EFFECT OF DRYING METHOD ON PHYSICOCHEMICAL PROPERTIES OF PUMPKIN FLOUR

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Abstract

*Yellow pumpkin is one of the most abundant foodstuffs in Indonesia. One of its uses is to become flour so that it can be used as a base for food preparations and can be stored in the long term. This study aims to determine the effect of the drying method on physicochemical properties and nutrient content and β-carotene in pumpkin flour. This study uses two methods of drying tray drying and drum drying with three varieties of pumpkin, namely Cucurbita maxima D, Cucurbita maxima L and Cucurbita moschata. The results showed that drying tray drying and drum drying did not provide significant data differences in water content, protein content, ash content, carbohydrate content and fiber content of pumpkin flour produced from three varieties. But the drying method makes a difference to the fat content of pumpkin flour. The range of starch water content in three pumpkin varieties is between 11% -22.67%, ash content 9.39% -11.95%, protein content 6.06% -16.57%, fat content 1.3% -6.58%, carbohydrate content 65.47% -80.35%, crude fiber 8.21 % -21.55%. The drying method does not give different data on the content β carotene of pumpkin flour. The β carotene content of pumpkin flour ranges from 0.84 mg / g-2.8 mg / g. The drying method yields different water absorption and bulk densities on Curcubita maxima D flour. The absorption capacity of pumpkin flour ranges from 6.86 ml / g-9.41ml / g. Bulk density of flour is between 0.56 g / ml-0.75 g / ml and flour yield based on the total weight of fruit ranges between 6.29% -10.11%. The drying method does not make a difference in the brightness value of the flour, but produces a difference in the value of a (redness) and b (yellowness). The brightness value of flour (L) ranges from 72.41-85.57, the value of a * range from 7.86-21.79, the value of b * ranges between 44.14-59.5. In the gelatinization profile analysis, the drying method gives peak viscosity data and gelatinization time is significantly different in the resulting pumpkin flour. The peak viscosity of pumpkin flour ranged from 1298cP to 3964cP, through ranged from 1303cP-177 cP, Final viscosity ranged from 1941cP to 3342 cP, peak time ranged from 2.3 to 13 seconds, and pasting temperature between 50.1-93.4°C. Conclusions from the results of the study this drying method affects physical and chemical properties in pumpkin flour.*

Keywords *: Pumpkin flour, tray drying, drum drying, β-carotene, physicochemical.*

1. Introduction

Pumpkin is a family *cucurbitacea* sp. This plant is a specific type of yellow vegetable. The older the pumpkin, the more orange the color indicates the higher carotene content of 3,915 µg / gr [1]. Research results [2] showed that pumpkin contains β-carotene among 92.21–97.5%. The results of the study [3] showed that the pumpkin had total carotenoids 234.21–404.98 µg / g, α-carotene 67.06-72.99 µg / g, and β-carotene 244.22-141.95 µg / g. Pumpkin contains alkaloids and flavonoids [4]. The active component contained in pumpkin shows that the extract of pumpkin (*Cucurbita moschata*) has a hypoglycemic effect and acts as an antidiabetic [5]. Pumpkin extract using alcohol turned out to be able to reduce fasting blood sugar by increasing insulin production from pancreatic beta cells and can reduce cholesterol and triglyceride levels and increase HDL, so pumpkin can have potential as antidiabetic and antihyperlipidemic [6]. Pumpkin plants can also be used as traditional medicine as anti-diabetic, anti-hypertensive, anti-tumor, immunomodulating, and anti-bacterial because they contain many nutrients and bioactive compounds such as phenolics, flavonoids, vitamins (including vitamins β-carotene, vitamin A, vitamin B2, α-tocopherol, vitamin C, and vitamin E) [7]. According to [8] pumpkin has a water content (93.64%) protein (0.63%), fat (0.09%), fiber (66%) and beta carotene (17.5 µg / g). The protein and carbohydrate content in pumpkin shows anticancer activity [6]. Pumpkin extract with ethanol can improve performance in mice and can be used as an anti-weak diet and can increase energy [9].

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Currently the use of pumpkin is still limited to traditional food processing such as *dodol* (kind of traditional snack in Indonesia), compote, pickles, sweets, vegetables, soups, puddings, wet cakes, and other foods with a short shelf life and limited distribution [10]. Considering the important role of active ingredients in pumpkin, it is necessary to further study the processing of pumpkin. Pumpkin has a high moisture content and good nutritional content so it is easily damaged. The large volume is also a problem in the storage and distribution of pumpkins to other places. The best alternative processing is made into flour. Research into the manufacture of pumpkin flour has been widely carried out, including [11] using a treatment with sodium metabisulfite 0.2% (W / V) immersion. Soaking sodium metabisulfite can increase protein content, beta carotene, and antioxidant activity in pumpkin flour. The results of the study of making pumpkin flour using sunlight obtained a yield of pumpkin flour 10.49% with carbohydrate content 14.22%, protein content 10.12%, fat content 4.87%, fiber content 10.28%, water content 11.88%, and 7.73% ash content [12]. But drying with sunlight has many weaknesses, including lack of hygiene and difficulty controlling temperature. The right drying method will determine the quality of flour produced.

To find out what types of products can be made from pumpkin, it is necessary to know the characteristics of the flour produced. The development of a variety of processed food products must be supported by the availability of information about the characteristics of the raw materials used because the characteristics of a material will determine the desired product characteristics. The object of research is pumpkin from three varieties which are quite numerous in West Java, namely *Cucurbita maxima* D (pumpkin), *Cucurbita maxima* L. (kabocha) and butternut squash (*Cucurbita moschata*). In this study using two drying methods, namely by using a drum dryer and tray dryer. Both of these drying methods will produce flour with different characteristics, so it is necessary to analyze the chemical content, physical properties and profile of flour gelatinization which are the objectives of this research.

2. Detailed Experimental

a. Materials

Dryers used are Tray dryer and Double rotary drum dryer, slicer, discmill, 60 mesh sifter and analytical equipment such as ovens, analytical balance, UV-VIS spectrophotometer. The materials used are three pumpkin varieties, namely *Cucurbita maxima* D., *Cucurbita maxima* L., Obtained from POLBANGTAN, Bogor and *Cucurbita moschata* obtained from Bukit Unggul Lembang Gardens.

