Study on the effect of different concentration of *Spirulina platensis* paste added into dried noodle to its quality characteristics

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**Abstract.** High nutritional content of microalgae *S. platensis* is very good for human health especially for its protein and β-carotene. These compounds can be used for improving quality of food from nutritional point of view. This study was designed to observe the effect of different concentration of *S. platensis* paste to dried noodle quality based on physical, chemical and sensory perspectives. Material used in this study was *S. platensis* powder obtained from CV Neoalgae, Sukoharjo. The best treatment observed from preliminary study was then used for further study and compared to control treatment (without added *S. platensis* paste). The dried noodle resulted was then analyzed for elasticity, chemical (β-carotene, water, protein, ash, fat and carbohydrate) and sensory (hedonic). Parametric data obtained were analyzed using t-Test while non-parametric data was analyzed using *Kruskal-Wallis* followed by *Multiple Comparison* test. The study showed that dried noodle added with 9% *S. platensis* paste give significant effect (P<0.05) on elasticity; β-carotene, water, protein, ash, fat and carbohydrate and also sensory (hedonic). Dried noodle without added *S. platensis* paste has lower in β-carotene and protein compared to that of added *S. platensis* paste with the value of 0.06 mg/100 gr and 17.51 mg/100gr (β-carotene) and 8.88% and 38.6% (protein), respectively. Those, chemical composition of dried noodle added with *S. platensis* comply with Indonesian National Standard in term of protein, water, and ash content with sensory of $7.26 \leq H \leq 7.63$. Addition of *S. platensis* can significantly increase the nutritional of dried noodle especially protein (by 4 times) and β-carotene.

Key words: dried noodle, *S. platensis*, β-carotene, protein

1. Introduction

Malnutrition experienced by Indonesian people reached 50% or more than 100 million people. Nutrition problems are often missed and take a long time to overcome, which can bring a big problem. Generally there is a big macro nutrition problems could be identified, include Malnutrition disorder, Animea, and lack of vitamin A (Vitamin A deficiency).

*Spirulina* is a multicellular and one type of blue-green algae that belong to class of *Cyanobacterium* and *Spirulina* sp. as the species. Spirulina contains a lot of proteins, vitamins, essential
amino acids and essential fats. Spirulina contains 60-70% protein, a lot of vitamin B12 dan pro-vitamin A (β-carotene) and mineral, especially iron (Fe) [1].

Some people often consume noodles as a substitute of rice because it is simple, easy to be processed and fast to be served. Nowadays noodle products are lack of nutrition. The proportion of wheat, which contains a lot of carbohydrate, are more dominant than the proportion of other nutrition, therefore we need to improve the noodle’s nutrition, especially the proteins and minerals [2]. Many studies have been conducted on quality and processing improvement of dried noodle including efficiency on energy consumption for drying process [3], effect of additive and steaming process [4], the use of buckwheat flour as antioxidant [5] and wheat bran on instant and dried noodles [6], application on functional properties of chitosan-xylose that produce Maillard reaction product to improve quality of semi-dried noodle [7], . However, there is no study yet with concern on its quality improvement especially for protein and β carotene of dried noodle.

The addition of *Spirulina sp.* in producing dried noodle can increase its nutritional quality, because *Spirulina* contain high protein and β-carotene. Carotenoids which have β-carotene as the main compounds are zeaxanthin, echinenone, myoxanthophyl, dan β-cryptoxanthin that present in *Spirulina*. β-carotene as an antioxidant, convert pro-vitamin A into vitamin A in human body. Nowadays *Spirulina* is available in high doses supplement. People believe that *Spirulina* can decrease the risk of cancer because of its antioxidant [8].

This study was aimed to know the effect of *S.platensis* paste addition to dried noodle’s nutrition and to compare the quality of dried noodle with *S.platensis* paste addition and dried noodle without *S.platensis* paste addition, in physical, chemistry and hedonic perspectives.

2. Materials and Methods

2.1. Experimental Design

Experimental design used was experimental laboratories. According to Nazir (2005), experimental laboratories is designed to know whether there is a relation or not between each treatment and how much the relation influence to the treatment [9].

This study used paired T-test because comparing the 2 groups, dried noodle control, without the addition of *S.platensis* paste and dried noodle with the addition of 9% *S.platensis* paste. Paired T-test is a methods where the data used is paired [10].

