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Characteristics of Red Sweet Potato (Ipomea batatas) Analog Rice (SPAR) From The addition of Cassava Flour (Manihot utillisima) and Carrot (Daucus carota)

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***Abstract*— The objective of this research was to determine the effect of the addition ratio of cassava flour and carrots in making sweet potato analog rice. This research also used completely randomized design with 5 treatments and 3 replication. The treatment in this study was the addition of cassava flour 90%, 80%, 70%, 60%, 50%, and the carrots 10%, 20%, 30%, 40%, 50% to the entire material. The results showed that the addition of cassava flour and carrots give significantly different results on fat content, antioxidant activity and beta-carotene, no significant difference in moisture content, ash content, protein content, crude fiber content, carbohydrates, total polyphenol. The results of treatment E (50% cassava flour : 50% carrot) obtained an average water content of 7.75%, 2.67% ash content, protein content of 2.56%, 0.41% fat, carbohydrate content of 86.59%, crude fibre content 18.74 %, 48.97% antioxidant activity, total polyphenols 0.61%, the determination of the energy value 3.58kcal, beta-carotene 5017.83µg / 100ml.**

***Keywords*— Cassava flour; Carrots; Analog Rice; Red Sweet Potatoes**

I. Introduction

Rice has been a staple food for most of Indonesian society. An alternative way that can generate value for nutritional needs of the community needs to create products that have similarities with rice, both the form and content of nutrients in it. People still consume lots of tubers that have not varied. Cassava is one of most important foods in tropical countries, and it is largely processed as cassava flour as one of the staple food [1]. Beside cassava so many tubers can use as staple food, such as carrots. Therefore, the technology required to process these materials into a form that can be processed to resemble rice and eaten like rice.

The food that resembles rice is called analog rice (AR). AR made of non- rice, but made of tuber - crops that contain carbohydrates that can be processed into AR . Sweet potato is one of tuber that can processes into AR. In Indonesia, cassava is the third most important staple food after rice and maize. Cassava including food rich in carbohydrates, but not yet optimized utilization as a source of carbohydrate. In fact, if treated properly the results are not inferior to other materials, such as biodegradable plastic or other product [2]. In addition to the red sweet potato and cassava, carrot is also a plant that can be added in the manufactured of AR because carrots contain beta carotene which is almost the same as the red sweet potatoes.

The addition of carrots on AR also serves to reinforce the colour of the product. The resulting AR will have a more interesting colour because of the pigment carotene in carrots. Carrots contain high fibre, rich in vitamin A Carrots are considered as one of the cheapest sources of beta-carotene to reduce the incidence of the disease [3]. To combine sweet potato and carrots will give values to AR. Antioxidants that are believed to play a very important role in the body's defence system against ROS are of great value in preventing chronic and degenerative diseases. The consumption of plant foods is associated with a reduced risk of chronic diseases, in part because of substances with antioxidant capacity. Beta-carotene, α-carotene and lutein from a fresh carrot extract was developed [4].

II. Materials and Methods

Raw materials used in this study is the red sweet potato , cassava flour, carrots gained from Ibuh Market Payakumbuh.

Chemicals used in this study were hexan, NaOH , DPPH (1 - Diphenyl - 2 - picrylhydrazyl), ethanol , KOH, HCl, selenium mix, distilled water, H2SO4, diethyl ether and Conway indicators.

The design used in this research is completely randomized design (CRD) with 5 treatments and 3 replications. Data were analysed statistically by F test if significantly difference, followed by Duncan 's test New Multiple Range Test (DNMRT) at 5% significance level .

The treatments used in this study were the addition of cassava flour and carrots :

A = Cassava Flour : Carrots (90 % : 10 %)
B = Cassava Flour : Carrots (80 % : 20 %)
C = Cassava Flour : Carrots (70 % : 30 %)
D = Cassava Flour : Carrots (60 % : 40 %)
E = Cassava Flour : Carrots (50 % : 50 %)

The process of making analog rice are as follows : Mix all the ingredients such as cassava flour , sweet potato flour, carrots and water. Material that has been mixed with water and then printed using a tool that has a hollow shaft diameter of 2 mm and downsizing to cut by 0.5 cm . Then drying by using an oven at 60C for 17 hours until the water level reaches below 10 % . This drying process is the final process of the manufacture of AR .

