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FORMULATION AND DETERMINATION OF VITAMIN C CONTENT IN INSTANT POWDER NUTRACEUTICAL FROM BEETROOT EXTRACT (*Beta vulgaris* L.)

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ABSTRACT

Anaemia is a condition where the haemoglobin (Hb) level in the blood is lower than the normal value. The rate of anaemia in Indonesia increased from 37.1% to 48.9%. One way to prevent anaemia is by consuming iron-rich foods. Beetroot is also rich in nutrients such as vitamin C, which helps in the absorption of iron and the formation of red blood cells. To maximise its health benefits, beetroot can be developed into an instant powder nutraceutical preparation. The aim of this research is to determine the physical quality characteristics and vitamin C content of the instant powder nutraceutical preparation of beetroot juice. The beetroot juice was obtained using a juicer and then made into a powder preparation through crystallisation with sugar. The instant powder was then analysed for its physical quality characteristics, including organoleptic properties, pH, dissolution time test, flow time test, and angle of repose test. The determination of vitamin C content was carried out using a spectrophotometer. The research results show that the instant powder nutraceutical preparation of beetroot juice meets the physical quality requirements, with a pH value of 6, a dissolution time of 30 seconds, a flow rate of 10 g/second, an angle of repose of 14.65°, and a vitamin C content of 0.034 mg/mL.

Keywords: *beetroot, formulation, nutraceutical powder, vitamin C*

INTRODUCTION

Anaemia is a condition where the Haemoglobin (Hb) level in the blood is lower than the normal value for age and gender groups. In adolescent girls, the normal haemoglobin level is 12-15 g/dL, while in adolescent boys it is 13-17 g/dL. The World Health Organization (WHO) estimates that around 40% of children aged 6-59 months, 37% of pregnant women, and 30% of women aged 15-49 years worldwide suffer from anaemia (Naning et al., 2014). The prevalence of anaemia in Indonesia increased from 37.1% in 2013 to 48.9% in 2018 among the age groups 15-24 years and 25-34 years. During the third trimester, foetal growth peaks and requires more iron to form sufficient red blood cells. The impact of anaemia on pregnant women includes an increased risk of bleeding complications that heighten the risk of maternal death, a decrease in immune function making them more susceptible to infectious diseases, and hindering foetal growth (Fitriani, 2018). One of the efforts to prevent anaemia is by implementing the consumption of foods that contain iron.

Beetroot (*Beta vulgaris L.)* is known to contain iron (Fe) at a level of 29.59 mg per 100 grams of fresh fruit. Beetroot is known as a nutrient-rich food source, especially in iron, folic acid, and vitamin C. The iron in beetroot plays an important role in the formation of red blood cells, thus helping to combat anaemia. Additionally, the vitamin C content in beetroot also contributes to the absorption of iron and the formation of red blood cells (Baiao et al., 2018). Beetroot has a distinctive bland taste with a strong earthy aroma, making it less popular. To

maximise the health benefits of beetroot and address the issues of beetroot juice's unpopularity and storage, an innovation is needed in the form of instant powder drinks made from beetroot juice. The production of instant powder drinks from beetroot juice is one of the innovations in the development of functional/nutraceutical food products. Instant powder drinks have the advantage of being easy to store, transport, and consume (Akther et al., 2020). The process of making instant powder can preserve the nutritional content of beetroot, thus still providing maximum health benefits. Thus, instant powder drinks made from beetroot can be a practical and effective alternative solution to help address anaemia issues in the community (Aditya et al., 2018).

Beetroot contains iron and vitamin C, both of which play important roles in the pharmacokinetics of iron, particularly as promoters that help the absorption of non-heme iron in the small intestine through the reduction of ferric iron (Fe^{3+}) to ferrous iron (Fe^{2+}), making it easier to absorb and aiding the release of iron from transferrin into body tissues, inhibiting the formation of hemosiderin which is difficult to mobilise in iron release, and enhancing blood formation (Saula et al., 2020).

Beetroot tubers are a potential base for functional food products aimed at preventing and addressing anaemia in the form of powdered drinks. In addition, to produce a high-quality product that is acceptable to consumers, formulation and testing of the characteristics of beetroot powder drink are conducted. Based on this background, it is hoped that this research can determine the best formulation and vitamin C content in instant powder nutraceutical preparations of beetroot (*Beta vulgaris L.*) extract, resulting in a product with good quality and vitamin C content. With this research, it is hoped that it can contribute to efforts to improve public health and the development of innovative and high-value-added functional food products. Research related to the vitamin C content in combinations with beetroot and other forms of nutraceutical preparations.

METHOD

The research was conducted in the laboratory of the Pharmacy Department at Poltekkes Kemenkes Surakarta. The equipment used for the research includes a Rinnai gas stove, a non-stick stainless steel frying pan, a silicon stirrer, 500 ml beaker glass (pyrex), 250 ml beaker glass (pyrex), 50 ml beaker glass (pyrex), Passpro digital scale, Radwag analytical scale , stirring rod, Nesco pH stick, flow time tester, calliper, Innova UV-Vis spectrophotometer, cuvette, glass funnel (pyrex), and test tubes. The materials used include beetroot, aquadest, and vitamin C standard.

