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Formulation and Evaluation of Two Types of Functional Beverage Granules Made of Extracts of Guava Leaves, Purple Sweet Potato and Cinnamon

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ABSTRACT

Functional foods are bioactive compounds that have the potential to provide health benefits beyond the basic nutritional values. This study was conducted to formulate and evaluate functional beverage granules with the use of guava leaves, purple sweet potatoes, and cinnamons as functional herbal-based food. Granules from the ethanol extracts of guava leaves and purple sweet potatoes were prepared with three different ratios: Formulas 1 (3:2 %), 2 (3:2.5 %), and 3 (3:3 %). Also, ethanol extracts of guava leaves and cinnamons were formulated with three different ratios: Formulas I (3:1 %), II (3:2 %), and III (3:3 %). These granules were formulated by the wet granulation method, and then their characteristics were evaluated. The results showed that the functional beverage granules made of guava leaves and purple sweet potatoes had % fines of 1.52±0.55–6.04±0.06, moisture contents of 1.51±0.10–2.06±0.12%, flow rates at 9.34±0.77–10.89±0.32 g/sec, angles of repose at 29.64 ± 0.67–30.70±1.55, compressibility index of 16.19±0.82–17.32±3.43%, and Hausner ratio of 1.20±0.01–1.22±0.03. Meanwhile, those made of guava leaves and cinnamons had % fines of 1.63±0.49–1.85±0.81, moisture contents of 0.71±0.10–1.06±0.02 %, flow rates at 7.93±0.44–8.61±0.74 g/sec, angles of repose at 20.95±1.56–31.17±1.29, compressibility index of 19.56±1.32–20.37±1.32%, and Hausner ratio of 1.24±0.02–1.25±0.02. All granule formulas containing guava leaves and purple sweet potatoes met the predefined specifications. Conversely, the granule formulas containing guava leaves and cinnamons did not meet the standard specification.

Keywords: Cinnamons, Functional beverages, Guava leaves, Purple sweet potatoes, Granule

Introduction

Psidium guajava L., commonly known as guava, is a shrub that belongs to the Myrtaceae family and is native to Southern Mexico, Central America, and South America. The plant is widely cultivated in almost all parts of the world because it grows easily in tropical and subtropical climates. In several countries, guava leaves are traditionally used for, especially, anti-diarrhea. In another dosage form, i.e., infusion or decoction, the leaves prove effective in the treatment of rheumatism, diarrhea, diabetes mellitus, and cough in India, China, Pakistan, and Bangladesh. In South Asia and Nigeria, a guava leaf decoction is used for mouthwash and anti-bacterial agent. Some external uses of the plant include topical application on injured skin, as widely practiced in Mexico, Brazil, the Philippines, and Nigeria. Also, in Ethnomedicine, the leaves are used by the people of the Muna tribe in Southeast Sulawesi as anti-diarrhea medicines.[1,2] Guava leaves have active compounds, such as polyphenols, ascorbate, gallic acid, caffeine, flavonoids (quercetin), tannins, and isoprenoids. These are associated with several pharmacological activities, namely cough suppressant, anti-spasmolytic, anti-bacterial, anti-amoebic, anti-fungal, anti-diarrhea, anti-hyperglycemia, antioxidants, cardioprotective effects, and immunostimulants.[3,4]

Ipomoea batatas L. (Convolvulaceae family), known as the sweet potato in Indonesia, is a "superfood", widely used for nutritional purposes, especially in diabetes mellitus patients. Sweet potato is one of the low glycemic index foods that release glucose very slowly into the bloodstream. This type of food benefits the pancreas by lowering the load on the pancreas and making people feel replenished for a longer time. Sweet potato is also known to regulate adiponectin, which is a protein hormone that controls insulin metabolism. The nutritional contents of sweet potato are carbohydrates, various vitamins, minerals, protein fiber, and pro-vitamin A.[5,6] There are four types of sweet potato cultivars known worldwide: purple sweet potato, orange-red sweet potato, yellow sweet potato, and white sweet potato. Apart from the richness in nutrients, purple sweet potato also contains anthocyanin compounds with high antioxidant activity. Its antioxidant content is the highest compared to other cultivars, with cyanidin and peonidin as the main anthocyanins.[6–8]