1) Water Content [5]: Clean aluminium cup and dried in an oven for 1 hour at a temperature of 110̊C , after the cup is cooled in a desiccator and weighed . After bowls weight obtained , put 5 g of sample into the cup. Aluminum cup containing the sample is inserted into the oven at a temperature of 110̊C.

$$\text{Water content } (\%) = \frac{\text{initial weigh} - \text{final weight}}{\text{initial weight}} \times 100\%$$

2) Ash content [5] : A 5 gram samples put in a porcelain cup . Heat the sample until the sample becomes charcoal and smoke. Then put in furnace for 15 minutes and weighed immediately after reaching room temperature.

$$\text{Ash content } (\%) = \frac{(\text{weight of ash} + \text{cup weight})}{\text{weight of sample}} \times 100\%$$

3) Protein Content [6]: The crude protein was determined by the Kjeldahl method with slight modification. A 0.5 g of the powdery form of each analog rice was digested with 5 ml of concentrated sulphuric acid in the presence of Kjeldahl catalyst. The nitrogen from the protein in the sample was converted to ammonium sulphate that reacted with 2.5 ml of 2.5 % Brucine reagent, 5 ml of 98 % sulphuric acid to give a coloured derivative and the absorbance read at 470 nm. The percentage nitrogen was calculated and multiplied by 6.25 to obtain the value of the crude protein.

4) Fat content [6]: A total of 5 grams of sample (W) wrapped with filter paper , and then put in a Soxhlet flask which had previously been weighed . Hexane was poured into the Soxhlet flask and then assembled tool . Reflux performed for 5 hours . Then heated in an oven at a temperature of 105̊C until all the solvent evaporates . Flasks containing fat cooled in a desiccator and then weighed.

$$\%\text{ Fat} = \frac{\text{fat weight (g)}}{\text{sample weight}} \times 100\%$$

5) Crude fiber content [5]: A 2 g samples extracted using Soxhlet. Move the material into 600 mL Erlenmeyer flask and add boiling stones. Then enter 200 mL H2SO4, simmer for 30 minutes while being shaken occasionally. Filter the suspension with filter paper, the residue is left in the flask was washed with distilled water. The residue was washed through a filter paper until the washing water is not acidic again (tested with litmus paper). Move quantitatively residue from the filter paper into Erlenmeyer, and the rest residue is washed with 200 ml of NaOH.

Shake for 30 minutes then filter with filter paper to dry. Wash the residue with boiling distilled water with 15 ml of 95% alcohol. Then dry the filter paper at a temperature of 110C to constant weight (1-2 hours).

6) Levels of carbohydrates by different [7]: Carbohydrate content was calculated as the rest of moisture , ash , fat , and protein . Carbohydrate content was calculated as follows :

$$\text{Carbohydrate content } (\%) = 100\% - (\text{c.Water} + \%\text{k.Ash} + \%\text{k Protein} + \%\text{k.Fat})$$

7) DPPH radical scavenging activity: DPPH radical scavenging activity was determined using the method originally developed by Blois (1958) [8]. A portion (0.1 ml) of the extract solution (1.0 mg/ml methanol) in a test tube was well mixed with 3.9 ml of methanol and 1.0 ml of a DPPH solution (1.0 mM in methanol). The mixture was kept at ambient temperature for 30 min prior to measurement of the absorbance at 517 nm (A517 nm). All measurements were done in triplicate.

$$\text{Percent DPPH} - \text{RSA} = [(\text{control absorbance} - \text{extract absorbance}) \times 100/\text{control absorbance}$$

8) Total Polyphenol: The total polyphenol content of the extract was measured with the Folin–Ciocalteau method [9], using gallic acid as a standard. A 0.1 ml of the extract solution was sampled into 2 ml of 2% Na2CO3 and mixed for 3 min. After adding 0.1 ml of 50% Folin–Ciocalteau reagent, the final mixture was left for 30 min before reading the absorbance at 750 nm. All measurements were conducted in triplicate and the data were expressed as g gallic acid equivalent (GAE) per kg of the extract, based on the calibration curve of gallic acid.

9) Determination of Energy (Bomb calorimeter): Determination of the energy of the product is done by using a bomb calorie-meter . A 5 gram sample insert into the sample tube. Tube already containing the sample is introduced into the bomb calorimeter apparatus where the device has been set in advanced , wait for ± 5 minutes and the results of the energy of the sample can be seen on the screen bomb calorie-meter .

