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Effect of variation ultrasound time and trehalose concentration on physicochemical characteristics durian monthong (Durio Zibethinus) powder produced by freeze dryer

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Abstract

The purpose of this study was to determine the effect of variations in extraction time and trehalose concentration on the physicochemical characteristics of durian monthong powder extract using the freeze-drying method. The research design used a Randomized Group Design (RAK) with a 3x3 factorial pattern consisting of 2 (two) factors with 2 (two) replications, resulting in 18 experimental units. These include extraction time (W) with 3 levels, namely w1 (90 minutes), w2 (120 minutes), and w3 (150 minutes), and trehalose concentration (K) with 3 levels, namely k1 (10%), k2 (20%), and k3 (30%). The responses contained in this study are physical responses and chemical responses. Physical responses include dissolving time, solubility, yield, camba density, hygroscopicity, color intensity, and Scanning Electron Microscope (SEM) test. Chemical responses include water content, protein content, fat content, total sugar content, vitamin C content, antioxidant activity content, and aromatic compound analysis. The results showed that the effect of extraction time affects the response of solubility time, yield, color intensity, water content, protein content, total sugar content, vitamin C content, and antioxidant activity. The concentration of trehalose significantly affects the response of dissolving time, solubility, yield, camba density, hygroscopicity, color intensity, water content, protein content, total sugar content, vitamin C content, and antioxidant activity. The interaction between extraction time and trehalose concentration affects the response of solubility time, yield, color intensity, water content, protein content, total sugar content, vitamin C content, and antioxidant activity. Treatment w1k1 (extraction time 90 minutes and trehalose concentration 10%) provided the best sample results in product quality.

Keywords: Extraction Time, Freeze Drying, Monthong Durian Extract, Trehalose.

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1. Introduction

Indonesia is the origin and spread of various durian species. Variations of genotypes have grown and spread throughout the territory of Indonesia, which stretches from Sabang to Merauke. Durian production in the last five years (2015-2019) showed a significant increase, where in 2019, durian production reached 1,169,802 tons [1].

Durian (Durio zibethinus) is one of the most popular fruits in Indonesia and has the nickname "The King of Fruits." It is one of the fruit varieties that has been tested and confirmed by the Decree of the Minister of Agriculture Number 476/KPTS/Um/8/1997 as a superior fruit variety in Indonesia. Durian belongs to the Bombacaceae family and is found in wet tropical areas such as Indonesia, Thailand, and Malaysia [2].

Durian fruit has good nutrition. Every 100 grams of durian (without seeds) contains 2.7 grams of protein, 3.4 grams of fat, 27.9 grams of carbohydrates, 40 milligrams of calcium, 1.9 milligrams of iron, 150 milligrams of vitamin A, and 23.3 milligrams of vitamin C. The substances contained in durian are needed by the body. However, durian has a very high calorie content, as 100 grams of durian contains 153 calories [3].

So far, durian has been produced in fresh condition, either consumed directly or processed into products. However, the processed products have a short shelf life. Therefore, the utilization of post-harvest processing technology is a potential option to increase the shelf life of durian fruit. This allows consumers to enjoy durian fruit even after the durian season has ended. Natural dye powders produced from natural ingredients such as mangosteen peel generally require a drying process to maintain quality and color stability. Improper drying can result in discoloration and loss of active compounds in the natural dye powder. Traditional drying methods such as sun drying have several disadvantages, such as long drying time, susceptibility to environmental pollution, and inconsistent results.

Processing durian fruit can help protect the harvest from damage, extend the shelf life, and open wider marketing opportunities. In addition, processing with the drying method can increase the variety of products produced from durian fruit. Drying is a method to remove or eliminate some of the water from a material by evaporating it until the moisture content is balanced with normal air conditions or moisture content equivalent to the value of activity water (Aw), which is safe from microbiological, enzymatic, and chemical damage [4]. The purpose of drying durian fruit is to extend the shelf life of the product while maintaining the quality of the dried food product [5].

