used during the drying process at the SEAFAST Center Laboratory (IPB). Proximate nutrient content analysis (water, ash, protein, fat, and carbohydrate), antioxidant activity tests, total phenolics, flavonoids, and protein digestibility were conducted at the Nutritional Biochemistry Laboratory, IPB. Beta-carotene content analysis was conducted at the Saraswanti Indo Genetech (SIG) Laboratory, Bogor. The iron extraction readings were conducted at the Testing Laboratory of the Department of Soil Science and Land Resources, Faculty of Agriculture, IPB.

Table 1 presents the ingredients used in instant cream soup formula. All instant cream soup ingredients were purchased through online market platforms, with moringa leaves harvested from moringa trees aged 12–15 weeks and pumpkin from the *Cucurbita moschata* variety Hammer 334. For making the cream soup, pumpkin, carrots, and tomatoes were cut, cleaned of seeds, and then diced. The onions and garlic were sautéed in margarine. Chicken broth, pumpkin, carrots, chicken meat, leeks, celery, and moringa leaves were then added. The soup was then boiled for approximately 15-20 minutes. After the soup was cooked, it was pureed using a blender until it became porridge and filtered. It was then cooked again for 5-10 minutes while being added with cooking cream, cornstarch, pepper, and salt were added. Next, fresh cream soup was dried using a drum dryer (130°C) to produce fresh cream soup powder. A temperature of 130 °C was chosen because trials showed that it produces cream soup powder that is perfectly dried, neither wet nor burnt. The short contact time between the cream soup and drum dryer at high temperatures helps minimize the degradation of bioactive compounds such as beta-carotene and antioxidants. This temperature ensured effective drying while preserving the functional quality of the product.

Table 1. Instant cream soup formula

Ingredients	F1 (%)	F2 (%)	F3 (%)
Pumpkin	14	14	14
Moringa leaves	1	2	3
Chicken	10	10	10
Carrot	9	8	7
Tomato	2	2	2
Margarine	2	2	2
Cooking cream	48	48	48
Cornstarch	5	5	5
Garlic	5	5	5
Onion	2	2	2

A sensory evaluation was conducted using the hedonic test method on 35 semi-trained panelists. The panelists signed an informed consent form before testing. The assessment test was conducted by presenting the samples individually using a three-digit random code. This test aimed to evaluate the preference for the samples in terms of color, viscosity, aroma, taste, mouthfeel, aftertaste, and overall cream soup on a scale of 1 to 9 (1= strongly dislike to 9= strongly like). The semi-trained panelists used in this sensory evaluation received basic training, which included an introduction to the sensory evaluation methods and instructions on how to use the rating scales. The semi-trained panelists met several criteria, including the absence of allergies to pumpkin, moringa leaves, chicken, milk, or their derivatives. Additionally, the panelists were healthy, had no olfactory impairments, were not colorblind, and had no psychological disorders that could have affected the sensory assessment. The sensory evaluation was conducted using the hedonic test method with 35 semi-trained panelists. The panelists signed an informed consent form before participating in this study.

The physical characteristics of the cream soup measured included pH measured using a pH meter (Ohaus Starter 3100; 180 USA), yield calculated based on the percentage between the weight of instant cream soup and fresh cream soup before drying, rehydration power calculated by rehydrating 0,5 g of cream soup with 5 ml of distilled water and then centrifuging at 2,500 rpm for 30 min, and viscosity analysis performed using a Brookfield LVT Analog Viscometer.

The moisture content was determined by drying the samples in an oven at 105°C at a constant weight for approximately three–five hours. The ash content was calculated by burning the samples in a furnace at 550°C for five–eight hours until a constant weight was achieved. The analysis of moisture content and ash content was conducted based on the Indonesian National Standard (INS) 01-2891-1992. Protein content was determined using the Kjeldahl method. The protein analysis was conducted based on AOAC 2001.11.2005 and the Indonesian National Standard (SNI) 01-2891-1992. The fat content was determined using the Soxhlet method with a Foss Tecator Soxtec 200. The analysis of fat content was conducted based on the Indonesian National Standard (INS) 01-2891-1992 The method of determining carbohydrate content by difference was used to determine carbohydrate content, which involves water, ash, fat, and protein content. Fe content was analyzed using the Atomic Absorption Spectroscopy (AAS) method by AOAC (2012), in which the samples were first subjected to the wet-soaking process.

