



THE ANALYSIS OF STRAWBERRY POWDER CONTENT AND POTENTIAL IMPLICATIONS AS ANTI-OBESITY

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ABSTRACT

The prevalence of obesity in Indonesia has increased from 21.8% in 2018 to 23.4% in 2023. Contributing factors include an unbalanced diet, lack of physical activity, and genetic factors. One strategy for dealing with obesity is regulating diet with nutritious intake. Strawberries are rich in antioxidants and flavonoids that are beneficial for obese groups, such as improving lipid profiles and reducing oxidative stress. Its high water content makes it perishable, processing it into powder can increase shelf life without reducing its nutritional content. This article examines the nutritional content and benefits of strawberry powder in managing obesity. Method: A descriptive research design with laboratory analysis approach. The powder making process began with drying using a cabinet dryer at a temperature of $\pm 40-600^{\circ}\text{C}$ for 16 hours, followed by grinding process using a grinder, the compound content in strawberry powder was analyzed. Analysis revealed that 100 grams of strawberry powder contained 3.18% fat, 6.43% protein, 71.67% carbohydrates, 0.57% crude fiber, 397.72 mg vitamin C, 77.63% antioxidant inhibition and 555.10 ppm anthocyanin. The drying and powdering processes didn't significantly reduce the compound content of the strawberry. Strawberry powder demonstrated potential as an anti-obesity agent, offering benefits in improving obesity biomarkers.

Keywords: analysis; anti-obesity; potential; strawberry powder

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INTRODUCTION

Obesity is one of the most common nutritional problems in Indonesia. According to the results of the 2023 Indonesian Health Survey, the prevalence of obesity was recorded at 23.4% (BKPK Kemenkes, 2023), when compared to the prevalence in 2018 which was 21.8%, this figure shows an increase of 1.6% in the last five years (Kementerian Kesehatan RI, 2018). Obesity can be caused by the accumulation of fat that occurs over a long period of time (Kinansi et al., 2023). The accumulation of fat that occurs in the obese group is influenced by several factors such as excessive food intake, lack of physical activity, unhealthy lifestyles and genetics (Farahany et al., 2025). One approach to obesity management is providing a diet by paying attention to food intake such as food portions, types of food, and how to process food ingredients consumed by the obese group.

The Indonesian Ministry of Health has created an “*Isi Piringku*” guide with several food elements to meet daily nutritional needs and maintain normal nutritional status for the Indonesian people. Fruits are one of the elements of a balanced nutritional plate with a recommended consumption of 1/6 of the plate (Kementerian Kesehatan RI, 2024). According to a survey, the proportion of lack of fruit and vegetable consumption in Indonesia is 96.7%

(BKPK Kemenkes, 2023), while it was recorded that the total fruit production in Indonesia in 2023 was 28,238 kilotons (Badan Pusat Statistik Indonesia, 2024). Strawberries are a subtropical fruit that is quite popular in Indonesia (Mahardika et al., 2023). Several places such as highland areas with low temperatures are often used as places to cultivate strawberries. According to data from the Central Statistics Agency, Indonesia produced 27,721 tons of strawberries in 2023 (Badan Pusat Statistik Indonesia, 2024).

Strawberries are rich in nutrients and bioactive compounds that are beneficial for the body (Zadeh et al., 2021). The results of a literature review state that the compounds contained in strawberries have a positive effect on the health of the obese group (Lail et al., 2021). Study shows that strawberries have good antioxidant content which can improve lipid profiles in the obese group (González et al., 2023), the other study also showed an improvement in MDA levels in the obese group after being given strawberry juice (Anggraeny et al., 2021).

Strawberries themselves have a high water content of approximately 90%, making them rot quickly and have a short shelf life lama (Asharo et al., 2022). This is one of the obstacles for producers and traders in distributing strawberries from cultivation sites to the market. One alternative to maintaining the quality and nutritional content when storing strawberries is to reduce the water content of the strawberries by drying them (Ulfa et al., 2023). After the drying process, strawberries can be made into flour so that they have a long shelf life. This article aims to look at the nutritional content and bioactive compounds contained in strawberry flour and see its benefits for obese groups.