The product of drying is usually a slurry or powder. Food and beverages made into powders by the drying process can produce a denser amount of material, making them easier to transport and saving space. In addition, it can reduce costs and alleviate difficulties in packaging, handling, transportation, and storage [4]. Instant powdered beverages are a type of food product that is easy to serve in a short time and are usually in the form of dry fine granules with low water content [6]. Powdered beverages are a popular alternative to processed products because they align with the lifestyle of today's society, which tends to choose instant and ready-to-eat products.

Instant powder drinks can be processed with several drying methods, one of which is freeze drying. Freeze drying is a drying process carried out on foodstuffs where the water in the foodstuff is sublimated. The manufacture of guava fruit powder was carried out by comparing freeze drying, spray drying, and tunnel drying methods, which found that the freeze drying method was the best method in producing guava fruit powder with good quality in terms of ascorbic acid content and flavor retention [7]. In addition, freeze drying has advantages, including maintaining product stability by avoiding changes in color, aroma, and organoleptic elements, and maintaining the stability of the material structure by preventing shrinkage and deformation after drying.

In the process of making powdered drinks, fillers are needed. The powder processing requires fillers such as trehalose [8]. Trehalose is a non-reducing disaccharide consisting of two glucose molecules. Trehalose is considered to have better stability compared to other types of disaccharides and is not sensitive to changes in temperature and pH. In addition, trehalose can accelerate the drying process of a food ingredient, prevent damage to ingredients due to heat, coat flavor components, and is easy to maintain.

The study compared the effect of different sugar additions on volatile retention during freeze-drying and foam-mat drying of strawberry puree [9]. The study added 8% trehalose before drying and observed that the addition of trehalose resulted in the lowest total aroma loss as well as volatiles per fruit when compared to sucrose, as determined by headspace solid-phase micro-extraction in combination with gas chromatography (GC). In addition, some literature on the use of trehalose as a food drying aid for freeze-drying focused on aroma retention.

Fillers are needed in the drying process because they can accelerate drying, increase yield, coat components, enhance flavor, and prevent heat damage. Large total solids will accelerate the drying process so that damage to the material due to heating can be prevented [10]. Good fillers have several criteria, including not reacting with other active substances and excipients, not having physiological and pharmacological activity, having consistent physical and chemical properties, not causing or contributing to segregation of the mixture when added, not causing microbial growth, and not affecting dissolution. They should also be colorless and odorless. One example of fillers is trehalose, which is used in low-calorie foods and can play a role in maintaining cell structure in food and is heat stable [11].

2. Materials and Methods

2.1. Materials

The materials used in the process of making durian fruit extract powder are Monthong durian fruit obtained from Durian Lovers Bandung Store, Jalan Laswi No. 1A, Kacapiring, Batununggal District, Bandung City, and trehalose obtained from PT Aroma Indonesia International. The materials used for analysis in this study were distilled water, filter paper, 96% ethanol, NaCl solution, carbon tape, Kjeldahl salt, concentrated H_2SO_4 solution, 0.1 N HCl solution, PP indicator, 0.1 N NaOH solution, n-hexane solution, Luff Schoorl solution, 6 N H_2SO_4 solution, KI powder, standard sodium thiosulfate

solution, amylum solution, 9.5 N HCl solution, 10 N NaOH solution, 0.01 N iod solution, PA methanol solution, DPPH solution, DPPH test solution, and methanol solution.

