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BANANA AND PLANTAIN AS MEDICINAL FOOD

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INTRODUCTION

Indonesia is mega diversity country with 25.000-30.000 plant species has 6.000 species of medicinal plants [1]. One of potential plants to be explored as medicinal plants is banana. The plant family *Musaceae*, composed of bananas, plantains, and ornamental bananas, originally evolved in Southeast Asia and surrounding tropical and subtropical regions. More than 145 million tons of banana and plantain were produced worldwide in 2011 according to FAO estimates. Banana are grown in nearly 130 countries. In addition to fruit, bananas and plantains provide many cultures with medicines, beverages, fibers, edible floral parts, dyes, fuel, steam for cooking, cordage, wrapping materials, etc [2].

Bananas are among the world's leading food crops, after rice, wheat and maize. Banana is dessert fruit that its edible part is pulpy, firm to tender, free from seeds or pips, and has a characteristic flavour. Plantain is a cooking banana subgroup. Plantain resemble banana but are longer in length, have a thicker skin, and contain more starch. Most dessert banana cultivars in the world are AA or AAA, this last group includes almost all the cultivars sold to export market. Cooking bananas, often named plantains, are mostly AAB, ABB, or BBB [3,4].

Banana and plantain are important staple foods in many developing countries, especially in Indonesia. *Musa* are rich in vitamin C, B6, minerals, and dietary fiber. They are also a rich energy source, with carbohydrates accounting for 22% and 32% of fruit weight for banana and plantain, respectively. People annually consume 28 kg of banana and plantain per capita, or 155 kg per year, or almost half of 1 kg per day. Four African countries have the highest per capita consumption of banana/plantain in the world, with Uganda having the highest [2].

Recent knowledge diet may modulate various functions in the body and may play detrimental or beneficial roles in some diseases. Foods are expanding from emphasis on survival, hunger satisfaction, and preventing adverse effects to emphasizing the use of foods to promote a state of well-being and better health and to help reduce the risk of disease. The study investigated the beneficial/healthy effect of banana and plantain consuming.

NUTRITION VALUE OF BANANA AND PLANTAIN

Dessert bananas have become very popular in modern westernized diets and is basically a supplementary snack food. They are popular for their flavour, texture and convenience value, being easy to peel and eat. Bananas make a useful contribution to the vitamin A, C and B6 content of the diet, and are an important and immediate source of energy, often being eaten by sportspeople during competition. They are also cholesterol-free and high in fibre.

It is not a whole meal or even a major part of a meal; therefore it differs from plantains and cooking bananas which often fit into the latter category. However, dessert banana is a good source of energy, due to its high carbohydrate content (twice the value of apples and three times that of citrus). A medium-sized banana contains 280 kJ which is more than deciduous or citrus fruits. The energy and nutritional value of banana and plantains relative to other some staple foods is shown in Table 1.

Table 1. Energy and nutritional value of staple foods (bananas, plantain, rice, cassava, wheat, Date)

Nutrition value (g/100 g edible portion)	Staple Food					
	Banana[2]	Plantain[2]	Date[5]	Wheat[5]	Rice[5]	Cassava[5]
Energy (kJ/ 100 g)	368	556	580	1570	1610	559
Protein	1.1	1.1	1.8	10.6	73	1.0
Fat	0.2	0.4	1.0	1.9	2.2	0.2
Carbohydrate	22	31	36	71.1	61.6	31.9
Calcium	7	14	35	-	-	-
Phosporus	27	32	350	-	-	-
Iron	0.9	0.9	6.0	-	-	-
Vitamin A	0.03	0.20	0.01	-	-	-
Vitamin B (Thiamine)	0.04	0.05	0.07	-	-	-
Vitamin C	10	20	30	-	-	-
Ash	-	-	-	1.4	1.4	0.7

From this, it is evident that both banana and plantain are high-energy fruits which are similar to dates and cassava. Some plantain cultivars are especially rich in provitamin A carotenoids and are important in enhancing nutritional status, while preventing cancer and other human diseases [6].

