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The Effect of Maltodextrin Concentration and Spray Dryer Drying Temperature on the Characteristics of Coconut Milk Powder

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A B S T R A C T

Coconut milk has a higher water content than other contents, so microbes can easily damage and spoil it. To obtain a low-moisture powder product, the liquid coconut milk was dried using a Buchi Mini Spray dryer B-290 with inlet temperatures of 150°C, 160°C, and 170°C. The researchers added maltodextrin to coconut milk, which had a ratio of grated coconut to the water of 1:3, in concentrations of 9%, 10%, 11%, 12%, and 13%. The addition of maltodextrin and the use of drying temperature did not significantly affect the pH, solubility, and percentage of product mass but did significantly affect the moisture content. The best operating conditions for producing coconut milk powder were at a maltodextrin concentration of 13% and a temperature of 170°C. Under these conditions, the produced coconut milk powder had a pH value of 6.12, a moisture content of 4.56%, a solubility of 98.74%, a product mass of 24.99 grams and an overall percentage of product mass of 21.32%.

INTRODUCTION

Coconut (Cocos nucifera L.) is one of the easily found plants in tropical regions such as Indonesia and has many benefits for human survival. Indonesia's coconut production increased to 2.85 million tons in 2021 [1]. The value increased by 1.47% from the previous year. Coconut trees can produce various processed products, including coconut milk. Coconut milk products usually are used on a household scale.

Coconut milk has a higher water content than other contents, so microbes can easily damage and spoil it [2]. One solution to overcome the weakness of liquid coconut milk is to make a coconut milk powder product. Coconut milk in powder has a low moisture content, resulting in a longer shelf life. People use a spray dryer to obtain coconut milk powder. In the spray dryer, the feed in the form of liquid will be changed into droplets and dispersed with the help of hot air, so the water content in the droplets will evaporate and produce fine particles in the form of powder [3], [4], [5].

People often add filler materials to produce powder products to reduce the tendency of particles to adhere to the walls of the drying equipment. Maltodextrin can be used as a filler material [6], [7]. Maltodextrin is an additive substance that thickens food materials, increases volume, and preserves products. Coconut milk powder without filler has a low yield value, clumps, yellowish white colour, and sticks to the drying equipment. Expectations are that the addition of maltodextrin in the production of coconut milk powder will facilitate the drying process and improve the characteristics of the coconut milk powder [8], [9]. People need to consider the level of filler material in the form of maltodextrin, as it can impact the characteristics of the resulting product. Determining the amount of maltodextrin is necessary to produce good characteristics in coconut milk powder.

The researchers conducted the drying process of coconut oil into coconut milk powder using a spray dryer with an inlet temperature of 130°C and variations of maltodextrin concentration of 8%, 10%, and 12% [8]. Researchers obtained the best

characteristics of coconut milk powder using 12% maltodextrin with a moisture content of 8.42%.

Using a spray dryer, researchers also studied the impact of maltodextrin concentration on coconut milk powder's moisture content and solubility time. The operating condition is an inlet temperature of 150°C and with maltodextrin concentration variations of 2%, 4%, 6%, 8%, and 10% [10]. Researchers achieved the lowest water content of 6% by using 10% maltodextrin.

To determine its water content, the researchers studied the effect of temperature on spray drying using coconut milk powder with a 10% maltodextrin concentration [3]. The inlet temperature variations used were 110°C, 120°C, and 130°C. The study found that the temperature in the spray dryer influences the moisture content of coconut milk powder, achieving the lowest moisture content of 7% occurred at 130°C.

The maximum moisture content for coconut milk powder in the Indonesian National Standard Design Concept (RSNI) is 5% [11]. The moisture content plays a significant role in coconut milk powder's shelf life and solubility. According to previous research conducted by scientists, the moisture content obtained in coconut milk powder still needs to meet standards. Therefore, the proper operating conditions are necessary to achieve the desired characteristics. The temperature in the spray dryer can affect the moisture content, with a drying temperature of 140°C providing the highest yield of 7.66% [3]. Based on many reasons mentioned above, this study aimed to investigate the impact of maltodextrin concentration and inlet temperature on the characteristics of the resulting coconut milk powder.