METHOD

The design of this study is a descriptive study with a laboratory analysis approach of strawberry powder products. The strawberries used in this study came from one of the *UMKM* plantations in Tawangmangu sub-district, Karanganyar district, Central Java province with the business name "Strawberry Land" which has a micro business permit certification and a low risk level. The preparation and drying process was carried out at the Food Chemistry and Biochemistry Laboratory of ITP, Faculty of Agriculture, Sebelas Maret University, then continued with the flouring process at the Food Science Laboratory, Faculty of Health Sciences, Muhammadiyah University of Surakarta. The materials used in this research process were fresh strawberries, and the tools used were knives, cutting boards, large trays, cabinet dryers, flour grinders, sieve size 80, sieve shakers, masks, handsoons, spoons and jars.

Procedures:

1. Strawberry drying process

Strawberries are separated from their leaves and then washed using running water. The washed strawberries are then drained so that the washing water dries. Next, the strawberries are cut thinly to facilitate the drying process. The thinly cut strawberries are then arranged neatly on a tray. After the slices are neatly arranged and not piled up, the tray is inserted into the cabinet dryer machine and the cabinet temperature is set at $\pm 40-60^{\circ}\text{C}$ and the drying process is carried out for ± 16 hours.

2. Dry strawberry flouring process

The dried strawberry slices are then ground using a flour grinder. The flour grinding process using a grinder machine is carried out for approximately 2 minutes and the grinder machine is rested for 15 minutes before continuing the next grinding process. The ground strawberries are then sieved using a sieve size of 80 and assisted by a sieve shaker machine to speed up the sieving process. The result of the sieving is a strawberry flour product that will be analyzed for nutritional content and bioactive compounds in it.

3. Analysis of strawberry powder content

Analysis of strawberry powder content was conducted at the Food Chemistry and

Biochemistry Laboratory of ITP, Faculty of Agriculture, Sebelas Maret University. The components tested used different analysis methods.

RESULT

The process of making strawberries into strawberry powder can certainly change the physical characteristics of strawberries. The finished powder product has a reddish brown color, different from strawberries which have a red color (figure 1). The weight of strawberries also decreases when they become strawberry powder.



Figure 1. Strawberry Powder Product

The analysis carried out, such as proximate tests in the form of carbohydrate, protein, fat and vitamin C and mineral components, then phytochemical compounds such as flavonoids, tannins, phenols, anthocyanins and antioxidant levels were also tested and the results obtained were that strawberry powder contained the content in table 1

Table 1.

Strawberry Powder Content

Component Test	Analysis Method	Analysis Results (wb)
Water	Thermogravimetric	14,53%
Mineral	Dry Ashing	4,19%
Fat	Soxhlet	3,18%
Protein	Kjeldahl	6,43%
Carbohydrate	<i>By Different</i>	71,67%
Crude Fiber	Acid and Alkali Hydrolysis Method	0,57%
Vitamin C		397,72 mg
Flavonoid	Spectrophotometry	18,83 (mgQE/g)
Tannin		1,89%
Phenol	Folinciocalteau	0,66%
Anthocyanin	pH differential	555,10 ppm
Antioxidant	DPPH	77,63 % inhibition

The drying process on strawberries causes strawberries to lose approximately 90% of their water, so that when compared, 100 grams of fresh strawberries are equivalent to approximately 10 grams of strawberry powder. Table 3 shows that the difference in macronutrient content between fresh strawberries and strawberry powder is not much different except for crude fiber. The carbohydrate, fat and fiber content in strawberry powder is lower than that of strawberries, while the protein content in strawberry powder is higher than that of strawberries. The difference in calories between strawberries and strawberry powder also shows that it is not much different.

Table 2.

Comparison of Macronutrient and Fiber Content

	100 g strawberry fruit*	10 g strawberry powder**
Energy (Kkal)	32	34,12
Protein (g)	0,67	0,64
Fat (g)	0,3	0,32
Carbohydrate (g)	7,68	7,17
Crude Fiber (g)	2	0,057

*Food ingredient composition list (DKBM) data is taken from Fatsecret, 2024

**Primary Data (table 1)

DISCUSSION

Berries contain bioactive flavonoid compounds such as flavanols, flavones, anthocyanidins which are antioxidants. These compounds have benefits for reducing free radicals in the body (Lail et al., 2021). Literature review states that strawberries and their processed products have significant health benefits against several diseases. Because they contain antioxidants that can reduce oxidation in the body, strawberries also have phenolic compounds that have anti-cancer, anti-obesity and anti-inflammatory properties (Rahaman et al., 2023). Strawberry cultivation has special criteria to produce good quality strawberries, Tawangmangu sub-district is one of the sub-districts that has an average temperature of 19-21°C and a humidity level of approximately 80-95% (Badan Meteorologi Klimatologi dan Geofisika, 2024), a literature states that in strawberry cultivation, the role of temperature and humidity influences the quality of the strawberries. It is said that the suitable temperature for strawberry cultivation is around 17-20°C with humidity of 80-90% (Mahardika et al., 2023).

