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THE EFFECT OF STEAMING TIME OF THE DOUGH ON THE PREFERENCE LEVEL OF SQUID CRACKERS (*Loligo* sp.)

Pengaruh Lama Pengukusan Adonan Terhadap Tingkat Kesukaan Kerupuk Cumi-Cumi (*Loligo* sp.)

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ABSTRACT

Squid (*Loligo* sp.) is a high-value fishery commodity with rich nutritional content, so it has the potential to be developed into various nutritious processed products such as squid crackers. Squid cracker processing involves several important stages, where the steaming process plays a major role in determining the physical and organoleptic quality of the final product. This study aimed to analyze the effect of steaming time of the dough on the preference level of squid crackers (*Loligo* sp.) to produce a product favored by panelists, as well as to examine the physical properties of the preferred squid crackers. The research was conducted at the Fishery Product Processing Laboratory, Faculty of Fisheries and Marine Sciences, and the Testing Laboratory, Faculty of Agro-Industrial Technology, Padjadjaran University, from December 2024 to February 2025. An experimental method was used with three different steaming durations: 30 minutes, 45 minutes, and 60 minutes. The parameters observed were organoleptic characteristics assessed by 20 semi-trained panelists including appearance, aroma, taste and texture, as well as physical properties such as hardness and expansion power. Data obtained from the results of the Hedonic test observations were analyzed using the Friedman test and data obtained from the hardness test were analyzed descriptively and the expansion power test was analyzed using ANOVA analysis. The research results showed that squid crackers with a steaming time of 45 minutes were the most preferred treatment by the panelists with an average value of appearance of 7.9; aroma 7.4; taste 8.0; and texture 8.0. The results of the hardness test of treatment B were 2,301.632 gf and the swelling power test was 56.57%.

Keywords: Squid (*Loligo* sp.), squid crackers, steaming time of the dough, level of preference, physical properties.

ABSTRAK

Cumi-cumi (*Loligo* sp.) merupakan komoditas perikanan bernilai ekonomi tinggi dengan kandungan gizi yang kaya, sehingga berpotensi dikembangkan menjadi berbagai produk olahan bergizi seperti kerupuk cumi-cumi. Pengolahan kerupuk cumi-cumi melibatkan

beberapa tahapan penting, di mana proses pengukusan berperan besar dalam menentukan kualitas fisik dan organoleptik produk akhir. Penelitian ini bertujuan untuk menganalisis pengaruh lama pengukusan adonan terhadap tingkat kesukaan kerupuk cumi-cumi (*Loligo* sp.) sehingga menghasilkan produk yang disukai oleh panelis, serta menganalisis sifat fisik dari kerupuk cumi-cumi yang disukai. Penelitian ini dilaksanakan di Laboratorium Pengolahan hasil Perikanan Fakultas Perikanan dan Ilmu Kelautan Universitas Padjadjaran, dan Laboratorium Fakultas Teknologi Industri Pertanian Universitas Padjadjaran pada bulan Desember 2024 hingga Februari 2025. Metode penelitian yang digunakan adalah metode eksperimental dengan 3 perlakuan lama pengukusan adonan yaitu 30 menit, 45 menit dan 60 menit. Parameter yang diamati yaitu karakteristik organoleptik yang dinilai oleh 20 panelis semi-terlatih yang meliputi kenampakan, aroma, rasa dan tekstur, serta sifat fisik seperti uji kekerasan dan uji daya kembang. Data yang diperoleh dari hasil pengamatan uji Hedonik dianalisis menggunakan uji *Friedman* dan data yang diperoleh dari uji kekerasan dianalisis secara deskriptif serta uji daya kembang dianalisis menggunakan analisis ANOVA. Hasil penelitian menunjukkan bahwa kerupuk cumi-cumi dengan lama pengukusan 45 menit merupakan perlakuan yang paling disukai oleh panelis dengan nilai rerata kenampakan 7,9; aroma 7,4; rasa 8,0; dan tekstur 8,0. Hasil uji tekstur (*hardness*) perlakuan B sebesar 2.301,632 *gf* dan uji daya kembang sebesar 56,57%.

Kata Kunci: Cumi-cumi (*Loligo* sp.), Kerupuk Cumi-cumi, Lama Pengukusan Adonan, Tingkat Kesukaan, Sifat Fisik.