Bananas and plantains are particularly high in K, having more than double the concentration in ripe pulp than most other tropical fruits. However, important differences exist between banana genotypes regarding Ca and Mg, with plantains having significantly lower levels than dessert bananas and cooking bananas. Differences in mineral concentrations (P, Mg and Ca) as well as carbohydrate concentration in fruit pulp are also influenced by location and duration of bunch growth. These differences may justify special labels to differentiate bananas from different places, which may provide an excellent market strategy to add value to bananas from a given origin [2].

There were nutrient values of four Indonesia banana cultivars i.e Berlin (AA), Ambon Hijau (AAA), Raja Bandung (ABB) and Kepok (ABB) (Table 2). Berlin and Ambon Hijau varieties are banana, while Raja Bandung and Kepok varieties are plantain [6].

Table 2. Nutrient values of four Indonesia banana cultivars in 100 gram edible portion [6]

Parameter	Berlin (AA)	Ambon Hijau (AAA)	Raja Bandung (ABB)	Kepok (ABB)	Average
Water (%)	80.94	72.94	66.49	62.01	70.6
Ash (g)	0.79	0.78	0.82	0.89	0.82
Carbohydrates (g	16.72	24.33	31.13	35.24	26.86
Protein (g)	1.48	1,92	1.51	1.78	1.67
Fat (g)	0.07	0.03	0.05	0.08	0.06
Total Sugar (g)	12.12	15.91	20.82	17.03	16.47
Vitamin C (mg)	25.54	19.10	16.45	30.27	22.84
Potassium (mg	375	275	350	365	341.25
Energy (cal)	73.43	105.27	131.01	148.8	114.63

The nutrient values of four Indonesian banana cultivars in 100 g of edible portion contained high carbohydrates, total sugar, potassium and vitamin C; moderate protein, low fat and high calories. Due to its high nutrient values, bananas are nutritious food recommended for people at all ages, especially for baby, also diet food for adults but consumption must be limited for diabetic and kidney problem patients.

MODIFIED PLANTAIN FLOUR

Plantain agung semeru var (*Musa paradisiaca* formatypica) was used for this study. The fully mature but unripe banana fruits were obtained from Central Supply in Lumajang Regency, which were harvested at 120 days after flowering. Modified plantain flour was prepared by peeling the fruits, and slicing into 5 mm, immediately rinsed in sterile distilled water (750 g/L), then incubated at room temperature for 24 h. The slices were drained and pressure-cooked (autoclave) at 121°C for 15 min. The mixture was cooled at room temperature and stored at 4°C for 24 h. Autoclaving-cooling process were repeated and then the sample was dried at 50°C in a convection oven for 8 h and ground into 80 mesh. Native plantain flour was prepared by peeling the fruits, cutting into 5 mm, drying at 50°C in a convection oven for 8 h, grinding to pass 80 mesh [7]. The modified and native plantain flour were analyzed for chemical composition including moisture, ash, protein, fat and carbohydrate content [8]. Rapidly digestible starch (RDS), slowly digestible starch (SDS) and resistant starch (RS) content were determined according to Englyst *et al*. (1992)[9].

Chemical composition

Chemical composition of native and modified plantain flour are presented in Table 3. The moisture content of the modified banana flour was slightly higher compared with the native plantain flour. There were no difference (P<0.05) in fat and protein content of the flour, but there was difference (P<0.05) in ash and carbohydrate content. The carbohydrate content decreased from 88.75 ± 0.06 g/100g to 85.66 ± 0.03 g/100g of flour.