The treatments were repeated three times for each parameter. The parameter observed on this research include β-carotene content test, proximate analysis (moisture, ash, protein, fat, and carbohydrate), and elasticity test as well as sensory analysis on dried noodle without addition of *S.platensis* paste and with addition of 9% *S.platensis* paste.

2.2. Materials

Material used for producing dried noodle consist of *S.platensis* paste made from *S.platensis* powder produced by PT Indofood Sukser Makmur. The other materials such as salt, CMC (carboxymethyl celullosa), basil leaf, egg and water were also used. The materials used for analysis of each parameters observed are presented in Table 1.
Table 1. Materials used for parameters analysis of dried noodle

| No. | Parameters      | Materials                                                                                                                                 |
|-----|-----------------|------------------------------------------------------------------------------------------------------------------------------------------|
| 1.  | β-carotene      | Dried noodle, DMSO, Heptane, saturated KOH and methanol                                                                                 |
| 2.  | Moisture content| Dried noodle                                                                                                                              |
| 3.  | Ash content     | Dried noodle                                                                                                                              |
| 4.  | Protein content | Dried noodle, H2SO4, Selenium, NaOH 40%, H3BO3 2%, aquadest, MR and BCG, and HCl 0.1 N                                                  |
| 5.  | Fat content     | Dried noodle, aquadest, and Ethyl ether                                                                                                 |
| 6.  | Carbohydrate content | Dried noodle                                                                                     |
| 7.  | Elasticity      | Dried noodle                                                                                                                              |
| 8.  | Hedonic         | Dried noodle                                                                                                                              |

2.3. Methods

2.3.1. Production of S.platensis Paste

Dried S.platensis was mashed in the mortar and filtered with mesh size of 80 mm to get the same size of dried S.platensis. Fresh basil was selected for fresh green and perfect leaves. Fresh basil was washed to clean the leaves and extraction was done by grounding the basil leaves using mortar without the addition of water.

The S.platensis paste was made by adding the S.platensis powder as much as the basil extracts concentrate. The ratio between S. platensis powder and basil extract is 1:3, for example 7% concentration was made by mixing 16.24 g of S.platensis powder and 48.78 g of basil extract. Analog for 9% and 11% concentration.

2.3.2. The Procedure of dried noodles manufactured

Manufacture of dried noodle added with S.platensis paste was conducted as follow: Preparation of S.platensis powder, mix with basil leaf to form paste. The basil leaf was used in order to eliminate fishy flavor of S.platensis. The paste was mixed and kneaded with wheat flour, salt, egg and water. The dough was mixed until homogenous, shiny appearance, soft, smooth, and not sticky. The formulation of the dried noodles was presented in Table 2. It was followed by forming and cutting of homogenous dough to produce noodle. The noodle was steamed at 90°C for 5 minutes and then dried at 50°C for 90 minutes. Pressing and rolling were done by put the dough to the roller press. The aim of this process was to smoothing the gluten fiber and to dividing the dough into pieces. The distance between the rollers can be set to get the desire thickness. The following steps were forming and steaming. Thin sheet noodles were put to the hammer grill that can change the noodles sheet into the wavy noodles shape, then the wavy noodles shape were steamed in the steamer in the boiling water (100°C) for 5 minutes. Drying was conducted after the steamed noodles were drained then it was dried in the vacuum drying for 90 minutes at 50°C then cooled it down.
Table 2. The Formulation of Dried Noodles

| Ingredients             | Control | 7% | 9% | 11% |
|-------------------------|---------|----|----|-----|
| *S. Platensis* powder   | -       | 16.24 | 20.88 | 25.52 |
| Basil extract           | -       | 48.72 | 62.64 | 76.56 |
| Wheat flour             | 200     | 200  | 200 | 200 |
| Egg                     | 30      | 30   | 30  | 30  |
| Salt                    | 1       | 1    | 1   | 1   |
| Baking powder           | 1       | 1    | 1   | 1   |

Note: *S. platensis* powder percentage was calculated from total weight of the control

3. Results and Discussion

3.1. Preliminary Study

The processing of dried noodles consists of some ingredients: wheat flour, salt, baking powder and eggs with the addition of 0%, 7%, 9% and 11% of *S. platensis* paste. The aim of adding the different concentration of *S. platensis* in dried noodles is to observe the highest concentration that acceptable by panelist based on hedonic score covering appearance, odor, flavor, color and texture.

3.2. Main Study

The main study was purposed to compare the quality and β-carotene content between dried noodle without addition of 9% *S. platensis* paste, and dried noodle with addition of 9% *S. platensis* paste. The addition of 9% *S. platensis* paste (w/v) was obtained from the preliminary study.