INTRODUCTION

Squid (Loligo sp.) is a fishery product with high economic value and good nutritional value. Total national squid production in 2021 reached 204,156.28 tons, with an economic value of IDR 8.73 trillion (KKP, 2021). This commodity is highly sought after in both domestic and international markets due to its high meat quality and versatility in various food preparations. Per 100 grams of squid meat contains 15.3 grams of protein; 1.0 gram of fat; 1.8 grams of ash; 15 milligrams of calcium; 194 milligrams of phosphorus; 1 milligram of iron; 0.03 milligrams of thiamine; and 0.08 milligrams of riboflavin (Prabawati, 2005). These contents make squid a nutritious source of animal protein with high potential for further development, both as a direct consumption ingredient and as a raw material for the fishery product processing industry.

Processed squid products for local consumption in Indonesia are still very limited. According to research by Sari et al. (2015), although Indonesia has significant potential for squid production, its utilization in processed products is still limited. Most squid produced is exported or sold fresh because it is considered easier to cook and tastes more savory than frozen or processed squid. This indicates a significant opportunity to diversify squid-based processed products in the local market, including the development of crackers as a nutritious and attractive snack alternative, similar to squid crackers. Squid crackers are made from ground squid meat and added tapioca flour and other additives such as water, garlic, flavoring, and salt (Jumiati et al., 2019).

Squid crackers have a distinctive aroma and taste that can stimulate appetite. According to research by Carrascon et al. (2014), the aroma of squid is caused by volatile compounds formed during the cooking process, particularly through the Maillard reaction. These compounds include aldehydes, pyrazines, and other sulfur-containing molecules. Some specific compounds that contribute to the distinctive aroma of squid include 2-acetyl-1-pyrroline and 4,5-dimethylthiazole. Squid also contains free amino acids such as glutamate, alanine, glycine, and arginine, which contribute to the umami and mild sweetness of squid meat. The content of the compound inosine monophosphate (IMP) also contributes to the

umami taste of squid (Hutriani et al., 2019). Squid meat has advantages compared to other seafood, such as its lack of bones, making it easier to process, and almost all parts of the squid can be utilized.

The process of making squid crackers consists of several steps, including preparing the raw materials, weeding, washing, grinding, making the dough, steaming, cutting, drying, and frying. One of the important factors determining the success of squid cracker production is the steaming of the dough, which can cause changes in the physical and organoleptic characteristics of the final product. According to Yulistiani et al. (2004), if the dough is steamed for less than 40 minutes, the center of the cracker will be white and will not expand when fried. Conversely, if steamed for too long, approximately more than 60 minutes, the dough will become soft, making it difficult to cut. According to research by Manik and Pakpahan (2022), steaming that lasts longer than 60 minutes will result in a decrease in the ability to expand and crispiness of the crackers. Steaming time also causes differences in the color of the cracker dough. This is because the dough steaming process changes the color of the material caused by the gelatinization process. Steaming the dough for more than 60 minutes and temperatures above 70°C during the gelatinization process will dissolve the chemical components in the cells, allowing sugars and proteins to react to form pigments that give a transparent or yellowish appearance (Palupi et al., 2011). Therefore, it is necessary to test the level of preference because crackers made from squid are rarely available on the market and the steaming time for the squid cracker mixture has not been widely studied.

RESEARCH METHODS

Place and Time

This research was conducted from January to February 2025. The production of squid crackers, hedonic testing, and expansion test were conducted at the Fisheries Product Processing Laboratory, Building 2, Faculty of Fisheries and Marine Sciences, Padjadjaran University, Jatinangor. Hardness testing on crackers was conducted at the Testing Laboratory of the Faculty of Agricultural Technology, Padjadjaran University.

Tools and Materials

The tools used in making squid crackers include a plastic basin, chopper, gas stove, oven, pot, frying pan, knife, cutting board, digital scale, spatula, spoon, tray, and plastic wrap. The ingredients used include 600 g tapioca flour, 450 g fresh squid, 30 g garlic, 30 g salt, 15 g flavoring, and 120 ml water.

Research methods

The method applied in this study is an experimental method. The treatment in this study refers to the research of Zulisyanto et al., (2016) which consists of 3 treatments, namely A (30 minutes), B (45 minutes), and C (60 minutes) which were tested on 20 semi-trained panelists as replications. The semi-trained panelists used were students of the Faculty of Fisheries and Marine Sciences, Padjadjaran University, Jatinangor who had basic knowledge of organoleptic testing to determine the level of panelists' preference for squid crackers.

