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The effect of mixture of banana pseudostem flour proportion on organoleptic properties, dietary fiber content, resistant starch, and antioxidants of canna starch-based food bar

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Abstract

The objective of the recent study was to evaluate the effect of banana pseudostem flour (EBP) to the organoleptic properties, levels of dietary fiber, resistant starch and antioxidants of canna starch-based food bar. The research design was true experimental in the form of completely randomized design with 6 treatments using canna starch: banana pseudostem flour. The six treatments were 100:0, 95:5, 90:10, 85:15, 80:20, and 75:25 ratio. The best food bar was determined by scoring through organoleptic test, content of soluble dietary fiber and antioxidants. Food bars processed with mixture of banana pseudostem flour proportion 85:15 was selected as the best food bar with a score of color attribute 3.12±0.08, aroma 3.00±0.06, flavor 3.04±0.18, texture 3.16±0.12, soluble dietary fiber content 0.83±0.07% db, insoluble dietary fibers of 6.75±0.14% db, total dietary fiber 7.58±0.13% db, resistant starch 6.54±0.24% db, total phenolic 105.75±0.64 mg/100 g, antioxidant activity 6.97±0.77% RSA, color brightness (L*) 52.52±0.60 and hardness level 5.08±1.95 N. The substitution of banana pseudostem flour on the canna starch-based food bar increased level of soluble dietary fiber 0.83%, total dietary fiber 4.81%, resistant starch 2.89%, total phenolic 43.01 mg/100 g and antioxidant activity 3.98% RSA as well as sensory panelists preferred. The higher the mixture pseudostem flour proportion, the higher the tendency of the levels of dietary fiber, resistant starch, total phenolic and antioxidant activity.

1. Introduction

Changes in lifestyle drove people diet pattern leads to a tendency to consume fast food that possibly triggered abnormal lipid fraction that was called dyslipidemia such as hypercholesterolemia (Nie *et al*., 2017). This condition could occur because of fast food was usually rich in saturated fats and high in carbohydrates. The growth of hypercholesterolemia condition could be interpreted as an opportunity to develop or create nutritious snacks which were beneficial for health (antidyslipidemia). One of the snacks that met these criteria was high-fiber food bar. Food bar was food prepared by mixing various ingredients such as egg whites, margarine, powdered sugar, glucose syrup, starch, and others into rod-shaped dense food consumed in between the main meals or served as a snack food (Eka, 2013). Form of food bars was also selected because it was practical and had been developed. Nowadays, food bars became a trend as one of the healthy food products (Herawati *et al*., 2019).

Unfortunately, food bar sold in markets were processed from wheat flour and soy flour that were imported flour (Ladamay and Yuwono, 2014). Whereas food bar was able to be processed by utilizing the abundant and affordable local raw material. Some researchers claimed that the food bar could be processed by utilizing the Indonesian local flour such as pumpkin flour with mung bean flour (Fajri *et al*., 2013), tofu flour with yam flour (Rachmayani *et al*., 2017), and white millet flour with red bean flour (Anandito *et al*., 2016) and others.

One of the local materials that could be used as material for the production of the food bar is Cavendish Jepara 30 banana pseudostem flour (EBP) because it was rich in dietary fiber and antioxidants. EBP flour contained high levels of total dietary fiber 43.82±0.36% db, soluble fiber 5.90±0.27% db, insoluble fibers

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37.92±0.62% db, resistant starch (RS) 13.13 ± 0.32% db, total phenolic components 132.81±2.14 mg/100 g, and the antioxidant activity of 18.04±0.23% RSA (Yuliatmoko *et al*., 2019).

Meanwhile, canna starch was reported as a local starch containing high carbohydrates of approximately 84.34% db so it was suitable for raw materials for food products (Pangesthy, 2009). However, dietary fiber content and antioxidants were reported to be low (Yuliatmoko *et al*., 2019). Based on the characteristics of those two materials, food bar made from the substitution of EBP flour with canna starch flour could be further developed. Material substitution probably changed the characteristics of the processed product so that the appropriate formulations was required. Formulations were very important in order to know the proper proportion of both flour in producing food bars that were high in dietary fiber and antioxidants but also preferred by potential consumers.

However, there was no research references that discussed the ability of EBP flour as dietary fiber and antioxidant enricher on canna starch-based food bar nor information on the ratio of canna starch flour: EBP flour to produce food bar. The purpose of this study was to determine the ability of EBP flour as dietary fiber and antioxidants enricher on canna starch-based food bar and to evaluate the best food bar based on sensory characteristics, the content of dietary fiber and total phenolic content, and physicochemical properties.

