Development of arrowroot flour and taro flour snack bar with banana bud flour supplementation as snack for diabetes patient

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Abstract. Banana bud flour contains high fiber while arrowroot flour and taro flour have low glycemic index. The snack bar from these ingredients was developed for diabetic patients to reduce patient’s hunger and avoid the worsen of patient’s condition. The study used Randomized Group Design (RGD) consisted of 2 factors, namely: the proportion of arrowroot flour: taro flour powder (w/w), 70:30 (P1); 60:40 (P2) and banana bud flour supplementation of 10 (T1); 20 (T2); and 30% (T3) of total flour, resulting in 6 combinations with 4 times replicates. Chemical variables were analyzed using F test and followed by Duncan's Multiple Range Test 5%, while sensory variables were analyzed by Friedman test and continued with 5% Dual Appeal. The best treatment was analyzed using Effectiveness Index. The chosen food bar from 6 treatments was P2T1 (60% arrowroot flour and 40% taro flour with 10% banana bud supplementation) which contributed 2922.6 kcal, water content 25.2% ww, ash content 1.388% ww, fat content 2.83% ww, carbohydrates 58.1%; and total food fiber 14.3%; color 3.5 (light brown); texture 2.6 (less broken); aroma 2.3 (less direct); taste 2.6 (less sweet); and favorite 2.7 (less like). However, organoleptically it is still less preferred.

1. Introduction

Instant food has become a lifestyle which can lead to a degenerative disease. Unhealthy behaviors such as smoking, alcoholic beverages, unhealthy and unbalanced dietary pattern such as consuming high-fat and low-fiber food can even worsen the condition of the disease [1]. One of the degenerative diseases is diabetes. Diabetes is a degenerative disease which known by high level of sugar in blood, diabetic patient often felt hungry because the cell doesn’t get energy [2].

There are several ways to reduce hunger, such as by eating high-fiber snacks. High-fiber foods that have the potential as many types of snacks such as broccoli, oatmeal, asparagus, and banana bud. The banana bud has many health benefits, especially for those who want to run a diet program, because the banana bud contains high fiber and only a little fat and low in protein [3]. Other than the banana bud, there are other foods that are good for diabetes, namely arrowroot and taro. Both tubers are good because of the low glycemic index. The glycemic index in taro is 14.6 while arrowroot tuber has a glycemic index of 32. Both of these ingredients are low according to Waspadji [4] which states that the glycemic index value is categorized into three groups: low GI food with IG value <55, food Moderate GI with a range of IG values of 55-70, and high GI food with a range of IG values >70. A
high glycemic index tends to be possessed by foods that have a high content of fat and energy but are low in vitamins and fiber so that they are absorbed more quickly by the small intestine which results in increased blood sugar quickly [5].

To make it easier for consumers to consume the heart of bananas, taro and arrowroot and extend their shelf life, these ingredients can be used as flour which can later be processed into snacks in the form of snack bars. Therefore, this study was conducted to develop snack bar which can be another way for diabetic patients to have healthier snacks.

2. Methods
The study used Randomized Group Design (RGD) with 2 factors, namely: the proportion of arrowroot flour: taro flour powder (P, w/w), 70:30 (P1); 60:40 (P2) and banana bud flour supplementation (T) of 10 (T1); 20 (T2); and 30% (T3) of total flour. There were 6 treatment combinations repeated 4 times to obtain 24 experimental units. The chemical variables were analyzed using F test (95%) and followed by Duncan's Multiple Range Test (DMRT) 5%, while the sensory variables were analyzed by Friedman test and continued with the 5% Dual Appeal. The best treatment was analyzed using the Effectiveness Index

2.1. Sample preparation
This study was conducted in the Food Service Laboratory, Jenderal Soedirman University in Purwokerto. The banana bud was obtained from Pasar Manis and processed to make banana bud flour. Since there are no studies have previously reported, preliminary studies were carried out to establish basic processing methods prior to commencing the main study. To make banana bud flour the banana which has been cleaned, soaked in water with 3% salt for an hour. This method used for maintaining the color of banana bud and clean the sap out of banana bud. After being soaked and clean, banana bud has 2 treatment, first treatment was dried under the sunlight for 12 hours until dry and the other one the banana bud was hot water blanching for 30 minutes before dried under the sunlight. Both of dried banana bud crushed and sifted at 60mesh strainers. The results of the preliminary study indicate that hot water blanching caused a rapid browning giving a dark black color to the final product.

