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Food Diversification of Cassava as Non-Rice Based Functional Food in Lampung

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ABSTRACT

Cassava has been known to have low glycaemic index (GI) recommended for diabetics. Cassava can be used as alternative food source for substitution of rice as Indonesian staple food. The current study aimed to investigate phisycal and chemical properties of food diversification of cassava. Levels of dietary fibre were measured by enzymatic-gravimetric AOAC, while total sugar content was measured by Lane-Eynon titration. Determination of starch was observed by using spectrophotometer and energy analysis by bomb calorimetry. Level of glycaemic index (GI) was determined by EL, S.N. method. The sensory analysis was performed by preference test by using hedonic scale towards 20 panelists. Analysis of cost and benefit was used to investigate the economic feasibility of the products. Among several products of cassava, analog rice has the highest value of dietary fibre (4.72%), starch (75.64%) and energy level (349.38 cal/kg). In addition, it has the lowest value of total sugar content (1,19%) and GI (56). It is also the most preferable in terms of colour (4.35), aroma (3.90), taste (4.35) and general acceptance (4.05). Economically, analog rice provides the highest profit than instant tiwul and oyek, which are 1.66; 1.56 and 1.47 respectively.

Keywords: Cassava, Food diversification, Functional food

ABSTRAK

Singkong diketahui memiliki indeks glikemik (IG) rendah yang direkomendasikan untuk penderita diabetes dan dapat digunakan sebagai sumber pangan alternatif untuk substitusi beras sebagai makanan pokok Indonesia. Penelitian ini bertujuan untuk mengetahui sifat fisik dan kimia dari diversifikasi pangan ubi kayu. Tingkat serat makanan diukur dengan enzymatic-gravimetric AOAC, sedangkan kadar gula total diukur dengan titrasi Lane-Eynon. Penentuan pati diamati dengan menggunakan spektrofotometer dan analisis energi dengan kalorimetri bom. Tingkat indeks glikemik (IG) ditentukan oleh metode EL, S.N. Analisis sensori dilakukan dengan uji preferensi dengan menggunakan skala hedonik terhadap 20 panelis. Analisis biaya dan manfaat digunakan untuk mengetahui kelayakan ekonomi produk. Di antara beberapa produk ubi kayu, beras analog memiliki nilai serat makanan tertinggi (4,72%), pati (75,64%) dan tingkat energi (349,38 kal / kg). Selain itu, memiliki nilai total kandungan gula terendah (1,19%) dan IG (56). Beras analog juga yang paling disukai dalam hal warna (4,35), aroma (3,90), rasa (4,35) dan penerimaan umum (4,05). Secara ekonomi, beras analog memberikan keuntungan tertinggi (1,66) daripada tiwul instan (1,56) dan oyek (1,47).

Kata Kunci: Ubi kayu, Diverifikasi pangan, Pangan fungsional

INTRODUCTION

Functional food can be defined as diverse food or food components containing health properties. Functional foods are believed to have positive effects on promoting health, reducing the risk of certain disease and, in some cases, increasing the aesthetic value of final product. Recently, the growing interest of community towards functional food has increased in line with the increasing awareness of the importance of consuming safe and healthy food (Schmidt, 2000). Considering that Indonesia has the seventh largest number of people with diabetes mellitus (DM) in the world in 2013 with 8,5 million of cases of 154 million total adult population and the number will increase up to 11,8 million in 2030 in which 90-95% is type 2 (International Diabetes Federation, 2013). Generally, the DM type 2 is caused by the consumption of food containing high fat and sugar and low fibre causing obesity and the increasing of blood sugar level. Dietary treatment is important to control sugar level in the blood. Food with low glycaemic index could minimize medication and lessen the complications of DM. Indonesian are used to consume cassava as one of staple food other than rice. Cassava and its derivatives have low glycaemic index which are recommended for diabetics (Marsono, 2002).

