



Nutritional Composition, Sensory Properties and Antioxidant Activity of A Newly Developed Instant Cream Soup Made from Shrimp (*Litopenaeus Vannamei*) and Beetroot (*Beta Vulgaris L.*)

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Abstract

Shrimp (*Litopenaeus vannamei*) and beetroot (*Beta vulgaris l.*) are two promising protein and mineral food sources. Both have a high potential to be developed as a cream soup that can alleviate micronutrient (iron and folic acid) deficiencies among pregnant women. To our knowledge, lack of effort to develop a cream soup made from marine products, particularly shrimp, was classified as one of the most perishable foods. The current study tries to develop cream soup formulas and examine their nutritional composition, sensory properties, and antioxidant activity. The ratio of shrimp and beetroot were formulated into F0 (200g: 0g); F1 (150g: 50g); F2 (100g: 100g); and F3 (50g: 150g) and were dried in drum dryer to produce instant cream soup. Proximate and other micronutrient content analyses were carried out in an accredited laboratory. At the same time, 16 semi-trained panellists evaluated sensory properties (descriptive test). At the same time, antioxidant activity was determined by the DPPH method and expressed as IC₅₀. All formulations met the national standard for instant cream soup. F2 had a score above 7.0 for all hedonic parameters and had determined as the best formula. F2 contained, per 100 gram, 49.25% carbohydrate, 10.26% fat, 26.68% protein, 4.75% moisture, 9.05% ash, 1.69 mg iron and 14.68 µg folic acid. F2 fulfilled the 'high protein' and 'iron source' nutrition claims based on the Indonesian Food



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Drugs Administration standard (BPOM). The antioxidant activity (IC_{50}) of the best formula was about 15.49 ppm. The combination of marine and plant-based foods into instant food products by drum drying mechanisms can be used to produce a nutritious, desirable, and alternative antioxidant food source as well as practically easy to serve.

Introduction

Anaemia, which is defined as low blood haemoglobin concentration, has been a public health problem affecting low, middle, and high-income countries with adverse health consequences and adverse impacts on socioeconomic development.¹ According to the International Food Policy Research Institute (2016), out of 185 countries globally, Indonesia ranks 61st with an anaemia prevalence of 22.5% in women of childbearing age.² The most significant contributors to anaemia were poor dietary patterns that lack micronutrients such as iron, which composed nearly 50% of anaemia,³ and folate.⁴

A novel food product that meets the demands of a segmented market group, can be a part of their diet, and contribute to their health, are of the best food choices. The current study proposes the development of instant cream soup for women of childbearing age made from Shrimp (*Litopenaeus vannamei*) and beetroot (*Beta vulgaris l.*). Both are two promising protein and mineral food sources that can alleviate micronutrients (iron and folic acid) among women of childbearing and contribute as antioxidant food sources. Besides low fish intake among the national population, fish intake, including shrimp among women of childbearing, is assumed to be lower than national level.^{5,6} To our knowledge, lack of effort to develop a cream soup made from marine food-based, mainly shrimp, was classified as one of the most perishable foods but highly available since Indonesia had a great potential for fish supply, including the shrimp.

As a marine animal food, shrimp is known as higher protein food sources (21 g/100 gr) if compared with commonly eaten land-animal protein food sources such as chicken and egg. Raw shrimp also contains a good level of haem-iron (8 mg/100 gr) which is comparable with chicken flesh. Beetroot, as a tuber-type food, possesses good folic acid (109 µg/100 gr) and iron (1 mg/100 gr) that had a significant antioxidant activity due to the phenolics

and betalain compounds.⁷⁻⁹ In combination, both food sources may provide minerals (copper, magnesium, and potassium) and B-complex, including folic acid and B12, which help prevent anaemia by improving the haemoglobin levels.¹⁰ Therefore the purpose of this study was to develop and evaluate the nutritional content, sensory properties, and antioxidant activity of an instant cream soup product made from a combination of shrimp and beetroot by using a drum dryer.

Materials and Methods

Formulation

The instant cream soup was produced by a combination of shrimp (*Litopenaeus vannamei*) and beetroot (*Beta vulgaris*) by modifying Hardiman recipes¹¹. All ingredients (Table 1.) were gathered from a market in West Jakarta, Indonesia.

In brief, after selection and cleaning, the beetroot was blanched for 2 minutes to reduce odour. Fresh cream soup then prepared by sautéing margarine, onion, and shrimp meat; add the blanched beetroot and shrimp broth; cooked until all soft. This mixture was then put into a food processor (Philips HR 7310), which blended until smooth. Afterwards, it was poured into a saucepan. Other ingredients such as flour, milk powder, salt, sugar, and pepper were added. The mixture was being cooked and stirred until thick, then subjected to the drying system. The product preparation and formulation were undertaken in the Food Development Laboratory of Nutrition Department, Universitas Esa Unggul, Jakarta, Indonesia.

