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Effect of the Addition of Egg White and Maltodextrin on the Characteristics of Dayak Onion Powder (*Eleutherine palmifolia*) by Foam Mat Drying Method

Sabila Rosda[1], *Rosida Rosida*[1*]

[1]*Food Technology Study Program, Faculty of Engineering and Science, Universitas Pembangunan Nasional "Veteran" Jawa Timur. Surabaya, Indonesia*

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CORRESPONDING AUTHOR

*E-mail: rosida.tp@upnjatim.ac.id.

ABSTRACT

Dayak onion is a plant that has antioxidant content and chemical components that can be used as spices, flavor enhancers, fragrances, and food preservatives whose use is limited. Dayak onions that are easily damaged are processed into powder to make them more durable. The manufacture of powder products uses the foam mat drying method with foaming agents, namely egg white, and foam stabilizer, namely maltodextrin. This study aims to determine the effect of adding egg whites and maltodextrin on Dayak onion powder's physicochemical and organoleptic characteristics by the foam mat drying method. This study used a two-factor Complete Random Design (CRD) with three replicates. The observation data was processed using ANOVA at a confidence level of 5%, if there is a significant influence, a further DMRT test of 5% is carried out. The results showed a significant interaction between adding egg white and maltodextrin in different moisture, phenol, and solubility. The best treatment was obtained with the addition of 8% egg white and 15% maltodextrin with 7.32% moisture content; 2.11% ash content; 51.08% antioxidant activity; 3.37 mg GAE/g phenol content, 46.65% solubility; 54.03 L; 21.00 a*; 11.43 b*; and color hedonic score 3.96 (quite red); aroma hedonic score 3.36 (slightly scented of Dayak onions); texture hedonic score 2.92 (slightly rough); 0.01% flavonoid content; and 9.35 ppm anthocyanin content.

1. INTRODUCTION

1.1. Research Background

Dayak onion (*Eleutherine palmifolia*) is a plant native to tropical America. Dayak onion is a genus of Eleutherine that is spread in Asia, including in Indonesia [1]. Dayak onion have tubers containing anthraquinone derivative compounds with laxative properties, namely eleutherine, isoeleutherine, and similar compounds, as well as lactone compounds called eleutherinol. Dayak onion also contain other chemical compounds such as alkaloids, saponins, triterpenoids, steroids, glycosides, tannins, phenolics, flavonoids, and polyphenols. Fresh dayak onions have a moisture content of 62.31%, ash content of 6.2%, and vitamin C of 16.1 mg/100g [2].

Dayak onions are empirically used as medicinal plants or herbs because they have antioxidants. The antioxidant activity contained in dayak onions is 60.57%, which shows that dayak onions have the ability to inhibit free radical activity [3]. Phenols and flavonoids can act as antioxidants. Compounds that belong to the phenol and flavonoidd groups can become DPPH molecule reducing compounds so that they can dampen the mechanism of action of DPPH [4]. Dayak onions apart from being herbal, can also function as a spice. Dayak onions have aromatic chemical components that can be used as spices, flavor enhancers, fragrances, and food preservatives whose use is limited [5].

Dayak onions are easily damaged if they are not stored in good condition. The high water content in dayak onions makes this commodity susceptible to physical, chemical, and microbiological damage. One of the alternatives that can be done to prevent damage to Dayak onions is to process them into various processed products. Dayak onion processing is aimed at increasing product diversity, use value and economic value and extending shelf life [6]. Dayak onion seasoning can be made in powder form. Powder form is a more durable, lighter, smaller

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volume product so that it can make it easier to package and transport [2].

The drying process is one of the decisive processes in the manufacture of powder products. The characteristics of some material components that are easily damaged at hot temperatures make it important to choose the best drying method [7]. A method that is considered relatively simple and can be used on heat-sensitive foods is foam mat drying [8]. The foam mat drying method is a process to produce stable foam using foaming agents and foam stabilizers on food that has been crushed into liquid form before drying. The foam mat drying process has three stages, namely material preparation, whipping/mixing (foaming agent + foam stabilizer + main liquid material), and drying [9].

The foam mat drying method requires foaming agents that form and maintain the homogeneity of gaseous phase dispersion in liquid or solid food ingredients [10]. The formation of stable foam is one of the important things that determine the success of the foam mat drying process. Protein is a foaming agent that also has a function as a foam stabilizer due to its hydrophobic properties. Some types of protein commonly used in the foam mat drying method are egg whites, gelatin, whey protein, and soy protein [11]. The use of egg whites as a foaming agent is because it is affordable, easy to obtain, and natural. The foaming process uses egg whites because it takes a relatively short time compared to other types of foaming agents. The use of egg whites containing ovomusin protein can form a layer or film so that it is able to stabilize the foam that forms [10].

The foam mat drying method, with the addition of foam stabilizers, usually uses hydrocolloids. Hydrocolloids are more widely used because they can increase the viscosity of the solution, which reduces the speed of water. Foam stabilizers usually used in foam mat drying are maltodextrin, xanthan gum, arabic gum, and cyclodextrin. Maltodextrin is a type of hydrocolloid that is often used in powder drying. Maltodextrin can form a gel and retain water [9]. The properties of maltodextrin include experiencing a rapid dispersion process, having high solubility, forming low hygroscopic properties, low browning properties, inhibiting crystallization, and having binding solid power [12]. Adding maltodextrin to powder drying can function as a filler and coating agent in the drying process. Maltodextrin can protect essential compounds so that it does not damage important compounds as much in the dried material [7].