10) Beta-carotene [10]: A 1 ml sample added to 8 ml of distilled water, homogenized and shaken by vortex , Then 2 ml inserted into the reaction tube , add 2 ml of 96 % alcohol and 10 ml of hexane . Shaken for 2 minutes using a vortex and then centrifuged for 3-5 minutes. Taken hexane formed and marked as layer 1, the rest having taken hexane (layer 1) is added again with 10 ml of hexane . The mixture was shaken again for 3-5 minutes. Take hexane layer formed and marked as the second layer into one with a layer 1. Read at a wavelength of 450 nm.

11) Calculation

$$\text{Beta} - \text{carotene levels (mg / 100ml)} = (A \times F \times 1000 / 0.04) \times 0.5$$

III. Results And Discussion

A. Raw Material

Chemical analysis performed on the raw material that is water content and ash content. The results of chemical analysis on raw materials can be seen in Table 1.

TABLE I
RESULTS OF CHEMICAL ANALYSIS RAW RICE ANALOG

Materials	Cassava flour (%)	Sweet potato flour (%)
Water		6.02
Ash	1.43	2.51

Sweet Potato Analogue Rice (SPAR)

TABLE II
THE WATER CONTENT OF SPAR

Treatment	Water content (%)
A = (90% : 10%)	6.43
B = (80% : 20%)	6.78
C = (70% : 30%)	7.06
D = (60% : 40%)	7.35
E = (50% : 50%)	7.75
Coef Var = 14.49%	

Results of analysis of variance can be seen in Table. 2 showed that the blending of cassava flour and carrots were not significantly different on the water content of sweet potatoes analog rice (SPAR). There were no influences of the addition sweet potato and carrot to the water content.

B. Ash Content

Ash is inorganic substances residual combustion products of a food. The ash content and composition depend on the type of material. Most foodstuffs, which is about 96% composed of organic matter and water. The rest is an inorganic material in the form of a mineral called gray [7].

Based on the analysis of variance, showed that mixing cassava flour and carrots there were no significantly different on ash content of SPAR. The ash content range from 2.22 % to 2.67 %, This is presumably due to the addition of cassava flour and carrots have higher ash content due to the type of sweet potato (ash content of about 2.51%).

TABLE III
THE ASH CONTENT OF SPAR

Treatments (Cassava flour: carrots)	Ash content(%)
A = (90% : 10%)	2.22
B = (80% : 20%)	2.35
C = (70% : 30%)	2.52
D = (60% : 40%)	2.64
E = (50% : 50%)	2.67
Coef Var = 8.28%	

C. Protein content

Protein is a complex compound consisting of amino acids bonded together by peptide bonds. Nitrogen atom contained in the amino group is a characteristic of proteins. On average, there is 16 % of nitrogen in a protein. Therefore, the protein content in foodstuffs is determined by converting the nitrogen content obtained by the Kjeldahl method with a conversion factor of 6.25 [11].

TABLE IV
PROTEIN CONTENT OF SPAR

Treatments (Cassava flour : carrot)	Protein content (%)
A = (90% : 10%)	3.34
B = (80% : 20%)	2.81
C = (70% : 30%)	2.79
D = (60% : 40%)	2.65
E = (50% : 50%)	2.56
Coef Var = 16.20%	

The results of the analysis of variance at 5% level can be seen in Table. 4 showed that the addition of cassava flour and carrots are not significantly different from the protein content of SPAR. This is due to differences in the amount of cassava flour is used resulting in differences in the amount of protein in SPAR.

A protein content of crude protein levels, because the protein content was determined using the Kjeldahl method and then converted by the conversion factor of 6.25 under the assumption that the nitrogen content in the protein is 16% [12].

D. Fat content

TABLE V
THE FAT CONTENT OF SPAR

Treatments (Cassava flour : carrot)	Fat Content (%)
A = (90% : 10%	0.55 a
B = (80% : 20%)	0.53 ab
C = (70% : 30%)	0.51 bc
D = (60% : 40%)	0.46 bc
E = (50% : 50%)	0.41 c
Coef Var = 16.27%	

Description: The numbers in the same column followed by the same small letter not the significant at 5%.

Fat is a non-polar ester compounds are not soluble in water, which is produced by plants and animals. Fats and oils have an important function in food processing [12]. Fat or lipid soluble properties in nonpolar solvents such as ethanol, chloroform and benzene [13]. The average fat content of SPAR can be seen in Table 5.

