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Characteristics of Purple Waxy Corn Yoghurt Powder (*Zea mays var ceratina kulesh*) With The Foam Mat Drying Method (Study of the Addition of Maltodextrin And Tween 80)

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A B S T R A C T

This study's main ingredient in making yogurt powder is purple waxy corn. This study studied the making of purple waxy corn yoghurt powder because it contains a lot of anthocyanins and antioxidants. To speed up the delivery process and maintain the viability of lactic acid bacteria and other heat-resistant compounds, it is necessary to add maltodextrin and tween 80. This study aimed to analyze the effect of the addition of maltodextrin and tween 80 on the characteristics of yogurt powder and determine the best treatment combination of these variations. The method used was a Complete Random Design (RAL) with a 3x3 setup, where Factor I was the amount of maltodextrin added (6%, 10%, 14%) and Factor II was the amount of tween 80 added (0.8%, 1%, 1.2%). We analyzed the obtained data using ANOVA, followed by a further DMRT test of 5%. The results showed a real interaction (p?0.05). Purple waxy corn yogurt powder with the addition of maltodextrin 14% and tween 80 1.2% is the best treatment that produces yogurt powder with a moisture content value of 3.66; ash content 0.5; solubility 88.03; viscosity 283; total dissolved solids 17.75; pH 4.56 total BAL 8.45 log. CFU/ml; antioxidant activity 65.25 and protein 0.39. The organoleptic characteristics yielded scores of 4.32 for color, 4.20 for texture, 4.04 for aroma, and 4.28 for taste.

Contribution to Sustainable Development Goals (SDGs):
SDG 3: Good Health and Well-Being
SDG 9: Industry, Innovation, and Infrastructure
SDG 12: Responsible Consumption and Production

1. INTRODUCTION

1.1. Research Background

According to BPOM (2018) on Food Consumption Rates, the daily consumption of fermented milk products, including yogurt, among Indonesians is approximately 155 grams per person. This consumption rate highlights the potential for developing new yogurt-based products. Traditionally, yogurt is made from animal-derived milk; however, individuals with lactose intolerance or allergies to animal milk may benefit from alternatives such as plant-based milk. One promising option is purple waxy corn milk, which is rich in anthocyanin pigments and offers both nutritional and functional benefits.

Purple waxy corn (*Zea mays var ceratina kulesh*) is a local food with a high anthocyanin content, acting as a natural antioxidant that is good for health. The use of purple waxy corn as the main ingredient in making yogurt provides an attractive natural purple color and can also increase the final product's nutritional value and selling value. In addition, the use of local ingredients is in line to empower domestic agricultural products.

The ease of consuming and storing food products makes drying technology one of the methods that can be chosen. The method chosen is foam mat drying. This method is an efficient drying technique for liquid products such as yogurt, with the

advantage of maintaining aroma, color, and nutritional content. In this process, foaming agents such as Tween 80 are used to form a stable foam, as well as maltodextrin as a coating agent to protect the bioactive components during the drying and storage process.

The use of maltodextrin and tween 80 is able to maintain the viability of lactic acid bacteria as well as senaywa which are not heat-resistant. Maltodextrin will be in charge of protecting the compound by forming a strong matrix around the solution during the drying process. The role of tween 80 is as a foaming material that will expand the surface area of the material at the time of drying, so that the drying time is relatively shorter.

1.2. Literature Review

Purple waxy corn has the same nutritional value as yellow corn and waxy corn, but its specialty is that it contains anthocyanins as antioxidants and anti-inflammatories [1]. The phenolic compounds of purple corn have the potential to be antioxidant, anti-inflammatory, anti-mutagenic, anti-cancer, and anti-angiogenesis. It can also prevent diseases due to the wrong lifestyle, such as obesity, diabetes, hyperglycemia, hypertension, and cardiovascular [2]. The anthocyanin content in purple corn is very high, namely 290 – 1323 mg/100g dry weight, and anthocyanin acylation 35 – 54 % [3].