The stability of foam in Dayak onion powder with foam mat drying needs to consider the observed process variables, including the addition of egg white as a foaming agent and the addition of maltodextrin as a foam stabilizer. Therefore, the researcher will research the effect of adding egg whites and maltodextrin on the characteristics of Dayak onion powder produced by the foam mat drying method.

1.2. Literature Review

Dayak onion is a plant with many health benefits, especially the bulb. The plant is an annual herbaceous habitus plant and has pseudo-stems forming tubers. The tubers are layered, consisting of several layers of scales and leaves in the centre. Dayak onion bulbs have a slightly sour taste, slightly spicy, and a distinctive smell [13]

Dayak onions are useful as traditional medicine and natural food additives, including preservatives, antioxidants, and dyes [14]. Dayak onion bulbs have chemical content that can be used and processed into powder so that they are more practical and can extend the shelf life. According to [15], fresh Dayak onions contain 52.24% water, 0.95% ash, 1.07% protein, and 0.96% fat. Dayak onions also contain 60.57% antioxidants [3] anthocyanins 10.32 ppm [1], phenol levels of 1.06 mg GAE/g [16] and flavonoid levels of 0.094% [17].

Foaming material is an active ingredient that can lower surface tension and facilitate foam formation. Adding egg whites will increase the volume of the ingredients, which causes greater heat transfer, thereby speeding up the drying process. The use of egg whites as a foaming agent is due to its affordable price, easy availability, and natural [18]. The mechanism of foam formation begins with opening the bonds of protein molecules so that the chain becomes longer. Air then enters between the unchained and held molecules so that the egg white volume develops. The next stage is adsorption, which forms a monolayer or film from denatured proteins. The air is captured and surrounded by a film and forms bubbles. A second monolayer is formed around the bubble to replace the coagulated part of the film. The protein film of the adjacent bubbles will come into contact and prevent the release of fluid. Egg whites that are beaten for too long or stretched as widely as possible will cause a loss of elasticity [19].

Research by [20] related to the manufacture of onion powder with the addition of egg whites with different concentrations of 0%, 4%, 8%, and 12% resulting in drying with different times, the more egg whites are used, the faster the drying process will be. The addition of higher egg whites will reduce the water content in the onion paste because the egg whites expand the surface of the ingredients, thereby speeding up the heating process.

The addition of maltodextrin in powder manufacturing aims to be a coating. Maltodextrin will be a microencapsulate that serves as a protective layer and outer wall of the material to be dried to protect the material from denaturation [21]. Research [22] shows that adding maltodextrin to bitter melon herbal powder by 5% has a significant effect on total phenol levels and total flavonoid levels. The addition of 10% maltodextrin is considered the mushroom broth powder with the best formulation for yield, solubility, moisture content, and color L, a*, and b* [18]. Research [23] stated that the addition of maltodextrin to mango powder by 15% resulted in better antioxidant activity compared to no addition of maltodextrin.

1.3. Research Objective

This research aims to determine the effect of adding egg whites and maltodextrin on Dayak onion powder's physicochemical and organoleptic characteristics. Moreover, to determine the best combination of treatment between the addition of egg whites and maltodextrin to produce Dayak onion powder with the best physicochemical characteristics and preferred by the panelists

2. MATERIALS AND METHODS

2.1 Materials and Tools

The raw materials used in the study were dayak onions, egg whites, and maltodextrin. Dayak onions obtained from the Lumajang area, egg whites are obtained at the "Nur Gemilang" store and maltodextrin is obtained from the www.minyak-atsiri.com. The analysis materials used were aquades, methanol (Technical), DPPH powder (Sigma-Aldrich), KCl 0.025 M, HCl, $CH_3CO_2Na.3H_2O$, hexamethylenetetramine, acetone, ethyl

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acetate, AlCl3, glacial acetic acid solution, Follin-Denis reagent, Na_2CO_3, and gallic acid.

Tools for the processing process include digital scale, knive, baking pan, basin, blenders (Mitochiba), *mixer* (Oshiyama), 60 mesh sieve, cabinet dryer (Tianshi XMT-7000), and grinder. Tools for analytical balance (Sartorius), weighing bottle, desiccator, *beaker* glass (Schott Duran), measuring flasks (Iwaki Pyrex), porcelain cups, erlenmeyers, test tube (Schott Duran), measuring pipette, clamp, pump pipette, filter paper, measuring cup, stopwatch, hot plate (Thermo Scientific), furnace (Thermolyne), ovens (Memmert), colorimeter, vortex (Velp Scientifica), spectrophotometer UV-Vis (Genesys 10S UV-VIS).

2.2 Design Experiment and Analysis

This study uses a Complete Random Design (CRD) factorial pattern with two factors and three replicates. The first factor is the addition of egg whites, which consists of three levels: 4%, 8%, and 12%. The second factor is the addition of maltodextrin, which has three levels: 5%, 10%, and 15%. The data obtained were processed using Analysis of Variance (ANOVA) at a confidence level of 5% to determine the influence on each treatment; if there is a significant effect, further tests are carried out using the Duncan Multiple Range Test (DMRT) method at a confidence level of 5%.

2.3 Research Implementation

2.3.1 Making Dayak Onion Powder

Dayak onions are sorted, then peeled, then washed thoroughly. Dayak onions are weighed at as much as 200 grams and blended at medium speed by adding 40 ml of water. Dayak onions are then homogenized with egg whites and maltodextrin according to a predetermined combination of treatments using a low-speed mixer for 15 minutes. The frothed Dayak onion is then poured on a baking sheet coated with baking paper. Dry with a cabinet dryer at 60°C for 5 hours. The dried Dayak onion is then ground until smooth and sifted using a 60-mesh sieve.

