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Effect of Maltodextrin Concentration on Physical Characteristics of Strawberry Extract That May Prevent COVID-19 in the Elderly

Pengaruh Konsentrasi Maltodekstrin terhadap Karakteristik Bubuk Stroberi yang Berpotensi Mencegah COVID-19 pada Lansia

Mia Srimiati[1]*, Annisa Dinya Zahra[1], Febry Harsanti[1], Putri Habibah[1], Alfisah Ratu Maharani[1]

[1]Program Studi Gizi, Fakultas Ilmu Kesehatan dan Teknologi, Universitas Binawan, Jakarta, Indonesia

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****Correspondent:***
Mia Srimiati
mia@binawan.ac.id

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ABSTRACT

Background: The strawberry is an antioxidant-rich fruit with the potential to prevent COVID-19, especially in the elderly. However, the fruit's high-water content makes it susceptible to decay and diminishes its quality. Product diversification into instant powder with a spray drying method and the addition of maltodextrin is one possible solution.
Objectives: The purpose of this study is to examine the effect of maltodextrin concentration on the physical properties of strawberry powder produced by spray drying.
Methods: The experimental study employed a completely randomized design and three maltodextrin concentrations: P1 (20%), P2 (25%), and P3 (30%). Organoleptic data were gathered using a questionnaire with a 1 to 9 hedonic scale scoring method. 35 students from the sixth and eighth semesters of Nutrition at Binawan University served as panelists.
Results: The addition of maltodextrin to strawberry powder significantly altered the powder's flavor, aroma, texture, and color. The solubility test revealed that the strawberry powders P1, P2, and P3 were water-soluble. The selected strawberry powder contained 5.08% moisture, 1.05% ash, 1.13% protein, 0.02% fat, and 92.73% carbohydrates, according to approximative analysis results. The results revealed that the antioxidant levels of P1 (20%), P2 (25%), and P3 (30%) were 7.95 ppm, 8.07 ppm, and 8.36 ppm, respectively.
Conclusions: When added, maltodextrin at a concentration of 30% produces the best possible physical properties.

INTRODUCTION

Coronavirus or COVID-19 is an RNA virus that causes severe respiratory syndrome in humans. In December of 2019, COVID-19 was first identified in Wuhan, China. As of January 16, 2022[1], there were approximately 326.279.424 confirmed cases of COVID-19 worldwide, including 5.536.609 deaths, and the numbers continue to rise. As of January 17, 2022[2], there were 4.272.421 confirmed cases in Indonesia, which continues to experience an increase of 0.2%, or 170 active cases. The elderly group is one of the groups with the highest risk of being affected by COVID-19. The mortality rate among COVID-19-exposed elderly was 46.8%. If a patient has a comorbid condition, the COVID-19-caused mortality rate will be even higher. The comorbid disease is a comorbid condition that can increase the mortality risk of elderly COVID-19 patients[3]. Age-related declines in body function and endurance cause this. The urgent need to protect the elderly population, who are more vulnerable to the virus due to age-related declines in body function and endurance, calls for an exploration of effective preventative measures.

Adopting a healthy lifestyle, such as consuming more fruits and vegetables, can contribute significantly to strengthening immunity[4]. Fruit can protect and maintain the body's immunity during a pandemic. This is a result of the high levels of antioxidants and vitamin C, which help maintain the body's defenses[5]. Strawberry (*Fragaria x ananassa*) is a fruit that is widely consumed, particularly in Indonesia, due to its high antioxidant content. In the year 2020, 8.350 tons of strawberries will be produced. In 2019, the total production of strawberries increased by 10.17% to 7.501 tons[6].

