



Cornfood bar (*Zea mays* L) and Gorocho banana (*M. Accincanafe*) as alternative foods interlude people with type 2 diabetes mellitus

Food bar jagung (zea mays l) dan pisang Gorocho (M. Accincanafe) sebagai alternatif makanan selingan penderita diabetes melitus

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Abstract

The World Health Organization (WHO) reported an increase in type 2 diabetes cases in Indonesia, from 8,4% in 2000 to 21,3 in 2030. Functional food innovation to prevent diabetes in the form of corn and Gorocho banana-based food bars needs to be performed. This study aimed to determine preference and nutritional value in a preliminary study of food innovation. This research method used a one-variable completely randomized experimental design (CRD), three treatments; ratio of corn and gorocho banana; F-1 (90:10), F-2 (80:20), and F-3 (70:30). The preference test was conducted in the organoleptic laboratory of the Nutrition Department of Gorontalo Health Polytechnic using 30 semi-trained panelists to obtain the most preferred formula based on the ranking test presented in averages and analyzed using the Friedman test followed by the Wilcoxon post-hoc test. The nutritional value of the food bars was tested at the Gadjah Mada University Food Laboratory from May to June 2020. Results of preference level for corn-based food bars (*zea mays* l) and gorocho banana-based food bars (*M. Accuminafe*) sequentially F-1 (90:10) with a mean of 3,40, nutritional value of 4,76% fat, 7,28% protein, 66,21% carbohydrates, and 1,28% crude fiber. In conclusion, F-1 was selected as a food source for people with diabetes mellitus.

Keywords: *Food bar*, corn, gorocho banana, diabetes mellitus

Abstrak

Organisasi Kesehatan Dunia (WHO) melaporkan peningkatan kasus diabetes tipe 2 di Indonesia dari 8,4% di tahun 2000 menjadi 21,3 di tahun 2030. Inovasi pangan fungsional sebagai pencegahan diabetes melitus berupa food bar berbasis jagung dan pisang gorocho perlu dilakukan. Tujuan penelitian ini untuk mengetahui tingkat kesukaan dan analisis nilai gizi sebagai studi pendahuluan inovasi pangan tersebut. Metode penelitian ini menggunakan rancangan percobaan acak lengkap (RAL) satu variabel, dengan tiga perlakuan yaitu ratio jagung dan pisang gorocho yaitu F-1 (90:10), F-2 (80:20), dan F-3 (70:30). Uji tingkat kesukaan dilaksanakan di laboratorium organoleptik Jurusan Gizi Politeknik Kementerian Kesehatan Gorontalo menggunakan panelis semi terlatih berjumlah 30 orang untuk mendapatkan formula yang paling disukai berdasarkan uji rangking yang disajikan dalam bentuk rerata dan dianalisis dengan uji friedman dilanjutkan dengan uji *post-hoc* wilcoxon. Nilai gizi food bar di uji di laboratorium pangan Universitas Gadjah Mada pada bulan Mei-Juni 2020. Hasil Tingkat kesukaan *Food Bar* berbasis jagung (*zea mays* l) dan pisang gorocho (*M. Accuminafe*) yaitu F-1 (90:10) dengan nilai rerata 3,40 dengan kandungan nilai gizi lemak 4,76%, protein 7,28%, Karbohidrat 66,21% dan serat kasar 1,28%. Simpulan F-1 merupakan food bar terpilih sebagai snack bagi penderita diabetes mellitus.