2.4 Research Parameters

2.4.1 Dayak Onion

Analysis parameters include moisture content, ash content, antioxidant activity, anthocyanin content, flavonoid content, and phenol content.

2.4.2 Dayak Onion Powder

Analysis parameters include moisture content, ash content, antioxidant activity, phenol content, solubility, color values (L, a*, and b*), and scoring scale hedonic organoleptic tests on color, aroma, and texture.

2.4.3 The Best Treatment of Dayak Onion Powder

Analysis parameters include flavonoid content and anthocyanin content.

3. RESULT AND DISCUSSION

3.1. Characteristics of Dayak Onion

The analysis of Dayak onion carried out in this study includes moisture content, ash content, antioxidant activity, anthocyanin content, total fenol, and flavonoid content. The results of the analysis of Dayak onion can be seen in **Table 1**.

Table 1. Results of analysis of raw materials for Dayak onions

Parameters	Content
Moisture content (%)	59.37±0.068
Ash content (%)	1.22±0.12
Antioxidant activity (%)	60.81±0.739
Anthocyanin content (ppm)	10.42±0.225
Phenol content (mg GAE/g)	1.12±0.006
Flavonoid content (%)	0.03±0.98

The results of the analysis are in **Table 1**. It is known that Dayak onions have a moisture content value of 59.37% and an ash content of 1.22%. The value of the moisture content is greater than that of the literature. The moisture content in dayak onions is 52.24%, while the ash content is 0.95% [15]. The difference in the analysis results is suspected to be caused by different post-harvest storage treatments. Storage at different locations and temperatures can affect the respiration and transpiration processes so that the chemical composition of Dayak onions changes [24].

The analysis results in **Table 1**. showed that the antioxidant activity in Dayak onions was obtained by 60.81%. Analysis of antioxidant activity showed greater results compared to the literature. The antioxidant activity of dayak onions is 60.57% [3]. The difference in the analysis results is suspected to be caused by the environmental conditions of growing dayak onions. This statement follows Ref [25], where the plant's growing location's environmental conditions can affect the production of antioxidant activity.

The analysis results are in **Table 1**. which showed the anthocyanin level of Dayak onions of 10.42 ppm. Analysis of anthocyanin levels showed greater results compared to the literature. The anthocyanin content of Dayak onions was obtained at 10.32% [1]. This difference can be caused by the environmental conditions of growing Dayak onions, one of the causes is the different shade levels. This statement follows Ref [1], that different shade levels when planting Dayak onions can affect the anthocyanin levels of Dayak onions because Dayak onion plants receive different light intensities, so anthocyanin production is not the same.

The analysis results in **Table 1**. showed a phenol level of Dayak onions of 1.12 mg GAE/g. The phenol level analysis results showed greater results than the literature. According to Ref [16], dayak onions have a phenol of 1.06 mg GAE/g. The type of simplicia can cause the difference the method used, and the difference in the number of samples against the amount of solvent [26].

The results of the analysis are in **Table 1**. The flavonoid level of Dayak onions was 0.03%. The results of the flavonoid level analysis showed smaller results than those of the literature. According to Ref [17], the flavonoid content of Dayak onions was obtained with a result of 0.094%. Different Dayak onion cultivation techniques can cause these differences. This statement follows Ref [17], that dayak onions planted with a wider planting distance produce large levels of flavonoids. With this, the plant gets enough sunlight exposure to optimally produce flavonoid levels.

3.2. Moisture Content

The moisture content in food products is an important factor affecting a product's quality. Moisture content is the main parameter in determining the quality of dry products, low moisture content can prevent the growth of microorganisms that can damage the product [21] Based on the results of the variety analysis, there was a significant interaction ($p \leq 0.05$) between the treatment of adding egg whites and maltodextrin, and each treatment had a significant effect on the moisture content of the dayak onion powder produced. The average moisture content of Dayak onion powder with egg white and maltodextrin can be seen in **Table 2.**

Table 2. The average value of moisture content of Dayak onion powder

Treatment		Moisture Content (%)	DMRT 5%
Addition of Egg White (%)	Addition of Maltodextrin (%)		
4	5	8.22±0.03^{e}	0.214
	10	7.73±0.21^{c}	0.213
	15	7.26±0.03^{b}	0.211
8	5	8.15±0.01^{de}	0.209
	10	7.62±0.06^{c}	0.206
	15	7.32±0.15^{b}	0.202
12	5	8.03±0.03^{d}	0.196
	10	7.31±0.06^{b}	0.187
	15	6.79±0.18^{a}	-

The average moisture content of Dayak onion powder with the addition of egg whites and maltodextrin in **Table 2.** ranges from 6.79% to 8.22%. The treatment of adding egg whites of 12% and maltodextrin of 15% resulted in the lowest moisture content of 6.79%. In comparison, adding 4% egg whites and 5% maltodextrin resulted in the highest moisture content of 8.22%. The higher the addition of egg whites and maltodextrin, the lower the moisture content of Dayak onion powder. This is because egg whites contain proteins that can form foam, which produces a porous structure that makes it easier for water to evaporate when drying. Maltodextrin has hygroscopic properties that can absorb water in the material. Still, when heating occurs, the water absorbed by the maltodextrin will be released.

