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Preparation and Characterization of Analog Rice from Purple Yam Flour, Cassava Flour, Corn Flour

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Abstract

Analog rice is one of the processed foods that can be prepared from different tubers and can be used as a substitute for rice. The aim of this study is to prepare and analyze the content of carbohydrate, amylose, amylopectin, FTIR analog rice prepared from a combination of purple yam flour, cassava flour and corn flour by cold extrusion method. In the sample variation consisting of 55% purple yam flour, 40% cassava flour, 5% corn flour with a composition of 300 mL water and a temperature of 90o C (4D), the best analog rice was obtained, with carbohydrate content: 83.26%; amylose: 4.61%; and amylopectin: 95,39%. Meanwhile, sample 4C in FTIR analysis has a narrower area than sample 3C, indicating that cassava flour and corn flour affect the C-H bond. The C-H group is an element that forms carbohydrate compounds and glucose, which affects the glycemic index of food.

Keywords: Analog Rice , Composite flour from purple yam, cassava, corn, Cold Extrusion

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1. Introduction

Rice is the most important nutritional need of people, which must be met especially in developing countries such as Japan and Indonesia. The demand for rice continues to increase every year. Total food intake is about 45% of the consumption pattern, and the main carbohydrate source is 80%, indicating a high food dependency. This can lead to problems of vulnerability to national food security [1–6]. The need for an alternative to rice, analog rice can reduce people's dependencen rice and support food diversification. Food diversity is one of the solutions to achieve national food security [7–13]. Analog rice, or artificial rice, is a possible rice product that can be made from corn flour, sago flour, cassava flour, or other composite flours and then processed into rice grains [4] Two techniques are employed in the production of analog rice: the hot extrusion granulation method and the cold extrusion method [14] Analog rice processed using the cold extrusion method is carried out with a series of tools consisting of four stages, including; making corn flour, making composite flour, synthesizing analog rice, and analyzing the characteristics of analog rice [15]. While the hot extrusion method is carried out with a heating process under various conditions, such as; drying process, mixing, heating, stirring, and forming analog rice to match natural characteristics[16]. Both methods have been developed to date to meet the needs of analog rice. According to research [17], stated that the advantages of the cold extrusion method in the form of analog rice making process using low temperatures will avoid excessive heat transfer, so that the analog rice produced is according to natural characteristics and minimizes the physical damage to the analog rice. Consumption of this analog rice can reduce the risk of degenerative diseases [15]. This is supported by researchers [7] which states that analog rice contains more protein and fiber than real rice. Therefore, analog rice can be an alternative food solution for diabetics because it contains low-calorie carbohydrates [18].

This research was conducted using raw materials such as purple yam flour, cassava flour, and corn flour. According to [19] yam flour contains 75-84% carbohydrates and 7.4% protein [8]. Cassava flour contains 87.00% carbohydrates, 2.59% protein, so cassava flour can be used as raw material in making analog rice [20]. Corn flour also contains 10% protein and 70% carbohydrate. This content has potential in the development of alternative raw materials in analog rice [21]. Further research is needed regarding the nutritional content and the use of appropriate methods in the development of analog rice. The novelty in this research is that the ingredients for making analog rice consist of purple yam flour, cassava flour, and corn flour using a cold extrusion method that has never been done. Therefore, this study aims to determine the effect of ingredient composition on the nutritional content of analog rice using the cold extrusion method.

2. Materials and methods

2.1 Material

The main ingredients used were purple yam flour, cassava flour, and corn flour. Water, pandan extract solution, skim milk from CV Sari Indo Prima, vegetable oil produced by PT Barco, glycerol monostearate (GMS) produced by Asian Chemical.

2.2 Methods

Purple yam flour, cassava flour, and corn flour were mixed by adding glycerol monostearate (GMS), skim milk, pandan extract solution, vegetable oil, and water to make dough. Besides, the mixture was wrapped employing a cloth for 30 minutes for preconditioning at a temperature of 90º C to ended up composite flour some time recently being nourished into a single screw extruder.

2.2.1. Preparing Analog Rice

Make analog rice has four variables. First, it makes purple yam flour, cassava flour, corn flour at 55%, 5%, 40% with 5 g GMS, 10 mL vegetable oil, 50 mL pandan extract solution, and 150 mL water. Second, it makes purple yam flour, cassava flour, corn flour at 55%, 45%, 0% with 5 g GMS, 10 mL vegetable oil, 50 mL pandan extract solution, and 150 mL water. Third, mix 150 mL of water, 10 mL of vegetable oil, 50 mL of pandan extract solution, 5 g GMS, and cassava, corn, and purple yam flour to a 55%, 0%, and 45% ratio. Ultimately, the mixture of 5 g GMS, 10 mL vegetable oil, 50 mL pandan extract solution, 150 mL water, and purple yam flour, cassava flour, and corn flour as much as 55%, 40%, and 5% was created. Additionally, proximate testing will be carried out on carbohydrate, amylose, and amylopectin levels.