The material preparation stage begins with preparing the durian fruit that has been purchased for the next process. The trimming stage is carried out to separate the durian fruit meat from the skin and seeds of the durian fruit. The sorting stage is conducted to separate the fresh durian fruit meat from the Monthong durian fruit meat that does not match the quality. Weighing I is done by measuring the weight of the durian fruit meat according to a predetermined formulation. Monthong durian meat that has been weighed is crushed using a chopper. The ultrasonic extraction stage is carried out by placing the crushed Monthong durian fruit meat into a 1-liter beaker and then putting it into an ultrasound bath machine at a temperature of 50ºC, with variations in extraction time for 90 minutes, 120 minutes, and 150 minutes. Additionally, the Monthong durian meat is dissolved with a solvent in the form of distilled water in a ratio of 1:5. This extraction uses ultrasonic waves with a frequency of 40 kHz in the extraction process. After ultrasonic extraction, the durian Monthong extract will be obtained and then filtered. Filtering is done by using filter paper to filter the extracted Monthong durian extract to obtain results that are free from residue. Extracts that do not pass through the filter will become residue, commonly referred to as pulp. The resulting durian Monthong liquid extract will be evaporated using a Vacuum Rotary Evaporator by inserting the extract into a series of Vacuum Rotary Evaporator tools at 55ºC for 30 minutes. This evaporation process aims to obtain concentrated durian Monthong extract by using high temperatures; the final result of this process is concentrated durian Monthong liquid extract. Mixing is done by combining the concentrated liquid durian Monthong extract with the filler material in the form of trehalose before being placed into the freeze-drying machine for the drying process. Mixing is done with a predetermined formulation where the durian Monthong extract is 90%, 80%, and 70%. Next, trehalose is used in amounts of 10%, 20%, and 30%. This mixing stage involves stirring the concentrated durian Monthong liquid extract and trehalose until evenly distributed. After mixing the concentrated durian Monthong liquid extract with trehalose according to the formulation, the extract is poured into a container and then leveled over the entire surface. It is important to flatten the extract to a thin layer to speed up the freezing process. The container containing the extract is placed into the freezer at -40ºC for 12 hours. After freezing I with a freezer at a temperature of -40ºC for 12 hours, the frozen extract sample is put into the freezer again at a different temperature of -80ºC for 12 hours to optimize freezing. Extracts that have been frozen for 48 hours at different temperatures are then dried. Drying is done by drying the frozen liquid extract of Monthong durian using a freeze-drying machine. The purpose of this drying is to remove some of the water content contained in the Monthong durian extract at temperatures of -40ºC and -80ºC for 48 hours until the water content reaches a maximum of 3%. This drying process will produce dry durian Monthong extract. Size reduction is done by placing the dried durian Monthong extract into the chopper to obtain the results of durian Monthong extract in the form of fine powder. Sieving with mesh 80 is done to achieve powdered durian Monthong extract with a uniform size. Powdered durian Monthong extract that does not pass through the mesh 80 sieve can be returned to the size reduction stage to refine the texture of the powder so that it can pass through the mesh 80 sieve. After sieving, the results obtained are fine powdered durian Monthong extract. Packaging is done by inserting the uniform-sized powdered durian Monthong extract into packaging in the form of a standing pouch. The powdered durian Monthong extract that has been placed in the package must be weighed. Weighing II is done by measuring the weight of the powdered durian Monthong extract product to obtain the final weight of the product.

2.2. Chemical Analysis of Monthong Durian Extract

2.2.1. Moisture content analysis

The procedure for analyzing the moisture content using the gravimetric method is as follows: the empty cup is heated in an oven at 105ºC for 30 minutes and then placed into a desiccator for 15 minutes and weighed (W0). A sample of 2 grams is then placed in a cup with a known weight and weighed (W1), after which it is dried in an oven at 105ºC for 3 hours. The sample is then placed in a desiccator for 15-30 minutes, after which the cup and its contents are weighed and dried again for 1 hour, then placed back in the oven for another hour. Finally, the cup and its contents are placed back into the desiccator and weighed again (W2).