Antioxidant activity was measured using the DPPH (2,2-diphenyl-1-picrylhydrazyl) method (Molyneux, 2004). The beta-carotene content was analyzed using the HPLC-PDA method. The total phenol content in the instant cream soup was analyzed using the Folin-Ciocalteu method using the gallic acid standard (Kupina et al., 2019). Total flavonoid levels in the samples were analyzed using the quercetin standard colorimetric method (M. Gonzalez-Paramas et al., 2012).

Protein digestibility was analyzed in vitro using the INFOGEST 2.0 protocol (Brodkorb et al., 2019), which mimics protein digestion in the human gastrointestinal tract using digestive enzymes, including oral, gastric, and small intestinal digestion stages.

Data were processed using Microsoft Excel 2019 and statistically analyzed using SPSS 26.0 for Windows. Organoleptic data, physical characteristics, and proximate nutrient content of the three instant cream soup formulas were analyzed using One-way ANOVA to determine the effect of the proportion of moringa leaves and carrots, followed by Duncan's multiple range test to identify differences between treatments. A paired Sample t-test was used to compare the proximate nutrient contents (water, ash, protein, fat, and carbohydrate) between fresh and instant cream soups.

Result and Discussion

Sensory analysis

Sensory analysis is a method used to evaluate the sensory characteristics of food ingredients or other products (Lewkowska et al., 2015). The results of the sensory analysis are presented in Table 2.

Table 2. Results of the hedonic sensory test of instant cream soup

Sensory Attributes	Formula			p value
	F1	F2	F3	
Color	6,380 ± 1,543^{a}	5,980 ± 1,530^{a}	5,194 ± 1,849^{b}	0,011
Viscocity	5,117 ± 2,250^{a}	6,306 ± 1,659^{b}	6,006 ± 1,533^{b}	0,002
Aroma	5,711 ± 1,688^{a}	6,606 ± 1,416^{b}	6,006 ± 1,665^{ab}	0,062
Taste	5,189 ± 1,363^{a}	5,926 ± 1,605^{b}	6,260 ± 1,662^{b}	0,015
Mouthfeel	5,380 ± 1,529^{a}	5,877 ± 1,459^{a}	5,854 ± 1,481^{a}	0,293
Aftertaste	6,031 ± 1,608^{a}	5,920 ± 1,540^{a}	5,711 ± 1,499^{a}	0,682
Overall	5,920 ± 1,232^{a}	6,397 ± 1,677^{a}	6,617 ± 1,425^{a}	0,112

Values with the same superscript in the same row indicate no significant difference

The results of the hedonic test analysis on the color attribute showed the highest preference for the F1 cream soup formula and the lowest preference for the F3 formula. This indicates that the panelists had the highest color preference for formula F1, which tended to have a more orange color than the other formulas.

The instant cream soup formula that received the highest aroma attribute score was formula F2, whereas the lowest score was for formula F1. Formula F1 and F2 showed a significant difference, while F3 showed no significant difference compared to F1 and F2. This suggests that the panelists' preference for the aroma of instant cream soup was not affected by the increasing composition of Moringa leaves in the soup. The cream soup had an aroma that resembled chicken broth, so the addition of moringa leaves did not affect the dominant aroma of the soup.

The results of the hedonic test analysis on the viscosity attribute showed that the average score for formula F3 showed a significant difference compared to formulas F1 and F2, whereas samples F1 and F2 did not show a significant difference from each other. Formula F3 received the highest score, whereas formula F1 received the lowest score. This indicates that the panelists preferred the texture with higher viscosity in formula F3, which contained a higher composition of moringa leaves compared to the other formulas.

The sensory evaluation results showed that formulation F3, with the highest concentration of moringa leaves, achieved the highest scores for taste, thickness, and overall acceptance, significantly differing from F1. Although the color score of F3 was lower than that of F1, its aroma score was comparable to that of F2 and was well-received. Additionally, the mouthfeel and aftertaste of F3 were favorable, although they were not significantly different from those of F2. These results indicate that the addition of moringa leaves to F3 positively influenced sensory attributes, particularly taste and thickness. With the highest overall score, F3 had the potential to be the most preferred functional cream soup product for panelists.

