Physic-chemical characteristics of porang and iles-iles flour used several process production techniques

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Abstract
Porang and iles-iles are plants that are widely cultivated in Indonesia. Porang and iles-iles are tubers that contain high levels of glucomannan. Several characteristics of porang and iles-iles flour can be analyzed to meet the required quality standards as well as the required physico-chemical characteristics. The purpose of this research activity is to research the effect of the types and stages of treatment on the physico-chemical characteristics of the porang and iles-iles flour produced. The research method includes: testing the implementation of several stages of the stripping treatment, soaking techniques and drying methods, analyzing the physico-chemical characteristics of the porang flour and the resulting iles-iles. Based on the analysis, the highest levels of glucomannan were obtained in the porang flour treatment method, soaking a combination of sodium bisulfite and ethanol for 2 hours with a glucomannan content of 66.89%. The best treatment (PPlSmE2O) has color characteristics with an L value of 96.21, a value of -0.81 and b of 16.71 with a viscosity of 978.85 cP. Further research is needed regarding the optimization of the increase in glucomannan content and further viscosity.

1. Introduction
Iles-iles is a plant that has begun to be widely cultivated in Indonesia. Iles-iles (Amorphophallus muelleri Blume) is one of the root crops belonging to the Araceae family, Monocotyledoneae class. The iles-iles tubers can be extracted to produce glucomannan. Iles-iles plants can grow well in tropical areas, including in Indonesia, Japan, China, Vietnam, Cambodia and Thailand [1-2]. Sumarwoto (2005) [3] describes porang and its characteristics.

The preparation of raw materials in the form of crude iles-iles flour is carried out using technology, namely tuber stripping, 3-5 mm slicing, immersion in 1500 ppm sodium meta bisulfite solution, drying with a tray drier at 80oC, and flour using a 1 mm screen. [4]. Arifin (2001) [5] immersed in 5% NaCl solution and further immersed with NaHSO3 at a concentration of 5 ppm. Nindita et al. (2012) [6] conducted a research on making porang chips using an oven, until it was found that the porang chips had a constant moisture content and could be further processed by crushing them with a wiley mill and sieving with a size of 40 mesh. Based on these research results, one of the important parameters of the characteristics of porang flour is the effect of process technology on its physico-chemical characteristics.
One of the important parameters in making porang and iles-iles flour is glucomannan content. Glucomannan has several benefits as a food additive [7] and as a pharmaceutical product [8]. The highest level of glucomannan while in mannan flour resulted from the purification of stratified washing with 2 washing stages for 2 hours was 83.07% (bk). The enzymatic method, the highest levels of glucomannan were temporarily produced in the treatment of 2.5% α-amylase enzyme concentration with an incubation time of 2 hours to produce mannan flour with a glucomannan content of 39.61% [4]. To increase glucomannan levels, further extraction research can be carried out.

Glucomannan extraction technology can be carried out by several methods, both physical, chemical and biological. The method of extraction of glucomannan from flour tissue or cell walls of raw material sources, so the extraction method is highly dependent on the structure of the cell walls [9]. In general, the extraction method using solvents includes using water, ethanol, acid and Pb (Ac) 2 solvents, after pre-treatment [10]. Xu et al. (2008) [11] conducted research on the purification of glucomannan extraction from konjac flour, in combination with the use of 40% v/v ethanol solvent with a heating temperature range of 28 to 78 °C. Chua et al (2002) [12] conducted a study on the relationship between extraction method and glucomannan content. Furthermore, Cheng et al (2010) [13] carried out the extraction of glucomannan by the ultrasonic method. Effect of extraction temperature influenced to the physico-chemical properties of glucomannan [14]. The combination of the types of raw material sources, soaking process technology and drying methods affects the characteristics of the flour products produced. The purpose of this research activity is to research the effect of the types and stages of treatment on the physico-chemical characteristics of the porang and iles-iles flour produced.