Strawberry is rich in antioxidants, flavonoids, phenolic compounds, and vitamin C[7]. Strawberries have a high economic value in addition to their high nutritional content. However, strawberries have a high-water content, making them susceptible to rot and quality loss due to the influence of shelf life or storage conditions[8]. To extend the product's shelf life, it is possible to diversify it into powder form. The drying method can be utilized to

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produce strawberry powder. One potential solution to this problem is to diversify strawberries into a powder form using the spray drying method. This process not only extends the shelf life of the fruit but also makes it more widely available for consumption such as instant pudding[9] and cookies, offering protection against COVID-19, especially for the elderly population. The spray drying technique involves spraying food in the form of fine dispersions into a hot air stream and often requires a filler, such as maltodextrin[10]. Maltodextrin accelerates the drying process, prevents heat damage, and encapsulates the product's constituents effectively[11]. According to several studies, the encapsulation efficiency of maltodextrin can increase with the use of high maltodextrin concentrations, thereby protecting the product's constituents more effectively. However, if the concentration is too high, it can also cause the suspension to become viscous, making atomization difficult[12,13]. Considering the urgency, severity, and growth of the COVID-19 pandemic, this study aimed to examine the influence of maltodextrin concentration on the spray drying method for producing nutrient-rich strawberry powder with optimal physical properties. By enhancing the stability and availability of strawberries, this research contributes to the development of preventative measures to protect the elderly and other high-risk groups from the adverse effects of COVID-19.

METHODS

This experiment utilized a simple Completely Randomized Design (CRD) to determine the highest quality strawberry powder. This research comprises the following steps: 1) formulation of a strawberry solution; 2) the spray-drying process; 3) the solubility and antioxidant tests; 4) the organoleptic test; and 5) the proximate analysis of the selected treatments obtained from the organoleptic test. In this study 100 grams of fresh strawberries were used and three concentrations of maltodextrin were added for each treatment: P1 (20% maltodextrin concentration), P2 (25% maltodextrin concentration), and P3 (30% maltodextrin concentration).

The equipment used for the strawberry drying process included a spray drying machine, digital scale, blender, 80-mesh sieve, oven, desiccator, thermometer, stopwatch, cup, and filter. The analysis equipment consists of a single-screw extruder, a cup, a distillation apparatus, a measuring flask, a test tube, a dropper, a spectrophotometer, an erlenmeyer, an oven, an analytical balance, a vacuum pump, a set of supporting glassware, and organoleptic test equipment. In this study, fresh strawberries were used as the material to be dried and maltodextrin was used as a filler in the spray drying machine. Maltodextrin is used as a filler in the spray drying process.

This study utilizes primary data including yield data, physical characteristics data including organoleptic and solubility tests, proximate data including ash content (AOAC method), moisture content (oven method), protein content (Kjeldahl method), fat content (Soxhlet method), and carbohydrates (by difference method), as well as antioxidant content data (DPPH method). The organoleptic test employed an existing questionnaire with a 1 to 9 hedonic scale scoring method, ensuring its suitability for the food characteristics under examination. From laboratory results, approximate data, solubility, and antioxidant levels were obtained. The panellists for the organoleptic test consisted of students at Binawan University majoring in Nutrition, who were expected to possess adequate knowledge about sensory properties and food analysis. A purposive sampling method was employed to select 35 panellists from this population. These panellists were semi-trained, consisting of sixth and eighth-semester Nutrition students who had completed the Food Technology and Nutrition course and had been trained to determine certain sensory properties. The chosen sample size and respondent profile were considered appropriate to ensure a diverse range of sensory perceptions and provide relevant, informed feedback on the strawberry powder's organoleptic properties[14]. The validity and reliability of each analysis method were ensured through adherence to standard procedures and the use of established methods[15].

Microsoft Excel 2010 and statistical data processing software using analysis of variance (ANOVA) were used to process the obtained data. The results of organoleptic tests were examined for normality using the Kolmogorov Smirnov test, followed by the Kruskal Wallis test and the Mann Whitney test. The Health Research Ethics Committee, Faculty of Medicine, University of Indonesia - Dr. RSUPN. Cipto Mangunkusumo has granted ethical approval for this study (KET-636/UN2.F1/ETIK/PPM.00.02/2022).

RESULTS AND DISCUSSION

The Strawberry Powder Organoleptic Test

According to Table 1's hedonic test results, P3 obtained the highest acceptability value for the color aspect, which was 7.74 (like), while P1 obtained the lowest preference value[5] (somewhat like). According to the results of the Kruskal-Wallis test, the strawberry powder product affected the color quality. The hedonic quality test (Table 2) reveals that the strawberry powder products P1 and P2 have a reddish-white color, whereas P3 has a slightly reddish color. The red color of strawberries is caused by anthocyanins, which produce a large amount of pigment. Because anthocyanins are not stable at high temperatures, the presence of high temperatures can result in color changes. This is what causes the red color to transform into a slightly red hue. Maltodextrin can be used to maintain anthocyanin substances to maintain wakefulness. If the anthocyanins are stable, the color will not fade, and it will have no effect on the powder's color loss[11].

