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Development and Evaluation of Functional Instant Powder Drink from a Combination of Turmeric Rhizome (*Curcuma longa* L.) and Purple Sweet Potato Tubers (*Ipomoea batatas L.)*

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Abstract

This study aims to develop and evaluate a functional instant powder drink formulated from a combination of Turmeric Rhizome (*Curcuma longa* L.) and Purple Sweet Potato Tuber (*Ipomoea batatas* L.) as a practical herbal drink that has antioxidant potential. The study was conducted through several stages, including sample preparation, phytochemical screening, instant powder formulation, physical evaluation, identification of curcumin compounds using Thin Layer Chromatography (TLC), and antioxidant activity testing using the DPPH method. Physical evaluation included organoleptic tests, flow rate, angle of repose, water content, pH, viscosity, solubility, sedimentation, stability, and hedonic tests. The results showed that the combination of Turmeric Rhizome and Purple Sweet Potato contains secondary metabolites in the form of flavonoids, alkaloids, saponins, tannins, and phenolic compounds that have potential as antioxidants. The resulting instant powder has good physical characteristics and meets the evaluation requirements for instant powder preparations. Identification using TLC showed the presence of curcuminoid compounds, namely curcumin, demethoxycurcumin, and bisdemethoxycurcumin, in the formulation. Antioxidant activity testing using the DPPH method showed that the turmeric extract had very strong antioxidant activity with an IC_{50} value of 19.786 ppm, while the instant powdered drink formulation showed weak antioxidant activity with an IC_{50} value ranging from 255,743–321,101 ppm. The decrease in antioxidant activity is thought to be due to the heating process during powder production, which results in the degradation of some of the active compounds. Therefore, an instant powdered drink combining Turmeric Rhizome and purple sweet potato has the potential to be developed as a natural functional beverage with good physical properties and antioxidant activity.

Keywords: antioxidant, DPPH, instant powder, sweet potato, turmeric

Introduction

Indonesia is a country rich in herbal plants and local food ingredients that have the potential to be developed into functional food products. One form of functional food development that is currently in high demand is instant powdered drinks because they are practical, easy to serve, and have a longer shelf life.[1] Instant powdered drinks made from natural ingredients are also growing along with increasing public awareness of the importance of consuming natural health products that contain bioactive compounds such as antioxidants.[2] Antioxidants play an important role in scavenging free radicals that can cause cell damage and trigger various degenerative diseases such as diabetes, cancer, hypertension, and premature ageing.[3]

One of the herbal plants with high antioxidant activity is turmeric *(Curcuma longa L.).* Turmeric is known to contain curcuminoid compounds, especially curcumin, which functions as an antioxidant, anti-inflammatory, antibacterial, and immunomodulator. Curcumin is able to capture free radicals and inhibit oxidative damage in the body, so it is widely used in food products and traditional medicines. In addition, turmeric is also easy to obtain and has long been used empirically by the Indonesian people as an ingredient in traditional herbal medicine. In addition to turmeric, purple sweet potatoes *(Ipomoea batatas L.)* also have great potential as a functional food ingredient because they contain high levels of anthocyanins.[4] Anthocyanins are natural pigments of the flavonoid group that function as natural antioxidants and give tubers their distinctive purple colour. The anthocyanin content in purple sweet potatoes is known to help ward off free radicals and has the potential to prevent various degenerative diseases. In addition to anthocyanins, purple sweet potatoes also contain vitamins, minerals, fibre, phenols, flavonoids, and other secondary metabolite compounds that are beneficial for health.[5]