2. Materials and methods

The implementation of research activities is carried out from April-August 2020. Activities are carried out by taking the tubers at the points according to the partners of PT. Niaga Indotama. Furthermore, the process of optimization and analysis of the results of glucomannan products is carried out in the testing and development laboratory of the Postharvest Agricultural Research and Development Center. The technique used is a combination of treatments carried out by [4] and [15]. Haryani and Hargono (2008) [16] cut porang tubers with a thickness of 2 to 3 mm. Some of the treatments used in this study included: with and without chip stripping, immersion with sodium bisulfite, immersion in ethanol for 2 and 4 hours, drying with sun and oven and compared with the control. Control was a sample that directly peeled, dislicered, dried, crushed and sieved without going through any immersion or extraction treatment processed.

Chemical quality analysis includes analysis of glucomannan content, oxalate content and ethanol residue found in flour with chip immersion treatment using ethanol. Analysis of the physical quality of the Iles-iles and porang flour products was carried out including color analysis which included the values of L, a, b and the whiteness index. Analysis of oxalate content was carried out using the HPLC method. Porang flour and iles-iles flour were extracted and prepared further, then analyzed using HPLC tools. Analysis of the quality of the product viscosity is carried out on the flour products that have been produced.

2.1 Glucomannan Content Analysis [17]

A total of ± 1 g of sample was added with 30 ml of distilled water while stirring until homogeneous, extracted in a shaker which is set at 45 °C for 2 hours. Centrifuge was performed at 4 000 rpm for 20 minutes to separate the glucomannan, maltodextrin, and flour dregs fractions. The glucomannan fraction was separated from the maltodextrin and flour dregs, then put in a beaker and kept in an ice cupboard for one hour. Glucomannan in a beaker is then added with 96% alcohol as much as 13 ml while stirring constantly until a glucomannan precipitate is formed. The mixture of glucomannan and alcohol which has been deposited with glucomannan is filtered with Watman filter paper size 41, then dried to air. Then the glucomannan is put in an oven at 35-40 °C to produce a fixed weight of
glucomannan. The dry glucomannan is weighed and the glucomannan content is calculated using the formula:

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\text{Glucomannan Content (\%) } = \frac{\text{Sediment Weight}}{\text{Sample Weight}} \times 100\%
\]

3. Result and discussion

3.1 Glucomannan content from Iles-Iles and Porang Flour

One of the main components found in porang and iles-iles flour is glucomannan content. There are several differences between the glucomannan levels from the results of the treatment compared to the control. Oxalate content is a component found in porang flour and iles-iles flour. The two components are as listed in Table 1 below.

| No | Sample      | Glucomannan Content (%) | Oxalate Content (ppm) |
|----|-------------|-------------------------|-----------------------|
| 1  | PSkS        | 44.61                   | 308,013               |
| 2  | PPIS        | 36.69                   | 563,839               |
| 3  | PSkS        | 58.38                   | 626,410               |
| 4  | PPIO        | 47.43                   | 277,064               |
| 5  | PskSmO      | 49.75                   | 172,871               |
| 6  | PPSmO       | 53.15                   | 431,264               |
| 7  | PskSmE2O    | 35.37                   | 658,959               |
| 8  | PPSmE2O     | 66.89                   | 739,406               |
| 9  | PskSmE4O    | 45.77                   | 587,874               |
| 10 | PPSmE4O     | 53.44                   | 500,295               |
| 11 | ISkS        | 35.26                   | 329,071               |
| 12 | IPlS        | 33.00                   | 827,563               |
| 13 | IPIO        | 43.14                   | 1303,831              |
| 14 | ISkSmO      | 33.49                   | 1915,551              |
| 15 | IPlSmO      | 32.98                   | 835,627               |
| 16 | ISkSmE2O    | 22.82                   | 856,519               |
| 17 | IPISmE2O    | 27.66                   | 739,406               |
| 18 | ISkSmE4O    | 25.21                   | 632,276               |
| 19 | IPlSmE4O    | 25.02                   | 159,778               |
| 20 | KGI PT. Niaga Indotama | 28.51    | 15728,530            |

