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The Characteristics of Flour from Mango Seeds

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ABSTRACT

Indonesia produces 3,308,895 tons of mangoes in 2022. One type of mango in Indonesia is mango golek. Golek mango seeds can be processed into flour as a source of carbohydrates. The research contribution is to analyze the feasibility of golek mango seed flour based on SNI 3751:2009. Proximate analysis was used to determine the nutritional content of the golek mango seed flour. Flour is produced within 2 hours 30 minutes where the temperature variations are 80, 85, 90, 95, and 100 °C. The proximate analysis consisted of the analysis of carbohydrate content, protein content, fat content, moisture content, ash content, and organoleptic tests. This study obtained an average carbohydrate content of 13.39%, an average protein content of 5.32%, an average water content of 0.80%, an average fat content of 0.33%, and a moderate ash content. 0.97%. The lower the yield of protein, water, fat, and ash, the lower the carbohydrate content, and vice versa. The results of the organoleptic test showed that the higher the temperature used during the oven, the darker the colour, the sharper the aroma, and the smoother the texture of the golek mango seed flour.

1. INTRODUCTION

Based on data from the Badan Pusat Statistik (BPS) 2022, Indonesia imported up to 11.172 tons of wheat flour (Badan Pusat Statistik, 2022). Therefore, in overcoming the side effects of organic waste, one of which is mango seed waste, it can be used as mango seed flour (Yatnatti et al., 2014). Mango seeds can be an alternative to rice flour to meet the need for carbohydrates as a staple. Mango seeds can be processed into flour because they contain carbohydrates and good nutritional value, as well as the carbohydrate content of tubers and cereals (Dewi et al., 2022; Qalsum et al., 2015).

Golek mango seed flour is a semi-finished product from the waste of *golek* mango seeds. *Golek* mango seed waste can be processed into flour, which can be reprocessed into flour-based food preparations such as lunkhead, porridge, cakes, bread, etc (Mas'ud, 2022). The content in the *golek* mango seed waste is expected to be in accordance with the SNI standard for rice flour so that this *golek* mango seed flour can be an alternative to rice flour, and it is also hoped that *golek* mango seed flour can compete in the world of trade and can minimize imports of rice flour to Indonesia. Based on the description above, this research was conducted to utilize the waste of *golek* mango seeds into *golek* mango seed flour to minimize flour imports and as an alternative to help fulfil carbohydrates and protein. Conduct a feasibility analysis of *golek* mango seed flour in accordance with SNI 3751:2009 food quality standards.

Mango *(Mangifera indica L)* is a fruit that grows a lot in tropical areas like Indonesia. According to the Central Statistics Agency and the Directorate General of Horticulture, in 2019, the mango production rate in Indonesia was 2,808,939 tons/year. Then, in 2021, the mango production rate increased by 2,835,442 tons/year, with an increase of 0.94% (BPS, 2021). Mango *golek* originates from East Java, to be precise, in the Probolinggo and Pasuruan areas. Mango *golek* has a length of 30 cm and thick, soft, non-fibrous flesh. When the mango fruit is ripe, it has a reddish-yellow colour with a sweet taste (Melo et al., 2019; Nugraheni et al., 2020).

One hundred grams of *golek* mango contains 21.3 grams of sugar, 30.85 grams of carbohydrates and 66.53 grams of water (Asif et al., 2016; Nugraheni et al., 2020; Zou et al., 2021). In general, mango seeds are high in carbohydrates, so they can be used to make flour and are good for treating diarrhoea. There are several nutritional contents in mango seed, namely 3.737% of fibre; 154.9944 mg/100 gram of vitamin C; 49.0419% of amilum, and 9.2856% of protein (Okpala & Gibson-Umeh, 2013; Paramita, 2012; Patiño-Rodríguez et al., 2020). Therefore, this research contribution is to analyze the feasibility of *golek* mango seed flour based on SNI 3751:2009. Its feasibility is characterized by proximate analysis used to determine the nutritional content of *golek* mango seed flour.