Table 3. Chemical composition of native and modified plantain flour [7]

Chemical Composition (%)	Plantain Flour			
	Unripe	Spontaneous Fermentation	Autoclaving-cooling	Spontaneous Fermentation & Autoclaving-cooling
Water[1]	5.03 ± 0.05^{d}	7.79 ± 0.03^{b}	6.72 ± 0.02^{c}	9.74 ± 0.03^{a}
Ash [2]	2.21 ± 0.05^{a}	1.77 ± 0.01^{c}	1.84 ± 0.04^{b}	1.67 ± 0.01^{d}
Fat [2]	1.02 ± 0.03^{a}	1.09 ± 0.03^{a}	1.07 ± 0.06^{a}	1.07 ± 0.04^{a}
Protein[2]	1.99 ± 0.03^{a}	1.89 ± 0.04^{a}	2.04 ± 0.06^{a}	1.86 ± 0.04^{a}
Carbohydrate[2]	88.75± 0.06^{a}	37.47 ± .030^{c}	38.32 ± 0.05^{b}	85.66 ± 0.03^{d}
Starch[2]	70.16 ± 0.12^{a}	59.79 ± 0.14^{b}	7.12 ± 0.86^{d}	67.67 ± 0.52^{c}
Amylose[3]	13.56 ± 0.05^{d}	15.44 ± 0.01^{b}	14.52 ± 0.01^{c}	16.54 ± 0.53^{a}
RDS[3]	38.15 ± 0.05^{a}	32.64 ± 0.16^{b}	21.53 ± 0.07^{c}	18.26 ± 0.33^{d}
SDS[3]	24.66± 0.01^{b}	32.80 ± 0.35^{a}	9.42 ± 0.14^{c}	18.39 ± 0.12^{d}
RS[3]	10.48 ± .06^{c}	6.24± 0.73^{d}	8.97 ± 0.32^{b}	45.83 ± 0.96^{a}

[1] wet basis, [2] dry basis, [3] dry basis based on starch
Values followed by the same letter in the same row are not significantly different ($P < 0.05$)

The results demonstrated that during 24 h of spontaneous fermentation the amylose content was increase and the starch content was decrease. Amylose content increased from 13.56 ± 0.05 g/100g of starch (unripe plantain flour) to 16.54 ± 0.53 g/100g of starch (modified plantain flour). During fermentation debranching of amylopectin might occur and amylose with lower degree of polymerization (DP) was formed. The linear fragments of starch (amylose) can contributed to starch retrogradation and decreased the enzymatic susceptibility of starch [10].

RDS and SDS were calculated from the in vitro starch digestion at 30 and 120 min of enzymatic incubation respectively [9]. The RDS was higher for the unripe/native plantain flour and significantly lower for all modified plantain flour. But the SDS was higher on fermented banana flour. The result showed that spontaneous fermentation can reduce RDS but not for SDS.

Fermented-retrogradated banana flour had the highest amount of RS than the others. Modification two cycles of autoclaving-cooling process could be able to increase the RS content significantly. RS content of unripe plantain flour (RS2) was 10.48 ± 0.06 g/100g of flour, while RS content of modified plantain flour (RS3) was 45.83 ± 0.96 g/100g of flour [11].

RS3 was formed by heating and cooling while RS2 was unstable and destroyed. Autoclaving-cooling process can destroy the starch granular crystalline structure so decreased RS2 content. A high content of resistant starch was detected in the native plantain flour (30.4%), but the value decreased drastically after boiling the banana flour (3.6%) [11]. The combination of debranching by using pullulanase with autoclaving processes (121 °C for 30 min) followed by cooling process (4°C for 24 h) can increase RS content of plantain starch up to six times [10].

Glycemic index

Glycemic index of native and modified plantain flour are presented in Figure 1. Medium GI were showed by native and fermented plantain flour. Unripe banana flour is a starchy food that contains a high proportion of indigestible compounds such as resistant starch and non-starch polysaccharides, included in the dietary fiber content so the flour has medium GI [12]. Saguilan *et al.* (2007) reported that cookies prepared from resistant starch-rich powder of plantain starch showed moderate available starch and slow release carbohydrate features.

