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PSYCHOCHEMICAL CHARACTERISTICS OF SNACK BAR MADE FROM MANGROVE FRUIT API-API FLOUR (AVICENNIA MARINA)

Karakteristik Fisikokimia Snack Bar Tepung Buah Mangrove Api-Api (Avicennia Marina)

Muhammad Fairuz Zenadine, Titik Dwi Sulistiyati, Hardoko Hardoko, Yunita Eka Puspitasari*

Fisheries Product Technology Departmenet, Faculty of Fisheries and Marine Sciences, Brawijaya University, Indonesia

Veteran Malang street, Malang City, East Java Province, Indoensia 65145

*Corresponding author: yunita_ep@ub.ac.id

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ABSTRACT

Consuming snack bar with high sugar content and low fiber cause degenerative disease. Mangrove fruit api-api Avicennia marina is consumed as traditional food by mangrove society regarding to bioactive compounds of its. Therefore, snack bar is added mangrove fruit flour api-api (Avicennia marina) to increase the nutrition and to produce functional food. The purpose of this study was to characterize physochemical of snack bar formulated with mangrove fruit flour api-api (Avicennia marina). This study was conducted into two steps such as determination the proportion dry material and wet material, formulation snack bars added mangrove fruit flour api-api (Avicennia marina). The proportion of dry and wet material were 55:45 and 65:35. The best proportion of treatment was 55:45. The concentration mangrove fruit flour api-api (Avicennia marina) was 0%, 5%, 10% and 15%. Additional mangrove fruit flour api-api (Avicennia marina) 5% was significantly different in snack bar formulation with physichocemical characteristic such as texture 191.34; lightness 45.066; redness 9.27; dan yellowness 43.99; carbohydrate content 54,052. Proximate analysis was moisture 24,05%, ash content 1.50%, protein content 9.37%, lipid content 9.05%, and carbohydrate content 54,20%. Organoleptic analysis was colour 3.564, aroma 3.564, flavor 3.592, and texture 3.456.

Keywords: Avicennia marina, Fruit, Mangrove, Snack bar

ABSTRAK

Konsumsi *snack bar* dengan kadar gula tinggi dan rendah serat dapat menyebabkan penyakit degeneratif. Buah mangrove api-api *Avicennia marina* dikonsumsi sebagai makanan tradisional oleh masyarakat mangrove, sebab mengandung beberapa senyawa bioaktif yang bermanfaat untuk mengatasi penyakit degeneratif. Untuk itu perlu diformulasikan *snack bar* dengan penambahan tepung buah mangrove api-api (*Avicennia marina*) untuk meningkatkan nutrisi dan menjadi produk pangan fungsional. Tujuan dari penelitian ini adalah untuk mengetahui karakteristik fisikokimia dari *snack bar* yang dibuat dari tepung buah mangrove api-api. Penelitian ini dilakukan dalam dua tahap yaitu proporsi bahan kering dan bahan basah

dari *snack bar* kemudian dilanjutkan dengan formulasi *snack bar* dengan penambahan tepung buah mangrove api-api *Avicennia marina.* Proporsi bahan kering dan bahan basah yang diteliti di tahap awal adalah sebesar 55:45 dan 65:35. Proporsi terbaik ditunjukkan pada bahan kering:bahan basah 55:45. Penambahan tepung buah mangrove api-api *Avicennia marina* adalah 0%, 5%, 10% dan 15%. Hasil analisis menunjukkan bahwa konsentrasi penambahan tepung buah mangrove api-api *Avicennia marina* sebesar 5% berpengaruh nyata pada produk *snack bar* dengan uji fisika yaitu tekstur 191,34; lightness 45,066; redness 9,27; dan yellowness 43,99; kadar karbohidrat sebesar 54,052. Nilai analisis proksimat yaitu kadar air 24,05%, kadar abu 1,50%, kadar protein 9,37%, kadar lemak 9,05%, dan kadar karbohidrat 54,20%. Uji organoleptik skoring warna 3,564, aroma 3,564, rasa 3,592, dan tekstur 3,456.

Kata Kunci: *Avicennia marina*, Buah, Mangrove, *Snack bar*

INTRODUCTION

The Avicennia marina fiery mangrove belongs to the Avicenniaceae family and grows like a bush up to 10 meters high in tropical areas. This plant has several tuberous branches with thick leaves. Avicennia sp. has aerial roots that grow up to about 20 cm with a diameter of about 1 cm. The roots firmly support the plant during high tides. The flowers are white to golden yellow in clusters of three to five. The fruit has large cotyledons that surround the stem of the new seedling. In extreme salinity conditions, the leaves will adapt by releasing salt to the surface (O.H Aljaghtmi & Zeid, 2018).