According to Ref. [27], the proteins in egg whites that can form foam are globulin, ovomusin, and ovalbumin. Ovomusin is a protein in egg whites that is able to form a layer or film that is insoluble in water, stabilize the foam that forms, and bind water. Globulin is also an egg white protein that can increase viscosity and reduce surface tension, so it helps the foam formation stage to form small, many, and soft air bubbles; low surface tension is required. In addition, ovalbumin can help form a strong foam.

Adding higher egg whites causes more foam produced by egg white proteins, which can expand the drying surface to accelerate rapid water evaporation and reduce the moisture content of the product. This statement follows Ref. [28] which stated that the increased addition of egg whites causes the foam produced by egg whites to form more cavities. The number of air cavities produced can increase the drying surface area so that the surface exposed to the drying temperature is larger. As a result, the drying rate increases and produces rapid water evaporation.

Maltodextrin has hygroscopic properties that allow it to absorb water in the material, but when maltodextrin is heated, the absorbed water will be released. Therefore, the higher the concentration of maltodextrin given, the more water is absorbed and evaporated so that the water content decreases [29]. According to Ref. [30], maltodextrin has a simple molecular structure, so bound water and free water can be easily excreted during drying. In addition, higher maltodextrin makes the material thicker and binds to water more. The higher the concentration of maltodextrin, the thicker the foam is formed so that the moisture content in the material becomes smaller. Low water concentrations tend to evaporate faster, so that the moisture content decreases faster, but water bound in maltodextrin is also difficult to evaporate.

3.3. Ash Content

Ash content is a parameter that indicates the value of inorganic substances contained in a material or product. Determining total ash content can be used to determine whether or not processing is good, to know the type of ingredients used, and to determine the nutritional value parameters of a food ingredient [23]. Based on the results of the variety analysis, it was found that there was no significant interaction ($p \geq 0.05$) between the treatment of adding egg whites and maltodextrin to the ash content of Dayak onion powder produced. The treatment of adding egg whites had a significant effect ($p \leq 0.05$), while the treatment of adding maltodextrin ($p \geq 0.05$) had no significant effect on the ash content of Dayak onion powder. The average value of ash content of Dayak onion powder with the addition of egg white and maltodextrin can be seen in **Table 3.**

Table 3. Average value of ash content of Dayak onion powder in the treatment of adding egg white

Egg White (%)	Ash Coontent (%)	DMRT 5%
4	2.04±0.02^{a}	-
8	2.10±0.01^{b}	0.02
12	2.16±0.02^{c}	0.02

Average ash content of Dayak onion powder with the addition of egg white in **Table 3.** ranges from 2.04% to 2.16%. The treatment of adding egg whites of 4% resulted in the lowest ash content value of 2.04%, and the addition of egg whites of 12% resulted in the highest ash content value of 2.16%. The higher the addition of egg whites, the higher the ash content will be. This is because egg whites contain minerals. This statement follow Ref [31] that the increase in egg whites given will result in higher ash levels along with the addition of egg whites, because egg whites contain minerals. Based on Ref. [32], egg whites contain 0.6% ash content.

The average ash content of Dayak onion powder with maltodextrin addition treatment in Table 4 ranges from 2.09% to 2.11%. Based on the quality requirements of SNI 01-3709-1995 concerning the quality requirements of good powdered spices, which is to have a maximum ash content of 7%, so that the ash content of Dayak onion powder produced has met the set SNI requirements. The higher the addition of maltodextrin, the higher the ash content value will be, but statistically, there is no significant difference. This is because the addition of maltodextrin has a relatively small ash content, so the difference is insignificant. Based on Ref. [33], maltodextrin contains an ash content of 0.03-0.21%. This statement follows Ref. [15], which states that adding maltodextrin does not affect the increase in ash levels because maltodextrin only has a relatively small mineral

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content so the difference is not significant. The ash contained in maltodextrin also depends on the ash content of the starch raw material. The ash content will not change in the modification process because the heat applied to the processing process does not reach the minerals contained in the material.

Table 4. Average value of ash content of Dayak onion powder in the treatment of adding maltodextrin

Maltodextrin (%)	Ash Content (%)	DMRT 5%
5	2.09±0.05[a]	-
10	2.10±0.05[a]	0.02
15	2.11±0.06[a]	0.02

3.4. Antioxidant Activity

Antioxidants can prevent or slow down the oxidation process at low concentrations by binding to free radicals and highly reactive molecules so that cell damage will be inhibited. Antioxidants are generally found naturally in plants and have an important role in protecting the health of the body [34]. The results of the variety analysis showed no significant interaction ($p \geq 0.05$) between the treatment of adding egg whites and maltodextrin on the antioxidant activity of Dayak onion powder. The treatment of adding egg white and maltodextrin, respectively, had a significant effect ($p \leq 0.05$) on the antioxidant activity of Dayak onion powder. The average value of the antioxidant activity of Dayak onion powder in egg white treatment can be seen **in Table 5.**

Table 5. The average antioxidant value of dayak onion powder in the treatment of adding egg white

Egg White (%)	Antioxidant Activity (%)	DMRT 5%
4	49.01±0.92[a]	-
8	49.61±1.25[b]	0.28
12	51.65±0.83[c]	0.29

The average antioxidant activity of dayak onion powder with the addition of egg whites is shown in **Table 5.** ranging from 43.62% to 47.37%. The treatment of adding egg whites by 4% resulted in the lowest antioxidant activity of 43.62% and the addition of egg whites by 12% resulted in the highest antioxidant activity of 47.37%. The higher the addition of egg whites, the higher the antioxidant activity. This is because the higher the addition of egg whites, the more foam will form, which can speed up the drying process and result in maintaining antioxidant activity from damage during the drying process. This statement follows Ref. [35], Research shows that adding egg whites does not cause high activity of free radical deterrence in instant powder, but the role of egg whites is that they are a foaming agent that helps in the drying process so that essential compounds of dried materials do not suffer damage.

