Rice Noodle (Vermicelli) Characteristics Made from Local Cultivar Red Rice and Corn Starch

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Abstract. The objectives of this research was investigated a proper proportion of red rice flour and corn starch in the formulation of vermicelli as a functional food. The experiment was arranged with Randomized Completely Block Designs (RCBD) of a single factor with three replications. The proportion of red rice and corn starch in total weight of flour in formulation were 100 g and 35 g; 80 g and 55 g; 60 g and 75 g; 40 g and 95 g; 20 g and 115 g, respectively; and 100 g white rice flour and 35 g corn starch to produce rice noodle (vermicelli). Reduction sugar, amylose content and acceptence of the vermicelli were measured, and the highest score of the vermicelli acceptance was feed to diabetic mice to determine the efficacy of the vermicelli lowering the blood glucose. Data were analyzed with analysis of variance at 5 percent level of significancy. The post hoc test was honestly significant difference at the same level of significancy. The result showed that the higher proportion of red rice flour in formulation, the higher acceptance score and amylose content of vermicelli, but the lower reduction sugar and blood glucose of diabetic mice. The proportion of 100 g red rice flour and 35 g corn starch gave the highest score of the vermicelli acceptance (aroma, taste, colour, texture), the highest amylose content (36.5%), the lowest reduction sugar (3.33%) and the blood glucose of diabetic mice reduce sharply.

Keywords: corn starch, functional food, red rice, vermicelli.

1 Introduction

Consuming functional and healthy foods raises awareness of their ability to prevent and reduce the occurrence of degenerative diseases. Furthermore, the accuracy of functional

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food formulations can increase dietary fibre intake, bioactive compounds, resistant starch, and proteins, making it one of the solutions to reduce the risk of degenerative diseases [1].

The development of gluten-free noodles can result in well-accepted noodles by the community and have the benefits of being high in fibre, resistant starch type 3 (RS3), bioactive compounds, and antioxidants. It has the potential to be used as a functional food to lower the risk of degenerative diseases.

Rice flour is used to produce gluten-free noodles [2][3]. Rice flour is thought to be the best wheat flour substitute because it tastes bland, has high digestibility, and starch granules can form the characteristic texture of noodles. However, the glycemic load of rice flour is quite high.

Gluten-free rice noodle widely used rice flour, particulary with high amylose content, is widely used for forming rice noodle due to providing the acceptable texture, and sensory properties [4]. According to Boers *et al*. (2015) amylose provides stability to rice flour gel, and it also gives chewiness and elasticity to rice noodle texture because of its low swelling capacity [5]. Unfortunately, there are also some detrimental consequences to white rice consumption. It is understood to raise blood glucose levels that can contribute to the development of chronic metabolic diseases [6].

Food product manufacturers have been moving towards colored or pigmented rice that contains higher bioactive compounds and nutrients than white rice to anticipate the growth of consumers's preferences for functional and nutraceutical [7][8]. It is reported that pigmented rice retards free radical reactions that can damage biological molecules in the human body and cause oxidative stress [9]. Pereira-Caro *et al*. (2013) also described those biochemical compounds in colored rice [10]. Consuming colored rice could delay rice diabetes and obesity due to it reduced glycemic index [5].

Red rice of Inpari cultivar is a famous pigmented rice variety in Indonesia due to its unique colour and high in fiber content. However, this pigmented rice has low amylose content, giving low cooking and texture qualities, resulting in lower consumer acceptance [11]. On the other hand, corn starch, particulary high amylose corn starch has been classified into resistant starch and it is one of the most important carbohydrates in human life, with different applications in food industries [12]. High amylose corn starch cannot be digested by enzymes in the small intestine, but can be fermented by microorganisms to produce short-chain fatty acids to promote beneficial intestinal flora and human health [13]. Therefore, reducing the digestibility of starch is an effective strategy to prevent and control chronic diseases such as diabetes and obesity.

Steaming, extrusion, boiling, cooling, and drying gluten-free noodles can raise RS3 noodle levels [14]. Food containing RS3 can be antiinflammatory, antidiabetic, and immune-boosting [15][16]. Combining red rice and corn starch flour to make gluten-free noodles as functional foods requires the proper process and formulation. The objectives of this research were investigated a proper proportion of red rice flour and corn starch in the formulation of vermicelli as a functional food.

2 Materials and Methods

Two varieties of Indonesian rice (*Oryza sativa* cv.) which are IR 64 white rice and Inpari 24 red rice cultivar were used. IR 64 white rice grains cultivar were purchased

from local market in Mataram and Inpari 24 was provided from farmer in Banten of West Java. Rice flour was prepared by grinding the two-rice grain into powder with a hammermill and then passed through a 60-mesh sieve.