During the time, Indonesian people rely on rice as daily staple food. Moreover, the consumption pattern of Indonesians is now being rice-dependent. The Central Bureau of Statistic have reported that the consumption of rice has reached 115.5 kg per capita per year and is rising more than 139 kg per capita per year. However, rice production rate in Indonesia is 0.20% per year which is lower than population growth rate, which is 1.65% per year (Mulyadi et al., 2015). Rice has a high contribution to calorie (55%) and protein (44%) consumption. The dependency of Indonesian on rice is considered unfavourable in term of food security (Irawan and Sutrisna, 2011). In order to improve food security, Indonesian Government has launched a food diversification program based on local food. The program encourages people to consume a broader food variety and nutrition regarding with balanced principles (Budijanto and Yuliana, 2015; Widyantiet al., 2014).

Cassava is one of Indonesian local food which is likely to be developed as an alternative source of calories and it has opportunity to replace rice as staple food. Moreover, cassava is popular in most area in Indonesia including Lampung Province. However, the utilization of cassava has not been optimal yet and is limited on snack and flour processing. Analog rice is artificial rice made from cassava flour and shaped like rice using granulator machine. Oyek is traditional rice made from cassava tuber. Generally, it has round shape and yellowish colour. Instant tiwul is made from dried cassava (*gaplek*) which is milled into flour then shaped by using traditional cooking tool called *tampah*. The round shaped tiwul is steamed and dried. The instant tiwul is ready to cook traditional rice. This study aimed to identify physical and chemical properties of cassava derivatives products such as analog rice, oyek, instant tiwul and their opportunity as functional food.

MATERIALS AND METHODS

The research was performed in Bandar Lampung and Lampung Timur Regency from May to August 2014. The material used were cassava cv. Kasetsart, collected from the farmer's field in Negara Ratu village, Lampung Selatan Regency, and water for irrigation.

Preparation of Instant Tiwul

The cassava was peeled and sliced into small pieces then soaked in the water over night. Then, sliced cassava was dried under the sun for four days, washed and dried again for two days under the sun. The dried cassava was milled into a flour as raw material of instant tiwul. The cassava flour was dipped in the water (27 °C) for 24 hour and pressed to minimize water content. Then the wet cassava flour was granulated with traditional tool called *tampah*. The granulated cassava flour was dried under the sun for about two hour, then it was steamed. The steamed cassava was dried to get the dry form of instant tiwul.

Preparation of Oyek

Firstly, the cassava was peeled and washed with fresh water, then soaked in the water for 3 days. In the fifth day, the water was changed every two hour. After getting soft, the cassava was pressed to minimize water content. The cassava was mashed by using *lumpang*. The mashed cassava was granulated by using *tampah*, then it was dried under the sun about an hour. The process was followed by steaming of cassava. The cassava was dried to get dry oyek.

Preparation of Cassava Analog Rice

The cassava was peeled and washed with fresh water then grated into smaller pieces. The grated cassava was dipped in the water for a night then drained and pressed to minimize water content.

The grated cassava was dried under the sun to get dry grated cassava. The dry grated cassava was milled into flour then 1 liter water was added per 1000 g flour to bind the flour. The mixture was granulated by using granulator machine. Analog rice processing requires a slope of 35° and a field speed of 28 RPM. In order to get the uniform size, the granulated cassava flour was sifted then dried under the sun about two hour, then it was steamed.

Analysis of Dietary Fibre, Sugar Content, Starch, Energy and GI

The dietary fibre was determined by using enzymatic-gravimetric AOAC (Association of Official Analytical Chemists) method which has been performed by Prosky et al. (1988). The Lane-Eynon titration method for determination of total sugar content in the products is based on method as described in AOAC (1990). Starch analysis was performed by using spectrophotometric determination based on procedures performed by Jarvis and Walker (1993). Energy analysis was determined by using bomb calorimetry as performed by Doyle et al. (2007). Analysis of glycaemic index was performed by using El method (1999) with 8 panelists who have to fast for 10 hours before blood sugar analysis.

