Fortification of seaweed (*Eucheuma cottonii*) flour on nutrition, iodine, and glycemic index of pasta

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Abstract. Pasta is a nutritious and energy product which produced from the dough of wheat flour and water. It contains less of iodine and high of glycemic index. *Euchema cottonii* belongs of red seaweed is food substance that contains much of iodine and dietary fiber. The objective of this study was to know the fortification effect of *E. cottonii* flour on the nutrition, iodine, and glycemic index of pasta. *E. cottonii* was collected from the culture farm of *E. cottonii* on the Wongsorejo beach, District of Banyuwangi, East Java on April-June 2015. Wheat flour and pasta ingredients were obtained locally at shops of Pasar Besar, Malang. Pasta was produced by weighing of components, mixing, dough, milling, steaming and drying. *E. cottonii* flour was added on mixing process at 0; 7; 14 and 21 % of ingredients. The parameter of this study was the level of water, lipid, protein, ash, and carbohydrate (by difference), iodine, crude fiber, the total of dietary fiber, soluble fiber, insoluble fiber, and glycemic index, respectively. Data were analyzed by variance and the least square difference used to determine the difference between treatments. The highest concentration group showed more nutritious than other treatments. The characters of its product were water 6.70%, lipid 2.26%, protein 23.09%, ash 14.11%, carbohydrate 53.84%, iodine 3.71 ppm, crude fiber 8.02%, the total of dietary fiber 20.88%, soluble fiber 11.69%, insoluble fiber 9.19%, and glycemic index 44.45, respectively. In conclusion, the fortification of *E. cottonii* flour enhances the nutrition value, iodine content, and glycemic index of pasta.

1. Introduction

Pasta is a food product that produced from wheat powder dough. Based on the type, this product can be divided to fresh and dried pasta, meanwhile, based on the form, it consists of long and short pasta. The long form of it is spaghetti and fettucini whereas the short one is macaroni [1]. Pasta can be classified as the high glycemic food caused its carbohydrate content is relatively high [2].

Glycemic index is the indicator of a food product that can increase of blood glucose. The product has the high glycemic index if it consumed and then shortly increase of blood glucose. Food product with the high glycemic index is mainly produced from carbohydrate substances. This index value can be affected by many dietary factors, such as; fiber and iodine [3].

Iodine is one of essential micronutrient for the human body. The growth disturbance, intelligence, and insulin secretion associated to this mineral unavailability. The hyperglycemia phenomena can be related to the lack of iodine availability in the body [4]. Dietary fiber is food ingredient that can’t be hydrolyzed by the digestion enzymes. Although this substance can’t be digest and low in the nutrition
value, its role in the obesity, cholesterol profile and hypoglycemic activity. Hypoglycemic effect of dietary fiber is their capability on the hindrance of glucose hydrolysis and absorption [5].

*Eucheuma cottonii* is carrageenophyte that belonged to red seaweed. This seaweed contains nutrition substances, mineral, and dietary fiber [6]. This alga has been used, supplemented and fortified on bread, doughnut, and instant noodle. The enrichment of this alga on these products is addressed to enhance the nutritious and functional value of it [7, 8, 9].

Pasta is the high glycemic food that can be decreased this value by the fortification of iodine and dietary fiber. *Eucheuma cottonii* is seaweed that contains iodine and dietary fiber. The purpose of this research was to evaluate the fortification of *Eucheuma cottonii* flour on the nutrition, iodine, and glycemic index of pasta.

2. Material and methods

2.1. Material

*Eucheuma cottonii* were obtained from Wongsorejo Beach, Banyuwangi District, East Java Province, Indonesia on April-June 2015. Wheat flour and pasta ingredients were bought from the shops on Pasar Besar, Malang. Chemical materials for proximate analysis were obtained from Merck. Glucometer strips were found from GlucoDr. Thermamyl, pepsin, and pancreatin were obtained from Sigma-Aldrich.

2.2. Methods

The sample was washed by tap water, bleached by CaCO2 5% for a night, dried by the sun drying for 3 days, milled, and sieved on 80 mesh size and obtained seaweed flour. This study was experiment and treatment of this experiment was the percentage of *Eucheuma cottonii* flour, i.e., 0, 7, 14, and 21%, respectively, meanwhile, their parameter was proximate, iodine, dietary fiber, crude fiber, and glycemic index. Pasta was produced by mixing of seaweed flour and wheat flour (treatment portion), after that blending with salt and egg, and then mixing with water and finally cooking oil to obtained the dull dough. The dough was blended several times by blending machine to form dough sheets. These sheets were poured with wheat flour, after that the sheets were steamed for 10 minutes and after cooling at room temperature, pasta was dried for 7 hours at 55°C [10].