2. 1. Rice Noodle Preparation

Red rice flour (100 g; 80; 60; 40; 20 g), and corn starch flour (115 g, 95 g, 75 g, 55 g dan 35 g), 1 g Sodium tripolyphosphate (STPP) were used as the ingredients used to make rice noodles. White rice flour (100 g) was used for standard rice noodles. The ingredients were mixed with distilled water (60 g). Corn starch flour and water are mixed in a 3:2 (b/v) ratio and the resulting slurry was spread on stainless trays at a thickness of 1 mm. It was then steamed for 3 min. Subsequently, rice noodle sheets were peeled off and dried at 70 °C for 10 min. They were kept at room temperature for 3 h (covered with cheesecloth) and cut into strands 3 mm wide. Rice noodle strands were further dried at 40 °C for 4 h, decreased moisture content to 10-12%. Finally, the rice noodles were wrapped in plastic until further examination.

2. 2. Amylose Content of Rice Noodles

Amylose content was measured by using a colorimetry method [17]. The blended rice noodle (100 mg) was added with 95% ethanol (1 mL) and 2 M NaOH (9 mL). The mixtures were added with 0.2% iodine solution (2 mL) and adjusted to 100 mL with distilled water. The absorbances of the solutions were measured at 620 nm (Genesy 10S UV–Vis spectrophotometer, Thermo Fisher Scientific, Massachusetts, USA). The amylose content was estimated by referring to a calibration standard curve that was prepared by amylose from potato.

2. 3. Total Sugar of Rice Noodles

Total sugar content was measured by using Luff Schoorl Method [18]. As much as 5 g of rice noodle is mixed with 40 mL boiling water while being stirred, and pH is maintained between 6.5-8 by adding 0.05 N KOH or 0.05 N HCl. Extract, which pH has been regulated, is then moved into 100 mL volumetric flasks and calibrated until 100 mL. Temperature of the extract is maintained between 85 °C ± 2 °C with continuous stirring for 10 minutes. The result of rice noodle extraction in the concentration of 50 mg/mL, is added with H_2O free O_2. Extract solution is inserted into iodine flask 250,0 mL, added with 25,0 mL Luff Schoorl reactant and some boiling chips, heated for 4-5 minutes while closing the iodine flask; After cooled, 10 KI 20% solution and 25 mL H_2SO_4 25% solution are added, then titrated with sodium thiosulphate 0,1 N solution using starch 0,5% solution as indicator.

2. 4. Blood Glucose in Mice

Blood glucose in mice was measured by adopting Mayaswari methods [19]. A mice male Swiss Webster strains was used. Male mice were induced with alloxan and experience hyperglycemia. The animal being tested were male mice divided into treatment and control groups. The treatment group, hyperglycemic mice, were given the rice noodles. Positive control group, hyperglycemic mice were given the rice noodles. A negative control group, normal and not given the rice noodles. The study was conducted for two weeks. Observations were made on blood glucose levels of mice before and after being given rice noodles. Blood samples were taken on days 0, 3, 7, 11 and 14 in hyperglycemic mice treated. The animal being tested, their blood was taken after fasting for one night. Blood collection was taken from the caudal vein section by making a wound. Blood was inserted into the measurement strip automatically as much as 0.08 µl for one test. The measurement was continued by reading the scale found on the screen of the Autocheck glucotest tool. The wounded tail part was cleaned with alcohol to prevent infection.

2. 5. Preference Test of Rice Noodles

A semi-trained panelists consisting of 20 (men and women) was constituted to evaluate the rice noodles using a 7-point hedonic scale ranging from 1 (extremely disliked) to 7 (extremely liked). The panelists were asked to score sensory atrributes for aroma, taste, colour, and texture.

2. 6. Statistical Analysis

Experiments were arranged with completely block randomized designs with three replications. To analyze differences, one-way ANOVA was used, followed by the honestly significant diference at 5% level of significancy.

3 Results and discussion

Table 1. The chemical properties and sensory attributes of rice noodles

Proportion of Red Rice Flour and Corn Starch Flour	Chemical Properties		Sensory Attributes			
	Reduction Sugar (%)	Amylose Content (%)	Colour	Texture	Taste	Aroma
100 g WR : 35 g	3.27^{b}	21.63^{a}	5.7	5.5	6.1^{b}	5.6^{c}
20 g RR : 115 g	3.39^{a}	26.70^{b}	5.8	5.3	5.5^{a}	4.6^{a}
40 g RR : 95 g	3.64^{a}	29.67^{c}	5.7	5.5	5.5^{a}	4.8^{ab}
60 g RR: 75 g	3.53^{b}	32.53^{d}	5.9	5.0	5.6^{a}	4.9^{b}
80 g RR : 55 g	3.36^{b}	34.33^{e}	6.3	5.4	5.7^{a}	4.9^{b}
100 g RR : 35 g	3.33^{b}	36.50^{f}	6.4	5.5	6.0^{b}	5.7^{c}
HSD 5%	0.13	0.69	-	-	0.13	0.20