2. Materials and methods

2.1 Materials

Raw materials used were canna starch purchased from Mekar Sari Farmers Group, Sendangsari, Kulonprogo and Cavendish Jepara 30 banana pseudostem flour (EBP) processed from EBP CJ30 waste obtained from banana plantations PT Nusantara Trofical Farm (NTF) Terbanggi Great, Lampung, Indonesia. Additional materials for food bar included white eggs from chamart Lampung, 'Vita' branded margarine, 'Rose Bran' branded refined sugar, 'Epicerie Katrina' branded glucose syrups. All chemicals used were analytical grade chemicals.

2.2 EBP flour processing

Banana pseudostem (EBP) flour was processed following the procedure done by Yuliatmoko *et al*. (2019). Fresh harvested EBP obtained from banana plantation PT NTF then cut 30 cm with 7-inch stainless Zebra Smart cleaver. Then, EBP was washed with clean water and sliced into 2 mm thick by fruit vegetable slicer machine J23-Maksindo then the results were collected in a plastic container containing water basin for ± 10 mins, drained, and then heated in a pan of boiling water for 10 mins. The sliced EBP inserted into the hollow while draining for 20 mins and then dried in an oven at a temperature of 55°C for 96 hrs. Next, sliced dried EBP was used to make flour using local engine Mitra Usaha Mandiri. Flour was sieved on 80 mesh. The product was EBP flour packed in airtight plastic container and stored in a cold room at 5°C.

2.3 Food bar formulations of canna-starch-EBP

Food bar was formulated by preparing slight modification formulated by Pramitasari *et al*. (2015) (Table 1). Raw material of food bar which was originally used canna flour and agar-agar powder was replaced with canna starch and EBP flour. The use of EBP flour with concentrations of 0, 5, 10, 15, 20, and 25 g aimed to determine the effect of the components of dietary fiber and antioxidants of EBP flour in enriching fiber and antioxidants of canna starch so that the resulting food bars that contained dietary fiber and antioxidants were sensory preferred by the panelists.

Food bar processing began by mixing all the ingredients such as egg white, glucose syrup, refined sugar, span 80, margarine, EBP flour and canna starch according to dose into the container glass bowl with mixer until a dough was formed. Next, the dough was molded with a size of 10 cm x 3 cm x 1 cm and put into a cake pan and then steamed for 5 minutes in a pan of boiling water container. Tray containing food bar baked in the oven with a temperature set at 80°C for 40 mins, 90°C for 30 mins, and a temperature of 100°C for 30 mins. Furthermore, food bars were removed from the

Table 1. Food bars formulation canna starch - EBP

Material	The ratio of canna starch-EBP flour					
	100:00:00	95:05:00	90:10:00	85:15:00	80:20:00	75:25:00
Canna starch	100 g	95 g	90 g	85 g	80 g	75 g
EBP flour	0 g	5 g	10 g	15 g	20 g	25 g
Span 80	2 g	2 g	2 g	2 g	2 g	2 g
Egg whites	10 g	10 g	10 g	10 g	10 g	10 g
Margarine	30 g	30 g	30 g	30 g	30 g	30 g
Fine sugar	50 g	50 g	50 g	50 g	50g	50g
Glucose syrup	30 g	30 g	30 g	30 g	30 g	30 g

oven and cooled for 30 mins. After being cold, food bar was packed in an airtight plastic container and stored in a refrigerator until further analyzed.

2.4 Analysis of chemical composition

Chemical analysis of food bar was performed three replications using procedure AOAC (AOAC, 1995), included, moisture content, ash, crude protein micro-Kjeldahl, Soxhlet extraction of crude lipid, and total carbohydrates.

2.5 Sensory analysis

Sensory analysis used six samples, namely Canna Starch-based Food Bar substituted with EBP flour with ratio 0%, 5%, 10%, 15%, 20% and 25%. The purpose of the sensory evaluation was to determine how much EBP flour could be substituted on canna starch that had similar characteristics with commercial food bar. Commercial food bar used as a comparison was strawberry-flavored Soyjoy. Sensory evaluation conducted was hedonic test with 5-options-hedonic scale, namely strongly dislike, dislike, neutral, like, extremely like.

