Journal Techno, Vol. 9, No.2, 2023, pp. 097 - 106
ISSN. 2461-1484

THE OPTIMIZATION OF DRYING IN THE PROCESS OF TAKING GLUCOMMANAN AS PORANG FLOUR (*Amorphophallus Spp.*)

Bambang Sugiarto, Angela Merici Herdyana Proklamagita, Juana Hizkia Hasibuan, RR Endang Sulistyowati
Chemical Engineering, Universitas Pembangunan Nasional Veteran Yogyakarta
Corresponding author : bambang_tekim@upnyk.ac.id

Abstract

Porang (Amorphophallus Spp.) is one of the Indonesian commodities that are full of benefits because they contain glucomannan, but Porang also contains calcium oxalate, which is dangerous if consumed in large quantities so it requires pre-treatment such as immersion. Besides that, immersion also serves to maintain and improve the physicaland chemical quality of Porang. In this research, the immersion media used were water, salt solution (NaCl), vinegarsolution (CH_3COOH) and ethanol. Porang that have gone through the immersion process are then removed from thewater content using spinner and then dried using dehydrator. This research used drying temperature variations of 40°C, 45°C, 50°C, 55°C, and 60°C. The purpose of this research was to obtain the optimal drying temperature for the glucomannan content of Porang flour. Glucomannan content was determined using DNS method. The result showed that each immersion media had a different optimal temperature due to the difference in oxalate released.

Keywords*: Porang, glucomannan, oxalate, DNS method.*

INTRODUCTION

Indonesia is a country with abundant natural resources which makes the country becoming mega-biodiversity. However, with huge number and abundant natural resources, Indonesian are still having problems on maximize the natural resources and it cause many natural resources have not been maximally used and become concerned by the country itself. One of the natural resources or commodities which is not being maximally used is Porang Tubers which are being concerned, used and actually getting more attention from other countries due to its benefits.

According to Ferdian and friends in 2021, Porang Tubers (*Amorphophallus oncophyllus*) belong to the tuberplant of Araceae family with dominant content in it such as glucomannan (45-65%), water (79.7%), starch (2%) and crude fiber (8%).

Glucomannan is a heteropolysaccharide which is having a β-1, 4- glycosidic bond. Related to its good biodegradability and gel-shapeing ability, Glucomannan is also used on medicine, laboratories, as a basic and fundamental ingredient for cosmetics such as in the production of cleaning soap, toothpaste, shampoo and also

as an additive ingredient on the production of food such asin the production of cakes, noodles, jelly, ice-cream bread,jams, juices (Hapsari, 2020).

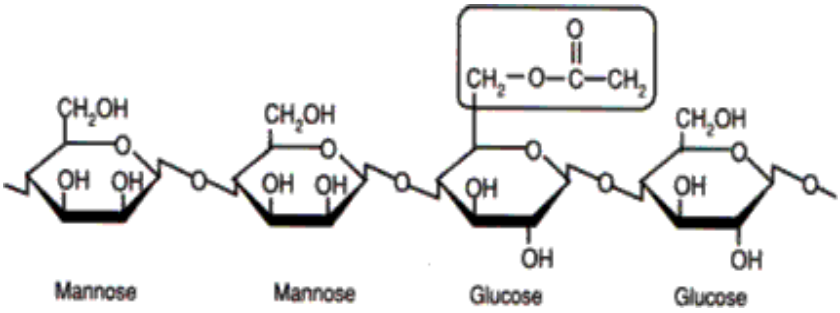

Figure 1. Glucomannnan Molecule Shapeula. (Saputro et al., 2014)

Moreover, Porang tubers also contain a chemical substance called calcium oxalate which is becoming an obstacle on processing it for human. Oxalate together withcalcium minerals in human body can shape and create insoluble compound that cannot be absorbed by the body and it will cause itching for the human skin or body. In addition, ifwe try to extract the Porang tubers, it will affectand decrease the quality of glucomannan flour and that is necessary to reduce the calcium oxalate levels (Handayaniet al, 2020).

