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Seed Enriched Yellow Pumpkin (*Cucurbita moschata* Duchesne) Flour

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Abstract. Yellow pumpkin (*Cucurbita moschata* Duchesne) flour enriched with its seed has been made in this research. Yellow pumpkin seeds contain unsaturated fatty acid such as linoleic acid which can be added to improve not only the nutritional contain (such as fiber and linoleic acid) in yellow pumpkin's flour but also the economic value. Flour was made by the heating at 60^0C followed by the determination of fiber, linoleic acid, moisture, and ash content to determine its quality. This study showed that the addition of pumpkin seeds on the flour increased the levels of fiber and linoleic acid. The fiber content raised from 6.61% to 7.18% and linoleic acid raised from 0.042% to 1.030%. Water content and ash content on seedless flour was 11.80% and 8.37% while in seed-enriched flour was 11.95% and 8.57%. Hedonic test's result 60-80% panelists said they liked the flour and the processed flour product. The addition of pumpkin seeds significantly increase fiber and linoleic acid, and the water content of flour fulfill mean while ash content didn't fulfill Indonesian National Standard requirement.

Keywords: Yellow pumpkin, Fiber, Linoleic acid.

1. Introduction

Pumpkin is often processed into healthy foods that can nourish the body. Pumpkin is a natural source of needs for lutein, selenium, beta carotene, vitamin E, vitamin C, fiber and carbohydrates [1]. Pumpkin fruit has several benefits, including helping digestion, preventing coronary heart disease, treating intestinal worms, maintaining pancreas' health and improving insulin performance, as well as being consumed by people who suffered from diabetes mellitus [2]. Apart from the fruit, pumpkin seeds which in most people serve as waste turned out to have health benefits, one of which is antihypercholesterolemia. It was proved by the research conducted by Ratna and Arintina (2014) which concluded that the distribution of pumpkin seeds powder for 2 weeks was able to reduce LDL (Low Density Lippoprotein) in all treatment groups significantly $p < 0.05$.

Pumpkin seeds are reported to have antihypercholesterolemic effects because they are enriched with nutritional sources. According to the 2010 United States Department of Agricultural (USDA), there are contents of phytosterols 265 mg, 6 g fiber, polyunsaturated fatty acids (PUFA) 20.9 g, and antioxidants (Vitamin C 1.9 mg, vitamin E 35.10 mg, and beta carotene 9 µg) in 100 grams of pumpkin seeds. According to Glew (2006) and Aziz (2011) research, unsaturated fatty acids found in pumpkin seeds were linoleic acid 52.69% and linoleic acid 1.27%. The recommended consumption of pumpkin seeds per day in humans is 30-40 gram/day [3].

Dietary fiber is a food consisting of 3 or more types of carbohydrates that cannot be digested and absorbed by the small intestine [4]. Regular intake of fiber consumed from foods such as fresh vegetables, fruit, whole grains and nuts is associated with decreased levels of low density lipoprotein (LDL), decreased glucose levels and insulin response, and it can improve digestion. In addition, consuming fiber can be the basis and associated with people with high fiber diets, especially in epidemiological studies in an effort to reduce risks such as obesity, coronary heart disease (CHD), diabetes, diseases of the gastrointestinal tract, constipation and colon cancer [5]. There are several mechanisms for decreasing LDL levels by dietary fiber, including fiber capable of altering absorption and metabolism of bile acids, fiber can modify absorption and metabolism of

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lipids, and short chain fatty acids as a result of fiber fermentation affecting cholesterol metabolism and lipoproteins.

Unsaturated fatty acids are divided into two parts, namely monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA). Linoleic acid, linolenic acid and arachidonic acid are examples of PUFAs that play an important role in fat transfor and metabolism, immune function, maintaining membrane integrity and function [6]. Unsaturated fatty acid content in pumpkin seeds can mediate to reduce the risk of coronary heart disease by preventing the formation of blockages in the heart vessels and it can also be used as an immunomodulator [7]. Consumption of PUFA can prevent PJK by lowering cholesterol levels in the blood [8].

The characteristics of pumpkin powder in the form of fine grains, passing on 60-mesh sieve, yellowish white in color, smells typical of pumpkin with a moisture content of approximately 13%. Pumpkin powder is also hygroscopic, so it must be protected from air and sunlight during the storage. Selected packaging suitable for pumpkin powder is plastic coated with aluminium foil. By being kept in a dry place, pumpkin powder will last for two months [9]. Pumpkin powder has specific characteristic with a distinctive aroma. In general, the powder has the potential as a companion to flour and rice flour in various food processed products. Flour-making technology is one of the alternative processes of semi-finished products that are recommended because it is more resistant to be keep in the storage, easily mixed (made composite), molded, enriched with nutrients and cooked faster according to the demands of a practical, modern life [9].