Drum Drying System

The powder of instant shrimp – beetroot cream soup was obtained by feeding the fresh cream soup into a heated drum dryer in Pilot Plant Food Processing Laboratory, Southeast Asian Food and Agriculture Science and Technology Centre, IPB University, Bogor, Indonesia. The processing was executed at a T 120°C for 34 s. The dried material was collected

as a thin layer from the drum surface. Those (Philips HR 7310) and stored in a vacuum plastic flakes were then ground using a food processor before further analysis.

Table 1: Instant shrimp – beetroot cream soup formulation

Ingredients	Formulation			
	F0 (Standard)	F1	F2	F3
Shrimp (g)	200	150	100	50
Beetroot (g)	0	50	100	150
Shrimp broth (mL)	600	600	600	600
Full cream milk powder (g)	30	30	30	30
Flour (g)	46	46	46	46
Butter (g)	8	8	8	8
Onion (g)	20	20	20	20
Garlic (g)	8	8	8	8
Pepper (g)	1.25	1.25	1.25	1.25
Salt (g)	7.5	7.5	7.5	7.5
Sugar (g)	4	4	4	4
Lime water (mL)	2	2	2	2

Sensory Properties

Sensory properties consisted of hedonic (colour, texture, aroma, and taste) test and hedonic quality (colour, viscosity, roughness, aroma, and taste) test assessed by 16 semi-trained panellists. All hedonic parameters measured from 0 – 10

(dislike – like) while hedonic quality measured from 0 – 10 and specific for each parameter such as colour (pale – dark red), viscosity (liquid – thick), texture (rough – smooth), aroma (unpleasant - pleasant), and taste (tasteless – savoury)¹²

Table 2: Organoleptic values of instant shrimp – beetroot cream soup

Parameters	Formulation (mean ± S.D.)				
	F0	F1	F2	F3	P
Hedonic parameters					
Color, mm	5.88±2.55	7.44±2.12	7.69±1.49	6.44±2.20	0.102
Texture, mm	6.19±2.26	6.78±1.92	7.04±1.90	5.91±2.40	0.421
Aroma, mm	7.56±1.47	6.46±2.54	7.20±2.13	6.59±2.34	0.431
Taste, mm	7.97±1.36 ^b	6.06±2.43 ^a	7.89±1.73 ^b	6.32±1.96 ^a	0.012
Hedonic quality parameters					
Color, mm	2.34±1.11 ^a	8.73±1.09 ^c	7.61±1.26 ^b	6.59±1.28 ^d	0.001
Viscosity, mm	8.07±1.29	8.09±1.62	8.59±0.93	7.91±1.79	0.761
Roughness, mm	6.96±2.35 ^a	7.03±2.16 ^a	6.41±2.49 ^a	4.04±2.43 ^b	0.001
Aroma, mm	7.13±1.73	6.57±2.52	7.42±1.62	6.75±2.15	0.642
Taste, mm	8.36±0.82	7.61±1.65	8.19±1.10	7.82±1.22	0.481

¹One Way Anova test, ²Kruskall Wallis test. The numbers followed by different superscript letters in the same row represent significantly different values ($p \leq 0.05$). Hedonic measured from 0 – 10 (dislike – like) for all parameters. Hedonic quality measured from 0 – 10: colour (pale – dark red), viscosity (liquid – thick), texture (rough – smooth), aroma (unpleasant - pleasant), taste (tasteless – savoury).

The panellists' criteria were healthy and normal appetite, no allergic to a particular food ingredient, physically well, not fatigue or worried, and not colour-blind. The panellists assessed each sensory parameters following to the level of preference or rating scale. Visual Analog Scale was used as a primary instrument in the organoleptic assessment. The organoleptic test was carried out in the Organoleptic Laboratory of Nutrition Department, Universitas Esa Unggul, Jakarta, Indonesia.

Proximate Analysis

The proximate composition of selected formulation based on organoleptic tests' result was determined according to AOAC methods, particular sub-components of 979.09, 920.29, 925.09, 923.03, and 962.09 for crude protein, fat, moisture, total ash, and crude fibre, respectively.¹³ Carbohydrate content was determined by calculation.^{14,15} The proximate analysis was performed in Mbrio-Food Laboratory, Bogor, Indonesia.