METHODS

Materials and equipments

The raw materials used were grated coconut obtained from the Sarijadi market, mineral water, and maltodextrin. The equipment used was a Buchi Mini Spray Dryer B-290 (**Figure 1**), an oven, a universal pH meter, and a pH meter.

Figure 1. *Buchi Mini Spray Dryer B-290*

The steps of the research implementation are summarized in **Figure 2**.

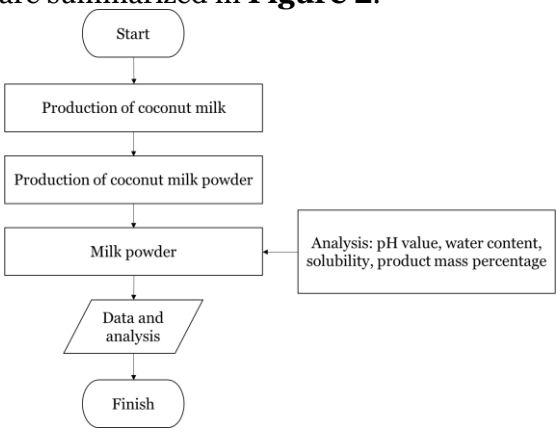

Figure 2. Research Steps

Production of coconut milk powder

The grated coconut and hot water were mixed at a ratio of 1:3 to make liquid coconut milk, and then homogenization and filtration were performed. The filtration process separated the coconut milk (filtrate) and the coconut residue. The obtained coconut milk was left to stand for one hour, and the coconut milk would separate into two layers, the fatty layer (cream) and the bottom layer, which is the water-rich phase (skim). The production of coconut milk powder uses skim. The obtained skim added with maltodextrin at varying concentrations of 9%, 10%, 11%, 12%, and 13%. A stirrer was used for homogenization to speed up the contact between the skim coconut milk and maltodextrin. The spray dryer receives the mixed solution. The variations of the dryer

inlet temperature were 150°C, 160°C, and 170°C.

The pH value analysis

The researcher used a pH meter and a universal pH paper indicator to conduct the analysis. The pH analysis of the powdered coconut milk product was taken as much as 3 grams and then dissolved in 18 ml of water (based on recommendations for using commercial products). The RSNI concept for coconut milk products requires the quality of coconut milk to have a neutral pH with a minimum of 5.9 [11].

The water content analysis

According to SNI 01-2891-1992, the water content test is performed by weighing a 2-gram sample and placing it in a dried crucible cup. The heating process was repeated in an oven at 105°C for 30 minutes and then weighed until they achieved a constant weight. Equation (1) does the calculation of water content.

$$Water\ content\ = \frac{(a-b)}{a} x\ 100\% \quad (1)$$

with:

a = Weight of powdered coconut milk before drying in the oven (grams)
b = Weight of powdered coconut milk after drying in the oven (grams)

The solubility analysis

The analytical method begins by mixing the coconut milk powder weighing 0.75 grams (a) with 100 ml of hot water at 80°C [12]. A magnetic stirrer can homogeneously stir the mixed solution. Then the solution was filtered using a vacuum pump with dried filter paper. Residues that do not dissolve will be trapped on filter paper and then dried in an oven at 105°C for 30 minutes. This drying process is continued to obtain a constant weight (c). Equation (2) does the calculation of solubility.

$$Solubility\ = \left(1 - \left(\frac{c-b}{a}\right)\right) x\ 100\% \qquad (2)$$

with:

a = Weight of powdered coconut milk before drying in the oven (grams)
b = Weight of powdered coconut milk after drying in the oven (grams)
c = The constant weight of powdered coconut milk after being dissolved and dried (grams).