In Post-harvest situation, Porang tubers need to be given additional pre-treatment. The initial treatment aims to maintain or improve the physical and chemical properties of the chips or Porang flour. The most commoninitial treatment is soaking Porang tubers. The oxalate compounds contained in the tubers are in the shape of oxalic acid which is soluble in water and calcium oxalate crystals which are insoluble in water.

After harvesting, Porang tubers need to be given somepre-treatment which aims to maintain or improve the physical and chemical properties of the Porang flour. Themost common initial treatment is soaking Porang tubers. The oxalate compounds contained in the tubers are in the shape of oxalic acid which is soluble in water and calcium oxalate crystals which are insoluble in water. (Wardani et al, 2019a).

In a previous study by Febri Hadi and FredyKurniawan (2021), soaking in water was able to reduce thelevels of oxalate compounds in porang tubers that were peeled to 53.53%. Soaking with water for 60 minutes and120 minutes was also able to reduce calcium oxalate levelsin porang flour, which decreased by 31.11% and 46.67%,respectively. In addition, immersion in salt solution (NaCl), showed the percentage of oxalate reduction whichtends to increase with increasing solution concentration, 15% saline solution (NaCl) can reduce calcium oxalate upto 91.6% with glucomannan content of 21.55% (Ulfa, D.A.N., & Nafi'ah, R., 2018).

In a study conducted by Ratih Kusuma Wardani and Prasetyo Handrianto (2019a), a 20% vinegar solution wasable to reduce calcium oxalate levels in porang flour by 90.27%. In another experiment, it was found that the average calcium oxalate level due to washing treatment with graded ethanol ranged from 1.28 to

0.19%. The mean levels of glucomannan due to treatment with graded ethanol ranged from 36.68 to 81.72%. (Kurniawati & Widjanarko, 2010).

Based on the background that has been described, the researcher wants to conduct further research on the effect of temperature on the glucomannan and oxalate levels of porang flour. The drying method was carried out using a dehydrator at temperatures of 40°C, 45°C, 50°C, 55°C, and 60°C to dryness. The treatment after dried Porang was floured and then tested for glucomannan levels and calcium oxalate levels.

METHODOLOGY

1. Tools and Materials

The equipments used in this research are a digital balance, food processor, spinner, burette, stative, thermometer, erlenmeyer, measuring flask, measuring cup, dropper, electric stove, dehydrator, Genesys 10 Vis UV-Vis spectrophotometer , magnetic stirrer, water bath, and centrifuge.

The ingredients used include Porang tubers (bought at Rumah Kompos & Kebun Porang Organik, Yogyakarta), acetic acid food grade 20% (v/v), acetic acid food grade 30% (v/v), ethanol Merck 40% (v/v), ethanol Merck 60% (v/v), aquadest, NaCl 14% (w/v), water, formic acid Merck KGaA, 0.1M NaOH Merck, glucose p.a. Merck KGaA, 2M NaOH Merck, 6M NaOH Merck, 3M H_2SO_4 Merck, 4N H2SO4 Merck, 6M HCl Merck, potassium sodium tartrate Merck, 3,5 Dinitro Salysilic Acid (DNS) powder (Sigma-Aldrich).

2. Method

a. Porang Flour Production

First, the Porang tubers were peeled and washed with running water, then cut using a food processor in the shape of diced. The Porang tubers were then weighed as much as 100 grams and soaked in water at 70°C for 120 minutes. After soaking the Porang tubers, they need to be washed first with water until the pH of the washing water is the same as the pH of the initial water (checking pH every 15 minutes). Then, porang tubers that have been neutral are put in a spinner to be drained. After that, the Porang tuberswere dried using a dehydrator at 40°C.

