# Pumpkin Enriched Shirataki Noodle as A Low Calorie and Nutritious Functional Food

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**Abstract.** Demand for functional foods has increased nowadays. Utilization of local food material may play an important role in functional food development. This paper presents the potential role of pumpkin flour in improving the quality of shirataki noodles. This research was carried out in laboratorial trial using Completely Randomized Design with the treatment of pumpkin flour fortification at 6 different concentrations (0%, 2%, 4%, 6%, 8%, and 10%) and 3 replications. The observation data were analyzed using the analysis of variance at 5% significant level, and were further analyzed using the honest significant difference at the same level when needed. The results indicated that pumpkin flour fortification significantly increased the nutrition level of shirataki noodles. It also improved the color, although it did not change the panelists' preference to the aroma and the taste of the products. Further research is needed to optimize the process for producing good quality pumpkin shirataki noodles to support the development of nutritious functional foods.

**Keywords:** functional foods, pumpkin, quality, shirataki noodle

## 1 Introduction

Noodles are a staple food in many Asian countries, including Indonesia. Traditional noodles are usually produced from refining wheat flour, resulting in a food product low in fiber. Meanwhile, shirataki noodles are developed from porang glucomannan flour, which is classified as high in fiber, thus making shirataki noodles highly satiating while still being low in calories [1] [2]. With these characteristics, shirataki noodles have various benefits for health, including weight loss, reducing cholesterol, preventing constipation, as well as being safe for consumption for diabetics [3]. However, in order to improve the functional qualities of shirataki noodles, its raw ingredients need to be fortified with nutritional components; one way is through pumpkin flour fortification.

Pumpkin (*Cucurbita moschata* Durch) is known as an agricultural product that contains high beta carotene which can act as an antioxidant [4]. Pumpkin flour contains 77.65% carbohydrates, 0.08% fat, 5.04% protein, 11.14% water, and 5.89% ash [5]. A study conducted by [6] has also shown that the chemical content in pumpkin flour is


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quite good, namely a low fat content of 2.91%, protein content 1.44%, crude fiber content 10.54% and beta carotene content 4468.7µg/g. Other studies have also indicated that the beta carotene content in fresh pumpkins is 6.9 mg per 100 g of material, while the beta carotene content in pumpkin flour is 7.29 mg per 100 g [7]. Besides being rich in beta carotene, pumpkin flour also has good gelatinisation properties, which allows it to be formed into a consistent and elastic dough [8]. With these properties, pumpkin flour shows high potential to be used as a fortification ingredient in shirataki noodles.

Research by [9] has shown that the addition of 5% pumpkin flour in the production of wet noodles can increase the water content, ash content, beta carotene content and fiber content of wet noodles. [10] have also reported that a 10% substitution of pumpkin flour for wheat flour in the production of wet noodles produced noodles with 62.224% water content, 0.611% ash content, 0.1225% total carotene, 1.62% crude fiber content, and 11.67% protein content. However, there is still limited research on shirataki noodles which have been fortified with pumpkin ingredients. Therefore, this research aims to examine the effect of adding pumpkin flour on the physicochemical and organoleptic properties of Shirataki noodles. The results are presented below.

## 2 Materials and Methods

### 2.1 Materials and Instruments

The materials used in this research include commercial porang flour under the brand name "Glukomanan Powder*"*, local pumpkin cv "Bokor", and other chemical materials needed for laboratorial analysis. The instruments used include a stove, basin, cutting board, knife, spatula, measuring cup (1000 mL), cabinet dryer, size 80 mesh flour sifter, blender (Phillips HR 2056), fruit slicer (GETRA), steamer boiler, and stainless steel manual noodle maker (Ardin CM2020), furnace, porcelain cup, desiccator, thermometer, analytical scales (Kern), erlenmeyer (Iwaki CTE33), UV-Vis spectrophotometer (Thermo Scientific evolution 201), color meter (AMT 566), oven (memmert), volumetric flask (25 mL size), measuring cup (100 mL), hot plate (Gerhartz), back cooler, glass funnel, measuring cup (50 mL), beaker (600 mL), desiccator, and vortex (Heidolph).

### 2.2 Method

This research employed an experimental method using Completely Randomized Design with the treatment of pumpkin flour fortification at 6 different concentrations (0%, 2%, 4%, 6%, 8%, and 10%). The stages of research included production of pumpkin flour, production of shirataki noodles, and analysis of the parameters of the shirataki noodles' quality properties.

The production of pumpkin flour begins with cleaning, peeling, and deseeding the pumpkin, followed by rinsing the pumpkin under running water. The pumpkin flesh is then cut into small parts and steamed for 5 minutes at $\pm 85^0$C. Afterwards, the pumpkin flesh is sliced using a slicer. The pumpkin slices are then dried for ±10 hours in a cabinet dryer at $60^0$C. The dried product is then turned into flour, and then sifted using a size 80 mesh sifter, to then be processed into shirataki noodles.

