Fermented cassava as an alternative flour for pasta noodle

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Abstract. Cassava is widely cultivated in South East Asia countries like Indonesia. However, ordinary cassava flour cannot substitute wheat flour due to lack of gluten. Fermented cassava flour (fercaf) is a protein enriched cassava flour which is produced from a fermentation process of cassava flakes by lactic acid bacteria. Fercaf may serve as substitution to wheat flour, especially in pasta production. Nevertheless, a number of modifications should be exercise in product formulation to meet the ordinary ‘wheat base’ pasta product specifications. The current study was focus on these modifications i.e., addition of other flour and addition of hydrocolloids. The properties of pasta such as elasticity, yield, cooking weight, hardness, stickiness as well as sensory property were examined to determine the best pasta formulation. The results show that pasta made from fercaf with the addition of rice and corn flour gave strong and elastic texture while hydrocolloid addition increased water-binding of the pasta. The final pasta formulation included ratio of fercaf:rice:corn flour by 70:10:20 and addition of 2,5% xanthan gum.

1. Introduction

Pasta and noodle are loved by many people around the world. The consumption of noodle increases due to its variety and readiness. Even though noodle is not a main food for Indonesian people, but noodle consumption significantly increases every year. However, pasta and noodle are made from wheat which is mostly grown in sub-tropical countries. Tropical country like Indonesia must import wheat from other countries. In the other side, there are many food carbohydrate sources grown in tropical area such as rice, corn, sweet potato, cassava etc. The difference between these carbohydrate sources and wheat is the gluten protein content. This wheat protein may build a structure thus yield a good texture of the food.

A number of study have been carried out in replacing wheat [1–6]. Charoenthaikij [2] has developed a method of making noodle from brown rice with addition of pre-gelatinized cassava starch and xanthan gum. Abidin [1] has successfully developed a method of noodle making using a mixture of cassava flour and wheat flour with a portion of 5:1.

Cassava is a tropical crop which is usually used as food carbohydrate source. Unlike wheat, cassava tuber contains quite small protein so for some extent it cannot substitute wheat due to the absence of gluten protein. However, cassava can be partly fermented to increase its protein content [7,8]. This product is named as fermented cassava or "fercaf". Fercaf has been successfully used as flour for bread and some cake making. However, it is very limited publication that mentions the use of fercaf in noodle making.

The purpose of this study is to develop the method of noodle making using fercaf as main flour. Some noodle properties have been improved by addition of other flours such as maize and rice flours. The noodle properties such as elasticity; water content as cooking weight; yield; and texture as hardness.
and stickiness were evaluated. In addition, a number of hydrocolloids such as xanthan gum, guar gum, arabic gum and carboxymethyl cellulose were also employed for property improvements.

2. Materials and Methods

2.1. Materials

Fermented cassava (fercaf) flour was prepared from local cassava tubers according to the method from Kresnowati [7,8]. Multi-purpose wheat flour, rice flour and maize flour were purchased in local markets. All hydrocolloid agents such as xanthan gum, guar gum, arabic gum, and carboxymethylcellulose (CMC) were food grade and purchased from local supplier. Whole fresh eggs were used in all experiments.

2.2 Methods

Determination of the best composition of flour mixture were carried out according to the pre-set composition design which is shown in table 1. An automatic noodle maker, Renoodle RN-77 was used in all noodle preparation to maintain consistent product. The noodle recipe supplied by Renoodle RN-77 was used in all experiment: 150 g flour was entered to the machine followed by 60 g water and 5 g scrambled egg (hydrocolloid was added at last if applicable). Renoodle RN-77 kneaded the dough automatically for 9-12 minutes. The noodle was then extruded from the noodle maker and flour dusting was done to prevent the noodle stick one to each other. A couple of raw noodles were withdrawn for texture and water content analysis while the rest was cooked in boiled water for 2-3 minutes. The cooked product was drained and used for analysis of elasticity, weight and texture. The analyses were carried out directly after noodle making and cooking process.

| Sample Code | Wheat | Fercaf | Maize | Rice |
|-------------|-------|--------|-------|------|
| CTRL       | 100   | -      | -     | -    |
| F1         | -     | 100    | -     | -    |
| M1         | -     | 70     | 30    | -    |
| M2         | -     | 70     | -     | 30   |
| M3         | -     | 60     | 40    | -    |
| M4         | -     | 60     | -     | 40   |
| M5         | -     | 70     | 15    | 15   |
| M6         | -     | 70     | 10    | 20   |
| M7         | -     | 70     | 20    | 10   |

Table 1. Composition of flours in every experiment runs.