2.2.2. Protein content analysis

Testing of protein content is done by weighing the sample asmuch as 0.1 to 0.5 g, then put into a 100 mL Kjeldhal flask. thendeconstructed (heating in boiling state) until the solution becomesclear green and SO2 disappears. The solution was allowed to cooland transferred to a 50 ml flask and diluted with distilled water to themark, put into a distillation device, added with 5-10 ml of 30-33%NaOH and distilled. then the distillate was collected in a solution of 10 ml of 3% boric acid and a few drops of indicator (0.1% bromcresol green solution and 0.1% methyl red solution in 95% alcohol separately and mixed between 10 ml of bromcresol greenwith 2 ml of methyl red). And titrated with 0.02 HCl solution untilthe solution turns pink.

2.2.3. Fat content analysis

The procedure for analyzing the fat content using the Soxhlet method is as follows: the sample is weighed to a maximum of 5 grams, wrapped in filter paper, and then placed on a Soxhlet extraction device mounted on a condenser, with a fat flask positioned below it. Hexane solvent is poured into the fat flask in sufficient quantity according to the size of the Soxhlet apparatus and is refluxed for at least 16 hours until the solvent returns to the fat flask. The solvent in the fat flask is then distilled and collected. The fat flask containing the extracted fat is subsequently dried in an oven at 105ºC for 5 hours. After drying, the fat flask is cooled in a desiccator for 20-30 minutes and then weighed.

2.2.4. Carbohydrate content analysis

The procedure for analyzing the total sugar content of the Luff-Schoorl method consists of two stages, namely determining the total sugar content before inversion and after inversion.

2.2.5. Vitamin C content analysis

The vitamin C analysis procedure of the idiometric method is that the sample is crushed and weighed to a maximum of 5 grams. Then, the sample is dissolved in a 100 mL flask and marked. The solution is filtered, and the filtrate is pipetted to a volume of 25 mL. Add a few drops of starch indicator and then titrate quickly using 0.01 N iod solution until a blue color appears as TAT.

2.2.6. Antioxidants Content Analysis

Started by making a 0.2 M DPPH solution, a blank solution, and a test solution. Each solution was incubated at room temperature for 30 minutes in the dark, and then the absorbance was measured using a UV-Vis spectrophotometer at a wavelength of 515 nm. The IC50 value was determined using the linear regression equation formula with percent inhibition as the ordinate (y) and concentration as the abscissa (x).

Aromatic Compounds Content Analysis

Determination of aromatic compounds using Gas Chromatography-Mass Spectrometry (GC-MS). The purpose of this GC-MS analysis is to determine the organic compounds contained in the sample. Perform sample preparation first by macerating using methanol solvent in a ratio of 1:2. The solution is allowed to stand for 2 x 24 hours, or ultrasound can be applied for 30-60 minutes until maximum dissolution is achieved, then separated to obtain the filtrate and residue. The methanol filtrate obtained is then evaporated to remove the solvent until a thick extract is obtained. After that, the sample is diluted with methanol 50 times and then analyzed by GC-MS.

2.3. Physical Analysis of Monthong Durian Extract

2.3.1. Dissolving Time Testing Content Analysis

Weigh 5 grams of the sample, then dissolve it in 50 mL of water and stir using a magnetic stirrer at a speed of motion 7 until homogeneous. Record the length of time for the sample to dissolve completely in water.

2.3.2. Solubility Testing Content Analysis

Prepare filter paper and then put it in the oven at 105ºC for 30-60 minutes. Then let it stand at room temperature, then put it in a desiccator and do the weighing. Weigh the sample to a mass of 10 grams, then add 200 mL of water at a temperature of 60ºC and stir using a magnetic stirrer at a speed of 7. After dissolving, pour it into filter paper that has been dried and weighed. The unfiltered sample will remain on the filter paper as residue. Dry the filter paper in an oven at 105ºC for 2 hours, then cool it at room temperature and place it in a desiccator. Weigh the filter paper that has been dried for 2 hours.

2.3.3. Yield Test

The yield is obtained from the ratio between the weight of the dried powder beverage and the total weight of solids in suspension. The initial weight of solids is the weight of the added dressing material.