3.3. Parameters of Product Quality

3.3.1. Hedonic Test

The quality test of dried noodles was referring to SNI-01-2987-1992, this method was used to measure the panelists’ acceptance of the products by using the score sheet. The panelists’ acceptance can be different based on the quality range. The test can be changed to numbers and do the statistics analysis to make the conclusion.

3.3.2. β-carotene Test [11]

*Extraction*

The sample was weighed about 30 g and put to the test tube and add 3 g of some piece of glass then 2.5 mL DMSO in each test tube. Vortex each tube for 30 seconds and then place the tube into 50°C water bath for 30 mins, in every 10 mins remove the tubes from the water bath and vortex for 30 seconds until end. Add 5 mL of ethanol to each tube, close the tube and vortex it for 30 seconds. Centrifuge the tubes at 4200 rpm for 3 mins, with dropper, take the supernatant from each tube and put it into the funnel. Add 4 mL of methanol, closed the tube, vortex it for 15-30 seconds and centrifuge for 3 mins. Collect all the supernatant into the funnel. Add the methanol to cover some piece of glass. Close the tube and vortex it for 30 seconds. Remove the cover and add 4 mL of methanol. Close the tubes and vortex for 30 seconds, do until the methanol is evident. The remaining color in the methanol is β-carotene. After all supernatant are collected add the methanol until 25 mL and centrifuge when it is required.
β-carotene Analysis
Take 8 mL of 25 mL methanol extract in the funnel with dropper and put it into the centrifuge tube of 115 mL. Add 5 mL of heptane and 1.5 mL of saturated KOH in methanol. Close the tube without mixing. Place the tubes in a dark place to saponification for 15 mins, vortex the tube lightly. After 30 mins, vortex tube for 15 seconds and centrifuge for 3 mins at 4200 rpm. Take heptane layer with a dropper and put it into 10 mL cylinder. Add 1 mL of fresh heptane into the tube and wash the interphase. Add 3 mL more of fresh heptane into the tube. Close the tube and shake lightly 8 times to make sure the heptane was added to the remaining β-carotene. Let heptane separated from methanol in 2 mins then take heptane with dropper to 10 mL cylinder. Then pour about 5 mL heptane extract into a clean tube then add some water up to maximum level and vortex for 5 seconds. Centrifuge the tubes for 3 mins at 4200 rpm. With the spectrophotometer, read the absorbance at 436 nm of the extract of the blank (heptane).

\[
\beta\text{-carotene \%} = \frac{\text{Abs } 436 \times 25 \text{ mL} \times 1.25 \times 100 \times 0.84}{196 \times (\text{weight (mg)} \times \text{dry weight})}
\]

Ash Content Test [12]
Put 4 gram wet sample to porcelain crucible and put it to the oven at 60-105°C for 8 hours. Dried sample was burned using a hot plate until smokeless time for ± 20 minutes. The sample was ash in a furnace at 600°C for 3 hours and weigh it.

\[
\% \text{ Ash Content} = \frac{\text{ash weight (g)} \times 100}{\text{Sample weight}}
\]

Protein Content Test [12]
There are 3 steps in protein analysis, destruction, distillation, and titration. Protein was determined using micro Kjeldahl methods. Put 0.25 gram sample to 100 ml Kjeldahl tube, add 0.25 gram selenium and 3 ml concentrated H₂SO₄. Destruction the sample at 410°C for about an hour then cool it down. Add 50 ml aquadest to Kjeldahl tube and 20 ml NaOH 40 %, then distillation the sample at 100°C. Put the distilled sample in a 125 ml flask that contain 10 ml boric acid (H₃BO₃) 2% and 2 drops of methyl red indicator. If the volume of distillate reached 40 ml and bluish green, stop the distillation process, then distillate was titrated with 0.1N HCl until it changes color into pink.

\[
\% N = \frac{\text{(ml HCl sample} - \text{ml HCl blank}) \times N \text{ HCl} \times 14.007 \times 100}{\text{mg sample}}
\]

Protein content (%) = Conversion Factor x %N

Fat Content Test [12]
Fat content used 0.5 ml sample, covered with filter paper and placed on the extraction tool. Pour hexane solvent into the flask accordance with the size of the soxhlet reflux for at least 16 hours until the solvent drops back into the tube. The solvent in the flask was distilled and collected. Dried the tube that contain fat extraction in an oven at 105°C for 5 hours. Cool it down in a desiccator for about 20-30 mins.