2.2.1 Proximate analysis / nutritional value of flour composition in analog rice

2.2.1.1 Analysis of carbohydrate content in analog rice

Analysis of carbohydrate content based on research from [22], using the carbohydrate difference method.

$$\%carbohydrate = 100\% - (\%protein + \%fat + \%ash + \%water)$$

2.2.1.2 Analysis of amylose and amylopectin content in analog rice

Analysis of amylose content was carried out according to [23]. Determination of amylopectin was carried out using the method as described by previous research [24].

2.2.2 FTIR analysis of analog rice

FTIR analysis conducted on analog rice using PerkinElmer Spectrum IR 10.6.1. FTIR spectra will be obtained from the recording results of the IR spectrometer 10.6.1 used in total reflection operation, then equipped with an attenuated diamond crystal cell (ATR). Spectra were obtained (32 scans/sample *file*) in the range of 400 - 4000 cm^{-1} with a resolution of 4 cm^{-1} [25]

3. Results and Discussions

3.1 Effect of flour composition on nutritional value of analog rice

Analog rice is made from various flour compositions and different water compositions shown in Table 1.

3.1.1 Carbohydrates

Analog rice 4D (55:40:5; 300 mL; 90 ° C) is known to have the highest carbohydrate content among other analog rice compositions which is 83.26%. While analog rice 1A (55:5:40; 150 mL; 90º C) is known to have the lowest carbohydrate content of 81.20% shown in Table 2. This is because in sample 4D the composition of cassava flour is more than in sample 1A, thus producing higher carbohydrates. Carbohydrate content in analog rice is influenced by the carbohydrate content of each raw material. In the research obtained, formulations that use a larger composition of cassava flour and purple yam flour will produce analog rice with higher carbohydrate content. Analog rice with tuber raw materials has a low glycemic index level, so this analog rice is suitable for consumption by people with diabetes mellitus and cholesterol [26]. The low glycemic index is because amylose cannot be digested by enzymes, therefore amylose cannot be absorbed as glucose in the intestine [27] Therefore, analog rice can be used as an alternative staple food to meet daily needs.

3.1.2 Amylose

Analog rice 4D (55:40:5; 300 mL; 90º C) is known to contain the highest amylose content among others at 4.61%. While analog rice 1A (55:5:40; 150 mL; 90 °C) is known to have the lowest amylose content of 4.23% as shown in Table 2. Amylose is a glucose polymer whose chains are straight and unbranched. Amylose is an important property of rice grains, it can affect the texture, processing, utilization and consumption of rice, especially food quality [28, 29]

3.1.3 Amylopectin

4D analog rice (55:40:5; 300 mL; 90º C) is known to contain amylopectin levels. The lowest among the others is 95.39%. While analog rice 1A (55:5:40; 150 mL; 90º C) is known to have the highest amylopectin content of 95.77% shown in Table 2. In Harper's research, 1981, stated that the high level of starch contained in food ingredients will cause water to be easily absorbed, so that amylopectin molecules are reactive to water molecules. As a result, the number of water molecules that will be absorbed into food ingredients will also increase. Figure 1 shows the FTIR spectra obtained from analog rice in the composition of 55% purple yam flour, 5% cassava flour, 40% corn flour, 90 ºC temperature of precondition with variations in water composition (1A; 150 mL), (1B; 200 mL), (1C; 250 mL), and (1D; 300 mL) have almost the same pattern. Samples 1A; 1B; 1C; and 1D obtained wave numbers of 3286.72 cm^{-1}; 3287.26 cm^{-1}; 3285.27 cm^{-1}; and 3286.40 cm^{-1} which is a representation of the absorption of O-H bonds. O-H bonds in analog rice mean that in analog rice there are compounds forming flavonoids or phenols that are useful as food antioxidants [25] Samples 1A; 1B; 1C; and 1D obtained C-H bond absorption of 2923.96 cm^{-1}; 2924.21 cm^{-1}; 2925.14 cm^{-1}; and 2924.59 cm^{-}

[1] which belongs to the alkane group. C= C bond absorption was obtained at 1638.28 cm^{-1}; 1638.65 cm^{-1}; 1638.68 cm^{-1}; and 1639.25 cm^{-1}. The highest absorption area is the C-H bond at 858.00 cm^{-1} in sample 1A; 858.56 cm^{-1} in sample 1B; and 859.03 cm^{-1} in sample 1D, in this area there are also nitro compounds with NO_2 bonds (Skoog et al., 1998). Sample 1C has a narrower absorption than samples 1A; 1B; and 1D, this is influenced by the composition of water by 250 mL which causes the number of C-H groups to decrease.