2. MATERIALS AND METHODS

2.1. Materials

Equipment used such as knife, pot, stove, bucket, oven, grinder, sieve, 100 ml volumetric flask, 100 ml kjeldahl flask, distillation flask, burette, 25 cm stir bar, ball heater, soxhlet tool, furnace, scissors, sample container, trays, porcelain exchangers, hoses, weights, desiccators, adapters, erlenmeyer, statives and clamps, condensers, filter paper, porcelain cups, digital scales, magnetic stirrer, pro pipettes and measuring pipettes. The materials used: Mango *golek* seeds, tap water, distilled water, Na_2SO_4, $CuSO_4$, Concentrated H_2SO_4, Selenium (TiO_2), 40% NaOH, 35% Na_2S_2O, 0.02 N HCl, Hexane as a solvent, boiling stone, Mr indicator -BCG, boric acid (H_3BO_3) 4% and all chemical used in this research was provided from laboratory of chemical engineering department of Universitas Ahmad Dahlan. The material used is *golek* mango seeds from several fruit juice stalls on campus 4 of Universitas Ahmad Dahlan.

2.2. Research Methods

2.2.1. The Process of Making *Golek* Mango Fruit Seed Flour

Sort the good quality *golek* mango seeds, then wash the mango seeds three times. After that, the mango seeds are boiled until half-cooked. Then, the *golek* mango seeds are drained and cooled. The skin and flesh of the *golek* mango seeds are separated. The flesh of the *golek* mango seeds that have been separated and then cut into small pieces. Then, the pieces were baked in an oven with a temperature variation of 80 ˚C, 85 ˚C, 90 ˚C, 95 ˚C, and 100 ˚C for 2 hours 30 minutes, then cooled briefly then blend the fruit seeds until they become granules. Then, the flour is sieved until a fine *golek* mango seed flour is obtained.

2.2.2. Analysis of Protein Content

Analysis of protein content uses the Micro Kjeldahl Method. The sample of *golek* mango seed flour was weighed as much as 0.2 grams, and then the sample was put into the Kjedahl flask. Then add 0.7 grams of N catalyst (250 grams of Na_2SO_4 + 5 grams of $CuSO_4$ + 0.7 grams of selenium/TiO_2), then add 4 ml of concentrated H_2SO_4. Further destruction in a fume cupboard until the colour changes to clear green, then cool and then add 10 ml of distilled water. After the destruction process, then distillation by adding 20 ml of NaOH – Tio (40% NaOH + 35% Na_2S_2O). As a container, use 4% H_3BO_3, which has been given the Mr-BCG indicator. Perform distillation until the volume of distillate results reaches 60 ml (red colour changes to blue). After the volume reaches 60 ml, stop the distillation and then the distillate results are titrated using a standard 0.02 N HCl solution until the end point of the titration (blue colour changes to pink) (Apriantono, 2022). After that, record the titration volume obtained and then calculate the protein content using the equation (1) and (2).

$$\%\,Nitrogen = \frac{v\ titration \times N\ HCl \times 14.008}{mass\ of\ sample} \times 100\% \qquad (1)$$

$$\%\,Protein = \%\,Nitrogen \times (6.25) \qquad (2)$$

2.2.3. Analysis of Ash Content

The sample is weighed as much as 1 gram and then put into a porcelain cup. Place the cup in the oven at a maximum temperature of 600 ℃ for 5 hours until whitish ash is obtained. The porcelain cup was removed from the furnace and cooled, then weighed, and the ash content was determined (BSN, 2009). Equation (3) used to calculate the ash content of the sample.

$$\%\,Ash = \frac{(W2 - W0)}{(W1 - W0)} \times 100\% \qquad (3)$$

Description:
W0 = sample weight (g)
W1 = empty cup weight (g)
W2 = weight of empty cup and ashes (g)

2.2.4. Water Content Analysis

Weigh 1 gram of the sample and then put it in a porcelain cup. The porcelain cup was put into the oven for 2 hours at 150 °C. Cool the porcelain cup, weigh it, and calculate the water content (BSN, 2009). Then, calculate the water content using the equation (4).