Table 6. Average value of the antioxidant activity of Dayak onion powder in the treatment of adding maltodextrin

Maltodextrin (%)	Antioxidant Activity (%)	DMRT 5%
5	49.00±1.35[a]	-
10	50.04±1.22[b]	0.28
15	51.24±1.13[c]	0.29

The average antioxidant activity of dayak onion powder with maltodextrin addition treatment in **Table 6.** ranges from 49.00% to 51.24%. Antioxidant activity with 5% maltodextrin addition treatment obtained a result of 43.62%, 10% maltodextrin addition treatment obtained a result of 45.20%, and 15% maltodextrin addition treatment obtained a result of 46.88%. The higher the addition of maltodextrin, the higher the antioxidant activity. This is because maltodextrin, in addition to functioning as a filler, can also play a role in maintaining or protecting heat-sensitive antioxidant compounds. Based on Ref. [36], maltodextrin is an encapsulated ingredient that can protect nutritional components, including antioxidant activity, and has binding solid power to coated materials. The maltodextrin capsule wall can protect sensitive components such as antioxidants, color, and other nutritional components.

3.5. Phenol Content

Phenol compounds are secondary metabolites that play a role in maintaining the human body. Phenol compounds are known to have antioxidant activity because they play a role in preventing oxidation. Based on a reduction-oxidation reaction, the phenol principle determines the follin-ciocalteu content where a blue complex compound is formed [37]. The results of the variety analysis showed a significant interaction ($p \leq 0.05$) between the treatment of adding egg whites and maltodextrin, and each treatment had a significant effect on the phenol content of Dayak onion powder produced. The average value of phenol content of Dayak onion powder with the addition of egg white and maltodextrin can be seen in **Table 7.**

Table 7. The average value of phenol content of Dayak onion powder

Treatment		Phenol Content (mg GAE/g)	DMRT 5%
Addition of Egg White (%)	Addition of Maltodextrin (%)		
4	5	3.35±0.01[b]	0.02
	10	4.14±0.02[e]	0.03
	15	3.97±0.01[c]	0.03
8	5	4.18±0.02[f]	0.03
	10	3.27±0.01[a]	-
	15	3.37±0.01[b]	0.03
12	5	4.29±0.01[h]	0.03
	10	4.25±0.02[g]	0.03
	15	4.00±0.02[d]	0.03

The average phenol content of Dayak onion powder with egg white and maltodextrin in **Table 7.** ranged from 3.27 mg GAE/g to 4.29 mg GAE/g. The treatment of adding egg whites of 8% and maltodextrin of 10% resulted in the lowest phenol content of 3.27 mg GAE/g, while the treatment of adding egg whites of 12% and maltodextrin of 5% produced the highest phenol content of 4.29 mg GAE/g. The higher the addition of egg whites, the higher the phenol content of Dayak onion powder. While the higher the addition of maltodextrin, the phenol content tends to decrease. The interaction between egg white and maltodextrin affects the phenol contents of Dayak onion powder because egg white can strengthen the protective layer (film) on the dissolved material in the foam system so as to minimize oxidative damage during drying, while maltodextrin as a filler can increase the amount of solids [38].

The higher the egg white, the higher the phenol content. This is because egg white is proteins that are able to form a strong film that protects the components in the foam system during

drying. This statement follow Ref [8] which states that, egg white is one of the proteins that has a stable foam. Egg white can also increase the surface area of the dried material which can speed up the drying time so that the compound components contained in the material can be maintained from hot temperatures that can damage phenol compounds in dayak onions.

The treatment of adding maltodextrin can have a significant effect on phenol content that tends to decrease. The decrease in phenol content is caused by the fact that maltodextrin, which acts as a filler, can increase the total solids in the material so that the total measured phenols are less [39]. This statement follow Ref. [22] Add maltodextrin to lower phenol in the measured bitter melon herbal powder. This happened because maltodextrin has a white color while the complex color of phenol compounds is blue so that when measured with a spectrophotometer, the intensity of the blue color decreases so that the total phenol level tends to decrease [39].

3.6. Solubility

Solubility is the level of ability of dry products such as powders, flours, or grains to dissolve in water. Solubility is a quality requirement for instant powder because instant powder should be in the form of a powder, have a crumb texture, be easily dissolved with cold or hot water, easy to serve, and easily dispersed [40]. Based on the results of the variety analysis, it was shown that there was a significant interaction ($p \leq 0.05$) between the treatment of adding egg whites and maltodextrin, and each treatment had a significant influence on the solubility of the dayak onion powder produced. The average solubility of Dayak onion powder with the addition of egg white and maltodextrin can be seen in **Table 8.**

Table 8. Average value of solubility of Dayak onion powder

Treatment		Solubility (%)	DMRT 5%
Addition of Egg White (%)	Addition of Maltodextrin (%)		
4	5	42.33±0.31^{a}	-
	10	44.16±0.16^{c}	0.423
	15	45.27±0.15^{e}	0.450
8	5	43.50±0.31^{b}	0.402
	10	44.86±0.10^{d}	0.443
	15	46.65±0.09^{g}	0.458
12	5	44.48±0.44^{cd}	0.435
	10	45.94±0.07^{f}	0.455
	15	48.17±0.19^{h}	0.461

Average solubility of Dayak onion powder with the addition of egg white and maltodextrin in **Table 11.** ranging from 42.33% to 48.17%. Adding egg whites of 8% and maltodextrin of 5% produced the lowest solubility of 42.33%, while the treatment of adding egg whites of 12% and maltodextrin of 15% produced the highest solubility of 49.63%. The higher the addition of egg whites and maltodextrin, the higher the solubility of Dayak onion powder. This is because egg whites can form a more considerable foam expansion to produce air cavities that cause the powder to become more porous and absorb more water. In addition, the addition of maltodextrin causes solubility to increase due to the presence of a free hydroxyl group that can bind water well so that water will be hygroscopic and easy to absorb when the product is added.