The research design used is experimental. The data collection technique began with the formulation of the beetroot nutraceutical preparation, followed by quality characteristic tests of the beetroot nutraceutical preparation, which included organoleptic tests, pH tests, flow rate tests, angle of repose determination, dissolution time tests, and vitamin C content determination of the beetroot nutraceutical preparation.

Table 1. Formulation of nutraceutical beetroot preparation

No	Ingredient	Formula
1	Beetroot juice	75 mL
2	Carrot juice	75 mL
3	Sugar	300 g
4	Ginger	4 cm

The organoleptic test aims to assess the physical and chemical properties of the product through sensory observation, including taste, aroma, texture, and appearance. The method used is visual observation of the product preparation (Rusydi and Angela, 2023).

The pH test aims to determine the acidity or alkalinity level of the preparation, and the pH test is conducted using a universal pH indicator. The neutral pH requirement for nutraceutical preparations is 6 – 7 (Rusydi and Angela, 2023).

The flow rate test is conducted by weighing 100 grams of powder and placing it in a closed flow funnel. The powder will flow out when the funnel cover is opened. Next, measure the time it takes for the powder to flow using a stopwatch. The criteria for good powder flow is (≥10 g/second). The flow rate is calculated using the formula: (Syahrina & Noval, 2021)

$$\text{Flow Rate (Q)} = \frac{w}{t}$$

Explanation :
Q : Flow Rate (g/s)
w : weight of the flowing granules (g)
t : flow time (s)

Next, the angle of repose is measured using the formula:

$$\theta = \tan^{-1}\left(\frac{h}{r}\right)$$

Explanation :
θ : Angle of repose (°)
h : height of the granule pile cone (cm)
r : radius of the pile base (cm)

The dissolution time test was conducted by weighing 5 grams of the sample and dissolving it in 100 ml of distilled water. The dissolution time was then measured using a stopwatch until it was completely dissolved (Antari et al., 2011).

The determination of vitamin C content was performed using a UV-Vis spectrophotometer at a wavelength of 265 nm by preparing a standard ascorbic acid solution of 2 – 10 ppm. A 100 mg sample of beetroot nutraceutical powder was weighed and then analysed at a wavelength of 265 nm to determine the vitamin C content (Romli et al., 2025).

RESULTS AND DISCUSSION

This research began with the formulation of an instant beetroot powder nutraceutical preparation. Subsequently, quality characteristic tests and vitamin C content tests were conducted, the results of which can be seen in the table below.

Table 2. Quality characteristic tests of beetroot nutraceutical preparation

No	Test	Result			Conclusion
		R1	R2	R3	
1	pH	6	6	6	6
2	Organoleptic				
	- Form	Granul	Granul	Granul	Granul
	- Smell	beetroot	beetroot	beetroot	beetroot
	- Colour	red	red	red	red
	- Taste	sweet	sweet	sweet	sweet
3	Dissolution	30 s	31 s	30 s	30.3 s
4	Flowrate	10 g/s	10 g/s	10 g/s	10 g/s
5	Angel of Repose	14.72°	15.22°	14.03°	14.65°

Table 3. Determination of the Standard Curve for Vitamin C Content in Nutraceutical Beetroot Preparation

Concentration (ppm)	Absorbance	Standard Curve
2	0.200	y = 0.0672x + 0.068
4	0.333	R^2 = 0.9992
6	0.482	
8	0.605	
10	0.736	

Table 4. Results of Vitamin C Content Analysis in Nutraceutical Beetroot Preparations

Concentration (ppm)	Absorbance	Vol (Sample)	Weight	Concentration (mg/mL)
4000	0.297	0.01	100.1	0.0340
4000	0.290	0.01	99.9	0.0330
4000	0.296	0.01	100	0.0339
Average				0.0336

The active ingredient in this study is beetroot juice. Beetroot on average contains 29.59 mg of iron (Fe) in 100 grams of fresh produce. Consumption of beetroot juice can increase the average Hb by 1.3 g/dL, haematocrit levels by 4 col, and the number of erythrocytes by 310.329 cells/µL (Kartika & Rohana, 2018).

The preparation of beetroot juice is done using the squeezing method. The squeezing method has advantages compared to other extraction methods, as the process is simpler and faster without the need for special tools and expertise. The squeezing method also does not involve heating, thus keeping the content in the beetroot juice stable (Priamsari & Wibowo, 2020). Beetroot juice has a reddish-purple colour because it contains the pigment betacyanin (Lembong & Lara, 2021).