Table 3: Nutritional composition of selected instant shrimp – beetroot cream soup / 100 g dry weight

Parameters	Formulation (mean ± S.D.)		
	F0	F2	P1
Yield	19.43±0.45	20.43±0.48	0.48
Carbohydrate (%)	42.87±0.1 ^a	49.25±0.1 ^b	0.00
Fat (%)	9.39±1.8 ^a	10.26±0.0 ^b	0.00
Protein (%)	34.87±0.17 ^b	26.68±0.05 ^a	0.00
Moisture (%)	4.71±0.02	4.75±0.05	0.51
Ash (%)	8.15±0.0 ^a	9.05±0.00 ^b	0.00
Iron (mg)	2.71±0.00 ^b	1.69±0.00 ^a	0.00
Folic Acid (mcg)	14.68±16.08 ^b	9.25±4.92 ^a	0.00

¹Independent T-test, significant if $p < 0.05$. F0 (200 g shrimp : 0 g beetroot), F2 (100 g shrimp : 100 g beetroot)

Micro-nutrient: iron and folic acid analysis

The analysis of micro-nutrient was performed on iron and folic acid content in selected instant cream soup products. Determination of both iron and folic acid contents referred to an official method of AOAC¹³ and Monks *et al.*¹⁶, respectively. Both micro-nutrients were analyzed in Mbrio - Food Laboratory, Bogor, Indonesia.

Determination of Antioxidant Activity

The antioxidant activity was identified by the DPPH (1,1-Diphenyl-2-picrylhydrazyl) inhibitory measurement and was executed according to Molyneux¹⁷ with slight modification. About 100 μ L samples (0.62-4.96 mg/mL) mixed with 50 μ L 100 mM Tris-HCl (pH 7.4) and then added with 5 μ L 500 M (2.5 mg/mL) DPPH. In this study, a blank solution was ninety per cent ethanol, and the control solution was a blank DPPH solution. The solution was shaken vigorously for 1-3 minutes and kept at

room temperature for 30 minutes in dark conditions. The absorbance of the solution was measured using a spectrophotometer with a wavelength of 517 nm. The antioxidant activity was determined in Mbrio - Food Laboratory, Bogor, Indonesia. The value of antioxidant activity was expressed as IC₅₀ (half maximal inhibitory concentration), while the formula calculated the percentage of free radical inhibitory was below:

$$\text{Inhibition (\%)} = \frac{(\text{blank absorbancy} - \text{sample absorbancy})}{(\text{blank absorbancy})} \times 100\%$$

Experimental Design and Statistical Analysis

The experiment was conducted in a completely randomized design with two replications, data management by Microsoft excel 365 for windows. Statistical analysis was performed using SPSS version 20.0 for windows from SPSS Institute Inc., Cary, NC. Results were analyzed by performing

one way ANOVA and Kruskal Wallis tests, while mean comparison by Duncan's Multiple Range Test (DMRT) at P-value of 0.05. The standard error of the mean was also calculated.

Result and Discussion

In this study, the formulation was initially carried out from producing a fresh liquid cream soup. Then drying was done using a drum dryer technique. The drying process of fresh cream soup was performed to get an instant cream soup powder. This powder product then can be served simply by adding hot water with a temperature of about 70-80°C in a glass or bowl without going through the cooking process using a stove.

Sensory Properties

The 16 semi-trained panellists revealed that formulation F2 showed the highest sensory evaluation scores of those three formulations and against F0 as standard (Table 2). F2 was characterized as red colour, thick viscosity, smooth texture, pleasant aroma, and savoury taste. Interestingly, on hedonic parameters, except for the taste, no significant differences were identified across formulas. In contrast, significant differences were identified on hedonic quality parameters, particularly on colour and geometric-texture (roughness) quality. It means the applied ratios of shrimp and beetroot on those formulations might influence both colour and roughness quality. Without any beetroot added, the colour of cream soup seems pale. The small beetroot results in a pink to light red colour, while the more beetroot added may generate a darker colour. Beetroot is known as a red pigment source that may affect the colour of food developed from it. The majority of substances that contribute to the red colour known as betalain. Different processing may impact betalain content. A vacuum processing may increase the betalain content as implemented in this study.¹⁸

The current study emphasizes geometric texture (coarseness/roughness) assessed by the tongue sensation toward the ingested cream soup. The desirable coarseness was at a scale of 6.41, which can be described as a smooth texture. It seems the ratio of shrimp and beetroot contributes to the texture. Suhrawardi, Suparmi, and Buchari found the more beetroot added, and the more coarse powder paste's texture will be obtained.¹⁹ In contrast, Ann,

Suseson, and Utomo found that their marshmallow produced a soft texture caused by pectin substance from the beetroot.²⁰ It implies that the beetroot tends to create a smooth texture in the cream soup. We assumed different types of beetroot extraction explain the contradiction. In our study, the beetroot was extracted and filtered so that only soluble peptic substances contribute to the cream soup's smoothness.