Note: *the values were expressed as the mean of three repetitions; the same character (denoted above) was expressed that the difference between them was not significant (α = 5%).*

3. 1. Chemical Properties of Rice Noodles

Table 1 shows amylose and reduction sugar content of red rice (RR) and white rice (WR) noodles as a control. Gluten-free red rice noodles have an amylose and reduction sugar content ranging from 3-4% and 21-37%, respectively. Higher red rice proportion in the formulation brought about an overall sharp increase of amylose to the rice noodles, but decrease in reduction sugar content ($p>0.05$). The results showed that in the proportion of 100 g red rice (RR) and 35 g corn starch decreased reduction sugar compare to 20 g red rice and 115 g corn starch. Interestingly that the higher proportion of red rice flour in formulation, the lower reduction sugar, the lower amylose content of the noodles. It was indicated that amylose content of the rice noodles may contain resistant starch. Resistant starch plays important role to inhibit diabetes mellitus. When the formulation of higher content of red rice (80 g and 100 g red rice) formulation fed to mice, the blood glucose in mice reduced significantly (Table 2).

Table 2. Blood glucose in mice fed with rice noodles

Treatments	Blood Glucose in Mice		
	Before Feeding (mg/dl)	After Feeding (mg/dl)	Percentage of Blood Glucose Reduction (%)
Control (Positive)	339.67	272.67	19.7
Control (Negative)	406.67	267.33	34
Fed with rice noodles:			
80 g red rice flour and 55 g corn starch	445	260.80	41
100 g red rice flour and 35 g corn starch	559	183.85	67

Blood glucose in mice reduced twice when fed with the rice noodle made from 100 g red rice flour and 35 g corn starch if it compared to 80 g red rice and 55 g corn starch. This finding revealed that the noodles may have higher in resistant starch and fiber.

Amylose is an important component for providing desirable qualities (firmness and crispness) to noodle texture by three-dimensional network development [11]. Han *et al.* (2011) found that noodles made of high amylose rice varieties [20]. The formulation of the red rice and corn starch with 100 g red rice and 35 g corn starch had desirable cooking and texture properties. Consequently, decreasing amylose content in blended red rice flour may cause some undesirable texture properties. Therefore, the higher the amylose content, the better the rice noodles texture and preferred to the consumer.

3. 2. Sensory Evaluation of Rice Noodles

The overall acceptability of rice noodles depends upon appearance (colour), aroma, taste and texture. Various researchers have found differences in the desirability and acceptance of rice-based noodles. Overall acceptability score values of rice noodles on 9-point hedonic scale were in the range of 5.0 to 6.0. Rice noodles blended with 35 g corn starch showed maximum acceptance scores. Thomas *et al.* (2015) studied the sensory acceptance noodles [21]. It was observed that panelists usually give preference to firm noodle irrespective of the aroma [22]. It was observed form the previous literatures that variation in genetic makeup of rice as well as flour particle size contribute important role in final noodle acceptance [22].

Sensory properties including overall acceptability were developed by proportion of red rice flour and corn starch in formulation ($p>0.05$), however the proportion had no effect on sensory scores in terms of colour, and texture, but affected on taste and aroma of rice noodles ($p>0.05$) (Table 1). Using proportion of 100 g red rice flour and 35 g corn starch in formulation provided the highest sensory scores in terms of taste (6.0) and aroma (5.7) (Table 1) to rice noodle ($p>0.05$). Actually, high amylose rice flour provides a respectable quality noodle [22]. Nevertheless, this study found that the especially high amylose content in rice noodles of 100 g red rice and 35 g corn starch (Table 1) gave same effect on the noodles texture. High quality noodle must be neither too hard nor too soft. Texture of rice noodle is also affected by particle size. The acceptance rate of noodles made from flour of small particle size was more as compared to the flour of large particle size. Generally, rice-based noodles have soft, and sticky texture with lower elasticity. Firmness is the main factor in representing the texture of cooked noodles [22].

Aroma is evaluated subjectively based on the experience of panelists by smelling. Thomas *et al*. (2015) found slightly higher acceptance rate in case of aroma of noodle made from Basmati rice (5.87) than Bario rice (5.73) [21]. The aroma of cooked product is generally considered a minor quality factor than other sensory properties (taste, texture, color, etc.), as it minimally affects the consumer choice for accepting a product [22]. However, rice noodle blended with wheat flour showed higher acceptance (6.18-7.48) in term of aroma [22].

4 Conclusions

It can be concluded that the red rice cultivar combined with corn starch can be good ingredient for producing low glucose rice noodles (vermicelli). The proportion of 100 g red rice flour and 35 g corn starch flour is the best formulation to produce red rice noodles (vermicelli).

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