Both of modified plantain flour, retrogradated and the combination, had low glycemic index than native or fermented plantain flour. The GI reduced from medium (66) to low GI (46-52). This could be due to the fact that two cycles of autoclaving-cooling process could have caused reducing of digestible starch and increasing RS content, thus making it resistant for amylase digestion and release of glucose into the bloodstream.

Unripe banana flour is a starchy food that contains a high proportion of indigestible compounds such as resistant starch and non-starch polysaccharides [7], included in the dietary fiber content [12]. This confirms the research that storing rice in the refrigerator (4°C for 24h) led to a reduction of the estimated glycemic index for all cultivars [13].

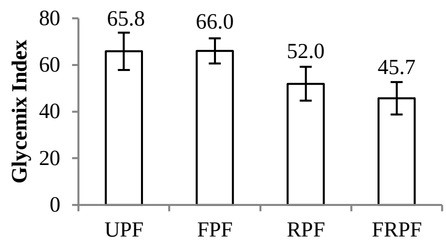

Fig 1. Glycemic index of unripe plantain flour (UPF), fermented plantain flour (FPF), retrogradated plantain flour (RPF) and fermented-retrogradated plantain flour (FRPF)

The reasons for differing GI values of the same type of foods may be due to different processing methods, different testing methods of GI, different testing methods used for determining the digestible carbohydrate content of the test foods and inherent botanical differences. In the other product showed that roasting decreased the GI of plantain meal from 65 to 57 [15], and frying process reduced GI into low GI on the sweet potatoes [16].

HEALTHY EFFECT OF BANANA AND PLANTAIN CONSUMING

Unripe bananas, or preferably plantains, can be sliced thinly and fried in vegetable oil to produce savoury chips. AAB plantain types, AAB cooking bananas are preferred for chips product [17]. Ripe banana is often restricted (the portion is limited) prescribed for diet of diabetic patients due to the high content of carbohydrates and sugars. Yet, uripe bananas (steamed /boiled) contain low glycemic index is acceptable alternative meal for diabetic patients [11].

Banana puree is important as infant food and can be successfully canned by the addition of ascorbic acid to prevent discoloration. Banana flour, both from green and ripe fruit, enriched with sugar, powdered milk, minerals and vitamins, is widely used in baby foods. Banana essence, extracted from ripe fruit, is a clear, colourless liquid which has an agreeable, concentrated aroma and is used in desserts, juices and drinks. Other processed products of banana, which are not so important commercially, are: (i) powder (cf. flour) made from grinding dried ripe fruit; (ii) juice extracted from ripe pulp with enzymes; (iii) jams made from cooked ripe pulp; (iv) flakes, which are dried, thin ripe slices; and (v) alcoholic beverages (liqueur).

Dessert bananas have therapeutic values in many special diets [2]:

- Ripe mashed banana is an excellent food for babies due to easy digestibility and the mineral and

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vitamin content. It is also very good for sports people.

● For elderly people, the fruit can be consumed in large quantities without being fattening or causing digestive disturbances.

● Banana is low in sodium, contains very little fat and no cholesterol, therefore it is useful in managing patients with high blood pressure and heart disease.

● Bananas are free from substances that give rise to uric acid. Therefore they are ideal for patients with gout or arthritis.

● Due to low sodium and protein content, banana is used in special diets for kidney disease sufferers.

● Banana can neutralize free hydrochloric acid, suggesting its use in peptic ulcer therapy. A fully ripe banana mixed with milk powder is especially recommended for ulcer patients.

● For patients with gastritis and gastro-enteritis, banana is one of the first foods to be introduced after nausea and vomiting are brought under control.

● The low lipid/high palatability combination is ideal for the diet of obese people.

● Ripe banana chip can stimulate the probiotic growth in the colon resulted short chain fatty acids especially butyric acid as colonic anticancer (Nurhayati *et al*., 2014).

CONCLUSION

Ripe bananas (banana and plantain) are nutritious food recommended for people at all ages, especially for baby. Consumption of ripe bananas must be limited for diabetic and kidney problem patients. Modified bananas flour by two cycles of autoclaving-cooling (retrogradation) processes can be recommended for use in the diet of low GI like diabetic patients. Further research can be developed to evaluate the marketable banana food products as medicinal food.