The dried Porang tubers were floured using a blender and then sieved using 100 mesh sieves. After becoming Porang flour, the glucomannan content, oxalate content, and the degree of whiteness were tested. Repeat the experimental steps with variations in drying temperatures of 45°C, 50°C, 55°C, and 60°C. Repeat the experimental steps with 1 L of 14% salt solution (NaCl) immersion media variation for 90 minutes, 30% vinegar (CH_3COOH)solution for 150 minutes, and 40% ethanol for 30 minutes.Repeating the experimental steps with variations in the shape of longitudinal slices of 1 L of 50°C water immersion was carried out for 150 minutes, 14% salt solution (NaCl) for 150 minutes, 20% vinegar (CH_3COOH) solution for 150 minutes, and 60% ethanol for 150 minutes.

b. Glucomannan

a) 3,5 – DNS Reagent Production

DNS solution was made by dissolving 1 gram of DNSpowder, 20 ml of 2M NaOH, 30 grams of Ka-Na tartrate to a volume of 100 ml (Julaeha et al, 2016)

b) Buffer Solution Production

Buffer solution (formic acid and 0.1 M NaOH) was prepared by mixing 1 ml of formic acid with 60 ml of distilled water into a 250 ml volumetric flask then weighed 0.2 g of sodium hydroxide and dissolved in 50 ml of distilled water. After that, the NaOH solution was put intothe volumetric flask and then diluted to a volume of 250 ml.

c) The Production of Standard Glucose Solution

A standard glucose solution (1 mg/ml) was prepared by weighing 0.1 g of glucose then diluted in 100 ml of distilled water

d) The Production of Standard Glucose Curve

Standard glucose solutions (0.4; 0.44; 0.48; 0.64; and 0.8) ml and 0.8 ml of distilled water (as blank) were added to a 10 ml volumetric flask, respectively. Aquadest were added until each volume was 0.8 ml and followed by the addition of 0.6 ml of 3.5 Dinitro Salicylic Acid solution to each volumetric flask and then homogenized. The mixturewas then heated in a water bath for 5 minutes, after which it was cooled and added with distilled water to a volume of 10 ml. The absorbance was measured at a wavelength of 540 nm. Absorbance measurements were carried out ateach concentration of glucose solution and then a standard curve plot was made with glucose content (mg) as abscissa (x) and absorbance as ordinate (y).

e) The Production of Glucomannan Extraction

The extract was made by weighing 0.2 g of the sample(glucomannan flour) and put into a beaker containing 50 ml of buffer solution (formic acid-sodium hydroxide) andthen magnetically stirred for 4 hours at 30°C then diluted with buffer solution to a volume of 100 ml. Then the mixture was centrifuged at 4000 rpm for 20 minutes to obtain glucomannan extract.

f) The Production of Glucomannan Hydrolyzate

The process of making the hydrolyzate was by inserting 2 ml of glucomannan extract into a 10 ml volumetric flask, adding 1 ml of 3 M sulfuric acid and homogenizing it. The mixture was heated in a boiling water bath for 1,5 hours and then cooled. Then 1 ml of 6MNaOH was added to the mixture and then homogenized and distilled water was added to a volume of 10 ml.

g) Sample Absorbance Masurement

Glucomannan extract, glucomannan hydrolyzate and distilled water (blank), each as much as 0.8 ml were put into a 10 ml volumetric flask then added 0.6 ml of 3.5- Dinitro Salysilic Acid (DNS) and put in a water bath for 5minutes. Then the solution was cooled to room temperature, then added with distilled water up to 10 ml. The absorbance value was measured at a wavelength of

540 nm. The glucose content in the extract and glucomannan hydrolyzate was determined by entering theabsorbance value in the straight-line equation of the glucose standard curve regression. Furthermore, the glucomannan content is calculated using the equation :

$$\text{Glucomannan Content (\%)} = 5000f\ (5T - T_0)\ m \quad (1)$$

Description :

f = correction factor (0,9)
T = the amount of glucose hydrolysate glucomannan(mg)
T_0 = the amount of glucose glucomannan extract (mg)
m = the mass of the extracted flour (200 mg)

c. Oxalate Level Test

1 gram of Porang flour was dissolved in a mixture of 190 ml of distilled water and 10 ml of 6 M HCl. The mixture is then heated in a water bath at 100°C. Heating is carried out for one hour. The mixture was then added withdistilled water up to 250 ml and filtered. The filtrate obtained was then taken as much as 50 ml and added 10 ml of 4 N H_2SO_4 solution. The solution was then heated toa solution temperature of 70°C and titrated with 0.1 N potassium permanganate solution. Titration was stopped when the color of the solution had changed to pink. Oxalate levels are calculated using the following equation:

$$\text{Oxalate content} = \frac{\text{V titrant} \times \text{N titrant} \times \text{BE oxalate}}{\text{Mf}} \times 100\% \quad (2)$$