\[
\% \text{ Fat Content} = \frac{\text{Fat weight (g)} \times 100}{\text{Sample weight}}
\]
**Carbohydrate Test** [12]

Carbohydrate analysis was calculated by different method of reduction of 100% with known moisture content, ash content, protein content and fat content. Carbohydrate affect other nutrients compounds.

\[
\% \text{ Carbohydrate} = 100\% - (\text{Moisture content} + \text{Ash content} + \text{Protein content} + \text{Fat content})
\]

**Elasticity Test** [12]

Elasticity is the rate of material change from its original shape after the external force is applied. Cut the sample with a diameter of 3 cm and a thickness of 3 cm. Put the sample under the probe and press the sample twice. The pace of decline is 3 mm per minute compared to 1: 1 at a rate of graph paper. Elasticity was calculated by divided the second graph high pressure (H2) with the top height chart after first pressure (H1).

**RESULTS AND DISCUSSION**

**Preliminary Study**

The first step of this study was making dried noodle with the adding of 0%; 7%; 9%; and 11% \textit{S.platensis} paste. The aim of adding the different concentrate of \textit{S.platensis} in dried noodles is to know the highest concentrate that acceptable by panelist using organoleptic score sheet. The result of hedonic test of \textit{S. platensis} paste added into dried noodle was presented in Table 3.

Dried noodle with addition of 9% \textit{S. platensis} paste performed highest hedonic value of \(7.26 \leq \mu \leq 7.63\). Hedonic test is conducted to evaluate consumer’s acceptance comprehensively on the product attributes, and usually consumer tend to select food that has attractive performance as a whole product [13]. Thus based on preliminary study, among the concentration treatments applied, it was selected that 9% addition of \textit{S.platensis} paste will be applied on main study.

| Concentration of \textit{S. platensis} paste | Hedonic Scale          |
|---------------------------------------------|------------------------|
| 0%                                          | \(6.21 \leq \mu \leq 7.24\) |
| 7%                                          | \(7.08 \leq \mu \leq 7.31\) |
| 9%                                          | \(7.26 \leq \mu \leq 7.63\) |
| 11%                                         | \(6.23 \leq \mu \leq 6.50\) |

**Main study**

The chemical parameters of dried noodle with the addition of 9% \textit{S.platensis} pasta compared to that of 0% \textit{S.platensis} was presented in Table 4.
Table 4. The chemical parameters of dried noodle with the addition of different concentration of S. platensis paste

| Parameters       | Concentration of S. platensis Paste |
|------------------|------------------------------------|
|                  | 0 %                   | 9 %                   |
| β-carotene (mg/100g) | 0.06 ± 0.007 | 1.51±0.305 |
| Moisture (%)     | 4.25 ± 0.12       | 5.61±0.28          |
| Ash (%)          | 1.37 ± 0.115      | 2.46±0.155         |
| Protein (%)      | 8.88±0.39        | 28.60±0.33         |
| Fat (%)          | 1.76±0.11        | 2.18±0.04          |
| Carbohydrate (%) | 83.72±0.38      | 61.12±0.55         |

β-carotene Content
Based on paired T-test, the result of β-carotene content showed significantly different result. Based on this result, the addition of S. platensis pasta showed significantly different result to β-carotene content in dried noodle. S. platensis contained rich in β-carotene with the amount of 58 mg/100 g [14]. Basil leaf has been proven not contained β-carotene as it has only 0.0006 mg/100 g of β-carotene. Moreover, highest carotenoid containing in S. platensis is β-carotene with the value of 26.74% [15]. β-carotene containing in dried noodle added with S platensis paste exceed the limit of β-carotene suggested by WHO. High consumption of natural β-carotene can be converted into free Vitamin A (retinol). Daily β-carotene consumption for supply nutrition ideally is 4 mg/100 g [16]. Decrease in β-carotene on dried noodle was due to heating process applied during processing as well as concentration used of S. platensis paste. High temperature process can reduce β-carotene and also possibility for oxygen exposure of the product which results in enzymic oxidation of β-carotene by lipoygenase enzyme that produce all trans- β-carotene [17]. Moreover, β-carotene is unstable to light and heat at temperature more than 60°C and convert the form into cis- β-carotene that is unstable due to isometric change [18].