Avicennia sp. It has been widely used as an antioxidant, anti-inflammatory, antiviral and anti-diabetic. Avicennia marina leaves are used as antidiabetic (Al-jaghthmi *et al.,* 2020). This is also related to the bioactive content of Avicennia sp which contains bioactive compounds such as alkaloids, flavonoids such as luteolin, phenols, saponins, tannins, glycosides such as marinoids J-L, terpenoids, caffeic acid such as maricaffeolylide A (Sharaf & Saleh, 2000; Wang *et al.,* 2023). Therefore, Avicennia can be used as a functional food product.

In recent years, people's lifestyles have undergone changes, namely increasing healthy lifestyles through the consumption of functional foods, including healthy snacks. Snack is a snack product that is widely consumed by adults and children. This is because unhealthy food increases the risk of metabolic disorders such as diabetes (Coello *et al.,* 2022). Snack bars can be consumed as part of heavy meals made from various plant ingredients and provide healthy nutrition (Olagunju *et al.,* 2022). For this reason, the idea gave rise to making healthy food in the form of snack bars which were added with Avicennia marina api-api mangrove fruit flour. The aim of this research is to determine the physicochemical characteristics of snack bars made from api-api mangrove fruit flour.

METHODS

Research was carried out at the Fish Nutrition Laboratory, Faculty of Fisheries and Marine Sciences; Biosystems Engineering Laboratory, Faculty of Agricultural Technology, and Nutrition Laboratory, Faculty of Public Health, Airlangga University in January-July 2023. The materials used in this research were Avicennia marina fruit obtained from the mangrove ecotourism BeeJay Bakau Resort Probolinggo; soy flour, vanilla, pumpkin seeds (pumkin seeds), dried cranberries, sunflower seeds and dried Malang apples were obtained from My Snack Hut, Malang.

The research method used was an experimental method, by treating different concentrations of Avicennia marina mangrove fruit flour and the parameters measured were physical parameters (texture and color), as well as chemical parameters (protein, fat, water, ash and carbohydrate content). The research stages are as follows:

- **Making Avicennia marina mangrove fruit flour**
  The manufacture of Avicennia marina api-api mangrove fruit flour refers to (Marina *et al.,* 2018). Mangrove fruit is sorted by selecting ripe fruit that is 3 months old after flowering with a characteristic length of 1.7-2.4 cm; width 1.2-1.8 cm; weighs 1.5-3.2 grams and is grayish green in color. After that, the outer skin of the fruit is peeled, then cut into small pieces (1 cm) and weighed. The fruit is then boiled in a ratio of 500 grams of mangrove fruit and 1 liter of water and cooled. The results of the boiling are soaked in water for 4 days with the soaking water replaced every 24 hours with a ratio of 500 grams of mangrove fruit to 1 L of water and 50 grams of husk ash. The addition of husk ash is intended to reduce tannin and HCN levels. Husk ash acts as active carbon which absorbs tannins and HCN. After 4 days, the mangroves were dried using an oven at 50°C for 16 hours. Then ground using a dry blender and sieved with an 80 mesh sieve.
- **Making snack bars from Avicennia marina mangrove fruit flour**
  Making snack bars refers (Coello *et al.,* 2022) to dry ingredients such as soybean flour, fiery mangrove fruit flour, vanilla, and wet ingredients such as egg yolk, agave syrup mixed in one container. The dry ingredients and wet ingredients are stirred until the mixture is evenly mixed, then add ingredients such as dried Malang apples, pumpkin seeds, sunflower seeds and dried cranberries, stir again until dry. The dough that has been mixed evenly is placed in a baking dish measuring (2.5x5x1 cm) which has been greased with a little butter. Place the baking sheet in the oven at 120°C for 20 minutes. Once cooked, the snack bar is cooled first before being packaged.

Phase 1 research: determining the proportion of dry and wet ingredients

The dry ingredients consist of api-api mangrove fruit flour, soybean flour, vanilla, pumpkin seeds, sunflower seeds, dried cranberries, dried apples. The wet ingredients consist of agave syrup and egg yolk. Two formulations were tested in the initial stages of research, namely (I) dry ingredients : wet ingredients (BK:BB) = 55% : 45% and (II) dry ingredients : wet ingredients (BK:BB) = 65% : 35%. Meanwhile, the concentrations of api-api mangrove fruit flour added were 0%, 10% and 20%. The formulation adapted from the modified one can be seen in Table 1. After making the snack bar, the product is tested for organoleptic scoring including color, aroma, taste and texture to determine the best ratio.

Table 1. Phase 1 research-dry weight to wet weight ratio snack bar formulation

Ratio BK/BB	Concentration of Mangrove Flour (%)	BK (%)							BB (%)	
		Mangrove flour	Soy flour	Vanilla	Pumpkin seed	Sunflower seed	Dried cranberry	Dried apples	Agave syrup	Egg yolk
55/45	0	0	30	1	7	6	6	5	22,5	22,5
	10	6	24	1	7	6	6	5		
	20	11	19	1	7	6	6	5		
65/35	0	0	40	1	7	6	6	5	17,5	17,5
	10	7	33	1	7	6	6	5		
	20	13	27	1	7	6	6	5		

Information :

- 0%, 10% and 20% addition of Avicennia marina mangrove flour from the total weight of all ingredients used

Phase 2 research: formulation of Avicennia marina api-api mangrove fruit flour snack bar

In phase 2 research, the formulation of the api-api mangrove fruit flour snack bar used the best dry weight: wet weight ratio from phase 1 research, namely 55:45; with api-api mangrove fruit

flour concentrations of 0%, 5%, 10% and 15%. Physicochemical testing was carried out with repetition 5 times.

