Characteristic chemical and physical of yellow pumpkin (Cucurbita moschata) traditional steamed cake (bolu kukus) with substitution and fermentation duration variation

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Abstract Pumpkin is one of the fruit in Indonesia that has contained much nutrition such as antioxidants (beta-carotene), carbohydrates, minerals, proteins, and fat. The utilization of yellow pumpkin is limited to food. One of the diversification products was the traditional steamed cake (bolu kukus). The research aimed to know the effect of yellow pumpkin (Cucurbita moschata) substitution and fermentation duration variations on the characteristics of physical and chemically of steamed pumpkin cake. Methods of research were randomized block design which consists of two factors. The first factor was the yellow pumpkin substitution variations (25% w/w of the total flour, 50% w/w of the total flour, and 75% w/w of the total flour) and the second factor was the fermentation time variations (1.5, 2, and 2.5 hours). The results showed that steamed pumpkin cake were contain the water about 31.09% - 54.52%, the ash about 0.81% - 1.23%, the protein about 4.41% - 7.87%, the fat about 0.26% - 0.52%, the carbohydrate about 40.73% - 59.99%, and the percentage of the expansion volume about 46.35% and 184.59%.

1. Introduction
Pumpkin (Cucurbita moschata) is tropical and sub-tropical vegetables that belong to the family Cucurbitaceae. Pumpkin has rich sources of ascorbic acid, carotenoids, minerals, and vitamins among colored vegetables, and these nutrients have an important role as a precursor of vitamin A and antioxidants in human health [1]. Many studies reported that the carotene of pumpkin may against carcinogenesis and heart diseases [2,3]. Based on studies conducted by [4] the Red pumpkin has a higher carotene content than carrots. The shelf life of the fresh pumpkin is very short due to the nutrition it contains. As a functional food, pumpkin can be substituted into cakes, bread, cookies, etc. Besides, pumpkin can be made into a powder that can enrich nutrients in biscuits, bread, noodles, cakes as well as natural coloring agent [5]. Based on the studies conducted by [6] was observed that the evaluation of Physico-chemical and organoleptic properties of cake can be affected by the addition of more than 10% of pumpkin powder. The traditional steamed cake is one of diversification on product pumpkin. All ages more preferred traditional steamed cake especially infants and older age. Also, the traditional steamed cake can be an alternative snack for patients in the hospital. Substitution pasta of yellow pumpkin in the dough of steamed cake can increase the beta-carotene contents.
Fermentation is one step of making steamed cake that can influence of final product. The research aimed to evaluate the characteristics of the chemical and physical traditional steamed cake with substitution pasta pumpkin and variation of time fermentation. Also, moisture, ash, protein, fat, carbohydrate and volume expansion of a steamed cake was observed.

2. Material and Methods

2.1. Material
The necessary materials were yellow pumpkin obtain from the Banyuwangi region. Other ingredients were wheat flour, eggs, sugar, yeast, water, vanilla, and salt. The raw materials for chemical analysis needed were H2SO4, Na2SO4, Petroleum Ether, NaOH solution, and HCl solution. The tools needed to be steam pan, mixer, analytic balance, oven, crus, Erlenmeyer, Kjeldahl glass, soxhlet, rules and beaker glass.

2.2. Methods

2.2.1. Pasta Pumpkin Preparation. Prepared the pasta of pumpkin by steaming the yellow pumpkin for 15 minutes, which has stimmed the peel. Grinded the steamed pumpkin by the blender. Weighing the ingredients available the research design in table 1.

2.2.2. Steam Cake Making Procedures. First, the stater must be prepared by adding the yeast in the sugar, flour, and water until 10 minutes. Mixed the sugar, salt, vanilla, and eggs until the dough was develop then added the pasta pumpkin and wheat flour well. Last, put the stater into the dough. Fermentation the dough available the research design that time fermentation was 1,5, 2 and 2,5 hours, then put the dough into the mold after then steam with a steam pan which has a towel in the lop off the pan.

| Percentage of pasta pumpkin (%) | Pasta Pumpkin (g) | Percentage Wheat Flour (%) | Wheat Flour (g) |
|---------------------------------|-------------------|-----------------------------|-----------------|
| 25                              | 200               | 75                          | 600             |
| 50                              | 400               | 50                          | 400             |
| 75                              | 600               | 25                          | 200             |

The formulation of the receipt consists of two receipts. First was stater receipt and the second was the mixed dough. Formulation of a stater was wheat flour contains high protein about 75 grams, sugar 25 grams, water 100 ml and fermion (yeast) 11 grams. Formulation of the dough were three eggs, sugar 250 grams, vanilla 11 grams, salt 10 grams and the weight of pasta pumpkin and the flour was used the research design.