Cinnamon (Lauraceae) is spice rich in active phytochemical compounds that act as an antioxidant. It is widely used in traditional medicines and classified as a medicinal plant in several countries. *Cinnamomum burmannii* is a cinnamon species known to contain active phenolic compounds (quercetin, kaempferol), proanthocyanidin, essential oils, and cinnamic acid. The essential oil of *C. burmannii* proves substantial in regulating glucose transporters and insulin expression in diabetic mice. Cinnamaldehyde compounds in essential oils are identified as potential antidiabetic compounds.[4,9]

The exploration of plant materials with efficacious compounds for their effects on diseases and their health benefits as functional/ nutritional foods is currently growing. Functional foods are bioactive compounds that occur naturally or as fortification ingredients in food products that potentially provide health benefits beyond their basic nutritional values. The Indonesian Food and Drug Administration (*Badan Pengawas Obat dan Makanan*, BPOM) defines functional

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foods as natural edible plants or processed foods that, based on scientific studies, contain one or more compounds and have specific physiological functions that are beneficial to health. Functional foods, for example, are vitamins, minerals, probiotics, phytosterols, and antioxidants.[4,9]

This research provides an alternative use of guava leaves, purple sweet potatoes, and cinnamons by formulating them into a functional herbal-based food preparation that is practical, safe, and of good quality according to applicable standards so that its use can be widely accepted in the community. Here, the functional foods are functional beverage granules made of two combinations: (1) extracts of guava leaves and purple sweet potatoes, and (2) extracts of guava leaves and cinnamon. This study was therefore aimed at developing and evaluating functional beverage granules from the combinations of guava leaves, purple sweet potatoes, and cinnamons.

Materials and Methods

Plant materials

Guava leaves (*Psidium guajava* L.) were harvested in Batu, East Java, Indonesia, in October 2019. The leaf samples were identified (ID No.: 1397/DT/IV/2019) at the Center for Information and Development of Traditional Medicine, Faculty of Pharmacy, University of Surabaya, Indonesia. Purple sweet potatoes (*Ipomoea batatas* [L.] Lam.) and cinnamons (*Cinnamomum burmannii* [Nees &Th. Nees]) were harvested in Batu, East Java, Indonesia, in October 2019. The potato and cinnamon samples were identified (ID No.: 074/158A/102.7/2019 and 074/235A/102.7/2019, respectively) in the Technical Implementation Unit of the Herbal Material Medical Batu Laboratory.

Chemical materials

The chemical materials used in this research included stevia sweetener (obtained from PT. Jamu Iboe), maltodextrin (Shandong, China), Poloxamer 188 (Merck Millipore, Singapore), xanthan gum (Shandong Fufeng Fermentation, China), Ac-Di-Sol® (BASF Corporation), Avicel® pH 101 (FMC Biopolymers, Ireland), melon flavoring (KH. Roberts, Indonesia), chocolate flavoring (KH Roberts, Indonesia), and sucrose (PT. Brataco, Indonesia).

Equipment used for the study

The equipment used in the research included an oven (Memmert), analytical balance (Ohaus), mesh sieves (No. 10, 16, and 60), water bath, tapped density tester (ERWEKA), moisture content balance (Mettler Toledo), standard funnel, stopwatch, tweezers, glass stirrer, parchment papers, filter papers, ruler, rotary evaporator (Buchi), pH meter (Schott), UV-Vis spectrophotometer (Shimadzu), VT-04 viscometer, and glassware for laboratory use.