The preparation of instant powder nutraceuticals from beetroot juice was carried out using the crystallisation method with sucrose as the crystallising agent. Crystallisation is carried out by concentrating the solution until the concentration of the solute becomes greater than that of the solvent at the same temperature. In this state, the subosa molecules in the form of crystal nuclei will adhere to each other and grow into larger crystals, forming a separate and dry powder (Mursalin & Rahmayani, 2019).

The first test conducted on the physical characteristics of the instant powder nutraceutical preparation of beetroot juice was the organoleptic test. The organoleptic test is an examination using the human five senses, including shape, smell, colour, and taste (Arziyah et al., 2022). The resulting form is powder, with the characteristic smell and taste of beetroot, as well as a pink-red colour. The pink-red colour of the instant powder nutraceutical beetroot extract is consistent with the colour of beetroot extract, which is red due to the presence of betacyanin pigments (Lembong & Lara, 2021).

The second physical characteristic test is the pH test. The pH test is conducted to determine the acidity level of a preparation, which ensures safety during consumption. The pH test results show a pH value of 6, while the pH requirement for instant powder is 5-7 (Nafilah et al., 2022). This indicates that the instant powder nutraceutical preparation from beetroot meets the requirements and is safe for consumption. The next physical characteristic test is the dissolution time to determine the solubility time of a preparation. The solubility of the preparation indicates the number of components that dissolve. The faster the dissolution time, the easier the use of instant powder. The dissolution time test results show that the instant powder nutraceutical preparation of beetroot extract is 30 seconds. The requirement for a good instant powder dissolution time is less than 5 minutes (Zuniarto et al., 2021). This indicates that the instant powder nutraceutical preparation of beetroot meets the requirements.

The last physical characteristic test is the flow time and angle of repose. The flow time and angle of repose are conducted to determine the flowability of the instant beetroot powder nutraceutical preparation. Instant powder contains sugar that can make the powder sticky and

clump together when in humid conditions, thereby reducing the flowability of the powder. High humidity or moisture content causes the attractive forces between particles to become stronger due to increased surface contact, resulting in the powder losing its flowability. The test results show that the flow time produced is 1 second for 10 grams of instant powder. The requirement for a good flow time test is greater than or equal to 10 seconds for 100 grams of powder (Andriani et al., 2023). This indicates that the instant powder nutraceutical preparation of beetroot meets the requirements and has good flow properties. In the angle of repose test results, an angle of 14.65° was obtained. The smaller the angle of repose of a powder, the better its flow properties, as it indicates that the powder particles have lower cohesion (the attractive force between particles) and tend to not stick easily. The angle of repose is divided into several classifications: an angle of repose <25° indicates very good flow properties, 25-40° indicates good flow properties, and >40° indicates poor flow properties. Based on the test results, the flow properties of the instant powder nutraceutical preparation of beetroot juice fall into the very good category (Thomas et al., 2021).

The quantitative analysis of vitamin C content in the beetroot nutraceutical preparation shows a linear regression equation of $y = 0.0672x + 0.068$ with a correlation coefficient of $r^2 = 0.9992$, where the value of r approaching 1 indicates that the relationship between absorbance and concentration has a linear correlation with all points lying on a straight line (Selpiana et al., 2016). Table 3 shows the absorbance results of the samples, calculated using the standard curve equation $y = 0.0672x + 0.068$. The measurement results with 3x replication show the vitamin C content in the beetroot nutraceutical preparation sample is 0.0336 mg/mL, indicating that the vitamin C content in the beetroot nutraceutical preparation sample is very low.

This can be influenced by several factors, including the nature of vitamin C, which is easily degraded by temperature, light, and surrounding air, leading to the degradation process of vitamin C (Cresna et al., 2014). The processing of instant powder nutraceutical preparations from beetroot involves several steps, including heating. Vitamin C is a compound that is sensitive to heat treatment. According to Lund (1977), boiling with water causes more even heating of the material, because in this case, the green leafy vegetables are directly exposed to the heat generated by the boiling water, which results in the rapid damage of the parenchyma cell walls and chromoplasts, and the process of osmosis occurs. This condition causes vitamin C to leak out of the beetroot cells and dissolve in the processing liquid.

CONCLUSION

Based on the research results, iron-rich beetroot extract has been successfully formulated into an instant powder nutraceutical preparation using the crystallisation method with sucrose as the crystallising agent. The results of the physical characteristic tests show that the preparation has a powder form, pink-red colour, characteristic smell and taste of beetroot, a pH value of 6, a dissolution time of 30 seconds, good flow time, and a flow angle of 14.65°, which falls into the very good flow property category, thus meeting the quality requirements for instant powder. These characteristics indicate that the produced preparation has good physical quality, is stable, and is easy to use by consumers. The analysis of vitamin C content shows a value of 0.033680231 mg/mL, which is classified as very low, although the measurement has very good

linearity with a correlation coefficient (r^2) value of 0.9992. The low vitamin C content is suspected to be caused by the processing, especially heating, as well as exposure to light and air, which can accelerate the degradation of vitamin C during the preparation of the formulation.

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