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ANALYSIS OF THE LEVEL OF PREFERENCE OF SNACK BARS WITH THE ADDITION OF BLUE SWIMMING CRAB SHELL FLOUR

Analisis Tingkat Kesukaan Snack Bar Dengan Penambahan Tepung Cangkang Rajungan

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ABSTRACT

Blue Swimming Crab (*Portunus pelagicus*) has a calcium content in the crab shell of 19.97%, which has the potential to be used as an additional ingredient in snack bar products. This study aims to determine the concentration of blue swimming crab shell flour to produce the snack bars that panelists prefer. The study was conducted from October to December 2024 at the Fisheries Product Processing Laboratory, Faculty of Fisheries and Marine Sciences, Padjadjaran University, Nutrition Laboratory, Faculty of Animal Husbandry, Padjadjaran University, and Saraswati Indo Genetech Laboratory, Bogor. The research is classified as experimental research with a Completely Randomized Design method, namely making snack bars with the addition of crab shell flour with four treatments (0%, 1.5%, 2.5%, and 3.5%) and 25 semi-trained panelists as replications to determine the level of panelist preference for snack bars. Data analysis was done using the Friedman and Bayes tests to determine the best treatment. The parameters observed were the organoleptic and chemical content of the snack bar. The results showed that the most preferred addition of crab shell flour was the 2.5% treatment because it had the most significant alternative value of 8.61 with an average appearance of 8.0, aroma of 8.3, texture of 7.4, and taste of 7.9. The chemical characteristics produced by this treatment: 1.75% water content, 2.85% ash content, 9.62% protein content, 12.93% fat content, 72.85% carbohydrate content, and 436.48 mg/100 g calcium content.

Key words: Blue Swimming Crab, Calcium, Flour, Hedonic, Proximate.

ABSTRAK

Rajungan (*Portunus pelagicus*) memiliki kandungan kalsium pada cangkang rajungan sebesar 19,97% yang berpotensi dimanfaatkan sebagai bahan tambahan dalam produk *snack bar*. Penelitian ini bertujuan untuk menentukan konsentrasi penambahan tepung cangkang rajungan guna menghasilkan *snack bar* yang paling disukai panelis. Penelitian dilaksanakan pada bulan Oktober sampai Desember 2024 di Laboratorium Pengolahan Hasil Perikanan Fakultas Perikanan dan Ilmu Kelautan Universitas Padjadjaran, Laboratorium Nutrisi Fakultas

Peternakan Universitas Padjadjaran, dan Laboratorium Saraswati Indo Genetech Bogor. Penelitian ini tergolong penelitian eksperimental dengan metode Rancangan Acak Lengkap yaitu pembuatan *snack bar* dengan penambahan tepung cangkang rajungan dengan empat perlakuan (0%; 1,5%; 2,5%; dan 3,5%) dan 25 orang panelis semi terlatih sebagai ulangan untuk mengetahui tingkat kesukaan panelis terhadap *snack bar*. Analisis data dilakukan menggunakan uji Friedman dan Bayes untuk mengetahui perlakuan terbaik. Parameter yang diamati adalah organoleptik dan karakteristik kimia *snack bar*. Hasil penelitian menunjukkan bahwa penambahan tepung cangkang rajungan yang paling disukai adalah perlakuan 2,5% karena memiliki nilai alternatif terbesar yaitu 8,61 dengan nilai rata-rata kenampakan yaitu 8,0; aroma 8,3; tekstur 7,4; dan rasa 7,9. Karakteristik kimia yang dihasilkan perlakuan ini yaitu kadar air 1,75%, kadar abu 2,85%; kadar protein 9,62%; kadar lemak 12,93%; kadar karbohidrat 72,85%, dan kadar kalsium 436,48 mg/100 g.

Kata Kunci: Hedonik, Kalsium, Proksimat, Rajungan, Tepung.

