

Optimization of the Proportion of Salted Egg in the Crackers Making Process in terms of Crispness, Nutritional Value, and Hedonic

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Abstract: Crackers are one of the foods that are in demand by all circles of society. Salted egg crackers are an innovative product of egg crackers made from duck eggs then mixed with tapioca starch. This study aims to determine the optimization of the addition of salted egg proportions to crispness and nutritional value in order to improve the flavor of salted egg crackers. There are 5 treatments of different proportions of eggs, namely 0 g (T₀), 62.5 g (T₁), 125 g (T₂), 187.5 g (T₃), and 250 g (T₄). The research method consists of experimental design, research procedures, parameter analysis, and data analysis. The results of the analysis showed that the difference in the proportion of salted egg addition to salted egg crackers affects the levels of protein, ash, fat, and calories. The higher proportion of salted egg will make protein and ash levels increase, while fat and calorie levels decrease. Physical and hedonic analysis showed that the highest crispness and most preferred by panelists overall was found in the proportion of salted egg 125 g (T₂). In conclusion, the optimal proportion of salted egg at 48% or 125 g of 387 g total dough produces good quality and crispy crackers.

Keywords: crackers, crispness, egg, protein, proximate

INTRODUCTION

Salted egg is a processed product from duck eggs that are processed through a salting process preserve and enhance its taste. Salted egg is liked by society due to their practicality, complete nutritional content such as carbohydrate, protein, fat, vitamins, and minerals, as well as their affordable price and accessibility. It became a common product in the market and can cause competition in sales, thus resulting in excess salted eggs that are not sold to be piled up in the storage. The longer salted eggs are kept in an opened room will decrease the quality due to lipid oxidation [1]. Therefore, preventive measures can be done through the diversification of salted egg products. Salted egg product diversification is intended to increase the selling power, extend the shelf life, and make it more favored by society and one of the diversification can be done by processing salted eggs to become the ingredient of crackers.

Crackers are processed dry snacks and have been known and favored by Southeast Asian residents, especially Indonesia. Crackers are commonly made out of tapioca flour that contains starch. Starch consists of amylose and amylopectin that can tie together ingredients and water, as well as provide crispness and savory flavor [2]. Crackers are famous for their crispy texture and savory flavor. The crispness of crackers become its appeal to be consumed as snacks or a complimentary side dish, furthermore, its affordable price, and accessibility and long shelf life made crackers to be more liked by all age groups. But, crackers that are distributed around Indonesia mostly have nutritional content such as carbohydrates derived from tapioca starch. The carbohydrate in tapioca starch is higher compared to other nutritional content such as fat 0.01% and protein 0% [3].

This poor nutritional content, especially protein, causes crackers need to improve their nutritional value so they can have better quality. Indonesian society's fondness towards crackers makes it necessary to be developed, but, the low nutritional content of crackers become its weakness. One way to overcome this problem is by-product development of crackers through nutritional content enhancement by adding a substance with a protein source. Animal-derived products that can be used as a protein source is salted egg. The salted egg has sufficient protein content and a relatively cheaper price compared to other animal-derived products [4]. This become one of the reasons for selecting salted egg as the protein source for crackers. The salted egg that will be used are from duck eggs since duck eggs contain 13,1% higher protein, than salted eggs from chicken eggs [5]. Salted egg has mineral contents in the form of high levels of salt compared to other animal-derived products. The high level of salt and protein content has the potential to create a savory flavor [6]. The making of crackers is developed by mixing tapioca starch and adding the salted egg. Besides being an alternative to increase nutritional value and flavor, salted egg crackers can be a solution to reduce the piling up of excess salted eggs. The development of salted egg cracker products can provide innovation for those who are not keen on the texture of salted eggs, with the existence of salted egg crackers, consumers can enjoy the taste of salted eggs but with the texture of crackers.