The product mass percentage analysis

The mass percentage of the product shows the number of products produced from the raw materials used. Weighing the grated coconut and the coconut milk product yields the percentage product weight. Equation (3) does the calculation of the mass percentage of the product.

$$Product\ mass\ percentage = \frac{a}{b} x\ 100\% \quad (3)$$

with:

a = Weight of powdered coconut milk (gram)
b = Weight of grated coconut (gram)

RESULTS AND DISCUSSIONS

The pH value analysis

Table 1 shows the results of the pH value analysis of powdered coconut milk products.

Table 1. pH value of powdered coconut milk

Maltodextrin	Temperature		
	150°C	160°C	170°C
9%	6.07	6.11	6.61
10%	6.01	6	6
11%	6.43	6.42	6.47
12%	6.36	6.34	6.39
13%	6.18	6.2	6.12

From the data in Table 1, the addition of maltodextrin concentrations showed the highest pH value at a concentration of 11%. At a concentration of 10%, the pH value is the lowest. The pH values lie from 6.00 to.d. 6,47. Maltodextrin comes from oligosaccharides, which contain many hydroxyl groups (OH), so they can neutralize the acidic nature of the raw material [13].

Statistical analysis of the pH data (Table 2) shows a p-value of 0.74. Statistically, the p-value > 0.05 indicates that the data obtained has no significant difference. The p-value shows that the concentration value of maltodextrin does not affect the pH value of coconut milk

powder.

Table 2. Significance test result of pH value data

Statistical Test	Value
Mean	6.21
Variance	0.0328
Pearson Correlation	0.9919
Hypothesized Mean Difference	0
df	4
t Stat	-0.3563
P(T<=t) two-tail	**0.7395**
t Critical two-tail	2.7764

The water content analysis

The water content in an ingredient can determine the shelf life of a product. The low moisture content has good physical and chemical stability and extends the shelf life [11]. The results of the water content analysis can be seen in Table 3.

Table 3. The water content of powdered coconut milk

Maltodextrin	Temperature		
	150°C	160°C	170°C
9%	5.863	5.743	5.563
10%	5.65	5.63	5.543
11%	5.421	5.585	5.474
12%	5.312	5.143	4.92
13%	5.197	4.949	4.563

Based on the data obtained, the addition of maltodextrin concentration affects the water content of coconut milk powder. The higher the maltodextrin concentration added, the lower the water content value. The phenomenon happens because maltodextrin can increase the total solids in the material to be dried. The results fit with [14] that the greater the use of added maltodextrin, the lower the water content contained in coconut milk powder.

The inlet temperature in the spray drying process also affects the moisture content of coconut milk powder. The higher the inlet temperature used, the lower the water content value. The higher the inlet temperature of the drying process, the faster the evaporation process will occur [15]. The results fit with [3] that the higher the drying temperature, the less water content in the coconut milk powder product will decrease.

Statistical analysis of the water content data (Table 4) shows a p-value of 0.02. Statistically, the p-value < 0.05 indicates that the data obtained significantly differ. The p-value shows that the maltodextrin concentration significantly affects the water content of coconut milk powder.

Table 4. Significance test result of water content data

Statistical test	Value
Mean	5.2126
Variance	0.2019
Pearson Correlation	0.9904
Hypothesized Mean Difference	0
df	4
t Stat	-3.7244
P(T<=t) two-tail	**0.0203**
t Critical two-tail	2.7764

Judging from the data obtained, the use of maltodextrin concentration and drying temperature affected the water content of the coconut milk powder produced. The lowest water content of 4.56% happened in the variation of 13% maltodextrin and the drying temperature of 170°C.

The solubility analysis

Table 5 shows the solubility percentage for variations in maltodextrin concentration and temperature.