Procedure for Making Squid Crackers

The modified procedure for making squid crackers according to Amelia et al. (2020) is as follows:

1) Fresh squid obtained from the Super Indo modern market is then put into a plastic container to be cleaned and cleaned with running water and the part that will be used is selected, namely only the meat.
2) Tapioca flour and other additional ingredients such as garlic, salt, flavoring are weighed according to the formulation.

3) The squid meat that has been drained is then ground using a food processor until smooth so that there are no lumps of meat during the cracker making process.
4) Additional ingredients such as garlic, salt, flavoring are put into the chopper and blended again until everything is evenly mixed.
5) Squid meat that has been mashed with other additional ingredients such as garlic, salt and flavoring is then mixed with tapioca flour.
6) The dough is kneaded slowly while adding warm water little by little until the dough reaches a smooth consistency.
7) The dough is shaped into long balls using your hands with a length of 20 cm and a diameter of ±5 cm.
8) The dough that has been formed is then steamed at a temperature of 70-80°C in a pan according to the predetermined treatment time, namely for 30 minutes, 45 minutes and 60 minutes calculated from when the water in the steamer pan boils.
9) The dough is removed from the steamer and left to cool at room temperature for 1 hour so that the texture of the cracker dough becomes solid because when the dough is still hot the texture tends to be soft.
10) 10) Store the cooled dough in the refrigerator at a temperature of 10°C for 24 hours to improve the texture and make it denser.
11) The dough is removed from the refrigerator and sliced into thin slices, about 3-4 mm thick. The slices are then dried in an oven at 60°C for 7 hours.
12) Dry raw crackers are fried at a temperature of 180-200°C for 10 seconds until the color of the crackers changes to golden yellow and expands perfectly.

Hedonic Test

Hedonic testing encompasses several assessment aspects, such as the appearance, aroma, taste, and texture of a food product. This method is based on the principle that panelists are asked to provide subjective responses regarding their level of liking or disliking the product being tested. This assessment is typically conducted using a hedonic scale listed on an evaluation sheet. The determined quality range can be converted into numbers and analyzed statistically to draw conclusions (Rahim et al., 2023).

Hardness Test

Hardness testing is carried out using a Texture Analyzer, expressed in gram force (gf). The procedure for using the Texture Analyzer according to (Kusnadi et al., 2012) is as follows:

1. The data cable from the Texture Analyzer is connected to the computer's CPU.
2. The computer is turned on after the connection is established.
3. The sample probe needle is installed and its position is adjusted close to the cracker sample.
4. The start test menu on the computer is selected to start the test.
5. The moving probe automatically pierces the squid cracker sample.
6. The test is complete when the probe returns to its original position.
7. The test results are displayed in the form of graphs and numbers on the computer screen.

Development Power Test

Cracker expansion is measured by comparing the circumference of the crackers before and after frying. The tools used for this measurement are string and a ruler. The first step is to measure the circumference of the raw crackers using the string. Then, after frying, the circumference is measured again to determine the extent to which the crackers have expanded (Kusumaningrum, 2009).

Data Analysis

The data obtained from the results of the orgnoleptic test were then analyzed using non-parametric analysis, namely the Friedman test. If the treatment had a significant effect, it was continued with Multiple Comparison analysis and the data obtained from the hardness test were analyzed descriptively and the swelling power test was analyzed using ANOVA analysis.

RESULT

Hedonic Test

Appearance

The appearance assessment aimed to determine panelists' acceptance of the shape and color of the squid crackers. Appearance is a visually observable organoleptic parameter that plays a role in attracting attention and influencing panelists' interest in a product (Asrim et al. 2022). The results of observations of the appearance of squid crackers with different dough steaming times are presented in Table 1.

Table 1. Results of the Hedonic Test of Squid Cracker Appearance with Different Dough Steaming Times

Treatment	Median	Average
A (30 minutes)	5	4,7a
B (45 minutes)	**7**	**7,9b**
C (60 minutes)	7	6,9b

Description: The average value of appearance followed by the same letter shows no significant difference according to the multiple comparison test at level 5%

The results of the Friedman test in Table 1 show that squid crackers with different steaming times have a significant effect on the appearance of squid crackers. Based on the results of the multiple comparison test on the appearance observation, treatment B (45 minutes) produced the best appearance of squid crackers. The median value produced by each treatment ranged from 5 to 7. The appearance of squid crackers with different steaming times of dough A (30 minutes), B (45 minutes), and C (60 minutes) is presented in Figure 1.