The use of turmeric and purple sweet potato as a combination of instant powdered drinks has not been widely developed, especially in the form of functional herbal products that are practical to consume. The combination of these two ingredients is expected to produce an instant drink product with better antioxidant content due to the combination of curcuminoid and anthocyanin compounds. In addition to providing health benefits, the combination of turmeric and purple sweet potato can also produce a more attractive colour, aroma, and taste, thereby increasing consumer acceptance of herbal products. Previous research has focused more on the use of turmeric or purple sweet potato alone, while research on the combination of these two ingredients in the form of instant powdered drinks is still limited. Therefore, this study has novelty in the form of an instant powdered drink formulation combining Turmeric Rhizome *(Curcuma longa L.)* and Purple Sweet Potato Tubers *(Ipomoea batatas L.),* as well as evaluation of physical properties, identification of chemical compounds using Thin Layer Chromatography (TLC), and testing of antioxidant activity using the DPPH method.[6]

The purpose of this study was to determine the best formula for an instant powdered drink made from a combination of turmeric and purple sweet potato, evaluate the physical properties of the preparation, determine the TLC profile of the active compounds, and determine the antioxidant activity of the preparation. This study hypothesized that the combination of Turmeric Rhizome and purple sweet potato can be formulated into an instant powdered drink that has good physical quality and contains antioxidant activity due to the presence of curcumin and anthocyanin as the main bioactive compounds.

Method

Tool

Analytical balance (Goto Kyla®), baking pan, blender (Philips), test tube (pyrex), funnel (pyrex), measuring cup (pyrex), stirring rod (pyrex), watch glass (normax), measuring flask (pyrex), basin, frying pan, stove (Quantum), knife, wooden spoon, stopwatch, oven, sieve or mesh, Hotplate stirrer (Thermo®), Flow tester, sedimentation tube (pyrex), Brookfield viscometer, moisture analyzer (OHAUS®), pH meter (OHAUS), UV lamp, capillary tube, cuvette, vial, UV-Vis spectrophotometer (Thermo scientific ®).

Material

Turmeric Rhizome, Purple Sweet Potato Tubers, granulated sugar (gulavit), distilled water, mercury chloride (II) (HgCl2) (PT. DPH), potassium iodide (KI) (Smartlab), tartaric acid (PT. Brataco), bismuth nitrate ($Bi(NO_3)_3$), anhydrous acetic acid (Merck), vanillin (Brataco), 1% gelatin (Merck), concentrated hydrochloric acid (Dexatama), zinc powder (Smartlab), amyl alcohol (Smartlab), $FeCl_3$ 5% (PT. DPH), NaOH 1N (PT. DPH), concentrated sulfuric acid (PT. DPH), ether (Smartlab), alcohol 70% (Smartlab), chloroform P (Smartlab), methanol p (Smartlab), ethanol P (Smartlab), Curcumin standard 0.1% (Merck), Silica gel 60 F254 (Merck), Vitamin C (Merck), DPPH (Smartlab).

Procedure

Making Instant Powder

Wash the Turmeric Rhizome and purple sweet potato, cut into small pieces, and blend the turmeric and purple sweet potato juice with granulated sugar as an additional ingredient. The mixture is heated until it forms powder crystals, then ground and sieved to obtain a homogeneous instant powder.[7]

Phytochemical Screening

Wash the Turmeric Rhizome and purple sweet potato, cut into small pieces, and blend the turmeric and purple sweet potato juice with granulated sugar as an additional ingredient. The mixture is heated until it forms powder crystals, then ground and sieved to obtain a homogeneous instant powder.[7]

Instant Powder Formula

It is made into four different concentrations, with turmeric as the active ingredient, purple tuber as the flavouring, granulated sugar as the crystallizer, and water as the solvent. The mixing process uses conventional methods over direct heat until it becomes a powder.[7]

Table 1. Instant Powder Formula

Material	Function	Formula			
		F1	F2	F3	F4
Turmeric Rhizome	Active Ingredient	50%	50%	50%	50%
Purple Sweet Potato Tubers	Taste	-	5%	10%	15%
Sugar	Crystallizer	50%	45%	40%	35%
Water	Solvent	qs	qs	qs	qs