Previous studies reported that the making of salted egg crackers using the best composition formulation of tapioca starch and salted eggs with the ratio of 80%:20% can create crunchy salted egg crackers product [7], however the nutritional content of the salted egg crackers have not yet to be studied. This research is aimed to determine the optimization of the addition of salted egg proportions to crispness, nutritional value, and consumer acceptance. The nutritional value was shown through the chemical characteristics of the products. The resulting product was expected to bring benefits for the crackers consumers for them to enjoy the crispness and signature flavor of the crackers with better nutritional content that is better than other crackers. Therefore, this research would show that there was an optimization effect

differentiating salted egg proportion on the dough formulation towards the salted egg crackers product results.

MATERIALS AND METHODS

Materials

The ingredients used are tapioca starch, salted eggs obtained from KTT Banyubiru, and other spices, food-grade yellow colouring, cooking oil, 0.1 N HCl, 4% H₃BO₃, 100 mL distilled water, 45% NaOH, n-Hexane solution, selenium, methylene red (MR) and methylene blue (MB).

Preparation of salted egg crackers

The process of making salted egg crackers is based on previous research with modifications [7]. The manufacturing process began with weighing the ingredients, then salted eggs were added according to the treatment T₀ with 0 g, T₁ with 62.5 g, T₂ with 125 g, T₃ with 187.5 g, and T₄ with 250 g. The salted eggs are then crushed and stirred until evenly mixed with the other ingredients. Salted eggs are then crushed and stirred until evenly mixed with other ingredients. The dough was then molded by dividing the dough into 2 using the formulation 70%:30%. 70% white dough and 30% yellow dough that has been added with 1 mL of yellow coloring. The white dough was spread on aluminum foil then the yellow dough was spread and placed on top of the white dough, then rolled into a cylinder and wrapped. The dough is then boiled with boiling water at 100 °C for 30 minutes, then put into the refrigerator with a chiller temperature of about 2 – 4 °C for 24 hours until the dough hardens slightly. The dough after being cooled was then cut thinly with a mandolin tool. Thin cutting aimed to make the drying process faster. Salted egg crackers are then dried by drying in the sun for 4 days. Drying is done until the crackers are completely dry or obtain a moisture content below 12%. The dried salted egg crackers are then fried until the crackers expand and then drained.

Parameter Analysis

According to the method described by AOAC [8], moisture content was tested through the calculation of the percentage difference between the weight of the sample after baking and before baking. Ash content was tested through the furnace method by calculating the percentage of ash weight to sample weight [9]. Protein content was tested using the kjedahl method by calculating the percentage difference between the sample titrant and the blank multiplied by the normality of the diluent and the conversion factor [9]. Testing fat content with the soxhlet method by calculating the percentage of sample weight after heating twice divided by the weight of the macerated sample [9]. Carbohydrate content testing by difference method through the subtraction of 100% protein, fat, water, and ash content. The total calorie test is calculated by adding the total energy of carbohydrate, protein, and fat content.

The crispness test was conducted using the Lloyd Instruments texture analyzer puncture method [2]. The test was conducted using a spherical probe with a diameter of 0.5 cm and the reader software Nexygen which is available on the computer system. Hedonic testing involved 25 trained panelists giving a rating scale from 1 to 4 (strongly dislike to strongly like).

Data Analysis

Parametric data were processed with Analysis of Variance (ANOVA) followed by Duncan Multiple Range Test with 5% confidence level, while non-parametric data were

analyzed using Kruskal Wallis test followed by Mann-Whitney test with 5% confidence level. Data analysis was carried out using the SPSS for Windows application.