INTRODUCTION

Blue swimming crab (Portunus pelagicus) is one of the fishery commodities with high economic value after shrimp and tuna. The export value of blue swimming crab has increased until 2021 reaching a value of 613.24 million US dollars (KKP, 2022). The process of taking crab meat produces waste in the form of shells of up to 40-60% of the total weight of the crab. Blue swimming crab shells contain useful chemical compounds such as protein, minerals, and chitin (Rochima, 2014). This by-product of blue swimming crab is easily rotten, so it requires proper handling so that it can be utilized effectively and efficiently to reduce pollution and increase added value. One form of utilization of blue swimming crab shells in the food sector is by processing it into flour as a source of calcium in processed products.

Blue swimming crab shell flour can be used as an alternative food ingredient that has a longer shelf life, easy handling and good nutritional content. Crab shell flour has high nutritional content such as 19.97% calcium, 1.81% phosphorus, 30-40% protein, and 30-50% minerals ($CaCO_3$) (Amalia, 2018; Zahro & Ainiyah, 2022). The high calcium content in crab shell flour can meet human daily calcium needs (Beybidanin et al., 2016). There are fast food products such as snack bars that can be an alternative source of calcium (Sukmawati et al., 2022).

Snack bar is one of the ready-to-eat food products in the form of a bar with a basic mixture of various ingredients, such as cereals, dried fruits, and nuts that are bound together with the help of a binding agent (Binder) (Falah *et al.,* 2022; Indrawan *et al.,* 2018; Zahro & Ainiyah, 2022). Snack bars are developed as emergency food sources of energy because they contain sufficient calories and complete nutrition, namely carbohydrates, fat, protein, fiber, vitamins, and minerals (Octaviany *et al.,* 2024). The addition of crab shell flour aims to enrich the mineral content, especially calcium which is generally still limited to snack bar products. This innovation is expected to support the development of food products, especially in the utilization of crab waste, as well as being an alternative to wheat flour which is still predominantly used. The use of crab shell flour in making snack bars is based on its high calcium content, complete nutritional composition, and has a good level of acceptance by consumers.

This study aims to determine the concentration of added crab shell flour to produce snack bars that are most preferred by panelists. This research is expected to be useful in the development of science, especially in the field of fishery product processing as a source of nutritionally valuable food additives.

RESEARCH METHODS

Time and Place

This research was conducted from October to December 2024. The implementation stage started from making crab shell flour, making snack bar products, and hedonic testing was carried out at the Fisheries Product Processing Laboratory, Faculty of Fisheries and Marine Sciences, Padjadjaran University. Chemical testing including water content, ash content, protein content, fat content, and carbohydrate content was carried out at the Nutrition Laboratory, Faculty of Animal Husbandry, Padjadjaran University, and calcium content was carried out at the Saraswati Indo Genetech Laboratory, Bogor.

Tools and Materials

The tools used in this study were electric oven, digital scales, basins, pans, gas stoves, baking paper, baking pans, grinders, 100 mesh sieves, ziplock plastic, spoons, whisks, teflon, tongs, plastic gloves, small plates, rags, mortars, pestles, and cameras. The materials used in this study were crab shells, oats, margarine, egg whites, palm sugar, powdered milk, vanilla flavoring, salt, cocoa powder, and mineral water.

Research Methods

This study used an experimental method consisting of four treatments and 25 replications. The treatments consisted of:
A : Without adding crab shell flour.
B : Adding 1.5% crab shell flour.
C : Adding 2.5% crab shell flour.
D : Adding 3.5% crab shell flour.

Research Procedure

Making blue swimming crab shell flour

The stages of making crab shell flour refer to the research of Pujianto *et al.* (2018), which was modified as follows: the crab shells are sorted to separate the crab shells that are still suitable for use, then cleaned using running water. Furthermore, the crab shells are boiled using a pan at a temperature of 100℃ for 30 minutes. After boiling, the crab shells are drained and reduced in size by 1-2 cm using a mortar and pestle to facilitate the ovening process. The crab shells are then dried using an oven at a temperature of 50 ℃ for 40 minutes, before finally being ground using a grinder and sieved using a sieve with a size of 100 mesh.

