

Glycemic Index of Snack Bar from Pedada Fruit Flours (*Sonneratia caseolaris*) and Legumes Flour

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Abstract—Snack bar is a snack in the form of bars made from cereals or nuts, has a high protein content which is usually consumed on the sidelines of meals. Pedada fruit is one of the mangrove fruits that contain high dietary fiber, while the legumes a good source of protein, and it also contains carbohydrates, vitamins and minerals. This study aims to determine the characteristics of snack bar from pedada fruit flour and legumes flour on glycemic index. This study used a completely randomized one-factor design, that is formula of snack bar from pedada fruit flour and legumes flour (green mung beans, kidney beans, soybeans, and peanuts) in proportion (10:90), by three replication. Measurement of glycemic index was carried out in vivo with 20 male Wistar rats, blood glucose were taken for 120 minutes with an interval of 30 minutes. The results showed that the best produced snack bar was obtained the formula on pedada fruit flour : peanuts flour (10:90) with characteristics 5.88% of moisture, 3.22% of ash, 18.81% of protein, 21.99% of fat, 51.64% of carbohydrate, 2.79% of crude fiber, 481.77 cal / 100 g of total calories, 40.8% of glycemic index and 5.86 of glycemic load.

Keywords—Snack bar; pedada fruit flour; legumes flour; glycemic index

I. INTRODUCTION

In recent years, fast food and snack consumption have been increased by times which reflect the population lifestyle changed. Most consumers prefer to pick over frozen food and product that readily use in the market rather than cooked by themselves. Among these products, the one that predominate was snack, especially a snack bar, which kind of ready to eat food contains rich nutrient to improve healthy and abate hunger [1], [2]. Snack bar with a low glycemic index is recommended product that can be eat by diabetics to regulate their diet. Previous research have been mentioned about mixed couple plant such pedada 20% with taro starch 80% to produce biscuit which had 48.83 of glycemic index and 7.39 of glycemic load [3].

Mangrove fruit comes from tropical coast such as pedada (*Sonneratia caseolaris*) has a high dietary fiber, 53.90% of insoluble dietary fiber and 9.80% soluble dietary fiber, so it can be used substitution in snack bar products [4]. Aside from mangrove fruit, couple legume like mung beans (*Vigna radiata*), kidney bean (*Phaseolus vulgaris*), soybean (*Glycine max*), and peanut (*Arachis hypogaea L.*) can be substitute for snack bar production because their essential nutrient containing inside. Mung bean has a green small-ovoid in

shape legume (green gram or golden gram) which consist rich vitamin A, B1, B2, niacin, vitamin C, potassium, phosphorus, alcium and 24% protein [5,6]. Kidney bean known has high protein, vitamin, minerals and relatively high in crude fibre, so it could improving nutritional product in the fortification or enrichment of cereal – based diets [7]. Soybean has high nutritional quality also, especially protein and amino acids [8]. Peanut has many active compound (tocopherols, flavonoids, phytosterol, resveratrol), high protein, and oil digestibility [9]. Among those all advantages of the legumes, it is possible to produce a snack bar with a low glycemic index that can be consumed by diabetics or to regulate diet.

Glycemic index known as response of the blood glucose that affected by level of food consuming and it measured as area under the curve (AUC), while glycemic load is a product of GI and quantity of carbohydrate eaten, indicates availability of glucose for energy or storage following a carbohydrate containing meal. GI and GL can used to estimate human meals and habitual diets [10].

Hence, the main purpose of this study was to determine the best formulation by mixing pedada fruit flour and legumes flour (green mung beans, kidney beans, soybeans, and peanuts) for diabetics and human diet.

II. MATERIAL AND METHODS

A. Snack Bar Formulation

Pedada fruit gotten from mangrove farmers in the Wonorejo village Surabaya The flour of Pedada were proceed by Jariyah [10]. Legums flour (green mung beans, kidney beans, soybeans, and peanuts) were purchased from Yogyakarta home industry. Ingredients for made snack bar were purchased from local market Surabaya. Snack bar was made by mix all material using mixer, then flattened by roller and formed to be snak bar shape. The mixture stored in the oven at 180°C, 15 minutes. The proximate analysis (moisture, protein, fat, ash, and carbohydrate by difference, yielded). Its were also analyzed of crude fibre, calorie, glycemic index, and glycemic load of the snack bar [11]. Snack bar formulated using 10% pedada fruit flour mix with 80% legumes flour as seen below :

- A: Pedada fruit flour : green mung bean flour
- B: Pedada fruit flour : kidney bean flour
- C: Pedada fruit flour : soybean flour
- D: Pedada fruit flour : peanut flour

B. Glycemic Index Measurement

Glycemic index measurement was conducted using 20 Wistar rats (2-3 month old, 140-160 gram weight). Rats were acclimatized along 1 week and fed. They fasted about 8-12 hours then.