Physical characteristics

The results of the analysis of physical characteristics are shown in Table 3. Physical analysis results showed that the F1 cream soup formula had the highest pH. The addition of different food ingredients can affect the pH and other characteristics of cream soup. The increase in carrot composition in cream soup in this study aligns with the increase in pH value. Carrots have a reasonably high pH value of around 8,07 (Angelia, 2017). This factor causes the pH value of cream soup containing more carrot composition (F1) to be higher than that of other cream soup formulas.

Table 3. Analysis result of cream soup characteristics

Physical characteristics	Formula			p value
	F1	F2	F3	
pH	5,62 ± 0,21[a]	5,61 ± 0,14[a]	5,47 ± 0,21[b]	0,007
Viscosity (cP)	1480 ± 28,28[a]	1390 ± 14,14[b]	1210 ± 14,14[c]	0,002
Yield (%)	9,88 ± 0,18[a]	9,78 ± 0,32[a]	9,54 ± 0,02[a]	0,376
Rehydration capacity (ml/g)	5,63 ± 0,43[a]	4,43 ± 0,63[a]	4,35 ± 0,53[a]	0,160

Values with the same superscript in the same row indicate no significant difference

Formula F1 has the highest viscosity. The higher carrot content in F1 may contribute to a higher viscosity value. Carrots contain pectin, which can play a role in gel formation (Moelants et al., 2012). Pectin in the food industry is commonly used as a gelling agent, stabilizer, emulsifier, and thickener in products such as jams, jellies, candies, and fruit juices (Jafari et al., 2016). This gel formation process by pectin can affect the viscosity of cream soup, thus making formula F1 thicker than other formulas with less carrot content. The decrease in viscosity of cream soup with the highest addition of moringa leaves is suspected to be due to the presence of saponin compounds in moringa leaves. Saponins are known to affect the viscosity of food. Saponins have been reported to reduce the viscosity and increase the foaming capacity of cowpea paste, subsequently influencing the physical characteristics of fried akara products (Park et al., 2005).

Formula F1 has the highest yield. The percentage yields of the three cream soup formulations did not differ significantly. This result indicates that the three formulas have the same production efficiency, and there is no significant difference in the conversion from fresh cream soup to the final product, namely, instant cream soup. The results of the rehydration power analysis of the three cream soup formulas showed no significant difference.

Proximate nutrient content

The proximate nutrient content analysis results shown in Table 4 showed no significant differences in ash, protein, fat, and carbohydrate contents among the three instant cream soup samples. Meanwhile, in the parameter of water content, there was a significant difference among the three instant cream soup samples.

The moisture content plays a vital role in determining the texture and stability of food products. F1 had the highest moisture content, which may also indicate that the higher the ratio of carrot composition in the instant cream soup, the higher the moisture content in the sample. This difference can be caused by the water content of carrots, which is slightly higher than that of moringa leaves. Water content in carrots ranges from 76,3% to 88,5%, while the water content in fresh moringa leaves based on the Tabel Komposisi Pangan Indonesia/Indonesian Food Composition Table (IFCT) is 75,6% (Kementerian Kesehatan, 2018; Rashidi & Gholami, 2011). This difference in water content may have caused significant differences among the three instant cream soup samples with varying ratios of moringa leaves and carrots.

Analysis of the Selected Cream Soup Formula

Based on the analysis of sensory, physical, and proximate nutritional characteristics of the three instant cream soup formulas, F3 was selected as the best formula. Formula F3 was chosen because it had the highest overall hedonic test value. In addition, the proximate nutrient content analysis showed that the three formulas did not have significant differences except for the water content. Therefore, formula F3 was chosen because it has the highest moringa leaf composition, which is expected to contain high levels of antioxidants and can help support the smooth production and release of breast milk in nursing mothers.

Table 4. Proximate nutrient content of instant cream soup

Composition (%)	Formula			p value
	F1	F2	F3	
Moisture (wb)	4,56 ± 0,06[a]	3,80 ± 0,06[b]	3,27 ± 0,09[c]	0,001
Ash (db)	8,63 ± 0,21[a]	8,70 ± 0,07[a]	8,47 ± 0,07[a]	0,342
Protein (db)	14,27 ± 0,01[a]	14,14 ± 0,50[a]	14,52 ± 0,16[a]	0,519
Fat (db)	23,14 ± 0,92[a]	23,19 ± 0,09[a]	23,40 ± 0,46[a]	0,903
Carbohydrates (db)	55,55 ± 1,01[a]	55,64 ± 0,47[a]	55,31 ± 0,54[a]	0,894

