

Product Innovation Of Beetroot (*Beta Vulgaris* L.) and Dragon Fruit (*Hylocereus Polyrhizus*) Peel Extract Instant Powder as Antioxidant Potential

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ABSTRACT: Dragon fruit is a type of fruit consumed either in juice drinks or whole. Dragon fruit contains natural antioxidants. Beetroot also has a high antioxidant content. Consuming dragon fruit leaves behind the skin, which becomes waste. The purpose of this research was to optimize the utilization of dragon fruit (*Hylocereus polyrhizus*) skin waste and to formulate an instant powder preparation combined with beetroot (*Beta vulgaris* L.) to maintain immunity. The research method included extracting dragon fruit skin with 70% ethanol and drying the beetroot, followed by phytochemical screening evaluation. The thick dragon fruit skin extract was dried using a spray dryer and formulated with beetroot powder to create an instant drink powder. The evaluation results obtained from the dragon fruit skin and beetroot extracts contained flavonoids, saponins, and tannins. The instant powder was red in color, had a distinctive beetroot odor, a water content of 8%, a pH of 6.67, a low-flowing property, and an IC₅₀ of 109.90±5.16. From the results of the hedonic test, 40% of respondents liked instant drink powder.

KEYWORDS: antioxidant; *Beta vulgaris* L; *Hylocereus polyrhizus*; instant powder; immunity.

1. INTRODUCTION

Nutrition plays a fundamental role in supporting immune system function. Adequate and balanced nutrition allows immune cells to function optimally, recognizing, responding to, and neutralizing threats that enter the body. Nutrients that support the immune system include macronutrients such as protein, healthy fats, and complex carbohydrates, as well as micronutrients, including vitamins, minerals, and bioactive compounds from food. Recent research shows that deficiencies in certain micronutrients can weaken the immune response, increase susceptibility to infection, and slow the healing process [1]. Furthermore, oxidative stress has been recognized as an important factor affecting immune function, highlighting the potential role of dietary antioxidants in supporting immune health.

Antioxidants are electron-donating compounds. Biologically, the term antioxidant refers to any compound that can reduce the negative impact of free radicals. Research has shown that dried red dragon fruit peel has an antioxidant activity (IC₅₀) of 89.36 ppm, indicating strong activity [2]. Furthermore, another study found that beetroot juice has a very strong IC₅₀ of 16,68 using the DPPH method [3]. This indicates that red beetroot has excellent antioxidant activity. Besides beets, dragon fruit is a source of natural antioxidants. Not only can dragon fruit flesh be consumed, but the skin is also very beneficial for health, even though in reality it is only considered as waste that has not been utilized properly.

In recent years, instant dosage forms are also increasingly developed, one of which is instant powder. Instant powder drinks are one of the beverage products in powder form, easily soluble in water, have a short rehydration time, are practical in serving and have a relatively longer shelf life [4]. From the above background, research was conducted to innovate instant drink powder products from beetroot (*Beta vulgaris* L.) and dragon fruit peel extract (*Hylocereus polyrhizus*) as an immunity enhancer.

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2. MATERIALS AND METHODS

2.1. Material

In this study, the tools used include scales (AND GR-200 & AND EJ-6100, Japan), ovens (Mettler, German), dehydrators (Wirastar, Indonesia), flow testers, rotary vacuum evaporators (Heidolph, German), glass jars, knives, blenders (Philips, Dutch), filter paper, sieves, and glassware (Pyrex, United States of America). The materials used in this study include dragon fruit peel (*Hylocereus polyrhizus*), beetroot (*Beta vulgaris* L.), 70% ethanol (Smartlab, Indonesia), distilled water (Smartlab, Indonesia), maltodextrin (Lihua Starch, China), lactose (Broth, sodium benzoate, and aerosil).