Making Blue Swimming Crab Shell Flour Snack Bars

The stages of making snack bars according to Syarafina *et al*. (2022), which were modified are as follows: margarine is heated using a Teflon and stove until melted. Next, egg whites, palm sugar, and liquid margarine are beaten using a whisk at medium speed until caramel forms. Vanilla flavor, salt, and powdered milk are then added to the caramel mixture. Crab shell flour is added according to the specified formulation. Oats and chocolate are also added to the caramel mixture, then the mixture is stirred using a spoon until evenly mixed. The dough is divided into several parts weighing 10 g each, then formed into bars measuring 4 x 2.5 x 1.5 cm. After that, the molded dough is then baked using an oven at a temperature of 125 ℃ for 25 minutes. The cooked snack bars are removed from the oven and cooled, then put into airtight packaging.

The formulation for making snack bars is used according to the treatment of adding crab shell flour that has been determined, namely A (0%), B (1.5%), C (2.5%), D (3.5%) as follows:

Table 1. Snack Bar Making Formulation

Material (g)	Blue swimming crab shell flour treatment			
	A (0%)	B (1,5%)	C (2,5%)	D (3,5%)
Oats	250	250	250	250
Crab shell flour	-	3,75	6,25	8,75
Margarine	44	44	44	44
Egg white	30	30	30	30
Palm sugar	82	82	82	82
Milk powder	12	12	12	12
Vanilla flavoring	0,5	0,5	0,5	0,5
Salt	0,5	0,5	0,5	0,5
Chocolate powder	15	15	15	15
Total	434	437,75	440,25	442,75

Observation parameters

The main parameters in this study were the panelists' preference levels obtained through hedonic testing and analyzed statistically using the Friedman test and the Bayes method. Other parameters also tested in this study included water content, ash content, protein content, fat content, carbohydrate content, and calcium content which were analyzed descriptively.

RESULT

Snack Bar Organoleptic Test

Appearance

Appearance is the first and quite important organoleptic parameter, because if the panelists give a good and preferred impression of the appearance, then the panelists will look at other organoleptic parameters, namely aroma, texture, and taste (Husen, 2022). The average results of the hedonic value of the appearance of snack bars with the addition of crab shell flour are presented in Table 2.

Table 2. Results of Hedonic Test of Appearance of Snack Bar with the Addition of Crab Shell Flour

Treatment	Median	Average
A (0%)	7	7,8[a]
B (1,5%)	7	7,8[a]
C (2,5%)	9	8,0[a]
D (3,5%)	7	7,2[a]

Description: The average treatment figures followed by the same letter show no significant difference according to the multiple comparison test at the 5% level.

The results of the statistical analysis of the Friedman test in Table 2 show that the addition of crab shell flour did not significantly affect the level of panelists' preference for the appearance attribute of the resulting snack bar. The results of the multiple comparison test showed that all treatments did not have significant differences. Treatment C (2.5%) was the best treatment in assessing appearance because it had the highest average value compared to other treatments. The median value of the level of preference for the appearance of the snack bar ranged from 7 to 9, which was included in the category of liking to really liking. The appearance of the snack bar in this study can be seen in Figure 1.

Figure 1. Appearance of Snack Bar with the Addition of Crab Shell Flour: (a) 0%; (b) 1.5%; (c) 2.5%; (d) 3.5%.

Aroma

Aroma is a very subjective smell and difficult to measure because each individual has different sensitivities and preferences. The aroma of food ingredients affects the deliciousness, taste preferences, and food safety by helping to identify freshness, rancidity, and the presence of toxic substances (Alam *et al.,* 2020). The average hedonic value of the aroma of snack bars with the addition of crab shell flour is presented in Table 3.