Based on Ref. [35], egg white foam can increase the surface area of the material so that the final product produced from *foam-mat drying* is very porous and absorbs water without forming large agglomerates. The particles' porosity greatly influences the solubility of the product; if the product is more porous, the material will absorb water more efficiently. Ref follows this statement. [41], adding egg whites makes the foam expand even more so that the dried powder has a large surface area. As a result, the level of water binding by the powder will also be higher.

Adding maltodextrin can increase the solubility of the powder because it has a hydroxyl group that can bind water. This statement follows Ref. [42] that, maltodextrin is composed of hydroxyl groups that can bind large amounts of water. The hydroxyl group that binds to water molecules can cause water molecules to be in maltodextrin granules so that they will easily dissolve in water. The more free hydroxyl groups in the filler, the higher the solubility, indicating the better product quality produced.

3.7. Color Value

The results of the variety analysis showed that there was no significant interaction ($p \geq 0.05$) between the treatment of egg white and maltodextrin addition to L (*Lightness*), a* (*Redness*), and b* (*Yellowness*) of Dayak onion powder. The treatment of adding egg whites and maltodextrins had a significant effect ($p \leq 0.05$) on color (L, a*, and b*), respectively. The average value of the color of Dayak onion powder in the treatment of adding egg white can be seen in **Table 9.**

Table 9. Average color values (L, a*, and b*) of Dayak onion powder

Addition of Egg White (%)	L	DMRT 5%	a*	DMRT 5%	b*	DMRT 5%
4	51.74±1.51^{a}	-	22.19±0.31^{c}	0.36	13.12±1.29^{b}	0.48
8	52.18±1.69^{ab}	0.66	21.30±0.30^{b}	0.34	12.57±1.14^{a}	0.45
12	52.68±1.83^{b}	0.70	20.62±0.76^{a}	-	12.24±1.08^{a}	-

‘

Table 9. showed the average L value in Dayak onion powder with egg white addition treatment ranged from 51.74 to 52.68. The treatment of adding egg whites of 4% resulted in the lowest value of 51.74 while the addition of egg whites of 12% produced the highest value of 52.68. The higher the addition of egg whites, the higher the L value. This is due to the white egg white not being translucent, so it can cover the original color of Dayak onion powder (reddish). According to Ref. [35], when the egg whites are beaten, the air bubbles will merge, gradually become smaller and change color from translucent to impermeable. In addition, the addition of egg whites will protect the instant powder from the Maillard reaction due to the heating treatment so that the instant powder becomes brighter.

Table 9. shows the average a* value in Dayak onion powder with egg white addition treatment ranged from 20.62 to 22.19. The treatment of adding egg whites of 4% resulted in the highest value of 22.19, while the addition of egg whites of 12% produced the lowest value. The higher the addition of egg whites, the lower the a* value. A decreasing a* value indicates that the color of the resulting powder is decreasing at a reddish level. This is because egg whites produce more and more foam so that the original color of Dayak onions is covered. This is in accordance with Ref. [35] that, frothed egg whites can protect the material from the Maillard

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reaction, which reduces the degree of redness because the opaque egg white foam covers the material's colour.

Table 9. showed that the average value of b* in Dayak onion powder with egg whites ranged from 12.24 to 13.12. The lowest b* value in the 12% egg white addition treatment was 12.24, while the highest b* value in the treatment of 4% egg white addition was 13.12. The higher the addition of egg whites, the lower the value of b*. A decreasing b* value indicates that the color of the resulting powder is decreasing in yellowishness. This is because egg whites can protect ingredients from the Maillard reaction. According to Ref [35], egg white foam is able to protect the material from the heating process so that the resulting powder does not experience significant color changes. Adding higher egg whites will protect the instant powder from the Maillard reaction.

Table 10. Average color values (L, a*, and b*) of Dayak onion powder

Addition of Maltodextrin (%)	L	DMRT 5%	a*	DMRT 5%	b*	DMRT 5%
5	50.42±0.58^{a}	-	21.82±0.56^{c}	0.36	13.92±0.60^{c}	0.48
10	52.14±0.59^{b}	0.66	21.34±0.73^{b}	0.34	12.62±0.59^{b}	0.45
15	54.03±0.97^{c}	0.70	20.94±0.93^{a}	-	11.39±0.51^{a}	-

Table 10. showed the average L value in Dayak onion powder with maltodextrin addition treatment ranged from 50.42 to 54.03. The lowest L value was produced from the treatment of 5% maltodextrin addition of 50.42 while the highest L value was produced from the treatment of 15% maltodextrin addition of 54.03. The higher the addition of maltodextrin, the higher the L value. This is because maltodextrin is white, so the higher the addition of maltodextrin, the L value will increase. According to Ref. [43], maltodextrin is white with an L value of 90, so when maltodextrin is added to the material to be dried, it will give a bright color. In addition, maltodextrin can speed up drying and prevent heat damage (browning reaction) [9].