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Physical Evaluation

Organoleptic

Organoleptic observations were conducted visually and using the senses, including the shape, colour, aroma, and taste of the instant powdered drink. This test aimed to determine the initial characteristics and level of product acceptance.[1]

Solubility

A total of 2 grams of instant powder was dissolved in 20 ml of water at 120 rpm magnetic stirrer. The time required for the powder to dissolve completely was recorded using a stopwatch. The requirement for good solubility is less than 5 minutes.[8]

Flow Time

The powder is weighed at 100 grams, then put into a flow test funnel. The time required for the powder to flow completely is recorded using a stopwatch. It is said to be good if 100 grams has a flow speed of ≤ 10 seconds. This test aims to determine the flow properties of instant powder.[1]

Angle of Repose

A 100-gram powder is allowed to flow through a funnel until it forms a cone on a flat surface. The height and diameter of the cone are measured, then the angle of repose is calculated using trigonometric formulas. The angle of repose is 20-40°. This test is used to determine the flow properties of the powder.[1]

Humidity

The 5-gram powder was processed using a moisture balance. After the process was complete, the moisture content percentage was listed, with a maximum requirement of 3%.[1]

pH

8 grams of instant powder in 100 ml is dissolved in distilled water and then measured using a calibrated pH meter. A good pH value is 4-7. The test is conducted to determine the acidity level of the preparation.

Viscosity

The viscosity of 5 grams of powder in 100 ml was measured using a Brookfield viscometer with spindle no. 2 with a standard value of <1 cP. The measurement was carried out to determine the flow characteristics and viscosity of the instant drink.[9]

Sedimentation

The instant powder solution was placed in a measuring cylinder, and the sediment volume formed during storage was observed at 0, 15, 30, 45, and 60 minutes. The initial and final sedimentation volumes were compared to determine the stability of the dispersion.[10]

Stability

The instant powder was stored under specific conditions for 28 days, then periodically observed for changes in colour, aroma, texture, and solubility. The test aimed to determine the physical stability of the preparation during storage.[11]

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Hedonic

Hedonic testing was conducted on 30 panellists. Panellists were asked to rate their preference for the colour, aroma, taste, and appearance of the instant powdered drink using a questionnaire.[1]

Chemical Properties Evaluation

The instant powder sample was dissolved using an appropriate solvent and then spotted on a GF254 silica gel plate with 3 points, namely (turmeric simplicia, curcumin comparator, and formula 3 powder preparation) then the plate was inserted into a chamber containing a mobile phase of chloroform: methanol (95:5). After elution was complete, the plate was dried and then observed under visible light, 254 nm UV light, and 366 nm UV. The Rf value of the spots was compared with the curcumin standard to identify the presence of curcumin compounds in the preparation.[12]

Antioxidant Activity Test DPPH Method

Preparation of DPPH Solution

DPPH solution was made at 50 ppm in 50 ml by dissolving 2.5 mg of DPPH powder using methanol pa.[13]

Preparation of Sample and Comparison Solutions

Instant powder samples were made at 1000 ppm, 50 mg in 50 ml of methanol pa, and vitamin C as a comparison was made at 500 ppm by dissolving 25 mg in 50 ml of methanol pa.[13]

Determination of Maximum Wavelength

The 50 ppm DPPH solution was measured using a UV-Vis spectrophotometer to determine the maximum wavelength of DPPH absorbance.[14]

Determining *Operating Time*

The DPPH solution is mixed with the sample, and then the absorbance is measured at certain time intervals until the optimum incubation time is obtained.[15]

Antioxidant Activity Testing

The sample solution was mixed with the DPPH solution and then incubated at room temperature in the dark. After the incubation time was reached, absorbance was measured using a UV-Vis spectrophotometer at the maximum wavelength. The percentage inhibition was calculated using the formula:

$$\% \text{ Inhibition} : \frac{(A0 - A1)}{A0} \times 100$$

Information: A1= Sample absorbance
A0 = Control absorbance

The IC50 value is determined from a linear regression equation between concentration (x-axis) and per cent inhibition (y-axis). The smaller the IC50 value, the stronger the sample's antioxidant activity.[15]