This is due to cassava flour and carrots contain low fat. The fat content ranged from 0.41 to 0.55%. Higher content of sweet potato flour also increase the fat content on SPAR. The fat content of cassava flour has a fat 0.5 g, while the carrot has a total fat content of 0.19 g [14].

E. Carbohydrates Content

Carbohydrates are the most important source of energy for human's life, because the molecule provides a carbon element that is ready for use by the cell. Chemically, carbohydrates can be defined as an aldehyde or ketone derivative of a polyhydric alcohol (because it contains more than one hydroxyl group), or a compound which produces the derivative when hydrolyzed [11].

TABLE VI
THE CARBOHYDRATE OF SPAR

Treatments (Cassava flour : carrot)	**Carbohydrate content (%)**
A = (90% : 10%)	87.43
B = (80% : 20%)	87.51
C = (70% : 30%)	87.09
D = (60% : 40%)	86.89
E = (50% : 50%)	86.59
Coef Var = 1.27%	

The results of carbohydrate in SPAR ranged from 87.51% to 86.59%. The highest carbohydrate contained in treatment B which ranges from 87.51% while the low carbohydrate in treatment E was 86.59%. Carbohydrate content in SPAR tends to decrease due to the reduction in the addition of cassava flour and the increasing addition of carrots.

Based on the analysis of variance at 5% significance level that can be seen in Table 7, showed that the addition of cassava flour and carrots were not significantly different on levels of carbohydrate to SPAR. The higher addition of the cassava flour, the higher levels of carbohydrates produce. This results based on the content of carbohydrate in cassava flour (88.2 g) higher than the carbohydrate content of carrots in the amount of 10.14 g.

F. Levels of crude fibre

The crude fibre content in a food can be used as an index of dietary fibre content, as commonly found in crude fibre as much as 0.2-0.5 part number dietary fibre [11].

The results of crude fibre content of the SPAR showed in Table 11 ranged from 16.21% until 18.74%. The highest fibre content contained in treatment E, this was due to the fibre content of carrots is quite high, around 3%. Low levels of crude fibre in the treatment of A because of the low fibre content of cassava flour than carrots, so the addition of carrots describe the fibre content in SPAR

TABLE VII
THE CRUDE FIBER CONTENT OF SPAR

Treatment (Cassava flour : carrot)	**Crude Fibre Content (%)**
A = (90% : 10%)	16.21
B = (80% : 20%)	17.54
C = (70% : 30%)	17.99
D = (60% : 40%)	18.54
E = (50% : 50%)	18.74
Coef Var = 18,49%	

Based on the analysis of variance with a 5% significance level that can be seen in Table 8, showed that the addition of cassava flour and carrots were not significantly different on the crude fibre content of SPAR.

G. Antioxidant Activity

Antioxidants are substances that can prevent the oxidation process. This substance is actually able to slow down or inhibit the oxidation of a substance that is easily oxidized even in low concentrations [15]. Analysis of antioxidant activity in SPAR using DPPH (1,1-diphenyl-2-picrylhydrazyl). The molecule of DPPH is characterized as stable free radical by virtue of the delocalization of the spare electron over the molecule as a whole, so that the molecules do not dimerize, as would be the case with most other free radicals [16].The average score of antioxidant in SPAR showed in Table 8.

TABLE VIII
THE ANTIOXIDANT ACTIVITY OF SPAR

Treatments (Cassava flour : carrot)	**Antioxidant activity (%)**
A = (90% : 10%)	19.79 a
B = (80% : 20%)	28.55 a
C = (70% : 30%)	32.71 ab
D = (60% : 40%)	43.64 bc
E = (50% : 50%)	48.97 c
Coef Var = 19.74%	

Description: The numbers in the same column followed by the same small letter not significant at the 5%

Results of analysis of variance at 5% significance can be seen in Table 8. Table 8 showed that the addition of cassava flour and carrots give real effect to SPAR. The antioxidant activity was analyse with a concentration of 100.000 ppm, The antioxidant activity of SPAR ranged from 19.79% to 48.97%, the lowest antioxidant activity contained in A treatment was 19.79%, while the highest antioxidant activity found in treatment E was 48.97%.