The processing of shirataki noodles begins with making the porang dough. This is done by mixing 30 g of porang flour and 450 mL of hot water, which is then left to rest for ±60 minutes. Subsequently, pumpkin flour is added according to the treatment levels (0%, 2%, 4%, 6%, 8%, dan 10%). Then, 60 g of lime betel is added, the dough is kneaded, then formed into the shape of shirataki noodles, after which it is boiled for ±3 minutes. The noodles are then taken off the heat and strained. At this point, an analysis of the properties of the shirataki noodles is conducted.

The parameters observed consist of chemical parameters, including beta carotene content [11], water content [12], ash content [12] and crude fiber content [13]; physical parameters, including aroma, flavor, texture and color of the shirataki noodles [14]. The observation data was analyzed using the analysis of variance at 5% level of significance. If there is significant difference, further analysis is conducted using the Honest Significant Difference Test at the same level [15].

## 3 Results and Analysis

The research results showed that the treatment of pumpkin flour fortification gave a significantly different impact towards the characteristics of shirataki noodles notably on its beta carotene content, water content, ash content, crude fiber content, color, aroma and flavor. Each parameter is discussed as follows:

### 3.1 Beta Carotene Content

Beta carotene is an important nutritional compound that is abundant in pumpkin flesh and can function as provitamin A [4]. This research showed that pumpkin flour fortification significantly increases the beta carotene content of shirataki noodles (Fig. 1).

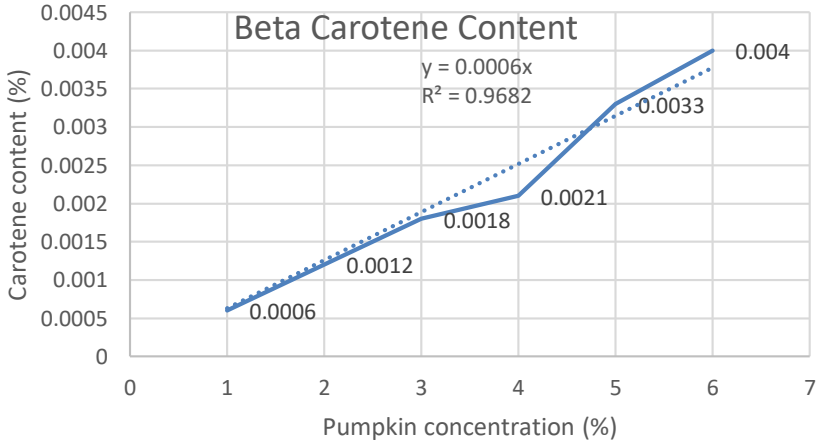


**Fig. 1.** Beta Carotene Content of Pumpkin Shirataki Noodles at Different Percentage of Pumpkin Flour Fortification

As indicated in Fig. 1, the beta carotene content of shirataki noodles without pumpkin flour fortification is very low at 0.0006%. After the addition of pumpkin flour in the noodle ingredients, the beta carotene content in shirataki noodles increased significantly in line with the increasing concentration of the pumpkin flour fortification. This increase of carotene content in the shirataki noodles is closely related with the beta carotene content of the pumpkin used as an ingredient. This is visible from the very high $R^2$ value. According to [16], beta carotene content in pumpkin flesh is 0.1569%. Meanwhile, the beta carotene content of pumpkin flour used as an ingredient in this research is 0.026%. Even with this low percentage, the beta carotene content in pumpkin flour was still able to increase the beta carotene content in shirataki noodles. The results of this research confirm the findings of [17], which have shown that the addition of 50% pumpkin flour in the making of chiffon cakes resulted in an end product with a beta carotene content of 0.0041%. Moreover, [9] have reported that fortifying wheat-based wet noodles with 12.5% pumpkin flour also resulted in nutritional wet noodles with a beta carotene content of 1.55%.

### 3.2 Crude Fiber Content

Crude fiber is a polysaccharide group which is a component of food ingredients [18]. Pumpkin is considered a high fiber food ingredient [19]. Pumpkin flour fortification in the processing of shirataki noodles increased the crude fiber content of the shirataki noodles (Fig. 2).