According to Table 1's hedonic test results, P3 is the highest preference value for the aroma quality, while P1 is the lowest (slightly disliked). The results of the Kruskal-Wallis test indicated that the strawberry powder had an impact on the aroma quality. The hedonic quality test in Table 2 reveals that P2 has a weak strawberry aroma and P3 has a fairly strong strawberry aroma, whereas P1 does not have a strawberry aroma. During the drying process, oxidation causes the loss of volatile and thermosensitive compounds, such as aromatic and phenolic compounds[16], resulting in a reduction in the

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aroma. Fragrance can be produced by the volatile compounds and essential oils in strawberries. Therefore, volatile oxidation occurring during the drying process may be responsible for the loss of strawberry aroma. In this case, maltodextrin is required to protect volatile substances that are sensitive to oxidation so that they can be maintained[17].

In Table 1, the hedonic test results for the taste aspect reveal that P3 has the highest preference value for the taste aspect, 7.09 (likes). P2 obtained the lowest preference value with a value of 4.51. (Slightly disliked). The results of the Kruskal-Wallis test indicated that the strawberry powder product affected the flavor quality. According to Table 2's hedonic quality test results, P1 has a very sour flavor, while P2 and P3 have a slightly sour flavor. The sour flavor of strawberries is caused by their acid content. Thus the use of spray drying with low levels of maltodextrin can affect changes in the taste of strawberries to be more sour.According to research by Sobulska et al.[18], one of the disadvantages of using a spray drying machine is that it can influence the flavor changes of a food product.

According to the outcomes of the hedonic test (Table 1), P3 has the highest acceptability value for texture, which is 7.26 (likes). P1 obtained the lowest acceptability value with a value of 4.66 (rather dislike). The results of the Kruskal-Wallis test indicated that the strawberry powder product affected the texture characteristic. According to Table 2's hedonic quality test, strawberry powder products P2 and P3 have a slightly softer powder texture. For strawberry powder, P1 has the texture of the strawberry powder, which is slightly coarse. The powder's texture is consistent with the findings of Sadowska et al.[19], which indicate that spray-dried powder products have the softest or smoothest texture. According to Agustina et al.[20], maltodextrin-produced powder has a fine texture that spreads evenly. This is because maltodextrin can maintain the product's texture and interact with water to create a powder with a soft, stable texture at high temperatures.

Table 1. The Results of Strawberry Powder Hedonic Test

Treatments	Aspect			
	Color	Aroma	Taste	Texture
P1 (20%)	6.49 ± 1.269[a]	4.77 ± 1.165[a]	4.86 ± 1.309[a]	4.66 ± 1.305[a]
P2 (25%)	6.71 ± 1.017[a]	6.11 ± 0.963[b]	4.51 ± 1.269[a]	5.20 ± 1.052[a]
P3 (30%)	7.74 ± 0.780[b]	7.11 ± 0.900[c]	7.09 ± 1.067[b]	7.26 ± 0.561[b]

The aspect scale ranges from 1 = extremely dislike to 9 = extremely like; different letters in the same column indicate a statistically significant difference (Kruskal Wallis, $p<0.05$).

Table 2. The Results of Strawberry Powder Quality Test

Treatments	Aspect			
	Color	Aroma	Taste	Texture
P1 (20%)	1.91 ± 0.742[a]	1.94 ± 0.684[a]	1.69 ± 0.151[a]	2.49 ± 0.702[a]
P2 (25%)	1.77 ± 0.547[a]	2.17 ± 0.841[a]	2.00 ± 0.686[b]	3.00 ± 0.642[b]
P3 (30%)	3.14 ± 0.733[b]	3.14 ± 1.200[b]	2.46 ± 0.741[c]	3.40 ± 0.881[c]

Color scale of 1 = reddish white to 5 = very red; 1 indicates no strawberry aroma, while 5 indicates a strong strawberry aroma. 1 = extremely sour, 5 = extremely sweet; Texture scale 1 = extremely hard to 5 = extremely soft (Kruskal Wallis, $p<0.05$)