Table 2. Phase 1 research-dry weight to wet weight ratio snack bar formulation

Ratio BK/BB	Concentration of Mangrove Flour (%)	BK (%)							BB (%)	
		Mangrove flour	Soy flour	Vanilla	Pumpkin seed	Sunflower seed	Dried cranberry	Dried apples	Agave syrup	Egg yolk
55/45	0 (TM1)	0	30	1	7	6	6	5	22,5	22,5
	5 (TM2)	3	27	1	7	6	6	5		
	10 (TM3)	6	24	1	7	6	6	5		
	15 (TM4)	8	22	1	7	6	6	5		

Information :

- 0%, 5%, 10% and 15% addition of Avicennia marina mangrove flour from the total weight of all ingredients used

Data Analysis

Test result data were analyzed using SPSS version 16. Physical parameters were analyzed using Analysis of Variance (ANOVA), where a significant value of $p<0.05$ indicates that the treatment in the study had a real effect, while a value of $p>0.05$ meant that the treatment in the study had no effect. real. The error rate is 5% and the confidence level is 95%. If the results are significantly different, continue with the Tukey test. For analysis of organoleptic parameters, the Kruskal-wallis test was used. After all parameters are analyzed, the best concentration is determined using the De Garmo method.

RESULT

Characteristics of *Avicennia marina* Api-api Mangrove Fruit Flour

The use of Avicennia marina mangrove fruit flour can be increased by adding it to processed food in the form of snack bars. The chemical composition of Avicennia marina api-api mangrove fruit flour can be seen in Table 3.

Table 3. Chemical composition of Avicennia marina mangrove fruit flour per 100 g.

Parameter	Mangrove Fruit Flour *A. marina**	Mangrove Fruit Flour *A. marina***	Mangrove Fruit Flour *A. marina****	Flour SNI 3751-2009
Carbohydrate	86,71%	85,39%	-	-
Proteins	4,55%	4,16%	-	Min 7,0%
Fat	0,43%	0,39%	-	-
Water	4,29%	6,19%	-	Maks 14,5%
Ash	4,02%	3,87%	-	Maks 0,70%
Tannin	239,17 mg/kg	-	0,49 mg/kg	-
HCN	3,03 mg/kg	-	10,51 mg/kg	-

Source:
*) Nutrition Laboratory, Faculty of Public Health, Airlangga University (2023)
**) Triastuti *et al.,* (2022)
***) Chrisssanty *et al.,* (2012)

Table 3 shows that api-api fruit flour contains higher carbohydrates, protein and ash compared to api-api fruit flour processed by Triastuti *et al.,* (2022). The water content of api-api fruit flour in the study met the SNI for flour, namely less than 14.5%, as did the ash content of 4.02%. The tannin content of api-api mangrove fruit flour was 239.17 mg/kg higher than the tannin content of api-api mangrove fruit flour as a result of research by Chrissanty *et al.,* (2012),

while the HCN content was lower than the tannin content of mangrove fruit flour fire-fire research results from Chrissanty *et al.,* (2012).

Physicochemical Characteristics: Avicennia marina api-api mangrove fruit flour snack bar formulation

The best concentration for adding Avicennia marina api-api mangrove fruit flour is 10% with the BK:BB 55:45 formulation, so that in the next research stage a concentration of api-api mangrove fruit flour of 0% (TM1), 5% (TM2), 10 is used. % (TM3) and 15% (TM4). The physical characteristics of snack bars with the addition of Avicennia marina mangrove fruit flour are hardness and color which include lightness, redness, yellowness and °Hue. Hardness is a sensation of pressure that can be observed with the mouth when biting, chewing and swallowing or by touching with the fingers (Irmayanti *et al.,* 2018). The results of ANOVA and further Tukey tests for texture parameters can be seen in Figure 1.

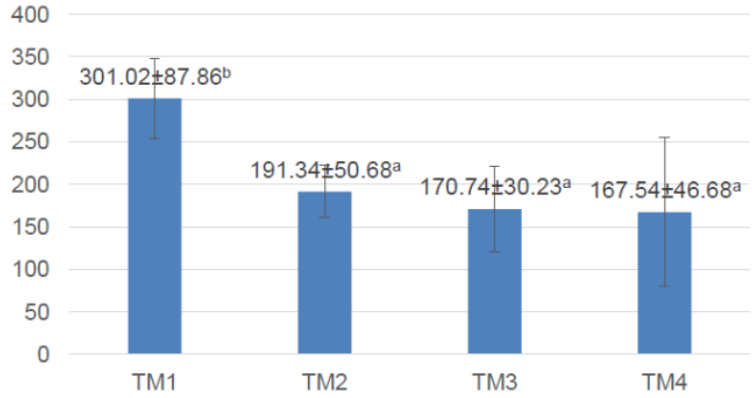

Figure 1. Graph of snack bar hardness with the addition of Avicennia marina api-api mangrove fruit flour (Note: 0% (TM1), 5% (TM2), 10% (TM3) and 15% (TM4) addition of Avicennia marina mangrove flour by weight total of all materials used)

