Sensory and Textural Characteristics of Noodle Made of Ganyong Flour (Canna edulis Kerr.) and Arenga Starch (Arenga pinnata Merr.)

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Abstract. Ganyong (Canna edulis Kerr) is a local tuber which highest amount of starch content, but has not been fully utilized well at present. One way to improve the usefulness of canna is to process it into noodle, but it needs arenga starch which has high amylose content. The aim of this research was to study the sensory and textural properties of noodle made from canna flour and arenga starch. Research methodologies consist of: (i) characterization of canna flour and arenga starch, (ii) noodle production, and (iii) characterization sensory and textural properties of the noodle. Noodle was made with five ratio variations of canna flour and arenga starch, i.e. 100:0; 75:25; 50:50; 25:75; and 0:100. Sensory analysis was done by hedonic scoring method with attributes: color, stickiness, elasticity, firmness, surface smoothness, and overall liking. Textural properties analyses consist of tensile strength, elongation, and stickiness measurements. The results showed that canna flour and arenga starch can be used in noodle making process. Noodle with 25% of canna flour was the most favored product and has the best textural properties. Factors which affect textural properties of product are the amylose and amylopectin amount in each starch. Tensile strength, elongation, and stickiness measurements of noodle with 25% of canna flour were 0.13 N; 41.61%; and 0.0115 N respectively.

1. Introduction
Indonesia has a great potential in agricultural product, including tubers. One of the local tubers that can be developed is ganyong (Canna edulis Kerr). Ganyong contain high amount of carbohydrates. It can be consumed as a source of energy supply for the body. Processing ganyong tuber into flour and starch can be highly prospective in terms of functional properties and chemical composition [1]. Ganyong is a potential agricultural product that can be used for food diversification. Therefore, it is necessary to increase the utilization and consumption of ganyong. Processing ganyong/canna tuber into noodles can increase the consumption of ganyong, but it need other ingredient because amylose content of canna tubers relatively low. Local ingredient that can be used is arenga starch which have high amount of amylose content. Arenga starch has been used for raw material of noodle because it has similar character with green bean starch, which contain high amylose, has a limited degree of bubbling granules, and has a viscosity Branbender curve type C [2].

Arenga starch has physical properties, chemical properties and functionally similar to the green bean starch that commonly used as a raw material in the manufacture of starch noodle and instant noodle [3]. Amylose content in arenga starch is high >35% [4]. By using canna flour and arenga starch in noodle-making, it is expected to develop a noodle made from local materials with good sensory, physical properties and acceptable by society. Some researcher reported use of canna flour and wheat flour in noodle processing [5, 6]. Srikaeo et al [7] and Wande et al [8] has been reported use of canna starch in a rice noodle product. There is no report about sensory and textural properties noodle made from canna flour and arenga starch. The aim of this research was to study the sensory and textural properties of noodle made from canna flour and arenga starch. By conducting this research, it is expected that the value of canna as local farm product can be elevated, i.e. by processing it as raw material for noodle making.

2. Materials and Method

2.1. Materials
Canna flour that used in this research was produced by Indonesian Institute of Sciences (LIPI) in Yogyakarta. The other ingredient was arenga starch from Klaten, Yogyakarta. The tools used for noodle making are noodle making machine (Food Extruder PD-4SN, La Pramigiana), UTM (Universal Testing Machine Zwick 0.5- Lloyd's Universal Testing Instrument) used for texture analysis.
2.2. Noodle process

Making noodles is based on the common practice in a large scale [9] with some modification to be performed in a laboratory scale. Noodle was made with five ratio variations of composition between canna flour and arenga starch, i.e. 100:0; 75:25; 50:50; 25:75; and 0:100. The first step was weighing a mixture of canna flour and arenga starch with a total of 300 grams. Starch flour is blended until homogeneous, then water is added to flour mixture. Stirring the flour and water is performed with a mixer, so that the dough can be hydrated evenly. The mixture is then molded into pellets with a length of 3-5 cm using the extruder with a diameter of 15 mm. Making pellets aims to expand the surface of the dough so as to facilitate the process of gelatinization when steamed. Pellets then steamed for ± 3 minutes until the surface becomes shiny. Steaming should not be too long because it is desired to gelatinization partially on the surface of the pellet. While pellets were still hot, put immediately into the extruder to be molded into noodle threads. The mold used in this process has a diameter of 0.7 mm. The obtained raw noodle is then hung on a cart and steamed for ± 20 minutes until the color of noodle becomes transparent. The cooked transparent noodle is allowed to stand until it reaches room temperature, then separated and dried in a cabinet dryer at 55°C for 6 hours until the moisture content is about 10%.