Table 10. the average a* value in Dayak onion powder with maltodextrin addition treatment ranged from 20.94 to 21.82. The lower the addition of maltodextrin is given, the effect is on the value of a*, where the reddish level is more dominant, while the higher the addition of maltodextrin, the weakening the redness level. However, the * value obtained is still positive, so the color produced shows that Dayak onion powder tends to be red. According to Ref. [29], maltodextrin tends not to react so that the color of the powder does not change from the color of the original material.

Table 10. showed the average value of b* in Dayak onion powder with maltodextrin addition treatment ranged from 11.39 to 13.92. The lowest b* value was produced from the treatment of 15% maltodextrin, in addition to 11.39, while the highest b* value was produced from the treatment of 5% maltodextrin, in addition to 13.92. The lower the addition of maltodextrin is given, the effect is on the value of b*, where the yellowness level is more dominant, while the higher the addition of maltodextrin, the lower the yellowness level. According to Ref. [29], white maltodextrin added in large quantities can fade the natural color of the pigment so that the color tends to be pale.

3.8. Color Hedonic Score

Color is the first impression that the panellists capture before recognizing other stimuli [21]. The results of the variety analysis showed that the treatment of adding egg whites and maltodextrin had a significant effect ($p \leq 0.05$) on the color preference score of Dayak onion powder. The average organoleptic score of Dayak onion powder color with the addition of egg white and maltodextrin can be seen in **Table 11.**

Table 11. The average organoleptic score of Dayak onion powder color

Treatment		Color	DMRT 5%
Addition of Egg White (%)	Addition of Maltodextrin (%)		
4	5	2.68±0.69^{b}	0.38
	10	3.36±0.64^{c}	0.39
	15	4.04±0.61^{e}	0.42
8	5	2.08±0.91^{a}	-
	10	3.56±0.77^{cd}	0.40
	15	3.96±0.68^{de}	0.41
12	5	2.36±0.64^{ab}	0.36
	10	3.76±0.60^{cde}	0.41
	15	4.16±0.80^{e}	0.42

The average color scoring test of Dayak onion powder with the addition of egg white and maltodextrin is in **Table 11.** ranges from 2.08 to 4.16. The treatment of adding 8% egg white and 5% maltodextrin produced the lowest color score of 2.08, which indicates a "pale" color. In comparison, the treatment of adding 12% egg white and 15% maltodextrin produced the highest color score of 4.16, which indicates the color "red".

The red color produced in Dayak onion powder is suspected to be caused by anthocyanin compounds. Anthocyanins are natural pigments widely distributed in nature and give flowers, tubers, fruits, and vegetables red, purple, and blue colors. The color stability of anthocyanins is affected by pH, solvent type, temperature, oxygen, light, and enzymes [34]. Organoleptic results are in **Table 11.** shows that the greater the egg whites added, the better the color of the powder produced. According to Ref. [44], the drying process causes the product's water content to decrease to improve the color. In addition, egg whites were added to the powder making using the foam mat drying method, which is suspected of giving a darker color. This statement follows Ref. [45]. In the manufacture of flour with the addition of egg white, it is possible to cause flour products to become darker in color because the protein contained in egg whites will be partially or entirely denatured, which is marked by a change in the color of the protein to darken.

The higher the addition of maltodextrin used, the color organoleptic score increased. This states that maltodextrin can protect the material from the heating process. According to Ref [46], maltodextrin is used in the encapsulation process to protect compounds that are sensitive to oxidation and heat. Adding high maltodextrin will help speed up the drying process so that it does not change the color of dayak onions.

3.9. Aroma Hedonic Score

Aroma is an indicator that provides the results of an assessment of whether the product is accepted or not. However, the aroma itself is difficult to measure, so many different opinions are usually raised when assessing the quality of the aroma [21]. Aroma is an odor caused by chemical stimuli smelled by olfactory nerves in the nasal cavity [47]. The results of the variety analysis showed that the treatment of adding egg whites and maltodextrin had a significant effect ($p \leq 0.05$) on the aroma preference score of Dayak onion powder. The average organoleptic score of the

aroma of Dayak onion powder with the addition of egg white and maltodextrin can be seen in **Table 15.**

Table 12. Average organoleptic score of dayak onion powder aroma

Treatment		Aroma	DMRT 5%
Addition of Egg White (%)	Addition of Maltodetrin (%)		
4	5	3.00±1.26[a]	-
	10	3.36±1.11[ab]	0.61
	15	3.80±0.96[b]	0.65
8	5	3.08±1.53[ab]	0.56
	10	3.12±1.24[ab]	0.59
	15	3.36±1.04[ab]	0.62
12	5	3.56±1.04[ab]	0.64
	10	3.76±1.09[ab]	0.65
	15	3.36±1.29[ab]	0.63

The average aroma scoring test of Dayak onion powder with the addition of egg white and maltodextrin in **Table 12.** ranges from 3.00 to 3.80. The treatment of adding 4% egg white and 5% maltodextrin produced the lowest aroma score of 3.00. In comparison, the treatment of adding 4% egg white and 15% maltodextrin produced the highest aroma score of 3.80 which showed a "slightly scented dayak onion" aroma. The organoleptic results showed that the aroma produced did not significantly differ with the addition of egg whites or maltodextrin. The insignificant increase is thought to be due to adding egg whites and maltodextrins that can maintain the aroma in foodstuffs. According to Ref. [48], adding fillers and foaming agents can prevent heat damage to the material and coat the volatile components found in the powder. Therefore, the aroma produced by Dayak onions can be restrained during the drying process using the foam mat drying method.