However, one of the disadvantages of using maltodextrin is that it can cause the powder to experience sticking issues if it is exposed to air for too long. According to the research of Schuck (2017)[21], the addition of maltodextrin to powder causes sticking issues. The powder becomes hygroscopic due to the rapid dehydration that occurs during the drying process. Consequently, the powder will have a high propensity to absorb moisture and exert a plasticizing effect. In addition, the powder will become sticky as a result. Due to the saccharide concentrate of starch found in maltodextrin, which can form caramel when exposed to high temperatures, a high amount of maltodextrin can make the powder sticky.

Determination of Preferred Treatment

Based on the overall results of the hedonic test or level of preference test, the optimal treatment is determined. P3 has superior characteristics to P1 and P2 based on the results of the hedonic evaluation of strawberry powder, so P3 is selected as the treatment. In the hedonic quality test for the chosen treatment, P3 strawberry powder possesses a slightly sweet taste characteristic (2.46), a relatively strong strawberry aroma (3.17), a slightly soft texture (3.40), and a slightly red color (3.14). Figure 1 depicts the physical appearance of the selected strawberry powder product.

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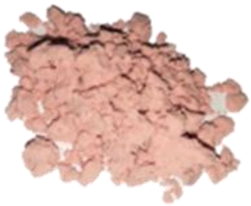

Figure 1. Selected Treatment of Strawberry Powder

Proximate Levels in Selected Treatments

Ash content, water content, protein content, fat content, and carbohydrate content were some of the approximate analyses performed. Table 3 indicates that P3 contains 5.08% moisture. The optimal water content of strawberry powder is 4.21%[22]. This is supported by the findings of Gong et al.[23], which state that strawberry powder contains between 4.52 and 4.92% water. This discrepancy is due to variations in the amount of maltodextrin concentration and inlet temperature used in this study, namely 165°C and 40% maltodextrin.

Powders with a moisture content below 5% are safe from microbiological activity and can be stored for an extended period. The result of a powder's low moisture content is dependent on the temperature conditions during the process[24]. The powder will become drier as the temperature is increased, resulting in lower water content. The addition of maltodextrin can also influence the powder's moisture content. The higher the maltodextrin concentration, the lower the water content of the resulting powder[25]. This is due to the increased flow rate of solid feed, which reduces the amount of water available for evaporation, thereby decreasing the water content of the final powder[26]. The analysis of P3 strawberry powder's ash content yielded a value of 1.05% based on Table 3. This result is consistent with the findings of Siacor et al.[27], which state that the ash content of spray-dried materials ranges from 0.81 to 1.80%.

Table 3. Proximate Level of P3 (per 100 grams)

Componen	P3 (%)
Water content	5.08
Ash content	1.05
Protein content	1.13
Fat content	<0.02
Carbohidrate content	92.73

P3 (30% maltodextrin concentration)

According to Table 3, the ash content of P3 strawberry powder was determined to be 1.05%. This result is consistent with the findings of Siacor et al.[27], which indicate that the ash content of spray-dried materials ranges from 0.81 to 1.80%. The results presented in Table 3 indicate that P3 strawberry powder contains less than 0.02% fat. This represents a decrease compared to the 0.11% fat found in fresh strawberries. Haluk et al.[25] concluded that the lower fat content in the strawberry powder is due to the product adhering to the surface of the spray drying glass during the drying process. This adhesion prevents the final powder from retaining its full-fat content, resulting in a lower fat content than fresh strawberries.

According to Table 3, P3 strawberry powder contains 1.13% protein. These results have increased in comparison to the strawberry protein content of 0.43%. This is consistent with the findings of Sobri et al.[28], who found that the use of high temperatures during the spray drying process can increase the powder's protein content. This is due to the reduction in water content caused by high temperatures, which causes the powder to become dry. The powder's protein content will increase as its dryness increases. However, excessively high temperatures are known to cause protein denaturation, which can reduce the nutritional value and quality of a food product[29].