2.3. Noodle analysis

Characteristic of canna flour and arenga starch were analysis with three replicates. Sensory analysis of noodle using hedonic scoring method with attributes: color, stickiness, elasticity, firmness, surface smoothness and overall liking to 25 panelist, with 1-7 grading scale (1=lowest preference, 7=highest preference). Dried noodle cooked using boiling water with a long time in accordance with the optimum cooking time, then allowed to stand no more than 30 minutes in a closed container. Samples are presented in colored bowl, and each panelist get a bowl of the same color for each sample. Textural properties analysis of noodle consist of tensile strength, elongation, and stickiness measurements [10] with three replicates. The design of the experiment used a completely randomized design (CRD). Statistical data analysis using the software of SPSS version 16 with One Way Anova method with a significant level of 5% in the comparison of means using Duncan method.

3. Results

3.1. Characteristic of canna flour and arenga starch

The characteristic of canna flour including water content, ash content, fat content, amylosa content, crude protein content, carbohydrate content, and starch content can be shown in Table 1.

| Component         | Content | % Wet basis (wb) | % Dry basis (db) |
|-------------------|---------|------------------|------------------|
| Water content     |         | 6.27             |                  |
| Ash content       |         | 2.98             | 3.18             |
| Fat content       |         | 0.55             | 0.59             |
| Amylosa content   |         | 32.10            | 34.37            |
| Crude protein content |     | 2.85             | 3.04             |
| Carbohydrate content |     | 87.35            | 93.19            |
| Starch content    |         | 53.0             | 56.55            |

*three replicates

The characteristic of arenga starch including water content, ash content, fat content, amylosa content, crude protein content, carbohydrate content, and starch content can be shown in Table 2.
Table 2. Characteristic of arenga starch*

| Component               | Content   | % Wet basis (wb) | % Dry basis (db) |
|-------------------------|-----------|------------------|------------------|
| Water content           | 15.27     |                  |                  |
| Ash content             | 0.11      | 0.13             |                  |
| Fat content             | 0.01      | 0.01             |                  |
| Amylosa content         | 37.86     | 44.68            |                  |
| Crude protein content   | 0.06      | 0.07             |                  |
| Carbohydrate content    | 84.58     | 99.82            |                  |
| Starch content          | 77.69     | 91.69            |                  |

*three replicates

3.2. Noodle process
Canna flour and arenga starch used as raw materials in noodle processing as shown in Figure 1.

Figure 1. (a) noodle made from canna flour:arenga starch = 100:0; (b) noodle made from canna flour:arenga starch = 75:25; (c) noodle made from canna flour:arenga starch = 50:50; (d) noodle made from canna flour:arenga starch = 25:75; (e) noodle made from canna flour:arenga starch = 0:100

3.3. Sensory Preference
Sensory analysis was performed with hedonic scoring method to identify which product is the most preferred by the panelist using attributes such as: color, stickiness, elasticity, firmness, surface smoothness and overall liking. Sensory analysis on noodle products aims to determine which products are most preferred by the panelist to reflect acceptance of products which is currently marketed. Sensory characteristics of noodle made from canna flour and arenga starch after cooking (cooked) can be seen in Table 3.
Table 3. Sensory preference characteristic of cooked noodle*

| Sample (Canna flour: arenga starch) | Sensory preference |       |       |       |       |
|------------------------------------|--------------------|-------|-------|-------|-------|
|                                    | Color              | Stickiness | Elasticity | Firmness | Surface smoothness | Overall liking |
| 100:0                              | 3.04<sup>a</sup>   | 2.12<sup>a</sup> | 2.04<sup>a</sup> | 2.40<sup>a</sup> | 2.28<sup>a</sup> | 2.16<sup>a</sup> |
| 75:25                              | 2.76<sup>b</sup>   | 2.08<sup>a</sup> | 2.00<sup>a</sup> | 2.56<sup>a</sup> | 2.24<sup>a</sup> | 2.12<sup>a</sup> |
| 50:50                              | 3.40<sup>ab</sup>  | 3.44<sup>b</sup> | 3.08<sup>b</sup> | 3.72<sup>b</sup> | 3.44<sup>b</sup> | 3.52<sup>b</sup> |
| 25:75                              | 3.76<sup>bc</sup>  | 4.64<sup>c</sup> | 4.28<sup>c</sup> | 4.16<sup>c</sup> | 4.16<sup>c</sup> | 4.56<sup>c</sup> |
| 0:100                              | 4.24<sup>c</sup>   | 3.68<sup>b</sup> | 3.44<sup>b</sup> | 3.72<sup>b</sup> | 4.00<sup>bc</sup> | 3.6<sup>b</sup> |