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REFERENCES

1. Kardono, L.B.S., Artanti, N., Dewiyanti, I.D., Basuki, T., Padmawinata, K. *Selected Indonesian Medicinal Plants*. Monographs and Descriptions. PT. Gramedia Widiasarana Indonesia. Jakarta (2003)
2. Robinson, J.C., Sauco, V.G., Bananas and Plantain. 2nd Edition. Series: Crop production science in horticulture ; 19. CAB International (2010).
3. Aurore, G., Parfait, B., Fahrasmane, L. Bananas, raw materials for making processed food products. Trends in Food Sci & Tech. **20,** 78-91 (2009)
4. Ploetz, R.C., Kepler, A.K., Daniells, J., Nelson, S.C. Banana and plantain—an overview with emphasis on Pacific island cultivars. Species Profiles for Pacific Island Agroforestry www.traditionaltree.org. (2007)
5. FAO Corporate Document Repository. Food and Agriculture Organization of the United Nations. Available at: http://faostat.fao.org (accessed 2 August 2016).
6. Lia Hapsari, L., Lestari, D.A. Fruit characteristic and nutrient values of four indonesian banana cultivars (*Musa* spp.) At different genomic groups. AGRIVITA Journal of Agricultural Science, 38 (3), 303-311 (2016).
7. Nurhayati, N., Jenie, B.S.L., Widowati, S., Kusumaningrum, H.D. Chemical composition and crystalinity of modified banana flour by spontaneous fermentation and autoclaving-cooling cycles. *J Agritech*. 34 (2) (2014).
8. Association of Official Analytical Chemist (AOAC). *Official Methods of Analysis*. Washington, DC. (1996).
9. Englyst H.N., Kingman S.M., Cummings J.H. Classification and measurement of nutritionally important starch fractions. *Eur J Clin Nutr* 46:S33–S50 (1992).
10. Soto, R.A.G., Acevedo, E.A., Feria, J.S., Villalobos, R.R., Bello-Perez, L.A. Resistant starch made from banana starch by autoclaving and debranching. *J Starch/Stärke,* 56, 495–499 (2004).
11. Nurhayati, N., Jenie, B.S.L., Widowati, S., Kusumaningrum, H.D. Low glycemic index plantain flour as functional foods. Proceeding. International Food Conference. Life Improvement through Food Technology. 2011.
12. Juarez-Garcia, E., Agama-Acevedo, E., Sayago-Ayerdi, S. G., Rodriguez-Ambriz, S. L., Bello-Perez, L. A. (2006). Composition, digestibility and application in breadmaking of banana flour. *J Plant Food for Human Nutrition*, 61, 131–137.
13. Frei, M., Siddhuraju, P., Becker, K. Studies on the in vitro starch digestibility and the glycemic index of six different indigenous rice cultivars from the Philippines. *J Food Chem*. 83, 395–402 (2003).
14. Foster-Powell, K., Holt, S.H.A., Brand-Miller, J.C., International table of glycemic index and glycemic load values. *American J Clin Ass*. 76, 5–56 (2002).
15. Ayodele, O.H., Erema, V.G. Glycemic indices of processed unripe plantain (*Musa paradisiaca*) meals. *African J Food Sci*. 4 (8), 514 – 521 (2010).
16. Astawan, M., Widowati, S. Evaluation of nutrition and glycemic index of sweet potatoes

ISBN 978-602-60569-3-1

and its appropriate processing to hypoglycemic foods. *Indonesian J Agr Sci*. 12 (1) (2011).
17. INIBAP (International Network for the Improvement of Banana and Plantain). Adding Value to Bananas: the Results of a Study and Workshop on the Contribution of Musa Processing Businesses to Rural Development. Progress report to the Rockefeller Foundation. INIBAP, Montpellier, France. (2006).