Sensory Evaluation

Samples were served to 20 panelists consisting of 5 males and 15 females with age range from 30 to 60. The samples were evaluated using a preference test based on five-point hedonic scale (1 = dislike, 2 = slightly dislike, 3 = neither like nor dislike, 4 = slightly like, 5 = extremely like). Sensory parameters including colour, taste, aroma and overall acceptance were also measured based on Villavicencio et al. (2007) with slight modification. Data from hedonic test were analyzed using ANOVA single factor in order to determine any significant difference between those three types of food made from cassava.

Socioeconomic Evaluation

In order to determine economic feasibility, benefit analysis from those types of food was performed. Data were analized by using analysis of cost and benefit (∏) and R/C ratio which is given with the following relationship (Soekartawi, 1995):

$$\Pi = TR - TC$$

Where ∏ = benefit (IDR)
TR = total revenue (IDR)
TC = total cost (IDR)

$$\frac{R}{C} = \frac{TR}{TC}$$

Where R/C <1 = unprofitable,
R/C >1 = profitable.

RESULT AND DISCUSSION

Analysis of Dietary Fibre, Total Sugar, Starch and Energy

Table 1. Content of Dietary Fibre, Total Sugar, Starch and Energy of Food Made from Cassava

Type of food	Parameter of observation			
	Dietary fibre (%)	Total sugar (%)	Starch (%)	Energy (cal/g)
Analog rice	4.72	1.19	75.64	349.38
Instant tiwul	3.07	1.34	77.69	309.37
Oyek	3.12	1.81	77.12	346.66

The result showed that cassava analog rice has the highest dietary fibre and energy. On the other hand, it has the lowest starch content compared to instant tiwul and oyek. This indicates that cassava analog rice is more potential as non-rice based functional food compared to other cassava diversification. The main source of energy content in food material is starch. However, dietary fibre is composed by non-starch polysaccharides as the main component which could not be digested by digestion enzymes. Some of the dietary fibre components soluble to water are fermented by intestinal bacteria to produce substance which could be absorbed and metabolized into energy (Bender, 2003). Content of dietary fibre, total sugar, starch (DM) and energy of several food made from cassava are presented in Table 1.

High dietary fibre content of analog rice is caused by the short time of dipping which was about 8 hour and the process was not repeated. However, soluble dietary fibre of the analog rice is lower than other type of food analyzed. On the other hand, the cassava analog rice has the lowest starch content because the cassava was grated during the process resulting in a wider surface area and more starch dissolved in the water. In addition, total sugar content in the analog rice is lower than other types of food as the starch is composed by simple sugars.

Glycaemic Index Analysis

Table 2. The Value of Glycaemic Index of Foods Made from Cassava

Type of food	GI value
Analog rice	56
Instant tiwul	59
Oyek	63

The dominant physical properties of the dietary fibre are high water absorption and water solubility. These properties are in line with an instant nature in which the increasing of solubility and absorption is caused by the low carbohydrate and high hygroscopic reducing sugar (Auliana, 1999). The soluble fibre holds more water than insoluble fibre. These properties are not only determined by the solubility in the water, but also determined by the pH of the gastrointestinal tract and the size of fibre particles. Moreover, the fine fibre has higher hydration compared to the crude fibre (Tala, 2009). The GI of cassava analog rice, instant tiwul and oyek are presented in Table 2.

Table 3. Level of Preferences Toward Cassava Products

Type of food	Parameter of observation			
	Colour	Aroma	Taste	General acceptance
Analog rice	4.35 a	3.90 b	4.35 a	4.05 a
Instant tiwul	3.25 c	4.50 a	3.20 c	3.30 b
Oyek	3.60 b	3.75 b	3.75 b	3.55 b

Note: Numbers in the column with different letter indicate significant differences ($p < 0.05$) between samples based on ANOVA test at 5% level.