Remarks: P : Porang; I: Iles-iles; Pl: Peel; Sk: Skin; S: Sun Drying; O: Oven Drying; Sm: Sodium Metabisulfite Immersion; E: Ethanol Immersion

Based on the analysis result of porang flour and iles-iles flour, the highest yield of glucomannan was 66.89% found in the treatment of peeled porang soaked in ethanol for 2 hours and combined with drying treatment using an oven. The levels of glucomannan obtained ranged from 22.82 to 66.89%. Mulyono et al (2009) [4] carried out the extraction of glucomannan with stratified purification stages and two-stage washing for 2 hours, the results of the glucomannan content were 83.07% (bk). When compared with the research results, it still requires further purification to produce higher levels of
glucomannan. Process modification and combination with extraction and drying technology can be done to increase the glucomannan content in the porang and iles-iles flour produced.

Oxalate content is one of the parameters that affects the quality of porang and iles-iles flour produced. Oxalate levels are identified with the onset of itching caused by high levels in foodstuffs. In the manufacture of porang and iles-iles flour, it is hoped that the resulting oxalate content will have a low value, so as not to cause itching in the product which will be implemented further. Based on the analysis, oxalate levels ranged from 159.778 to 1915.551 ppm. Meanwhile, commercial samples have oxalate levels of 15728.530 ppm. There are no maximum levels of oxalic acid standard in porang and iles-iles flour from the Japanese Konyaku Association, SNI or trading standards in China. However, what needs to be anticipated is that the maximum daily intake of oxalate is 70 - 150 mg / day.

3.2 Viscosity of Iles-Iles and Porang Flour

One of the quality parameters of porang and iles-iles flour is the viscosity capacity of the resulting product. The technology and the combination of the porang and iles-iles flour manufacturing processes affect the viscosity of the resulting product. Based on the results of the viscosity analysis of porang and iles-iles flour, the results are as shown in Table 2 below.

| No | Sample       | Viscosity (cP) |
|----|--------------|----------------|
| 1  | PSkS         | 981.90         |
| 2  | PPIS         | 28863.50       |
| 3  | PSkS         | 985.80         |
| 4  | PPIO         | 954.90         |
| 5  | PSkSmO       | 8543.60        |
| 6  | PPISmO       | 979.50         |
| 7  | PSkSmE2O     | 982.50         |
| 8  | PPISmE2O     | 978.85         |
| 9  | PSkSmE4O     | 971.45         |
| 10 | PPISmE4O     | 1451.35        |
| 11 | ISkS         | 1484.15        |
| 12 | IPIS         | 1466.75        |
| 13 | IPIO         | 1467.40        |
| 14 | ISkSmO       | 1473.45        |
| 15 | IPISmO       | 1467.20        |
| 16 | ISkSmE2O     | 1465.60        |
| 17 | IPlSmE2O     | 1454.25        |
| 18 | ISkSmE4O     | 1463.85        |
| 19 | IPlSmE4O     | 1462.30        |
| 20 | KGI PT. Niaga Indotama | 5225.80 |

Remarks: P : Porang; I: Iles-iles; Pl: Peel; Sk: Skin; S: Sun Drying; O: Oven Drying; Sm: Sodium Metabisulfit Immersion; E: Ethanol Immersion

The viscosity of the porang and iles-iles flour produced varied greatly from 954.90 cP to 28863.50 cP. While the results of commercial glucomannan have a viscosity value of 5225.80 cP. The presence of process combinaants affects the viscosity of porang flour and the resulting iles-iles. Glucomannan, which is soluble in water and is able to form a good gel, is closely related to its ability to increase the viscosity of the product it implements. Based on the results of research by Li and Xie (2006) [18], one of the factors that influence it is the molecular weight of glucomannan itself. There is an increase in glucomannan content which is not directly proportional to this viscosity, possibly because of the high
impurities found in the flour produced. Impurities such as starch and fiber content can also affect the viscosity of the flour produced. This requires a further refining process.