2.6 Measurement of dietary fiber

Dietary fiber of food bar was measured following the method of Asp *et al*. (1983). Insoluble fiber (IDF) and soluble fiber (SDF) was analyzed using procedure, 1 g of flour sample and the duplicate inserted into the container of 0.5 L Erlenmeyer flask, then mixed 0.025 L of 0.1 M sodium phosphate, pH 6.0, and the sample was deposited. Into the Erlenmeyer container, it was added 100 µL termamyl 120 L origin Novo US industry and the container was covered with aluminum foil material. Next, a container of samples flour was interred in a shaking water bath at a temperature of 80°C for 15 mins. After it turned cool, the sample was added by 20 mL distilled water and the pH was adjusted to 1.5 with HCI 4 M. Subsequently, the container containing the sample was added with 100 mg of pepsin, then covered and incubated in a shaking water bath with a temperature of 40°C for 60 mins shaking. After it cooled, the container containing the sample was added with 20 mL of distilled water and the pH was adjusted to 6.8 with NaOH 4 M. Then into the container containing the sample was added with 100 mg of pancreatin and the container was closed and incubated at 40°C water bath for 60 mins shaking. Subsequently, the pH was adjusted to 4.5 with HCI, the solution was filtered using a crucible, which was dry and already weighed (P2) containing 0.5 g of dry celite and washed with 2 x 10 mL distilled water. Residue of insoluble fiber (IDF) was washed with 2 x 10 mL of 94% ethanol, dried at 105°C temperature overnight, then cooled and weighed and ash at 550°C overnight. Soluble fiber (SDF) was analyzed by the following procedure: 400 mL of 95% ethanol was added to the filtrate 60°C temperature, the precipitates were allowed to form for 60 mins. The solution was filtered, and then added with 2 x 10 mL of 78% and 95% ethanol. Precipitate dried at 105° C temperature overnight, then weighed and samples were ash as the IDF. Blank value was obtained by following the procedure without sample. The dietary fiber content was calculated using the formula:

$$IDF = \frac{(D1-I1-B1)}{W} \times 100\% \quad (1)$$

$$SDF = \frac{(D2-I2-B2)}{W} \times 100\% \quad (2)$$

Total fiber content = (1) + (2)

Where D = g weight after drying, I = g weight after ashing, B = g ash-free blank, and W = g sample

2.7 Measurement of Resistant Starch

Resistant starch (RS) was measured using methods Goni *et al*. (1996). 0.1 g of sample food bar was inserted in the centrifuge tube with a lid, then added 10 mL KCL-HCL buffer pH 1.5 further vortex. Then into a container containing sample was added with 0.2 mL of pepsin and vortex Furthermore, the container containing the sample was put in the shaking water bath at temperature of 40°C for 60 mins. After it was cold, it was added into a container with 9 mL of 0.1 M Trismaleate buffer pH 6.9, then added 1 mL of α-amylase. Then, the container was incubated for 16 hrs at 37°C of shaking water bath. Next, the container was centrifuged at 3000 x *g* for 15 mins, and the supernatant was discarded, washed with 10 mL of distilled water, centrifuged again and the supernatant removed. Then, it was added with 3 mL of distilled water and 3 mL of 4M KOH. The container was put into the shaking water bath at room temperature for 30 mins. Furthermore, the container was added with 5.5 mL of 2 M HCl and 3 mL of sodium acetate buffer 0.4 M with a pH of 4.75. Then into the container, it was added 80 mL amyloglucosidase, mixed well and put in a shaking water bath temperature of 60°C for 45 m, then centrifuged 3000 x *g* for 15 mins. Then the supernatant was stored in a volume tube. Next, the residue was added with 10 mL of distilled water and centrifuged. Then, the supernatant was collected and mixed with 50 mL of distilled water. Then the standard curve was composed from glucose solution (10-60 ppm) of ki GOD PAP. Subsequently, 0.5 mL sample, blank, and standards were pipetted into the tube. Then it mixed with 1 mL reagent kit GOD PAP. Then it was put into a shaking water bath temperature of 37°C for 30 mins. Subsequently, the sample, blank, and standard calibrated at 510 nm. RS was calculated with the aid of a standard curve. Resistant starch was calculated as glucose × 0.9 mg.

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2.8 Measurement of total phenolic content

Total phenolic content of the food bar was measured using methods of Senter *et al*. (1989). Preparation of standard solution of gallic acid: (a) the production of gallic acid stock solution 20 $mg.100^{-1}$ mL; (b) The dilution was done by setting up 6 screw-threaded test tubes were each then filled with a stock solution in sequence as follows: 2 mL, 1.6 mL; 1.2 mL; 0.8 mL; 0.4 mL; and 0 mL; (c) the addition of distilled water into each tube in the following order: 0; 0.4 mL; 0.8; 1.2 mL; 1.6 mL; and 2 mL; (d) each tube was taken as 0.2 mL; (e) the addition of 1 mL of folin reagent Na_2CO_3 solution of 0.8 mL of 7.5% and 3 mL of distilled water each tube then performed using vortex; (f) incubated for 0.5 hr; (g) calibration with absorbance of 750 nm. Total phenolic contents were determined by means: (a) taking 1 mL sample of the food bar; (b) addition of 1 mL of folin reagent, 0.8 mL of Na_2CO_3 7.5%, and addition 3 mL of water and then performed using vortex mixing; (c) incubation for 0.5 hr; (d) absorbance with a spectrophotometer calibration λ750 nm

