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The development of rice substitute product using fermented cassava (*Oyek*) enriched with isolated soy protein

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The development of rice substitute product using fermented cassava (*Oyek*) enriched with isolated soy protein

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Abstract. *Oyek* is an analog or artificial rice made from fermented cassava that is popular in Java and Sumatera Islands. The aim of this research is developing a rice substitute product from fermented cassava (*Oyek*) by adding Isolated Soy Protein to achieve the protein content which similar to rice (7-9%) as our main staple food, as well as to improve its texture and acceptance level. *Oyek* itself only contains 1–2 % of protein, though it is a potential source of carbohydrate, reaching ± 85% of carbohydrate. Addition of Isolated Protein (ISP) is expected to increase its protein content as similar as normal rice. There are 3 formulations are made in the making of the artificial rice. Formula 1 is *Oyek* with 5% ISP, Formula 2 is with 6% ISP and Formula 3 is with 7% ISP. Based on the research, the best chosen formulation of the artificial rice is Formula 3 (added ISP 7%) with the highest protein level (8.98%), the lowest starch digestibility (36.01%), the lowest pasting temperature (65.48^{o}C) and the best score of overall acceptance (3.85) among the made formulas. It also contains moisture content (7.15%), ash content (0.76%), fat content (2.32%), carbohydrate (80.79%), crude fiber (1.30%), starch content (72.56%), amylose content (21.84%) and amylopectin (50.72%).

Keywords: rice substitute, fermented cassava, oyek, isolated soy protein

1. Introduction

Indonesia as the largest cassava producer can make up about 30% of the production in Asia Pacific [1]. Cassava is actually categorized as a staple food after rice and maize in Indonesia. Cassava (*Manihot esculenta* Crantz) is also known as a good source of carbohydrate, which has a potential to become a staple food substitution for rice [2]. Therefore, cassava has a huge potential to become an artificial or analog rice.

Analog rice is an artificial rice which can be made from other ingredients, such as tubers like cassava, sweet potato, etc. [3]. It is genuinely a food diversification which basically contains carbohydrates as energy source in food and with some additional ingredients to improve its quality as a staple food [4]. Oyek which comes from cassava can be made as an analog rice. Oyek is also known as dried Growol. Growol itself is produced by fermenting cassava for about five days. It is a traditional food that is quite popular for the low economic class [5] in Java and Sumatera islands. Cassava that is already soaked in the water for five days, or also called fermentation, will be washed and directly go to grinding process and Growol grain is produced, then it will be steamed and dried to get Oyek rice. In comparison to other cassava rice products, Growol also has some characteristics which are categorized as a compact food, broken white to yellowish white in color, with no seasonings added in the making process. It is actually tasteless with a little bit of sour taste and aroma since it utilizes fermentation process. It is also soft and glutinous in texture. Growol is included as a semi wet food product with 35.52 % of moisture content, starch content 30.50 % and protein content 0.32 % [6]. Different making processes and the final product characteristic makes Oyek different with other cassava analogue rice.

Oyek is the artificial rice made from fermented cassava and has some functional properties such as low in Glycemic Index (30), has anti-diarrhea properties and higher preference level compare to other artificial rice. As a rice substitute, *Oyek* has a limitation, which is low in protein content (1-2%), compare to normal white rice (7-9%). Isolated Soy Protein is expected as the suitable enrichment material, due to its high protein content (90%), low fat, tasteless, odorless and has similar color to *Oyek*. This study will be focused on improving the nutritional quality and as well as sensory properties of the enriched artificial rice, so it can be used as a rice substitute.

2. Materials and methods

The methods are divided into two stages. First stage is Production of *Oyek.* Cassava as the raw material was peeled, cut, fermented, washed, drained, pressed, grounded and dried to get the *Oyek.* Then this *Oyek* was further analyzed for its proximate, starch, amylose, amylopectin, Crude Fiber, *In Vitro* Starch Digestibility, Pasting Temperature and Qualitative Tannin Analysis. The second stage is the formulation and Production of the Artificial Rice. In the first stage, before the *Oyek* was being dried, it was added with Isolated Soy Protein (ISP) in accordance with the made formulation. Formulation 1 is *Oyek* with 5% ISP, Formula 2 is with 6% ISP and Formula 3 is with 7% ISP. Then it was round formed, steamed, dried and the enriched artificial rice was produced. The artificial rice was then being analyzed in terms of proximate, starch, amylose, amylopectin, Crude Fiber, *In Vitro* Starch Digestibility, Pasting Temperature, Qualitative Tannin Analysis and Sensory Hedonic analysis. The obtained data was being analyzed using statistical method to determine the significance difference.

3. Results and discussion

The produced artificial rice is round in shape, which is different with normal white rice, oval. It is because of the traditional rice forming using bamboo *Tampah.* The color of the enriched artificial rice is also browner compare to the control (0% ISP), due to Maillard reaction [7].