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Result

Table 2. Phytochemical Screening Results

No.	Phytochemical Test	Turmeric Rhizome	Purple tuber
1.	Alkaloid (mayer)	(+)	(+)
	Alkaloid (dragendorf)	(+)	(+)
	Alkaloid (bouchardat)	(+)	(-)
2.	Flavonoid	(+)	(+)
3.	Saponin	(+)	(+)
4.	Steroid	(+)	(+)
5.	Tannin	(-)	(+)
6.	Monoterpenes/Sesquiterpenes	(+)	(+)
7.	Quinone	(+)	(+)

Note: (+) = Detected (–) = Not Detected



Figure 1. Formulation results of the functional instant powdered beverage prepared from a combination of turmeric rhizome (*Curcuma longa* L.) and purple sweet potato tuber (*Ipomoea batatas* L.) in formula 1 (F1), formula 2 (F2), formula 3 (F3), And formula 4 (F4).

Table 3. Physical Evaluation Results

Parameter	F1	F2	F3	F4	Acceptance Criteria
Organoleptic	Dark yellow powder, very strong aromatic, Sweet turmeric	Weak yellow powder, Strong aromatic, Sweet turmeric sweet potato	Brownish yellow powder, weak aromatic, sweet turmeric sweet potato	Yellowish brown powder, very weak aromatic, sweet turmeric sweet potato	-
Solubility (minutes)	01.17± 0.02	01.48±0.01	02.45± 0.04	03.02±0.01	< 5 minutes
Flow time (seconds)	06.50±0.81	05.46±0.39	05.21±0.86	08.30±0.30	≤ 10 seconds
Angle of repose(o)	32.45	27.60	26.19	27.96	20–40°
Moisture content (%)	0.64 ± 0.16	0.52± 0.32	0.37± 0.37	0.47± 0.36	≤ 3%
pH	6.33± 0.01	6.15± 0.01	6.76± 0.01	6.39± 0.02	4-7

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Table 3. (Extension)

Parameter	F1	F2	F3	F4	Acceptance Criteria
Viscosity (cPs)	20.9±1.28	22± 1.74	27.3±1.00	33.0 ± 1.28	> 1 cP
Sedimentation	1	0.01	0.013	0.015	F value approaching 1
Stability	Stable	Stable	Stable	Stable	No physical changes observed

Table 4. Chemical Evaluation Results (Thin Layer Chromatography)

Spot	366 UV Detection		
	Color	Rf	Information
Simple ingredients	Green	0.7	(+)
	Yellow	0.71	(+)
	Yellow	0.81	(+)
Comparator	Green	0.65	(+)
	Yellow	0.72	(+)
	Yellow	0.8	(+)
The best formula	Green	0.67	(+)
	Green	0.74	(+)
	Yellow	0.81	(+)