The selection of pumpkin raw materials is determined by testing the sugar content (^{0}brix) using a refractometer so that the level of maturity is known. The variety *Cucurbita maxima* D. has a sugar content of about 7.1 - 7.5 ^{0}brix, *Cucurbita maxima* L has a sugar content of around 5-6 ^{0}brix, and *Cucurbita moschata* has a sugar content of about 10 - 10.8 ^{0}brix. Making of pumpkin flour from three varieties using Tray Drying and Drum Drying with two replications. Flow chart of making pumpkin flour (*Cucurbita* sp) can be seen in Figure 1.

b. Analysis of Chemical and Physicochemical

Water Content [13]

The cup to be used is preheated in the oven for 30 minutes at 100-105ºC. The cup is cooled in a desiccator to remove moisture and weighed. Samples were weighed as much as 2 g in a cup that had been dried then in the oven at a temperature of 100-105ºC for 6 hours. The sample was cooled in a desiccator for 30 minutes and weighed. This stage is repeated until a constant weighting is achieved.

$$\text{Water content (\% wb)} = \frac{W0 - W1}{W0 - W2} \times 100\%$$

$$\text{Water content (\% db)} = \frac{W0 - W1}{W1 - W2} \times 100\%$$

Note : W_0 : weight (empty cup + sample) before drying (g)
W_1 : weight (empty cup + sample) after drying (g)
W_2 : weight of cup (g)

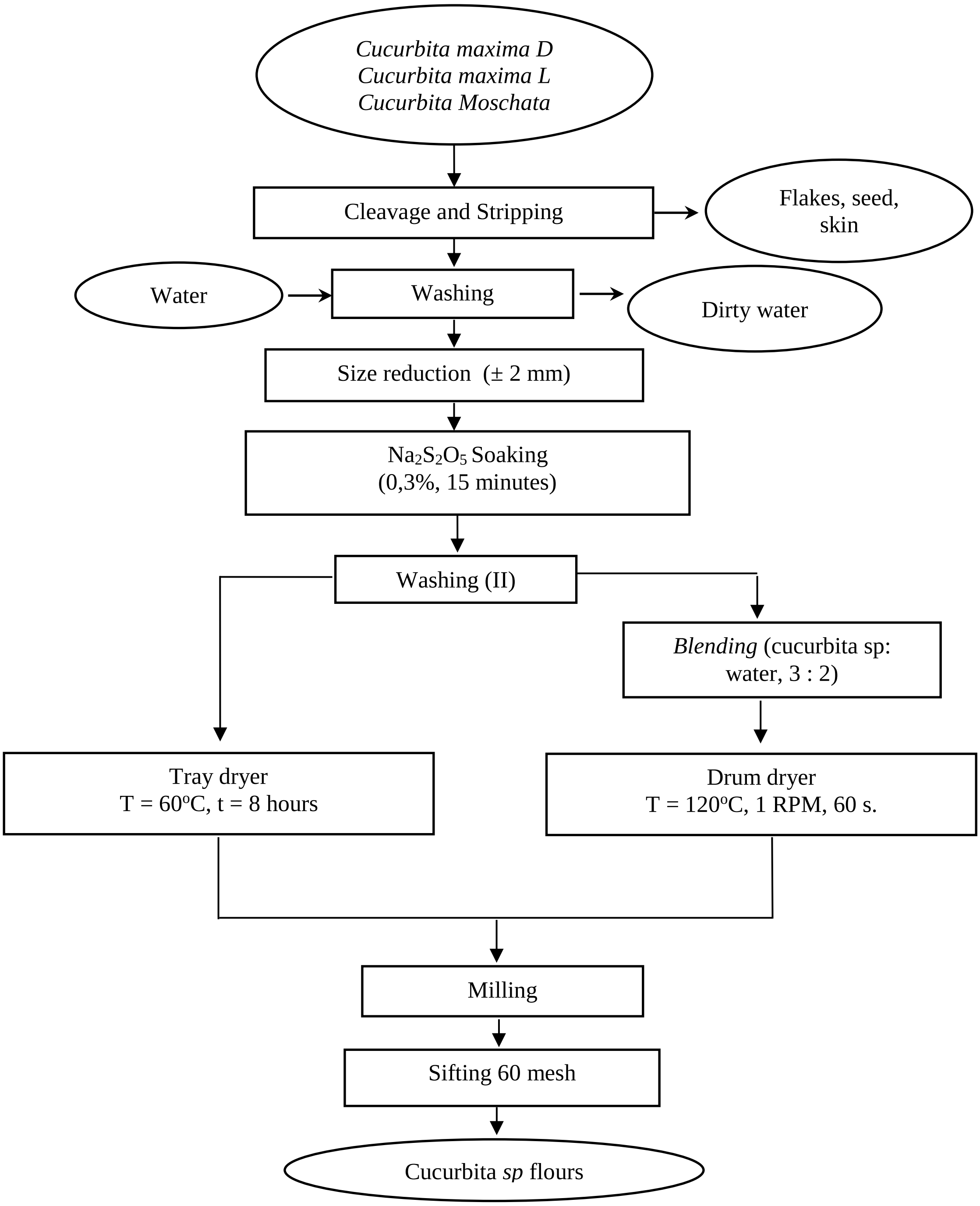

Figure 1. Flowchart of Flour Making of Three Pumpkin Varieties.

Ash content [13]

The cup to be used is preheated first in the oven for 30 minutes at a temperature of 100-105ºC. The cup is cooled in a desiccator to remove moisture and weighed. Samples were weighed as much as 2 g in a dried cup and then burned on the flame of the burner until they were not smoking and continued with ashes in the furnace with a temperature of 550 - 600ºC until complete incubation. Samples that have been refrigerated are desiccated and weighed. The combustion stage in the furnace is repeated until a constant weight is obtained.

$$\text{Ash content (\% wb)} = \frac{W0 - W1}{W0 - W2} \times 100\%$$

Note: A: weight of empty cup (g)
B: weight of cup + initial sample (g)
C: weight of cup + sample after ash (g)

Protein content [13]

Sample weighed 0.5 g, put into a 100 ml kjeldahl flask, added with two spades of selenium reagent, added H_2SO_4 12.5 ml of, then decocated for 3-4 hours or until the solution turns clear and SO_2 disappears. The solution is allowed to cool. Making a container for distillation is done by giving H_3BO_3 as much as 20 ml then adding 2 drops of the methyl red indicator. Then the solution that has been destructed when it has cooled is put into the distillation apparatus and its reservoir, added with 3 ml NaOH and distilled. Then it is titrated with 0.1024 N HCl solution until the solution changes color to clear yellow.