Taro flour was made manually using the same thing with banana bud flour. Taro which has been cleaned and cut thing, were soaked with sodium metabisulfite 0,1% for 20 hours. After taro was soaked, it was cleaned and steamed for 30 minutes and dried for 7 hours with oven at 80 ºC. After dried the taro crushed and sifted at 80 mesh strainers.

2.2. Snack bar processing
For processing snack bar, every proportion of arrowroot and taro (P1, P2) and every supplementation of banana bud flour (T1,T2,T3) was mixed with 20% of egg, 6% of diabetic sugar, 15% of skim milk, and 14% of margarine. All of the mixtures were formed as bar and baked on 140ºC for 25 minutes.

2.3. Determination of nutritional content
Snack bar samples were analyzed for proximate content (protein, fat, ash, carbohydrate, moisture, and total dietary fiber). Moisture content was estimated by gravimetric measurement of weight loss after drying in an oven at 105ºC until constant weight was obtained. Protein was determined by Kjeldahl method, and there after a conversion factor of 6.25 was used to calculate the total nitrogen to crude protein. Crude fat was analyzed by the Soxhlet extraction method. The content of ash was measured by gravimetric measurement of the sample in the furnace at 550ºC until the constant weight was achieved. Total dietary fiber was determined by using sulphuric acid solution (1.25%) and sodium hydroxide solution (1.25%) [3]. Calculation of carbohydrate levels is done by difference, namely by reducing 100% with other known nutritional components (moisture, ash, fat, and protein) in a wet base [6].
2.4. Determination sensory test
The criteria tested in the organoleptic test included taste, texture, color, flavor and individual preference. Hedonic test was used in this study to determine the value based on intensity and individual preference. Sensory assessment was carried out by 50 panelists. Each panelist provided an assessment according to the numerical scale that has been determined by filling in the questionnaire for the sensory test [7].

3. Results and discussions

3.1. Determination of nutrition content
The results of the analysis of the various effects of the treatments can be seen in Table 1.

| Chemical Variables | Treatments |
|--------------------|------------|
|                    | P          | T          | P×T         |
| Moisture           | **         | **         | **          |
| Ash                | ns         | **         | *           |
| Protein            | **         | *          | *           |
| Fat                | *          | **         | **          |
| Carbohydrate       | **         | **         | ns          |
| Total dietary fiber| ns         | *          | ns          |

** = very significant; * = significant; ns = not significant

The result of chemical analysis found that at proportion of arrowroot flour and taro flour (P) the treatment which has a very significant effect are the moisture, protein, and carbohydrate while fat has significant effect and the ash as well as dietary fiber has no significant effect. For optimal supplementation treatment of banana bud flour (T) which has a very significant effect that moisture, ash, fat, and carbohydrate and protein and fiber significantly. For the combination treatment (P×T) that has a very significant effect of moisture and fat content for the real impact that ash and protein content while dietary fiber and carbohydrate does not show the significant effect.

The best treatment combination was the P2T1 which has 60:40 arrowroot flour and taro flour also supplemented by banana bud flour 10%. The nutrition content can be seen in Table 2.

| Chemical Variables | P2T1 |
|--------------------|------|
| Moisture           | 25.2 |
| Ash                | 1.388|
| Protein            | 2.94 |
| Fat                | 6.6  |
| Carbohydrate       | 58.1 |
| Dietary fiber      | 14.34|

The moisture content of the best snack bar is high. According to USDA, maximum moisture content of a snack is 25.2%. The banana bud also play role on this moisture content since banana bud flour has a very high starch content of 70% of that amount about 25% is amylose and the rest are amyllopectin. This high content of amyllopectin causes the banana bud flour can absorb more water and the high content of amyllopectin causes the banana bud flour do not harden quickly after cooking.