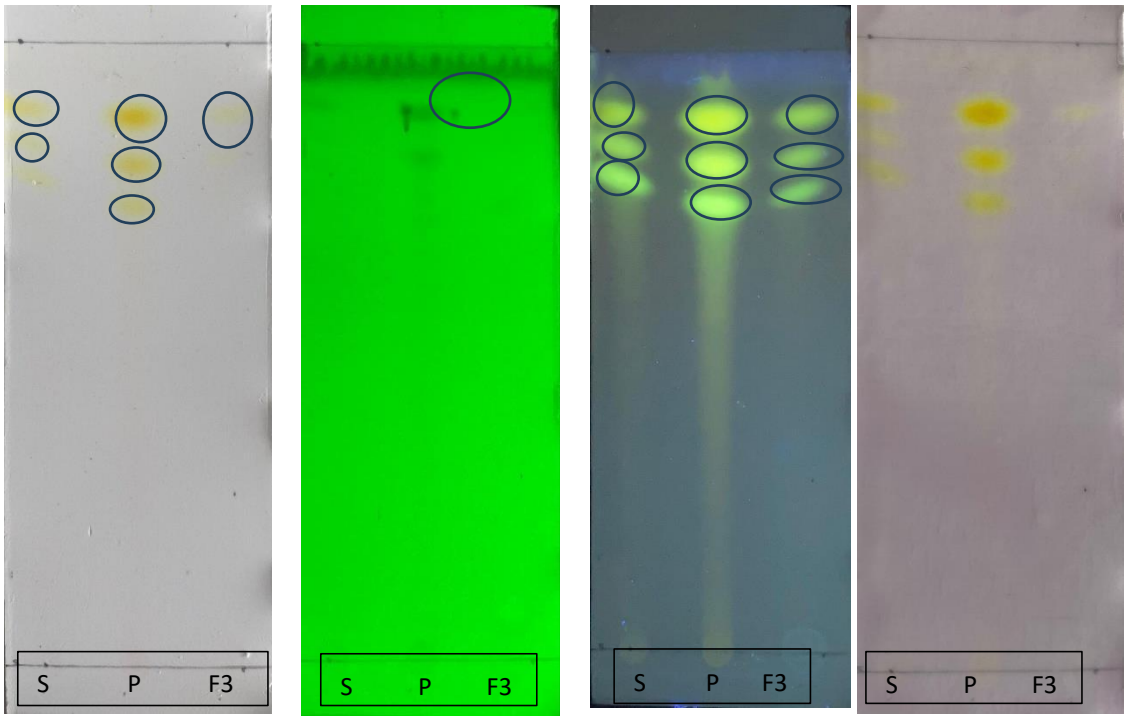


Figure 2.Thin-Layer Chromatography (TLC) profile of curcuminoid compounds in turmeric simplicia (S), curcumin standard (P), and the selected formula (F3), observed under: (1) visible light, (2) UV light at 254 nm, (3) UV light at 366 nm, and (4) after DPPH spraying.

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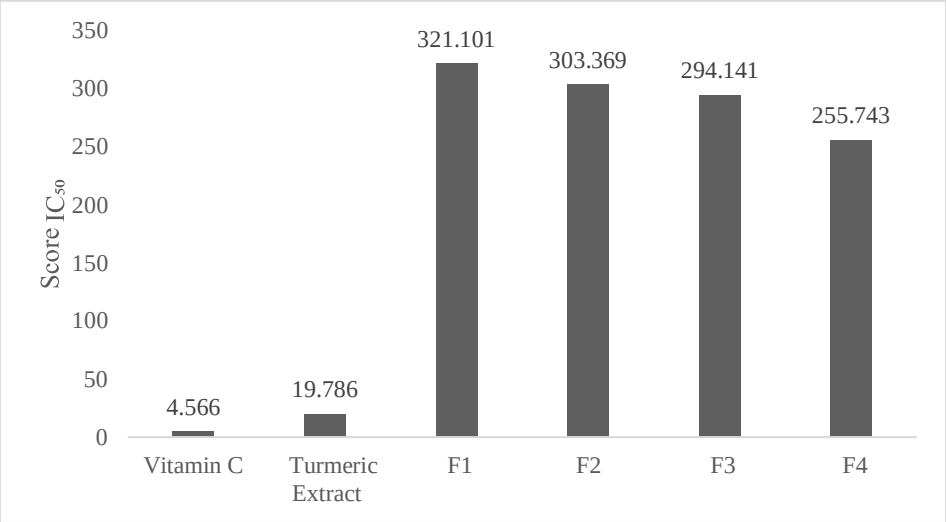


Figure 3. IC_{50} values of antioxidant activity of vitamin C, turmeric extract, and instant powdered beverage formulations (F1–F4) were determined using the DPPH method.