2.3 Research Design
This study was conducted by randomized block design consists of two factors with 3 replications. Factor 1 was substitution pasta pumpkin with 3 levels which the concentration 25%, 50%, and 75%, while factor 2 was the time of fermentation with 3 levels which the duration fermentation 1,5, 2 and 2,5 hours.

2.4 Parameters
2.4.1. Chemical Analysis.
Water contents. Water contents of cake was analized using oven drying method [7]. Sample was grinded and weighed about 2 g (A) and dried using drying oven at 105 °C for 4 hours. It was cooled down in desiccator for 15 min and then weighed. Afterward, it was drying again for 30 min and cooled
down. Drying was performed until the sample reached a constant weight (B). Water contents was calculated using formula as following equation (1):

\[
\text{Water Contents (\%)} = \frac{A - B}{A} \times 100\%
\]  

Whereas:
A: sample initial weight  
B: sample constant weight

**Ash Contents.** Ash contents of cake was analyzed using AOAC method [8]. Porcelain vessel was heated in furnace at 400-600 °C, then cooled down and weighed. Sample (3-5 g) (A) was weighed and placed into porcelain vessel, then heated in furnace at 400-600 °C for 4-6 h. Ash contents was calculated using formula as following equation (2)

\[
\text{Ash Content (% b.b)} = \frac{B}{A} \times 100\%
\]

Whereas:
A: sample weight  
B: ash weight

**Protein Contents.** Determination of Total Nitrogen (Kjeldahl method) according to [9]. 2 g of powdered sample was digested in a Kjeldahl digestion flask by boiling with 20 ml of concentrated H2SO4and a Kjeldahl digestion tablet (catalyst) until the mixture was clear. The digest was filtered into a 250 ml volumetric flask and the solution made up to mark with distilled water and connected for distillation. Ammonia was steam distilled from of the digest to which had been added 50 ml of 45% sodium hydroxide solution. 150ml of the distillate was collected in a conical flask containing 100ml 0.1N HCl and methyl red indicator. The ammonia that distilled into the receiving conical flask reacted with the acid and the excess acid in the flask was estimated by back titration against 2.0M NaOH with colour change from red to yellow (end point). Determinations were made on all reagentsalone (blank determinations).

\[
\% \text{Nitrogen} = \frac{[\text{ml standard acid} \times N \text{of acid}] - [\text{ml blank} \times N \text{of base}]}{\text{Weight of sample in grams}} \times 1.4007
\]  

When N: normality

**Fat Contents**  
Fat contents was carried out using AOAC method (AOAC 920.39; Ether extraction/Soxhlet method)

2.4.2. Physical Analysis  
**Expansion Volume (%).** Physical parameters of steamed cake was volume of expansion were assessed by measured initial height and after steamed cake by using rules. % volume expansion was calculated as following equation (4)

\[
\text{EV} (%) = \frac{[\text{height (cm) after steamed cake} - \text{initial height (cm) before steamed}] \times 100\%}{(4)

2.5 Data Analysis  
The experiments were carried out in triplicates and data obtained from experiments were analysed using the SPSS (version 16.0). Analysis of Variance by multivariate test was used to obtain the
significant difference between each treatment. The means were compared using Duncan Multiple Range Test at the 5% significance level.

3. Results and Discussion

3.1 Chemical Properties

Results revealed that substitution of pumpkin pasta significantly affected the proximate compositions of steamed pumpkin cake. The variance analysis results showed that the substitution of pasta pumpkin had a significant effect and fermentation time had a significant effect. The moisture content is total water in matrix food not only insoluble form but also in bounding form. The moisture content (%) of steamed pumpkin cake with substitution of pasta pumpkin has significant different that was due to pumpkin pasta contains moisture content was high so the highest concentration makes the highest moisture content in steamed pumpkin cake. A similar trend was also reported in a banana cake by [10] and in pumpkin bread by [11]. The interaction between the two treatments was very significantly different. The chemical properties of steamed pumpkin cake enriched with yellow pumpkin pasta be seen in Table 2.

Ash content showed that increased the substitution pumpkin pasta made the ash content was increased too. It was a connection with the nutrition of pumpkin contains minerals and vitamins. Pumpkin has a rich source of carotenoids, ascorbic acid, minerals and vitamins among coloured vegetables, and these nutrients have a major role as an antioxidant and precursor of vitamin A in human health [2]. The higher level of ash content in steamed pumpkin cake was contributed by a high ash content in pumpkin pasta. The average test results of the ash content of steamed pumpkin cake can be seen in table 2.