Yogurt powder is a product of fermented milk, which is then further processed through the drying process. The yogurt drying process can be done, one of which is, by the foam mat drying method. Foam-mat drying is a drying technique with the formation of foam on liquid or semi-liquid materials, namely with the addition of foaming agents and stabilizers, as well as drying treatment at low temperatures around 50-75oC using ovens or cabinet dryers[4]. Foam drying helps transform liquid or semi-solid food into stable foam by working in conjunction with a foaming or stabilizing agent. This method is relatively easy and can be done at a low cost of spray drying and freeze-drying [5]. This method is suitable for samples of heat-sensitive, sticky, and viscous materials that cannot be dried by spray drying[6].

In the drying process of yogurt, it is necessary to add fillers. Commonly used fillers as encapsulants can be derived from gum, carbohydrates, and proteins such as skim milk, lactose, sucrose, maltodextrin, alginate, gum arabic, starch, agar, gelatin, carrageenan, albumin, and casein [7]. Maltodextrin is a coating that has the purpose of coating flavor components, increasing mass, accelerating the drying process, preventing damage to materials caused by heat and increasing solubility and organoleptic characteristics [8].

Tween 80 is an ester of sorbitan polyoxyethylene fatty acids, with the chemical name polyoxyethylene 20 sorbitan monolete and with the chemical formula C64H124O26. Sorbitan polyoxyethylene ether is commonly called a polysorbate. Tween 80 has a stable HLB 15 value in water and oil so it can be used as an emulsifier [9]. HLB (Hydrophyle Lypophyle Balance) is a number that shows the comparison between hydrophilic compounds (water-like) and oleophilic compounds (oil-like) [10]. Tween 80 in low concentrations cannot change the color, smell and taste of the product [11]. The use of tween 80 at a concentration of 0.4-1.0% can act as a driving agent for foam formation [12].

1.3. Research Objective

The purpose of this study was to analyze the effect of addition of maltodextrin and Tween 80 on the characteristics of yoghurt powder, and to determine the best treatment combination from these variations.

2. MATERIALS AND METHODS

2.1 Material

The ingredients used to make yogurt are purple waxy corn, skim milk, maltodextrin and tween 80, *L. bulgaricus, S. thermophilus,* and *Bifidobacterium bifidum* starters, and sugar. Materials for analysis include aquades, NaOH, HCI, $FeCl3.6H_2O$, MRS Agar, NaCl, phosphate (0.2 M pH6.6), Na K. tartarat 1%, Folin-Ciocalteau, Bovine Serum Albumin Solution.

2.2 Research procedures

The experimental design used in this study was a Completely Randomized Design (CRD) factorial pattern consisting of 2 factors, namely the use of maltodextrin and tween 80, each consisting of 3 levels of tween 80 differences (0.8%, 1%, and 1.2%) and maltodextrin (6%, 10%, and 14%) and had 2 replications. The data obtained were analyzed using ANOVA (Analysis of Variance) with a confidence interval/level of 5% to determine the presence of significant interactions between treatments. If there is a significant difference in the treatment, a further DMRT (Duncan's Multiple Range Test) test is carried out at a level of 5%.

2.3 Making a Starter

Yoghurt starter is made by inoculating 0.08 ml of Streptococcus thermophilus, Lactobacillus bulgaricus, and Bifidobacterium bifidum cultures into 2.5 ml of MRS broth and fresh cow's milk that has been pasteurized beforehand. Incubate at 37°C for 24 hours. The lactic acid bacteria count of the resulting yohurt starter is done using the total plate count using mrs agar method.

2.4 Making Purple Waxy Corn Juice

Peel the purple waxy corn and wash it clean. Clean corn kernels are then ground using a blender with a ratio of purple waxy corn : water of 1: 3, then strain. The purple waxy corn juice is then left to settle for 1 hour to separate the corn juice from the starch.