$$\%\,Water = \frac{(A - B)}{A} \times 100\% \qquad (4)$$

Description:
A = initial sample weight (g)
B = sample weight after cooling (g)

2.2.5. Fat Content Analysis

The sample is weighed as much as 5 grams and wrapped using filter paper. The Soxhlet test kit is assembled, and the sample wrapped in filter paper is put into the Soxhlet test kit. Then, add 400 ml of hexane solvent and some boiling stones. When the test equipment is turned on, wait for the hexane solution to boil until the hexane solution can dissolve the fat in the sample. The result of the solution obtained is carried out by distillation. The separated fat is then put into a desiccator to be cooled (BSN, 2009). The fat obtained is then weighed, and its levels are calculated. Then, the fat content is calculated using the equation (5).

$$\%\,Fat = \frac{(b-a)}{mass\ of\ sample\ (g)}\ x\ 100\% \tag{5}$$

Description:
a = empty fat pumpkin weight (g)
b = fat pumpkin weight + fat yield (g)

2.2.6. Analysis of Carbohydrate Content

Calculation of carbohydrate content (KH) using by-different methods, mentioned in equation (6) (Dhila, 2019).

$$KH\% = 100\% - (KA\% + KP\% + KL\% + KAb\%) \tag{6}$$

Description:
KA = water content
KP = protein content
KL = fat content
KAb = ash content

3. RESULT AND DISCUSSION

3.1. Water Content

Moisture content is a parameter that determines the quality of a product, namely biological, physical, and chemical. The water content affects the resistance level of the resulting product, so the more water content it contains, the resistance level of a product will decrease. The drying process will affect the water content, which can affect the texture, durability, appearance, and nutritional value of the resulting product (Fapohunda et al., 2018).

In Table 1, it can be seen that the results of the analysis of water content show that samples of *golek* mango seed flour baked at 80 ℃ had the highest average percentage of water content of 0.82%, followed by *golek* mango seeds baked at 85 ℃ and 90 ℃ of 0.80% and in the *golek* mango seeds which were baked at 95 ℃ and 100 ℃ by 0.81%. The water content is determined by baking 1 gram of *golek* mango seed flour for 2 hours and 30 minutes. The results of the analysis obtained different results for each sample, and this could be due to the size before baking. The smaller the *golek* mango seed is cut when it is baked, the less water it contains.

Table 1. The results of research on the water content in mango *golek* seed flour with different temperatures using an oven

Temp. (℃)	A (g)	B+dish (g)	dish (g)	B (g)	Water content (%)
80	1	88.343	88.166	0.177	0.82
85	1	88.362	88.166	0.196	0.80
90	1	88.361	88.166	0.195	0.80
95	1	88.360	88.166	0.194	0.81
100	1	88.358	88.166	0.192	0.81

According to previous research, the average water content in mango seed flour ranges from 12.34-15.00% (Augustyn et al., 2016; Das et al., 2019). Meanwhile, mango *golek* seed flour, which has a moisture content of 0.82%, will have a relatively short shelf life of around two weeks. The research results showed that 80 ℃ has a short shelf life because it has a moisture content of 0.82%, followed by samples of mango seed flour at 95 ℃ and 100 ℃ has a moisture content of 0.81% and samples of Mango seed flour at 85 ℃ and 90 ℃ has a moisture content of 0.80% and has a relatively long shelf life. According to SNI 3751-2009, flour has a maximum water content of 14.5%, and when seen from the results of the water content test, mango *golek* seed flour has a water content lower than 14.5%. If you look at the results of the water content of the mango *golek* seed flour, of course, this contradicts the shelf life; however, in this study, it was also influenced by several factors, such as when selecting the mango seeds to have different qualities which affected the shelf life of the *golek* mango seed flour.

3.2. Ash Content

The ash content contained in food ingredients shows the large amount of minerals present in food materials. The ash content is the remaining result of the food sample, which is completely burned in the ashing process. Ash content is a mineral that cannot be burned into a substance that can easily evaporate. The mineral or ash content of a food ingredient destroys organic compounds by means of ashing, and only minerals are left (Wibowo, 2018).