The highest antioxidant activity derived from the content of beta-carotene than carrots. Carrot consist of antioxidant compounds that contain carotene especially beta-carotene which serves as capture free radicals. Antioxidants can inhibit oxidation in two ways: either by scavenging free radicals, in which case the compounds are called primary antioxidants, or by a mechanism that does not involve direct scavenging of free radicals, in which case the compounds are called secondary antioxidants [17].

H. Total Polyphenols

The ability of phenolic compounds to act as antioxidants has been demonstrated in the literature. Some researchers have investigated the antioxidant activity of flavonoid compounds that contribute to their activity. The average of total polyphenols in SPAR showed in Table 9.

TABLE IX
THE TOTAL POLYPHENOLS IN SPAR

Treatments (Cassava flour : carrot)	**Total Polyphenol (%)**
A = (90% : 10%)	0.49
B = (80% : 20%)	0.52
C = (70% : 30%)	0.53
D = (60% : 40%)	0.53
E = (50% : 50%)	0.61
Coef Var = 13.04%	

The results of total polyphenols in SPAR showed in Table 9, the total polyphenol ranged from 0.49% to 0.61%. The polyphenols in analog rice come from sweet potato and carrots, which have contribution to antioxidant activity in SPAR. The present of the antioxidant activity correlated with the contents of total polyphenol. The potential antioxidant activity of polyphenols is believed to be mainly due to their redox properties, which play an important role in adsorbing and neutralizing free radicals. This indicate that polyphenols are important for exploitation in free radical scavenging activity.

I. Energy

The energy contained in the food is influenced by three kinds of nutrients, namely carbohydrates, proteins and fats and expressed in units of calories. Determination of energy on SPAR showed in Table 10.

TABLE X
DETERMINATION OF ENERGY OF SPAR

Treatments (Cassava flour : carrot)	**Energy (kkal)**
E = (50% : 50%)	3.58
D = (60% : 40%)	3.57
C = (70% : 30%)	3.47
B = (80% : 20%)	3.52
A = (90% : 10%)	3.53
Coef Var = 3.23%	

Description: The numbers in the same column followed by the same small letter not significant at the 5% significance level DNMRT.

The results of the energy of SPAR seen in Table 10, the energy value is calculated by using a bomb calorimeter, the principle is that the energy released in the combustion is converted into heat, resulting in a rise in temperature of the water that surrounds the combustion chamber. Energy of each treatment using a bomb calorimeter has almost the same amount 3.58 kcal-3.43kcal. The highest energy value contained in the commission of E which ranges 3.58kcal, while the lowest energy value in treatment C which ranges from 3.47%. The addition of carrot increase energy value obtained higher, since the carrots have calories 43kcal [14].

J. Beta Carotene

Beta-carotene is a group of pigments in vegetables and fruits are yellow, orange, red, fat soluble. The statistical results of the beta-carotene in SPAR significantly different at 5% level (Table 11).

TABLE XI
BETACAROTENE OF SPAR

Treatment (Cassava flour : carrot)	**Betakaroten (μg/100 ml)**
A = (90% : 10%)	2085.33 a
B = (80% : 20%)	2881.50 ab
C = (70% : 30%)	3196.00 ab
D = (60% : 40%)	4193.33 bc
E = (50% : 50%)	5017.83 c
Coef Var = 10,33%	

Description: The numbers in the same column followed by the same small letter not significant at the 5% significance level DNMRT

Analysis of beta-carotene of SPAR ranged from 2085.33 g / 100 ml to 5017.83 g / 100 ml. The lowest beta-carotene contained in A treatment which ranges 2088.33 g / 100 ml, whereas the highest beta-carotene found in treatment E is ranging 5017.83 g / 100 ml. The addition of carrots into SPAR increased the beta-carotene value and give specific colour to product.

IV. CONCLUSIONS

The results showed that the addition of cassava flour and carrots give significantly different results on fat content, antioxidant activity and beta-carotene, no significant difference in moisture content, ash content, protein content, crude fibre content, carbohydrates, total polyphenol, the determination of the value of energy and water absorption index. The results of treatment E obtained an average water content of 7.75%, 2.67% ash content, protein content of 2.56%, 0.41% fat, carbohydrate content of 86.59%, crude fiber content 18.74 %, 48.97% antioxidant activity, total polyphenols 0.61%, the determination of the energy value 3.58kcal, betacarotene 5017.83µg / 100ml and water absorption index 2.14ml / g sample.

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