Preparation of ethanol extracts of guava leaves, purple sweet potatoes, and cinnamons

Guava leaves, purple sweet potatoes, and cinnamons were extracted separately. The resultant crude drug powder was sieved with a 60-mesh sieve. About 500 g of the powder was macerated using 70 % ethanol with a solid-to-solvent ratio of 1:5 for 3x24 hours. Then, the filtrate was evaporated in a rotary evaporator at 50 ^{0}C until a thick extract was formed.

Formulation of functional beverage granules

Two types of functional beverage granules were formulated: (1) the combined extracts of guava leaves and purple sweet potatoes; and (2) the combined extracts of guava leaves and cinnamons. For the first granules, the ethanol extracts of guava leaves and purple sweet potatoes were combined with three different ratios; Formulas 1 (3:2 %), 2 (3:2.5 %), and 3 (3:3 %). For the second granules, the ethanol extracts of guava leaves and cinnamons were combined with three different ratios: Formulas I (3:1 %), II (3:2 %), and III (3:3 %). The compositions of each formula are presented in detail in Table 1.

Granulation processing

The granules were manufactured by the wet granulation method. To facilitate the mixing of each extract with additives before the granulation process, a dispersing solution was prepared by dissolving 5 ml of Poloxamer 188 solution in 90 % ethanol solvent. The thick extract was placed in a container, dissolved by adding the dispersing solution, and stirred until a homogeneous (dispersed) solution was obtained. Afterward, the dissolved guava leaf extract was combined with the dissolved sweet potato extract and with the dissolved cinnamon extract, which was followed by the addition of additives: Avicel® pH 101, stevia, xanthan gum, Ac-Di-Sol®, maltodextrin, melon flavoring or chocolate flavoring, Na-benzoate, and sucrose as the sweetener and filler. These ingredients were mixed until homogeneous solution was achieved, and then water was added gradually until a granule mass consistency was formed. The mass of the granules was then sieved using a 10-mesh sieve and baked at 500^{o}C for 120 minutes, and then the granules were sieved again using a 16-mesh sieve.

Evaluation of granule characteristics

Moisture content analysis of processed granules

Five grams of the granules were analyzed for their moisture content using a moisture content tester. The tester was used to determine the material's weight every 5 minutes of the drying process and the granule's constant weight after an interval of 3 x 5 minutes. The percentage of the moisture content (MC) is a function of initial granule weight (W) and final granule weight (Wo), as presented in the equation below.[10]

$$\text{MC (\%)} = \frac{(W - Wo)}{Wo} x\ 100\%$$

Flowability of processed granules

The flow rate (g/sec) and angle of repose of the produced granules were measured. In the dry flow rate test, the funnel was placed on a stative, and the distance from the end of the bottom pipe to a flat plane was set at 10.0 ± 0.2 cm. One hundred grams of granules were carefully weighed and then poured into the funnel with the base attached. The funnel base was opened, and the stopwatch was switched on simultaneously. This process was used to determine the length of time taken for the granules to be completely emptied from the funnel. The flow rate was calculated as the division of granule weight by the length of time. After the dry flow rate test, the height of the granule pile on a flat plane (h, in cm) and the radius of the pile cone (r, in cm) were measured. The angle of repose (α) was calculated using the formula below.[11]

$$Tg\ \alpha = \frac{h}{r}$$

Measurement of processed granule density

The bulk density and tapped density were measured. In the bulk density measurement, 40 grams of granules were weighed on a weighing paper, then poured into a 100 ml measuring cup set at an inclination angle of 45° rapidly through the funnel. The measuring cup was raised and shaken rapidly to flatten the surface of the material, and the final volume (ml) was read. The bulk density (ρo in g/ml) is the division of the weight of the granule sample (w) by the granule volume (v), as presented in the formula below.[12]

$$\rho o = \frac{W}{V}\ \text{g/ml}$$

After the granule volume in the bulk density test was read, the measuring cup containing the granules was placed on a table. The tapped density tester (ERWEKA) was started, and the load volume was observed at every 100 beats for 100 to 500 beats. The load volume in the measuring cup was recorded at an interval of 100 beats until three consecutive observations showed a constant volume (V1 in ml). The tapped density (ρ in g/ml) is the division of the weight of the granule sample (w) by granule volume (v), as presented in the formula below.[12]

$$\rho = \frac{W}{V}\ \text{g/ml}$$

Particle size distribution test

Each sieve and container to be used for the particle size distribution test was weighed. One hundred grams of functional beverage granules were weighed.