2.5 Making Purple Waxy Corn Yogurt

100 ml of purple waxy corn extract is put into a sterile container, then added with skim milk with a concentration of 10% (w/v) and 10% sugar (w/v). Homogenize until mixed, then pasteurize at 80°C for 15 minutes. The mixture of skim milk and purple waxy corn extract is then cooled to 40°C and inoculated with 10% (v/v) yoghurt starter. The ingredients that have been mixed with the starter are then incubated at 37°C for 24 hours. Each of these ingredients is repeated 2 times. The yoghurt that has been formed is then analyzed for total lactic acid bacteria, acidity (pH), viscosity, and total dissolved solids.

2.6 Making Purple Waxy Corn Yoghurt Powder

Liquid yogurt was added with maltodextrin with concentrations of 6%, 10%, and 14% (w/v) and tween 80 with concentrations of 0.8%, 1%, and 1.2% (v/v). Homogenize with a mixer at low speed for 10 minutes until stable foam is formed. The mixed ingredients were poured onto a baking sheet lined with baking paper and dried using a cabinet dryer at a temperature of 55°C and a drying time of 5 hours. The dried yogurt was then blended and sieved

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using an 80 mesh sieve. The formed yoghurt powder was analyzed for water content, ash, acidity (pH), total lactic acid bacteria, viability of lactic acid bacteria, solubility, viscosity, total soluble solids, resistant starch content for the best treatment yogurt powder, and organoleptics.

3. RESULT AND DISCUSSION

3.1. Physicochemical Characteristics of yoghurt powder

Table 1. Analysis results of water content, ash content, solubility, and viscosity of yoghurt powder

Treatment	Water content	Ash content	Solubility	Viscosity
M1T1	4.87	1.75	85.32	246.00
M1T2	4.70	1.64	85.43	250.00
M1T3	4.65	1.53	85.71	257.00
M2T1	4.57	1.45	85.97	263.00
M2T2	4.35	1.23	86.38	269.00
M2T3	4.13	1.01	87.75	271.00
M3T1	3.92	0.75	87.23	278.00
M3T2	3.75	0.65	87.49	280.00
M3T3	3.66	0.50	88.03	283.00

Description :
M1T1 : Maltodekstrin 6%. tween 80 0.8%
M1T2 : Maltodekstrin 6%. tween 80 1.0%
M1T3 : Maltodekstrin 6%. tween 80 1.2%
M2T1 : Maltodekstrin 10%. tween 80 0.8%
M2T2 : Maltodekstrin 10%. tween 80 1.0%
M2T3 : Maltodekstrin 10%. tween 80 1.2%
M3T1 : Maltodekstrin 14%. tween 80 0.8%
M3T2 : Maltodekstrin 14%. tween 80 1.0%
M3T3 : Maltodekstrin 14%. tween 80 1.2%

Water content showed that the higher the addition of maltodextrin and Tween 80, the lower the water content. This is caused by the maltodextrin with modified starch molecules increases the amount of dry solids in the material, thereby reducing the water content [13]. The foam produced by tween 80 causes the surface area of the material to increase and provides a porous structure to the material so that it will accelerate the drying process because the transportation system is accelerated in removing water contained in the material during the evaporation process. With this, the resulting water content will be lower[14].

Ash content showed that the higher the addition of maltodextrin and Tween 80, the lower the ash content. maltodextrin and tween 80 do not contain minerals. Maltodextrin has no mineral content of the substance. The addition of maltodextrin to materials containing high minerals will lead to a decrease in the mineral content of the final product [11]. When Tween 80 is added in large quantities, the percentage of mineral-rich ingredients becomes smaller and smaller in the overall mixture. This causes the mineral concentration of the final product to decrease. Maltodextrin and tween 80 have no mineral content. This makes the addition of maltodextrin and tween 80 not cause an increase in the ash content of the product, so that the more maltodextrin and tween 80, the amount of ingredients in the product decreases causing the ash content to decrease [15]

Solubility showed that the higher the addition of maltodextrin and tween 80 causes the solubility of yogurt powder. This is because maltodextrin is a filler that has a high solubility level, this is because the nature of maltodextrin is soluble in water and has a fast dispersion process [11]. Tween 80 has a high HLB (Hydrophilic Lipophilic Balance) of 15, so it will facilitate the dissolution of components to dissolve in water. Semakin besar harga HLB berarti semakin banyak kelompok senyawa yang suka air [4].