Table 3. Hedonic Test Results of Snack Bar Aroma with the Addition of Crab Shell Flour

Treatment	Median	Average
A (0%)	7	7,6^{ab}
B (1,5%)	7	7,9^{ab}
C (2,5%)	9	8,3^{b}
D (3,5%)	7	7,0^{a}

Description: The average treatment figures followed by the same letter show no significant difference according to the multiple comparison test at the 5% level.

The results of the statistical analysis of the Friedman test in Table 3 show that the addition of crab shell flour has a significant effect on the level of panelists' preference for the aroma of the resulting snack bar. The results of the multiple comparison test showed that treatment C (2.5%) was significantly different from treatment D (3.5%), but not significantly different from treatments A (0%) and B (1.5%). Treatment D (3.5%) was also not significantly different from treatments A (0%) and B (1.5%). Treatment C (2.5%) was the best treatment because it had the highest average value and was significantly different from treatment D (3.5%). The median value of the level of preference for the aroma of the snack bar ranged from 7 to 9, which was included in the category of liking to liking very much.

Texture

Food texture is one of the physical and sensory characteristics used by consumers to assess the quality of food products. Texture plays a major role in identifying products and determining their overall (Hariyadi, 2022). The average hedonic value of snack bar texture with the addition of crab shell flour is presented in Table 4.

Table 4. Hedonic Test Results of Snack Bar Texture with the Addition of Crab Shell Flour

Treatment	Median	Average
A (0%)	7	6,5[a]
B (1,5%)	7	7,2[ab]
Perlakuan	Median	Rata-rata
C (2,5%)	7	7,4[ab]
D (3,5%)	9	7,9[b]

Description: The average treatment figures followed by the same letter show no significant difference according to the multiple comparison test at the 5% level.

The results of the statistical analysis of the Friedman test in Table 4 show that the addition of crab shell flour has a significant effect on the level of panelists' preference for the texture attribute of the resulting snack bar. The results of the multiple comparison test show that treatment A (0%) is significantly different from treatment D (3.5%), but not significantly different from treatments B (1.5%) and C (2.5%). Treatment D (3.5%) is also not significantly different from treatments B (1.5%) and C (2.5%). Treatment D (3.5%) is the best treatment with the highest average value and is significantly different from treatment A (0%). The median value of the level of preference for the texture of this snack bar ranges from 7 to 9 which is included in the category of like to really like.

Flavor

Taste is the main factor for consumers in choosing food products to be consumed (Wael et al., 2023). The taste of a food ingredient can be influenced by the combination of flavors produced by various ingredients used during the processing process (Singgih & Harijono, 2015). The average hedonic value of the taste of snack bars with the addition of crab shell flour is presented in Table 5.

Table 5. Hedonic Test Results of Snack Bar Flavor with the Addition of Crab Shell Flour

Treatment	Median	Average
A (0%)	7	7,4[ab]
B (1,5%)	7	7,3[ab]
C (2,5%)	9	7,9[b]
D (3,5%)	7	6,4[a]

Description: The average treatment figures followed by the same letter show no significant difference according to the multiple comparison test at the 5% level.

The results of the statistical analysis of the Friedman test in Table 5 show that the addition of crab shell flour has a significant effect on the level of panelists' preference for the taste attributes of the resulting snack bar. The results of the multiple comparison test show that treatment C (2.5%) is significantly different from treatment D (3.5%), but not significantly different from treatments A (0%) and B (1.5%). Treatment D (3.5%) is also not significantly different from treatments A (0%) and B (1.5%). Treatment C (2.5%) is the best treatment with the highest average value and is significantly different from treatment D (3.5%). The median value of the level of preference for the taste of the snack bar ranges from 7 to 9 which is included in the category of like to really like.

Decision Making with Bayes Method

The selection of the best snack bar was carried out using the Bayes method based on the multiplication of the median value of the hedonic test of each criterion in each treatment with

the weight value of the criterion. The results of the data are presented in the decision matrix in Table 6.