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Table 1: Formulation of functional beverage granules containing ethanol extracts of guava leaves, purple sweet potatoes, and cinnamons

Ingredients	Guava Leaves + Purple Sweet Potatoes			Guava Leaves + Cinnamons		
	Formula 1 (%)	Formula 2 (%)	Formula 3 (%)	Formula I (%)	Formula II (%)	Formula III (%)
Guava leaf extract	3	3	3	3	3	3
Purple sweet potato extract	2	2.5	3	-	-	-
Cinnamon extract	-	-	-	1	2	3
Stevia	0.5	0.5	0.5	0.5	0.5	0.5
Ac-Di-Sol®	0.5	0.5	0.5	0.5	0.5	0.5
Xanthan Gum	0.7	0.7	0.7	0.7	0.7	0.7
Poloxamer 188	0.1	0.1	0.1	0.1	0.1	0.1
Na-Benzoate	0.2	0.2	0.2	0.2	0.2	0.2
Maltodextrin	10	10	10	10	10	10
Avicel® pH 101	5	5.5	6	4	5	6
Melon Flavoring	2	2	2	-	-	-
Chocolate Flavoring	-	-	-	2	2	2
Sucrose	76	75	74	78	76	74

Furthermore, sieves of different mesh sizes: 20, 30, 50, 60, 80, and 100, were consecutively arranged from top to bottom with a container pan underneath. The weighed granules were placed on the top sieve, covered, and tightened. The sieves were vibrated with a RETSCH vibratory sieve shaker for 20 minutes at a speed of 60 rpm. Each sieve and the granules trapped in it were weighed together. Then, the granules trapped in each sieve and the pan were weighed. The objective of this test was to obtain a good grain distribution and % fines of <10 %.[13]

Determination of compressibility index

The compressibility index value was calculated using the equation below.[14]

$$\%\text{ compressibility } = \frac{(\rho - \rho o)}{\rho} \text{ x } 100\%$$

Determination of Hausner ratio

The Hausner ratio is a ratio of tapped density to bulk density. This ratio was then interpreted based on these criteria of granule flowability: good (<1.25), moderate (1.25–1.6), and poor (>1.6).[12]

$$\text{Hausner's Ratio } = \frac{\rho}{\rho o}$$

Evaluations of processed granules after reconstitution

pH measurement

In this procedure, 10 % of the granules were dissolved in 50 ml of water. Afterward, the pH value was measured at room temperature using a calibrated digital pH meter.[15]

Viscosity test

In the initial stage, the VT-04 viscometer was placed in the correct position by adjusting the position of the air bubble right in the middle of the red circle. The sample was then inserted into the bob (container on the viscometer). A spindle that matched the viscosity characteristics of the tested material was selected. The spindle and rotor were connected and lowered into the test solution until the spindle mark was immersed, then the scale on the viscometer was recorded. The viscosity value was calculated using the formula below and expressed in cps.[16]

$$\mu \ = \text{ The result of the scale reading x } 100$$

Determination of sedimentation volume

The functional beverage preparation was poured into a 25 ml measuring cup. Here, the initial volume (V_0) was recorded. Then, it was stored at room temperature and protected from light. Any changes in the volume were measured and recorded every 5 minutes for 30 minutes without stirring until a constant sedimentation level was formed. At this stage, the final volume (Vu) was obtained.[16]

$$F = \frac{Vu}{Vo}$$

Results and Discussion

The prepared functional beverages were tested for the organoleptic properties of their granules, namely shape, color, odor, and taste, to ensure that these granules complied with the given specifications. The results of the organoleptic tests are displayed in Table 2 and Figure 1. The resultant granules were evaluated for their physical characteristics, including moisture content, flow rate, angle of repose, bulk density, tapped density, compressibility index, Hausner ratio, and % fines. Flow properties are important parameters that determine whether the preparation's content is uniform and to what extent the granules can fill packages. The physical characteristics of the functional beverage granules are presented in Table 3. The reconstituted granules were also evaluated for their viscosity, pH, and sedimentation volume. The test results of the reconstituted granules are shown in Table 4.