Description:
V titrant = volume of titration $KMnO_4$ (ml)
N titrant = normality of $KMnO_4$ (0,1 N)
BE Oxalate $= \frac{\text{BM calcium oxalate}}{\text{Calcium Oxalate equivalent}}$
Mf = mass sample (g)
(Wardani et al, 2019)

RESULTS AND DISCUSSION

1. The Effect of Drying Temperature on OxalateLevels

Oxalate levels in this study used the permanganometric titration method. Permanganometric titration is consideredmore effective because it does not require an indicator. It can be seen in the graph, the oxalate content in the variation of the elongated tuber shape is lower than the diced form. This is because the surface area of the elongated tuber variation is greater so that the oxalate contained in the tuber is more dissolved in the soaking medium. The levels of oxalate contained in Porang flour in this study ranged from 2-7%. The safe limit for humansto consume oxalate is 0.60 – 1.25 grams/day.

The difference in drying temperature and immersion media affects the oxalate content contained in Porang flour. The results obtained in this study are

quite low in oxalate levels, so the resulting Porang flour is suitable forconsumption.

Based on the calculations, the oxalate levels is presented in figure 2.

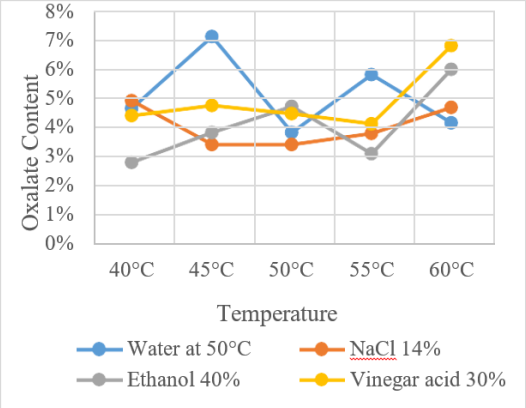

Figure 2. Oxalate content of diced tubers in eachmedium at various drying temperatures

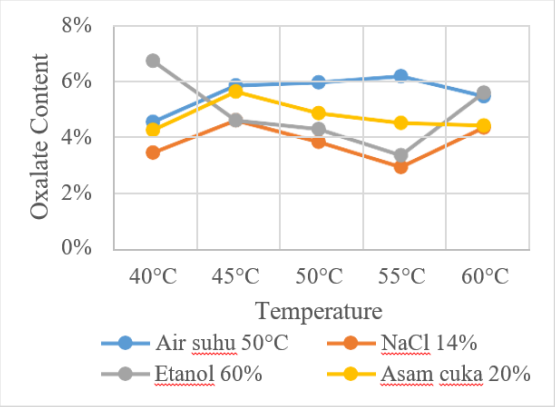

Figure 3. Oxalate content of elongated tubers in eachmedium at various drying temperatures

2. The Absorbance of Standard Glucose Solution

The analysis process begins by creating a standard curve. Pro-analyst glucose is used in making standard curves because glucose is a monomer of glucomannan which can provide more accurate measurement results than mannose. Based on Chua's research in 2011, standardglucose provides higher sensitivity than mannose with a more linear correlation coefficient value. Absorbance measurements were carried out at a wavelength of 540 nm because the reddish-orange 3-amino-5-nitrosalicylic acid compound can strongly absorb electromagnetic radiation at a wavelength of 540 nm (Gonçalves et al, 2010)

Table 1. Absorbance of Standard Glucose Solution

Glucose (ml)	Absorbance
0,4	0,24
0,44	0,259
0,48	0,302
0,64	0,416
0,8	0,505

The absorbance value that was read was higher as the glucose concentration increased. Based on the absorbancevalue of the standard glucose solution, a linear equation isobtained in figure 4.