Viscosity showed that the higher the addition of maltodextrin and Tween 80, the higher the viscosity. Maltodextrin has the property of being able to bind to hydrophobic substances, in addition maltodextrin is an oligosaccharide that is easily soluble in water, so it can form a homogeneously dispersed solution. The higher the concentration of maltodextrin, the more molecules in the solution, the greater the friction between the molecules, and the greater the viscosity of the product[16]. Tween 80 in the manufacture of powdered drinks functions as an emulsifier that unites the water phase and the oil phase due to the shaking process, causing the powdered drink to have a thick nature[17].

Table 2. Analysis results of TPT, pH, total BAL, antioxidant, protein of yoghurt powder

Treatment	TPT	pH	Total BAL	Antioxidant	Protein
M1T1	15.50	3.76	8.21	54.61	0.31
M1T2	15.65	3.84	8.27	55.33	0.32
M1T3	15.7	3.89	8.33	59.74	0.32
M2T1	16.45	4.10	8.35	59.64	0.34
M2T2	16.50	4.15	8.37	60.12	0.35
M2T3	16.80	4.20	8.38	62.19	0.37
M3T1	17.20	4.39	8.42	60.42	0.38
M3T2	17.65	4.44	8.43	63.55	0.38
M3T3	17.75	4.56	8.45	65.25	0.39

Total dissolved solid showed the higher the addition of maltodextrin and tween 80 causes the higher total dissolved solid. Maltodextrin increases the total dissolved solids because the substance is composed of free hydroxyl groups that can bind to water so that it is easily soluble in water[18]. The presence of free hydroxyl groups from oxyethylene in tween 80 causes tween 80 to be able to bind water, so that the solubility and total dissolved solids also increase [19]. Tween 80 has hydrophilic properties that easily bind water. The longer the drying time is related to the decreasing water content of the evaporated product so that the total solids are higher [20].

The pH value tends to increase as the concentration of maltodextrin added increases. This is because maltodextrin has a pH of 5.3, causing an increase in the pH value if the concentration of maltodextrin added increases [21]. Tween 80 does not affect the pH directly, because it is neutral. Tween 80 is added to function as a foaming agent that will accelerate the drying process [22].

Total lactic acid bacteria showed the higher the addition of maltodextrin and tween 80 causes the higher of total lactic acid bacteria. The higher the coating concentration, the encapsulation efficiency increases, the shell layer is better and stronger, so that it can protect the core material well and protect volatile substances during the drying process [23]. Adding a foaming agent can facilitate the structure of the material to become more hollow and open, so that the temperature used is relatively lower and the drying time is shorter [24].

Antioxidant activity showed the higher the addition of maltodextrin and tween 80 causes the higher of the antioxidant activity. The use of maltodextrin will prevent damage or reduction of antioxidants from within natural ingredients by forming a film layer around the powder, the higher the addition of maltodextrin, the higher the antioxidant components that can be protected [25]. Tween 80 in certain concentrations can

function as a driver of foam formation, in the form of foam the surface of the particles enlarges and can accelerate drying [26].

Protein showed the higher the addition of maltodextrin and tween 80 causes the higher of protein. Maltodextrin acts as a protective agent of protein. So that it can reduce denaturation of proteins. Maltodextrin is a modified starch product produced from the hydrolysis of starch by the enzyme α amylase which has the ability to protect the material it coated [27]. Adding a foaming agent can facilitate the structure of the material to become more hollow and open, so that the temperature used is relatively lower and the drying time is shorter [24].