Kata Kunci: *Food bar*, jagung, pisang gorocho, diabetes melitus

Introduction

Diabetes mellitus (DM) is characterized by elevated blood glucose levels due to genetic susceptibility, which causes impaired beta cell function in insulin production (Ruze et al., 2023). The WHO Health Organization predicts an increase in the number of patients with type 2 DM in the coming year. The World Health Organization WHO predicts that the number of type 2 DM patients in Indonesia from 8,4 million in 2000 to approximately 21,3 million by 2030. In 2018, Basic Health Research (Riskesmas) showed an increase in the prevalence of DM to 8,5% (Riskesmas, 2018) (Soelistijo, 2021). Obesity is a cause of insulin resistance is obesity. Environmental factors, genetics, aging, intestinal microbiota, and diet are risk factors that are directly or indirectly related to the likelihood of obesity (Ahmed et al., 2021). Therefore, it is necessary to maintain a healthy diet, which is supported by the Indonesian people's penchant for consuming snacks that are high in fat and low in fiber, such as various fried snacks. The consumption of fried foods leads to several diseases and obesity. Data from the 2018 Basic Health Research show that 41,7% of Indonesians aged over 2 years consume fatty and cholesterol-laden fried foods more than once every day, with females being the most common (Riskesmas, 2018). If continuously consumed, it can affect the health of the body. However, people who are increasingly aware of and concerned about body health have begun to choose healthy foods that contain dietary fiber. Therefore, the selection of the right food is an important component in determining a healthy quality of life (Kasim et al., 2017). *Food bars* are solid food products composed of a mixture of various dry ingredients, such as cereals, nuts, and dried fruits, combined with *binders*. This food bar is a product that is designed as a snack (Carella, 2016).

This interlude food, in the form of *bars*, was chosen because of its ease of consumption. The raw materials chosen were local food sources in the community (Antonia 2019). Existing snack bar products include banana bars as snacks for toddlers, snack bars based on banana flour and mung beans as emergency food, and snack bars based on rice flour and corn flour as high-fiber snacks (Andriani et al., 2018; Sarifudin et al., 2021; Mahendradatta et al.,

2020). Corn (*Zea Mays L*), based on its chemical composition and nutritional content, has a dietary fiber content (especially soluble fiber) that can lower cholesterol levels in the blood plasma through increased excretion of bile acids into feces, resulting in an increase in the conversion of cholesterol into bile acids in the liver. In addition, dietary fiber binds cholesterol and is secreted into feces to reduce cholesterol absorption in the intestines (Hadi et al., 2018). Gorocho banana (*M. Accuminate*) is a banana that is well known to the Gorontalo people. Currently, gorocho bananas are consumed in processed forms such as gorocho sticks, boiled gorocho, and fried bananas. Gorocho banana contains phenolic phytochemicals, which act as antioxidants. The Gorocho banana acetone extract had the highest total content of phenolic compounds and condensed tannins compared with the methanol and ethanol extracts. Gorocho banana fruit has potential as an antidote to free radicals. The resistant starch content of gorocho banana was 19,13 to 20,53 percent depending on the drying temperature (Lasale et al., 2022).

Interlude food is recommended at 10–15% of the need and can be consumed 2–3 times a day. Choosing the right interlude food for people with diabetes mellitus is an important component in determining healthy quality of life. Therefore, an alternative product derived from local foodstuffs, which is formulated in the form of a food bar as an intermediate food for people with diabetes mellitus, is needed (Rahmawati, 2018). The importance of adding nutritional value information on food labels and the level of consumer acceptance so that it is necessary to conduct research related to the test of the level of acceptance and nutritional value of innovative food bar products made from corn and Gorocho banana.

Methods

This study used a one-variable completely randomized experimental design (CRD), with three treatments, namely the ratio of corn to Gorocho banana, namely F-1 (90:10), F-2 (80:20), and F-3 (70:30), which were repeated three times. This study was conducted from May to June 2020. The level of preference test was performed in the organoleptic laboratory of the Nutrition Department of the Gorontalo Ministry

of Health Polytechnic using 30 semi-trained panelists to obtain the most preferred formula based on the ranking test presented in the form of an average.