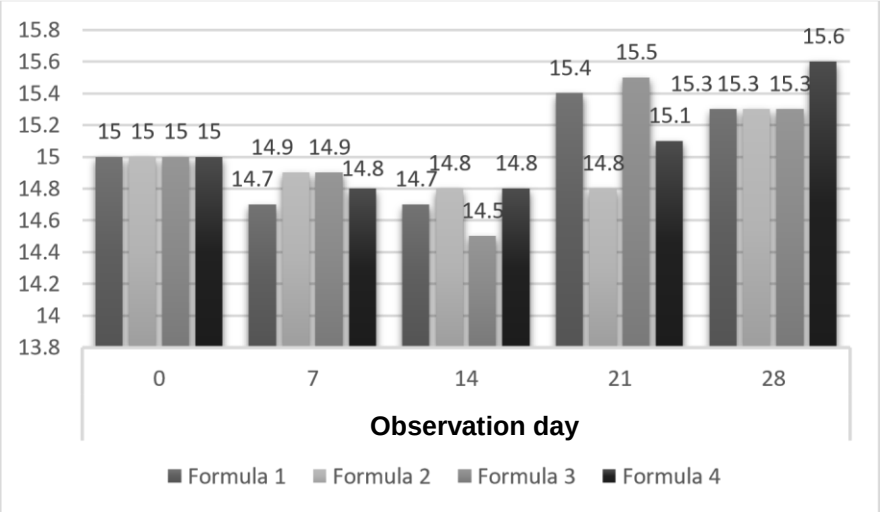


Figure 4. Stability test graph results (weight)

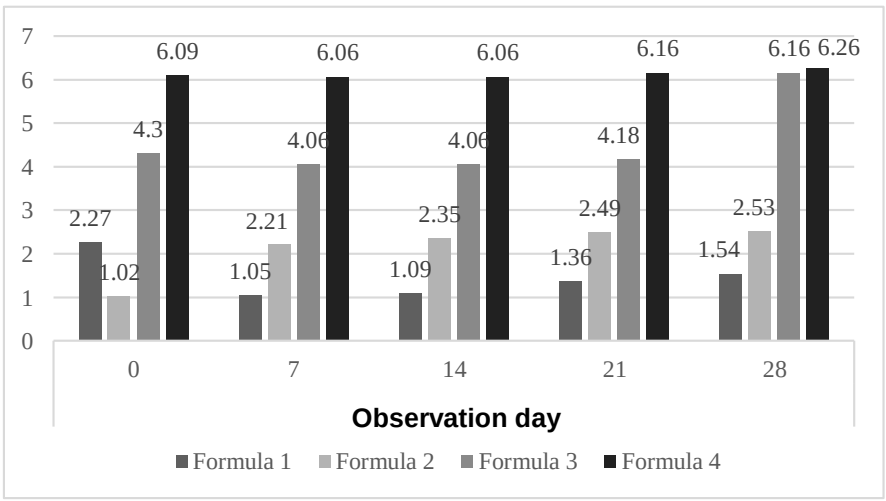


Figure 5. Stability test graph results (solubility)

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Discussion

Phytochemical screening was conducted to determine the secondary metabolite content in the combination of turmeric rhizome and purple sweet potato. Testing was carried out using specific reagents to identify compounds such as alkaloids, flavonoids, saponins, tannins, phenols, and terpenoids. The phytochemical screening results showed that the preparation contained flavonoids, alkaloids, saponins, tannins, phenols, and terpenoids. The presence of these secondary metabolites indicates that the combination of turmeric and purple sweet potato has potential as a functional beverage because these compounds are known to have antioxidant and other biological activities.[16]

Flavonoids and phenols act as antioxidants by donating hydrogen atoms to stabilise free radicals, thus preventing cell damage caused by oxidative stress. Saponins and tannins are also known to have antimicrobial and anti-inflammatory activities, while terpenoids and alkaloids play a role in the pharmacological activity of plants. The results of this phytochemical screening demonstrate that the natural ingredients used still contain active compounds even after being processed into instant powder.[16]

A physical evaluation was conducted to determine the quality, stability, and suitability of the instant powdered drink, a combination of turmeric and purple sweet potato, to ensure its suitability as a functional beverage. Tests included organoleptic, solubility, flow time, angle of repose, water content, pH, stability, sedimentation, viscosity, and hedonic properties.

