Characteristics of various flour and gluten free noodles from Indonesian local food

Heny Herawati¹, Elmi Kamsiatí¹

¹ Indonesia Center For Agricultural Postharvest Research and Development
Jl. Tentara Pelajar No 12, Cimanggu-Bogor

Abstract
Indonesia is an Agricultural Country, has very varied local food potential and also has the potential to be developed further. One of the potentials for local food development in Indonesia is local food flour. In general, noodles are made with wheat flour as raw material, where wheat is a producer of wheat flour. To produce gluten free noodles, can use raw materials from flour that come from local food in Indonesia. The purpose of this study to characterize gluten free flour and noodles from local food ingredients in Indonesia. The research method was carried out in stages such as: processing flour, characterizing local flour, processing gluten free noodles and characterizing gluten free noodle products with local flour raw materials. Based on the research results, the protein and fat content of hanjeli (Coix lacyma-Jobi L.) flour was higher, namely 14.30% and 2.58% compared to other flours. Meanwhile, the highest peak viscosity of the local flour was in the form of cassava (Manihot esculanta) flour at 3063 cP. Based on the characteristics obtained, local flour can be processed into gluten free noodles which can prospectively be further commercialized.

1. Introduction
Indonesia is an agricultural country, has a very varied local food potential and has the potential to be developed further. Local flour generally lacks the potential for viscosity and elasticity like flour. Several food additives can be used such as emulsifiers, hydrocolloids, and other food additives [1]. The most important component of flour is starch [2]. One of the potentials for local food development in Indonesia is local food flour. The flour used today generally still uses wheat flour. Many Indonesians currently consume bread, noodles, bakery, pasta as energy-producing foods. In general, bread, noodles, bakery, pasta are made with wheat flour as raw material, where wheat, as a wheat flour producer, cannot be grown in Indonesia, so it requires imports from wheat-producing countries.

According to BPS [3], wheat imports reached 5.7 million tons and absorbed US $ 1.8 million in foreign exchange. The use of wheat flour as a raw material in the manufacture of other food products will lead to dependence on imports of wheat flour.

One alternative solution to this problem is the use of local raw materials as a substitute or substitute for wheat flour. Substitutes for wheat flour include cane flour, hanjeli flour, corn flour, banana flour, sago flour, breadfruit flour, taro flour, sorghum flour, cassava flour, yellow sweet potato flour. Before being applied to the manufacture of food products, it is necessary to carry out the characteristics of flour, one of which is by doing a proximate analysis and a Rapid Visco Analyzer (RVA). Starch gelatinization is a complex phenomenon that occurs within the crystalline structure of the starch granules which are lost due to heating and the presence of water [4]. The gelatinization profile of each type of starch is different depending on differences in chemical characteristics such as granule shape, amyllose or amylopectin ratio, starch molecular and the presence of other components is the cause of differences in functional properties [5]. According to Kartikasari et al. [4] It is necessary to
characterize the chemical and technical functional properties of starch in a variety to predict the similarities and differences in its behavior at the application stage.

Measurements with RVA include the heating and cooling process phases at constant stirring. Data obtained from RVA measurements are the initial gelatinization temperature (PT), peak viscosity (PV), Hot Paste Viscosity (HPV), breakdown viscosity (BD), cold paste viscosity (CPV), reverse viscosity or setback viscosity (SV), and stirring stability. The advantage of RVA is that it creates a combination that combines speed, accuracy, flexibility and automation. RVA has been used extensively in various studies to determine the texture characteristics of food products, especially those containing starch to evaluate the gelatinization properties of starch during the cooking process [6].

The results of the characteristics of the local flour produced can be used as data to be used as a reference for further product implementation. Herawati et al [7] stated that some of the potential for local flour can be used for various gluten free processed products. Herawati et al [8-9] processed gluten free noodles from hanjeli flour. The gluten free noodle processing technology can be carried out using extrusion technology [7; 10; 11]. The purpose of this study to characterize gluten free flour and noodles from local food ingredients in Indonesia.