The drying process plays an important role in maintaining the content of strawberries, strawberries that are rich in antioxidants and bioactive compounds are susceptible to high temperatures. A study proves that antioxidant content will decrease when processed at temperatures above 60°C (Martinsen et al., 2020). Supported by other studies, it is also suggested that the optimum temperature and time used when drying food is below 60°C and 24 hours to maintain its nutritional content (Syafii & Fajriana, 2022). When viewed from table 3 in the results, the comparison of nutritional content in strawberries and strawberry powder which is not too far apart can be evidence that drying at a temperature of approximately 40-60°C and a time of 16 hours does not reduce the original content of strawberries. The content of strawberries has potential in several aspects of health, especially in the obese group. A literature says that the average strawberry contains approximately 150-600 mg of anthocyanin per kilogram (Putri et al., 2024), the results showed anthocyanin of the strawberry powder analysis obtained were 555.10 ppm (table 2) which is equivalent to 555 per kilogram, this proves that the flouring process does not reduce the anthocyanins from strawberries. Anthocyanins are one of the antioxidants from flavonoids contained in strawberries, studies showed that anthocyanins play a role in fat synthesis (Liu et al., 2021). Anthocyanin is a glycosylated compound of anthocyanidin which is one of the flavonoids. Other studies have also shown that flavonoids have a positive effect on weight loss, and have a role in normalizing lipid profiles in obese groups (Cercato et al., 2021). Here are some theoretical implications of strawberry powder having the potential to improve health for obese groups:

1. Improvement of lipid profile

Obesity is a sign of high macronutrients such as fat in adipose tissue. Fat that accumulates in adipose tissue can cause an increase in inflammatory adipokines in the obese group (Trinh et al., 2021). The accumulation of fat can disrupt the lipid profile in the obese group such as increasing low density lipoprotein (LDL) and triglycerides and decreasing high density lipoprotein (HDL) levels. A study proves the occurrence of dyslipidemia in the obese group (Shabana et al., 2020). Also supported by other studies showing data that the atherogenic index is significantly high in the obese group (Javardi et al., 2020). The anthocyanins contained in strawberries have been proven to play a role in fat metabolism, namely by interfering with the absorption of triglycerides and cholesterol in the intestines by inhibiting the lipase enzyme in the pancreas, so that this causes a decrease in lipolysis and has an effect on decreasing fat absorption (Liu et al., 2021). Anthocyanins affect enzymes in the body that are involved in fat metabolism, such as the enzyme carnitine palmitoyltransferase 1 (CPT-1), this enzyme has a function in fatty acid oxidation, where increasing the CPT-1 enzyme can help the process of breaking down triglycerides in the body (Fan et al., 2019). Supported by a study that showed that there was a significant

effect on increasing the CPT-1 and AcCoA enzymes in the group given strawberry drinks (González et al., 2023).

Anthocyanins can cause a decrease in acetyl-CoA carboxylase (ACC) activity, which can affect the production of triglycerides, cholesterol and LDL (Arifin et al., 2019). Anthocyanins can also affect the activity of the enzyme Lecithin-Cholesterol Acyltransferase (LCAT), LCAT plays a role in the formation of HDL. High levels of HDL have an effect on the process of cholesterol transfer in peripheral tissue to the liver so that it can be excreted. Thus, anthocyanins indirectly play a role in HDL production and offer benefits for obese groups (Garcia & Blesso, 2021). In addition to antioxidants, strawberries contain phytosterols that can help lower LDL levels, a study shows evidence that consuming strawberry powder for 4-6 weeks resulted in a significant decrease in LDL-C and total cholesterol levels in overweight and obese groups. The hypothesis in this study also suggests that consuming strawberry powder daily can reduce risk factors for vascular dysfunction and lipid issues, such as triglycerides (Richter et al., 2023).