2.9 Determination of antioxidant activity

Antioxidant activity was measured using the DPPH free radical scavenging activity method Hatona *et al.* (1988) and Yen and Chen (1995). Two hundred mg of sample was inserted into a test tube and a screw-threaded tube was added it 5 mL of methanol, then extracted by vortex for 60 mins. Furthermore, 250 µL supernatant was mixed with 5 mL of methanol and 1 mL of 0.1 mM DPPH solution and put in a glass test tube with a lid and incubated at room temperature for 30 mins. Furthermore, the absorbance was calibrated with spectrophotometer at λ 517 nm

2.10 Determining the best treatment

The best treatment was determined by the sensory test, the content of soluble fiber, and antioxidants by applying the principle of the method de Garmo (1984) in Diniyah *et al*. (2012). In sensory and chemical tests a weighting system was applied. The value in the sensory test was stated with criterion 3 for a highly preferred product, and 1 for an unwanted product. The value of food fiber and antioxidants was expressed as a value of 3 for the highest levels and a value of 1 for the lowest levels. The grading of the weights of each attribute was adjusted to the importance of the role of these attributes in the selection. Weighted values for sensory test by 30% while the dietary fiber and antioxidants were each given a weighting of 40% and 30%.

2.11 Subheading analysis of physical properties of food bars: the color and the level of hardness

Food bar color analysis was done by reading the fraction of color such as the value of the brightness (L*), redness (a*) and yellowness (b*) of samples of food bar with a Minolta instrument chromamometer as methods Hutchings. (1999). While testing the level of hardness was done by putting the sample in the sample container, then it was put on pressure using tool in which the measured values was recorded by the instrument in the form of a graph. The level of hardness of food bar was measured using a Zwick Universal Testing Machine tools ZO.5 type and expressed in Newton (N) unit.

2.12 Experimental design

The parameters observed such as proximate analysis (moisture, ash, protein, carbohydrates and lipid) and chemical analysis such as levels of dietary fiber, resistant search, total phenolic and antioxidant activity. Each parameter was triplicated. All research data were analyzed using one-way analysis of variance followed by Least Significant Difference Test using SPSS 20.0.

3. Results and discussion

3.1 The chemical and physical properties of canna starch and EBP flour

The chemical properties of raw materials were very important to know so that the nutritional content of macronutrient food bars produced met the standard of food bar as the total number of calories recommended by BPOM and USDA. The physical properties such as color raw materials was needed to know because it was very closely related to consumer preference towards food bars produced. The chemical and physical properties of canna starch and EBP flour as a raw material for producing food bars were presented in Table 2.

From Table 2 below, EBP flour contained dietary fiber and antioxidants that were higher than canna starch so that it was able to enrich the content of dietary fiber and antioxidants than canna starch. While the canna starch contained carbohydrates and had a very high degree of brightness. From the characteristics of the two ingredients, one suitable alternative product can be developed, namely a high-fiber food bar and antioxidants that are preferred by consumers. Food bar was chosen because this product is classified as a simple product, easy to make, and can be modified according to purpose. High-fiber food bars and antioxidants can be processed by determining the proportion of the mixture that fits between the two ingredients, namely EBP flour and canna starch. Judging from the characteristics of the two ingredients, canna starch is suitable to be used as the

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basic ingredient of a food bar. While EBP flour is more suitable as a substitute material because it is rich in food fiber. Thus the use of EBP flour is expected to increase the content of food fiber and antioxidant food bar produced. Meanwhile, canna starch as a base material that is rich in carbohydrates with higher brightness levels is expected to produce food bars that have colors that attract consumers' interest (Castilho *et al*., 2010). However, color is a determining aspect in whether or not the product is by consumers (Ladamay and Yuwono, 2014). On the other hand, the choice of high-fiber food bars and antioxidants because they are classified as functional food products is currently experiencing a trend of increasing consumption by the public (Herawati *et al*., 2019). Functional foods high in dietary fiber and antioxidants are very beneficial for health because they can improve plasma lipid profiles such as cholesterol reduction (Stephen *et al*., 2017; Cheurfa *et al*., 2019).