*25 replicates as represent of 25 panelist
Note: The same superscript symbol in the same column indicate that sample are not significantly different at a significance level of 95%
Scale: 1=lowest preference, 7=highest preference

3.4. Textural characteristic of cooked noodle

Textural characteristics of noodle made from canna flour and arenga starch after cooking (cooked) can be seen in Table 4. Textural properties include tensile strength, elongation, and stickiness measurements.

Table 4. Textural characteristic of cooked noodle*

| Sample (canna flour: arenga starch) | Tensile strength (N) | Elongation (%) | Stickiness (N) |
|------------------------------------|----------------------|----------------|----------------|
| 100:0                              | 0.03<sup>a</sup>     | 13.85<sup>a</sup> | 0.0056<sup>a</sup> |
| 75:25                              | 0.06<sup>b</sup>     | 17.35<sup>a</sup> | 0.0109<sup>b</sup> |
| 50:50                              | 0.07<sup>b</sup>     | 20.69<sup>a</sup> | 0.0148<sup>c</sup> |
| 25:75                              | 0.13<sup>d</sup>     | 41.61<sup>b</sup> | 0.0115<sup>d</sup> |
| 0:100                              | 0.18<sup>c</sup>     | 37.87<sup>b</sup> | 0.0059<sup>a</sup> |

*three replicates
Note: The same superscript symbol in the same column indicate that sample are not significantly different at a significance level of 95%

4. Discussion

As shown in Table 1, the water content of canna flour was 6.27% w.b. The ash content of canna flour was 2.98% (wb) or 3.18% (db). The result was higher than the maximum ash content from garut flour standard (SNI) which is 0.5% (b/b). The high ash content of canna flour can be caused by residue of metallic material left during the process of flouring. The fat content of canna flour was 0.59% (db). The low fat content in canna flour was related with the low fat content of ganyong tubers. Protein content of canna flour was 34.37% (db). Aprianita et al. [11] reported the amylose content from canna flour was 23.32%. Chansri et al. [12] reported that ideal starch as raw material for noodle is starch with high amylose content (21-28%).

Arenga starch contain high amount of carbohydrate, starch, and amylose content. As shown in Table 2, arenga starch contain high amount of amylose which is 44.68% (db). Arumudiniar [13] also reported the high amylose content of arenga starch was 40.78% (db). It caused arenga starch commonly used as a raw material in the manufacture of starch noodle and instant noodle [3, 4].

As shown in Figure 1, the noodle color were brown, which is influenced by the color of canna flour used. Differences in the proportion / ration of canna flour used affects the color of the products, especially the brightness of the products. The more canna flour used, the brightness of the product will be reduced. Noodle made from 100% canna flour has high brightness values because the product does not have a smooth surface and still contain ungelatinized flour perfectly.

Preference for color attributes in the noodle made from canna flour 100%, 75%, and 50% was not significantly different. The highest level of color preference is noodle made from arenga starch 100%. This could be due to visibility of noodle-based canna which has a brownish color (Figure 1) that is rarely found in the market, in contrast to noodle from arenga starch 100% which has clear visibility like commercial product. Previous research reported differences in the proportion of canna flour used affects the color of the noodle, especially the brightness of the noodle [14]. The more canna flour used, the brightness of the noodle product will be reduced.

Attributes stickiness judged by the ease of the product to disintegrate before being consumed. The desired
product is a solid product that is not easily destroyed when scooped. While the elastic properties is one of the
textural properties of the most frequently assessed when eating noodle products. Noodle is the preferred product
that is elastic, but easily chewed. As shown in Table 3, stickiness and elasticity preference were increased with
lower addition of canna flour. Previous study reported that use of canna flour will increase the noodle cooking loss
[14]. Higher cooking loss leads to undesirable noodles characteristics such as, high starch solubility and poor
cooking resistance or tolerance that causes stickiness in texture of noodles. Thus, the more canna flour is used, the
lower of stickiness and elasticity preference, due to the higher of cooking loss value. The highest level of
preference for stickiness and elasticity of the noodle is product noodle made from canna flour:arenga starch = 75:25.
It appears that the stickiness and elasticity in this product differs markedly from other noodle mixture.
Noodle product is said to be sticky if it is attached to the teeth and palate when eaten.