The FTIR spectra shown in Figure 2 obtained from analog rice in variations of the composition of purple yam flour, cassava flour, corn flour (1C; 55%, 5%, 40%), (2C; 55%, 45%, 0%), (3C; 55%, 0%, 45%), and (4C; 55%, 40%, 5%) at a water composition of 250 mL, and an 90 ^{o} C temperature of precondition produced almost the same pattern. The difference in raw material composition gave an insignificant effect on the spectra of samples 3C and 4C. Samples 1C; 2C; 3C; and 4C produced O-H bond absorption of 3285.27 cm^{-1}; 3290.21 cm^{-1}; 3292.57 cm^{-1}; and 3286.23 cm^{-1}. C-H bond absorption was also found in samples 1C; 2C; and 3C at 2925.14 cm^{-1}; 2923.97 cm^{-1}; 2923.74 cm^{-1}. C= C bond absorption was found in samples 1C; 2C; 3C; and 4C at 1638.68 cm^{-1}; 1637.44 cm^{-1}; 1638.90 cm^{-1}; and 1636.07 cm^{-1}. Sample 3C has a larger area than sample 4C. This shows that sample 4C does not have C-H bond absorption, thus indicating that cassava flour and corn flour have an effect on C-H bonds. C-H groups are elements that form carbohydrate and glucose compounds; therefore, they greatly affect the glycemic index of food [30].

Table 1. Research variables

Sample	Purple Yam Flour (%w)	Cassava Flour (%w)	Corn Flour (%w)	Water (mL)	Precondition Temperature (^{o} C)
1A	55	5	40	150	90
1B	55	5	40	200	
1C	55	5	40	250	
1D	55	5	40	300	
2A	55	45	0	150	90
2B	55	45	0	200	
2C	55	45	0	250	
2D	55	45	0	300	
3A	55	0	45	150	90
3B	55	0	45	200	
3C	55	0	45	250	
3D	55	0	45	300	
4A	55	40	5	150	90
4B	55	40	5	200	
4C	55	40	5	250	
4D	55	40	5	300	

Table 2. Nutritional value of analog rice

Sample	Amylose (%)	Amylopectin (%)	Carbohydrate (%)
1A	4.23	95.77	81.20
1B	4.34	95.66	81.43
1C	4.38	95.62	81.65
1D	4.42	95.58	81.90
2A	4.45	95.55	82.05
2B	4.49	95.51	82.30
2C	4.53	95.47	81.97
2D	4.58	95.42	82.13
3A	4.33	95.67	82.25
3B	4.38	95.62	82.67
3C	4.51	95.49	81.22
3D	4.56	95.44	83.21
4A	4.61	95.39	82.36
4B	4.54	95.46	83.02
4C	4.59	95.41	82.90
4D	4.61	95.39	83.26