The organoleptic test aimed to determine the initial physical characteristics of the preparation, including shape, colour, aroma, and taste. The results showed that the preparation had a fine powder form, a purplish-yellow colour, a distinctive turmeric aroma, and a slightly sweet, spice-like taste. The resulting colour comes from the curcumin content in turmeric and the anthocyanin content in purple sweet potatoes. These results indicate that the preparation has an attractive appearance and is sensorially acceptable.[1]

A solubility test was conducted to determine the powder's ability to dissolve in water and to determine the practicality of product preparation. The test results showed that the instant powder could dissolve completely in less than 5 minutes, thus meeting the requirements for instant powders. Good solubility is influenced by the powder's small particle size and low water content, which facilitate the rehydration process.[10]

The flow time test aims to determine the flow properties of powders, which influence the packaging and storage process. The test results showed that the flow time of the preparation was less than 10 seconds, thus meeting the requirements for good powder flow properties. A good flow time indicates that the powder is not too moist and has a relatively uniform particle size.[1]

The angle of repose test was conducted to determine the cohesiveness and flow properties of the powder. The measurement results showed that the angle of repose of the preparation was in the range of 25°–45°, thus meeting the requirements for a good angle of repose of powder. A suitable angle of repose value indicates that the friction between particles is not too great, allowing the powder to flow easily.[17]

The moisture content test aims to determine the water content in a preparation, which affects its stability and shelf life. The test results showed that the preparation's moisture content was less than 3%, thus meeting the quality requirements for instant powder. A low moisture content can prevent the growth of microorganisms, reduce the risk of clumping, and extend the preparation's shelf life.[10]

A pH test was conducted to determine the acidity level of the preparation and the stability of the active compounds it contains. The results showed that the preparation had a pH in the range of 4–7, thus meeting the pH requirements for natural-based preparations. A slightly acidic pH helps maintain the stability of active compounds such as flavonoids, anthocyanins, and curcuminoids, preventing them from easily degrading.[1]

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The viscosity test aims to determine the viscosity of the instant drink after dissolving. The test results indicate that the preparation has a low viscosity, making it easy to drink and meeting the characteristics of an instant drink, namely more than 1 cPs. The low viscosity is influenced by the amount of dissolved solids and the composition of the ingredients in the formulation.[18]

A sedimentation test was conducted to determine the presence of sediment in the instant powder solution after dissolution. Observations indicated a small amount of sediment in the solution, likely from insoluble natural material particles. However, the sediment formed was within acceptable limits, namely, the sedimentation requirement of an F value approaching 1, so it did not significantly affect the quality of the preparation.[18]

The stability test aims to determine the physical changes in the preparation during storage. Observations were made for 28 days, observing changes in colour, aroma, and texture of the powder. The results showed that the preparation remained relatively stable, despite slight changes in colour and aroma due to the influence of temperature, light, and humidity. This indicates that the preparation still has fairly good physical stability during storage.[17]

A hedonic test was conducted to determine panellists' preference for the product. The test was conducted on 30 panellists. The inclusion criteria for panellists were: aged 18–35 years, in good health, having no impairment of taste or olfactory function, having no history of allergy to turmeric or purple sweet potato, and willing to participate in the study by signing an informed consent form. The evaluation was conducted based on colour, aroma, taste, and overall acceptability using a 5-point hedonic scale. The results showed that the majority of panellists preferred the instant powdered drink, a combination of turmeric and purple sweet potato. The addition of sugar helped enhance the distinctive turmeric flavour, making the product more acceptable to consumers.