Table 6. Decision Matrix for the Assessment of Crab Shell Flour Snack Bars Using the Bayes Method

Treatment	Critera				Alternative Values	Priority Values
	Appearance	Aroma	Texture	Flavor		
A (0%)	7,00	7,00	7,00	7,00	7,00	16,42
B (1,5%)	7,00	7,00	7,00	7,00	7,00	16,42
Treatment	Critera				Alternative Values	Priority Values
	Appearance	Aroma	Texture	Flavor		
C (2,5%)	9,00	9,00	7,00	9,00	8,61	20,18
D (3,5%)	7,00	7,00	9,00	7,00	7,39	17,34
Bobot Kriteria	0,09	0,10	0,20	0,61	0,43	1,00

Based on the calculation using the Bayes method in Table 6, the results show that all snack bars with the addition of crab shell flour are still accepted or preferred by the panelists. The results of the snack bar decision matrix show that the most preferred treatment is the treatment of adding 2.5% crab shell flour because it has the highest alternative value and priority value than other treatments, namely 8.61 and 20.18. This shows that the 2.5% treatment has the most optimal sensory characteristics and is most preferred by the panelists based on consideration of all its attributes.

Chemical Characteristics

Chemical tests include water content, ash content, protein content, fat content, carbohydrate content, and calcium content. Chemical tests were conducted on snack bars without the addition of crab shell flour and the snack bar most preferred by panelists, namely snack bars with the addition of 2.5% crab shell flour. The results of the chemical test of the snack bar can be seen in Table 7.

Table 7. Snack Bar Chemical Test Results

No	Analysis Parameters	Chemical Analysis Results		Quality Requirements
		Crab Shell Flour 0%	Crab Shell Flour 2,5%	
1	Water content (%)	2,52	1,75	Maks. 11,3%*
2	Ash Content (%)	1,99	2,85	Maks. 1,72%*
3	Protein Content (%)	11,56	9,62	Min. 9,38%*
4	Fat Content (%)	13,41	12,93	1,4-14%**
5	Carbohydrate Content (%)	70,52	72,85	Min. 66,7%*
6	Calcium Level (mg)	88,15	436,48	Min. 65 mg*

Information:
*USDA (2018)
** Badan Standardisasi Nasional (1996)

Water Content

Based on the results of the chemical characteristic analysis in Table 7, it can be seen that the addition of crab shell flour can reduce the water content of the snack bar. The water content in the control snack bar (without the addition of crab shell flour) was 2.52%, while in the snack

bar that was most preferred by the panelists (the addition of 2.5% crab shell flour) it was 1.75%. The addition of 2.5% crab shell flour to the snack bar can reduce the water content by 0.77%. When compared with the quality requirements of USDA 25048:2018 regarding nutri-grain fruit and nuts, both treatments have met the maximum water content requirements of 11.3%.

Ash content

Based on the results of the chemical characteristic analysis in Table 7, it can be seen that the addition of crab shell flour can increase the ash content of the snack bar. The ash content of the snack bar in the treatment without the addition of 0% crab shell flour was 1.99% and the ash content of the snack bar in the treatment with the addition of 2.5% crab shell flour was 2.85%. The addition of 2.5% crab shell flour to the snack bar can increase the ash content by 0.86%. The ash content produced from both snack bar treatments was higher than the limit set in the USDA quality standard Number 25048 of 2018 for nutri-grain fruit and nuts, which is a maximum of 1.72%. Thus, the ash content of the snack bar tested did not meet the requirements set by the USDA.

Protein Content

Based on the results of the chemical characteristic analysis in Table 7, it can be seen that the addition of crab shell flour can reduce the protein content of the snack bar. The protein content of the control snack bar (without the addition of crab shell flour) was 11.56%, while the snack bar that was most preferred by the panelists (the addition of 2.5% crab shell flour) was 9.62%. The addition of 2.5% crab shell flour to the snack bar can reduce the protein content by 1.94%. When compared to the quality requirements of USDA 25048:2018 regarding nutri-grain fruit and nuts, the snack bar with the addition of 2.5% crab shell flour meets the minimum protein content requirement of 9.38%. Thus, the snack bar with the addition of 2.5% crab shell flour, in addition to being preferred by the panelists, can also meet the protein based on the USDA quality requirements.