2.2. Procedure

2.2.1. Dragon Fruit Peel Powder and Beetroot Powder Preparation

Dragon fruit peel extract was prepared using the maceration method. The dragon fruit peel extract was powdered using a blender. 100 grams of the dragon fruit peel powder was then weighed and placed in a glass jar. 70% ethanol was added at a 1:10 ratio for 3 days. The dragon fruit peel extract was concentrated using a rotary vacuum evaporator. The concentrated extract was then powdered using the spray drying method with 30% maltodextrin added. The spray dryer used an inlet temperature of 150°C and an outlet temperature of 80-100°C.

A total of 5 kg of beetroot was cut into small pieces and dried at 40-60°C until completely dry. The dried beetroot was ground using a blender to form a fine powder. The fine powder was sieved using a graduated sieve with a mesh size of 8/14. This was done to ensure the beetroot powder met the requirements for instant powder.

2.2.2. Phytochemical Screening [5]

This qualitative test is conducted on dragon fruit peel extract and includes tests for alkaloids, flavonoids, tannins, and saponins.

2.2.2.1. Alkaloid Test

A 4 g of powder is placed in a test tube, then 10 drops of 2 M sulfuric acid are added to clarify the separation of the two distinct phases. The upper phase is removed and Mayer's reagent is added. The presence of alkaloids in the sample is indicated by the formation of a red precipitate.

2.2.2.2. Flavonoid Test

A 2 g of powder is taken, sufficient magnesium powder and 10 drops of concentrated hydrochloric acid are added. The presence of flavonoids is indicated by the formation of a reddish-black, yellow, or orange color.

2.2.2.3. Tannin Test

A 2 g of powder is then added with 3-4 drops of FeCl₃ reagent. Observe the color change, which results in a blackish-green color.

2.2.2.4. Saponin Test

2-3 g of powder is placed in a test tube, then 10 mL of hot water is added, cooled, then shaken vigorously for 10 seconds, and then 1 drop of 2 N HCl is added. A positive test is indicated by the formation of a stable foam 1-10 cm high for at least 10 minutes.

2.2.2.5. Steroid Test

10 drops of glacial CH₃COOH and 2 drops of concentrated H₂SO₄ are added to 2 g of extract. The solution is shaken gently and left for several minutes. The presence of steroids is indicated by a blue or green color, while triterpenoids produce a red or purple color.

2.2.3. Instant Drink Powder Formulation

Instant powder is a pharmaceutical preparation composed of active ingredients, fillers, and binders. The active ingredients used are a combination of dragon fruit peel and red beetroot extract powder that has been ground and sieved.

Table 1. Instant drink powder formula combining dragon fruit peel and beetroot extracts.

Ingredient	Composition (grams)
Dragon fruit peel	0.5
Red beetroot	3.5
Laktose	3
Aerosil	0.001
Sorbitol	5
Sodium benzoate	0.001

2.2.4. Instant Drink Powder Quality Parameters

2.2.4.1. Organoleptic

Instant drink powder was directly observed for shape, color, and aroma.

2.2.4.2. pH [6]

Performed using a pH meter calibrated to pH 4 (potassium biphthalate) and pH 7 (phosphate buffer). One gram of the preparation was dissolved in 10 mL of distilled water. The pH meter electrode was dipped into the sample solution and the resulting pH was recorded.

2.2.4.3. Solubility [6]

Solubility is the maximum amount of a compound or substance that can dissolve in a given amount of solvent under certain parameters such as temperature and pH. The preparation was dissolved in distilled water with varying solvent volumes according to the provisions of the Indonesian Pharmacopoeia, Edition VI, regarding solubility. The solution was shaken and allowed to stand for several minutes. The precipitate formed was observed with varying solvent volumes. A 1 gr sample was used.