Even though it is not directly related to nutritional value, visually color appears first and really determines consumer acceptance. The brightness level of a product that creates a light or dark impression is expressed by the L value (Lightness). The L parameter has a value of 0 (black) to a value of 100 (white). The higher the L value obtained indicates that the product is brighter (Rahayu & Fidyasari, 2022). The results of ANOVA and Tukey's advanced test for lightness can be seen in Figure 3. The highest lightness value was in the TM1 treatment (0% Avicennia marina mangrove fruit flour) namely 47.858 ± 2.06 N, while the lowest lightness value was obtained in TM4 (15% fruit flour). Avicennia marina mangrove was 41.726 ± 0.88N. The lightness value decreased with the addition of api-api mangrove fruit flour.

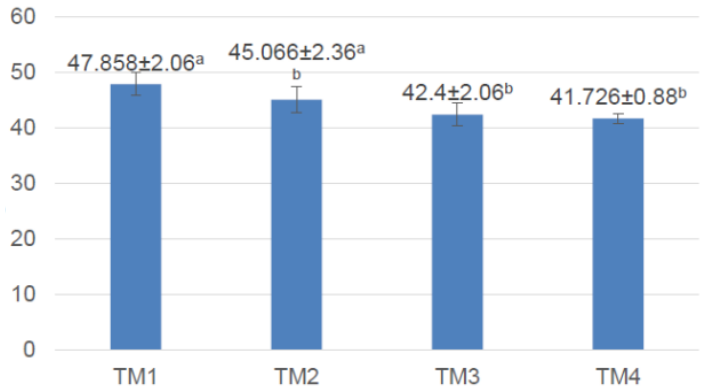

Figure 2. Graph of lightness snack bar with the addition of Avicennia marina api-api mangrove fruit flour (Note: 0% (TM1), 5% (TM2), 10% (TM3) and 15% (TM4) addition of Avicennia marina mangrove flour by weight total of all materials used)

The level of redness is indicated by the value a, where the higher the redness value (a), the redder the resulting color. The + a (positive) value is from 0 to +100 for red and the -a (negative) value is from 0 to -80 for green (Rahayu & Fidyasari, 2022). The results of ANOVA and Tukey's further test of redness can be seen in Figure 3. The redness value of snack bar products treated with A. marina mangrove flour increased at each concentration ranging from 8.656 - 13.398.

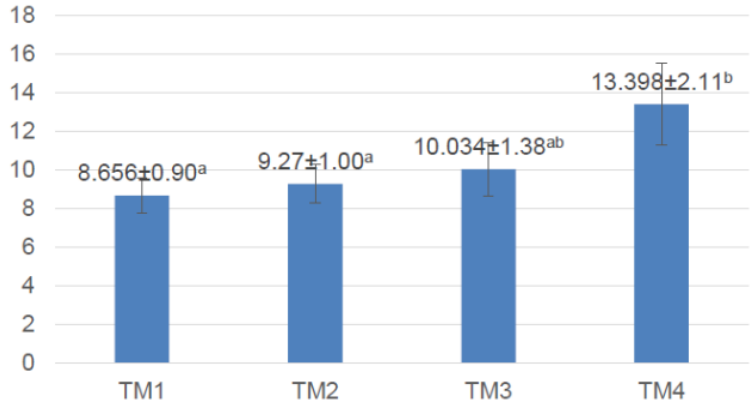

Figure 3. Graph of redness of snack bar with the addition of Avicennia marina api-api mangrove fruit flour (Remarks: 0% (TM1), 5% (TM2), 10% (TM3) and 15% (TM4) addition of Avicennia marina mangrove flour by weight total of all materials used)

The level of yellowness is indicated by the b value, the higher the yellowness value (b), the more yellow the resulting color. The + b (positive) value is from 0 to +70 for yellow and the -b (negative) value is from 0 to -70 for blue (Rahayu & Fidyasari, 2022). The higher the b value indicates that the intensity of the yellow color is increasing. The results of ANOVA and Tukey's further test of yellowness can be seen in Figure 4. The highest yellowness value was obtained in the TM1 treatment (0% A. marina Mangrove Fruit Flour) which was 44.252 ± 3.34 N. Meanwhile, the lowest redness value was obtained in the TM4 treatment (15 % Mangrove A. marina Fruit Flour) was 39.896 ± 2.71 N.