3.10. Texture Hedonic Score

Texture can be defined as a sensory description of a product's structure that is part of a pressure reaction, measured as a mechanical force by kinesthetic nerves in the muscles of the hands, fingers, tongue, teeth, and lips [34] The results of the variety analysis showed that the treatment of adding egg whites and maltodextrin had a significant effect ($p \leq 0.05$) on the texture preference score of Dayak onion powder. The average organoleptic score of the texture of Dayak onion powder with the addition of egg white and maltodextrin can be seen in **Table 13.**

Average scoring test of the texture of Dayak onion powder with the addition of egg white and maltodextrin in **Table 13.** ranges from 2.56 to 3.76. The treatment of adding 4% egg white and 15% maltodextrin produced the lowest texture score of 2.56, which indicates a "slightly rough" texture. In comparison, adding 8% egg white and 5% maltodextrin produced the highest texture score of 3.76, indicating a "slightly smooth" texture. The higher the addition of egg whites used as foaming agents, the lower the powder texture score produced. This follows Ref. [44], which states that adding higher egg whites will produce thicker foam so that the drying process becomes less optimal, decreasing the powder's texture value.

Table 13. The average organoleptic score of dayak onion powder texture

Treatment		Texture	DMRT 5%
Addition of Egg White (%)	Addition of Maltodextrin (%)		
4	5	3.40±1.04[bc]	0.54
	10	3.40±0.96[bc]	0.55
	15	2.56±1.04[a]	-
8	5	3.76±0.88[c]	0.56
	10	3.28±1.02[bc]	0.53
	15	2.92±1.08[ab]	0.51
12	5	3.68±0.80[c]	0.56
	10	3.00±0.87[ab]	0.52
	15	2.80±1.15[ab]	0.48

3.11. Characteristics of Best Treatment Product

The best treatment of Dayak onion powder products is then analyzed for flavonoid and anthocyanin content, presented in **Table 14.**

Table 14. Results of the analysis of the best treatment of Dayak onion powder

Treatment		Flavonoid Content (%)	Antochyanin Content (ppm)
Egg White 8%	Maltodextrin 15%	0.01	9.35

Results of the analysis **Table 14.** Dayak onion powder, with the best treatment, was found by adding as much as 8% egg whites and as much as 15% maltodextrin. The results of the flavonoid content of Dayak onions were obtained at 0.01%, while in the bulbs of Dayak onions, the flavonoid content was obtained at 0.03%. The difference in the analysis results showed that the level of flavonoids decreased after the processing process. This statement follows Ref. [49] which stated that, the level of flavonoids in kecombrang, which was dried with the addition of maltodextrin using the *foam mat drying* method, decreased. This is because flavonoids are phenolic compounds with a conjugated aromatic system that is easily damaged when heated for a long time at high temperatures. Flavonoids also have glycoside bonds with sugar molecules, so glycoside bonds will easily break at high-temperature heating.

The results of the analysis of anthocyanin levels of Dayak onion powder are best treated based on **Table 18.** obtained by 9.35 ppm. Meanwhile, in the analysis of anthocyanin levels of fresh dayak onions, the anthocyanin level was obtained at 10.42 ppm. Based on the results of the two data, the results of the analysis of anthocyanin levels decreased. This is suspected to be due to the heating process from drying. According to Ref. [50], in the extraction of anthocyanins from onion skins at temperatures of 50, 55, and 60°C, the amount of anthocyanins tends to increase as the temperature increases. Still, after the temperature reaches 60°C, the amount of anthocyanins decreases because the temperature above 60°C the cells in the onion skin are damaged and degraded due to heat.

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The treatment of adding egg whites to the process of making Dayak onion powder does not affect changes in anthocyanin levels because egg whites function as foam formers to protect and prevent compounds from heat damage. Based on Ref [35], *foam mat drying* requires fillers that form foam and coat components and prevent heat damage. The addition of egg whites does not affect anthocyanin levels because egg whites serve as ingredients used to speed up drying and do not affect anthocyanin levels. Egg whites contain proteins that play a role in the formation of foam consisting of ovomucin, globulin, and ovalbumin where these ingredients are not ingredients that play a role in increasing anthocyanin levels but only as ingredients to speed up drying.

The addition of maltodextrin to powder manufacturing can protect the bound compounds so that anthocyanins can be retained. According to Ref. [36] maltodextrin is an encapsulant that can protect nutritional components including antioxidant activity and has strong binding power to coated compounds. The maltodextrin capsules wall can protect sensitive components such as antioxidant components, flavors, vitamins, colors, and other nutritional components.

4. CONCLUSION

The conclusions that can be drawn from the results and discussion include: (1) The treatment of adding egg whites and maltodextrin provides a significant interaction ($p \leq 0.05$) on the moisture content, phenol content, and solubility of Dayak onion powder. However, the treatment did not provide a significant interaction ($p \geq 0.05$) on ash content, antioxidant activity, and color (L, a*, and b*) of Dayak onion powder. (2) Dayak onion powder in the treatment of adding 8% egg white and 15% maltodextrin was the best treatment with a moisture content value of 7.32%; ash content 2.11%; antioxidant activity 51.08%; phenol levels of 3.37 mg GAE/g; solubility 46.65%; color analysis (L 54.03; a* 21.00; and b* 11.43); and color organoleptic score of 3.96 (quite red); aroma 3.36 (slightly scented of Dayak onions); texture 2.92 (slightly rough); flavonoid content 0.01%; and anthocyanin levels of 9.35 ppm.

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