2. Materials and Methods

2.1. Materials

The materials used are canna (Canna edulis Kerr.) flour, hanjeli (Coix lactyma-Jobi L.) flour, corn (Zea Mays) flour, banana (Musa Linnaeus) flour, sago (Metroxylon sagu) flour, breadfruit (Artocarpus altitis) flour, taro (Colocasia esculenta) flour, sorghum (Shorghum bicolor L.) flour, cassava (Manihot esculenta) flour, yellow sweet potato (Ipomoea batatas) flour, tapioca, hydrocolloid, distilled water, sulfuric acid pa (Merck, Germany), selenium pa (Merck, Germany), hexane pa, BCG-MM indicator, 0.1 N HCl solution, 4% H3BO3 solution, 30% NaOH solution, Na2B4O7.10H2O pa (Merck, Germany).

The tools used are the Digestor Stove HYP-1008, the KDN-103F Automatic Nitrogen Determinator distillation device (Shanghai, Qianjian Instrument), the Fat Determinator and Soxtech SZC-D (Shanghai, Qianjian Instrument) tool, stirring rod, canister, cup, aluminum, porcelain cup, desiccator, fat-free cotton, analytical balance (Precisa, Swissmade), Memmert UF 110 Open Lab 108 oven, cup clamp, 10.00 mL measuring pipette, paddle, RVA Tecmaster (Perten Instrument), spoon, spatula, test tube large, furnace (Lenton Furnace).

2.2. Methods

The local flour is uniform in size 100 mesh added with water and food additives, after that analyzed its physical characterization is carried out by performing RVA analysis and proximate analysis [12]. Local flour is used to make gluten free noodles. The various local flours are added with tapioca, hydrocolloid and water and stir until evenly distributed. The obtained dough is then steamed for 15 minutes until optimal pre-gelatinization conditions are obtained. The pre-gelatinized material is then molded into a noodle dough using an extruder. The noodles obtained are then dried using an oven tray. The gluten free noodles obtained were then analyzed proximate, RVA profile and crystallinity using XRD.

2.3. Modified Rapid Visco Analyzer (RVA) Analysis (Method Work Instructions)

The prepared sample was weighed x gram and put into the canister. ± 25 mL of distilled water was added, put into the canister which already contains the sample. Insert the paddle into the canister containing the sample. Inserted the tool into the RVA tool. Next, select the profile or method used for sample testing, according to the method used with the type of wheat flour sample, then select general starch. Then press down on the tower where the can contains the sample, distilled water, and paddle. When the test is complete, the tower where the can and paddle will rise again and a graph appears on the computer screen. The formula for x weighing the sample is as follows:
\[ x \text{ (gram)} = \frac{(100 - MB)}{(100 - \text{Moisture content})} \times W_{\text{theory}} \]

Notes:
- MB = Moisture Base theory (%)
- X = Symbol weight (g)
- W = Weight theory based (g)

3. Results and Discussion

3.1. Proximate Analysis

Proximate analysis is an analysis carried out to determine the composition of the macro components present in food or food products. In this research activity, analysis of the moisture, ash, protein and fat content of the local flour. Analysis of carbohydrate content is calculated by different. Based on the results of the analysis of the proximate content of several local flours obtained, the proximate levels produced are as etraised in Table 1 below.