2. Methodology

2.1 Tools

The tools used to make the powder were knives, basins, cabinet dryers and 60-mesh sieves. In addition, tools for evaluating powder were includes analytic scales, crucible plates, crucible clamps, desiccators, ovens, furnaces, azeotrop distillation devices, heating mentles, Buchner funnel, vacuum pump, glass tool, shaker, soxhlet and gas chromatography.

2.2 Ingredients

The ingredients used for making flour are pumpkin obtained from Garut Regency, sodium metabisulfite ($Na_2S_2O_5$) food grade, $CaCO_3$, Aerosil and water. In addition, materials for evaluation of flour such as HCl, NaOH p.a, H_2SO_4, linoleic acid, n-hexane p.a, methanol p.a, aquadest, ethanol and ash filter paper Whatman 541 were used.

2.3 Procedure

The research procedure can be seen in **Figure 1**, starting from collecting raw materials to evaluating powder. The stages of powder making can be seen in **Figure 2** and the pumpkin powder formula can be seen in **Table 1**, then the powder evaluation is determined by the measurement of water content, ash content, fiber content, linoleic acid level and hedonic test.

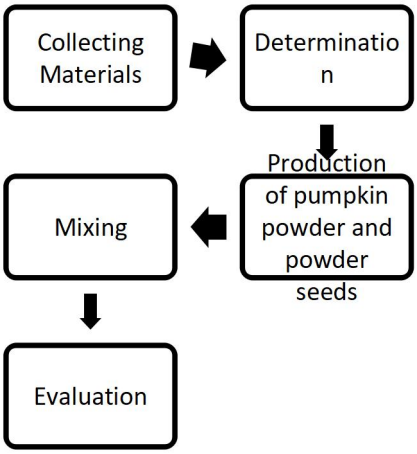

Figure 1. Research Procedure

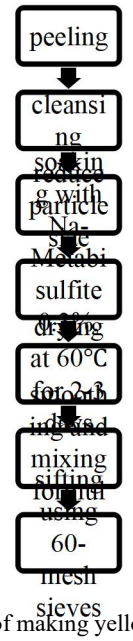

Figure 2. Steps of making yellow pumpkin powder

Table 1. Yellow pumpkin powder formula every 100 gram

Formula	Yellow Pumpkin Powder (g)	Pumpkin Seeds (g)	Aerosil: $CaCO_3$ (%)
I	100	0	2:2
II	80	20	2:2

3. Result and discussion

Pumpkin powder production starts from the selection of raw materials which is one of the determinants of the

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success rate of powder making. Pumpkin fruit is chosen with a level of maturity that is not too old and not too young. If it is too old, there will be more sugar content so that it can interfere with the drying process, especially with the occurrence of Maillard reaction, which is a reaction involving sugar with amino acids, so that it will speed up the browning process during drying process of the pumpkin [10].

The pumpkin was peeled and washed to remove the impurities that are attached to its fruits, then the particle size is reduced to expand the contact surface between the pumpkin with the heat during the drying process. The next step was to soak the pumpkin in 0.3% Sodium Metabisulfite. This soaking process aims to protect the components of other nutrients that act as antioxidants, especially beta carotene, which was not dissapear during the subsequent process due to oxidation. Sodium Metabisulfite was chosen as an antioxidant because it is a powerful antioxidant with an IC_{50} value of 0.065 µg/ml. Aside from being an antioxidant, at concentrations of 0.1-1%, Sodium Metabisulfite has activity as an antibacterial and antifungal [11].

Drying method is a way to eliminate or remove some of the water from materials with the evaporation process using heat energy [12]. The drying process in powder making is an important step to obtain the desired powder characteristics. Furthermore, the advantages of drying process are to reduce moisture content so that the products' moisture content is in accordance with the requirements of SNI for powder [13]. SNI is the abbreviation of "Standar Nasional Indonesia" as Indonesian National Standard. Reduced moisture content from pumpkin are around 80% through the drying process, it can also reduce the volume of material to facilitate packaging and packing, and also to prevent the growth of microorganisms [12].