Values with the same superscript in the same row indicate no significant difference
wb= wet basis, db= dry basis

The analysis showed a significant difference in water and protein content between fresh and instant cream soups (p-value <0,05. Meanwhile, the ash, fat, and carbohydrate contents could not be tested because there was no variation in the mean difference between the two groups, or it could be said that there was no difference in ash, fat, and carbohydrate contents between fresh and instant cream soups. The results of the nutritional analysis of the fresh and instant cream soup in formula F3 are presented in Table 5. Fresh cream soup had high moisture content. This figure shows that most of the fresh cream soup was composed of water. Meanwhile, instant cream soup had a much lower moisture content of 0,8 g. This drastic decrease in moisture content resulted from the drying process using a drum dryer to create instant cream

Table 5. Proximate nutrient content of selected cream soup products (F3)

Content (g)	Fresh cream soup	Instant cream soup	p-value
Moisture (wb)	182,4	0,8	0,000
Ash (db)	1,85	1,65	N/Aa
Protein (db)	6,65	3,5	0,010
Fat (db)	4,75	5,65	N/Aa
Carbohydrate (db)	14,6	13,4	N/Aa

[a]= statistical analysis could not be performed because the difference between the two data sets being compared is constant or negligible

The drying process aims to reduce the moisture content to a deficient level to extend the shelf life and facilitate storage. Lower moisture content in food products will result in longer shelf life (Ergun et al., 2010). Low-moisture foods are regarded as safe for human consumption because the limited water content does not support microbial activity (Karuppuchamy et al., 2024).

The protein content of the fresh cream soup was higher than that of the instant cream soup, indicating that the drying process performed on the instant cream soup may affect the structure or concentration of the protein. This change can be caused by protein denaturation due to an increase in temperature or heating. Denaturation is a biochemical process that occurs when there is a change in the secondary, tertiary, or quaternary structure of the protein molecule, resulting in disruption of covalent bonds. This denaturation can reduce the protein's biological activity or a change in shape that can affect the protein content measured in the analysis (Acharya & Chaudhuri, 2021).

Formula F3 was further analyzed for iron content, antioxidant activity, total phenols, flavonoids, beta-carotene, and protein digestibility, the results of which are presented in Table 6. The iron content of the selected instant cream soup was 0,22 mg/g or 22 mg/100 g sample. The relatively high iron content can be attributed to the pumpkin and moringa leaves, which are the raw materials for cream soup. According to the Indonesian Food Composition Table (IFCT), pumpkins contain 180 mg of iron per 100 g of material, while moringa leaves contain 6 mg per 100 g of material (Kementerian Kesehatan, 2018). Iron is an important mineral that plays a role in the formation of hemoglobin in the blood. Consumption of foods rich in iron can increase hemoglobin levels, serum ferritin, and reduce the risk of anemia and iron deficiency (Gera et al., 2012). Fe plays a crucial role in maternal and infant health during pregnancy and lactation. Adequate iron intake is essential for fetal development and successful lactation (Orlova et al., 2022).

Table 6. Iron content, phytochemicals and protein digestibility of selected instant cream soups (F3)

Parameter	Unit	Content of Cream Soup
Iron (Fe)	mg/g	0,22
Antioxidant Activity (IC_{50})	ppm	167,79
Total Phenol	mg GAE/g	50,95
Total Flavonoid	mg QE/g	20,33
Beta-carotene	mcg/g	40,50
Protein Digestibility	%	43,57

During lactation, maternal intestinal iron absorption increases through hypoxia-inducible factor-2α (HIF-2α) activation, which is vital for maintaining the iron levels in breast milk. Disruption of intestinal HIF-2α in lactating mothers can lead to anemia, growth deficits, and cognitive impairments in offspring (Ramakrishnan et al., 2015). The high iron content in this cream soup can help prevent anemia, especially in breastfeeding mothers who need higher iron intake than in non-breastfeeding women.

The antioxidant activity was measured using the IC_{50} value, which is the concentration of a substance required to inhibit 50% of the free radical activity in the test system. A lower IC_{50} value indicated a higher level of antioxidant activity. Based on the DPPH method, the selected instant cream soup had an IC_{50} value of 167,79 ppm. This result indicates weak antioxidant activity. Antioxidant activity is categorized as very strong if the IC_{50} value is less than 50 ppm, strong between 50-100 ppm, moderate between 100-150 ppm, and weak if more than 150 ppm (Molyneux, 2004). The antioxidant activity of moringa leaves and pumpkin, which are the main ingredients of instant cream soup, was classified as very strong. The antioxidant activity of moringa leaf extract ranges from 1,60-2,31 ppm, while pumpkin has an antioxidant activity of 23,85 ppm (Charoensin, 2014; Indrianingsih et al., 2019).