The main problem with herbal medicinal formulations is the taste of the extracts; most are generally bitter or have an unpleasant taste and smell. The guava leaf extract formulated in this study was a thick extract with a dark brown color, distinctive odor, and rancid taste, while the cinnamon extract was thick with a reddish-brown color, specific odor, and spicy but slightly sweet taste. Also, products made of raw sweet potato flour leave a bitter aftertaste. Some phenolic compounds or alkaloids are responsible for the bitterness of herbal extracts. Generally, the unpalatable taste can be masked by adding sweetener or making a film-coated layer with cyclodextrin. The sweeteners used to mask rancid taste are sucrose, maltodextrin, and stevia. Sucrose and maltodextrin in granules have two functions: sweeteners and fillers.[20–24] Based on the organoleptic test results, it can be concluded that the processed functional beverage granules complied with the predetermined specifications. The functional beverage granules prepared from the combined extracts of guava

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leaves and purple sweet potatoes had a granular shape, brownish-white color, melon scent, and sweet taste. Meanwhile, those formulated from the combined extracts of guava leaves and cinnamons had a granular shape, brownish-white to brown color, chocolate scent, and sweet taste. High moisture content can lead to low flowability because it causes intergranular cohesion and makes granules adhere to the filler walls, affecting the flow of granules into the package and causing different weights and doses in the same-sized packages of functional beverage granules. High moisture content can also create a favorable environment for the growth of microorganisms, which decompose the active ingredients or damage the functional beverage granules. Overall, the moisture content test ensures that the granules are dry when stored to prevent mold growth and avoid adhesion to the packaging.[23,25] For good-quality granules, the moisture content must be 2–4 %. At lower than 2 %, the granules tend to be brittle (deformed). The test results showed that Formulas I, II, and III (the combined extracts of guava leaves and cinnamons) produced granules with moisture contents of 0.71 ± 0.10, 0.97 ± 0.11, and 1.06 ± 0.02, respectively, which are lower than the requirements. These results might occur because the added granulating fluid was not optimal and the drying process was too extensive. High temperature and long drying time will transfer more heat energy from the outside to the inside of the granules, inducing more water evaporation from the inside; hence, dry granules.[25,26]

Flowability can be measured with two intercorrelated parameters: flow rate (g/sec) and angle of repose (^{0}). The lower (higher) the angle of repose, the better (worse) the granules' flowability into the package or sachet. This is because a smaller angle of inclination allows better flow properties. Granules are taken to have good flow characteristics if the angle of repose is 25–50° and poor flowability if the angle of repose is >40°. Flowability determines whether the preparation can fill each packaging unit time-efficiently and homogenously.