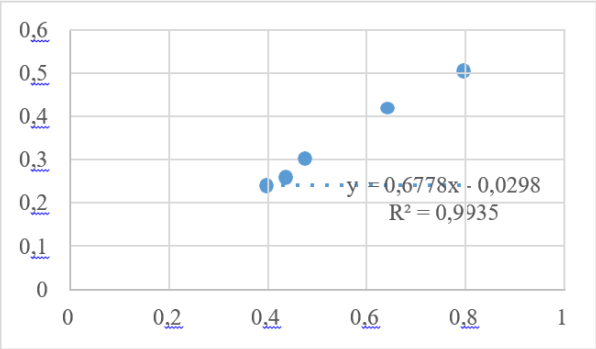

Figure 4. Standard Glucose Curve

Based on the curve obtained linear regression equationy = 0.6778x – 0.0298 with R^2 = 0.9935. Absorbance measurements were carried out at each concentration of glucose solution and then a standard curve plot was madewith glucose content (mg) as abscissa (x) and absorbanceas ordinate (y).

3. The Effect of Drying Temperature on Glucomannan Levels

Quantitative analysis of glucomannan was carried outusing the DNS method to determine the level of glucomannan obtained. The DNS method was chosen because it is the most frequently used method and is moreprecise than other methods such as phenol sulfuric acid (Chua, 2011). DNS functions as a reagent that can form colored compounds in the presence of reducing sugars such as glucose and mannose so that they can absorb electromagnetic radiation. The reaction that occurs is a redox reaction between glucose and DNS which forms acompound of 3-amino-5-nitrosalicylic acid (Chua et al, 2012).

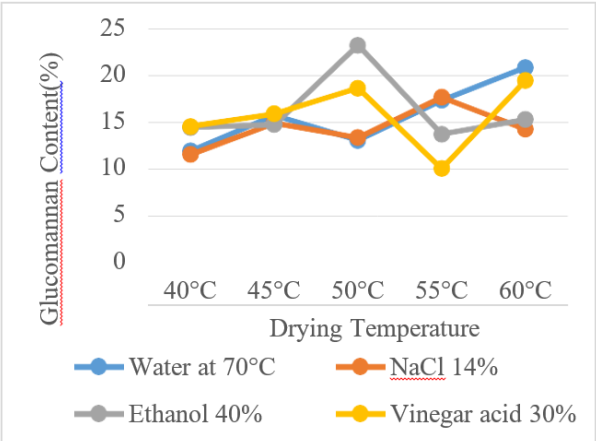

Figure 5. Glucomannan content of Porang tubers ina shape of diced in each medium at various drying temperatures

The test results must meet SNI 7939-2013 that presentedin table 2.

Table 2. Porang Flour Quality Requirements

Test criteria	SNI Requirements 7939-2013 (%)		
	Quality I	Quality II	Quality III
Water content	≤ 13	13 - <15	15 - 16
Ash content	≤ 4	>4 - <5	5 - 6,5
Protein	≤ 5	>5 - <13	14
Fat	-	-	-
Carbohydrate	-	-	-
Glucomannan	> 25	20 - ≤ 25	15 < 20

Source: SNI 7939-2013

Porang flour with diced chip form produces glucomannan content as shown in table 3. Based on the requirements set by SNI 7939-2013, the Porang flour produced in this study was included in the quality variationIII and some did not meet the standards.

Table 3. Variants of glucomannan flour with diced shapethat meet SNI 7939-2013 specifications

Media	Glucomannan levels in drying temperature (%)				
	40°C	45°C	50°C	55°C	60°C
Water at 70°C	11,86(TM)	15,69(M 3)	13,00(TM)	17,30(M 3)	20,82(M 2)
NaCl 14%	11,46(TM)	14,85(TM)	13,30(TM)	17,63(M 3)	14,20(TM)
Ethanol 40%	14,38(TM)	14,68(TM)	23,18(M 2)	13,67(TM)	15,24(M 3)
Vinegar acid30%	14,50(TM)	15,84(M 3)	18,60(M 3)	9,98(TM)	19,41(M 3)

Description :
TM = Not qualifying the SNI 7939-2013
M 2 = Qualifying the SNI 7939-2013 at quality II M 3 = Qualifying the SNI 7939-2013 at quality III

Based on the requirements set by SNI 7939-2013, thePorang flour produced in this study was included in the quality variation III and some did not meet the standards.