RESULT AND DISCUSSION

Salted Egg Crackers Nutritional Value

Nutrition in food can be reviewed through chemical characteristics including protein, moisture, ash, fat, carbohydrate, and calorie content and, can be seen in Table 1. The majority of protein in salted egg crackers came from the salted egg added to the crackers. It is proven that salted eggs consist of albumen which had high protein [10]. The addition of salted egg proportion significantly affected the nutritional value of the final product, this could be seen based on protein, ash, fat and calorie content ($p < 0.05$). The addition of salted egg proportion did not affect the moisture and carbohydrate content ($p > 0.05$). This occurred because the process of processing crackers by drying using high temperatures results in the evaporation of water resulting in a uniform moisture content of around 7% - 9%. The moisture content of the crackers complied with SNI 0272-1990 of about 5% - 12%, indicating that the salted egg crackers were of good quality. Carbohydrate content was not affected by the addition of salted egg proportion due to the manufacture of salted egg crackers using tapioca starch which is mostly composed of carbohydrates. Tapioca contains more than 90% carbohydrates while in salted eggs the carbohydrate content is only about 4.1% [11], this is the cause of the addition of salted eggs has no effect. Increasing the proportion of salted egg would cause an increase in protein and ash levels, but decrease fat and calorie levels. The decrease in calorie content was influenced by decreasing fat content. Fat and calorie content began to decrease in the treatment of salted egg addition of 167.5 g to 250 g.

Table 1 Salted egg crackers nutritional value

Parameters	Proportion of Salted Egg				
	T ₀	T ₁	T ₂	T ₃	T ₄
Protein	0.55 ± 0.08 ^a	2.43 ± 0.38 ^b	4.26 ± 0.28 ^c	6.22 ± 0.32 ^d	7.60 ± 0.52 ^e
Moisture	9.56 ± 2.29	8.11 ± 0.64	7.94 ± 0.64	7.85 ± 0.73	7.33 ± 2.44
Ash	0.53 ± 0.23 ^a	1.12 ± 0.15 ^b	1.47 ± 0.17 ^{bc}	1.83 ± 0.54 ^c	2.37 ± 0.27 ^d
Fat	30.33 ± 6.14 ^a	26.19 ± 4.99 ^{ab}	23.91 ± 2.52 ^{ab}	22.21 ± 3.83 ^b	19.29 ± 9.45 ^b
Carbohydrate	59.04 ± 6.93	62.16 ± 5.04	62.43 ± 3.06	61.90 ± 4.11	63.42 ± 6.84
Calorie	511.29 ± 30.37 ^a	494.05 ± 23.37 ^{ab}	481.91 ± 10.30 ^{abc}	472.33 ± 18.48 ^{bc}	457.66 ± 16.40 ^c

Data are shown as Mean ± Standard Deviation where different superscripts on the bars indicate significant differences between treatments ($p < 0.05$).

The increasing protein content was due to the increasing proportion of salted eggs in the crackers. Duck eggs have a protein content that is mostly found in egg whites formed from albumin-containing ovalbumin with about 54% protein [12]. This results in the protein content of the crackers increasing so that the addition of 250 g proportion had the highest protein content and 0 g salted egg proportion had the lowest protein content. The lowest protein content was caused by the use of tapioca starch as the only ingredient. Tapioca starch is the main ingredient of crackers that have low protein content [11]. The increased protein in the five treatments indicated that the nutrients in the crackers had increased, so this was one indicator of good cracker quality. Another nutrient that is an important component of food and can affect quality is water content. The water content in all five treatments decreased, it was due to the process of drying and deep frying. Drying and deep frying caused the water in salted egg crackers to evaporate so that the water content began to decrease and pores form [13].

Moisture and ash content of crackers were inverse each other. The lower moisture content, the higher ash content [14]. The least ash content was obtained by the proportion of 0 g egg due to no salted egg added in the making of crackers. Meanwhile, the highest ash content was obtained by the proportion of 250 g egg thus added with salted egg at most. The increase in ash content showed an increase in food's mineral content[15]. Salted eggs contain high minerals such as salt, which is used as the main ingredient for salted egg crackers making[16]. Crackers with 250 g salted egg added showed high salt content, therefore the ash content obtained was also high. The fat content of crackers also showed an inverse relation with the ash content. The decrease in fat content was caused by the increase in ash content. Mineral content could obstruct oil absorption thus the absorption capacity of oil is decreased[17]. The mineral content in the salted eggs will break down the lipoprotein bonds, therefore the fat is extracted[18]. Another influencing factor of the oil absorption capacity is protein content. The high protein content of crackers also obstructed the oil absorption because starch granules are interfered with by the rigid protein matrix[19]. The higher protein content is obtained by the proportion of 187.5 g to 250 g salted egg, with the result that the lower fat content is obtained. This by cause of the starch granules interfered to bind the fat. Excess of denatured protein could break down the hydrophobic bonds, thus causing the lower oil absorption and fat content of crackers.