Firmness preference of noodle made from canna flour 100% and 75% were not significantly different, while
the other product (noodle made from canna flour 50%, 25%, and arenga starch 100%) also not significantly
different. Qazi et al [15] reported the effect of canna starch in the stretch firmness of rice noodle. Firmness
preference correlated with stability ratio, as variation between amylose and amylopectin content. Firmness of
noodle also correlated with hydration index and swelling index. Previous study [14] reported that value rehydration
noodle made from 100% canna flour and noodle made from 75% canna flour are quite large, so it cause the lower
firmness preference. The best firmness preference was noodle with canna flour 25%, but not significantly different
with noodle made from canna flour 50% and noodle made from arenga starch 100%.
Noodle surface smoothness can be assessed through visibility and sensibilities in the mouth of panelists.
Products that have the highest level of preference in this case is the noodle made from canna flour 25%, but not
significantly different to the products made from canna flour 50% and arenga starch 100%. Noodle products which
were overall preferred by panelists is noodle made from canna flour:arenga starch = 25:75. This product has the
highest scale, significantly different with other canna flour and arenga starch noodle. The highest scale of noodle
made from canna flour:arenga starch = 25:75 was positively correlated with the other attributes, i.e. stickiness,
elasticity, firmness, and surface smoothness.

Tensile strength and elongation are important textural properties in noodle. Noodle quality which customers
want is a product with a value of tensile strength and high elongation. Both of these properties are correlated with
each other positively. The more compact the structure of the noodle, the elongation will increase, and it will be
more difficult to break up when pulled. Amylose content in the noodle will affect the strength of the product when
stretched [2, 12]. Noodle products from mung bean starch has a tensile strength values higher than the product of
canna starch [12]. From the results of statistical tests with p <5%, it was obtained that the tensile strength of the
sample noodle significantly different at each variation of the ratio, except the noodle made from canna flour:arenga
starch = 75:25 and 50:50. Tensile strength and elongation values increasing as more arenga starch added in the
mix due to an increase in the amylose crystalline clusters noodle threads. Noodle made from high amylose material
has a tensile yield strength and strong texture / compact [3]. High amylose content which causes retrogradation
perfect so that the structure of starch instant noodle produced more rigid, robust and compact [3]. Qazi et al [15]
reported the effect of canna flour that decrease the tensile strength of noodle. Meanwhile, the elongation noodle
made from canna flour 100%, 75% and 50% were not significantly different. Noodle made from canna flour 25%
and arenga starch 100% were not significantly different. Elongation values increasing as more arenga starch added
in the mix due to an increase in the amylose crystalline clusters noodle threads. The more compact the structure of
the noodle will increase the elongation.

Stickiness is also a determinanrt factor of noodle quality, because higher level of stickiness will cause the
strands of noodle difficult to separate after the cooking process. Sticky nature of the noodle product is not favored
by consumers, so it is expected that noodle have lower levels of stickiness. Sticky nature commonly found in
products with a high amylopectin content, since amylopectin is able to absorb water but has a less compact
structure so that water can not be absorbed properly restrained in starch granules [16, 17, 18]. Stickiness of noodle
product can be seen in Table 4. It shows that there is a trend, i.e. if more arenga starch is added, the value of the
product stickiness is greater. But the results of statistical tests with P <0.05 indicates that the stickiness of the
product made from canna flour 100%, arenga starch 100% were not significantly different. The stickiness level of
noodle made from canna flour 75% and 25% were not significantly different.

5. Conclusion
The ratio between canna flour and arenga starch affect the sensory and textural characteristic of noodle. Preference
for color attributes in the fifth sample of canna noodle was not significantly different. The highest level of
preference for stickiness and elasticity of the noodle is noodle made from canna with composition of canna
flour:arenga starch = 75:25. Noodle products which were overall preferred by panellists is noodle made from canna
with composition of canna flour:arenga starch = 25:75. Factors which affect textural properties of product are the amylose and amylopectin amount in each starch. The value of tensile strength, elongation, and stickiness will increase with more addition of arenga starch. The best textural properties is noodle with 25% of canna flour. Tensile strength, elongation, and stickiness measurements of noodle with 25% of canna flour were 0.13 N; 41.61%; and 0.0115N respectively.

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