Table 2. Chemical and physical properties of canna starch and EBP flour

Parameter	Canna Starch[1]	EBP[1]
Chemistry:		
The water content (% wb)	17.7±0.21	6.19±0.12
The ash content (% db)	0.03±0.00	26.01±0.01
The protein content (% db)	0.29±0.00	0.89±0.03
Fat content (% db)	0.17±0.00	7.22±0.06
Carbohydrate content (% db)	81.8±0.21	59.69±1.89
Levels of total dietary fiber (% db)	7.37±0.33	43.82±0.36
Soluble fiber (% db)	1.43±0.13	5.90±0.27
Insoluble fiber (% db)	5.94±0.41	37.92±0.62
Resistant starch ((% db)	13.32±0.64	13.13±0.32
Components of total phenolic (mg / 100 g)	0.18±0.06	132.81±2.14
The antioxidant activity (% RSA)	7.24±0.24	18.04±0.23
Physical :		
Brightness (L *)	89.47±0.20	59.41±0.48
Redness (a *)	4.73±0.03	8.16±0.20
Yellowness (b *)	2.15±0.08	12.54±0.41

[1]Data source from Yuliatmoko *et al*. (2019).
EBP = Banana pseudostem, wb = wet basis, db = dry basis, and RSA = radical scavenging activity.

3.2 The chemical composition

The results of ANOVA of the chemical composition of canna starch – EBP-based food bars showed that the treatment group affected the chemical composition of food bar significantly at $p<0.05$. The test results showed the difference among the treatment groups that there was significant difference among the treatment groups (Table 3). The water content and carbohydrate of food bars tended to decrease with the increasing ratio of EBP flour. This was due to the higher water content and starch carbohydrates of canna compared to water content of the EBP flour (Yuliatmoko *et al*., 2019)

In addition, the proportion of canna starch compared to six food bars were higher than EBP flour. Canna starch could increase the starch content of food bars that served as water-binding agent so that the water content food bar had also increased. Starch molecule had big hydroxyl groups so that the ability to bind water was also strong (Ladamay and Yuwono, 2014). The lower carbohydrate content of food bars with increasing EBP flour indicated that substitution at high starchy foods could produce low-carbohydrate food bar.

Ash, fat, and protein of 6 food bars tended to increase with increasing the ratio of EBP flour. This was due to the added EBP flour contained high level of ash, fat, and protein when compared with canna starch (Yuliatmoko *et al*., 2019). The ash content indicated mineral content of a material (Sudarmadji *et al*., 1989)

Based on international standards, commonly called food bar or granola bar should be per 100 grams of water containing nutrients such as 3.9%, 10.1% protein, 19.8% fat, 64.4% carbohydrate (USDA, 2019). Referring to these standards, canna starch-based food bar which was substituted with EBP flour had met the nutrient content in the form of fat and carbohydrates but did not meet the water and protein content. The high water content in the food bar from this study was due to the water content of the basic ingredients of food bar namely canna starch which was very high, which is 17.7±0.21% wb (Table 2). This canna starch water content did not meet the criteria

Table 3. The chemical composition of food bars canna starch-EBP

The ratio of canna starch: EBP flour	The chemical composition (% db)				
	The water	Ash content	Fat	Protein	Carbohydrate
100:00:00	8.34±0.05^{f}	0.43±0.00^{a}	9.89±0.02^{a}	1.15±0.00^{a}	80.19±0.05^{d}
95:05:00	8.18±0.03^{e}	0.97±0.01^{b}	10.20±0.04^{b}	1.21±0.00^{b}	79.52±0.07^{d}
90:10:00	7.88±0.09^{d}	1.92±0.02^{c}	10.52±0.01^{c}	1.44±0.00^{c}	78.24±0.11^{c}
85:15:00	6.95±0.05^{c}	2.68±0.01^{d}	10.93±0.00^{d}	1.50±0.00^{d}	77.95±0.46^{c}
80:20:00	6.60±0.29^{b}	2.96±0.02^{e}	12.03±0.07^{e}	1.56±0.01^{e}	76.85±0.46^{b}
75:25:00	5.62±0.03^{a}	3.89±0.00^{f}	14.27±0.01^{f}	2.02±0.05^{f}	74.19±0.47^{a}

EBP = banana pseudostem. Different superscript letters behind values in the same column show significant differences ($p<0.05$).

of starch or flour according to the Indonesian National Standard (SNI 01-6057-1999), namely the maximum water content of starch products is 16% (Indrianti *et al*., 2019). However, the water content of food bar produced has fulfilled the criteria of semi-solid food that was 20-40% (Sakidja, 1989). Food bar or snack bar is a type of solid food that is classified as semi-solid food (Hartaty *et al*., 2017). Unlike the very high food bar water content, the protein content of the food bar produced is very low. This was due to the two main ingredients of food bar namely canna starch and EBP flour which contain low protein. However, the low protein content has been previously thought and the focus of this research was developing a food bar that contained food fiber and antioxidants. To increase the protein food bar it is recommended to add flour or other ingredients that contain high protein.