Protein content (% wb) = % N x correction factor

$$\% \text{ N} = \frac{Vs - Vb \times N \times 14{,}007}{W} \times 100\%$$

Note : Vs : the volume of HCl spent on sample titration (ml)
Vb : volume of HCl spent on titration blank (ml)
N : normality HCL (N)
W : sample weight (mg)

Fat content [13]

The fat flask to be used is heated in the oven for 30 minutes at a temperature of 100-105ºC. Then cooled in a desiccator to remove moisture and weighed. The sample was weighed as much as 2 g and then wrapped in filter paper, covered with fat-free cotton and put into a Soxhlet which had been connected with a fat flask. The sample has been heated beforehand and the weight is known. The hexane solvent is poured until the sample is submerged and refluxed or extracted for 4-5 hours or until the fat solvent drops into a clear fat flask. Fat solvents that have been used, refined, and collected. The fat extract in the fat flask is dried in an oven at 100-105ºC for 1 hour. Pumpkin fat is cooled in a desiccator and weighed. The drying stage of the pumpkin fat is repeated until a constant weight is obtained.

$$\text{Fat content (\% wb)} = \frac{W1 - W2}{W0} \times 100\%$$

Note : W_0 : sample weight (g)
W_1 : fat pumpkin weight + extracted fat (g)
W_2 : empty fat pumpkin weight (g)

Carbohydrate content [14]

Carbohydrate by difference levels are obtained from the measurement of number 100 reduced by the percentage of components (water content, ash content, crude fat content and crude protein content).

Crude Fiber Levels [13]

A sample of 2 g was put into a 250 ml Erlenmeyer flask and then added 50 ml of H_2SO_4 1.25 N, hydrolyzed for 30 minutes at 100 ° C. After that it is cooled and added again with 3. ml of 3.25 N NaOH and hydrolyzed again for 30 minutes. The sample was filtered using Whatman No. filter paper 41 which is known to weigh. The filter paper was washed consecutively with boiling distilled water, 25 ml H_2SO_4 1.25 N, then boiled distilled water and finally washed with 95% ethanol. The filter paper that has been washed is then dried in an oven at 105 ° C for one hour. Drying is carried out to a constant weight and then calculated levels of crude fiber in the material in filter paper filter paper.

$$\text{Crube fiber (\% wb)} = \frac{C - B}{A} \times 100\%$$

Note: C = filter paper weight + residue
B = filter paper weight
A = sample weight

β-carotene content [15]

Making the standard curve is done by making a number of concentrations of standard raw materials *β*-carotene: 0.50 mg; 0.75 mg; 1,00 mg; 1.25 mg; 1.50 mg; 1.75 mg and 2.00 mg, dissolved with 2.5 mL acetone, added with n hexane to 25 mL, shaken until homogeneous. Pipette 2 mL of this solution, added n-hexane to 10 mL, shaken until homogeneous. Making blanks by inserting 0.2 mL acetone in a measuring cup, dissolved with n-hexane to 10 mL. Each solution is measured at absorption at a wavelength of 450 nm. Then a calibration curve is made, absorption as ordinate and concentration as abscissa. Determination of β-carotene levels by weighing 3 grams of sample that has been blended, adding 40 mL acetone and 60 mL n-hexane and 0.1 gram magnesium carbonate, let stand for 1 hour, filtering, the residue obtained then extracted again with 25 mL acetone (done 2 times). The residue obtained was then extracted again with n-hexane 25 mL, filtered all the filtrate obtained was mixed into a separating funnel and carried out separation by adding 100 mL aquadest 5 times, the top was accommodated in a 100.0 mL volumetric flask containing 9 mL acetone, diluted with n-hexane. The blank consisted of 0.9 mL acetone dissolved with n-hexane to 10 mL, shaken until homogeneous, the absorption was measured at a wavelength of 450 nm.

Yield

Yield is obtained from the ratio between the weight of dry flour produced with the weight of fresh ingredients.

Water holding power [16]

Sample 1 gram was added 10 ml of distilled water ($V_{1)}$.After mixing the two into a tube *centrifuge*, the tubes were mixed for 30 seconds and then allowed to stand for 30 minutes at room temperature. After settling for 30 minutes, the tube is then centrifuged at a speed of 3000 rpm for 20 minutes. After that, a supernatant is obtained which is then filtered using filter paper and the volume is measured (V_2).

Water holding capacity (ml / g) (wb) =

$$\frac{V1 - V2}{W}$$

Note : V1 = volume of distilled water supplied (mL)
V2 = supernatant volume after filtering (mL)
W = sample weight (g)

Color [17]

Measurement of color parameters of pumpkin flour was carried out using *Minolta Chroma Meter* CR-310. The principle of this tool is to measure the difference in color stimulated by the light reflected by the surface of the sample. The Hunter Lab color system has three attributes namely L, a, and b. L shows the brightness of the sample. The scale used for sample brightness is 0 (black) to 100 (white). A value indicates the degree of red or green of the sample. A positive (0-100) indicates red, a negative (0- (-80)) indicates green. A value of b indicates the degree of yellow or blue of the sample. A positive b value (0-70) indicates yellow and a negative b value (0- (-70) indicates blue.

Bulk Density [18]

The sample is weighed as much as 20 g, then put into a 100 ml measuring cup. The bottom of the measuring cup patted several times until a constant volume is obtained Starch.