Drying method in flour making was done by using a cabinet drying at a temperature of 60°C for 2 x 24 hours until moisture content is obtained which suited the type of material. Heating process is done at a low temperature of 60°C to prevent damage on food due to heating process, because temperature is one of the factors to accelerate the oxidation reaction which can damaging the nutrients in the material [12]. The next stage is refining flour using a blander, then sieving using 60-mesh. Smoothing and sieving is done to form the size of flour particles and improve texture. Flour without added seeds passes on 60-mesh as much as 79.45%, while flour with addition of seeds is 73.43%. The sieving process has obstacles due to flour clumping due to hygroscopic characteristics of flour [9].

Characteristics of the powder products were observed organoleptically, the result proved that pumpkin powder has a yellow color, smells of pumpkin and it has hygroscopic characteristic so that it can be easily agglomerates at room temperature. On the other hand, pumpkin seeds powder has characteristics such as stickiness due to its oil content, clots, it has white colour and smells like typical of yellow pumpkin seeds.

Based on the characteristics of the powder products above, in the next stage called as mixing, the two ingredients will experience difficulties, especially because there is clumping. Therefore, the solution for the problem was to added food additives as anti-flat to improve the characteristics of pumpkin powder enriched with seeds in order not to clot. Anti-deflating compounds are anhydrous salts which are quickly hydrated by binding water through bundle on the surface without getting wet and clumping, it usually added to food in the form of powder or particulates. The goal is to prevent clumping and keep the material still pourable (BPOM, 2013). The added anti-flat is aerosil (colloidal silicon dioxide) and calcium carbonate with a value that is still allowed to be found in foods that is a maximum of 2% [14].

Table 2. The Results of Evaluation on Yellow Pumpkin Powder Enriched by Its Seeds

Formula	Moisture Content (%)	Total Ash Content (%)	Acid insoluble ash content (%)	Fiber content (%)	Linoleic acid content (%)
I	11.800	8.370	2.180	6.610	0.042
II	11.950	8.570	2.480	7.180	1.030

Formula I = powder without the addition of seeds
Formula II = powder with enriched seed

a. Moisture Content

Moisture content analysis is carried out to determine the level of water content in the production of flour or powder products. The moisture content of the ingredients can influence the quality and stability of flour, especially during storage process. Moreover, water content also plays an important role in consumer acceptance (acceptability) and it also determines the formation of organoleptic characteristic such as texture, shape and flavor. Each food ingredients have a different water composition according to the type of ingredients, including flour which is physically a dry powder [15].

Determination of water content is adjusted to the constituent components of food ingredients. The method of the water content determination on pumpkin powder which has sugar and fat content from the addition of pumpkin seeds is determined by using azeotropic distillation which specifically only drag in water. However, if using thermogravimetry by direct heating at a temperature of 100 °C, the content of sugar and fat in

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flour can be oxidized and produce H_2O and O_2, so that it can increase the value of moisture content more than the actual value [15].

Observation data of moisture content on pumpkin powder can be seen in **Table 2**. The results of the data analysis of the moisture content in yellow pumpkin powder on flour without seed addition were 11.80% and the moisture content on flour with seeds addition was about 11.95%.

The moisture content obtained here is still in the range of moisture content that is still allowed according to SNI requirements for flour quality which is 14.5% [13].

a. Ash Content

Determination of ash content in flour aims to determine the mineral content contained in flour. Determination of ash content carried out by the gravimetric method includes determination of total ash content and acid insoluble ash content as an evaluation of the manufacturing process. The high content of acid insoluble ash indicates the presence of impurities such as silicates and sand entering the manufacturing process [15].

The results of ash content determination that has been carried out on both formulas can be seen in **Table 2**. The total ash content was 8.57% and 8.37% has exceeded the total ash content that is still allowed by the flour quality on SNI requirements, specifically 1-5%. The cause of the higher ash content is assumed to be due to the addition of food additives such as calcium carbonate and colloidal silicon dioxide (aerosil) as anti-flat against flour. Calcium and silicon are inorganic compounds that can increase mineral content.

b. Fiber Content

The method used in determining fiber content is the detergent method. The method of analysis using detergent method (neutral fiber detergent, NDF) is carried out by the gravimetric method which can only measure fiber components that are not soluble either under acidic or basic conditions. Insoluble fiber will shorten food transit time, inhibit absorption of other nutrients, and it will increase stool mass. The fiber content contained in pumpkin powder products is suitable to be used as practical food ingredients to increase daily fiber intake.
Based on statistical tests using *T-Test*, the addition of pumpkin seeds significantly influences the increase in fiber content with $p < 0.05$. The level of fiber content on seedless pumpkin powder is 6.61% and the fiber content in the added-seed powder is 7.18%. Increased levels of fiber in powder has become 7.18% and it suit the daily intake of insoluble fiber content according to Green (2000) of total dietary fiber intake around 6,5-7% is an insoluble fiber component.