Fat Content

Based on the results of the chemical characteristic analysis in Table 7, it can be seen that the addition of crab shell flour can reduce the fat content of the snack bar. The fat content in the control snack bar (without the addition of crab shell flour) was 13.41%, while in the snack bar that was most preferred by the panelists (the addition of 2.5% crab shell flour) was 12.93%. The addition of 2.5% crab shell flour to the snack bar can reduce the fat content by 0.48%. When compared with the quality requirements of SNI 01-4216-1996 concerning weight control diet food, the snack bar with the addition of 2.5% crab shell flour meets the fat content requirements ranging from 1.4-14%.

Carbohydrate content

Based on the results of the chemical characteristic analysis in Table 7, it can be seen that the addition of crab shell flour can increase the carbohydrate content of the snack bar. The carbohydrate content in the control snack bar (without the addition of crab shell flour) was 70.52%, while in the most preferred snack bar (addition of 2.5% crab shell flour) it was 72.85%. The addition of crab shell flour to the snack bar by 2.5% can increase the carbohydrate content by 2.33%. Based on USDA quality requirements Number 25048 of 2018 concerning nutri-grain fruit and nuts which states that the minimum carbohydrate content is 66.7%, the carbohydrate content of the resulting snack bar meets USDA requirements.

Calcium levels

Based on the results of the chemical characteristic analysis in Table 7, it can be seen that the addition of crab shell flour can increase the calcium content of the snack bar. The calcium content of the snack bar in the treatment without the addition of 0% crab shell flour is 88.15 mg and the calcium content of the snack bar in the treatment with the addition of 2.5% crab shell flour is 436.48 mg. The addition of 2.5% crab shell flour to the snack bar can increase the calcium content by 348.33 mg. Based on the quality requirements of USDA Number 25048 of 2018 concerning nutri-grain fruit and nuts which states that the minimum calcium content is 65 mg, the carbohydrate content of the resulting snack bar meets USDA requirements.

DISCUSSION

The results of the organoleptic test of the appearance of the snack bar showed that the highest average appearance value was in treatment C with the addition of 2.5% crab shell flour. The appearance of the snack bar in this treatment had a rather dark light brown color, a less intact bar shape and an inconsistent thickness. The lowest average value was in the treatment of adding 3.5% crab shell flour with a dark brown snack bar color, an incomplete bar shape and inconsistent thickness. Overall, Figure 1 shows that the color of the snack bar looks increasingly dark brown as the addition of crab shell flour increases. This brown color comes from the addition of cocoa powder in the same amount to all samples, which is 6%. The addition of cocoa powder also affects the visual component in the form of brown color in the sample. The brown color of the snack bar is also caused by crab shell flour, oats and palm sugar which undergo caramelization and Maillard reactions (Diana & Anggreini, 2023; Sari, 2016). This is in line with the research of Nur'aini *et al.* (2022), which states that the color of snack bars with the addition of male banana flour and tofu dregs is influenced by the sugar caramelization process and the Maillard reaction. The snack bars in this study have a bar shape. The addition of crab shell flour mixed with oats makes it difficult to achieve a homogeneous dough so that the final result becomes fragile, less intact and inconsistent in thickness during the molding process. This is in line with the research of Rahardjo *et al.* (2020), that the addition of oats in cookies causes the dough to be non-homogeneous and the final texture is fragile because there are differences in the particle size of the oats.