Gelatinization Profile (RVA)

Analysis of starch gelatinization profile was carried out using Rapid *Visco Analyzer (*RVA) Before measurement with RVA, the sample water content must be measured first A number of samples and distillate water were weighed and inserted into the canister. The number of samples and the water distillate is determined by a program on the appliance RVA according to the water content of the sample. Then, the mixture was stirred using a *paddle* plastic until miscible to avoid clot formation before it is inserted into the RVA. The sample is then inserted in the tool RVA and analysis is performed, then the heating and cooling cycles and constant stirring are arranged for 23 minutes. Samples were heated to 50˚C and maintained for 1 minute. Then the sample is heated again to a temperature of 95^0C for 7.5 minutes. The temperature of 95˚C is maintained for 5 minutes before it is cooled down to 50˚C for 7.5

minutes. 50^0C is maintained for 2 minutes. The parameters observed were initial gelatinization temperature, maximum viscosity (*peak viscosity),* viscosity at a temperature of 95^0C, viscosity at a temperature of 50^0C, viscosity *breakdown*, and viscosity *setback.*

c. Data Analysis

Data analysis used in this study uses the Statistical Product and Service Solution (SPSS) program. The statistical test used was a paired T test with a confidence interval of 95% (α = 0.05). Data interpretation of flour gelatinization profile was done descriptively.

3. Result and Discussion

Chemical Analysis of Flour Three Varieties of Pumpkin Yellow

Table 1. Results of Chemical Analysis of Flour Three Varieties of Yellow Pumpkin

Chemical analysis (proximate)	*Cucurbita maxima* D		*Cucurbita maxima* L		*Cucurbita moschata*	
	Drum drying	Tray drying	Drum drying	Tray drying Tray drying	Drum drying	Tray drying
Moisture content (% db)	22.67 ± 1.56^a	16.52 ± 0.28^a	12.62 ± 1.28^a	12.39 ± 0.44^a	11 ± 1.61^a	15.31 ± 0.47^a
Ash content (% db)	11.95 ± 0.78^a	9.39 ± 0.36^a	11.82 ± 1.40^a	11.29% ± 0.27^a	11.37 ± 0.71^a	10.24% ± 0.44^a
Protein content (% db)	13.05 ± 4.87^a	13.47 ± 0.51^a	16.07 ± 1.49^a	16.57 ± 0.08^a	6.06 ± 1.83^a	8.44 ± 0.34^a
Fat content (% db)	6.58 ± 0.24^a	5.25 ± 0.23^b	1.30 ± 0.09^b	1.77% ± 0.10^a	2.19 ± 0.05^a	1.79% ± 0.38^a
Carbohydrate (% db)	65.47 ± 1.02^a	71.90 ± 0.06^a	70.27 ± 0.98^a	70.36 ± 0.09^a	80.35 ± 2.60^a	79.53 ± 0.48^a
crude fiber (% db)	21.20 ± 0.19^a	21.55 ± 0.32^a	15.58 ± 0.02^a	18.93 ± 0.51^a	8.21 ± 0.21^b	14.02 ± 0.37^a
Energy (Cal)	373.96 ± 12.3^a	388.78 ± 0.16^a	357, 12 ± 1.18^b	363.69 ± 1.58^a	365.37 ± 2.57^a	367.97 ± 0.18^a

Note: Different letter notations on the same line show significantly different at α: 0.05

Results of research on Table 1 shows the drying by tray drying method and drum drying did not provide significantly different data on water content, protein content, ash content, carbohydrate content and fiber content of pumpkin flour from three varieties. However, the drying method shows differences in fat content in the three pumpkin flour varieties. The drying drum drying method produces higher fat content than the tray drying method.

Water content of pumpkin flour from 3 varieties ranged from 11% to 22% (db). The amount of water in the material will affect the resistance of the material to damage caused by microbes and insects. Drying in flour aims to reduce the water content to a certain extent microbial growth and the activity of enzymes that cause damage. According to [20] the limit of moisture content in microbes that can still grow is 14-15%. The data above shows that the moisture content produced from the two drying methods is not enough to protect pumpkin flour from microbial damage and enzyme activity that causes flour damage. The water content of flour *Cucurbita maxima* D is greater than the flour water content of other pumpkin variants.

Ash content of 3 pumpkin varieties by drying drum drying is higher than tray drying. Ash content indicates the amount of minerals present in pumpkin flour. The two drying methods do not give different results on the ash content. According to [21] states that ash content is not affected by chemical and physical processes, and only about 3% of the food cooking process is lost.

Protein content in pumpkin flour ranges from 6% -16%. The highest protein content is owned by *Cucurbita maxima* L flour, followed by *Cucurbita maxima* D flour and the lowest is flour *Cucurbita moschata*. According to [22] protein content in flour is expected to be high because it is related to its application which will not require substitution of other ingredients.

The fat content of 3 pumpkin varieties shows *Cucurbita maxima* D has the highest fat content, which is 6.58 (drum drying) and 5.25 (tray drying). Pumpkin fat content is high because of the presence of fat-soluble carotenoid pigments. However, high fat content is very susceptible to rancidity in flour because fat is more easily oxidized.

Crude fiber content consists of cellulose, a little lignin and hemicellulose. Pumpkin flour from 3 varieties has a fairly high fiber that is in the range of 8% -21%. Of the three varieties, flour *Cucurbita maxima* D has the highest crude fiber content reaching 21.55%. Pumpkin flour can be used as a material with a good source of fiber for foods that require high fiber. According to [23] food is said to be a source of fiber if it has a fiber content of 6 g / 100g. This means that pumpkin flour from these three varieties can be said to be a food with high fiber content.

Research results [24] flour *Cucurbita maxima* D (db) produced data of 10.79% water content, 6.78% ash content, 9.39% protein content, 4.65% fat content, 79.18% carbohydrate, 23.72% fiber content, 13.53% food fiber %, starch content 34.34%. This result is no different from the results of the study using the same drying method, tray drying.