Protein in food was changed by processing technology because of heat transfer in material food [12]. The protein content of steamed pumpkin cake was decreased. That was due to the formulation of each sample depending on the experimental design. Increased substitution of pasta pumpkin can decrease protein content. That was due to the effect of substitution of pasta pumpkin which decreased the amount of wheat flour.

| Substitution of Pumpkin Pasta (%) | Fermentation Time (Hours) | Moisture Content (%) | Ash Content (%) | Protein Content (%) | Fat Content (%) | Carbohydrate Content (%) |
|----------------------------------|---------------------------|----------------------|-----------------|--------------------|----------------|-------------------------|
| 25                               | 1.5                       | 35.49<sup>c</sup>    | 1.12<sup>d</sup> | 7.17<sup>c</sup>  | 0.53<sup>cd</sup> | 55.69<sup>d</sup>        |
|                                  | 2                         | 44.29<sup>d</sup>    | 1.05<sup>c</sup> | 6.49<sup>c</sup>  | 0.37<sup>bc</sup> | 47.82<sup>c</sup>        |
|                                  | 2.5                       | 56.21<sup>f</sup>    | 1.15<sup>d</sup> | 4.68<sup>ab</sup> | 0.44<sup>cd</sup> | 37.51<sup>a</sup>        |
| 50                               | 1.5                       | 31.64<sup>a</sup>    | 1.02<sup>c</sup> | 6.87<sup>c</sup>  | 0.58<sup>d</sup>  | 59.90<sup>c</sup>        |
|                                  | 2                         | 44.54<sup>d</sup>    | 1.01<sup>c</sup> | 6.98<sup>c</sup>  | 0.35<sup>bc</sup> | 47.15<sup>c</sup>        |
|                                  | 2.5                       | 54.62<sup>e</sup>    | 0.69<sup>a</sup> | 4.67<sup>ab</sup> | 0.04<sup>a</sup>  | 39.99<sup>b</sup>        |
| 75                               | 1.5                       | 33.70<sup>b</sup>    | 0.83<sup>b</sup> | 8.63<sup>d</sup>  | 0.21<sup>b</sup>  | 56.63<sup>d</sup>        |
|                                  | 2                         | 44.78<sup>d</sup>    | 0.86<sup>b</sup> | 6.05<sup>bc</sup> | 0.03<sup>a</sup>  | 48.29<sup>c</sup>        |
|                                  | 2.5                       | 55.92<sup>f</sup>    | 0.87<sup>b</sup> | 3.75<sup>a</sup>  | 0.02<sup>a</sup>  | 39.44<sup>b</sup>        |

Note: The different superscript letters indicate significantly different with Duncan’s test 5%.

Fat content was found to be decreased significantly affected by the substitution of pumpkin pasta and during the fermentation. Besides, the fat content can decrease significantly along with increased fermentation time and substitution pumpkin pasta, which was due to during fermentation fat was bound with sugar, pumpkin and wheat flour. It can be seen in table 2. A similar trend of fat content in cake supplementation of pumpkin flour by [6].

In this research, the carbohydrate content was found to be decreased, because of the substitution of pasta pumpkin. Increased the substitution made the steamed pumpkin cake contain low carbohydrate as well as fat content. It can happen, because as raw material pumpkin contains low carbohydrate. A similar trend of the carbohydrate content in cake supplementation of pumpkin flour by [6]. The average test results of the carbohydrate content of the steam cake pumpkin can be seen in table 2.
3.2 Physical Properties
Parameter physical of steamed pumpkin cake was determined by calculating the expansion volume of steamed pumpkin cake. Expansion volume was found to be decreased, that was due to yellow pumpkin has low gluten so the fermentation did not develop well. In our results that pumpkin pasta is not able to form an elastic structure. This may be responsible for the reduced expansion volume in steamed pumpkin cake. Similar findings by [13] reported that decreasing cake volume and increasing cake density can be affected by an increasing proportion of lentil flour. The average test results of the percentage of expansion volume of steamed pumpkin cake can be seen in table 3.

| Substitution of Pumpkin Pasta (%) | Fermentation Time (Hours) | Expansion Volume (%) |
|-----------------------------------|--------------------------|----------------------|
| 25                                | 1.5                      | 184.59^c             |
|                                   | 2                        | 117.78^abc           |
|                                   | 2.5                      | 46.35^a             |
| 50                                | 1.5                      | 135.89^abc           |
|                                   | 2                        | 161.90^c            |
|                                   | 2.5                      | 47.61^a             |
| 75                                | 1.5                      | 125.78^abc           |
|                                   | 2                        | 156.76^bc           |
|                                   | 2.5                      | 69.63^ab            |

Note: the different superscript letters indicate significantly different with Duncan’s test 5%.

4. Conclusion
The traditional steamed pumpkin cake by substitution of pumpkin pasta and fermentation time were contain water content about 31.09% - 54.52%, ash content about 0.81% - 1.23%, protein content about 4.41% - 7.87%, fat content 0.26% - 0.52%, carbohydrate content 40.73% - 59.99% and the percentage of the expansion volume about 46,35% and 184.59%. The substitution of pumpkin pasta and fermentation time significantly affect characteristic chemical and physical of traditional steamed pumpkin cake.

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