The results of the organoleptic test of the snack bar aroma showed that treatment C (2.5%) had the highest average value of 8.3. The aroma produced in this treatment was a distinctive blend of oats, margarine, and chocolate which was quite strong, and no chalky odor was detected. Meanwhile, treatment D (3.5%) had the lowest average snack bar aroma value of 7.0. The aroma produced in this treatment was a distinctive blend of oats, margarine, and chocolate, but the smell of chalk was already detectable. The addition of crab shell flour up to 2.5% can increase the level of liking for the snack bar aroma, but at an addition of 3.5% it decreased. This is because the smell of quicklime was detected due to the addition of crab shell flour. This decrease is in line with the research of Lestari *et al.* (2024), which showed that the level of panelists' preference for aroma decreased with the increasing percentage of crab shell flour in tempeh nuggets. The aroma characteristics of a product are influenced by the presence of volatile compounds contained in its ingredients (Pratama *et al.,* 2018). Crab shell flour has a quicklime aroma due to the high calcium carbonate ($CaCO_3$) content in its shell (Hastuti *et al.,* 2012). In addition, the aroma that appears in snack bars is also influenced by the use of oats and chocolate powder which produce a distinctive oat and chocolate aroma (Tarigan & Iflah, 2017). The aroma of snack bars is also influenced by margarine and milk powder (Vindianti *et al.,* 2024).

The results of the organoleptic test of the snack bar texture showed that treatment D (3.5%) had the highest average value of 7.9. This treatment produced a dense, slightly

crunchy/brittle, slightly sticky texture with a slightly rough and compact surface texture. In contrast, treatment A (0%) had the lowest average snack bar texture value of 6.5 with a dense but slightly hard, sticky texture and a slightly smooth surface texture. Crab shell flour contains calcium carbonate which is insoluble in water, so it can increase the hardness of the snack bar product. However, in controlled amounts, crab shell flour can also provide a crunchy effect because it is able to retain steam and form small cavities during the heating process. These results are in line with the research of Mardiyah *et al.* (2022), which states that the more anchovy flour is added to the snack bar, the more fragile, sandy and rough the resulting texture. This is also reinforced by Syarafina *et al.* (2022), that the more patin fish bone flour is added to the snack bar, the rougher the surface. The addition of egg white to snack bars can also reduce the level of crispiness, resulting in a harder texture (Cahya & Amara, 2024).

The results of the organoleptic test of the snack bar taste showed that treatment C (2.5%) had the highest average value of 7.9. This treatment produced a sweet taste, a slightly detectable savory taste, and no detectable bitter taste. In contrast, treatment D (3.5%) had the lowest average snack bar taste value of 6.4 with a slightly sweet, slightly savory and tending to be bitter taste. This is in line with the research of Sukmawati *et al.* (2022), which stated that the more anchovy flour added, the less sweet the resulting snack bar taste. The more savory taste of the snack bar with the addition of crab shell flour is caused by the amino acids that make up the protein in the crab shell. This is reinforced by the research of Syarafina *et al.* (2022), that the more patin fish bone flour added to the snack bar, the more savory the resulting taste will be. The addition of 3.5% crab shell flour causes the resulting snack bar to taste slightly bitter. The more crab shell flour, the more protein compounds are degraded. The bitter taste can be caused by protein degradation from crab shells when processed at high temperatures.

The results of the chemical characteristics of the water content of snack bars show that the more crab shell flour is added, the lower the water content. This is in line with Sari's research, (2016) which states that the addition of 0-15% crab shell flour can reduce the water content of sago crackers from 12.47% to 8.74%. This is also reinforced by research by Nafsiah *et al.* (2022), where the addition of 0-10% crab shell flour can reduce the water content of tortilla chips from 3.07% to 2.59%. The decrease in water content occurs because the addition of crab shell flour causes an increase in Ca^{2+} particles. These Ca^{2+} particles will bind OH^- particles which are components of water (H_2O) so that the water content decreases along with the increasing amount of crab shell flour added (Sari, 2016). Too high a water content in snack bars can make the texture denser, while snack bars with lower water content produce an increasingly crumbly texture (Nur'aini *et al.,* 2022).