For energy per 100 grams of flour the three pumpkin varieties give no different results for the two drying methods. Pumpkin flour energy produced from method tray drying for *Cucurbita maxima* D is 388.78 Kcal while for four *Cucurbita maxima* L is 363.9 Kcal and flour *Cucurbita moschata* 367.97 Kcal. In the method drum drying for flour *Cucurbita maxima* D is 373.96 Kcal, flour *Cucurbita maxima* L is 357.12 Kcal and *Cucurbita moschata* is 365.37 Kcal

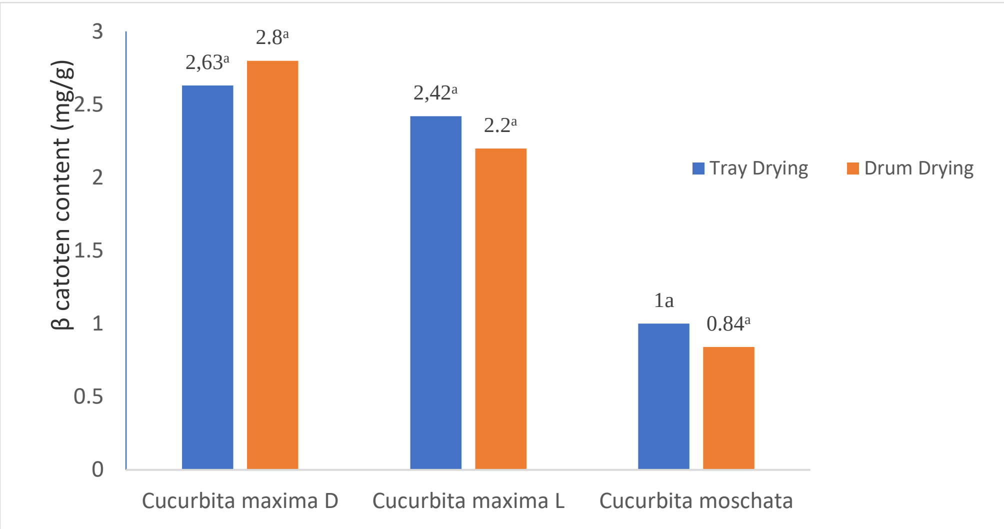

Figure 2. β Carotene content of three Yellow Pumpkin Flours

The beta carotene content of each flour pumpkin for both drying methods provides relatively the same data. This means that both drum drying and tray drying produce beta carotene levels for each pumpkin flour is not significantly different. The type of drying method does not produce a significant difference in the beta carotene content. The highest beta carotene content is owned by *Cucurbita maxima* D, which is 2.80 mg / g (drum drying) and 2.63 mg / g (tray drying). The lowest content of flour *Cucurbita moschata* is 0.84 mg / g (drum drying) and 1 mg / g (tray drying). When compared with fresh pumpkin β carotene content, all drying methods can reduce beta carotene content. Beta carotene has a double bond structure that causes beta carotene to be easily oxidized when exposed to air (O_2). The oxidation process will take place more quickly in the presence of light, a metal catalyst and a high heating process. This resulted in a change in the structure of the trans beta carotene to cis beta carotene. This form of cis beta carotene has lower provitamin A activity [25]. The β carotene content of the three pumpkin varieties shows differences in the β carotene content. The total carotenoid content is strongly

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influenced by variety, level of maturity, place of growth, climatic conditions, harvest, storage conditions [26].

Physical Analysis of Three Pumpkin Flour Varieties

Table 2. Physical Analysis of Yellow Pumpkin Flour Three Varieties

Analysis of Physical Properties	*Cucurbita maxima* D		*Cucurbita maxima* L		*Cucurbita moschata*	
	Drum drying	Tray drying	Drum drying	Tray drying	Drum drying	Tray drying Tray drying
Water absorption (ml / g) db)	6.86 ± 0.07[b]	9.41 ± 0.19[a]	7.40 ± 0.10[a]	7.13 ± 0.37[a]	9.16 ± 0.01[a]	9.31 ± 0.34[a]
Bulk density (g / ml) (db)	0.72 ± 0.01[a]	0.55 ± 0.01[b]	0.68 ± 0.02[a]	0.56 ± 0.01[a]	0.75 ± 0.01[a]	0.64 ± 0.01[b]
Yield of flour / whole fruit (%) (db)	7.66 ± 0.63[a]	8.38 ± 0.86 [a]	6.29[a]± 0.04[b]	10.11 ± 0, 12 [a]	7.66 ± 0.49[a]	8.36 ± 0.94 [a]

Note: Different letter notations on the same line show significantly different at α: 0.05

Water absorption is the ability to absorb water and hold it in a food system. Water absorption and binding is one of the functional properties [27]. The higher the water absorption of flour, the better the quality of flour because the flour is able to absorb water well [28]. The water absorption capacity can determine the amount of water available for the starch gelatinization process during cooking and also the function of this absorption facilitates the homogeneity of the flour mixture when mixed with water so that flour with high water absorption tends to be homogeneous quickly [29]. Data from Table 2 shows the drying method provides different water absorption in flour *Cucurbita maxima* D. However, water absorption for the two other pumpkin varieties did not show different data for the two drying methods.

Bulk Density is one of the physical properties possessed by various agricultural materials that can be used to plan a storage place, the volume of equipment used when processing, or as a means of transportation [30]. Buk density is the ratio between the weight of the material and the volume of the material itself with the final unit g / ml. The higher the Bulk density of a product, it can be interpreted that the product is concise and dense [31]. The data in Table 2 shows that the drying method has an effect on the bulk density on each pumpkin flour. Bulk density value from drying drum drying gives a higher value than drying tray drying. This means that flour produced from drying drum drying is denser than flour by drying tray drying.

Yield measurement is done to find out the amount of loss during the drying process. Data Table 2 shows that the drying method has no effect on the yield of *Cucurbita maxima* D and *Cucurbita moschata*, but it has an effect on the *Cucurbita maxima* L. The yield of pumpkin flour is relatively low, only about 7-10% compared to the yield of canna flour (canna) 12.94%, flour flour 11.56% (*Amorphophallus campanulatus*) and gembili (*Dioscorea esculenta*) 21.44% [22].