The use of Avicel® can produce granules with good flow characteristics because it promotes powder particle cohesion. Avicel® can act as a binder that combines particles into agglomerates and a disintegrant. It can facilitate water into intergranular cavities, allowing the granules to disperse quickly when in contact with water. Avicel® also has good compressibility properties so that it can produce granules of equal size.[26] A good flow rate of granules weighing 100 grams is >10 g/sec. However, the test is also highly dependent on the device used and the testing method or technique. Flow rate correlates with moisture content. The flow rate results showed that Formulas I, II, and III (the combined extracts of guava leaves and cinnamons) produced granules with flow rates of 7.93±0.44, 8.05±0.52, and 8.61±0.74, respectively, which are lower than the requirement. Meanwhile, the angle of repose of the granules was, on average, 30°, which indicated that the three formulas can produce functional beverage granules with excellent flow properties. A good flow characteristic occurs when the particles are not consolidated and can flow independently under the influence of gravity without external forces. In this context, flowability can be increased by improving several factors, namely particle size, particle shape, particle surface morphology, and force changes on the surface.[25–27] The granule density consists of bulk density and tapped density. Both are used to calculate compressibility index and Hausner ratio and correlate with flow properties/ flowability. A good compressibility index is in the range of 5–25 %, while granules with good flow properties have a Hausner ratio of 1.00–1.25. Based on the test results, the compressibility index (%) and Hausner ratio of all the formulas are by the requirements, indicating that all granules produced have excellent flow and compressibility. Equal size distribution and spherical particle are believed to play a significant role in granule flowability. Compared to powders, granules with a spherical shape and a larger size can organize themselves better when they fill a space. Changes in particle size and shape due to granulation decrease the average flow time and increase flowability.[28–30]

Particle size distribution ensures that the granules have equal size distribution with low % fines—an indicator of good flow properties. The test results showed that the granules had, on average, <10 % fines, which is classified as low. This percentage illustrates that the flow properties of the functional beverage granules fall into the category of excellent. The addition of maltodextrin as a binder to all granule formulas has several advantages: fast dispersion, high solubility, and a strong binding capacity, all of which are the prerequisites of low % fines in granules.[30]

The pH measurement and viscosity test results indicate that the six formulas fulfill the applicable granule specifications for both parameters, i.e., pH = 5.00–7.00 and viscosity = 40–50 cPs.

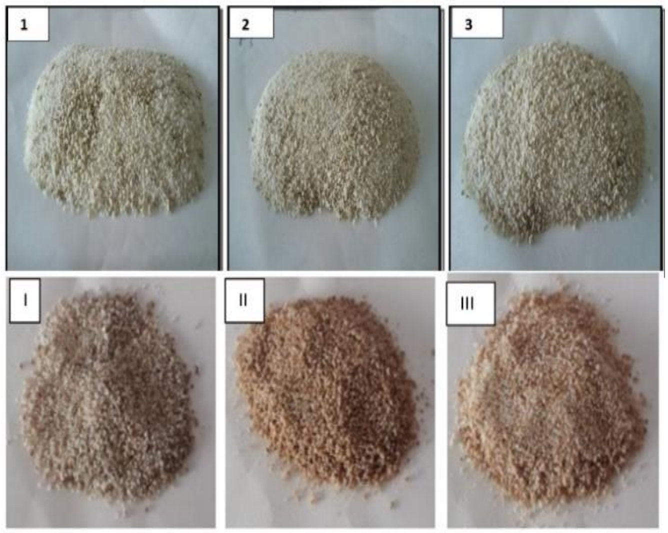

Figure 1: Functional beverage granules formulated from the combination of ethanol extracts of guava leaves with purple sweet potatoes (1, 2, and 3) and the combination of ethanol extracts of guava leaves and cinnamons (I, II and III).

Table 2: Organoleptic properties of the functional beverage granules formulated from the ethanol extracts of guava leaves, purple sweet potatoes, and cinnamons

Organoleptic	Guava Leaves + Purple Sweet Potatoes			Guava leaves + Cinnamons		
Properties	Formula 1	Formula 2	Formula 3	Formula I	Formula II	Formula III
Shape	Granule	Granule	Granule	Granule	Granule	Granule
Color	Brownish white	Brownish white	Brownish white	Brownish white	Dark brown	Dark brown
Odor	Melon scent	Melon scent	Melon scent	Chocolate scent (weak)	Chocolate scent (weak)	Chocolate scent (weak)
Taste	Sweet	Sweet	Sweet	Sweet	Sweet	Sweet

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Table 3: Physical characteristics of the functional beverage granules prepared from the ethanol extracts of guava leaves, purple sweet potatoes, and cinnamons