The proximate analysis includes moisture, ash, protein, fat and carbohydrate content. The moisture content of the produced artificial rice is in the range of 6.75% - 7.43% that has been fulfilled the standard of rice (SNI), the maximum content of 14%. The ash content is positively correlated to mineral content in the artificial rice. The highest ash content is Formula 3 (0.76 %). The addition of ISP shows the increasing in the ash content of the samples. The fat content is rising as the more ISP added to the formulation, but it still shows not significant difference among the samples, due to its low-fat enrichment material (ISP). As shown on **Table 1**, the protein of the samples is increased significantly from the control. This may happen because of the high protein from ISP that was added to the artificial rice which related to the water binding capacity that can hold its shape and remain bound together [8] and the steaming process did not give any effect in decreasing protein content. It has actually been reported as the critical factor in the protein functionality regarding to its effect in the sensory properties of the food product [9]. The protein content of the enriched artificial rice is in the range of normal white rice protein level (7-9%). The fat and protein content contribute in determining a low glycemic index of a food product [10]. The carbohydrate shows a significant difference between the 4 samples (control and 3 formulations). All samples have the higher carbohydrate content (80.79% - 90.63%) compare to normal white rice IR 64 (78.46%), which has a great potential to become a rice substitute.

Table 1. Protein content of the produced artificial rice*

Sample	ISP added (%)	Protein (%)
Control	0	$0.91{\pm}0.02^{a}$
Formula 1	5	$6.57{\pm}0.15^{b}$
Formula 2	6	$8.75{\pm}0.11^{c}$
Formula 3	7	$8.98{\pm}0.08^{c}$
IR 64	-	7.15

*Values are mean of duplicate analyses. Different superscript letter in the same column indicates significant difference (P<0.05).

The starch digestibility is directly correlated with the Glycemic Index (GI). The *In Vitro* starch digestibility was done in both raw and cooked form. The starch digestibility of the produced artificial rice in both forms (<42.68%), which is lower than IR 64 rice (>93.83%). The lowest Starch digestibility in cooked form is Formula 3 (31.24%). The addition of ISP affects the starch digestibility in the artificial rice [11], due to its ability to inhibit the swelling of starch which will decrease the digestion of starch.

The amylose and amylopectin content are related to the texture of the produced artificial rice. The enriched artificial rice is categorized as the moderated amylose content (20-25%). Moderate amylose content rice will give a desired taste, texture, appearance and also can maintain its texture even it has been left for several hours [12]. The amylopectin in the produced artificial rice (50.72% - 55.00%) is higher than IR 64 rice (49.10%), which means the texture of the rice will be more gelatinous and give a desirable taste [13].

Table 2. Overall Acceptance Result of Hedonic Sensory Analysis*

Sample	ISP added (%)	Overall Acceptance
Formula 1	5	4.18^{b}
Formula 2	6	4.30^{b}
Formula 3	7	5.85^{b}
IR 64	-	6.97^{a}

*Hedonic Scale: 1= Dislike Very Much, 4= Neither Like nor Dislike, 7= Like Very Much. IR 64 is used as a control in the analysis.

^{a,b,c}Different superscript letter in the same column indicates significant difference ($P<0.05$).

As can be seen in **Table 2**, the highest score of the overall acceptance level is still achieved by IR 64, due to the social culture habit in the society. The enriched artificial rice (Formula 1, 2 and 3) is showing not significantly different, which means the addition of ISP does not affect the sensory properties and have same overall acceptance in a range of neither like or dislike. Another texture analysis was done using RVA to see the difference in texture between samples technically.

Tannin is a phenolic compound that can form a crosslink with protein as an effective enzyme inhibitor which will reduce digestive enzyme activity [14]. Although the result of the tannin qualitative analysis is none among all the samples, the dried and processed cassava was proved still containing tannin [15]. It is assumed that the used analysis might not be sensitive enough to detect tannin in very low amount.

Pasting Profile is used to determine the pasting temperature of the artificial rice. From the Rapid Visco Analyzer (RVA) viscogram, the lowest pasting temperature was achieved in formula 3, which is 65.48^{o}C, which has a potential to become an instant artificial rice. The lower pasting temperature indicates the easier starch to be gelatinized so the cooking time needed id efficiently slower. The addition of ISP somehow affects the texture of the rice in some specific concentrations, regarding to other viscogram data.

4. Conclusions

The addition of ISP has improved the nutritional, along with the texture properties of the artificial rice. The chosen formula is Formula 3 with an addition of 7% ISP, in terms of protein content (8.98%) which is similar with the normal rice, the lowest starch digestibility (36.01%), the lowest pasting temperature (65.10^{o}C). Sensory hedonic analysis did not give a significantly difference among the made formulas (Formula 1, 2 and 3), regarding to all sensory attributes. The overall sensory acceptance of the artificial rice is in the range of neither dislike or like, and it still considerable to make it as a rice substitute in terms of its nutritional value and standard of the rice (SNI).

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