The result showed the lowest GI value was obtained in analog rice (56) compared to instant tiwul (59) and oyek (63) resulted from the difference of processing. A food material does not have a definite value of GI because the stucture and nutritive composition may change during processing. The same food materials might have different GI if they are processed in different ways (Foster-Powel et al., 2002; Ragnhild et al., 2004). According to Rimbawan and Siagian (2004), food processing influences the value of GI because it determines food digestibility and absorption. The higher food digestibility and food absorption, the faster the raise of the blood sugar level resulted in the high value of GI. The food processing influencing GI value includes flouring and cooking. The flouring results in the smaller size of food particles and wider surface area. As a result, the digestion and the absorption of carbohydrates run faster. While cooking can affect the GI because cooking causes starch gelatinization so that it is easier to be digested by enzyme in the colon and the blood sugar level may rise rapidly. Heating the starch with excess water results in starch gelatinization and structure changing. Reheating and cooling of gelatinized starch change the structure of starch leading to to the formation of new insoluble crystals when the cooked starch cools. Starch retrogradation changes the value of the GI (Halizaet al., 2006).

Food glycaemic index is a unique properties of food material which is influenced by type of material, processing and food material characteristic. Each component gives contribution and interaction to produce specific glycaemic response (Widowati, 2007; Indrasari et al., 2008). The recent study found that dietary fibre was inversely proportional with GI level. The analog rice has the highest dietary fibre (Table 1), on the other hand its GI level is the lowest (Table 2) compared to instant tiwul and oyek. This is in line with the study conducted by Trinidad et al. (2010) reporting that generally high dietary fibre leads to low GI. The dietary fibre may act as a physical resistor which slows the movement of food in digestive system and hampers enzyme activity. As a result, the digestion of starch runs slow and blood sugar becomes lower leading to the low GI level.

Rimbawan and Siagian (2004) have reported that based on the GI value, food is categorized into low GI (<55), middle GI (55-70) and high GI (>70). According to Wiardani et al. (2012), diabetics is recommended to choose the food with maximum GI of 70. However, it is not easy for Indonesian to replace rice which has high GI value as a staple food. Based on GI value of each product, the three types of cassava diversification are in the middle category with GI value about 56-63. The result of GI analysis showed that blood sugar level of eight panelists when consuming analog rice, instant tiwul and oyek is lower than when they consuming glucose. It was assumed that the cassava products may retard the increasing of blood sugar (glucose). The changes of blood sugar level are presented in Figure 1, Figure 2 and Figure 3.

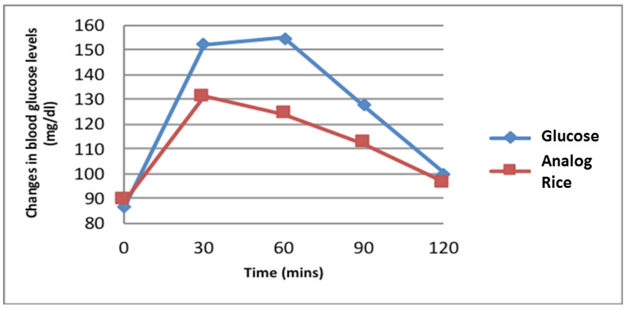

Figure 1. Blood Glucose Levels Changes of Panelists After Consuming Analog Rice

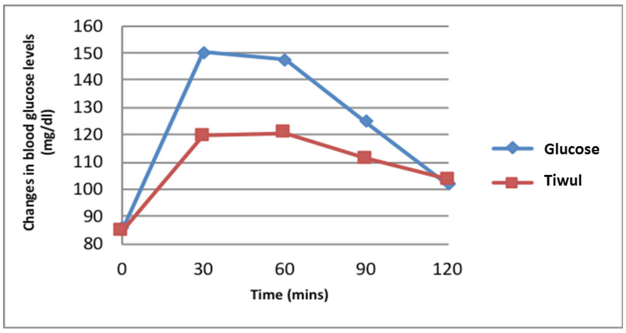

Figure 2. Blood Glucose Levels Changes of Panelists After Consuming Instant Tiwul