Nutritional Composition

Table 3 demonstrated the difference in nutritional content between the selected formula (F2) and standard formula (F0). Except for yield and moisture, other nutrient content of F2 significantly differed toward F0. Yield in this study may refer to the rest material after the drying process (rendement). It shows that the drying process through a drum dryer system at T 120°C for 34 was efficient in removing water content and producing almost the same yield. A study indicates that the drum dryer system, including steam pressure and the drum's rotary speed, influenced the moisture/ water content but would not significantly impact other proximate components producing powder stuff.^{21,22} The drum dryer is also frequently used in extensive food manufacture because it has low maintenance, less error, and relatively simple structure needed.²³

Ratio 50% beetroot to shrimp caused a significant rise in the number of carbohydrates, fat, and ash contents on F2 against control. But, vice versa, 50% beetroot created a significant lowering value on protein, iron, and folic acid. The different value related to the beetroot added ratio was due to each main ingredient's originate nutrient content. Several studies on white leg shrimp (*Litopenaeus vannamei*) identified a higher value in protein, fat, ash, and Fe than beetroot (*Beta vulgaris*). But, beetroot showed a better nutrient content on carbohydrate and moisture compared to white leg shrimp.²⁴⁻²⁶

Interestingly, both F0 and F2 met the nutrition claim based on the Indonesian Food Drugs Administration standard (BPOM), specifically high protein food, because they contain more than 17.5% protein in 100 mL.^{12,27} Although iron and folic acid content of F0 were higher than F2, both can be classified as iron and folic acid food sources because they contain more than 7.5% of those nutrients in 100 mL.²⁷ Beetroot might not significantly increase the nutrient

content, but it improved the sensory properties, particularly the colour. Colour is a vital property since an 'eye-catching' product might be more preferred than a pale colour product. A consumer who satisfies the sensory properties may increase the portion size to somewhat extent to achieve nutrient of interest comparable to the control formula (F0).

Antioxidant Activity

Antioxidant activities of selected and standard instant cream soup were expressed in a half-maximal inhibitory concentration or IC₅₀ (Table 4). This IC₅₀ reflects many antioxidants required in reducing 50% of free radicals.²⁸ The antioxidant activities of both F0 and F2 were 16.84 and 15.49 ppm, respectively. It showed that the use of shrimp and beetroot exhibits antioxidant properties. On the other hand, the critical process in the production of instant cream soup was the drum drying system. A drum dryer at 100 - 120°C required a short drying duration (422 -257 s) to reach low water contents (1.0 – 2.6%) of pomegranate peels and result in a not significantly reduce the total phenolic content and antioxidant activity.²⁹ In this study, drying processed was conducted at T 120°C for 34 s. Thus, the primary processing in the production of cream soup might not affect the antioxidant activity.

Table 4: Antioxidant activities of standard and selected instant shrimp – beetroot cream soups

Formula	IC ₅₀ (ppm)
F0 (standard formula)	16.84
F2 (selected formula)	15.49

Antioxidant activities presented in half-maximal inhibitory concentration (IC50 in ppm). F0 (200 g shrimp : 0 g beetroot), F2 (100 g shrimp: 100 g beetroot).

This instant food is contained shrimp as one of the main ingredients. Marine animal food, including shrimp, fish, and another mollusc, provides a valuable mineral, protein, vitamin, and offer a potential bioactive compound. Some previous studies investigated natural antioxidants from shrimp. A natural compound found in shrimp is carotenoids, which are lipid-soluble pigments. Most

carotenoids in shrimps extract are astaxanthin and found β-carotene and zeaxanthin at a low level. Another natural compound responsible for the free radical inhibitory is a polyhydroxylated derivative of aromatic amino acid and influenced by the composition and peptide size.³⁰ The use of shrimp, particularly in hydrolysate form in food development, found substantially inhibits lipid oxidation, as well as lowering the microbial growth, lead to an increase in the food shelf-life.³¹

Besides marine animal protein, this instant cream soup also contained beetroot, which aimed to create a high antioxidant food source. The beetroot possesses several bioactive compounds to work as antioxidants, mainly betalain and phenolic. Betalain is a pigment substance responsible for the red colour of beetroot. Betalain of beetroot consists of vulgaxanthins I and II, betanin, betanidin, and isobetanin.⁸ A scientific work identified total polyphenol content of 70 mL beetroot juice measured through invitro digestion methods was about 68.4 ± 0.3 mg GAE with an antioxidant capacity examined by ferric reducing antioxidant power (FRAP) assay was about 697.9 ± 1.6 mol.³² An in vitro study revealed that beetroot pomace has an EC50 = 2.06 ± 0.10 µg/ml on the DPPH scavenging effect.⁷ Besides, the total phenols and flavonoids also antioxidant scavenging power found were being increased by heat, which was performed in this study.³³

Conclusions

The combination of marine and plant-based foods into instant food products by drum drying mechanisms produces a nutritious and alternative antioxidant food source and is practically easy to serve. Moreover, the selected formula (F2) can be claimed to be a high protein food, iron and folate food source, and better sensory properties, particularly the 'eye-catching' red colour.

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Conflict interest

We declared there is no conflict interest in this research.

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