2.3.4. Custard Density Testing content analysis

Cage density is measured by putting the material into a measuring cup and compacting it until the volume reaches 50 mL. Then, all the material is removed and weighed. The Camba density testing procedure involves weighing an empty 50 mL measuring cup (a), and then the sample is put into the measuring cup until it reaches 50 mL. The measuring cup containing the sample is then weighed.

2.3.5. Hygroscopicity Testing Content Analysis

Hygroscopicity is the ability of a material to absorb air moisture or water in its surroundings either by absorption or adsorption. Hygroscopicity analysis is carried out by placing the sample in an applicator containing a high concentration of NaCl solution and allowing it to stand for a certain period of time. The result of this method is the difference between the weight of the sample before placing it in the applicator and after placing it in the applicator. The hygroscopicity analysis procedure involves weighing the sample to a mass of 1 gram in powder form, then placing the sample into an applicator containing a saturated NaCl solution with a relative humidity (RH) of 75.3% at a temperature of 25ºC for 4 hours. After 4 hours, the sample is weighed again, and hygroscopicity is expressed as grams of adsorbed moisture per 100 grams of dry solids (g/100 grams).

2.3.6. Color Intensity Content Analysis

Color intensity analysis using a chromameter aims to determine the difference in color size visually using a chromameter tool. The methods used in color measurement are L*, a*, and b*, where L* indicates lightness, a* indicates red (+a*) and green (-a*), and b* indicates yellow (+b*) and blue (-b*). For the color intensity analysis procedure using a chromameter, prepare the tools and materials that will be used for color analysis with a chromameter. After that, calibrate the chromameter using the white color standard found in the chromameter. Next, insert the sample into the cuvette contained in the chromameter and then perform 2 repetitions (duplo). Calculate the color intensity to determine the color L*a*b*.

2.3.7. Scanning Electron Microscope (SEM) Content Analysis

Before the sample is inserted into the specimen chamber, the sample is prepared first by attaching the powder to the double carbon tape that has been affixed to the holder. After that, blow air using a blower towards the powder to ensure the powder sticks firmly to the carbon tape. If there is powder that is not firmly attached, it is feared that the powder will be sucked in during the SEM vacuuming process.

2.4. Statistical Analysis

The research design used a Randomized Group Design (RAK) with a 3x3 factorial pattern consisting of two factors with two replications, resulting in 18 experimental units. Factor w is the extraction time, which consists of three levels: w1 (90 minutes), w2 (120 minutes), and w3 (150 minutes). Factor k is the addition of trehalose, which consists of three levels: k1 (10%), k2 (20%), and k3 (30%).

3. Results and Discussion

3.1. Moisture Content

Table 1.
Interaction of Variation in Extraction Time and Trehalose Concentration in Durian Monthong Powder Extract on Water Content (%).

Extraction Time (W)	Trehalose Concentration (K)		
	k1 (10%)	k2 (20%)	k3 (30%)
w1 (90 minutes)	B 12.75 ± 0.18 b	C 12.56 ± 0.08 b	B 8.87 ± 0.06 a
w2 (120 minutes)	B 12.69 ± 0.09 c	B 11.82 ± 0.08 b	B 8.79 ± 0.24 a
w3 (150 minutes)	A 11.50 ± 0.54 c	A 9.71 ± 0.13 b	A 7.81 ± 0.16 a

Note: The average value stated in lower case letters is read horizontally, while the average value stated in upper case letters is read vertically, and each different letter indicates a real difference at the 5% level.

Based on the results of Table 1, it was shown that the variation in extraction time (W) and the addition of trehalose concentration (K), as well as the interaction between the two factors (WK), significantly influenced the response of the water content of durian monthong powder extract. The water content and water activity of lyophilized powder in royal jelly powder with the addition of trehalose are 3.32-4.03% and 0.203-0.235 [12]. The moisture content contained in royal jelly powder is lower than 5%, which can maintain product stability.