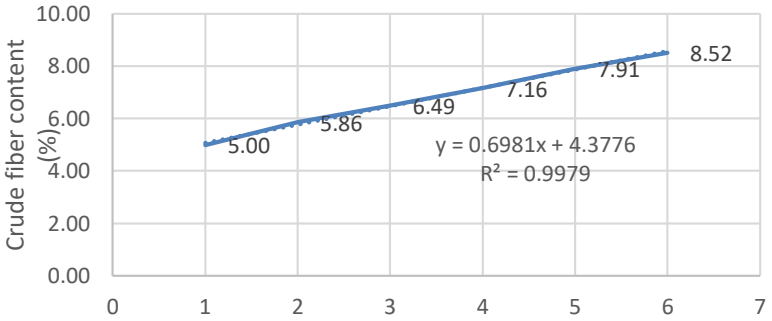


**Fig. 2.** Crude Fiber Content of Pumpkin Shirataki Noodles at Different Percentage of Pumpkin Flour Fortification

According to Fig. 2, the crude fiber content of shirataki noodles without pumpkin flour fortification is only approximately 4.995%. With the addition of 10% pumpkin flour, the crude fiber content of shirataki noodles increased significantly to almost twice at much at 8.515%. Research by [20] have also shown the same trend, namely that higher pumpkin flour fortification in the production of taro flakes impacted the increase of crude fiber content in the final product up to 4.50%. This increase of fiber content in shirataki noodles is caused by the fiber intake from pumpkin flour, as the fiber content in pumpkin flour is much higher compared to the fiber content in wheat flour. [21]

noted that there are high amounts of Insoluble Dietary Fiber (IDF) in pumpkin flour, including cellulose 40.4 g/100 g, hemicellulose 4.3 g/100 g, and lignin 4.3 g/100 g.

### 3.3 Moisture Content

Moisture content is the amount of water in food ingredients and is closely related with the stability and shelf life of the food product [22]. Pumpkin flour fortification in shirataki noodle dough has a significantly different impact on the moisture content of shirataki noodles (Table 1).

**Table 1.** Effect of Pumpkin Flour Fortification on Moisture content, Ash Content and Color of Pumpkin Shirataki Noodles

| Treatments (% of pumpkin flour) | Moisture Content (%) | Ash Content (%) | Color | |
|---|---|---|---|---|
| | | | ° Hue | L |
| 1 (0%) | 80.46 ± 4.82 | 0.86 ± 0.041 | 81.04 ± 1.87 | 54.07 ± 1,20 |
| 2 (2%) | 88.95 ± 0.87 | 0.95 ± 0.018 | 74.02 ± 1.65 | 50.30 ± 0,27 |
| 3 (4%) | 90.38 ± 0.19 | 1.03 ± 0.016 | 69.71 ± 0.82 | 49.47 ± 0,95 |
| 4 (6%) | 90.95 ± 0.25 | 1.12 ± 0.040 | 73.45 ± 0.53 | 49.48 ± 0,35 |
| 5 (8%) | 92.79 ± 0.50 | 1.24 ± 0.028 | 71.72 ± 0.57 | 48.62 ± 1,43 |
| 6 (10%) | 94.94 ± 0.86 | 1.46 ± 0.019 | 68.94 ± 2.77 | 48.07 ± 0,57 |

The addition of 2% pumpkin flour caused an increase of the moisture content in wet shirataki noodles ranging from 80.46% to 94.94%. Porang flour has a quite high glucomannan content which can bind and absorb water up to 200 times the mass of glucomannan [23]. However, the increase of pumpkin flour concentration from 4% to 10% did not cause a significant increase of water content in the produced shirataki noodles.

The moisture content of shirataki noodles produced in this research is classified as quite high when compared to the standard moisture content of wet noodles. These results are in line with research conducted by [24], which showed that the moisture content of moringa shirataki noodles ranged from 89.76% to 96.58%. [25] has also reported that the moisture content of shirataki noodles with moringa leaves extract fortification ranged from 95.83% to 96.71%. In addition, the water content of pumpkin flour influenced the increase of moisture content in shirataki noodles. The higher the concentration of pumpkin flour used in the ingredients, the higher the moisture of the produced shirataki noodles. This is closely related with pumpkin flour's capacity of water absorption, which is higher compared to wheat flour. This is possibly caused by the high amylose content in pumpkin flour, which increases its ability to absorb water in large amounts [26].

### 3.4 Ash Content

Ash content is the inorganic substance that is the residue of organic matter combustion. The ash content of a foodstuff differs according to the type of raw material and the source of that foodstuff [27] The mineral content found in pumpkin flour among others include calcium (45.00 mg/100 g), phosphor (64.00 mg/100g), and iron (1.40 mg/100 g) [8]. Pumpkin flour fortification resulted in a significant increase of the ash content of shirataki noodles (Table 1).

Data in Table 1 shows that the ash content of the shirataki noodles content produced in this research ranged from 0.86% - 1.46%. The ash content of shirataki noodles increased alongside with the increase of concentration of the pumpkin flour added. This is closely related with the ash content of the raw ingredients used in making shirataki noodles. The ash content of pumpkin flour used in the research is 10.09%. Meanwhile, the ash content of porang flour is lower at 8.99%. These results confirm the findings of [8] that pumpkin flour fortification at 30% as a carotene content in the production of wheat-based wet noodles results in a high ash content of 0.93%. Other research conducted by [27] has also documented that 45% pumpkin flour fortification in the production of purple sweet potato flakes resulted in flakes with an ash content of 6.44%.