The effect of hydrocolloid in noodle recipe was evaluated as follow. The best flour composition which had been formerly determined was used afterward. Four type of hydrocolloid were applied in the experiments i.e., xanthan gum (XG), guar gum (GG), arabic gum (AG) and carboxymethylcellulose (CMC). The quantities of each hydrocolloid were 0.5, 1.0, 1.5 and 2.0% of flour weight basis.

2.3. Analyses

The yield of noodle preparation was determined by the ratio of the weight of noodle product and the weight of raw dough. Cooking weight and water content expressed how the noodle absorbed water during cooking process. The cooking weight is the difference between the weight of cooked noodle and the weight of raw noodle. The water content was determined as follow: the sample of cooked noodle was weighed and then dried in the oven at temperature of 105°C for 4 hours. The dried sample was also weighed. The difference between cooked noodle weight and dried cooked noodle weight was considered as the weight of water contained in the sample. The elasticity of cooked noodle was determined as follow: first, the length of a piece of noodle was measured using a ruler. The piece of noodle was then
drawn out until its broke up. The elasticity was calculated using those data according to Li et.al [9]. The hardness, chewiness and gumminess were determined using TA.XTplus Texture Analyzer. About 4 pieces of noodle were used in every measurement. Different probes were used for each texture analysis measurement.

### 3. Results and Discussions

Noodles were made using different combination of flour (table 1) and the characteristics of those products are shown in table 2. Noodle made from a whole fercaf (F1) was failed and seemed to be soft, slimy, watery and had no elasticity at all. It indicates that additional protein developed during cassava fermentation could not imitate the function of gluten protein contained in wheat flour in noodle making process. Other flour such as maize and rice flour were used and mixed with fercaf to improve the characteristic of noodle products. The quantities of additional flour were set to be less than that of fercaf as main flour.

Maize flour addition improved the yields, the cooking weight and the elasticity. The maize also gave better noodle appearance (compare with that of wheat noodle). In the other hand, rice flour addition improved the texture (hardness and stickiness) of the noodles. Base on these results, the mixtures of fercaf, maize and rice flour were used for subsequent experiments.

#### Table 2. The characteristics of noodle from different source of flour.

| Sample Code | Hardness | Stickiness | Cooking Weight (%) | Strain (%) | Yields (%) |
|-------------|----------|------------|--------------------|------------|------------|
| CTRL        | 16.25    | -0.16      | 61.83              | 51.64      | 70.00      |
| F1          | 11.01    | -0.04      | 101.25             | -          | 47.05      |
| M1          | 12.58    | -0.21      | 103.99             | 39.02      | 52.50      |
| M2          | 18.31    | -0.03      | 133.08             | 32.43      | 45.91      |
| M3          | 17.33    | -0.09      | 47.81              | 42.92      | 42.73      |
| M4          | 25.30    | -0.06      | 54.17              | 30.82      | 45.68      |

The characteristics of noodles made from mixtures of fercaf, maize and rice flours are shown in table 3. The noodle from M7 experiment resulted a lower elasticity (19.34) and bad texture (with stickiness of -0.17), while other experiments (M5 and M6) yielded noodles with better characteristics. Since these noodles had similar results, it was hard to distinguish and choose the better one among other. Therefore, an analytic hierarchy process (AHP) technique was employed [10–12], and every characteristic item were weighted through comparison matrix (not shown). The AHP vector was calculated from eigenvector of comparison matrix and the parameter values reflected the importance of particular characteristics (table 3). The highest AHP score was 27.11 for sample M6 (the composition of fercaf:maize:rice flour was 70:10:20). This composition then used for subsequent experiments.

#### Table 3. The characteristic of noodles from fercaf:maise: rise flour at different composition; and analytic hierarchy process (AHP) scoring.

| Parameters      | AHP vector parameters | Sample Code |
|-----------------|-----------------------|-------------|
|                 |                       | M5          | M6          | M7          |
| Strain (%)      | 0.4684                | 33.25       | 33.39       | 19.34       |
| Yield (%)       | 0.0441                | 60.91       | 50.68       | 55.91       |
| Cooking Weight (%) | 0.0759   | 86.49       | 84.14       | 71.16       |
| Hardness        | 0.1436                | 14.69       | 19.75       | 18.17       |
| Stickiness      | 0.2681                | -0.05       | -0.06       | -0.17       |
| AHP score       | 26.94                 | 27.11       | 19.58       |