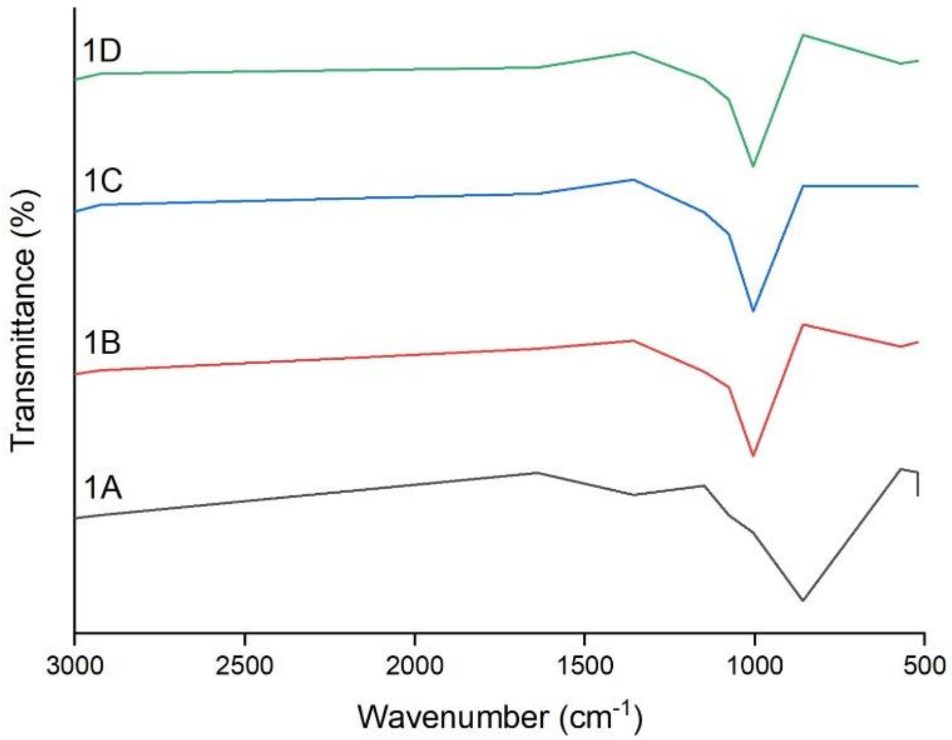

Figure 1. FTIR analysis of analog rice based on variation of water composition (1A; 150 mL), (1B; 200 mL), (1C; 250 mL), (1D; 300 mL) on the composition of 55% purple yam flour, 5% cassava flour,40% corn flour and 90 ^oC temperature of precondition.

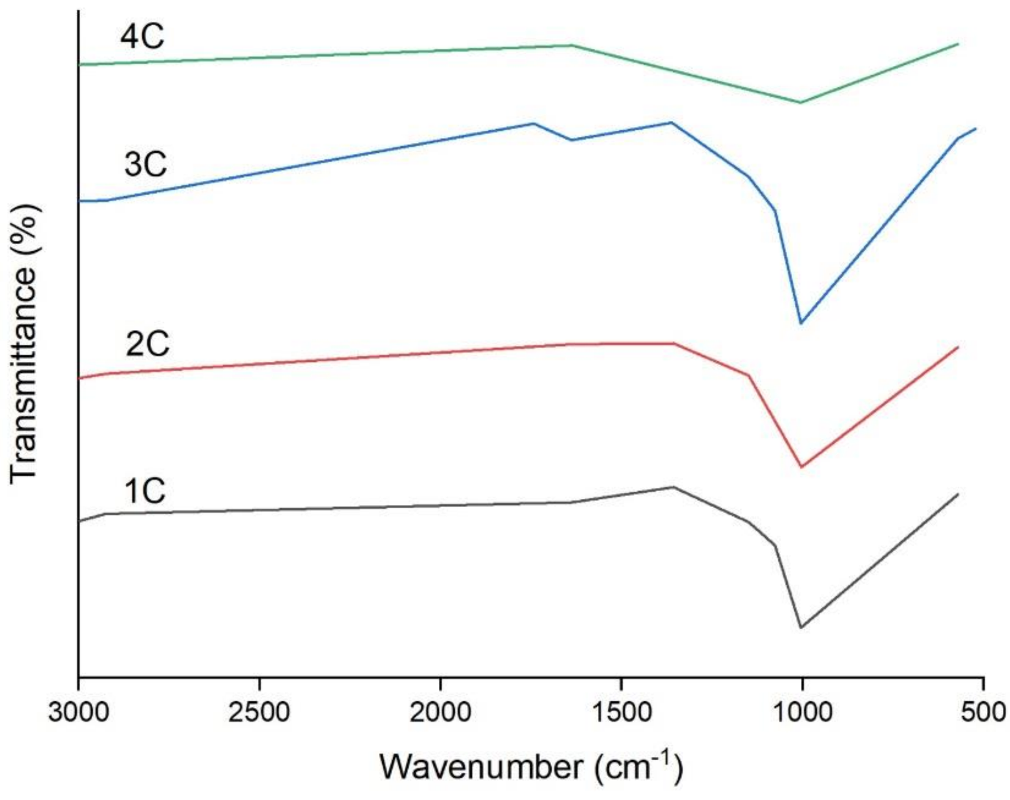

Figure 2. FTIR analysis of analog rice based on variations in the composition of purple yam flour, cassava flour, corn flour (1C; 55%, 5%, 40%), (2C; 55%, 45%, 0%), (3C; 55%, 0%, 45%), and (4C; 55%, 40%, 5%) at a water composition of 250 mL, and 90 ^{o} C temperature of precondition.

4. Conclusions

This study used the cold extrusion method with the results of the analysis of carbohydrate content, amylose, and amylopectin in analog rice on variations in composite flour composition. The best analog rice was produced in sample 4D, consisting of 55% purple yam flour, 40% cassava flour, 5% corn flour with a water composition of 300 mL and a temperature of 90º C. This formulation produced carbohydrate, amylose, and amylopectin content. This formulation produced carbohydrate; amylose; and amylopectin levels of 83.26%; 4.61%; and 95.39%. Sample 4C in FTIR analysis has a narrower area than sample 3C, indicating that cassava flour and corn flour affect the C-H bond. The C-H group is an element that forms carbohydrate compounds and glucose; therefore, it greatly affects the glycemic index of food.

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