The favorability test was assessed by asking panelists to fill out a food bar test form. Panelists were selected in advance with the characteristics of being in good health, not having allergies to food bar ingredients, and willing to sign an informed consent form. The panelists' preference test form used a hedonic scale, with scores of 1 (strongly dislike), 2 (dislike), 3 (like), 4 (like), and 4 (strongly like) (Libor et al., 2016).

The procedure for presenting the product level of preference is that three food bar products are taken with one piece served cold. Each food bar is assigned a random set code that is unknown to the panelists. Then, a food bar and mineral water were simultaneously provided to the panelists. The panelists were asked to assess color, aroma, taste, and density according to their distributed forms. The favorability test results were ranked to obtain the best formula. The food bar nutritional value test was conducted at the Food Laboratory of Gadjah Mada University (UGM). The methods used (moisture content, ash content, and crude fiber) were AOAC 2005, protein Kjeldahl method, Fat Soxhlet method, carbohydrate method carbohydrate by difference, energy bomb calorie method, vitamin A, C, E spectrophotometric method, and vitamin A, C, and E spectrophotometric methods. Data analysis was performed using the Friedman statistical test to determine the ranking of the means, and the Wilcoxon test to determine the difference between the two formulas and presented in the form of averages and standard deviations, graphs, and tables. This research was approved by the Ethics Commission of Poltekkes Kemenkes Gorontalo, based on Ethical Clearance No. LB.01.01/KEPK/44/2020.

The main raw materials used in this study were corn and Goroho bananas. The tools needed to make cookies in this study were a cabinet dryer (Getra, Indonesia), grinder, 80 mesh sieve, baking pan, knife, spoon, scale and gloves, stainless steel basin, spatula, and food scale. The required ingredients include corn flour, Goroho banana flour, margarine, and honey. The process of making Corn flour and Goroho banana flour were prepared in the

culinary laboratory of the Department of Nutrition, Polytechnic of the Ministry of Health, Gorontalo. The stage of making Corn flour was prepared by soaking the corn kernels for two hours. After drying under sunlight for 2 h, the corn kernels were ground and sifted using a 60-mesh sieve. The flour was then dried again for 1 h. In the process of making Goroho banana flour, the banana was peeled, sliced thinly using a knife, dried using sunlight for 2 h, and then dried again using a cabinet dryer for 6 h. The temperature was maintained at 60°C. They were then ground and sieved using an 80 mesh sieve. The process of preparing food bars involves mixing all ingredients of corn flour and Goroho banana flour, margarine, and honey. It was then placed in a pan and compacted until the texture became solid. The samples were baked in an oven at 150 °C for 25 min. then cooled, then cut with a length of 6 cm, width of 1,5 cm, and thickness of 1,5 cm. The food bar formulation is shown in Table 1 and the research flow is shown in Figure 1.

Table 1. Food bar formulation

Ingredient	Weight		
	F-1	F-2	F3
Corn Flour (gram)	90	80	70
Goroho banana flour (gram)	10	20	30
Margarine (ml)	20	20	20
Honey (ml)	30	30	30

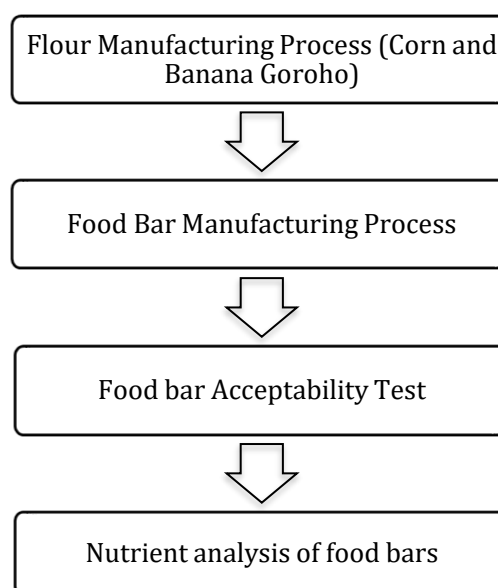
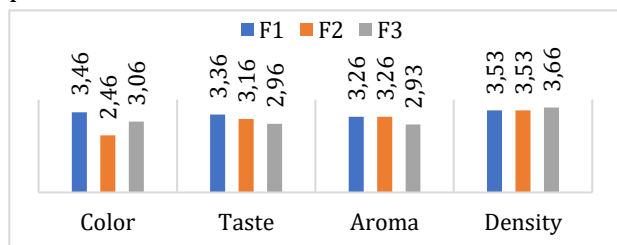