2. Anti-inflammatory and reduces oxidative stress

The release of free fatty acids that occurs in the obese group due to storage has reached its maximum in adipose tissue causing lipids to accumulate in other tissues such as the liver and blood vessels. This causes the obese group to be at risk of other diseases such as metabolic syndrome. The study found that in the obese group, the activity of M1 macrophages was greater than that of M2 macrophages in adipose tissue, which caused macrophages to produce more pro-inflammatory cytokines (Ren et al., 2022). Adiposity that occurs in the obese group causes an imbalance in the production of free radicals which increases the formation of reactive oxygen species (ROS) and malondialdehyde (MDA) and leading to a decrease in endogenous antioxidants such as superoxide dismutase (SOD) and catalase (CAT), this worsens inflammation in the obese group (Naomi et al., 2023). A study showed that MDA levels in obese groups were higher than in non-obese groups (Widhiani et al., 2023).

Strawberries, which have anti-inflammatory properties, have been shown to reduce levels of pro-inflammatory cytokines, supported by a study that showed a decrease in interleukin-6 (IL-6) levels in test animal subjects (Tony et al., 2022). IL-6 is one of the pro-inflammatory cytokines that plays a role in the inflammation process in the body of the obese group. Flavonoids contained in strawberries can help repair damage caused by ROS, antioxidants that successfully capture free radicals in the obese body can increase the activity of endogenous antioxidants such as SOD, GSH, and CAT (Anggraeny et al., 2021). The study showed that the group given the strawberry and blackberry juice combination intervention had lower MDA levels. Consumption of antioxidants contained in fruits makes antioxidant enzymes work and can also reduce lipid peroxides (Tony et al., 2022).

3. Benefits for weight and visceral fat

Body weight is the standard data used to determine a person's nutritional status whether they are obese or not. It is known that strawberries contain 2 grams of fiber per 100 grams (Harsanti, 2022). Fiber itself is a component that has an effect on weight loss. Soluble fiber in fruits works by binding fat in the small intestine, making the absorption process slower and helping the body feel less hungry (Tim Promkes RSST, 2022). A study shows that consuming foods and drinks that are high in fiber creates a feeling of fullness for a long time, thus limiting overeating (Zaki et al., 2022). Visceral fat tissue is a tissue with the function of storing energy reserves. In addition, visceral fat also plays a role in endocrine

function which is also related to the body's metabolic and inflammatory systems. Excessive accumulation can disrupt the body's metabolism (Spallanzani, 2021), that is why someone with visceral fat that exceeds the normal limit can be categorized as obese. A literature shows that there is a positive relationship between visceral fat and triglyceride levels in the obese group (Sukkriang et al., 2021).

Inhibition of fat absorption aided by fiber from strawberries in the small intestine affects triglycerides in the blood (Richter et al., 2023), triglycerides are also energy reserves stored in subcutaneous and visceral tissues. (Kolb, 2022). The decrease in fat absorption can affect the reduced visceral fat mass. A study showed a decrease in lipid accumulation when given strawberry extract (Giampieri, 2021). Other studies also show that there was a decrease in body weight and tissue mass in the group given strawberry powder (Lail et al., 2021).

CONCLUSION

Strawberries, rich in bioactive flavonoid components such as anthocyanins have good antioxidant properties for the obese group. Strawberries that are dried using a cabinet dryer at a temperature of approximately 40-60°C for 16 hours do not significantly reduce their nutritional content or anthocyanin levels, making them a viable alternative for overcoming short shelf life. From a theoretical perspective, strawberry flour has positive potential for the obese group such as improving lipid profiles by reducing LDL and triglyceride levels through inhibition of pancreatic lipase enzymes and increasing HDL by enhancing CPT-1 enzyme activity. The anti-inflammatory properties of strawberry powder also help reduce the release of pro-inflammatory cytokines and oxidative stress by increasing the activity of endogenous antioxidant enzymes. In addition, the fiber content in strawberry flour also has the effect of reducing body weight and visceral fat mass by helping to reduce fat absorption and providing a satiety effect. Thus, strawberry powder holds potential as a natural ingredient that can aid in overcoming obesity and improving metabolic profiles

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