3.3 The dietary fiber content and RS

The results of ANOVA of the fiber content and resistant starch of canna starch - EBP based food bar showed that the treatment group affected the content of dietary fiber and RS significantly at $p<0.05$. The test results showed the significant difference among treatment groups (Figure 1). Levels of insoluble fiber, soluble fiber, and total dietary fiber food bar tended to increase with the increase in the ratio of EBP flour. This was due to the levels of insoluble fiber, soluble fiber, and total dietary fiber EBP flour were greater than canna starch. Based on the content of dietary fiber, food could be classified into the fiber food and high-fiber foods. Fiber foods were foods containing dietary fiber not less than 3 g/100 g. High-fiber foods were foods containing dietary fiber not less than 6 g/100 g (BPOM, 2011). Under this definition, the canna starch-based food bar which was substituted with EBP flour could be classified into fiber food, namely food bars processed with the ratio of canna starch with EBP flour 95: 5 and the high-fiber food was a food bar processed by the ratio of canna starch with EBP flour 95: 10, 95: 15, 95:20, and 95:25. The high-fiber food in a food bar came from the substitution of EBP flour because flour contained high fiber food, which was 43.82±0.36% db (Yuliatmoko *et al*., 2019). Food bars containing dietary fiber could be involved as an alternative food to cope with the condition of dyslipidemia as the dietary fiber, especially dietary fiber soluble could improve the lipid profile such as lowering total cholesterol and LDL cholesterol (Galisteo *et al*., 2008; Erukainure *et al*., 2012; Marounek *et al*., 2017).

Levels of RS (% db) of canna starch-based food bar which were substituted with a varied and significant as presented in Table 4. Resistant starch level of food bar tended to increase with increasing the ratio of EBP flour. This was due to the higher level of RS of added EBP flour and it was more resistant to damage during processing. RS had a physiological effect that could improve the condition of dyslipidemia by lowering cholesterol levels, binds bile, laxative, and improved SCFA (Cummings *et al*., 1996; Marsono, 1998; Stephen *et al*., 2017).

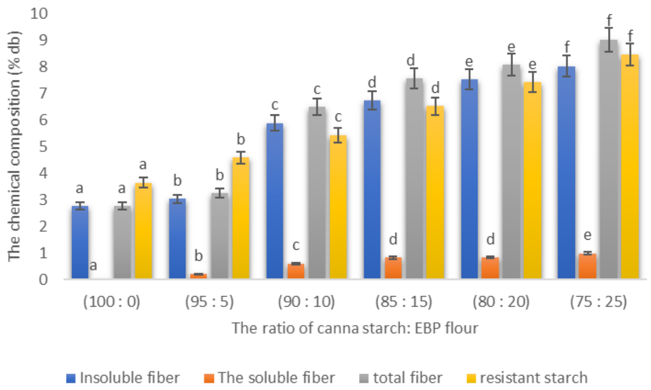

Figure 1. Composition of dietary fiber and resistant starch of canna starch- EBP food bar. Different superscript notations on the same color images show significant differences ($p<0.05$).

Table 4. Components of total phenolic and antioxidant activity Canna starch food bars - EBP

The ratio of canna starch: EBP flour	The chemical composition	
	Total phenolic compounds (mg/100 g)	The antioxidant activity (% RSA)
100:00:00	62.74±0.45^a	2.99±0.00^a
95:05:00	73.34±0.35^b	4.48±0.00^b
90:10:00	101.85±0.92^c	5.97±0.00^c
85:15:00	105.75±0.64^d	6.97±0.77^d
80:20:00	117.60±0.95^e	7.96±0.77^e
75:25:00	123.19±0.71^f	11.44±0.77^f

EBP = banana pseudostem, RSA radical scavenging activity. Different superscript letters behind values in the same column show significant differences ($p<0.05$).

3.4 The antioxidant activity

The result of ANOVA of total phenolic and antioxidant activity of canna starch - EBP food bar showed that the treatment group affected the total phenolic components and antioxidant activity ($p <0.05$). The test results showed the difference among the treatment groups as seen in Table 4. Total phenolic content of the food bar tended to increase with the increase in the ratio of EBP flour. This was due to the levels of total phenolic of EBP flour which were higher than canna starch.