Table 1. Nutritional content of local flour samples

| Local Flour     | Moisture (%bb) | Ash (%bb) | Fat (%bb) | Protein (%bb) | Carbohydrate by difference (%) |
|-----------------|----------------|-----------|-----------|---------------|--------------------------------|
| Ganyong         | 9.16 ± 0.02    | 4.00 ± 0.06| 0.50 ± 0.05| 2.72 ± 0.08   | 83.62                          |
| Breadfruit      | 8.68 ± 0.43    | 3.18 ± 0.05| 1.17 ± 0.04| 5.35 ± 0.01   | 81.62                          |
| Taro            | 11.30 ± 0.06   | 2.24 ± 0.10| 0.48 ± 0.08| 2.93 ± 0.01   | 83.05                          |
| Banana          | 8.66 ± 0.09    | 2/30 ± 0.09| 0.53 ± 0.05| 2.50 ± 0.21   | 86.01                          |
| Corn            | 11.58 ± 0.04   | 0.48 ± 0.10| 0.89 ± 0.03| 8.41 ± 0.04   | 78.65                          |
| Sago            | 15.57 ± 0.04   | 0.31 ± 0.23| 0.04 ± 0.00| 0.31 ± 0.00   | 83.77                          |
| Sorghum         | 10.05 ± 0.06   | 1.22 ± 0.16| 2.23 ± 0.02| 9.64 ± 0.02   | 76.86                          |
| Hanjeli         | 9.87 ± 0.01    | 0.92 ± 0.02| 2.58 ± 0.07| 14.30 ± 0.09  | 72.33                          |
| Yellow Sweet    | 8.55 ± 0.07    | 3/62 ± 0.01| 1.19 ± 0.03| 4.57 ± 0.05   | 82.12                          |
| Potato          | Max 14.50      | Max 0.70  | Max 7.00  |               |                                |

Based on the results of the analysis of the local flour composition, it shows that there are differences between the types of samples. The highest protein content is found in hanjeli flour which is 14.30%, compared to the protein content of other local flour. The protein content of corn flour was also relatively higher at 8.41%. Herawati [14] conducted an analysis of making Srikandi white corn flour to produce a protein content of 8.92%. Meanwhile, Riyani [15] produced a corn flour protein content of 10.77%. The difference in varieties and types of processing techniques affects the quality of the corn flour produced. Based on the BSN standard, the maximum moisture content requirement is 14.50%, the maximum ash content is 0.7% and the protein content is 7%. This actually refers to the protein content of wheat flour.

3.2. RVA Result Analysis

The method to determine the gelatinization profile of starch properties or starch sources is by measuring it using a Rapid Visco Analyzer (RVA). The working principle of the tool provides a continuous and controlled heating, cooling, stirring treatment. Flour samples have different profiles so they are grouped based on granule populations that vary in size, shape and energy required to expand. The determination of the starch gelatinization profile was observed at several temperature points, namely the initial temperature of 50° C, 95° C, and temperatures between 50-95° C. At a temperature...
of 50 °C, it was carried out to determine the resistance of starch to the stirring process at constant temperature.

The results obtained in Table 2 are flour samples. Based on Table 2, it can be seen that the peak viscosity, the highest breakdown viscosity and the lowest return viscosity. This is the highest peak viscosity possibly estimated according to Kusnandar [16] that cassava flour has a low amylose content so that it has the ability to form a gel that is less strong than other flours.

Table 2. Characteristics of local flour RVA result analysis

| Local Flour | Gelatinization Temperature (°C) | Peak Viscosity (cP) | Breakdown Viscosity (cP) | Back Viscosity (cP) |
|-------------|----------------------------------|---------------------|--------------------------|---------------------|
| Ganyong     | 78.5                             | 731                 | 100                      | -19                 |
| Breadfruit  | 77.6                             | 2501                | 119                      | 2058                |
| Taro        | 79.1                             | 3013                | 48                       | 1112                |
| Banana      | 78.6                             | 815                 | 3                        | 160                 |
| Corn        | 89.9                             | -                   | -                        | -                   |
| Sago        | 78.9                             | 1621                | 963                      | -662                |
| Sorghum     | 78.8                             | 1670                | 182                      | 1900                |
| Hanjeli     | 74.6                             | 1240                | 32                       | 594                 |
| Yellow Sweet| 80.3                             | 315                 | 17                       | 101                 |
| Potato      |                                  |                     |                          |                     |

The effect of this temperature is intended to see the cooking conditions that are often found in daily processes [6]. The data obtained from the measurement of RVA is peak viscosity (PV) is the viscosity when the starch granule expands to its maximum during the heating phase, holding viscosity is the viscosity of the starch paste after the temperature is maintained at 95 °C for a certain time, the breakdown viscosity (BD) is obtained as the difference between the viscosities, peak with holding viscosity, the final viscosity is the value of the viscosity of the paste after the end of holding at a temperature of 50 °C. The setback viscosity is obtained from the difference between the final viscosity and the holding viscosity, while the pasting temperature is the temperature at which the RVA begins to read the viscosity value [17].