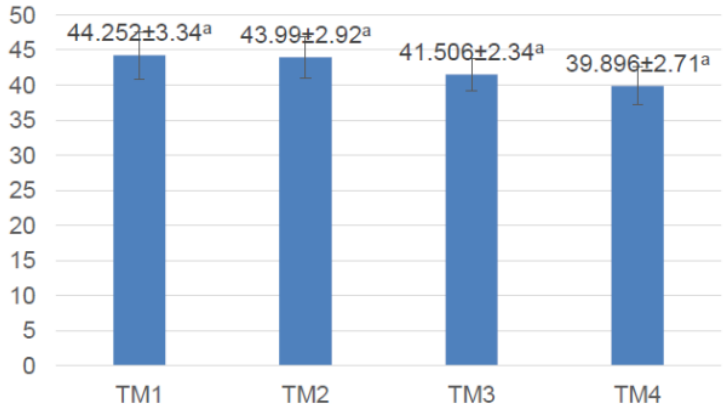

Figure 4. Graph of yellowness snack bar with the addition of Avicennia marina api-api mangrove fruit flour (Note: 0% (TM1), 5% (TM2), 10% (TM3) and 15% (TM4) addition of Avicennia marina mangrove flour by weight total of all materials used)

The °Hue value is used to determine the color characteristics of food products. Based on the °Hue color range, the snack bar is classified as yellow-red. The results of ANOVA and Tukey's further test of °Hue can be seen in Figure 5. The Hue value produced in the 0% to 15% treatment was 73°-78° indicating a yellow red color which means brown. This is in accordance with research conducted that the color of the snack bar produced is brown. °Hue shows the results of color angle measurements to distinguish whether the object is red, yellow, blue, green, or purple which is arranged in a circle with zero angles (0°, 360°) in red (Dewi & Ningtyas, 2021). The L value also indicates whether the yellow red color is brighter or less bright, so the greater the L value, the brighter the product.

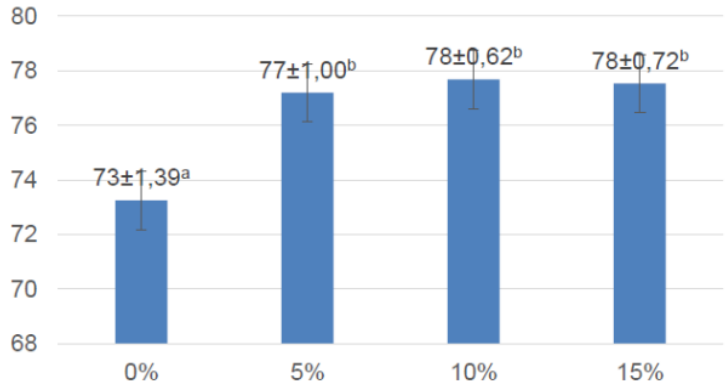

Figure 5. Graph of °Hue snack bar with the addition of Avicennia marina api-api mangrove fruit flour (Remarks: 0% (TM1), 5% (TM2), 10% (TM3) and 15% (TM4) addition of Avicennia marina mangrove flour from total weight of all materials used)

Apart from producing energy, carbohydrates also have other functions such as providing a sweet taste to food, conserving protein, regulating fat metabolism. The results of ANOVA and Tukey's further test for carbohydrate content can be seen in Figure 6. Based on the ANOVA results, it can be analyzed that the addition of Avicennia marina mangrove fruit flour to the snack bar has no significant effect ($p>0.05$) on the carbohydrate content of the snack bar. The greater the concentration of Avicennia marina mangrove fruit flour, the higher the carbohydrate content in the snack bar.

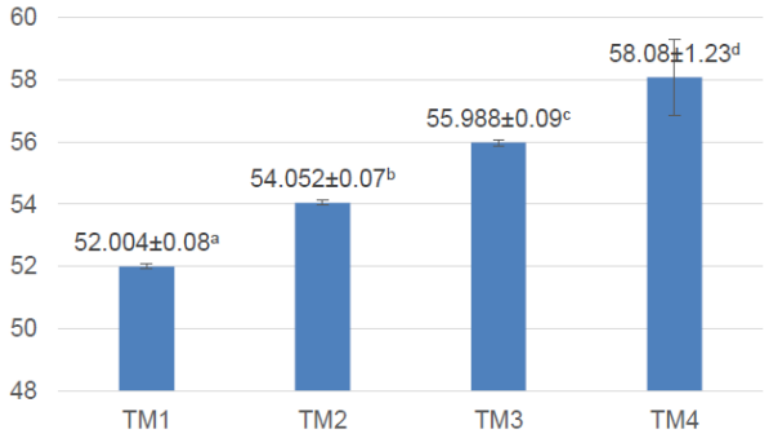

Figure 6. Snack bar carbohydrate graph with the addition of Avicennia marina api-api mangrove fruit flour (Note: 0% (TM1), 5% (TM2), 10% (TM3) and 15% (TM4) addition of *Avicennia marina* mangrove flour by weight total of all materials used)

Organoleptic Characteristics: *Avicennia marina* api-api mangrove fruit flour snack bar formulation

Organoleptic testing on the snack bar was aimed at determining the panelists' level of acceptance of the snack bar with the addition of Avicennia marina mangrove fruit flour. The scoring test is one of the organoleptic test methods used to assess product development products. The scoring test at this stage of the research used 50 semi-trained panelists. The assessments used on a product include the appearance of taste, aroma and texture. The results of the organoleptic test scoring snack bar Avicennia marina api-api mangrove fruit flour are presented in Table 4.