Granule Characteristics	Guava Leaves + Purple Sweet Potatoes			Guava Leaves + Cinnamons			Approved Specifications
	Formula 1	Formula 2	Formula 3	Formula I	Formula II	Formula III	
MC (%)	2.66 ± 0.50	2.51 ± 0.10	2.06 ± 0.12	0.71 ± 0.10*	0.97 ± 0.11*	1.06 ± 0.02*	2–4 %[18]
Flow Rate (g/second)	10.84 ± 0.2	10.89 ± 0.32	10.34 ± 0.77	7.93 ± 0.44*	8.05 ± 0.52*	8.61 ± 0.74*	≥ 10 g/second [11]
The angle of Repose (°)	30.56 ± 0.95	30.70 ± 1.55	29.64 ± 0.67	28.92 ± 1.09	20.95 ± 1.56*	31.17 ± 1.29	25–50°[11]
Bulk Density (ρB)	0.55 ± 0.02	0.56 ± 0.02	0.50 ± 0.00	0.51 ± 0.01	0.49 ± 0.01	0.49 ± 0.01	-
Tapped Density (ρT)	0.67 ± 0.01	0.67 ± 0.04	0.60 ± 0.00	0.63 ± 0.01	0.61 ± 0.01	0.62 ± 0.02	-
Compressibility Index (%)	17.32 ± 3.43	16.21 ± 4.61	16.19 ± 0.82	19.67 ± 1.15	19.56 ± 1.32	20.37 ± 1.32	5–25%[11]
Hausner Ratio	1.22 ± 0.03	1.20 ± 0.04	1.20 ± 0.01	1.24 ± 0.02	1.24 ± 0.02	1.25 ± 0.02	1.00–1.25[19]
Fines (%)	6.04 ± 0.06	4.77 ± 4.24	1.52 ± 0.55	1.63 ± 0.49	1.78 ± 0.13	1.85 ± 0.81	≤ 10%[11]

*: The characteristics of the prepared granules do not meet the requirements; Each test was carried out in triplicate

Table 4: Characteristics of the reconstituted functional beverage granules prepared from the ethanol extracts of guava leaves, purple sweet potatoes, and cinnamons

Granule Characteristics after Reconstitution	Guava Leaves + Purple Sweet Potatoes			Guava Leaves + Cinnamons			Approved Specifications
	Formula 1	Formula 2	Formula 3	Formula I	Formula II	Formula III	
Viscosity (cPs)	50.00 ± 10.00	40.00 ± 0.00	40.00 ± 0.01	43.33 ± 5.77	50.00 ± 0.00	50.00 ± 5.00	40.00–50.00
pH	5.88 ± 0.02	5.66 ± 0.14	5.61 ± 0.01	5.42 ± 0.02	5.37 ± 0.03	5.32 ± 0.02	5.00–7.00
Sedimentation Volume	1	1	1	0.96	0.96	0.96	-

Each test was made in triplicate

Viscosity can affect the taste of the functional beverages prepared with two combinations: the extracts of guava leaves and purple sweet potato and the extracts of guava leaves and cinnamons. If the viscosity was too thin, it will leave an aftertaste that stays longer. If the viscosity is too thick, the beverage will be difficult to swallow. Based on the sedimentation volume calculation, it can be concluded that the six formulas have a small sedimentation volume with a long sedimentation time. Sedimentation volume determines the ratio of deposition that occurs during storage. Quick sedimentation indicates that the nature of the suspension is a flocculated system, whereas slow sedimentation implies a deflocculated system. The flocculated suspension provides functional beverage granules with good stability because insoluble particles settle for a long time. In other words, the granules remain in a homogenous condition during the time lag, i.e., from reconstitution to ready-to-drink preparation.

Conclusion

The development and evaluation of functional beverage granules from the combined extracts of guava leaves and purple sweet potatoes with three different ratios show that all three formulas fulfill the determined specifications. On the other hand, the granules made of the combined extracts of guava leaves and cinnamons with three different ratios do not meet the requirements and specifications of % moisture content and flow rate.

Conflict of Interest

The authors declare no conflicts of interests

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

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