In general, the gelatinization mechanism basically occurs in three stages, namely (1) the absorption of water by the starch granules to a certain extent slowly where the water slowly and back and forth adds to the granules, (2) rapid development of the granules because it absorbs water quickly, (3) The granule breaks when the temperature continues to rise until the amylose molecules exit the granule. The temperature at which the starch suspension begins to increase in viscosity or when the starch granules begin to expand with the initial temperature of gelatinization. As the heating temperature increases above the gelatinization temperature, the starch granules will expand and can no longer hold water, as a result the starch granules will break. The starch suspension achieves a peak viscosity value. The decrease in viscosity (breakdown viscosity) will continue with increasing heating temperature [16].

There are phases in measuring using the RVA. In the first phase of the curve, the temperature is still below the gelatinization temperature of the starch, so the viscosity is low. In the second phase, the temperature is slowly increased until it reaches the gelatinization temperature of the starch, which is the temperature at which the starch granules begin to swell and the viscosity increases known as peak temperature and peak viscosity. When most of the starch granules swell, there is a rapid increase in viscosity. The third phase, when the fixed-temperature increases and stirring continues (holding), the starch granules will break and the amylose will come out of the liquid granules, which causes the viscosity to decrease. In the fourth phase, the mixture is then cooled, which causes re-association between the starch molecules (setback), so that a gel is formed and the viscosity increases again until it reaches the final viscosity [6].
3.3. Proximate Characteristics of Gluten Free Noodles

Local flour can be processed and developed into noodle products from various types of local flour which include corn flour, taro, purple sweet potato, yellow sweet potato, arrowroot, banana, breadfruit. Several types of flour have the ability to absorb different water. To increase the elasticity of the dough and noodle products so that they do not break easily, tapioca was added, which has the ability to increase the elasticity of the dough and the product. The results of the proximate analysis of gluten free noodles from several local flours are shown in Table 3 below.

| Content          | Gluten Free Noodle |
|------------------|--------------------|
|                  | Bread Fruit        |
| Moisture (%)     | 8.195              |
| Ash (%)          | 2.705              |
| Fat (%)          | 0.35               |
| Protein (%)      | 3.46               |
| Carbohydrate (%) | 85.29              |
| Energy (cal)     | 358.15             |
|                  | Purple Sweet Potato|
| Moisture (%)     | 6.425              |
| Ash (%)          | 2.375              |
| Fat (%)          | 0.3                |
| Protein (%)      | 3.23               |
| Carbohydrate (%) | 87.41              |
| Energy (cal)     | 366.3              |
|                  | Yellow Sweet Potato|
| Moisture (%)     | 5.62               |
| Ash (%)          | 2.88               |
| Fat (%)          | 0.32               |
| Protein (%)      | 2.34               |
| Carbohydrate (%) | 88.84              |
| Energy (cal)     | 367.6              |
|                  | Ganyong            |
| Moisture (%)     | 7.17               |
| Ash (%)          | 3.53               |
| Fat (%)          | 0.325              |
| Protein (%)      | 1.665              |
| Carbohydrate (%) | 87.31              |
| Energy (cal)     | 358.825            |
|                  | Corn               |
| Moisture (%)     | 7.255              |
| Ash (%)          | 0.78               |
| Fat (%)          | 0.275              |
| Protein (%)      | 2.42               |
| Carbohydrate (%) | 86.555             |
| Energy (cal)     | 369.235            |
|                  | Banana             |
| Moisture (%)     | 7.135              |
| Ash (%)          | 1.49               |
| Fat (%)          | 0.245              |
| Protein (%)      | 2.375              |
| Carbohydrate (%) | 88.71              |
| Energy (cal)     | 366.725            |
|                  | Taro               |
| Moisture (%)     | 7.06               |
| Ash (%)          | 2.675              |
| Fat (%)          | 0.145              |
| Protein (%)      |                    |
| Carbohydrate (%) |                    |
| Energy (cal)     |                    |