The antioxidant activity of food bar tended to increase with increasing the ratio of EBP flour. This increase in antioxidant activity was thought to originate from the higher total phenolic content of EBP compared to canna starch (Table 2). The antioxidant activity of a food ingredient was positively correlated with the total content phenolic (Wettasinghe and Shahidi, 2000; Cheng *et al*., 2013). Components of antioxidant polyphenols like flavans, anthocyanins, quercetin, myricetin, kaempferol, and resveratrol could lower plasma lipids such as plasma triglycerides and LDL cholesterol (Qin *et al*., 2009; Sayago-Ayerdi *et al*., 2014; Chen *et al*., 2019). Thus, substituting EBP flour for canna starch in canna starch food bar-EBP can increase the total phenolic component of food bar so that the antioxidant activity of food bar-EBP also increases. The high antioxidant component in canna starch food bars - EBP can be utilized to improve plasma lipids so that they are beneficial for health.

3.5 Sensory quality of food bars

The results of ANOVA of sensory quality of canna starch - EBP food bars showed that the treatment group significantly affected the sensory quality of food bar. The test results showed the difference among treatment groups (Figure 2). Food bars were derived from the treatment of canna starch-EBP flour 90:10 and 85:15 had the highest color score of 3.16±0.11 and 3.12±0.08 or neutral preference level. The both scores were not significantly different. From the analysis it was found that the addition concentrations of 10 and 15 of EBP flour on the formula bar made the color food bar more preferred by the panelists. However, the increased concentration of EBP flour caused the panelist preference level of the color attribute.

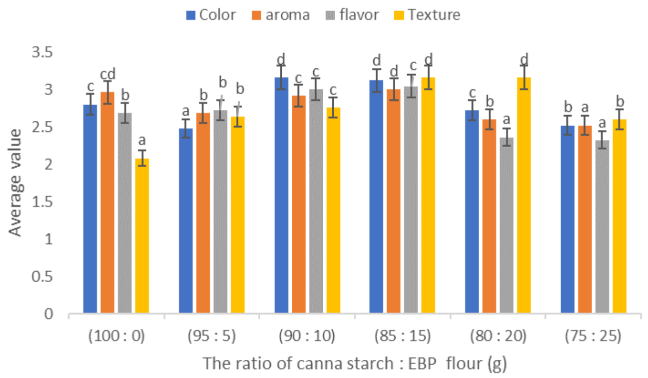

Figure 2. Hedonic food bars test results of canna starch – EBP. Different superscript notations on the same color images show significant differences ($p<0.05$).

The similar phenomenon was also demonstrated by the aroma attributes. Food bars were derived from the treatment of canna starch EBP flour substituted with a ratio 85:15 and 100: 0 to obtain the highest score of the scent, which was 3.00±0.06 and 2.96±0.14 or neutral preference level. The both scores were not significantly different. The concentration of 15 EBP flour in food bar caused food bar obtained preference response on the highest aroma and the response decreased with reduced or increased concentrations of EBP flour. During the processing of food bars, it was suspected that chemical reactions produced a particular aroma (Ladamay and Yuwono, 2014). One aroma formed during processing, furaneol, was formed by the Mailard reaction (Makfoeld *et al*., 2002).

Meanwhile, the different phenomenon demonstrated by the preference level of panelists on flavor and texture attributes. Food bar that got the highest response to the attributes of flavor that was 3.00±0.06 and 3.04±0.18 or neutral preference level was a food bar that was processed by the ratio of canna starch and EBP flour 90:10 and 85:15. The both scores were not significantly different. The greater the EBP flour in food bar could increase preference response till the optimum level. The increasing concentration of EBP flour could decrease the level of preference. The fall in the level of preference for flavor attributes by increasing EBP was allegedly linked to a high-fiber component on EBP flour. Furthermore, food bar that got the highest score of texture attribute from panelists were 3.16±0.12 and 3.16±0.10 or neutral preference level from food bar that was processed by the ratio of canna starch and EBP flour 85:15 and 80: 20. The both scores were not significantly different. The greater the EBP flour in food bar could increase preference response till the optimum level. The increasing concentration of EBP flour could decrease the level of preference of texture attribute. This condition was thought to be linked with higher content of dietary fiber in a food bar. The increasing proportion of dietary fiber carboxy methyl cellulose (CMC) had been reported to improve fracture/texture of food bars made from tapioca flour and mung bean flour (Ladamay and Yuwono, 2014). Insoluble fiber was fiber foods was reported to affect the hardness of the food product (Santala *et al*., 2014 cited in Yan *et al*., 2015). However, the increased concentration of materials containing high-fiber food such as tofu flour with a total dietary fiber content of 50.35% were reported to produce snack bar with rugged texture and less favored by panelists (Rachmayani *et al*., 2017). Insoluble dietary fiber had been reported to reduce the acceptance of the sensory by panelists (Robin *et al*., 2012) because it produced hard-texture product. This was presumably related to the role of insoluble fiber that could cause low levels of free water in the product.