A (30 menit) B (45 menit) C (60 menit)

Figure 1. Appearance of Squid Crackers with Steaming Time of Dough for A (30 minutes), B (45 minutes), and C (60 minutes)

Aroma

Aroma is the response of the olfactory sense (nose) to stimuli provided by a food product. Aroma is one parameter in determining whether a food product is acceptable or not, using the sense of smell. The results of observations of the aroma of squid crackers with different dough steaming times are presented in Table 2.

Table 2. Hedonic Test Results of Squid Cracker Aroma with Different Dough Steaming Times

Treatment	Median	Average
A (30 minutes)	7	6,5ab
B (45 minutes)	**7**	**7,4b**
C (60 minutes)	5	6,1a

Description: The average aroma value followed by the same letter shows no significant difference according to the multiple comparison test at level 5%

The Friedman test results in Table 2 show that different steaming times significantly affected the aroma of squid crackers. Based on multiple comparison tests on aroma observations, treatment B (45 minutes) produced the best squid cracker aroma. The median value for each treatment ranged from 5 to 7.

Flavor

Taste is a crucial aspect influencing the level of acceptance of a product by panelists. Taste is a sensation recognized by the human sense of taste, the tongue. The results of observations on the taste of squid crackers with different steaming times are presented in Table 3.

Table 3. Hedonic Test Results of Squid Cracker Taste with Different Steaming Times

Treatment	Median	Average
A (30 minutes)	7	7,5b
B (45 minutes)	**9**	**8,0b**
C (60 minutes)	6	6,2a

Description: The average aroma value followed by the same letter shows no significant difference according to the multiple comparison test at level 5%

The Friedman test results in Table 3 show that different steaming times significantly affected the taste of squid crackers. Based on the multiple comparison test for taste, treatment B (45 minutes) produced the best squid cracker flavor. The median value for each treatment ranged from 6 to 9.

Texture

Texture is one of the parameters used to assess the physical properties of a material, particularly regarding its resistance or strength when subjected to pressure (Irawan et al. 2021). Observations of the texture of squid crackers with different dough steaming times are presented in Table 4.

Table 4. Hedonic Test Results of Squid Cracker Texture with Different Dough Steaming Times

Treatment	Median	Average
A (30 minutes)	4	3,9 a
B (45 minutes)	**9**	**8,0 b**
C (60 minutes)	7	7,3 b

Description: The average aroma value followed by the same letter shows no significant difference according to the multiple comparison test at level 5%

The Friedman test results in Table 4 show that squid crackers with different steaming times significantly affected the texture of squid crackers. Based on multiple comparison tests on texture observations, treatment B was significantly different from treatments B and C, while treatment B was not significantly different from treatment C. The median value produced by each treatment ranged from 4 to 9.

Hardness Test

The tool used to test the hardness of a food product is a Texture Analyzer (Karjo et al. 2015). The results of the squid cracker hardness test are presented in Figure 2.

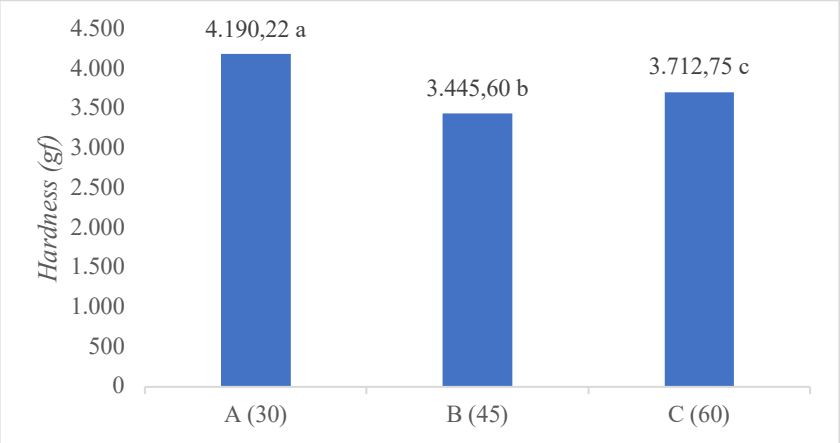

Figure 2. Results of Hardness Test of Squid Crackers with Different Steaming Times

Based on the results of the hardness test carried out on squid cracker samples, the lowest hardness value was obtained in treatment B with a value of 3,445.60 gf and treatment A had the highest hardness value of 4,190.22 gf.