Table 4. Organoleptic test results scoring snack bar *Avicennia marina* api-api mangrove fruit flour

Treatment	Color	Smell	Flavor	Texture
TM1	3,556±0.537[a]	3,540±0.5231[a]	3,516±0.524[a]	3,432±0.528[a]
TM2	3,564±0.513[a]	3,564±0.513[a]	3,592±0.492[a]	3,456±0.515[a]
TM3	2,012±0.731[b]	2,204±0.823[b]	2,152±0.740[b]	2,164±0.751[b]
TM4	1,772±0.739[c]	1,836±0.812[c]	1,776±0.844[c]	1,824±0.787[c]

Information: Different superscript letter notations in the same column indicate that in the comparison between treatments there is a very significant difference ($p<0.05$).
Color: (1) dark brown; (2) brown; (3) light brown; (4) brownish yellow
Smell: (1) very aromatic of mangrove; (2) slightly aromatic of mangrove; (3) slightly scented snack bar; (4) Very flavorful snack bar
Flavor: (1) strong mangrove taste; (2) slight mangrove taste; (3) a little snack bar taste; (4) Very strong snack bar taste
Texture: (1) very hard; (2) hard (3) a little crunchy; (4) crunchy

The color value of the snack bar with the highest average was found in the TM2 treatment (5% *Avicennia marina* mangrove fruit flour). Meanwhile, the lowest average was found in the TM4 treatment (15% *Avicennia marina* mangrove fruit flour). The highest average aroma value was found in the TM1 treatment (5% *Avicennia marina* mangrove fruit flour). Meanwhile, the lowest average was found in the TM4 treatment (15% *Avicennia marina* mangrove fruit flour). Increasing the concentration of *Avicennia marina* mangrove fruit flour caused a decrease in panelist acceptance. This is due to the increasing distinctive aroma of the *Avicennia marina* mangrove. The highest average taste value was found in the TM2 treatment (5% *Avicennia marina* mangrove fruit flour). Meanwhile, the lowest average was found in the TM4 treatment (15% *Avicennia marina* mangrove fruit flour). This is because the greater the concentration of *Avicennia marina* mangrove fruit flour, the more pronounced the bitter taste will be. So the panelists preferred snack bars with the lowest concentration. The texture value of the snack bar with the addition of *Avicennia marina* mangrove fruit flour ranged from 3.456 – 1.824. The highest average texture value was found in the TM1 treatment (5% *Avicennia marina* mangrove fruit flour). Meanwhile, the lowest average was in the TM4 treatment (15% *Avicennia marina* mangrove fruit flour. The increasing concentration of *Avicennia marina* mangrove fruit flour in the formula caused the product to become harder so that the panelists' acceptance of the texture decreased.

Based on the results of testing the physicochemical and organoleptic characteristics, the best treatment was determined by adding *Avicennia marina* api-api mangrove fruit flour to snack bar products using De Garmo analysis. Snack bars with the addition of 5% *Avicennia marina* api-api mangrove fruit flour were the best treatment and then carried out proximate

analysis. The results of the proximate analysis of snack bars with the addition of 5% *Avicennia marina* mangrove fruit flour are shown in Table 5.

Table 5. Proximate analysis of *Avicennia marina* api-api mangrove fruit flour snack bar

Parameter	*Mangrove fruit flour snack bar A. marina* *)	*Snack bar modified vegetables and fruit* **)
Water	24,05%	48,2%
Ash	1,50%	-
Fat	9,05%	6,9%
Proteins	9,37%	9,5%
Carbohydrate	54,20%	23,4%
Calories	341,91 Kkal	193,7 Kkal

Source:
*) Nutrition Laboratory, Faculty of Public Health, Airlangga University (2023)
**) (Sari *et al.,* 2017)

DISCUSSION

Avicennia marina api-api mangrove fruit flour, apart from containing carbohydrates, protein, fat, water and ash, also contains tannins and HCN. The HCN content in *Avicennia marina* mangrove fruit flour is 3.03 mg/kg, this level is lower than the results of research conducted by (Chrissanty, 2012), namely 10.51 mg/kg. The HCN content that is safe for human consumption is 0.5-3.5 mg/kg body weight. The safe limit for HCN content in food is 50 mg/kg (Sulistyawati *et al.,* 2012). The decrease in HCN levels was influenced by the length of time the api-api fruit was soaked in husk ash. The longer the soaking time, the lower the HCN content in the flour. Apart from that, the addition of husk ash during the soaking process can also accelerate the reduction of HCN because the carbon in husk ash binds cyanide from api-api mangrove fruit. This husk ash carbon is able to draw out cyanide from inside the mangrove fruit, then move through the carbon pores and be absorbed into the inside of the carbon walls, resulting in a reduction in the cyanide content of the mangrove fruit (Sulistyawati *et al.,* 2012).