Table 2. The results of research on ash content in mango *golek* seed flour with temperature differences using the furnace method

W0 (g)	W1 (g)	Temp. (℃)	W2 (g)	Ash content (%)
1	14.752	80	14.757	1.00
1	14.752	85	14.772	1.00
1	14.752	90	14.768	1.00
1	14.752	95	14.138	0.96
1	14.752	100	13.783	0.93

In Table 2, it can be seen that the results of the analysis of ash content show that samples of mango seed flour with temperature variations of 80 ºC, 85 ºC and 90 ºC have the highest average percentage of ash content of 1%, followed by samples of mango seed flour with time variations of 95 ºC of 0.96%, and the lowest was found in the mango seed flour sample with a time variation of 100 ºC of 0.93%.

Washing mango seeds and soaking them causes low ash content due to minerals dissolved in water and evaporation of mineral compounds during the ashing process (Sudarmadji & Haryono, 2010). According to previous research, the average ash content of mango seed flour ranges from 0.97-1.06% (Augustyn et al., 2016). Based on the results of another researcher, the ash content in honey mango seed flour was 1.06% and 0.97% for *arummanis* mango seed flour (Augustyn et al., 2016). Meanwhile, in the results of research on mango golek seed flour, the ash content obtained was around 0.98%. According to the national standard of Indonesia or SNI 3751-2009, flour has a minimum ash content of 0.70%. If you look at the results of the ash content test, *golek* mango seed flour has an ash content of more than 0.70%. Of course, this result is more optimal and makes mango *golek* seed flour meet the SNI for wheat flour.

In the analysis carried out by ashing using a furnace with a weight of 1 g of mango seed flour at a temperature of 600 ºC for 5 hours, different results were obtained for each sample of mango seed flour. The drying process influenced this; the longer the time, the higher the temperature used, the ash content will decrease. Food processing will affect the decrease in mineral content as a result of various factors such as drying heat. The boiling process will also affect the mineral content, which will decrease because the water that enters will make the minerals come out so that the minerals dissolve in the water (Martínez-Olivo et al., 2023; Wibowo, 2018).

3.3. Fat Content

The estimation of the fat content of food almost invariably involves the estimation not of the true fat content but of the lipid fraction of the food, i.e. those food constituents soluble in non-polar organic solvents such as petroleum ether (petroleum spirit) or diethyl ether (ethoxyethane). This fraction includes fats (also known as triglycerides or triacylglycerols), phospholipids, sphingolipids, waxes, steroids, terpenes and fat-soluble vitamins. Fats usually make up to around 99% of the lipid fraction of food, and the relative ease of estimating the total lipid content rather than the true fat content has resulted in the terms fat and lipid becoming virtually indistinguishable as far as food analysis for compositional purposes is concerned (James, 1995).

Table 3. The results of research on fat content in mango *golek* seed flour with temperature differences using the Soxhlet method

Weight of sample (g)	T (°C)	a+boiling stone (g)	b+boiling stone (g)	Fat content (%)
5	80	164.972	165.489	0.10
5	85	164.972	165.55	0.12
5	90	164.972	165.450	0.10
5	95	164.972	166.154	0.24
5	100	164.972	170.604	1.13

Table 3, seen from the results of the analysis of fat content, shows that samples of mango seed flour with a temperature variation of 100 ºC have the highest average percentage of the fat content of 1.13%, followed by samples of mango seed flour with a temperature variation of 95 ºC of 0.24 % and samples of mango seed flour with a temperature variation of 85 ºC was 0.12%. The lowest was found in samples of mango seed flour with a temperature variation of 80 ºC and 90 ºC of 0.10%. Based on previous research, the fat content of mango seed flour is 1.58%, which is certainly higher than that of *golek* mango seed flour (Pangestika et al., 2019). The drying process influences this; the higher the temperature used, the fat content will increase (Jahurul et al., 2014; Patiño-Rodríguez et al., 2021). According to other research, fat is indeed very important. Still, if the body has excess fat, it will be at risk of obesity and trigger the emergence of other diseases such as heart disease and hypertension. In contrast, if the body lacks fat, it will have an impact on immune cells and blood cells that are lacking so that the body will feel fatigue and weakness (Lauricella et al., 2017; Santika, 2016; Yatnatti et al., 2014).