The rats divided into 5 groups, each consist of 4 rats and fed with different snack bar formulation (A, B, C, D), while the other one fed with glucose standard solution. After each rats have been eaten the snack bar, blood sample taken from their tail every 30 minutes along 120 minutes was tested for glycemic index and glycemic load.

Rats blood sample taken by glucose test equipment merck Easy Touch GCU. Glycemic value testing calculated by area under the curve (AUC) in response to a test food consumed and glucose standard solution.

III. RESULTS AND DISCUSSION

A. Proximate of Snack bar

The result shows there was reducing snack bar size that can be caused by water evaporation during roasting. Table I shows that snack bar B formulation has the highest yield (76.54%) and moisture (8.12%) compared to other formulations. The higher water content in raw material, the higher moisture could be in product. Pedada fruit flour has quite high moisture, while kidney bean flour has high in protein content. Protein is binding to water (hydrophilic), so that the water that is bound to the material is less along with more kidney bean flour is added to the snack bar. Belitz and Grosh [12] said that proteins have polar groups such as carbonyl, hydroxyl, amino, carboxyl which are able to absorb water so the material hydration increased.

TABLE I. PROXIMATE ANALYSIS OF SNACK BAR FORMULATION

Formulation	Proximate Analysis (%)					
	Yielded	Moisture	Ash	Protein	Fat	Carbohydrate by difference
A	76.52 ^b	7.93 ^b	3.43 ^b	18.82 ^b	20.40 ^d	53.56 ^b
B	76.54 ^a	8.12 ^a	3.29 ^c	16.59 ^d	20.59 ^c	54.06 ^a
C	74.29 ^d	7.19 ^c	3.95 ^a	19.36 ^a	20.65 ^b	51.23 ^d
D	74.86 ^c	5.88 ^d	3.22 ^d	17.35 ^c	21.94 ^a	52.19 ^c

Snack bar formulation C which made from soybean flour had the highest ash value compared to the other formulations. According to Omoba and Omogbemile [13], the ash content of soybean flour caused by higher source of minerals, namely Ca, Fe, Cu, Mg, and Na. The higher ash in snack bar product come from much mineral containing in the raw material [14]. Besides, the ash in pedada fruit flour also quite high about 6.69%, so it could increase the level of snack bar ash also [4].

Not only the ash, formulation C had highest protein content (19.36%) compared to other formulations, because soybean flour has higher protein content (21.55%) between the other materials so it could improve snack bar products. Furthermore, pedada fruit flour also has higher protein content (6.21%) that could increase the protein value in snack bar. The comparison ratio of ingredients play an important role that could affect the protein content of the product, because the

more protein-rich raw materials were added, the protein content of the product would be increased.

In fat analysis, formulation D had the highest fat about 21.94% compared to the other formulations that caused by the fat component in the raw material of peanut was 22.88% so fat content in snack bar was increased.

The carbohydrate by difference, which strongly influenced by the levels of other nutrients, reflect the reduction of 100% moisture, ash, fat, and protein [12]. Table I shows that formulation B had the highest value (54.06%) among the others, that could come from kidney bean which had 68.45% and it would be able to satisfy the emergency food requirements, which was 40-50% carbohydrate.

B. Crude Fiber

Crude fiber could affect the digestibility of a food. The higher of crude fiber, the food will be difficult to digest so it reduces glucose absorption.

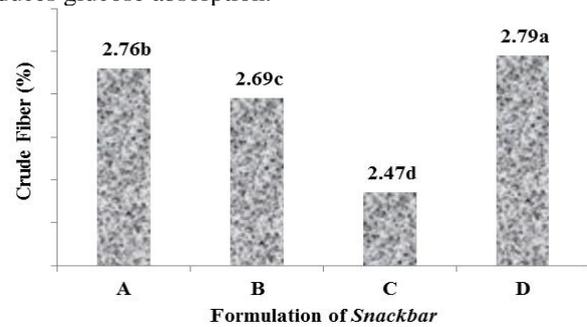


Fig. 1. Crude fiber of snack bar formulation

Figure 1 showed that the lowest crude fiber content of snack bar was formulation D (2.79%). So that the presence of crude fiber in solid food comes from the content of crude fiber found in raw materials. The level of crude fiber in a food product can be used as a food fiber content index. Because generally the amount of food fiber is 3-4 times the amount of crude fiber.