Low-fat content affected the carbohydrate content and calories of crackers. The carbohydrate content of crackers is also influenced by other nutritional content. The calories of crackers by statistic were decreased at the proportion of 187.5 g to 250 g salted egg. The decrease in calories was affected by the decrease in fat content in the five treatments. The fat content is directly proportional to the calories of crackers. The higher fat content, the higher calories of the cracker and likewise [20].

Salted Egg Crackers Crispness

Crispness is one of the important indicators regarding cracker quality[21]. Additions of salted egg proportion had a significant impact on the crispness level of salted egg crackers ($p < 0.05$). The optimal crispness of the cracker was achieved in 125 g salted egg proportion, crispness level on that proportion did not compare realistically to the 187,5 g proportion according to statistics but could compare to the 0 g, 62.5 g, and 250 g proportions. This was caused by the difference in crackers' nutrients, mainly protein, water, and fat. Levels of crispness was shown in Fig. 1.

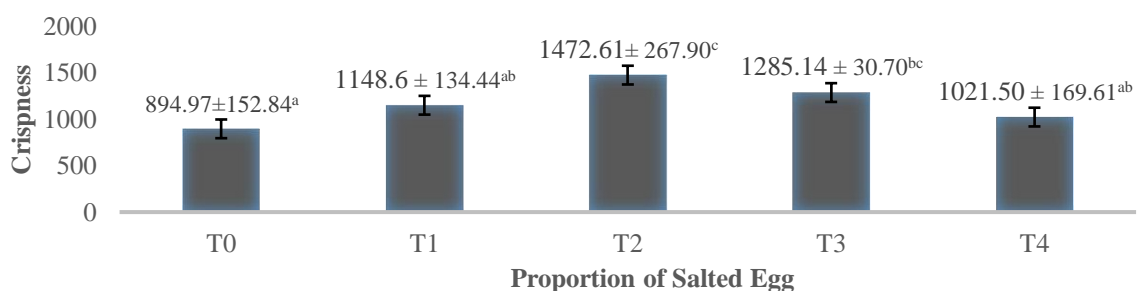


Figure 1 Crispness value of salted egg crackers. Data are shown as Mean±Standard Deviation where different superscripts on the bars indicate significant differences between treatments ($p < 0.05$).

An increase in crispness level showed that the crackers were crispier. Crispness levels were directly proportional to crispness [22]. Crispier crackers had a brittle texture and break easily. Optimal crispness based on the highest grade of the crispness was seen from the addition of the proportion of salted eggs 62.5 g. The crispness value increased to a maximum at the proportion of salted eggs 125 g while at the proportion of salted eggs more than 187.5 g the

crispness value decreased. The increase in grade of crispness was caused by the property of protein as an emulsifier in binding the dough together and producing a crispy texture [23]. The addition of protein in an appropriate amount caused a crispier cracker, but excessive addition would make the texture harder and reduce crispness. This could be seen in the 250 g salted egg proportion, in which the crispness level decreased when compared to the 125 g proportion. Compositions such as starch, protein, and salt will influence the product's texture [24]. The decrease in protein content could be caused by the denaturation of egg protein in high-heat applications.