### 3.5 Color

Color is one of the most important parameters for consumers when deciding to try a food product. If a food product has good nutrition, good taste, and good texture, but does not have an interesting color or hue, then the product will become less attractive in consumers' eyes. The bright color of pumpkin is hoped to have a positive influence on consumers' favorability towards pumpkin-based products. The results obtained in this research showed that pumpkin flour fortification has a significant impact on the hue of shirataki noodles (Table 1).

As visible in Table 1, the $^0$Hue value which indicates the color category of the shirataki noodles in this research is respectively 81.16; 74.02; 70.0; 73.45; 71.72; 68.94 degrees, which are all categorized as reddish yellow. The color of shirataki noodles is impacted by the color of pumpkin flour. The $^0$Hue value of the pumpkin flour used in this research is $67.90^0$ (reddish yellow). Even though this is still the same category (reddish yellow), it was visible that the higher the amount of pumpkin flour fortification, the less bright the color of the shirataki noodles became. This is shown by the L* value of the shirataki noodles, which tended to decrease with the increase of pumpkin flour fortification.

Other studies have also shown the same trends in other food products, such as muffin [28] and taro flakes [20]. Both products' brightness was inversely proportional to the percentage of pumpkin flour fortification used in production. An organoleptic assessment of panelists' favorability towards the color also showed that a higher amount of pumpkin flour fortification in the dough mix caused an increase of the panelists' favorability towards the color of shirataki noodles. The yellow color of shirataki noodles is produced by the beta carotene content in pumpkin flour, which also acts a natural dye [29].

### 3.6 Aroma

Aroma is an important parameter for food product as it can impact the taste of that product. Pumpkin flour fortification gave a distinct pumpkin aroma in shirataki noodles (Table 2) and increased the panelists' favorability towards the produced noodles. However, too much addition of pumpkin flour can cause a very dominant pumpkin aroma, which adversely decreased the panelists' favorability towards the shirataki noodles; the panelists' views here can be considered as representative of a wider consumer base.

**Table 2.** Effect of Pumpkin Flour Fortification on Texture, Aroma, and Flavor of Shirataki Noodles

| Treatments (% of pumpkin flour) | Aroma (score) | Flavor (score) | Texture (score) |
|---|---|---|---|
| 1 (0%) | 1.7 ± 0.179 | 1.75 ± 0.160 | 3.45 ± 0.185 |
| 2 (2%) | 2.95 ± 0.170 | 2.35 ± 0.109 | 3.5 ± 0.136 |
| 3 (4%) | 2.9 ± 0.191 | 2.25 ± 0.143 | 3.15 ± 0.167 |
| 4 (6%) | 3.25 ± 0.160 | 2.4 ± 0.152 | 3.3 ± 0.128 |
| 5 (8%) | 3.45 ± 0.211 | 2.6 ± 0.134 | 3.25 ± 0.160 |
| 6 (10%) | 3.4 ± 0.234 | 2.85 ± 0.150 | 3.3 ± 0.147 |

### 3.7 Flavor

Flavor is a stimulating sensation that is received by the taste senses and becomes an important parameter for someone when deciding to accept or reject a product. Pumpkin flour fortification produced a slightly sweet flavor in shirataki noodles (Table 2). This sweetness is closely related to the sugar content in pumpkin flour. However, this sweet flavor in shirataki noodles did not affect the panelists' favorability to the shirataki noodles. Overall, the panelists' slightly liked the flavor of the shirataki noodles produced with pumpkin flour fortification.

### 3.8 Texture

Texture is a series of physical properties produced by the structural elements of foodstuffs that can be felt by a human's touch senses. The texture of foodstuffs influences the resulting taste of a food product, and thus can become a key factor in the product's acceptance by consumers [30]. According to data in this research, pumpkin flour fortification did not give a significantly different effect on the texture of shirataki noodles.

Overall, the noodles produced in this research can be categorized as having a springy texture and was slightly liked by the panelists. The springiness of the noodles is principally caused by the glucomannan content in porang flour, which is the primary component of shirataki noodles and glucomannan is well known has a very high ability to bind water in noodle dough, thus resulting in springy noodles [31] [32].

## 4 Conclusion

Based on the data observed in this research, it can be concluded that pumpkin flour fortification can improve the nutrition of shirataki noodles. Fortification with 6% pumpkin flour produced shirataki noodles with 0.0021% beta carotene content, 7.16%, crude fiber content, 90.95% water content, 1.12% ash content, a slightly strong pumpkin aroma, and the flavor was slightly liked by the panelis

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