The ash content of the snack bar is high, the high ash content of the food bar was also due to the high ash content of banana bud flour which reached 1.3-1.9%. The result of this study almost the same with research conducted by Elavenia and Jayamuthungai [8] which states that the ash content of
banana heart flour is 3.5%. The ash content of banana bud flour is caused by high minerals; the higher supplementation, the higher the ash content of the food bar.

In this study, there was an increase in protein levels for each increase in banana bud flour supplementation. This is because the protein content of the banana's heart is quite high at 9.1%, this value is higher than the protein in wheat flour. Weigle et al. [9] in a study related to obesity states that high enough protein intake can reduce weight by increasing satiety. Therefore, food bar is suitable for patients with type 2 diabetes who have obesity.

Food bar fat content according to the Indonesian National Standard (SNI) 01-4216-1996 is 1.4-14, thus the supplementation of banana bud flour meets the quality requirements of SNI 1996 food bar. The fat value increases due to the use of eggs as a source main fat in the product [8]. Banana bud flour did not have a big effect on increasing fat content. This is in line with the research of Krishnan and Sinija [10] that the fat content of banana bud flour is lower than other flour, which is 0.43-0.54grams.

The results of the analysis showed that the treatment of banana bud flour supplementation significantly affected the levels of food bar carbohydrates (p> 0.05). Carbohydrate levels are influenced by other nutritional components, the lower the composition of other nutrients, the higher carbohydrate levels [11]. Almatsier [12] mentions that excessive carbohydrate intake can cause an energy imbalance resulting in obesity which can progress to type 2 diabetes.

Food bar with the highest fiber content found in P2T1 product which had a value of 14.34%. A high fiber value is caused by high supplementation of banana bud flour. This is in line with Sheng's [13] study which states that banana bud flour has a higher fiber content of 4.96-20% compared to other vegetables, therefore the banana bud can be consumed as a daily source of fiber. Similar results can be seen in previous studies conducted by Mamuja and Aida [14] which stated that the fiber content contained in abon made from banana bud was 17.8%. There was a slight difference in fiber values obtained between the present study and previous research due to differences between the raw material used.

3.2. Result sensory test

The results of the test of the effect of combination between the treatment of proportion of arrowroot flour × taro flour with supplementation of banana bud flour (P×T) can be seen in Table 3.

| Sensory Variable         | Treatment P×T |
|--------------------------|---------------|
| Color                    | **            |
| Texture                  | **            |
| Taste                    | **            |
| Flavors                  | **            |
| Individual preference    | **            |

** = very significant

Color, texture, taste, flavors, and individual preference were affected by combination of treatments. Snack bar with best treatment have a tendency to be darker compared to other food bar. This is because the banana bud flour used for supplementation has a dark color that affects the final results of food bar. The appearance of brown in food bar is also influenced by the heating temperature which results in the occurrence of non-enzymatic reactions called maillard reaction. Maillard reaction is a reaction between carbohydrates and proteins, especially in the hydroxyl groups of sugar in carbohydrates and amine groups in proteins [15]. According to the panelist, snack bar with best treatment was not crisp enough which caused by the water content. The texture of the food bar itself, one of which is determined by the water content, the greater the water content evaporated at the time of roasting will form a cavity that makes the product crisper, whereas the less water vaporized, the product is less crisp [16].
Taste of snack bar with best treatment is a little sweet due to the addition of low-calorie sugar and the addition of skim milk. Sugar provides of sweetness and color formation. Sweetness usually comes from non-ionic substances such as sugar, aldehydes, nitrogen bonds, some aliphatic chlorides (chloroform) and benzoic sulfides (saccharine).