2.2.4.4. Direct Powder Flow Test [7]

25 g of the preparation was weighed and placed in the funnel of the flow tester, keeping it closed. The lid was opened and the powder was allowed to flow within a time parameter, and the flow rate in g/second was calculated. Flow time is the time required for a certain amount of powder to pass through the funnel and is expressed as the amount of powder flowing per unit time. The flow time test aims to determine the powder flow rate to ensure high dosage accuracy when filling sachets.

2.2.4.5. Antioxidant Activity Using the DPPH Method [8]

2.2.4.5.1. Weigh 10 mg of powder and dissolve it in 10 mL of standard methanol in a volumetric flask to obtain a solution with a concentration of 1000 µg/mL. This solution serves as the stock solution. Next, prepare a series of extract solutions with concentrations of 500, 250, 125, 62.5, and 31.25 µg/mL. Each solution is then placed in a vial and tightly closed.

2.2.4.5.2. Preparation of the DPPH solution: Accurately weigh 10 mg of DPPH and dissolve it in 10 mL of standard methanol in a volumetric flask to obtain a DPPH concentration of 1000 µg/mL. Then, 0.8 mL of the 1000 µg/mL stock solution was pipetted and 10 mL of analytical grade methanol (80 µg/mL DPPH solution) was added. The solution was placed in a tightly closed bottle and placed in a dark place.

2.2.4.5.3. Preparation of the quercetin solution: Weigh 10 mg of quercetin and dissolve it in analytical grade methanol to make 10 mL (1000 µg/mL stock solution). Next, 10 mL of a series of solutions were prepared at concentrations of 100, 50, 25, 12.5, 6.25, and 3.125 µg/mL, then placed into vials lined with aluminum foil.

2.2.4.5.4. Determination of the operating time (OT): Pipette 20 µL of the quercetin reference standard and add 180 µL of the DPPH solution to a 96-well plate. Absorbance was measured at a wavelength of 517 nm at 20, 25, 30, 35, 40, 45, and 50 minutes using a microplate reader.

2.2.4.5.5. To measure absorbance, each solution was placed in a 96-well plate. Incubated for 30 minutes at room temperature, protected from light. Absorbance was measured at a wavelength of 517 nm using a microplate reader. Sample testing was performed in triplicate. The obtained absorbance value was used to calculate the percentage inhibition using the following equation:

$$\% \text{ Inhibition} = (((\text{Serapan kontrol} - \text{Serapan sampel}) : \text{Serapan kontrol}) \times 100\%)$$

2.2.5. Hedonic Test

The level of preference for the instant powder preparation was tested on 10 panelists using the direct product offering method. The hedonic test asks about preferences regarding the organoleptic properties of the preparation.

3. RESULTS

3.1. Making Beetroot Powder and Dragon Fruit Extract

Beetroot powder production required 5 kg of beetroot, yielding 130.74 grams of powder without extraction. The results showed that beetroot has a high water content of 97.38%. Beetroot powder contains carbohydrates (in the form of sugars with small amounts of protein and fat), which readily convert to energy, and iron, which helps the blood transport oxygen to the brain. Beetroot is a therapeutic treatment for clinical pathologies associated with oxidative stress and inflammation [9].

Dragon fruit peel extract production required 100 grams and yielded 8.1 grams of concentrated extract. The study found a yield of 8.1%, and after spray-drying, 11.3 grams of dried dragon fruit peel extract was obtained. This yield was higher than the concentrated extract due to the addition of maltodextrin, representing 30% of the concentrated extract weight, as a filler and primary coating agent during the spray-

drying process [10]. A spray dryer is defined as a device that converts liquid feed into a dry powder. The feed is sprayed into a hot drying medium, causing the water content in the feed to evaporate. The feed can be a solution, suspension, or paste, and the final product is a powder, lump, or granule. The characteristics of the spray drying process are a rapid drying cycle, short product retention in the drying chamber, and the final product is ready for packaging upon completion of the drying process.

3.2. Photochemical Screening of Beetroot Powder and Dragon Fruit Peel Extract Powder

Table 2. Phytochemical Screening Results.