Table 3. Color Analysis of Yellow Pumpkin Flour Three Varieties

Color Analysis of flour	*Cucurbita maxima* D		*Cucurbita maxima* L		*Cucurbita moschata*	
	Drum drying	Tray drying	Drum drying	Tray drying	Drum drying	Tray drying
L *	72.96 ± 0.24[a]	72.41 ± 1 , 85[a]	81.46 ± 0.05[a]	85.57 ± 0.64 [a]	79.30 ± 1.38[a]	80.25 ± 1.17 [a]
Color a *	14.20 ± 1.09[a]	21.79 ± 0.06 [a]	7.86 ± 0.97[a]	10.37 ± 0.18[a]	11.02 ± 1.06[b]	16.00 ± 0.95[a]

Color b *	44.23 ± 1.32[a]	47.29 ± 1.66[a]	48.25 ± 0.45[b]	58.59 ± 1.59 [a]	44.14 ± 2.00[a]	48.78 ± 1.02[a]
Color c *	46.46 ± 1.59[a]	52, 08 ± 1.53[a]	48.89 ± 0.60[b]	59.50 ± 1.59 [a]	45.51 ± 1.67[a]	51.35 ± 0.68[a]
H *	72.20 ± 0.78[a]	65 , 21 ± 0.66[b]	80.75 ± 1.04[a]	79.96 ± 0.10 [a]	75.93 ± 1.91[a]	71.83 ± 1.36[a]

Note: Different letter notations on the same line show significantly different at α: 0.05

Data in Table 3 shows the drying method (drum drying and tray drying) does not give different results to the value of L (brightness) from three pumpkin flour varieties. The highest brightness level is owned by flour, *Cucurbita maxima* D which is L value, range 81-85%.

The drying method on three pumpkin flour varieties gave significantly different results on the parameter values a* and b *. The drying method provides different a * values for *Cucurbita moschata* but a* values are not significantly different for other pumpkin varieties. The highest a* value is *Cucurbita maxima* D flour worth 21.79 and the lowest is *Cucurbita maxima* L. flour with a value of 10.37, meaning the flour *Cucurbita maxima* D has the reddest color. The tray drying method gives flour results more reddish than drum drying.

The drying method (drum drying and tray drying) did not give different results for *Cucurbita maxima* D flour and *Cucurbita moschata* flour against the b * *(yellowness)* parameter. However, it gives different b* data on *Cucurbita moschata* L flour. The tray drying produces *Cucurbita moschata* flour which is more yellow than drum drying. This color difference also shows the difference in the amount of β carotene pigments that are owned. When compared with the β cathotent data in Figure 2, the results of drying with tray drying produce beta carotene levels which tend to be higher (statistical analysis shows no significant difference). The results of the study [22] of flour *Cucurbita maxima* D.produced a value of L 53.85, a* value of 10.46 and value of b* 44.55 by drying tray drying. When compared with the results of research flour, flour produced is brighter and redder, but has almost the same yellow color.

The degree hue (h^o) indicates the color that is seen. The value of hue in pumpkin flour is between 65-80 which indicates red yellow. For color comparison of the three varieties of pumpkin flour can be seen in Figure 3 and Figure 4.

Cucurbita maxima D *Cucurbita maxima L* *Cucurbita moschata*

Figure 3. Three varieties pumpkin flour with Tray Drying method

Cucurbita maxima D *Cucurbita maxima L* *Cucurbita moschata*

Figure 4. Three varieties pumpkin flour with Drum Drying Method

Gelatinization Profile of Three Pumpkin Flour Varieties Yellow

The gelatinization profile of pumpkin flour is monitored using Rapid Visco Analyzer (RVA). RVA is a viscometer that uses heating and cooling methods as well as to measure the resistance of the sample to handle with controlled stirring. The principles of RVA measurement are the same as those of Brabender Amilographs, except that the measurement time is shorter (15-20 minutes). RVA is used to provide a simulation of the food processing process and is used to determine the effect of the process on the structural functional characteristics of the mixture [32].

Table 4. Profile Yellow Pumpkin Flour Gelatinization 3 Varieties

Profile gelatinisasi flour	*Cucurbita maxima* D		*Cucurbita maxima* L		*Cucurbita moschata*	
	Drum Drying	dryingTray	Drum drying	Tray Drying	drying drum	Tray drying
Peak (cP)	1298	2474	1488	1535	1776	3964
Through (cP)	1303	1767	1496	1402	1488	1450
Breakdown (cP)	-5	707	-8	133	288	2514
Final (cP)	2187	3342	3052	1941	3136	3304
Setback (cP)	884	1575	1556	539	1648	1854
Peak time (s)	13	3.27	13	4.93	5.13	2.3
Pasting temperature ($^{o)}$C)	-	50.10	50.3	67.6	50.35	50.2

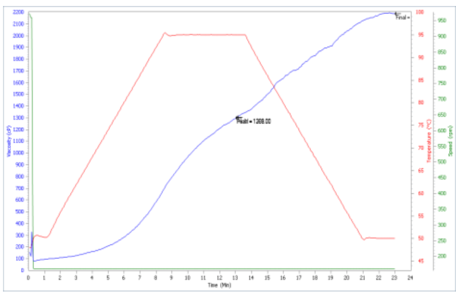
Note: Different letter notations on the same line show significantly different at α: 0.05

The initial temperature of gelatinization (pasting temperature) is the temperature at which the starch granules begin to absorb water or can be seen with the start of increasing viscosity [33]. Pasting temperature is a range of temperatures that results in almost all starches reaching maximum swelling. Gelatinization is the process of breaking bonds between starch molecules in the presence of water and heat and allows starch molecules to bind more water. The presence of water penetration will increase randomization in the structure of starch. The stronger the bonds between starch molecules, the higher the amount of heat needed to break bonds between molecules and therefore the higher the gel temperature [34]. From the data in Table 4 it can be seen that the temperature of pumpkin gelatinization ranges from 50^{o}C to 67^{o}C. The temperature of gelatinization of *Cucurbita moschata* flour produced from the two drying methods does not differ, meaning that both drum drying and tray drying temperatures are needed to break the bonds between starch molecules the same size, but the gelatinization temperature of the *Cucurbita maxima* D flour with tray drying method shows that the gelatinization temperature is higher than the flour produced from drying drum drying.