Table 3 shows that the carbohydrate content of P3 strawberry powder was 92.73%, which means that the value is higher than 7.89% of the initial carbohydrate content in fresh strawberries[30]. According to Agustina et al.[20], the carbohydrate content of the powder produced through the drying process with the addition of maltodextrin varied between 83.77 and 90.39%. The increase in carbohydrate levels was brought about by the addition of maltodextrin, the primary component of which was carbohydrates. The powder's carbohydrate content increases with increasing maltodextrin concentration.

Antioxidant Level

The antioxidant test revealed that strawberry powder containing 30% maltodextrin had the highest antioxidant capacity, measuring 8.36 ppm. Strawberry powder containing 20% maltodextrin was found to have the lowest value, 7.95 ppm. In general, strawberry antioxidant levels are quite high, ranging from 18.87 to 46.03 ppm per 100 gram[31]. The reduction in antioxidant levels may be attributable to the spray drying process, which may have removed some antioxidants from the strawberry fruit. While the addition of maltodextrin improves the product's physical properties, it is important to note that the vitamin C and antioxidant content decreases. Despite the reduced antioxidant content, the conversion of fresh strawberries to powder offers several advantages. Primarily, the powder has a longer shelf life, which reduces waste and enables more versatile application. In addition, the powdered form

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allows for a wider range of applications, including beverages, smoothies, and baked goods. Thus, although the strawberry powder may contain fewer antioxidants than fresh strawberries, its improved shelf life and increased versatility make it a valuable alternative.

Table 4. The Results of Antioxidant Levels Analysis (per 100 gram)

Maltodextrin (%)	Antioxidant Capacity (ppm)
P1 (20)	7.95
P2 (25)	8.07
P3 (30)	8.36

Strawberries contain anthocyanins and ellagitannins, which are effective as carcinogen detoxification in the body[32]. The heating process of spray drying at high temperatures tends to reduce the antioxidant content of strawberries. Anthocyanins are unstable at high temperatures, and high temperatures alter their color and reduce their antioxidant activity. Temperature, oxygen, light, and pH have effects on anthocyanins. These alterations render anthocyanins unstable. This is consistent with the findings of Fegus et al.[33], which indicate that freeze-dried blueberry powder has a higher antioxidant value than spray-dried powder. The thermal decomposition of heat-sensitive compounds is responsible for the decline in antioxidant activity.

However, according to another study, the effect of low temperature with a temperature range of 150-220 degrees Celsius did not significantly damage the phenolic compound and antioxidant content[34]. Alternatively, higher temperatures can accelerate the degradation of bioactive compounds. The chemical structure, pre- and post-harvest factors, and processing factors are additional factors that can influence the loss of antioxidant capacity in fruit and its derivatives. Different plant powder constituents contribute differently to total antioxidant capacity[35].

The study's limitations include a small sample size, which may not completely represent the diverse sensory preferences of the general population, and the use of non-elderly panellists, despite the fact that the product was intended for consumption by the elderly. This constraint may have impacted the evaluation of the product's sensory qualities in relation to the intended population. In future studies, it would be advantageous to include elderly panellists in order to more accurately evaluate the product's allure and suitability for the target consumer group. In addition, the study focused solely on the effect of maltodextrin concentration on the physical properties of strawberry powder, omitting other variables that may have influenced the retention of nutrients during the dehydrating process. To provide a more comprehensive comprehension, future research could investigate the combined effects of additional variables on the quality of the product.

CONCLUSIONS

The addition of maltodextrin to strawberry powder that produces the best organoleptic results is a 30% concentration with a slightly sour flavor, a relatively strong strawberry aroma, a slightly soft texture, and a slightly red hue. Antioxidant levels have decreased in the nutritional value of strawberry powder produced by spray drying. This can be caused by the temperature and the maltodextrin concentration used. However, because the powder's water content is relatively low, the chosen treatment can be stored for an extended period. The next study should investigate how drying methods and temperatures impact the antioxidant and nutrient retention of strawberry powder. Furthermore, it would be beneficial to investigate how various encapsulating materials affect the physicochemical properties and nutritional value of strawberry powder. This study contributes to product diversification by developing a strawberry powder with potential health benefits for elderly consumers, offering valuable insights into optimizing the spray drying process to improve nutrient preservation and extend shelf life, while promoting the use of locally produced fruits for value-added products, supporting local farmers and a sustainable food system.

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Conflict of Interest and Funding Disclosure

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