Secondary Metabolites	Beetroot Powder	Dragon Fruit Peel Extract Powder
Alkaloids	Positive	Negative
Flavonoids	Positive	Positive
Tannin	Positive	Positive
Saponins	Positive	Positive
Steroids/Terpenoids	Negative	Negative

Phytochemical screening is a method for identifying the secondary metabolite content of a natural product. This method is a preliminary step that can provide an overview of the content of certain compounds in the natural product being studied. Phytochemical screening can be conducted qualitatively, semi-quantitatively, or quantitatively, depending on the desired objective. Qualitative screening methods can be performed through color reactions using specific reagents. The primary objective of phytochemical screening is to determine the secondary metabolites contained in the test sample [5]. The active ingredients used in the manufacture of instant drink powders contain flavonoids, tannins, and saponins.

3.3. Practice Evaluation Testing

Table 3. physical and chemical evaluation results.

No	Evaluation	Results
1.	Organoleptic	
	Color	Red
	Taste	Sweet
	Smell	Typical of beets
	Shape	Powder
2.	Water content (%)	8%
3.	Direct powder flow properties	Poor
4.	Solubility (pure water solvent)	
	5 mL	Insoluble
	20 mL	Insoluble
	80 mL	Insoluble
	100 mL	Insoluble
5.	pH	6.67±0.036
6.	Antioxidant activity (IC ₅₀)	109.90±5.16 ppm (moderate)
7.	Vitamin and mineral content testing	
	Vitamin A	36 UI
	Vitamin B12	0.067 mg
	Vitamin C	4.9 mg
	Vitamin E	0.3 mg
	Logam Zn	0.35 mg

The organoleptic results of the instant powder show results that are in accordance with the formula made with a red color obtained from beetroot because it contains natural pigment compounds (betasianin) [11], a distinctive aroma from beetroot because it contains the organic compound geosmin with a distinctive aroma [12]. The sweet taste comes from lactose and sorbitol [10].

Flow time is the time required for a certain amount of granules to flow through a device. This flow property can be used to assess the effectiveness of a lubricant, where the presence of a lubricant can improve the flow properties of a 25-gram granule. The flow rate of the granules is expressed in grams per second, and the granules flow in no more than 10 seconds. Using a flow property table as a reference, the flow property data for the instant powder preparation are as follows. [7]

In the formula there is already aerosil as an additional ingredient used to improve the flow properties (lubricant), but from the results obtained the flow properties are still difficult to flow, this can happen because the formula contains many hygroscopic ingredients, namely dried dragon fruit skin extract with maltodextrin, beetroot which contains a lot of carbohydrates, lactose and sorbitol which have a high level of solubility in water, causing the powder to become damp easily and difficult to flow [10].

Based on the Indonesian National Standard SNI 01-4320-1996 for traditional beverage powders, the maximum water content requirement is 3%. The results obtained did not meet the standard due to the hygroscopic nature of the powder.

Based on SNI 01-3553-2006, the pH requirements for bottled drinking water are 6-8.5 for mineral water and 5-7.5 for demineralized water. From the results obtained from testing the instant powder, the pH 6.67 ± 0.036 , so the pH of the instant drink solution is still within the pH range required for consumption.

Solubility is the maximum amount of a compound or substance that can dissolve in a given solvent under certain parameters such as temperature and pH. The preparation was dissolved in distilled water with varying solvent volumes in accordance with the provisions of the 6th edition of the Indonesian Pharmacopoeia regarding solubility. The solution was shaken and allowed to stand for several minutes. The precipitation that occurs with varying solvent volumes was observed. One gram sample was used [6]

Water-soluble substances can precipitate if the solution reaches saturation point (exceeding the solubility limit).

This is the condition where the solvent has accommodated the maximum amount of solute. At this point, a dynamic equilibrium occurs between the dissolved substance and the precipitated substance, so that the large amount of solute in the formula (12.002 g) causes the water-soluble substance to precipitate because the amount of solvent is insufficient.