The high acceptance of panelists at food bar that have supplementation of 10%. Increasing the banana bud supplementation reduced the panelists' acceptability. Banana bud flour has a slightly bitter taste tendency which comes from tannin content of 88.31 mg/100g banana bud, which has a bitter taste [17]. The flavors of snack bar are a little bit off flavors which caused by the lipoxygenase enzyme that can trigger fat oxidation which results the peroxide compounds. Banana bud flour also causes a change in the aroma of the food bar [18]. Banana bud flour has a slightly burnt aroma due to the drying process [19]. Panelist individual preference showed products with a proportion of 60% arrowroot flour; 40% taro flour with 10% banana bud flour supplementation with a value of 2.7 (less like). This includes the overall acceptance assessed by panelists, namely taste, texture, aroma, and color.

4. Conclusion
The best food bar product with organoleptic preferred by panelists was P2T1 (proportion of arrowroot flour: taro flour 60%: 40% with banana bud flour supplementation by 10%). Food bar P2T1 contributes water content 32.63% ww; ash content 1.69% ww; 4.6% fat ww; 2.94% protein ww; carbohydrates by difference 52.75% ww; and food fiber 17.74% per 100g, which some of them can fulfil the daily dietary recommendation.

References
[1] Casey ARN and Benson HMD 2012 Reducing Blood Pressure (Jakarta: PT. Bhuana Ilmu Populer)
[2] Riset Kesehatan Dasar (Riskesdas) 2013 Badan Penelitian dan Pengembangan Kesehatan Kementerian RI tahun 2013 Accessed: 1 April 2017, from http://www.depkes.go.id/resources/download/general/Hasil%20Riskesdas%202013.pdf.
[3] Kusumaningtyas D R, Rengga W D Pand Suyitno H 2010 Jurnal Penerapan Teknologi dan Pembelajaran 8 2–4
[4] Waspadji S 2003 Indeks Glikemik Berbagai Makanan Indonesia (Jakarta: Fakultas Kedokteran Universitas Indonesia)
[5] Moses R G 2009 Diabetes Care 32
[6] Sudarmadji S, Haryono B and Suhardi 2010 Analisa Bahan Makanan dan Pertanian (Yogyakarta: Liberty)
[7] Moskowitz HR, Beckley, Jacqueline H and Resurreccion AVA 2012 Sensory and Consumer Research in Food product Design and Development Second Edition (UK: Blackwell Publishing Ltd)
[8] Elavenia E and Jayamuthunagai J 2014 International Journal of Chemtech Research 64446–4456
[9] Weigle DS, Breen PA and Matthys CC 2015 America Journal Clinic Nutrition 82 41–8
[10] Krishnan A and Sinija V R2015 International Journal Of Agriculture And Food Science Technology 7 13–22
[11] Sugito and Hayati A 2006 Jurnal Ilmu Ilmu Pertanian Indonesia. 8 147–151
[12] Almatsier S 2003 Basic Principles of Nutritional Science (Jakarta: PT Gramedia Pustaka)
[13] Sheng, Zhan-Wu et al. 2010 African Journal of Biotechnology 9 3888–3895
[14] Mamuja, Christine F and Aida Y 2014 Food Science and Technology Journal 2
[15] Wang HY, Qian H, Yao WR 2011 Food Chem 128 573–584
[16] Avianty S 2013 Nutrient Content and Level Of Preference Of Black Soybean And Sweet Potato Snack Bar As Alternative Food For Type 2 Diabetes Melitus Patients Undergraduate Thesis (Semarang:UniversitasDiponegoro)
[17] Ismarani 2012 Jurnal Agrabisnis dan Pengembangan Wilayah 3
[18] Mulyani S 2013 Pemanfaatan Biji Kecipir (Psophocarpus Tetragonolobus) Sebagai Bahan Dasar Pembuatan Susu Dengan Penambahan Ekstrak Jahe Merah (Zingiber Officinale) Dan Kayu Manis (Cinnamomum Burmanni) Skripsi (Surakarta: Universitas Muhammadyah Surakarta)

[19] Kurniasih A 2016 Daya Patah Dan Daya Terima Flakes Jagung Yang Disubstitusi Jantung Pisang Skripsi (Surakarta: Universitas Muhammadyah Surakarta)