3.2. Protein Content

Table 2.
Interaction of Variation in Extraction Time and Trehalose Concentration in Durian Monthong Powder Extract on Protein Content (%).

Extraction Time (W)	Trehalose Concentration (K)		
	k1 (10%)	k2 (20%)	k3 (30%)
w1 (90 menit)	A 0.5921 ± 0.001 a	A 0.6439 ± 0.004 b	A 0.7140 ± 0.004 c
w2 (120 menit)	B 0.6511 ± 0.004 a	B 0.6855 ± 0.003 b	B 0.7778 ± 0.003 c
w3 (150 menit)	C 0.6627 ± 0.003 a	C 0.6953 ± 0.005 b	C 0.7952 ± 0.001 c

Note: The average value stated in lower case letters is read horizontally, while the average value stated in upper case letters is read vertically, and each different letter indicates a real difference at the 5% level.

Based on the results of Table 2 show that the variation of extraction time (W) and the addition of trehalose concentration (K) as well as the interaction between the two factors (WK) significantly affect the response of durian monthong extract protein content powder. %. When the protein is heated or alcohol is added, the protein will clot because alcohol attracts the mantle of water that surrounds the protein molecules which causes the protein to clot [13].

Table 3.
Results of Analysis of Variation of Treatment of Extraction Time (W) and Trehalose Concentration (K) on Fat Content (%)

Treatment	Fat Content (%)
w1k1	0.30 ± 0.03[a]
w1k2	0.26 ± 0.03[a]
w1k3	0.25 ± 0.01[a]
w2k1	0.28 ± 0.08[a]
w2k2	0.27 ± 0.04[a]
w2k3	0.26 ± 0.06[a]
w3k1	0.29 ± 0.04[a]
w2k3	0.31 ± 0.01[a]
w3k3	0.36 ± 0.08[a]

3.3. Fat Content Analysis

Based on the results of ANOVA calculations, it was shown that the variation in extraction time (W) and trehalose concentration (K), as well as the interaction between the two factors (WK), did not significantly affect the response of the fat content of durian monthong extract powder. The presence of water allows fat to be hydrolyzed into glycerol and fatty acids [13]. The heating process in the extraction can reduce the fat content of food by melting the fat. This is due to the rupture of fat components into volatile products such as aldehydes, ketones, alcohols, acids, and hydrocarbons.

Table 4.
Interaction of Variation in Extraction Time and Trehalose Concentration in Durian Monthong Powder Extract on Total Sugar

Extraction Time (W)	Trehalose Concentration (K)		
	k1 (10%)	k2 (20%)	k1 (10%)
w1 (90 menit)	A 8.08 ± 0.09 a	A 10.22 ± 0.05 b	A 11.22 ± 0.14 c
w2 (120 menit)	B 8.66 ± 0.07 a	B 12.38 ± 0.23 b	B 13.51 ± 0.31 c
w3 (150 menit)	C 9.61 ± 0.18 a	C 12.70 ± 0.21 b	C 14.07 ± 0.37 c

Note: The average value stated in lower case letters is read horizontally, while the average value stated in upper case letters is read vertically, and each different letter indicates a real difference at the 5% level.

3.4. Total Sugar

Based on the results of ANOVA calculations, it is shown that the variation in extraction time (W) and the addition of trehalose concentration (K), as well as the interaction between the two factors (WK), significantly affect the response of total sugar content in durian monthong extract powder. The cooking process with prolonged heating can lead to a decrease in water content, resulting in an increase in the percentage of total sugar. The evaporation of water during heating in extraction causes the water content to decrease, and the concentration of solids will increase. Therefore, the greater the decrease in water content, the higher the level of nutrients retained in food ingredients [14].

3.5. Vitamin C content

Table 5.
Interaction of Variation in Extraction Time and Trehalose Concentration in Durian Monthong Powder Extract on.