2.2.1. Proximate. Water content was assayed based on thermogravimetry method. The free water of sample was evaporated at 105°C for 3 hours to constant weight. Ash content was determined by burner system. The Sample was carbonized and burned in the burner at 500-600°C for several hours and the product was weighed and determined as ash content. Lipid content was assayed by Soxhlet method. The lipid of the sample was extracted by the organic solvent in the Soxhlet tube for several hours. Protein content was tested by the Kjeldahl method. Protein of the sample was assayed by the determination of nitrogen content of sample by destruction, distillation, and titration. Carbohydrate content was determined based on by difference method [11].

2.2.2. Iodine. Iodine content was assayed based on precipitation and titration method [12]. This mineral was determined based on the formation of amylum-iodine complex by iodate oxidation.

2.2.3. Dietary and crude fiber. The total, soluble and insoluble fiber were determined by enzymatic-gravimetric digestion method [13]. The crude fiber was evaluated by hydrolysis method [11]. The crude fiber was eliminated from the sample by extraction of the sample in acid and base solutions.

2.2.4. Glycemic Index. This index was determined by comparison of area under curve between the area of blood glucose after consuming sample and bread as standard [14]. Ten volunteers that health, non-diabetes and their blood glucose level between 70-120 mg mL⁻¹ were used in this study.
2.3. Statistical analysis
Data of this study were stated as a mean. The difference among of treatments was evaluated by analysis of variance. The least square difference test was used to determine the difference among treatment groups. The significant level was set at $P < 0.05$.

3. Results and Discussion
The effect of seaweed flour percentage on proximate and iodine content of pasta can be seen in Table 1. The result showed that increasing of seaweed percentage decrease water, ash, protein, and lipid content but it enhances carbohydrate and iodine content of pasta.

| Treatments (%) | Water (%) | Ash (%) | Protein (%) | Lipid (%) | Carbohydrate (%) | Iodine (ppm) |
|---------------|-----------|---------|-------------|-----------|------------------|--------------|
| 0             | 10.77<sup>a</sup> | 9.67<sup>a</sup> | 27.43<sup>b</sup> | 3.03<sup>ns</sup> | 49.10<sup>ns</sup> | 2.47<sup>b</sup> |
| 7             | 9.68<sup>c</sup> | 13.50<sup>b</sup> | 24.03<sup>a</sup> | 2.62<sup>ns</sup> | 50.17<sup>ns</sup> | 2.81<sup>b</sup> |
| 14            | 8.40<sup>b</sup> | 13.68<sup>b</sup> | 23.23<sup>a</sup> | 2.45<sup>ns</sup> | 52.24<sup>ns</sup> | 3.59<sup>b</sup> |
| 21            | 6.70<sup>a</sup> | 14.11<sup>b</sup> | 23.09<sup>a</sup> | 2.26<sup>ns</sup> | 53.84<sup>ns</sup> | 3.71<sup>b</sup> |

3.1. Proximate and iodine
Table 1 exposed that the water content of pasta is influenced by the increasing percentage of <i>E. cottonii</i> flour. The previous study [15] showed that supplementation of <i>E. cottonii</i> flour decreases water content of instant noodle. <i>E. cottonii</i> is foodstuff that contains hydrocolloid substance, such as, carrageenan. This constituent has hydroxyl compound that able to bind free water of substance.

Table 1 exhibited that the fortification of <i>E. cottonii</i> flour enhances the ash content of pasta. The former research [16] stated that <i>E. cottonii</i> is one of foodstuff that encloses mineral more than terrestrial food. Fortification of <i>E. cottonii</i> flour on the food product will consequently increase this mineral content in the product.

Table 1 displayed that the fortification of <i>E. cottonii</i> flour decreases the protein content of pasta. The earlier investigation [17] showed that protein content of pasta is related to the protein of wheat flour. The fortification of other flour on pasta, therefore, it will decrease protein content of pasta.