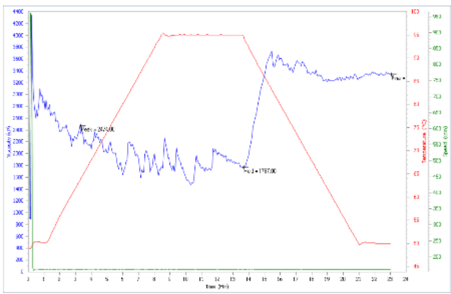
The peak time of gelatinization (peak time) is the time needed to reach the peak viscosity value or the peak of gelatinization. Table 4 shows that the peak time of gelatinization for pumpkin flour with tray drying method requires faster time than drum drying. [35] stated that a shorter gelatinization time indicates the possibility that the flour has undergone pregelatinizing. Short gelatinization time will reduce costs, while low gelatinization temperature will shorten the processing. The temperature and time of starch gelatinization are affected by the structure of amylopectin, starch composition and architecture of starch granules [36].

The peak viscosity is the maximum point of flour viscosity during the heating process and shows the initial conditions of the gelatinized starch granule or maximum development until it will break later. Peak viscosity describes the fragility of the expanding starch granule, i.e. when it first expands to burst due to stirring [37]. The results of research with two drying methods show that the tray drying method gives a higher peak viscosity value for the three pumpkin flowers than the drum drying method. This tendency is caused because when drying using a drum dryer the temperature used is already high at 120ºC for 1 minute then followed by oven drying at 55ºC for 1 hour. According to [38] the use of temperatures higher than 60ºC can cause starch gelatinization. Most likely on drum drying, almost all starch components, both amylose and starch amylopectin, have been gelatinized so that only a few granules have gelatinized.

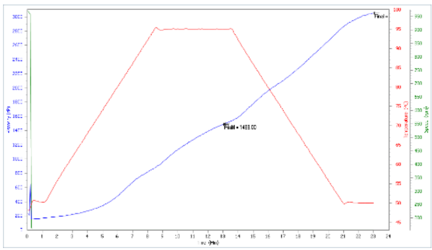
According to [39] explained that there are several factors that influence the nature of the starch gelatinization pattern including the source of starch, the size of the granules, the presence of acids, sugars, fats and proteins, enzymes, cooking temperatures and stirring. Fat content in flour can interfere with the gelatinization process because fat is able to form complexes with amylose thereby inhibiting the release of amylose from starch granules. In addition, most of the fat will be absorbed by the surface of the granules to form a hydrophobic layer of fat around the granules. As a result, this layer will inhibit the binding of water by starch granules which will cause a reduction in the amount of water and result in a decrease in viscosity [22]. Furthermore, [40] states that the formation of these complexes can reduce the tendency of amylose to bind, form a gel and retrogrades, thereby inhibiting the increase in viscosity during heating. According to [32] the protein and fat components in the ingredients can also reduce the strength of the gel which further impacts on the characteristics of gelatinization and the thickness of the material when it is processed. Interaction of protein with starch will form complexes on the surface of starch granules so that the gel strength is low and starch viscosity decreases [41]. Data Table 4 shows the thickness of *Cucurbita maxima* D flour and *Cucurbita maxima* flour tends to be smaller than the thickness of *Cucurbita moshata*. This is because the protein content and fat of both starches are higher than *Cucurbita moschata* (Table 1). The water absorption value (Table 2) also shows that *Cucurbita moschata* flour has a higher water absorption compared to the other two pumpkin flour varieties. Water absorption will affect the development of viscosity in starch due to an increase in water binding by starch molecules present in pumpkin flour.



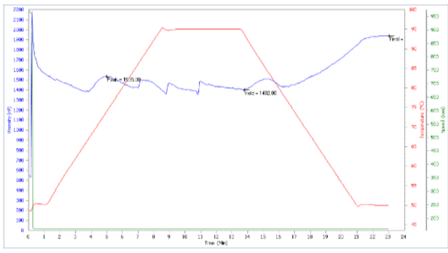
(A0)



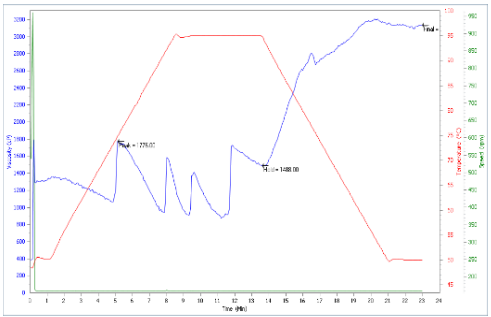
(A1)



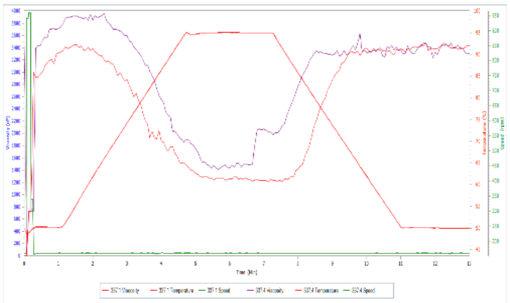
(B0)



(B1)



(C0)



(C1)

Figure 5. Pumpkin Flour Gelatinization Profile (A= *Cucurbita maxima* D, B= *Cucurbita maxima* L, C= *Cucurbita moschata*, 0 = Drum drying, 1 = Tray Drying)

Viscosity through or minimum viscosity of starch paste when heating shows stability of starch when heating, higher viscosity through values indicate stability of starch when heating. Viscosity through is the minimum viscosity at a constant temperature phase that measures the ability of starch to withstand breakdown during the heating process [42]. The highest throughput density is found in *Cucurbita maxima* D flour that is 1767 cP while *Cucurbita maxima* L flour is 1496 cP and *Cucurbita moschata* flour is 1488 cP. The two drying methods show that both methods are able to make the flour produced stable during heating, as seen from the through value is quite high for all flour from three varieties.
Breakdown viscosity shows stability of starch gel during heating. Breakdown indicates how easily the structure of the starch granule is broken or cracked [43]. According to [44] breakdown is an important factor which has an influence on the application of starch in food. When the starch granules swell and experience heat and shear, the starch undergoes fragmentation and results in a reduction in viscosity which indicates starch breakdown. Breakdown viscosity describes the stability of pasta starch during cooking and can be defined as the difference between the maximum viscosity of starch paste viscosity after reaching at 95°C [39]. Breakdown viscosity flour of three different varieties. The drying tray drying method gives a greater viscosity breakdown compared to the drum drying method for all pumpkin varieties. This means that the tray drying method is better able to sustain damage to the starch structure during heating.