3.4. Protein Levels

Protein content is one of the most important criteria used to evaluate the nutritional and functional qualities of raw barley, yet its relation with starch digestibility remains elusive (Zhou et al., 2021). In Table 4, the results of the analysis of protein content show that mango seed flour has the highest average percentage of protein content of 5.70% at 80 ºC, then at 85 ºC a protein content of 5.46% is obtained, followed by a sample of mango seed flour at 90 ºC was 5.32% and mango seed flour at 95 ºC was 5.16%, the lowest sample of mango seed flour was obtained at 100 ºC sample of 5.14%. The statistical analysis of the results obtained varied for each sample. Based on previous research, the protein content of mango seeds was found to be 7.52%. This result is certainly higher than the protein content of mango *golek* seed flour, which has an average of 5.32% (Pangestika et al., 2019). The temperature factor influences this; namely, the higher the temperature used in the processing of *golek* mango seed flour, the lower the protein content obtained. This is also reinforced by the statement (Widowati et al., 2001) that this low protein content is related to the process of processing mango seeds into flour, which causes the loss of amino acids which are easily soluble in water and are damaged during heating.

Table 4. The results of the research on protein content in *golek* mango seed flour with differences in temperature using the Kjeldahl method

Temp (℃)	Protein content (%)
80	5.70
85	5.46
90	5.13
95	5.16
100	5.14

According to SNI 3751-2009, flour has a protein content of at least 7%, and when seen from the results of the protein content test, mango *golek* seed flour has a protein content below 7%. This makes *golek* mango seed flour not meet SNI flour. Thus, the product of mango *golek* seed flour can add to the diversification of protein-sourced food products needed for human activities (Adilah et al., 2018; Bello-Pérez & Agama-Acevedo, 2019).

3.5. Carbohydrate Levels

Carbohydrate content is a source of energy, so it is often used as a staple food. Mango seed flour products can add to the product diversification of carbohydrate sources needed for human activities. Carbohydrates are macromolecular compounds which are a source of energy for humans, where 1 gram of carbohydrates can produce 4.0 calories (Kumar et al., 2023; Winarno, 2008).

In Table 5, it can be seen that the higher the temperature used, the higher the carbohydrate content will increase. Still, at a temperature of 100 ℃, the carbohydrate content decreases drastically because the fat content at 100 ℃ increases, so it affects the results of the carbohydrate content.

According to previous research, the average carbohydrate content of mango seed flour is around 48.12-52.73%. The content of honey mango seed flour was 48.11%, and mango *arummanis* seed flour was 52.74% (Augustyn et al., 2016; Menon et al., 2014). Meanwhile, in the results of research on golek mango seed flour, the carbohydrate content obtained was, of course, lower than other mango seed flour, which was around 13.39%. Calculations on protein content, water content, ash content, and fat content in golek mango seed flour influence the carbohydrates. The lower the protein, water, ash and fat content, the lower the carbohydrate content and vice versa.

Table 5. The results of research on carbohydrate levels in mango *golek* seed flour with differences in temperature

T (℃)	Percentage (%)				
	KA	KP	KL	KAb	KH
80	0.82	5.7002	0.10	1.00	13.12%
85	0.80	5.4639	0.12	1.00	13.54%
90	0.80	5.3150	0.10	1.00	13.86%
95	0.81	5.1625	0.24	0.96	13.94%
100	0.81	5.1407	1.13	0.93	12.48%

4. CONCLUSIONS

The results of the research showed that the carbohydrate content was lower than other mango seed flours, with an average of around 13.39%. The results for protein content obtained an average of 5.32%. The results of calculations on protein content, water content, fat content and ash content in golek mango seed flour can influence carbohydrate content.

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