The decreased antioxidant activity in the cream soup and its weak classification can be caused by the cooking process of fresh cream soup and the drying process at a high temperature (130 °C) during the production of instant cream soup. This is in line with the research of antioxidant activity in sweet potato extract, which showed that high temperature and longer duration of heating process can reduce antioxidant activity (Anggraeni et al., 2015).

Phenols are organic compounds with one or more hydroxyl groups (–OH) attached to an aromatic ring. Phenolic compounds included phenolic acids, flavonoids, stilbenes, and lignans. Based on this analysis, the selected instant cream soup had a total phenol content of 50,95 mg GAE/g sample. The total phenolic content was equivalent to the gallic acid content. This total phenol content is not much different from the phenol content in pumpkin and moringa leaves, which are the main ingredients of the cream soup. Total phenol content in pumpkin flour is 48,56 mg/g (Manhivi et al., 2020). Meanwhile, the phenol content in moringa leaves is 63,16 mg GAE/g sample (Fachriyah et al., 2020).

Flavonoids are a group of phenolic compounds that belong to subgroups, such as flavonols, flavones, flavanones, flavan-3-ol, anthocyanidins, and isoflavones. Based on the analysis of the quercetin standard, the selected cream soup had a flavonoid content of 20,33 mg QE/g sample. This flavonoid content is equivalent to that of quercetin. Flavonoids are derived from moringa leaves and pumpkins. Moringa leaves contain flavonoids of 10,477 mg QE/mg sample, while pumpkin contains flavonoids around 29,799–93,017 mg GAE/g (Fachriyah et al., 2020; Pujiastuti et al., 2022).

Polyphenol compounds, including flavonoids, enhance breast milk production by modulating molecular signaling pathways such as Stat5 (differentiation), Stat3 (remodeling), mTOR, insulin (energy production), and nuclear factor kappa beta (NFκβ), which is associated with oxidative stress and inflammation, as revealed by a systematic review (Kelleher et al., 2024).

Beta-carotene is a natural pigment found in plants and is a precursor to vitamin A. This pigment is generally orange in color. This pigment generally has a distinctive orange-yellowish color. Based on the analysis, the selected instant cream soup contains beta-carotene of 40,50 mcg/g or 4,050 mcg/100 g sample. This content is not much different from the pumpkin cream soup in Irwan's (2017) research, which showed a beta-carotene content of 33,8 mcg/g in instant cream soup (Irwan, 2017). The beta-carotene content of instant cream soup in this study is converted into vitamin A (Retinol Equivalent / RE), then the value is equivalent to 168,76 mcg RE per serving size. This result aligns with Aulia's research in 2020, which shows that pumpkin cream soup with added tempeh contains around 54,25–206,9 mcg RE per serving size (Aulia, 2020). Beta-carotene can come from pumpkin, moringa leaves, and carrots used in cream soups. Pumpkin contains beta-carotene, which ranges from 29,16 mg/100 g to 154,76 mg/100 g or 29,160 mcg/100 g to 154,760 mcg/100 g of material (Norshazila et al., 2014). Moringa leaves contain beta-carotene, which is also relatively high, amounting to 10.477 mg/100 g of sample, while carrots contain beta-carotene around 3,784 mcg/100 g of material (Kementerian Kesehatan, 2018). Beta-carotene is a provitamin A that plays a crucial role in breastfeeding mothers, as it supports breast milk production. Vitamin A aids in steroid production, which together stimulate the proliferation of alveolar epithelium and increase the number of alveoli and ducts in the mammary glands (Qiao et al., 2013). A deficiency in vitamin A intake increases the risk of reduced breast milk production by up to 1,8 times (Rahmadani et al., 2020). Therefore, beta-carotene is an essential component for meeting the nutritional needs of breastfeeding mothers.