According to [45] starch which has a gelatinization profile with a peak of high enough viscosity and is followed by a sharp decrease in viscosity (breakdown viscosity) during heating indicates that the starch is less resistant or less stable in the heating process. Table 4 shows that all pumpkin varieties show the insecurity or instability of all pumpkin varieties for heating. In the cooling phase, the viscosity of the starch paste gradually increases again, this is due to the recombination of amylose and amylopectin molecules through hydrogen bonds. Increased viscosity during the cooling phase also shows retrogradation of pumpkin flour. According to [45] the tendency for retrogradation of starch paste during cooling because it has quite high amylose.

Final viscosity is a parameter that shows the ability of starch to form a thick paste or gel after heating or cooling and paste resistance to shear forces that occur during stirring [37]. According to [46] and [47] the final viscosity is directly proportional to the high amylose, meaning that the higher the final viscosity value, the higher the amylose value. When viewed from the final viscosity data of the three pumpkin varieties, flour is *Cucurbita moschata* likely to have the highest amylose content between the two other pumpkin varieties because it has a final viscosity value of 3304 cP. Setback viscosity shows the ability of retrogrades during the cooling process. Viscosity Setback is a parameter used to see the retrogradation tendency of a paste and the syneresis of a starch paste [48]. Retrogradation is the process of re-crystallization of starch which has undergone gelatinization. Starch retrogradation has advantages and disadvantages that depend on its use. High starch retrogradation is undesirable in bread products because it can cause product surface hardening, reducing shelf life and consumer acceptance. However, starch retrogradation is desirable in terms of nutrition because starch digestion takes longer so that the release of glucose into the blood is not too fast [49]. Setback viscosity shows the tendency of retrogradation that occurs in amylose molecules because amylose is more easily exposed to water and easily crystallized than amylopectin [37]; [45]. The Viscosity value is a setback obtained from the difference between the final viscosity value and the heat viscosity value. The highest setback viscosity value owned by flour *Cucurbita moschata* reaches 1854 cP, it means that flour *Cucurbita moschata* tends to retrograde after being cooled compared to other pumpkin flour. The higher the setback value, the higher the tendency to form the gel during cooling. Setback value the higher is not expected for cake and cake products because it causes violence after the product has cooled. However, high setback values are good for fillers and thickener because they produce more stable products [22]. Data Table 4 shows the effect of the drying method on the viscosity value of the pumpkin flour setback shows the difference. For *Cucurbita maxima* D flour by tray drying, the value of setback viscosity is higher than drum drying. This is the reverse that occurs in *Cucurbita maxima* L. flour However, in flour it *Cucurbita moschata* does not show any changes, meaning that the viscosity value of the two sets back of the drying method produces almost the same value.

The profile of pumpkin flour gelatinization can determine the development of pumpkin flour-based products. Maximum viscosity is very influential on preparations for example for cakes and bakery products requiring low peak viscosity and high protein content, whereas for high peak viscosity either as a filler or thickener [22]. The level of viscosity also showed differences in the proportion of starch components (this study did not analyze the starch and pumpkin flour amylose content). High or low ratio of amylose and amylopectin in starch gives a big influence on the product produced. Starches with high amylose content are generally applied in gel making or film formation on biodegradable capsules forming films, making glass noodles, vermicelli and noodles. Starch with low amylose can be applied to the manufacture of baby food, paper and thickening agents [39]. From the results of the flour gelatinization profile, it is seen that the tendency for flour is *Cucurbita moschata* suitable to be used as filler and thickener because the peak viscosity is highest among the other flour and its retrograde power is quite high. As for *Cucurbita maxima* D and *Cucurbita maxima* L flour, it is suitable for making cake, cake or baby food ingredients. The drying method influences the peak viscosity data of the flour and its gelatinization period. Drying drum drying already has the ability to make the flour undergo most gelatinization so that the time to reach peak gelatinization is longer with the development of a relatively smaller viscosity.

4. Conclusion

Drying tray and drum drying methods for pumpkin flour drying show no different data on water content, protein content, ash content, carbohydrate content and fiber content of pumpkin flour produced from three varieties. But the drying method makes a difference to the fat content of pumpkin flour. The range of starch water content in three pumpkin varieties between 11% -22.67%, ash content 9.39% - 11.95%, protein content 6.06% -16.57%, fat content 1.3% -6.58%, carbohydrate content of 65.47% - 80.35%, crude fiber 8.21 % -21.55%. The drying method does not give different data on the content β carotene of pumpkin flour. The β carotene content of pumpkin flour ranges from 0.84 mg / g-2.8 mg / g. The drying method yields different water absorption and bulk density on *Curcubita maxima* D flour. The absorption capacity of pumpkin flour ranges from 6.86 ml / g-9.41ml / g. Bulk density of flour is between 0.56 g / ml-0.75 g / ml and flour yield based on the total weight of fruit ranges between 6.29% -10.11%. The drying method does not make a difference to the brightness value of the flour but it makes a difference in the value of a (redness) and b (yellowness). The brightness value of flour (L) ranges from 72.41-85.57, the value of a * ranges from 7.86-21.79, the value of b * ranges between 44.14-59.5. In the gelatinization profile analysis, the drying method gives peak viscosity data and gelatinization time is significantly different in the resulting pumpkin flour. The peak viscosity of pumpkin flour ranged from 1298 to 3964cP, through ranged from 1303-177 cP, Final viscosity ranged from 1941-3342 cP, peak time ranged from 2.3 to 13 seconds, and pasting temperature was between 50.1-93.4ºC.

Conclusions from the results of the study This drying method affects physical and chemical properties in pumpkin flour. The results of gelatinization profile and physical chemical data show that flour from varieties is *Cucurbita maxima* D and *Cucurbita maxima* L suitable for making cake and baby food ingredients. While *Cucurbita moschata* is more suitable to be used as filler or thickener.

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