Table 5. Solubility value of powdered coconut milk

Maltodextrin	Temperature		
	150°C	160°C	170°C
9%	98.45	99.02	98.19
10%	98.38	98.17	98.72
11%	98.16	98.05	98.55
12%	98.24	98.11	98.84
13%	98.89	98.21	98.74

Statistical analysis of the solubility data for coconut milk powder (Table 6) shows a p-value of 0.36. Statistically, the p-value > 0.05 indicates that the data obtained have insignificant differences. The p-value shows that the concentration of maltodextrin affects the solubility of coconut milk powder, but not significantly.

Table 6. Significance test result of solubility data

Statistical test	Value
Mean	98.312
Variance	0.16032
Pearson Correlation	-0.87110172
Hypothesized Mean Difference	0
df	4
t Stat	-1.040964
P(T<=t) two-tail	**0.356672**
t Critical two-tail	2.77644510

The higher concentration of

maltodextrin added did not show an increase or decrease in the solubility of the coconut milk powder product. This phenomenon differs from [8] that the higher concentration of maltodextrin added will cause higher solubility of coconut milk powder. That is because maltodextrin has high solubility properties. However, in this study, maltodextrin worked according to its properties, having a high solubility in water with a solubility percentage value ranging from 98% to 99%.

The product mass percentage analysis

Table 7 shows the mass percentage of powdered coconut milk products

Table 7. Mass percentage of powdered coconut milk

Maltodextrin	Temperature		
	150°C	160°C	170°C
9%	16.8173	17.915	17.913
10%	18.9118	19.01	19.892
11%	19.384	20.88	22.0899
12%	23.211	23.4714	23.695
13%	25.719	25.9121	24.988

Statistical analysis of product mass data (Table 8) shows a p-value of 0.077. Statistically, the p-value > 0.05 indicates that the data obtained have insignificant differences. The p-value shows that the concentration of maltodextrin affects the mass of coconut milk powder, but the effect is insignificant.

Table 8. Significance test result of mass percentage data

Statistical test	Value
Mean	21.1231
Variance	10.5778
Observations	10
Pearson Correlation	0.9793
Hypothesized Mean Difference	0
df	9
t Stat	-1.9956
P(T<=t) two-tail	**0.0771**
t Critical two-tail	2.2621

The higher the concentration of maltodextrin added, the increased mass of the product obtained. The phenomenon can happen because maltodextrin is a filler that can increase the number of total solids produced. The results obtained show agreement with the results of [16] that the higher the concentration of maltodextrin used, the greater the mass of the product produced. When maltodextrin is not present, the particles formed are small enough to be carried by air.

In addition, the temperature used can affect the mass of coconut milk powder produced. The higher the inlet temperature, the higher the percentage of product mass. These results fit the study [16] that the higher the inlet temperature of the spray dryer, the more product produced will be drier and will not stick to the drying chamber, so the coconut milk powder produced will be more abundant at high drying temperatures.

Determination of the Best Operating Conditions

The best operating conditions within the range of parameter variations studied were 13% maltodextrin concentration and 170°C temperature. Under these conditions, coconut milk powder products have a pH value of 6.12; water content of 4.56%; solubility of 98.74%; product mass of 24.99 grams; and a mass percentage of the overall product is 21.32%. This operating condition can be declared the best because it produces powdered coconut milk products with a pH value of 5,9, above the quality requirements for the Coconut Milk Product RSNI Concept, and a maximum water content value of 5%. The percentage solubility value close to 100% indicates the ease with which the product dissolves in water when consumed. Commercialization opportunities need to be studied further.

CONCLUSION

The addition of maltodextrin and the use of drying temperature did not significantly affect the pH value, solubility, and mass percentage of the product but significantly affected the water content. The best operating conditions for making coconut milk powder were at a concentration of 13% maltodextrin and a temperature of 170°C. Under these conditions, powdered coconut milk products have a pH value of 6.12, a water content of 4.56%, a solubility of 98.74%, a product mass of 24.99 grams and a total product mass percentage of 21.32%.

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