### 3.3 Color Analysis Results

The color of the flour produced is one of the important parameters of the quality produced. Porang tubers have a yellow color, while iles-iles bulbs have a white color. The difference in raw materials affects the results of the color analysis of the flour produced. WI (Whiteness Index) is a parameter to measure the degree of whiteness of the flour produced. The results of the color quality analysis of L, a, b and WI which can be identified from the porang and iles-iles flour produced are as shown in Table 3 below.

| No | Sample  | L     | a     | b     | WI    |
|----|---------|-------|-------|-------|-------|
| 1  | PSkS    | 73.57 | 3.15  | 12.38 | 70.64 |
| 2  | PPlS    | 72.43 | 3.44  | 12.38 | 69.58 |
| 3  | PSkS    | 85.11 | 2.26  | 10.86 | 81.43 |
| 4  | PPIO    | 86.28 | 2.32  | 10.93 | 82.31 |
| 5  | PSkSmO  | 87.63 | 2.60  | 9.89  | 83.95 |
| 6  | PPlSmO  | 94.62 | 0.64  | 13.95 | 85.03 |
| 7  | PSkSmE2O| 93.02 | 1.20  | 14.615| 83.76 |
| 8  | PPlSmE2O| 96.21 | -0.81 | 16.71 | 82.85 |
| 9  | PSkSmE4O| 95.94 | -2.13 | 20.83 | 78.67 |
| 10 | PPlSmE4O| 100.68| -3.84 | 24.74 | 74.95 |
| 11 | ISkS    | 83.10 | 2.20  | 12.21 | 79.03 |
| 12 | IPlS    | 85.49 | 1.52  | 12.57 | 80.74 |
| 13 | IPIO    | 95.57 | 0.50  | 7.55  | 91.23 |
| 14 | ISkSmO  | 94.86 | -0.30 | 7.81  | 90.65 |
| 15 | IPlSmO  | 99.95 | -0.38 | 9.32  | 90.67 |
| 16 | ISkSmE2O| 98.79 | 0.40  | 7.56  | 92.33 |
| 17 | IPlSmE2O| 103.34| -0.08 | 6.72  | 92.50 |
| 18 | ISkSmE4O| 102.19| -0.20 | 5.99  | 93.62 |
| 19 | IPlSmE4O| 105.08| -0.54 | 4.54  | 93.17 |

Remarks: P: Porang; I: Iles-iles; Pl: Peel; Sk: Skin; S: Sun Drying; O: Oven Drying; Sm: Sodium Metabisulfit Immersion; E: Ethanol Immersion

The values of L, a and b of porang and iles-iles flour were varied. This value is used as a basis for calculating the degree of whiteness or WI (Whiteness Index). The WI value of porang flour ranged from 69.58 to 85.03. Meanwhile, the WI value of iles-iles flour was higher than that of porang flour. The WI value of iles-iles flour ranged from 79.03 to 93.17. The whiteness index value of iles-iles flour was higher than that of porang flour. This is because iles-iles has a white tuber color compared to porang which has yellow as its raw material.

### 3.4 Texture Analysis

Another important parameter of porang and iles-iles flour that affects the quality is the texture characteristics produced. The results of the initial research which had relatively higher levels of glucomannan, then analyzed the texture profile compared to commercial samples. Commercial samples and research samples from Mulyono et al. (2009) [4] further compared the optimal yields of porang and iles-iles flour. The results of the texture profile analysis are as shown in Table 4 below.
Table 4. Results of Porang Flour Texture Analysis Compared with Commercial Products