Figure 1. Research flow

Result and Discussion

Results of the study obtained for the acceptability test in terms of color, taste, aroma, and density of corn and banana Gorooho food bars with three treatments on 30 semi-trained panelists.



Grafic 1. Analysis color, taste, aroma and density snack bar

Acceptability of corn food bars (*Zea Mays L*) and Gorooho bananas (*M. Acuminata*) obtained the highest value/ranking between F-1, F2, and F3, namely in the F-1 Food bar product (corn flour (*Zea Mays L*) 90 g and Gorooho banana flour (*Musa Acuminata, sp*) 10 g) with a value of 3,40, and the lowest value in F-2 (corn meal (*Zea Mays L*) 80 g and Gorooho banana flour (*Musa Acuminata, sp*) 20 g) with a value of 3,10. The overall favorability level was the parameter that the panelists assessed against the overall combination of the previous parameters, namely, color, taste, aroma, and density.

Table 2. favorite level of F-1, F-2 and F-3 food bars

Formula	Mean Favorability Level				Mean	Rank	P Value*
	Color	Taste	Aroma	Density			
F-1	3,46	3,36	3,26	3,53	3,40	1	0,000
F-2	2,46	3,16	3,26	3,53	3,10	3	
F-3	3,06	2,96	2,93	3,66	3,15	2	

*Friedman Test (significant $p < 0,05$)

Table 3. Wilcoxon post-hoc test 2 food bar formulas

Test Statistics			
P value	F2 – F1	F3 – F1	F3 – F2
Color	0,000	0,032	0,000
Taste	0,211	0,041	0,273
Aroma	0,928	0,064	0,176
Density	1,000	0,317	0,248

*Wilcoxon Test (significant $p < 0,05$)

The table 2 shows that the overall *food bar* product preferred by the panelists is formula one (F-1) with a ratio of cornmeal (*Zea Mays L*) 90 gr and gorooho banana flour (*Musa Acuminata, sp*) 10 gr. Formula one (F-1) had a brown color with a distinctive corn aroma, and the texture of the *food bar* was soft and sweet. Food bars were selected after hedonic quality tests (favorability), and their nutritional content was analyzed. Based on the results of the liking level test by the panelists, which included the color, taste, aroma, and density of three formulas (F-1, F-2, and F-3) Gorooho banana flour *food bar* (*Musa Acuminata, sp*) to which corn flour was added (*Zea Mays L*), the selected result was formula 1 (90:10) Color is very influential on appetite. Food color is formed by pigments, oxidation reactions, maillard reactions,

caramelization reactions, and the addition of dyes. The color produced by corn food bars and Gorooho bananas is affected by the caramelization reaction of honey (Lisda Juniarsy Rahardjo et al., 2019). At high temperatures, a reaction known as the Maillard reaction occurs between reducing sugars and amino acids. Melanoidin is a brown polymer generated via the Maillard process (Suniati & Purnomo, 2019).