Table 1 revealed that the lipid content of pasta is not influenced by fortification of <i>E. cottonii</i> flour. The earlier research [18] showed that <i>E. cottonii</i> is less or not contain the lipid. It, therefore, does not influence on lipid content of product when the <i>E. cottonii</i> flour is fortified.

Table 1 showed that the carbohydrate content of pasta also not influenced by the increasing of <i>E. cottonii</i> flour concentration. The previous research [19] showed that supplementation of <i>E. cottonii</i> flour does not affect the carbohydrate content of pasta. This is possibly caused the mass equilibrium among the food component of the product. Pasta is a food product that produced mainly by carbohydrate compound of wheat flour. <i>E. cottonii</i> flour is a foodstuff that containing generally carbohydrate. Supplementation of wheat flour by <i>E. cottonii</i> flour does not cause the changing of the carbohydrate content of this product.

Table 1 showed that fortification of <i>E cottonii</i> flour able to enhance the iodine concentration of pasta. A previous study [20] showed that fortification of <i>E cottonii</i> able to increase iodine content on an instant noodle. It is possibly caused <i>E. cottonii</i> is food substance that contains iodium. Fortification of <i>E cottonii</i> flour on pasta will affect to the increasing iodine content in this product.

3.2. Dietary and Crude Fiber
The effect of seaweed flour percentage on the dietary fiber content of pasta can be seen in Table 2. The result showed that increasing of <i>E. cottonii</i> flour percentage enhance total, soluble and insoluble dietary and crude fiber content of pasta.
Table 2. Total, Soluble and insoluble dietary and crude fiber content of pasta on several E. cottonii flour percentage

| Treatments (%) | Total Dietary Fiber (%) | Soluble Fiber (%) | Insoluble Fiber (%) | Crude Fiber (%) |
|----------------|-------------------------|-------------------|---------------------|-----------------|
| 0              | 13.89\textsuperscript{a} | 8.90\textsuperscript{a} | 4.99\textsuperscript{a} | 5.26\textsuperscript{a} |
| 7              | 16.48\textsuperscript{b} | 9.27\textsuperscript{b} | 7.21\textsuperscript{b} | 5.53\textsuperscript{a} |
| 14             | 18.39\textsuperscript{c} | 9.90\textsuperscript{c} | 8.49\textsuperscript{c} | 7.70\textsuperscript{b} |
| 21             | 20.88\textsuperscript{d} | 11.69\textsuperscript{d} | 9.19\textsuperscript{d} | 8.02\textsuperscript{b} |

Table 2 showed that fortification of E cottonii flour able to increase the total, soluble and insoluble fiber concentration on pasta. A previous study \[20\] exhibited that the total, soluble, and insoluble dietary fiber of E. cottonii are 82.0; 38.8; and 43.2 \% of dry weight, respectively. These compounds are huge contained in this seaweed, so the fortification of these compounds on foodstuff will subsequently affect the composition of the food product.

Table 2 showed that fortification of E cottonii flour able to enhance the crude fiber concentration of pasta. A previous study \[21\] that fortification of seaweed will increase the concentration of crude fiber of instant noodle. It is possibly caused the main component of E. cottonii is carbohydrate. This compound consists of polysaccharide polymer, and it is naturally composed of the fiber.

3.3. Glycemic Index
The effect of seaweed flour percentage on the glycemic index of pasta viewed on Figure 1. The result showed that the increasing of seaweed percentage decrease glycemic index value of pasta.

![Glycemic Index](image.png)

Figure 1. The glycemic index of pasta on several of E. cottonii flour percentage

Figure 1 showed that the glycemic index of pasta is affected by the fortification of E. cottonii flour. The previous study \[20, 21\] stated that E cottonii contain dietary fiber and iodine. These substances have been known affect the blood glucose. The food product that fortified with E. cottonii flour will decrease their glycemic index value. The soluble fiber able prevents increasing of blood glucose level caused this fiber hinder the polysaccharide hydrolysis by α-glucosidase and then inhibit the glucose absorption on the gastrointestinal \[5\]. Iodine of this flour also prevents increasing of blood glucose. It is caused this mineral able to induce insulin secretion \[22\]. Insulin is the hormone that works to initiate of glucose uptake by body cells.
4. Conclusion

The fortification of *E. cottonii* flour improve the nutrition value, iodine content, and glycemic index of pasta

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