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c. Linoleic Acid Levels

Linoleic acid was isolated from flour using a fat solvent, which is n-Hexan in the form of total fat and formed into fatty acid methyl ester compounds through the esterification process. Total fat that has been isolated and dried will be dissolved in n-Hexane and reacted with NaOH in methanol, so that it can release fatty acids and glycerol. NaOH acts as a catalyst that will help accelerate reactions and hydrolyze fats into fatty acids and glycerol. Esterification with base catalysts is preferable to do rather than with acid because it does not require heat, thus avoiding the reduction of ester levels due to the ester evaporating. The process is carried out in neutral and water-free conditions, this is done to avoid the hydrolysis of ester compounds due to saponification. Saponification reactions are greatly avoided because they can reduce the production of ester compounds and cause the separation of glycerol due to emulsion formation [16].

Fatty acids that have been formed in the form of fatty acid esters have a lower boiling point and are volatile so they can be analyzed using gas chromatography. Measuring conditions using gas chromatography with a flame ionization detector (FID) in the condition of DB-WAX 30 m column with a column temperature of 195 ^oC, injection temperature of 250 ^oC, detector temperature of 280 ^oC. At the time of injection of the sample, the fatty acid ester will be formed in a gaseous form and the column temperature is adjusted in such a way that the analyte is still maintained in gas form. Gas will flow through the column with the carrier gas. The carrier gas used was nitrogen that was inert to both columns and analytes, with a flow rate of 50 ml / minutes and attenuation of 10, injection volume of 1 µL, H_2 pressure of 1.5 kg / cm2 and pressure of O_2 1.9 kg / cmO^2.

The results of measurements of linoleic acid retention time from both samples are close to the standard retention time values. Based on measurements by gas chromatography, it was obtained linoleic acid levels in both flour formulas without addition of seeds and seeds enriched consecutively were 0.042% and 1.030%. Based on the results of the Independent T-Test statistical test, the addition of pumpkin seeds to pumpkin powder significantly affected the improvement in linoleic acid levels with $p < 0.05$.

d. Hedonic Test

Hedonic test or organoleptic test is carried out to assess consumer preferences or responses to the product using the senses. Parameters of preference were made for the color, odor, and texture of pumpkin powder and the taste of pumpkin powder processed product combined with the seeds, it was called as marrow porridge. From the data in Figure 3, it states that 60-80% of panelists fond of both flour and pumpkin flour processed products enriched with seeds.

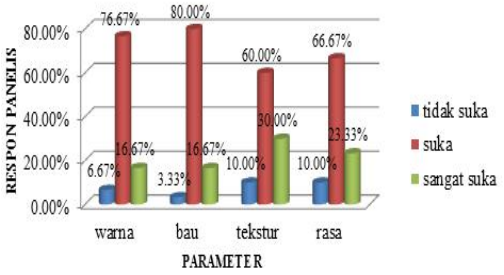

Fig 3. Diagram of the result of Hedonic Test on Powder and Processed Yellow Pumpkin Powder

4. Conclusions

Based on the results of research on making pumpkin powder enriched with seeds, it can be concluded that:

a. Based on the results of the Independent T-Test statistical test, the addition of pumpkin seeds to yellow pumpkin powder significantly affected the levels of linoleic acid and fiber with $p < 0.05$.
b. Fiber content without the addition of seeds and with the addition of seeds consecutively was 6.61% and 7.18%.
c. Linoleic acid levels without and with the addition of seeds were 0.042% and 1.030%.
d. Test of the quality of powder with enriched seeds that was seen from the parameters of moisture content still meets the SNI requirements, approximately 11.96%, while the ash content does not meet the SNI requirement, which was 8.57%.

Suggestions

There are several suggestions for the future researchers who will conduct the development of this research:

a. It is necessary to develop formulas such as making food supplements made from pumpkin seeds which are rich with linoleic acid and has been proven to have potential benefits for health, so that pumpkin seeds are not only used as waste or rubbish.
b. Further research needs to be done so that diversification of food with the ingredients of pumpkin enriched with seeds can be used as an alternative food for diet, especially for people who has risk of coronary heart disease.

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