C. Calories

Calories was calculated empirically by multiplying energy from protein, fat, and carbohydrates from snack bar. Energy values indicate the number of calories that can be produced per 100 g of food.

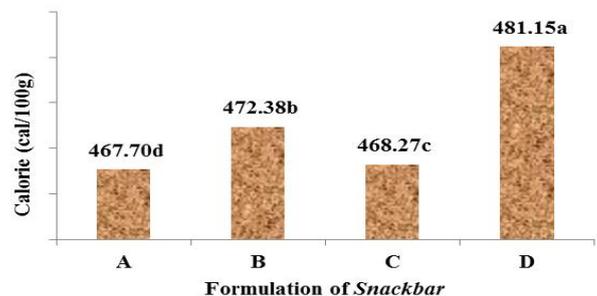


Fig. 2. Calorie of snack bar formulation

Figure 2 showed that highest calories come from formula D snack bar which energy value was 481.15 cal / 100g. This value has fulfilled the requirements of snack bar energy values

that are implied in SNI, which is 400 kg / 100 g. Belizt and Grosch [12] state that energy is the amount of energy stored in food that has been determined per unit volume or mass, fat stores 9 calories / gram, carbohydrates and proteins each store 4 calories/gram.

D. Glycemic Index

Snack bar given to each rat was 0.2 gram which equivalent to 0.15 gram carbohydrate containing in based on glycemic index test result. The magnitude of glycemic index was calculated by comparing the area under the test food curve which standart food (glucose) as a control and four snack bar formulation by using different ratio between pedada fruit flour and legumes flour. Glycemic index average value from different formulation can be seen in Table II.

TABLE 2. GLYCEMIC INDEX OF SNACK BAR

Formulation	Glycemic Index	Clasification
A	47.45	Low
B	44.24	Low
C	42.67	Low
D	40.86	Low

*IG classification: low (<55); Medium (55-70); High (>70)

Based on Table II, glycemic index average of the snack bar were 40.86 to 47.45. The lowest glycemic index was come from formulation D, about 40.86. High fat content on a food tend to lower gastric emptying rate, thus causing slower food digestion in the human intestine. Meanwhile, high protein content in food expected to stimulate insulin secretion which maintain blood glucose level. Based on fat analysis result of the snack bar, formulation D also had highest fat content as mentioned before. Fat content in the food will slowly leave gastric, thus causing satiety. However, fatty foods must be consumed wisely. Total fat consumption should not surpass within 30% of total energy while total saturated fat should not surpass 10% of total energy. Protein content in formulation D had also high which affect glucose absorption [15]. Foods that have high fat and protein content tend to lower GI which compared to another similar foods [16,17]. Crude fiber in formulation D had highest value compared to the other, that tend to lower glycemic index result testing. Crude fiber increase food mixture volume in digestive tract, thus slower enzyme catalization and lower digestive process which decrease blood glucose respond.

E. Glycemic Load

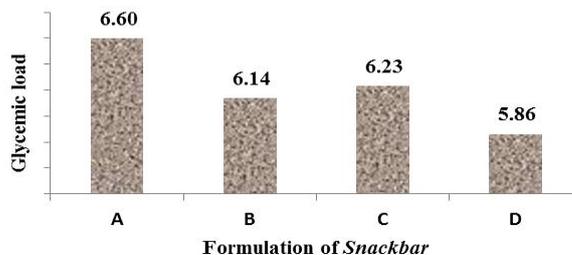


Fig. 3. Glycemic load of snack bar formulation

The lower glycemic index affect glycemic load value. Glycemic load aims to evaluate the impact of carbohydrate consumption by taking into account GI food. The lower glycemic levels the lower blood glucose levels increasing. Based on figure 3, formulation D has the lowest glycemic load than the other snack bar. According to Eleazu [18], if the category of glycemic load was more than 20, it categorized as high, 10-19 for the medium glycemic load and less than 10 for low glycemic load. All the formulation had low glycemic index category.

IV. CONCLUSION

There was a different value of four kind of snack bar formulations using fruit pedada flour and legumes flour in yield, moisture, ash, protein, fat, carbohydrate by difference and crude fiber. The best snack bar formulation was obtained from formulation D which had characteristics 74.86% of yield, 17.35% of protein, 21.94% of fat, 2.79% of crude fiber, 481.15 cal/100 g of calories, lowest glycemic index (40.8) and glycemic load (5.86).

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