| Sample                        | Hardness (N) | Adhesiveness Force (N) | Adhesiveness (mJ) | Cohesiveness | Springiness (mm) | Guminess (N) | Chewiness (mJ) |
|-------------------------------|--------------|------------------------|-------------------|-------------|-----------------|--------------|--------------|
| Konjac Commercially Porang peel-ethanol 2 hr | 0.1223       | 0.0733                 | 1.0600            | 1.3300      | 10.1500         | 0.1603       | 1.6333       |
| Iles-iles peel-ethanol 2 hr   | 0.1703       | 0.0457                 | 0.2167            | 1.0400      | 10.1567         | 0.1773       | 1.8000       |
| Control porang                | 0.2035       | 0.0340                 | 0.0850            | 1.2650      | 15.5600         | 0.2585       | 4.1000       |
| Control Iles-iles             | 0.1260       | 0.0227                 | 0.1467            | 1.4467      | 12.0800         | 0.1823       | 2.2133       |
| Control Konjac PT. Niaga Indotama | 0.1633   | 0.0590                 | 0.6533            | 1.0167      | 6.9933          | 0.1680       | 1.1833       |

The hardness value of the sample from the research results was higher than that of the sample Mulyono et al (2009) [4]. The hardness value of the peeled porang soaked in ethanol for 2 hours was 0.1703 and the peeled iles-iles immersed in ethanol for 2 hours was 0.2035. Both treatments were higher than the commercial glucomannan samples. Meanwhile, chewiness for peeled iles-iles samples immersed for 2 hours also had a higher value compared to commercial glucomannan samples.

Characteristics of Konjac Manan Gel Compared to Commercial Products as research results [19]. The different varieties of glucomannan sources and the extraction method affect the resulting texture. Gel formation is closely related to pH and process temperature. Gel can be formed in general at a pH of 9 to 10 with heating conditions above 200 °C [20]. Konjac Manan gel can be used as a thickening agent and gelling agent which is often referred to as "konyaku" [20-21].

3.5 Ethanol Residue Content

Combination treatment to increase glucomannan extraction in this flour is by using ethanol immersion technique. To determine the residual content that is still there, an analysis of the residual levels of ethanol is still left in the porang flour and the resulting iles-iles. Based on the results of the analysis of the ethanol residue found in porang and iles-iles flour, it is shown in Table 5 below.

Table 5. Ethanol Residue Analysis Results

| No | Sample                | Ethanol Residue (ppm) |
|----|-----------------------|-----------------------|
| 1  | Iles-iles peel -4 hr  | 98,287                |
| 2  | Porang peel- 4 hr     | 89,653                |
| 3  | Iles-iles with skin- 4 hr | 118,535            |
| 4  | Porang with skin- 4 hr| 103,351               |
| 5  | Iles-iles peel- 2 hr  | 58,797                |
| 6  | Porang peel- 2 hr     | 65,785                |
| 7  | Iles-iles with skin- 2 hr | 65,338              |
| 8  | Porang with skin-2 hr  | 69,179                |
| 9  | SPE                   | 49,995                |
| 10 | KGI                   | 46,792                |
The residual levels of ethanol contained in the porang and iles-iles flour samples carried out in this analysis were only in the treatment using ethanol immersion technique compared to the Mulyon et al. (2009) [4] sample and the commercial glucomannan sample. Based on the results of the ethanol residue analysis, the ethanol content in the research sample was still higher than the sample Mulyono et al. (2009) [4] and the commercial glucomannan sample. The ethanol residue contained in iles-iles and porang soaked for 4 hours was higher than the other samples. This is possible because, the longer the soaking process, the residue contained in the flour increases.

4. Conclusion

Based on the analysis, the highest levels of glucomannan were obtained in the porang flour treatment method, soaking a combination of sodium bisulfite and ethanol for 2 hours with a glucomannan content of 66.89%. The treatment has color characteristics with an L value of 96.21, a value of -0.81 and b of 16.71, WI 82.85 with a viscosity of 978.85 cP. The whiteness index value of iles-iles flour was higher than that of porang flour. This is because iles-iles has a white tuber color compared to porang which has yellow as its raw material. The longest time of ethanol soaking process, the more ethanol residue in the flour increases. Further research is needed regarding the optimization of the increase in glucomannan content and further viscosity.

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