3.2. Organoleptic Characteristics of yoghurt powder

Table 3. Organoleptic of yoghurt powder

Treatment	Tekstur (%)	Warna (%)	Rasa (%)	Aroma (%)
M1T1	1.80	1.71	3.76	3.68
M1T2	1.96	2.00	3.6	3.72
M1T3	2.04	2.36	3.8	3.72
M2T1	2.48	2.48	3.68	3.76
M2T2	2.64	2.84	3.84	3.8
M2T3	3.36	3.36	3.8	3.92
M3T1	3.60	3.80	3.88	4.04
M3T2	3.72	4.08	3.72	4.04
M3T3	4.20	4.32	4.28	4.04

The results of the organoleptic test of the texture of yogurt powder showed a significant interaction ($p \leq 0.05$) between the treatment of adding maltodextrin and tween 80. The highest texture value (4.20) was found in the treatment of adding maltodextrin 14% and tween 80 1.2%. Maltodextrin is able to produce a fairly good texture in instant products, the more maltodextrin is added, the thicker the product will be [28]. The addition of Tween 80 in the manufacture of powdered drinks serves as an elmusifier that unites the water phase and the oil phase due to the shaking process so that the powdered drink has a thick nature [17].

The results of the organoleptic test of the texture of yogurt powder showed a significant interaction ($p \leq 0.05$) between the treatment of adding maltodextrin and tween 80. The highest color value (4.32) was found in the treatment of adding maltodextrin 14% and tween 80 1.2%. Purple waxy corn contains anthocyanins that are highly susceptible to high temperatures, so maltodextrin helps stabilize them so that the purple color remains bright after being powdered. Maltodextrin can function to reduce non-enzymatic browning reactions in a powder product [29]. The use of Tween 80 results in a faster and more efficient drying time, and can maintain the color and aroma quality of tomatoes, which is important for heat-sensitive compounds [30].

The results of the organoleptic test of yogurt flavor powder showed no significant interaction ($p \geq 0.05$) between the treatment of adding maltodextrin and tween 80. The treatment of adding maltodextrin 14% and tween 80 1.2% resulted in the highest number of rankings according to the panelists of 158. This treatment received an average score of 4.28. The average of 4.28 is classified as a "like" according to the panelists. This is because tween 80 does not have a flavor that can affect the original taste of yogurt [31]. The addition of 5 to 15% maltodextrin does not have a significant effect on the taste of the instant drink produced. It is known that maltodextrin contains no more than 20% sugar [32].

The results of the organoleptic test of the aroma of yogurt powder showed that there was no significant interaction ($p \geq 0.05$) between the treatment of adding maltodextrin and tween 80. The aroma of purple waxy rice powder yogurt tends to smell fresh and sour like the aroma of yogurt in general. This acidic aroma comes from the fermentation of lactic acid by lactic acid bacteria. Tween 80 has no significant odor and does not directly affect the product's scent. Maltodextrin is an odorless filler. The addition of tween 80 at a low concentration does not affect the aroma of a product. In addition, the addition of maltodextrin also has no effect on the aroma of yoghurt powder [31].

4. CONCLUSION

There was a significant interaction ($p \leq 0.05$) between the treatment addition of maltodextrin and tween 80, moisture content, ash content, solubility, viscosity, total dissolved solids, total lactic acid bacteria, antioxidant activity, and protein content of yoghurt powder. Meanwhile, there was no real interaction on pH of yoghurt powder. This treatment has a significant effect on the color, and texture but has no real effect on the aroma and taste of yoghurt powder. Purple waxy corn powder yogurt with the addition of maltodextrin 14% and tween 80 1.2% is the best treatment that produces yogurt powder with a moisture content value of 3.66; ash content 0.5; solubility 88.03; viscosity 283; total dissolved solids 17.75; pH 4.56 total BAL 8.45 logs. CFU/ml; antioxidant activity 65.25 and protein 0.39%, and the organoleptic characteristics of color score (4.32), texture score (4.20), aroma 4.04 (like), and taste 4.28 (like).

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