Thin Layer Chromatography (TLC) testing was performed to identify the presence of curcumin in an instant powder preparation combining turmeric and purple sweet potato. The test was performed by spotting the sample solution on a GF254 silica gel plate and then eluting it using a specific mobile phase. The plate was then observed under visible light, UV 254 nm, and UV 366 nm.[19]

The test results showed yellow spots with Rf values close to the curcumin standard. This indicates that curcumin was still present in the preparation after the instant powder production process. The presence of fluorescent spots during UV observation confirmed the identification of curcuminoid compounds in the sample. The Rf values close to the standard indicate that the formulation and heating processes were still able to retain some of the active compounds in turmeric.[19]

The purpose of the TLC method is to provide a simple, rapid, and effective qualitative identification of active compounds. TLC results demonstrate that the preparation still contains bioactive compounds that have the potential to provide antioxidant activity.[19]

Antioxidant activity testing was performed using the DPPH method to determine the preparation's ability to scavenge free radicals. The DPPH method was chosen because it is simple, rapid, and widely used to measure the antioxidant activity of natural compounds. The principle of this test is based on the colour change of the DPPH solution from purple to pale yellow due to the presence of hydrogen atom donors from the antioxidant compound.[20]

The test results show that turmeric extract has an IC_{50} value of 19 ppm, which is included in the strong antioxidant category, while the instant powdered drink preparation has an IC_{50} value ofIC_{50} of 304 ppm, which is included in the weak antioxidant category. The valueIC_{50} indicates the sample concentration required to inhibit 50% of DPPH free radicals. The smaller the valueIC_{50} then, the stronger the antioxidant activity.[6]

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The decrease in antioxidant activity in the preparation is thought to be due to the heating process during the instant powder production. Active compounds such as curcumin and anthocyanins are known to be sensitive to high temperatures and therefore can degrade during processing. Furthermore, the addition of sugar and the crystallisation process can also affect the levels of active compounds in the preparation.

These findings are consistent with the study conducted,[1] which reported that turmeric instant beverage formulations exhibited reduced antioxidant activity after the heating process due to partial degradation of curcuminoid compounds. The processing of herbal materials into instant powder products through thermal treatment could decrease the levels of phenolic and flavonoid compounds responsible for antioxidant activity.

A similar phenomenon has also been reported in other dosage forms containing turmeric extract as the active ingredient. Turmeric-based functional beverage formulations exhibited lower antioxidant activity compared to the crude extract, although the active compounds remained detectable in the final product.[6] These findings suggest that dosage form modification involving thermal processing may contribute to a reduction in antioxidant activity, thereby supporting the assumption that the decrease observed in this study was primarily caused by the degradation of bioactive compounds during heating.

Although the antioxidant activity of the preparation is relatively weak, the results of the study indicate that the combination of turmeric and purple sweet potato still has potential as a natural functional drink because it still contains secondary metabolites and bioactive compounds that are beneficial for health.

Conclusion

The combination of turmeric rhizome *(Curcuma longa L.)* and Purple Sweet Potato Tubers *(Ipomoea batatas L.)* was successfully formulated into an instant powdered drink with good physical characteristics and met physical evaluation parameters such as organoleptic, solubility, flow time, angle of repose, water content, pH, stability, sedimentation, viscosity, and hedonic. The results of phytochemical screening showed the presence of flavonoids, alkaloids, saponins, tannins, phenols, and terpenoids, while the Thin Layer Chromatography (TLC) test showed the presence of curcumin compounds in the preparation. The antioxidant activity test using the DPPH method showed a value ofIC_{50}turmeric extract of 19 ppm, which is included in the strong antioxidant category, while the instant powdered drink preparation has a valueIC_{50} of 304 ppm, which is considered a weak antioxidant due to the heating process during the instant powder production process. However, the preparation still has the potential to be developed as a functional drink made from natural ingredients.

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