The tannin content in *Avicennia marina* mangrove fruit flour is 239.17 mg/kg, this value is higher than research conducted by (Chrissanty, 2012), namely 0.49 mg/kg. The safe limit for tannin content in food is 560 mg/kg body weight/day. The high tannin content in api-api mangrove fruit flour is caused by the lack of soaking time for api-api mangrove fruit. The longer the soaking time, the lower the tannin content will be. The longer the soaking with ash husks when making flour, the tannin content will diffuse out of the cells so that the tannin remaining in the material decreases (Permana *et al.,* 2017).

Based on physicochemical characteristics, the addition of *Avicennia marina* api-api mangrove fruit flour affects the texture and color. The addition of *Avicennia marina* api-api mangrove fruit flour increases the texture and color value of the snack bar. This is in accordance with research (Utari *et al.,* 2016), the higher the concentration of api-api mangrove fruit flour, the brightness of a product will decrease or the color will become darker. In addition, brightness is affected by the roasting process due to the Maillard reaction. Likewise with the redness value, the more the concentration of api-api mangrove fruit flour increases, the redness increases. The redness or redness value is also influenced by the high temperature of the oven where the sugar will react with the protein, causing the snack bar product to tend to be brown in color or react in a Maillard manner. The Maillard reaction during the color measurement process tends to be positive (Pradipta & Putri, 2015). Similar to research results (Utari *et al.,* 2016) stated that the more Avicennia marina mangrove flour increases, the yellowness color (b) will decrease. The °Hue value produced in the 0% to 15% treatment is 73°-78° indicating a yellow red color which means brown.

The organoleptic scoring test is carried out by observing color, aroma, taste and texture. The results of the scoring test on all parameters showed that increasing the concentration of api-api fruit flour reduced the panelists' acceptance of color, aroma, taste and texture. The addition of *Avicennia marina* api-api mangrove fruit flour in high concentration causes a brownish color and astringent taste in the snack bar. This is because high tannin levels cause a brown color and astringent taste. The results of De Garmo's analysis showed that the 5% concentration of api-api mangrove fruit flour in the snack bar was the best concentration and was acceptable to the panelists. This snack bar with the addition of api-api mangrove fruit flour contains 24.05% water; ash 1.50%; fat 9.05%; protein 9.37%; carbohydrates 54.20%; and calories 341.90 Kcal. This snack bar product still needs to be developed and further researched for its functional properties so that in the long term it can be used to reduce malnutrition rates in society (Yan *et al.,* 2017). The protein content in the api-api mangrove fruit flour snack bar can also be increased by adding fish (Zulaikha *et al.,* 2021) or collagen for consumption by the elderly (Hastaoğlu *et al.,* 2023).

CONCLUSION

The concentration of adding Avicennia marina api-api mangrove fruit flour of 5% had a significant effect on snack bar products with physical tests, namely texture 191.34; lightness 45,066; redness 9.27; and yellowness 43.99; carbohydrate levels of 54,052. The proximate analysis values were water content 24.05%, ash content 1.50%, protein content 9.37%, fat content 9.05%, and carbohydrate content 54.20%. Organoleptic test scoring color 3.564, aroma 3.564, taste 3.592, and texture 3.456.

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REFERENCES

Al-jaghthmi, O. H. A., Eldin, I., Elamin, M., & Zeid, A. (2020). Hypoglycemic and hepatoprotective effect of Rhizophora mucronata and Avicennia marina against streptozotocin-induced diabetes in male rats. *Journal of Advanced Veterinary and Animal Research, 7*(1), 177–185. doi: 10.5455/javar.2020.g408

Aryanti, N. (2016). Ekstraksi dan Karakterisasi Klorofil dari Daun Suji (*Pleomele Angustifolia*) Sebagai Pewarna Pangan Alami. *Jurnal Aplikasi Teknologi Pangan*, *5*(4). https://doi.org/10.17728/jatp.196

Chrissanty, A. (2012). Penurunan Kadar Tanin pada Buah Mangrove Jenis *Brugueira gymnorrhiza*, *Rhyzophora stylosa* dan *Avicennia marina* untuk Diolah Menjadi Tepung Mangrove *Decreasing Tannins Level in Mangrove Type Avicennia marina*, *Brugueira gymnorrhiza* and *Rhyzophora stylosa* for. *Jurnal Industria*, *1*(1), 31–39.

Coello, K. E., Frias, J., Martínez-Villaluenga, C., Cartea, M. E., Velasco, P., & Peñas, E. (2022). Manufacture of healthy *snack bar*s supplemented with moringa sprout powder. *Lwt*, *154*. https://doi.org/10.1016/j.lwt.2021.112828

Dewi, A., & Ningtyas, R. (2021). Kesegaran Fillet Ikan Patin Pada Suhu Chiller Smart Packaging Based on Purple Sweet Potato Extract As. *SAGU Journal-Agri. Sci. Tech*, *20*(2), 40–48.