Moisture Content
The paired T-test showed that P (T<=t) one-tail (0.001) < (p=0.005), the addition of S.platensis pasta showed significantly different result to moisture content in dried noodle. Water content is an important parameter to determine the characteristic of product, because water content influence appearance, texture, flavor of food [19]. Dried noodle added with 9% S.platensis has higher water content comparing to that of 0% concentration of S.platensis paste. This phenomenon was due to addition of S.platensis paste which has basil leaf extract containing water. S.platensis powder has low water content of <10%, however it has hygroscopic and non-polar properties that can react with water so that addition of 9% S.platensis paste has increased water content of dried noodle.

Ash Content
The result of ash content in dried noodle without addition of S.platensis paste is 1.37% and dried noodle with addition of 9 % S.platensis paste is 2.46% and this profound that there is an increase in ash content. Based on this result, the addition of S.platensis paste showed significant different to ash content of dried noodle. Ash content is an important parameter to food nutrition. Ash is an inorganic substances resulted from the combustion of an organic material. The high result of ash content was affected by high mineral content of S.platensis or the materials have been contaminated. Ash content can be used as the contamination indicator such as sand and stone [12]. The maximum ash content of dried noodle is 3% [20].
Protein Content
Protein is an important component that affecting the quality of noodles both nutrition and elasticity. The paired T-test showed that $P(T \leq t)$ one-tail (0.000) < (p=0.005). The addition of $S.platensis$ paste showed significant different to protein content of dried noodle. Dried $S.platensis$ contains 55-75% of protein [14]. Protein is important parameters for enzyme formation, antibody and hormones. Protein can be used as energy. Protein complex is proteins that contain all the essential amino acid that suitable for the growth purposes and needs [21].

Fat Content
The paired T-test showed that $P(T \leq t)$ one-tail (0.000) < (p=0.005), the addition of $S.platensis$ pasta showed significantly different result to fat content in dried noodle. The fat function in human body is as a source of energy, a source of essential fatty acids, fat soluble vitamin transportation, to save the use of proteins in the body, to give a sense of satiety and delicacy and to protect organs [21]. Moreover, the fat function in food is to give savory flavor and as an energy savory in human body.

Carbohydrate Content
Based on this result, the addition of $S.platensis$ pasta showed not significantly different result to carbohydrate content in dried noodle. The low moisture content cause the high carbohydrate content. Carbohydrate content was determined by difference of total percentage (100%) reduced by moisture content, ash content, fat content and protein content [22]. The physical and sensory result of dried noodle with the addition of 9% $S.platensis$ pasta presented in Table 4.

Table 4. The physical result of dried noodle with the addition of different concentration of $S.platensis$ paste

| Parameters   | Concentration of $S.platensis$ Paste |
|--------------|-------------------------------------|
|              | 0 %                                 |
|              | 9 %                                 |
| Elasticity (gf) | 2157.91±25.64                       |
|              | 2430.187±16.89                      |
| Hedonic      | $6.89 \leq \mu \leq 7.27$           |
|              | $7.10 \leq \mu \leq 7.49$           |

Elasticity
Based on this result, the addition of $S.platensis$ pasta showed significantly different result to elasticity in dried noodle. The elasticity of dried noodle was affected by the moisture content, so the dried noodle becomes more lenient. $S.platensis$ is one of microalgae that are hygroscopic, therefore it is important to know the best drying methods to obtain constant dry weight [22]. The elasticity of wet noodle is depending on its protein [24]. Moreover not only the adding of $S.platensis$ paste influence dried noodle elasticity, but also the flour that used in the making proses of dried noodle. The functions of wheat flour are to form the noodle structure, protein and carbohydrate source. Gluten that contained in wheat flour can influence the noodle elasticity and structure.

Hedonic Score
Hedonic is a subjective test intended to determine the level of preference of the panelists to a product that is tested. Each panelist rates the dried noodle parameters such as appearance, odor, flavor, and elasticity with score sheet. The panelist numbers are 30 people. Hedonic test is conducted to evaluate
consumer’s acceptance comprehensively on the product attributes and usually consumer tend to select food that has attractive performance as a whole product [15]. The hedonic result showed that the panelists prefer dried noodle with the S. platensis paste addition.

Conclusion

Based on the study, it can be concluded that addition of S. platensis paste into dried noodle can improve its nutritional value, especially on protein and β-carotene. Dried noodle added with S. platensis comply with Indonesian National Standard in term of protein, water, and ash content with acceptable sensory score of $7.26 \leq H \leq 7.63$. Protein content of dried noodle added with S. platensis paste was 4 times higher than without S. platensis

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