Protein digestibility is an indicator of how well the proteins in food can be digested and absorbed by the body. Protein digestibility in this study was measured using the in vitro method with digestive enzymes, which refers to the static in vitro simulation procedure of food digestion in the digestive tract by INFOGEST 2.0. The protein digestibility value is expressed as a percentage obtained by dividing the protein content by the total protein contained in a material or food. The higher the percentage of protein digestibility, the better the protein can be absorbed and used by the body. The instant cream soup in this study contained proteins mainly derived from animal proteins, namely chicken meat and breast parts. As shown in Table 7, the protein digestibility of the selected cream soup product was 43,57%. This result aligns with research by Lee et al. (2023), which showed that chicken breast meat has the most digestible protein, around 40% (Lee et al., 2023).

Contribution of Cream Soup Nutritional Content to the Nutritional Needs of Breastfeeding Mothers

The nutrient contribution of instant cream soup in one serving size (25 g) was also calculated based on the Indonesian Recommended Dietary Allowance (RDA) of breastfeeding mothers aged 19–29 and 30–49 years. Nutrient contribution was calculated in these two age ranges because the needs of breastfeeding women in these age ranges are different, especially in terms of energy, fat, and carbohydrate requirements. The nutrient content and contribution of instant cream soup per serving size to the Indonesian

Recommended Dietary Allowance of breastfeeding mothers at exclusive breastfeeding period aged 19–29 years and 30–49 years are presented in Table 7.

The analysis results show that one serving (25 g) of instant cream soup fulfills 5% of the RDA for energy, 4% of the RDA for protein, 3% of the RDA for carbohydrates, 30% of the RDA for iron and 18% of the RDA for vitamin A for breastfeeding mothers aged 19–49 years. Meanwhile, the fat content contribution varies by age, contributing 8% of the RDA for breastfeeding mothers aged 19–29 and 9% for those aged 30–49. According to the 2019 Ministry of Health Regulation on Nutritional Adequacy Levels for breastfeeding mothers, vitamin A needs are measured in Retinol Equivalents (RE). Therefore, the beta-carotene content in instant cream soup was converted into vitamin A in RE units. One mcg RE is equivalent to six mcg beta-carotene, so one serving of instant cream soup contains 168,76 mcg RE of vitamin A, contributing 18% of the needs for breastfeeding mothers aged 19–49 years.

Table 7. Nutrient content and contribution per serving size of instant cream soup to the RDA of breastfeeding mothers.

Nutrient content	Nutrient Content per Serving Size	Breastfeeding Mothers			
		RDA		%RDA	
		(19–29 y.o)	(30–49 y.o)	(19–29 y.o)	(30–49 y.o)
Energy (kcal)	118,9	2580	2480	5	5
Protein (g)	3,5	80	80	4	4
Fat (g)	5,7	67,2	62,2	8	9
Carbohydrate (g)	13,4	405	385	3	3
Iron (mg)	5,43	18	18	30	30
Vitamin A (RE)	168,76	950	950	18	18

It is recommended that one serving of instant cream soup be consumed twice a day to meet 10% of the needs of breastfeeding mothers. Instant cream soup can also be consumed as a snack with two slices of white bread (74 g), which meets 12% of the RDA for breastfeeding mothers in one meal

Conclusion

Adding Moringa leaves at three concentration levels in cream soup resulted in significant acidity (pH), viscosity, and moisture content differences. Hedonic testing showed that panelists preferred instant cream soup from formula F3, which had the highest moringa leaf composition (3%). This formula received the highest thickness, taste, and overall evaluation scores. The selected instant cream soup (F3) contained iron, antioxidant activity, phenol, flavonoid, beta-carotene, and had relatively good protein digestibility, with one serving size (25 g) fulfilling 5% of the Indonesian Recommended Dietary Allowance (RDA) for breastfeeding mothers aged 19–49 years. Cream soup formula (F3), which contains essential nutrients, supports the nutritional needs of breastfeeding mothers, while its antioxidant content acts as a galactagogue, promoting increased breast milk production.

Further research should focus on human clinical trials to evaluate its efficacy for increasing breast milk production and improving maternal health. Preclinical studies using experimental animals can also provide insights into the mechanisms of action. Additionally, shelf-life studies are necessary to assess the stability of the product, including its nutritional quality, antioxidant activity, and safety, under various storage conditions.

Pumpkin cream soup with moringa leaves can be recommended as a dietary supplement for breastfeeding mothers, supported by educational materials highlighting its potential benefits for lactation and nutrition. Collaboration with local health clinics or breastfeeding support groups could facilitate its promotion as a functional food through educational campaigns to increase the awareness of its nutritional benefits.

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