Table 4. Variants of glucomannan flour with anelongated shape that meet SNI 7939-2013 specifications

Media	Glucomannan levels in drying temperature (%)				
	40°C	45°C	50°C	55°C	60°C
Water at 50°C	17,30(M 3)	15,81(M 3)	14,63(TM)	17,30(M 3)	13,43(TM)
NaCl 14%	11,61(TM)	11,59(TM)	17,40(M 3)	18,23(M 3)	14,03(TM)
Ethanol 60%	12,69(TM)	15,04(M 3)	14,58(TM)	10,99(TM)	18,26(M 3)
Vinegar acid20%	15,14(M 3)	11,71(TM)	13,67(TM)	12,16(TM)	19,01(M 3)

Description :
TM = Not qualifying the SNI 7939-2013
M 3 = Qualifying the SNI 7939-2013 at quality III

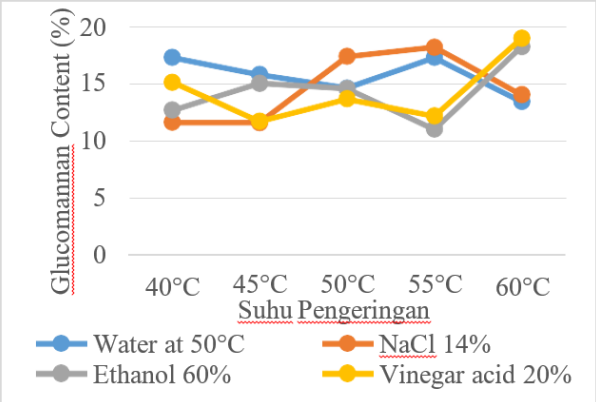

Figure 6. The water content of Porang tubers is elongatedin each soaking medium with variations in drying temperature

The difference in drying temperature affects the glucomannan content of Porang flour, each soaking medium has a different optimal drying temperature. In addition, the quality and physical properties of glucomannan are also influenced by oxalate content, tuberquality, and processing methods and equipment.

The glucomannan levels obtained were lower than previous studies conducted by Handayani et al. (2020), theglucomannan content of Porang flour is known to be in therange of 47 -52%. This is influenced by several factors such as harvest age, harvest time, growing location, pretreatment, and the quality of the Porang tubers used. The longer the harvest age of the tubers, the glucomannan content also increases and vice versa.

The level of glucomannan is also influenced by the level of oxalate released during washing Porang. Thehigher the release of oxalate when washing Porang, the lower the oxalate content in the flour, this makes the glucomannan content higher and vice versa.

CONCLUSION

Based on the research data and the results of the discussion, it can be concluded that In the variation of diced chip shape, the optimal 70°C water immersion media at 50°C, 14% NaCl immersion media at 50°C, 40% ethanol immersion media at 40°C, 30% vinegar acid immersion media at 40°C 55°C. In variations of elongatedchip shape, optimal 50°C water immersion media at 40°C, 14% NaCl immersion media at 55°C, 60% ethanol immersion media at 55°C, 20% vinegar soaking media at 60°C C.

In variations in the shape of the diced chip, the optimal70°C water immersion media at 60°C, 14% NaCl immersion media at 55°C, 40% ethanol soaking media at 50°C, 30% vinegar soaking media at a temperature 60°C.In variations in the shape of the elongated chip, the optimal50°C water immersion media at 40°C and 60°C, 14% NaCl immersion media at 55°C, 60% ethanol soaking medium at 60°C, 20% vinegar soaking media at 60°C.

ACKNOWLEDGEMENT

The author would like to thank to the Lembaga Penelitian dan Pengabdian pada Masyarakat (LPPM) UPN "Veteran"Yogyakarta and Author Corresponding.

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