The color that the panelists liked was produced using more corn flour when making food bars. This is in line with research conducted by Ramadhani et al. (2021). White gorooho banana (*Musa acuminata Colla*) fruit extract has a Maillard reaction inhibitor and is used as a suitable alternative food for diabetes mellitus. Acetone, ethanol, and methanol extracts have Maillard reaction inhibitory activities of 5.49, 3.18, and 2.96%, respectively (Tampa'i, 2019). Compounds that cause taste sensations (sweet, bitter, sour, and salty) and trigeminal (astringent, cold, and hot) after eating are called taste compounds. Taste compounds can affect the body's senses through the tongue (Tarwendah, 2017). Taste is a crucial factor in determining consumer willingness to accept or reject food products. Despite other parameters being deemed acceptable, if the taste is not to

your liking, the food or product in question will be rejected (Ramadhani et al., 2021). The addition of honey and margarine gives a sweet taste to the food bar, but the ratio of corn flour to Goroho banana flour also affects the taste of the food bar. Starch contained in flour causes a special flavor in food because of its texture, which is in line with previous research (Widiantara, 2018).

Aroma is closely related to the sense of smell, an aroma that is said to be good if there is a combination of ingredients that are very appropriate. The distinctive aroma of corn is caused by the presence of volatile components that are exposed to heat and evaporates, which can be smelled by the sense of smell (Kusumastuty et al., 2015). The addition of a strong aroma resulting from margarine with volatile fatty acids, as well as the baking process resulting in the evaporation of moisture content. Panelists preferred the aroma of F-1 and F-2 with the addition of 10-20% goroho banana flour. The densities of the three food bar formulas were almost the same, but the density of F-3 was preferred by panelists compared to F-2 and F-1. In addition to being influenced by the addition of 30% Goroho banana, the density of the food bar is influenced by the way the mixture is compacted in the baking pan (Amanda et al., 2021). The nutritional content of food bars is an important component of the selected products. The nutritional value of food bar Formula 1 is shown in Table 4.

Table 4. Nutritional value of food bar F-1 (90:10) in 100 grams with 2 repetitions

Tests Performed	Mean±SD
Fat (g)	4,76±0,01
Protein (g)	7,28±0,01
Carbohydrate (g)	66,21±1,09
Crude Fiber (g)	1,28±0,01
Vitamin A (µg/100g)	1663,1±11,25
Vitamin C (mg/100g)	24,36±4,92
Vitamin E (mg/100g)	147,5±0,08
Energy (calorie/g)	366,8±1,8033
Moisture (%)	20,4±0,31
Ash (%)	1,34±0,04

SD= standard deviations

Table 4 shows that F-1 food bars are suitable for people with Diabetes Mellitus Where

F-1 has fiber and Vitamin C values. A and E, which were sufficient to meet the needs of these micronutrients. This is because the main ingredient of F-1 (90:10) is cornstarch, where the nutritional content of corn has a dietary fiber content (especially soluble fiber). The crude fiber content in Goroho banana flour was 0,79±0,01 mg/100 g. In addition to crude fiber, it also contains high antioxidants such as total phenols of 97,42±0,59 mg/100 g, total tannins of 159,70±2,83 mg/100 g and total flavonoids of 1,34 + 0,07 mg/100 g (Suniasi & Purnomo, 2019). Dietary fiber that dissolves in warm or hot water and precipitates when combined with the four parts of ethanol is known as soluble fiber (SDF). Gum, pectin, and a small amount of soluble hemicellulose present in plant cell walls are sources of SDF (Sukainah et al., 2023). SDF has physiological effects, such as delaying gastric emptying, improving glycemic control, lowering blood sugar spikes and LDL cholesterol levels, promoting healthy gut bacteria, boosting immunity, increasing satiety, and promoting weight loss (Saboo et al., 2022). In individuals with diabetes mellitus, higher fiber consumption is associated with better insulin sensitivity, mild inflammation, and good glycemic control (Abutair et al., 2016).