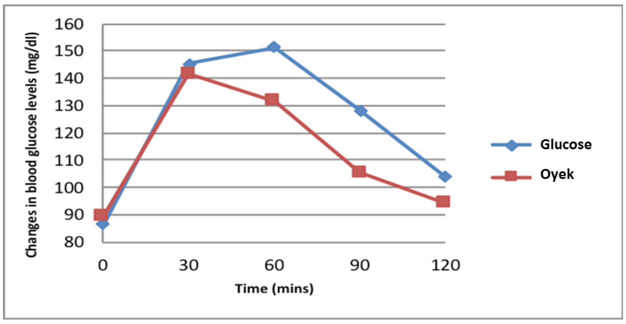

Figure 3. Blood Glucose Levels Changes of Panelists After Consuming Oyek

Sensory Evaluation

Table 3 showed the preference of panelists on the three types of food made from cassava. The analog rice was the most preferred compared to instant tiwul and oyek in terms of colour, taste and general acceptance. However, the instant tiwul has the most preferred aroma. According to the panelists, the taste of analog rice was almost the same as the flavor of rice and there was no aroma of cassava.

Sosioeconomic Analysis

Production of analog rice yield the greatest profit (R/C ratio 1.66) compared to instant tiwul (R/C ratio 1.50) and oyek (R/C ratio 1.47). The result shows that analog rice is the most potential to be developed in business scale. Table 4, Table 5 and Table 6 show the profit analysis of the cassava products.

Table 4. Profit Analysis of Analog Rice Production

No.	Materials	Volume	Unit	Unit price (IDR)	Total (IDR)
	Production cost				
1.	Cassava	117.5	kg	1,000	117,500
2.	Salt	0.5	kg	4,000	2,000
3.	Electricity cost	3	m	1,000	3,000
4.	Water	1	unit	6,000	6,000
5.	Gasoline	1	litre	8,000	8,000
6.	Diesel fuel	1	time	2,500	2,500
7.	LPG (3 kg)	2	unit	18,000	36,000
8.	Screen printing plastic	30	unit	500	15,000
9.	Labour cost	1	time	40,000	40,000
				Total cost production	230,000
	Production yield				
1.	Total production	29.3	kg	13,000	380,000
				Profit	150,000
				R/C ratio	1.66

Table 5. Profit Analysis of Instant Tiwul Production

No.	Materials	Volume	Unit	Unit price (IDR)	Total (IDR)
	Production cost				
1.	Cassava	109	kg	1,000	109,000
2.	Electricity cost	5	m	1,000	5,000
3.	LPG (3 kg)	1	unit	20,000	20,000
4.	Plastic bag	60	unit	100	6,000
5.	Labour cost				
	Peeling, chopping, washing	1	time	30,000	30,000
	Drying	1	time	20,000	20,000
	Flouring	40	kg	500	20,000
	Granulating	1	kali	20,000	20,000
				Total cost production	230,000
	Production yield				
1	Total production	30	kg	12,000	360,000
				Profit	120,000
				R/C ratio	1.56

CONCLUSIONS

The three food types of cassava diversification (analog rice, instant tiwul and oyek) are likely to be developed as functional food to subtitute rice. Based on the result of the study, the analog rice has the greatest nutrition than instant tiwul and oyek in term of the highest dietary fibre and energy and the lowest sugar content and GI. The analog rice is also the most preferred compared to other cassava products. Economically, the analog rice provides the highest profit compared to instant tiwul and oyek.

Table 6. Profit Analysis of Oyek Production

No.	Materials	Volume	Unit	Unit price (IDR)	Total (IDR)
	Production cost				
1.	Cassava	122	kg	1,000	122,000
2.	Electricity cost	10	m	1,000	10,000
3.	LPG (3 kg)	1	unit	20,000	20,000
4.	Plastic bag	60	unit	100	6,000
5.	Firewood	4	bunch	2,500	10,000
6.	Plastic bag	33	unit	100	3,300
7.	Labour cost				
	Peeling, chopping, washing	1	time	30,000	30,000
	Mashing	1	time	40,000	40,000
	Granulating	1	time	30,000	30,000
	Drying	1	time	20,000	20,000
				Total cost production	
	Production yield				
1	Total production	32.5	kg	12,000	390,000
				Profit	124,700
				R/C ratio	1.47

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