Extraction Time Variation (W)	Trehalose Concentration (K)		
	k1 (10%)	k2 (20%)	k3 (30%)
w1 (90 minutes)	C 307.28 ± 2.50 c	C 248.10 ± 2.00 b	C 197.42 ± 1.51 a
w2 (120 minutes)	B 278.58 ± 2.00 c	B 192.81 ± 2.00 b	B 171.90 ± 2.51 a
w3 (150 minutes)	A 219.03 ± 1.00 c	A 167.64 ± 1.50 b	A 138.58 ± 2.50 a

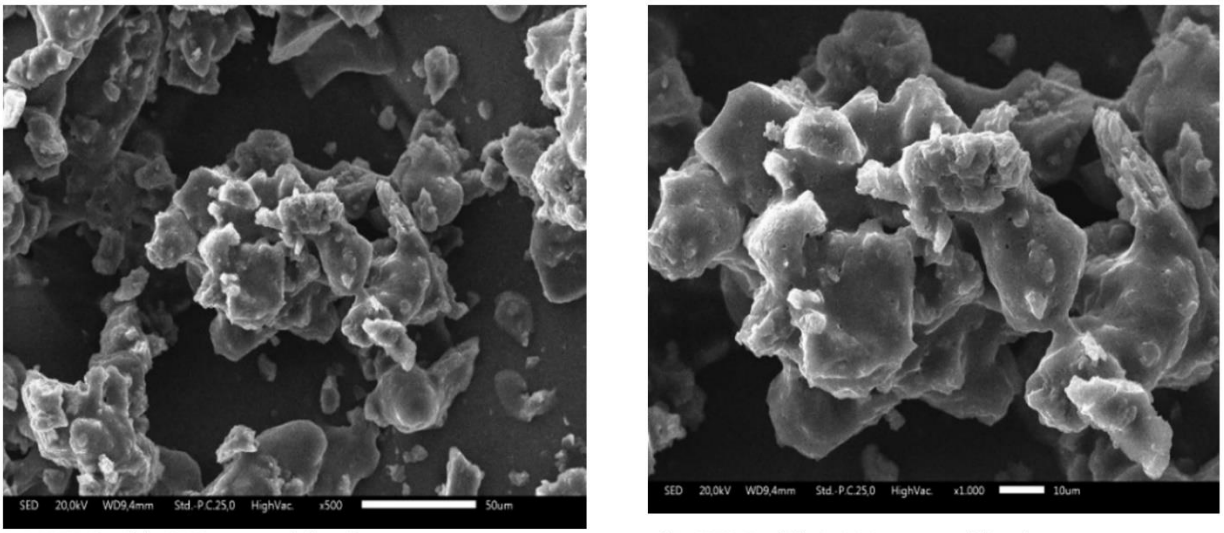
Note: The average value stated in lower case letters is read horizontally, while the average value stated in upper case letters is read vertically, and each different letter indicates a real difference at the 5% level.

Based on the results of ANOVA calculations, it was shown that the variation in extraction time (W) and the addition of

trehalose concentration (K), as well as the interaction between the two factors (WK), significantly affect the response of vitamin C content in durian monthong extract powder. The vitamin C content in freeze-dried durian with added trehalose for 30 hours and 36 hours decreased because the longer the drying time, the higher the reduction in vitamin C in freeze-dried durian [15]. In the durian extracts of the D11 and Ang Jin varieties, the concentrations of vitamin C obtained were 25.13 mg/mL and 18.87 mg/mL, respectively.

3.6. Scanning Electron Microscope (SEM)

SEM testing was carried out using only one selected sample, namely the sample with an extraction time of 90 minutes and a 10% trehalose concentration (w1k1). This test aims to observe the microstructure of lyophilized powder with magnifications of 500x, 1,000x, 2,500x, and 5,000x. In this SEM test, the tool used is the Scanning Electron Microscope X-MaxN with a detector size of 20 mm² from the brand Oxford Instruments. The following are the results of the Scanning Electron Microscope (SEM) test.