Protein is a nutrient in food that is essential to a healthy body. Proteins serve as a fuel for the body and help to form and regulate new cells. The protein content of banana flour and moca-based food bars was lower than the protein of corn flour and goroho banana flour food bars at 4,22 g (Fertiasari et al., 2023). The protein content of corn and banana Goroho food bars was 7,28 g lower than that of sweet potato flour and corn snack bars by 9,3%, and the low protein content was caused by the source of ingredients used, which was not milk or eggs (Rahmawati, 2018). Consumers may perceive protein bars as convenient, healthy, or nutrient-rich, but they may not perceive protein bars as energy-dense. Consumers should consider consuming protein bars as a meal or snack replacement based on the bar's calorie density (Pang et al., 2023). Calorie restriction and high-protein diet improve gut microbiota in obesity. Fiber consumption of 25-30 grams per day and 0,8 grams/kilogram of body weight (Dong et al., 2020). High-protein foods, which have larger portion sizes, lower caloric density, and higher

digestive viscosity (either solid or semisolid), empty the stomach and control hedonic hunger. High-fat foods, on the other hand, increase satiety responses (Rakha et al., n.d.).

The carbohydrate content of the food bars was 66,21%, which is supported by the nutritional content of corn and banana goroho, which are sources of carbohydrates. This is in line with the results of previous research on food bar bran flour and corn flour, which have a carbohydrate content of 70,5% (Kusumastuty et al., 2015). The content and structure of carbohydrates cause significant diversity in satiety responses. Other factors that affect hunger include food type, timing, frequency, palatability, portion size, and psychological factors (Rakha et al., n.d.).

The moisture content of the food bar was 20,4%, which was higher than the water content of corn-based snack bars, arreas sprouts, and kecipir bean sprouts (2,77%) because of the raw materials used, where the ingredients were not processed into semi-finished materials into flour and in the food bar roasting process, which is relatively less time than the baking time of the snack bar (Nasir & Harijono, 2018). The moisture content of banana flour and mocaf-based food bars was similar to that of corn flour and Goroho banana flour food bars at 19,23% (Fertiasari et al., 2023).

The ash level varied between 0,26 and 0,44%. Yellow corn flour had the highest ash concentration, measuring at 0,44%. The maize flour produced still met the SNI quality standards, with an ash percentage of no more than 1,5 (% w/b) (Augustyn et al., 2019). The variation in the addition of tapioca flour and Goroho banana flour was in the range of 1,43%-2,23% while the ash content of white Goroho banana flour was 2,29%. In this study, the ash content of the food bars based on corn flour and Goroho banana flour was 1,34%. The ash content was determined to determine the amount of minerals present in the food bar. The mineral content in question was in the form of calcium, potassium, sodium, zinc, and other minerals. The following minerals are typically found in maize kernels: magnesium (0,17%), sodium (0,01%), calcium (0,03%), phosphorus (0,32%), potassium (0,35%), and sulfur (0,12%) (Lalujan et al. 2017).

Lifestyle changes seem to be an important cause of problems in people with DM; this will continue to increase if people do not change their lifestyle to consume sweet, low-fiber, and

high-fat foods. The levels of crude fiber and vitamins A, C, and E in the food bar indicate that the food bar has all the nutritional values needed for micronutrient needs. The limitations of this study include the lack of analysis of the mineral, antioxidant, resistant starch, and prebiotic food bar contents, as well as the failure to intervene in healthy subjects or individuals with diabetes mellitus.

Conclusion

Food bar innovation as a preliminary study as a diabetic snack food selected based on the level of preference of 30 semi-trained panelists was F-1 (90 g of corn flour and 10 g of banana flour) and nutritional value of 4,76 g, protein 7,28 g, carbohydrates 66,21 g, vitamin A 1663,1 µg/100 g, vitamin C 24,36 mg/100 g, vitamin E 147,5 mg/100 g, and crude fiber 1,28.

Further research is needed to examine the effects of food bars with high acidity and low fat content on cholesterol profiles and other metabolic disorders that may be used as a functional snack to prevent obesity or diabetes mellitus. It would be better for researchers to test the nutritional analysis of all formulas so that they can compare each food bar.

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