In accordance with the proximate content found in flour as the raw material, the protein content in corn noodles is higher than other gluten free noodles. This shows that the proximate composition will be influenced by the type and concentration of the raw material for which it is made. Based on the results of the proximate composition analysis, it shows that the fat content of all gluten free noodles is lower than that of wheat flour noodles. The water content of gluten free noodles ranges from 5.62 to 8.195%. The moisture content greatly determines the shelf life of the gluten free noodles produced.

3.4. Gluten Free Noodle RVA Results Analysis

Based on the results of the profile analysis of the RVA (Rapid Visco Analysis) of various local food noodles, it can be seen that the characteristics of these noodles are due to the addition of water and the implementation of heat used. Based on the results of the RVA analysis of noodles using various local food raw materials as shown in the table below.

| Gluten Free Noodle | RVA Analysis |
|--------------------|--------------|
|                    | Peak Viscosity (cp) | HPV (cp) | CPV (cp) | VBP (cp) | VEP (cp) | Breakdown (cp) | Setback (cp) |
| Bread Fruit        | 264          | 240       | 561      | 261      | 248      | 25             | 297          |
| Purple Sweet Potato| 118          | 108       | 268      | 117      | 118      | 10             | 150          |
| Corn               | 306          | 291       | 516      | 137      | 296      | 15             | 211          |
| Ganyong            | -            | -         | 203      | 57       | 89       | -              | -            |
| Banana             | -            | -         | 436      | 87       | 212      | -              | -            |
| Taro               | -            | -         | 1182     | 158      | 595      | -              | -            |

In ganyong, banana and taro noodles did not show any peak viscosity patterns. The addition of additional materials and process technology affected the peak viscosity and HPV patterns of ganyong gluten free noodles, banana and taro. This also results in no breakdown and etback from the resulting
viscosity calculation. The highest peak viscosity is found in gluten free noodles from the main raw material in the form of corn flour, which is 306 cP.

3.5. Gluten Free Noodle XRD Results Analysis
To determine the differences in the profile of the amorphous and crystalline phases of noodle products using raw materials from several local food sources, the amorphous and crystalline phases of the products were analyzed and the results were as shown in the table below.

| No | Gluten Free Noodle       | Crystalline Phase (%) | Amorph Phase (%) |
|----|--------------------------|-----------------------|------------------|
| 1  | Ganyong                  | 30                    | 70               |
| 2  | Corn                     | 32                    | 68               |
| 3  | Banana                   | 26                    | 74               |
| 4  | Breadfruit               | 29.4                  | 70.6             |
| 5  | Taro                     | 30.5                  | 69.5             |
| 6  | Yellow Sweet Potato      | 28.5                  | 71.5             |
| 7  | Purple Sweet Potato      | 25.5                  | 74.5             |

Based on the analysis of the crystallinity pattern of gluten free noodles with raw based main local flour, it shows that noodles made from sweet potato and banana flour have a higher amorphous phase than others. This shows that the crystallinity pattern and the amorphous phase of the main raw material for gluten free noodles greatly affect the crystallinity pattern of the resulting gluten free noodles.

4. Conclusion
Several variations of the source of raw flour used affect the proximate levels produced. Hanjeli and corn flour have higher protein content compared to other flours. The protein content in the flour raw material affects the protein content in the noodles produced. The different types of raw flour sources also affect the resulting viscosity profile, where the canna, banana and taro noodles do not have peak viscosity. Based on the analysis of the crystallinity pattern of gluten free noodles with raw based main local flour, it shows that noodles made from sweet potato and banana flour have a higher amorphous phase than others. Some local flours are very feasible to be developed into commercial products in the form of gluten free noodles.