The noodle made from fercaf had no water binding capability due to lack of gluten protein. The addition of hydrocolloid might alter the gluten function thus improve the water binding. A number of hydrocolloids i.e.: xanthan gum (XG), guar gum (GG), arabic gum (AG) and carboxymethyl cellulose
The current study has shown that sole fercaf could not be used for noodle making. However, a mixture of fercaf along with maize and rice flours was successfully used for noodle making. Table 4 shows that hydrocolloid such as xanthan gum (XG) and carboxymethyl cellulose (CMC) were added into the flour mixture to improve the noodle properties. In addition, 2.5% XG also gave a better stickiness. The experimental results show that the hardness of noodles decreased with the increasing amount of XG. The hardness is an important property where it serves the strength and strain of the noodle. CMC made a better hardness with the average strain value of 42.07% compare to other hydrocolloid such as GG and AG. The experimental results show that CMC could hold more water in noodle among other hydrocolloid. Since less stickiness caused by CMC, it seemed to be a firm character.

Cooking weight property indicates the capability of cooked noodle to hold water. CMC in noodle could hold more water inside the cooked noodle among others up to 48%. It seems that CMC made a better structure in holding water [13]. However, noodle with high moisture content (i.e., high cooking weight) could be gummy.

Stickiness property of the noodle show how easy a noodle sticks one to other. The high negative value of stickiness property indicates the easiness of noodles to lose each other. Since less stickiness noodle are preferable, thus a lower stickiness value is better. AG (1%) and XG (2.5%) resulted the better stickiness property. The addition of hydrocolloid did not alter the yield significantly because the amount of hydrocolloid added into the flour mixture was relatively small (up to 2.5%). The experimental results show this phenomenon. The difference values among results might be caused by measurement random error.

By means of AHP technique, the addition of 2.5% XG has the highest score. It is obvious since XG improved elasticity and hardness of the noodles. In addition, 2.5% XG also gave a better stickiness. In conclusion, the current study has shown that sole fercaf could not be used for noodle making. However, a mixture of fercaf along with maize and rice flours was successfully used for noodle making and gave good noodle properties. In addition, hydrocolloid such as xanthan gum can be used to improve the noodle properties.

Table 4. The characteristic of noodles from mix flour (fercaf:maize:rice of 70:20:10) with addition of hydrocolloid of xanthan gum (XG), guar gum (GG), arabic gum (AG) and carboxymethyl cellulose (CMC).

| Hydrocolloid | Amount (%) | Strain (%) | Yield (%) | Cooking Weight (%) | Hardness | Stickiness | AHP Score |
|-------------|------------|------------|-----------|-------------------|----------|------------|-----------|
| XG          | 1          | 34.22      | 52.61     | 51.15             | 24.29    | -0.19      | 25.77     |
|             | 1.5        | 36.15      | 39.27     | 49.12             | 22.64    | -0.12      | 25.67     |
|             | 2          | 48.40      | 49.23     | 61.50             | 20.07    | -0.09      | 32.42     |
|             | 2.5        | 49.52      | 51.74     | 61.46             | 21.83    | -0.05      | 33.29     |
| GG          | 1          | 27.62      | 60.05     | 57.83             | 15.18    | -0.10      | 22.18     |
|             | 1.5        | 39.13      | 52.43     | 60.94             | 12.03    | -0.11      | 27.02     |
|             | 2          | 38.64      | 51.24     | 65.55             | 8.41     | -0.10      | 26.57     |
|             | 2.5        | 27.50      | 51.41     | 47.35             | 10.19    | -0.11      | 20.23     |
| AG          | 1          | 20.02      | 57.68     | 63.91             | 12.51    | -0.05      | 18.58     |
|             | 1.5        | 24.42      | 47.03     | 90.29             | 9.26     | -0.07      | 21.71     |
|             | 2          | 18.26      | 49.56     | 81.68             | 19.32    | -0.10      | 19.74     |
|             | 2.5        | 20.77      | 58.78     | 71.11             | 7.85     | -0.07      | 18.86     |
| CMC         | 1          | 25.91      | 64.12     | 77.05             | 16.66    | -0.11      | 23.23     |
|             | 1.5        | 20.98      | 53.44     | 103.91            | 15.75    | -0.16      | 22.37     |
|             | 2          | 20.26      | 49.23     | 89.69             | 11.28    | -0.08      | 20.11     |
|             | 2.5        | 15.49      | 44.37     | 88.61             | 24.25    | -0.15      | 19.46     |

The elasticity of noodles is an important property where it serves the strength and strain of the noodle. Table 4 show that XG resulted a better elasticity with the average strain value of 42.07% compare to other hydrocolloid such as GG with the average strain value of 33.20%. In addition, XG was also shown better hardness property (with value of 24.29). The experimental results show that the hardness decreased with the increasing amount of XG. The hardness is an important noodle property since the noodle with a high hardness value has a firm character.
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