Based on the IC_{50} parameter table, the antioxidant activity of instant powder is consistently in the moderate category, ranging from 100 to 150 ppm. The lower the IC_{50} value, the higher the antioxidant activity. The IC_{50} value obtained for the instant powder was 109.90 ± 5.16 ppm, which is higher than the IC_{50} values of beetroot and dragon fruit peel extracts. This difference likely arises because the extract underwent a drying process (spray drying) and the addition of 30% maltodextrin to dragon fruit peel extract, leading to an increased IC_{50} value compared to extracts in other studies; the heating stage alters antioxidant structures such as vitamin C and other phenolic compounds through oxidation, and the combination of temperature changes and maltodextrin can result in reduced antioxidant activity [13]. Antioxidant activity testing was conducted on the instant powder formula. Consuming foods rich in antioxidants can help boost the body's immunity. Antioxidants have the ability to neutralize free radicals, thereby preventing damage to immune cells. Antioxidants can fight free radicals and prevent oxidative stress, thus preventing cell damage. Antioxidants have excess electrons that can ward off free radicals. When foreign substances such as viruses or bacteria attack, the antioxidants in immune cells will respond and produce higher levels of free radicals [14].

Vitamin A, for example, plays a role in maintaining the integrity of epithelial cells, the body's first line of defense, while vitamins C and E act as antioxidants, protecting immune cells from damage caused by free radicals. Minerals such as zinc, selenium, iron, and copper also contribute significantly to immune function. Zinc is known to play a role in the proliferation and differentiation of immune cells, while selenium acts as an antioxidant that helps reduce inflammation and oxidative stress. Iron deficiency can reduce the production of white blood cells, which are the body's first line of defense against infection [1].

3.4. Hedonic

The instant powder preparation preference test was conducted on 10 panelists using a direct product offering method. The inclusion criteria for panelists were: physically and mentally healthy, free from allergies, non-smoking for at least 1-2 hours prior to testing, having not consumed strong-tasting foods or beverages (spicy, acidic, or coffee) before testing, and being adults (capable of distinguishing flavors). The hedonic test included the preparation's organoleptic properties.

Table 4. Panelist assessment test results.

Panelist	Appearance	Color	Smell	Taste
1	Like	Like	Like slightly	Like
2	Like	Like	Dislike slightly	Like
3	Like	Like	Dislike slightly	Dislike
4	Like	Like slightly	Dislike	Dislike
5	Like	Like slightly	Dislike slightly	Dislike slightly
6	Like	Like slightly	Dislike slightly	Dislike slightly
7	Like	Like slightly	Dislike slightly	Dislike slightly
8	Like	Like	Dislike slightly	Dislike
9	Like	Like slightly	Like slightly	Dislike slightly
10	Like	Like slightly	Dislike slightly	Dislike slightly

From the overall data results which include appearance, color, smell and taste from a total of 40 responses, 16 responses were like (40%), 8 were somewhat like (20%), 12 were less like (30%) and 4 people did not like it, most of the panelists did not like the aroma of beetroot and some did not like the taste. Earthy taste found in red beets because red beets are present geosmin compound [12]. Based on the hedonic test results, the majority of panelists did not favor the aroma and taste; to improve acceptance of the aroma, a more pleasant essence could be added, while incorporating beetroot in extract form could help mask the vegetable's natural flavor.

3. CONCLUSION

The instant beetroot powder and dragon fruit peel extract preparations have moderate antioxidant properties with an average IC_{50} of 109.89. Our formula has a low-flow rate with an average flow rate of 3.8211 g/s. Hedonic testing showed that only 40% of panelists responded favorably to the instant powder preparation. Evaluation of the preparation can be carried out regarding the composition of flavoring agents and improvements to the excipient composition to demonstrate good flow properties.

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