References
[1] Herawati H., Sunarmani. 2016. Teknologi pengolahan produk roti gluten free. Prosiding Seminar Nasional dalam Rangka Dies Natalis ke-53 Fakultas Pertanian Universitas Sriwijaya, Palembang 14 September 2016.
[2] Herawati H. 2012. Teknologi proses produksi food ingredient dari tapioka termodifikasi. Jurnal Litbang Pertanian 31(2): 68–76.
[3] BPS Badan Pusat Statistika. 2008. Data Impor Tepung Terigu. BPS. Jakarta
[4] Kartikasari Subekah Nawa, Sari Puspita, Subagio Achmad. 2016. Karakterisasi Sifat Kimia, Profil Amilografi (RVA) dan Morfologi Granula (SEM) Pati Singkong Termodifikasi Secara Biologi. Jurnal Agroteknologi Vol 10 (01) 2016
[5] Copeland L, Blacek J, Salman H, Tang M. 2009. Form and Functionality of Starch. Food Hydrocolloid (23):1527-1534.
[6] Imanningsih Nelis. 2012. Profil Gelatinisasi Beberapa Formulasi Tepung-tepungan untuk Pendugaan Sifat Pemasakan. Penel Gizi Makanan Vol 35 (1): 13-22
[7] Herawati H, Sunarmani, Kamsiati E. 2017. Teknologi Produk Gluten Free sehat Dengan Gluten Free. IPB Press. ISBN: 978-979-493-000-0.
[8] Herawati H, Kamsiati E, Bachtiar M. 2020. Modification of Process and Formulations Technology To The Characteristics of Hanjeli Gluten Free Noodles. IOP Conf. Series: Earth and Environmental Science 519 (2020) 012038. doi:10.1088/1755-1315/519/1/012038

[9] Herawati H, Kamsiati E, Bachtiar M. 2020. Effect of Formulation Technology on Characteristics and Prices of Cassava Instant Noodles Seasoning Gluten Free. IOP Conf. Series: Earth and Environmental Science 519 (2020) 012038. doi:10.1088/1755-1315/519/1/012038.

[10] Herawati H, Kusnandar F, Adawiyah DR, Budijanto S.2014.Teknologi Proses Produksi Beras Tiruan Mendukung Diversifikasi Pangan. J. Litbang Pert. Vol. 33 No. 3 September 2014: 87-94.

[11] Herawati H and Sunarman. 2016. Gluten Free Noodle and Pasta Process Production Technology. Prosiding of The Intrenational Food Conference 2016 “ Innovation of Food Technology To Improve Food Security And Health”, October 20-21th 2016. Widya Mandala Catholic University, Surabaya.

[12] AOAC . 1998. Official Method of Analysis. 15th Edition, Association of Official Analytical Chemists, Washington DC.

[13] (BSN) Badan Standar Nasional. 1992. SNI 01-2891-1992 Cara Uji Makanan dan Minuman. Indonesia (ID).

[14] Herawati H. 2014. Optimasi proses, analisis termal, dan profil isothermis sorpsi air beras tiruan instan [Disertasi]. Institut Pertanian Bogor.

[15] Riyani 2007. Teknologi produksi dan karakterisasi tepung jagung varietas unggul nasional [Skripsi], Fakultas Teknologi Pertanian, IPB, Bogor.

[16] Kusnandar F. 2017. Kimia Pangan Komponen Makro. Bogor: Institut Pertanian Bogor.

[17] Syamsir E, Hariyadi P, Fardiaz D, Andarwulan N, Kusnandar F. 2011. Karakterisasi tapioka dari lima varietas ubikayu (Manihot utilisima Crantz) asal lampung. Jurnal Agrotek 5 (1): 95-105.