The results of the analysis of the chemical characteristics of ash content showed that the more crab shell flour was added, the more the ash content increased. In line with the research of Nafsiah *et al.* (2022), the ash content in tortilla chips increased along with the increasing concentration of crab shell flour addition, namely 4.06% to 7.07%. This is because crab shell flour contains a fairly high ash content of 56.10%, which is the main cause of the harder snack bar texture (Hapsoro *et al.,* 2017). In addition, the increase in crab shell flour is also due to the high mineral content in crab shell flour, namely calcium of 39.32% and phosphorus 2.67 mg (Hapsoro *et al.,* 2017; Khasanah & Hartati, 2016).

The results of the analysis of the chemical characteristics of protein content showed that the more the addition of crab shell flour, the lower the protein content. The decrease in protein content comes from the high temperature used in the cooking process (Sundari *et al.,* 2015). The results of this study are in line with the research of Hapsoro *et al.* (2017), which showed that the addition of 0% -7.5% crab shell flour can reduce the protein content in cookies from 10.43% to 9.65%. The results obtained showed that the protein content was dissolved with the water in the cookies and evaporated during the baking process. The higher the addition of crab

shell flour, the lower the protein content. This is because the protein content in crab shell flour is lower than oats due to the deproteinase process during the flour making process (Hapsoro *et al.,* 2017).

The results of the analysis of the chemical characteristics of fat content showed that the more the addition of crab shell flour, the lower the fat content. This is in line with the research of Khasanah & Hartati, (2016) which showed that the addition of 0-20% crab shell flour can reduce the fat content in wet noodles from 2.82% to 2.3%. The low fat content along with the increase in the concentration of crab shell flour is because the fat content in oats is higher, namely 6.52%, compared to crab shell flour which is only 2.88% (Hapsoro *et al.,* 2017; Pane, 2023). The decrease in fat content can also occur due to the heating process during processing which allows some of the fat components to evaporate. This is in accordance with research (Pratama *et al.,* 2014) which states that a decrease in fat content can occur due to an increase in nutrient content such as ash content in the proximate test.

The results of the chemical characteristic analysis of carbohydrate content show that the more crab shell flour is added, the higher the carbohydrate content. Carbohydrates in crab shell flour include polysaccharides composed of N-acetylglucosamine monomer units in chitin and glucosamine in chitosan (Rochima, 2014). According to Trisyani & Syahlan, (2022) the carbohydrate content in a food product is also influenced by the composition of its ingredients. The ingredients of the snack bar as a source of carbohydrates come from oats (67.7 g), palm sugar (95 g) and cocoa powder (57.90 g) (Aprianto *et al.,* 2024; Pane, 2023). The increase in carbohydrate content by difference in snack bars is also influenced by other nutritional components such as water, ash, protein, and fat content. This shows that the lower the nutritional value of the other components, the higher the carbohydrate content in the snack bar.

The results of the chemical characteristic analysis of calcium content show that the more crab shell flour is added, the higher the calcium content. The results of this study are in line with the research of Azizia *et al.* (2024), regarding biscuits with the addition of 0%; 2.5%; 5%; and 7.5% crab shell flour are 297 mg, 499.5 mg, 534.6 mg, and 569.7 mg/100 g. This is because crab shell flour contains higher levels of calcium compared to the control, so that calcium levels will increase if the concentration of added crab shell flour in food products is higher. Research on snack bars with the addition of crab shell flour shows that one pack of snack bars weighing around 120 g/12 bars contains 532.776 mg of calcium. This proves that the addition of 2.5% crab shell flour to snack bar products can meet human daily calcium needs, which is 500-1000 mg/day (Pangestika *et al.,* 2021).

CONCLUSION

Based on the results of the study, it can be concluded that the concentration of the addition of crab shell flour of 2.5% produces the most preferred snack bar by panelists with an average value of the level of preference including appearance 8.0; aroma 8.3; texture 7.4; and taste 7, and has chemical characteristics in the form of water content 1.75%; ash content 2.85%; protein content 9.62%; fat content 12.93%; carbohydrate content 72.85% and calcium content 436.48 mg/100 g which has the potential to help meet human daily calcium needs.

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