(a) SEM with 500x magnification (b) SEM with 1.000x magnification

Figure 1.
Scanning Electron Microscope (SEM) sample with extraction time of 90 minutes and 10% trehalose concentration (w1k1)

3.7. Antioxidant Content

Table 6.
Analysis of antioxidant activity in selected samples.

Sample Code	Antioxidant Activity Value in Value IC_{50} (ppm)
w1k1	689.643

Antioxidant Activity Analysis with the DPPH method states that the results of the antioxidant activity analysis using the DPPH method on selected samples of durian monthong extract powder show an IC50 value of 689.643 ppm. These results indicate that the antioxidant activity, with an IC50 value, is classified as less active but has the potential for antioxidant activity in powdered durian monthong extract products. The antioxidant activity ranged from 65.44% to 70.55%, where each treatment was significantly different [16]. The increase in antioxidant activity is thought to be the effect of extraction time, which causes the antioxidant activity to increase. This increase is attributed to the prolonged ultrasonic extraction time, which damages the extracted plant cell tissue, thereby increasing the liberation of active components. Additionally, the solvent factor used can affect the results, with 70% methanol being the solvent employed.

Table 7.
Analysis of Aromatic compounds content in selected samples.

Identified Compounds	Retention Time (minutes)	Peak Height
Methyl alcohol (CH_4O)	2.705-2.824	31.10
2-propanone. 1-hydroxy ($C_3H_6O_2$)	3.397-3.459	42.97
Glyserin ($C_3H_8O_3$)	3.760-3.806	61.00
n-propyl acetate ($C_5H_{10}O_2$)	3.806-3.846	61.00
DL-2.3-butanediol ($C_4H_{10}O_2$)	4.259-4.342	42.88
2-hydroxy-gamma-butyrolactone ($C_4H_6O_3$)	7.169-7.397	56.83
4-hexen-3-one.4.5-dimethyl ($C_8H_{14}O$)	10.757-10.974	96.79
1.6-anhydro-.beta.-D-glucofuranose ($C_6H_{10}O_5$)	15.010-15.345	56.80
3-deoxy-d-mannoic lactone ($C_6H_{10}O_5$)	17.581-17.995	56.80
n-hexadecanoic acid ($C_{16}H_{32}O_2$)	19.430-19.512	72.78

3.8. Aromatic Compounds Content

Based on the results of the analysis of volatile compounds by GC-MS listed in Table 7, it can be seen that only 2 out of 10 aromatic compounds were detected in the powdered Monthong durian extract sample. Aromatic compounds detected as volatile compounds contained in durian fruit are n-propyl acetate and DL-2,3-butanediol. The n-propyl acetate compound was identified as an ester and the DL-2,3-butanediol compound as an alcohol where the compound components are contained in durian fruit. The results of aromatic compounds obtained were compared with research on aromatic compounds in various durians [17].

4. Conclusion

Variation in extraction time of durian monthong extract powder affects the response of dissolving time, yield, color intensity, water content, protein content, total sugar content, vitamin C content, and antioxidant activity. The concentration of trehalose in durian monthong extract powder affects the response of dissolving time, solubility, yield, Kamba density, hygroscopicity, color intensity, water content, protein content, total sugar content, vitamin C content, and antioxidant activity.

The interaction of extraction time variation and trehalose concentration in durian Monthong powder extract on the response of dissolving time, yield, color intensity, water content, protein content, total sugar content, vitamin C content, and antioxidant activity is significant. Selected samples based on vitamin C analysis, namely samples with an extraction time of 90 minutes and 10% trehalose concentration (w1k1), contain an antioxidant activity of 689.643 ppm and aromatic compounds in the form of n-propyl acetate (ester) and DL-2,3-butanediol (alcohol).

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