Development Power Test

Cracker expansion rate is one indicator used to determine whether the ingredients used and the cracker processing are successful (Mawaddah et al. 2021). The results of the squid cracker expansion rate test are presented in Figure 3.

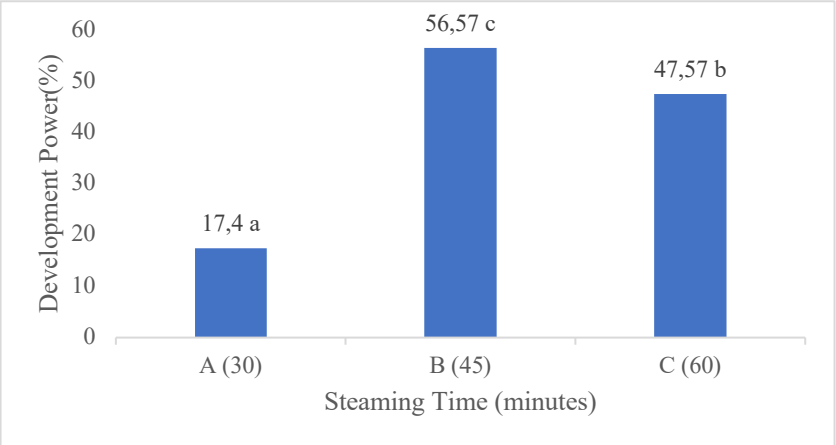

Figure 3. Results of Squid Crackers Expansion Test with Different Steaming Times

DISCUSSION

The results of the organoleptic test of the appearance of squid crackers showed that the highest average value was produced in treatment B (45 minutes) of 7.9 with a median value of

7 producing squid crackers with an uneven brownish color appearance, neat and fluffy shape like crackers in general so that the crackers were preferred by panelists. The lowest appearance of squid crackers was produced in treatment A (30 minutes) which had an average value of 4.7 with a median value of 5 producing squid crackers with a bright appearance, creamy color, untidy shape, and some did not puff up. Overall, the color of the squid crackers became increasingly brown along with the length of steaming the dough. In line with the research of Zulisyanto et al. (2016), the longer the steaming time, the browner the resulting color. This is caused by changes in the color of the material during the steaming process related to the starch gelatinization process. The color of the crackers also becomes browner with increasing percentage of squid meat as a raw material, influenced by the Maillard reaction. According to Ketaren (1986), the Maillard reaction occurs through the interaction of reducing sugars from carbohydrates with primary amine groups in proteins. The Maillard reaction occurs due to the abundant presence of reducing sugars and proteins, producing the brown pigment melanoidin.

Organoleptic aroma testing of squid crackers showed the highest average aroma score of 7.4 in treatment B (45 minutes), with a median score of 7, producing squid crackers with a distinctive squid aroma. Research by Carrascon et al. (2014) explained that squid has a distinctive, soft, oceanic aroma with a subtle briny touch. The lowest squid cracker aroma was produced in treatment C (60 minutes) with an average value of 6.1 with a median value of 5 resulting in squid crackers with a weak squid aroma because the duration of steaming causes the squid aroma to decrease so that it is less preferred by panelists. This is in line with research by Zulisyanto et al., (2016) which states that the longer the steaming process, the more the aroma will decrease. According to research by Carrascon et al., (2014) squid aroma is caused by volatile compounds formed during the cooking process, especially through the Maillard reaction. These compounds include aldehydes, pyrazines, and other sulfur-containing molecules. Some specific compounds that contribute to the distinctive aroma of squid include 2-acetyl-1-pyrroline and 4,5-dimethylthiazole. According to research by Astawan (2017), it states that squid meat contains sulfur compounds such as dimethyl sulfide which can produce a distinctive fishy aroma during the cooking process.