Hastaoğlu, F., Hastaoğlu, E., Bağlam, N., & Taş, İ. N. (2023). Sensorial and Nutritional Properties of a Collagen-Fortified *Snack bar* Designed for the Elderly. *Nutrients*, *15*(16). https://doi.org/10.3390/nu15163620

Irmayanti, I., Syam, H., & Jamaluddin P. (2017). Perubahan Tekstur Kerupuk Berpati Akibat Suhu Dan Lama Penyangraian. In *Jurnal Pendidikan Teknologi Pertanian, 3(3), 165-174*. https://doi.org/10.26858/jptp.v3i0.5716

Marina, Emmanuali, & Yulia, A. (2018). Pengaruh Lama Pengukusan Terhadap Penurunan Kadar Asam Sianida (HCN) Biji Api-api dalam Pembuatan Tepung Biji Api-api (*Avicennia marina*) (Forks) Vierh. *Prosiding Seminar Nasional Fakultas Pertanian Universitas Jambi*, 487–503.

Olagunju, A. I., Arigbede, T. I., Makanjuola, S. A., & Oyebode, E. T. (2022). Nutritional compositions, bioactive properties, and in-vivo glycemic indices of amaranth-based optimized multigrain *snack bar* products. *Measurement: Food*, *7*(5), 1-9. https://doi.org/10.1016/j.meafoo.2022.100039

Permana, K. D. A., Hartiati, A., & Admadi, B. (2017). Pengaruh Konsentrasi Larutan Natrium Klorida (NaCl) Sebagai Bahan Perendam Terhadap Krakteristik Mutu Pati Ubi Talas (*Calocasia esculenta L. Schott*). *Jurnal Rekayasa Dan Manajemen Agroindustri*, *5*(1), 60–70.

Pradipta, I. B. Y. V., & Putri, W. D. R. (2015). The Effect of Wheat Flour and Mung Bean Flour Proportion and Substitution with Rice Bran Flour in Biscuit. *Jurnal Pangan Dan Agroindustri*, *3*(3), 793–802.

Rahayu, L. O., & Fidyasari, A. (2022). Organoleptic And Dietary Fiber Quality of Black Pigeon Pea Flour As Bioencapsulation Material. *Jurnal Inovasi Penelitian*, *3*(4), 5911–5918.

Sari, D. Y. E., Angkasa, D., & Swamilaksita, P. D. (2017). Daya Terima dan Nilai Gizi *Snack bar* Modifikasi Sayur dan Buah Untuk Remaja Putri. *Jurnal Gizi*, *6*(1), 1–11.

Sharaf, M. U., & Saleh, N. A. M. (2000). *New flavonoids from Avicennia marina*, *71*(3), 274–277.

Sulistyawati., Wignyanto., & Kumalaningsih, S. (2012). Produksi Tepung Buah Lindur (*Bruguiera gymnorrhiza* Lamk) Rendah Tanin dan HCN Sebagai Bahan Pangan Alternatif. *Jurnal Teknologi Pertanian*, *13*(3), 187–198.

Triastuti, J., Nashir, N. G. A., & Nirmala, D. (2022). Pengaruh Tepung Buah Api-Api (*Avicennia marina*) Sebagai Substitusi Tepung Terigu Terhadap Kualitas dan Peningkatan Serat Crackers. *Journal of Marine and Coastal Science, 11*(2), 74-80. https://doi.org/10.20473/jmcs.v11i2.35021

Utari, K. S. T., Dewi, E. N., & Romadhon. (2016). Sifat Fisika Kimia *Fish Snack Ekstrusi* Ikan Nila (*Oreochromis niloticus*) dengan Penambahan Grit Buah Lindur (*Bruguiera gymnorrizha*). *Jurnal Pengabdian & Bioteknologi Hasil Perikanan, 5*(4), 33–42.

Wang, J., Qin, Y., Lin, M., Song, Y., Lu, H., Xu, X., Liu, Y., Zhou, X., Gao, C., & Luo, X. (2023). Marine Natural Products from the Beibu Gulf: Sources, Chemistry, and Bioactivities. *Marine Drugs*, *21*(2). https://doi.org/10.3390/md21020063

Yan, M. R., Parsons, A., Whalley, G. A., & Rush, E. C. (2017). Effects of a healthier snack on snacking habits and glycated Hb (HbA1c): A 6-week intervention study. *British Journal of Nutrition*, *116*(12), 2169–2174. https://doi.org/10.1017/S0007114516004372

Zulaikha, Y., Yao, S. H., & Chang, Y. W. (2021). Physicochemical and functional properties of *snack bar*s enriched with tilapia (*Oreochromis niloticus*) by-product powders. *Foods*, *10*(8). https://doi.org/10.3390/foods10081908