Proteins denature during boiling and deep frying. Protein denaturation causes hydrophobic group interaction, severance of hydrogen bonds, and the opening of reactive group or protein folding [25]. Open reactive groups will form a strong bond. The open reactive bond will form a strong bond with any reactive group nearby [26]. This strong bond can cause hardening, with more bonds formed resulting in a harder texture [27]. A hard texture indicates decreasing crispness level, this means that higher protein content causes a harder cracker texture. Another nutrition content that affects crispness is moisture content. The increase in water content causes a decrease in crispness level and the texture became softer, while a low water content causes the texture to be hard. A decrease in moisture content is caused by the process of drying and deep frying. Drying will lower water content so the crackers will be puffed once it's fried [28]. Deep frying causes the pore's structure to be formed as the water inside the crackers vaporized [29]. The formation of pores can influence the cracker's texture. The pores that are formed during frying result in reduced water and some of the oil seeping into the space and resulting in a crispier cracker [30]. The lower moisture content can increase the crispness of cracker but meanwhile, too low a value of moisture content could impact the hardness of the crackers. The lowest crispness value in the 0 g salted egg proportion was due to the high water and fat content in the crackers. This high-fat content could make the crackers susceptible to fat oxidation so that the texture of the crackers became soft and the high 6áter content caused the crackers to lose their brittleness so that it would be difficult to break.

Salted Egg Crackers Hedonic

The addition of the salted egg ratio affected the texture, color, and overall ($p < 0.05$) without affecting the taste and the aroma ($p > 0.05$). The panelists enjoyed the textures and the taste of crackers with 125 g of salted egg proportion while enjoying the colors with 0 g of salted egg.

Table 2 Salted Egg Crackers Hedonic

Parameters	Proportion of Salted Egg				
	T ₀	T ₁	T ₂	T ₃	T ₄
Texture	2.64 ± 0.95 ^{abc}	3.04 ± 0.84 ^{ab}	3.12 ± 0.78 ^b	2.32 ± 0.85 ^c	2.68 ± 1.03 ^{abc}
Aroma	2.96 ± 0.94	3.16 ± 0.75	2.64 ± 0.95	2.68 ± 0.85	2.68 ± 0.85
Flavor	2.72 ± 1.14	2.80 ± 0.91	2.88 ± 0.78	3.00 ± 1.08	3.00 ± 0.82
Colour	3.72 ± 0.68 ^a	3.12 ± 0.53 ^b	2.60 ± 0.53 ^c	1.96 ± 0.94 ^c	2.24 ± 1.13 ^c
Overall	2.60 ± 0.96 ^{ac}	3.00 ± 0.82 ^{ab}	3.24 ± 0.72 ^b	2.40 ± 1.00 ^c	2.48 ± 0.65 ^c

Data are shown as Mean ± Standard Deviation where different superscripts on the bars indicate significant differences between treatments ($p < 0.05$).

The higher salted egg content caused the texture to harden, losing its crunchiness. This was expected to be caused by protein content. The addition of ingredients containing protein might cause textures in crackers to harden [31]. The panelists enjoyed the crackers with intermediate hardness and crunchiness. The panelists didn't enjoy much of the colors of crackers with higher salted egg content. This happened because the higher salted egg content caused the crackers to have browner color. The brownish color on the crackers was expected to be caused by browning when deep frying. The browning reaction on the salted egg crackers

is non-enzymatic because it was caused by the reaction of the carbohydrates specifically the sugar and protein on the crackers [32]. Adding 125 g until 250 g of salted egg contained high protein levels caused the crackers to turn browner after deep frying. The addition of protein-rich ingredients caused the panelists to dislike the colors of the crackers after deep frying [33]. The panelists enjoyed both the aroma and taste of all variants of the salted egg crackers, the aroma and taste were a result of processing the main ingredients and addition of other different ingredients [34]. The addition of salted egg caused the crackers to be much more savory, which the panelists enjoyed them much more. The overall score given by the panelists showed the most liked salted egg crackers variants. The most liked cracker variant had the highest overall score being 3.24 and it contained 125 g of salted egg. The overall score showed that the panelists liked the variant with the salted egg proportions the most.

CONCLUSION

The optimum salted egg proportions added to create high-quality crackers was 48% or 125 g of the total 387 g dough produced. The product was likely enjoyed due to its crispy texture and its nutritional value that matches to crackers' quality standards (4.3% protein, 8% moisture content, 1.5% ash content, 24% fat content, 62.2% carbohydrate, and 482 kcal calories).

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CONFLICT OF INTEREST

The authors declare that this research does not have any conflict of interest.

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