3.6 Determining the best food bars

The best food bar was determined based on the selection of observational parameters according to

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research priorities, which then determine the weight, worst value, and best value (De Garmo, 1984; Diniayah *et al*., 2012). The observation parameter used to choose the best food bar was a sensory test, the content of soluble dietary fiber, and total phenolic compounds (Table 5). The evaluation resulted the best food bar was food bar with canna starch: EBP flour 85:15. This food bar had the highest value compared to other five food bars.

Table 5. The best food bars were based on hedonic test parameters, soluble food fiber, and total phenolic compounds

The ratio of canna starch: EBP flour	Parameter*		
	Hedonic test	Soluble dietary fiber	Total phenolic
100:00:00	1	1	1
95:05:00	2	1	1
90:10:00	2	1	2
85: 15 **	3	2	2
80:20:00	2	2	2
75:25:00	1	3	3

The score criteria for rating each parameter: 1 = lowest score, 2 = medium score, and 3 = high score
*weight criteria for each parameter: hedonic test of 30; soluble fiber by 40 and total phenolic by 30.
**The best treatment of election result

The best food bar had a characteristic color: brightness (L*) of 52.52±0.60, and the level of hardness by 5.08±1.95 (Table 6). When compared to the control food bar, Soyjoy, the best food bar had a higher brightness level. This was presumably because the brightness level of raw materials of the best food bar was higher than the control food bar, but had a lower level of hardness than the control food bar, 8.96±2.80. The texture of food was determined by the moisture content, fat, carbohydrate, and protein constituent (Fellows, 2009). Insoluble fiber also affected the hardness of a product, the more insoluble fiber contained made the appearance tended to be harder and rough (Santala *et al*., 2014; Yan *et al*., 2015). Fiber was able to bind large amounts of water, upon heating would trap the other components so that the texture of the product became compact. The formation of the texture of food products was affected by the processing methods, the kinds of products used, and the ingredients are added (KramLich, 1971). More details of nutritional content of best food bar and control were presented in Table 6.

4. Conclusion

The substitution of EBP flour on canna starch-based

Table 6. The chemical, physical and sensory attributes of canna starch - EBP food bar vs control

Parameter	*food bar*	Control (Soyjoy)
Chemical composition:		
Servings (g/serving)	30***	30
Total Energy (kcal)/100 g	416.17	433.33[a]
The water content (% wb)	6.95±0.05	-
The ash content (% db)	2.68±0.01	-
The protein content (% db)	1.50±0.00	13.33[a]
Fat content (% db)	10.93±0.00	15[a]
Carbohydrate content (% db)	77.95±0.46	63.33[a]
Levels of total dietary fiber (% db)	7.58±0.13 **	-
Soluble fiber (% db)	0.83±0.07	10[a]
Insoluble fiber (% db)	6.75±0.14	-
Resistant starch (% db)	6.54±0.24	-
[b]Total phenolic compounds (mg/100 g)	105.75±0.64	46.66[b]
Physical :		
Brightness (L *)	52.52±0.60	47.92±6.75
Redness (a *)	9.08±0.15	13.44±2.61
Yellowness (b *)	17.03±0.28	28.68±4.67
Broken power (N)	5.08±1.95	8.96±2.80
Sensory:		
Color	3.12±0.08	4.49±0.16
Aroma	3.00±0.06	4.41±0.14
Flavor	3.04±0.18	4.44±0.08
Texture	3.16±0.12	3.92±0.18

wb = wet basis; db = dry basis. aInformation of nutritional Value "Soyjoy" on packaging, bisoflavones
**Included in foods high in fiber
***To meet the daily needs of adult fiber of 30 g/person/day, it is necessary to consume 7 food bars @30 g/serving

food bar could increase the levels of ash content, fat, and protein of food bar but lowered levels of water content and carbohydrates. The higher concentration of EBP flour tended to contribute to the higher ash content, fat, protein and lower the water content and carbohydrates. Based on the scoring test against sensory characteristics, levels of soluble dietary fiber and total phenolic, it was obtained that food bars processed with the treatment of canna starch: banana pseudostem flour of 85:15 was selected as the best food bar which had similar characteristics with commercial food bar products (Soyjoy). The substitution of banana pseudostem flour on canna starch-based food bar could increase the levels of soluble dietary fiber, total dietary fiber, resistant starch, total phenolic, and antioxidant activity. The greater the ratio of banana pseudostem flour, the greater the tendency of the levels of dietary fiber, resistant starch, total phenolic and antioxidant activity.

Conflict of Interest

The authors declare no conflict of interest.

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