The results of the organoleptic test of the taste of squid crackers showed that the highest average value of squid cracker taste was produced in treatment B (45 minutes) of 8.0 with a median value of 9 producing squid crackers with a complex distinctive taste, such as umami and slightly natural sweetness and the lowest average value of squid cracker taste was produced in treatment C (60 minutes) which had an average value of 6.2 with a median value of 6 producing squid crackers with a weak squid taste because the length of steaming caused the distinctive taste of squid to be reduced so that it was less preferred by panelists. In line with the research of Zulisyanto et al. (2016), that the length of steaming affects the decrease in the intensity of the taste of crackers caused by protein denaturation during the steaming process due to exposure to high temperatures and water vapor. This denaturation mainly affects proteins such as myosin, actin, and tropomyosin, which are important in the formation of umami taste. As a result, the protein loses its ability to bind flavoring compounds and experiences a decrease in water holding capacity, allowing flavor compounds to escape with the steam or water during steaming (Nguju et al., 2018).

The results of organoleptic texture tests of squid crackers showed that the highest average texture value was obtained in treatment B (45 minutes) at 8.0 with a median of 9, resulting in squid crackers with a crunchy texture, favored by panelists. The lowest average texture value was obtained in treatment A (30 minutes), with an average value of 3.9 with a median of 4, resulting in squid crackers with a partially hard texture. This is because some of the squid cracker dough was still undercooked during the steaming process. Consistent with research by Yulistiani et al. (2004), if the dough is steamed for less than 40 minutes, the center of the crackers will be white and will not expand when fried. Conversely, steaming for too long, more

than 60 minutes, will result in a soft and less cohesive dough. Squid meat, the main ingredient, contains heat-sensitive myofibrillar proteins, and denaturation of these proteins during steaming affects the dough's elasticity and cohesiveness. Excessive denaturation causes the protein structure to lose its binding strength, making the dough brittle and easily damaged during processing. Furthermore, the steaming process also affects the starch structure, where excessive heating causes the starch granules to overcook, weakening hydrogen bonds, and releasing hydrophilic groups, ultimately resulting in a soft and unstable dough texture. (Biliaderis, 1992).

Hardness tests conducted on squid crackers revealed the lowest hardness value in treatment B, with a value of 3,445.60 gf, and treatment A, with the highest hardness value of 4,190.22 gf. Treatment B had a crispier texture than treatment A. According to research by Mahdalena et al. (2021), mackerel crackers with a low hardness value of 2,020.15 gf indicate a crispier texture, while a higher hardness value of 3,457.46 gf indicates less crispy crackers. It is suspected that the measured hardness value of squid crackers is influenced by the steaming time. The steaming time of the dough significantly affects the water content of the crackers, where the longer the steaming time, the higher the water content due to the starch structure being less compact and more easily absorbing water (Biliaderis, 1992). High water content results in a less crispy cracker texture, while low water content supports crispness. The composition of ingredients such as the amylopectin content in tapioca flour, the presence of salt, and the gelatinization temperature also affect the swelling power and hardness of the crackers. Perfect starch gelatinization allows the formation of a strong matrix to withstand steam pressure during frying, resulting in an optimal crispy and fluffy texture (Amelia et al. 2020; Hendrikayanti et al., 2022).

The results of the expansion power test using one-way analysis of variance showed that the highest expansion power percentage was found in treatment B, which was 56.57%, and the lowest expansion power percentage was found in treatment A, which was 17.4%. The difference in the expansion power of squid crackers was influenced by the duration of the dough steaming. Steaming the cracker dough for 30 minutes and steaming for more than 45 minutes can reduce the expansion power of the crackers. In line with the research of Yulistiani et al. (2004), if the dough is steamed for less than 40 minutes, the center of the crackers will be white and will not expand when fried. Conversely, if the dough is steamed for more than 60 minutes, the dough will become soft and less cohesive. In addition, the composition of ingredients such as the amylopectin content of tapioca flour supports expansion power, while the high protein content of squid meat actually decreases it. Kneading or mixing the dough also plays an important role, because inhomogeneous mixing inhibits even gelatinization and reduces expansion power. Optimal gelatinization with even mixing allows the formation of a gel matrix that is able to withstand steam pressure, resulting in crackers that expand perfectly and have a crispy texture. (Kusumaningrum, 2009).

CONCLUSION

Based on the results of this study, it can be concluded that the steaming time for squid cracker dough (Loligo sp.) for all treatments was still acceptable by the panelists. The most preferred steaming time for squid cracker dough was treatment B, which was 45 minutes with hedonic test results of appearance 7.9; aroma 7.4; taste 8.0; and texture 8.0. The results of the hardness test were 3,445.60 gf and the swelling power test was 56.57 gf %.

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