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The Quality of Salted Egg using Red Ginger as Natural Antioxidant

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The aim of this research was to determine the best percentage of adding red ginger to salted eggs based on physicochemical quality and organoleptic quality using the dry salting method.
Study Design: This research used was a laboratory experimental design with a Completely Randomized Experiment design with 4 treatments and 5 replications.
Place and Duration of Study: This research was conducted from 1 December 2023 to 30 January 2024. The processing of duck eggs into salted eggs was carried out on the campus of the University of North Sumatra, Faculty of Agriculture, Animal Science Study Program. Salted egg testing was carried out at the Animal Products Technology Laboratory, Faculty of Animal Science, Brawijaya University, Malang. Salted egg testing consists of physical, chemical, organoleptic quality.

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Methodology: This research methods using laboratory experimental design. The data was analyzed using analysis of varians, by and if there were significant effects in each treatment, continued by using Duncan's Multiple Range Test.
Results: Based on the results of the research conducted, the addition of red ginger to making salted eggs had an effect ($P<0.05$) on the organoleptic, physical and chemical quality of salted eggs.
Conclusion: The addition of red ginger at a concentration of 3% in making salted eggs is good enough to obtain the best quality salted eggs.

Keywords: Red ginger; salted eggs; duck eggs; antioxidant.

1. INTRODUCTION

Duck eggs are a good source of nutrition, with a protein content of 13.1%, higher calories and fat than chicken eggs [1]. One of the weaknesses of duck eggs is that they are easily damaged like other poultry eggs, either physically, chemically, or by microbes. Damage to eggs will affect the quality and shelf life of eggs [2]. Duck eggs have a sharp fishy smell, so the use of duck eggs in various foods is not as widespread as chicken eggs. In order to maintain the quality of eggs, preservation can be carried out through a salting process so that egg damage can be inhibited (Lesmayati and Rohaeni, 2014). There are 3 methods of making salted eggs, the first is soaking in a saturated salt solution. Second, polishing eggs with a mixture of bricks or kitchen ash and solid or dry clay. Third, wrapping eggs in a thick, semi-wet red brick or kitchen ash paste [3]. Salted eggs have a limited shelf life. To increase the shelf life, it is necessary to add ingredients that can extend the shelf life of salted eggs as natural antioxidant. Currently, salted eggs on the market still have the original taste, therefore innovation is needed in salted eggs, one of which is by adding ginger.

Ginger (*Zingiber officinale*) is one of the spices/herbs that are quite abundant and easy to obtain in the community and continues to experience an increase in production and exports [4]. The advantages of ginger as a herbal plant and a plant that is widely used as a preservative, because ginger has activity as an antioxidant and antimicrobial, such as zingerone, shogaol, gingerol, gingerdiol, diarylheptanoid and curcumin compounds. In addition, ginger has an essential oil content that can provide a distinctive aroma. Salted eggs with the addition of red ginger during the salting process is a processing innovation to increase consumer interest in salted egg products. Ginger is a source of natural antioxidants, in addition ginger also contains antimicrobials that have the ability to preserve food, antioxidant intake in the body is important to protect the body from free radicals. Antioxidants in ginger are expected to inhibit the oxidation process so that they can reduce rancidity and extend shelf life. Based on the description above, it is necessary to conduct a study to examine the addition of red ginger to salted eggs in different storage. The aim of this research was to determine the best percentage of adding red ginger to salted eggs based on physicochemical quality and organoleptic quality using the dry salting method.

2. MATERIALS AND METHODS

2.1 Tools

The equipment used for processing salted eggs includes candlers, sponges, digital scales, egg trays, jars, markers, pens, and label stickers. The equipment used in the analysis of salted eggs includes calipers, screw micrometers, depth micrometers, egg yolk color fans, thermometers and hygrometers, egg trays, porcelain cups, beakers, clear jars, 60°C ovens, 105°C ovens, Erlenmeyer flasks, electric stoves, pipettes, burettes, small plates, transparency plastic, manila paper, scissors, and permanent markers with a thickness of 0.1 mm. Moisture content testing is carried out using the Thermogavimetry method and pH using a pH meter. Salt content testing uses the Mohr method and the color of salted egg yolks uses the Color Reader tool.

2.2 Materials

The main ingredient used is duck eggs with an average weight of 63 ± 2 grams. Duck eggs were obtained from the Pantai Labu laying duck farm, Pantai Labu Village, Deli Serdang Regency. The materials used to make salted eggs include beach sand, ash, red ginger powder, water, and salt. The materials used for the analysis of salted eggs are HNO_3 4 N,

$AgNO_3$ 0.1 N, Fe_2 (SO_4) 3 40%, and KSCN O,11 N. H_2SO_4, NaOH, HCl 0.1 N, NaCl, $K_2Cr_2O_7$, PCA media, and Eosin Methylene Blue Agar.

2.3 Experimental Design

This study used a laboratory experiment with a Completely Randomized Design (CRD) with 4 treatments and 5 replications. This study consisted of 2 stages, each using 100 duck eggs. This study aims to see the physicochemical quality and organoleptic test of salted eggs, and the second stage is to see the quality of salted eggs with different storage times. The treatments that will be carried out in this study are as follows:

P0: Without adding red ginger (Control)
P1: Addition of 2% red ginger from the total weight of eggs
P2: Addition of 4% red ginger from the total weight of eggs
P3: Addition of 6% red ginger from the total weight of eggs

2.4 Research Procedure

Egg selection: The weight of duck eggs to be used is in the range of 60±2 grams, this range aims to reduce the diversity of duck eggs. Duck eggs to be used are selected based on requirements including, not rotten, not cracked, and not soft. In addition, candling is also carried out, which aims to determine the condition of the egg shell (cleanliness and cracks), air sacs and the position of the egg yolk. The sorted eggs are washed using warm water and drained on an egg tray.

2.5 Making Salted Egg Dough

The ingredients in making salted egg dough are beach sand, ash, red ginger powder and coarse salt, where after all are weighed in a ratio (1:1:1). The addition of red ginger powder is mixed into the dough and enough water is added, then after it is thought that the dough has formed like a paste, then the eggs are put into the dough until covered. This is also in accordance with Yuniati and Almasyhuri [5] that the mixture of red brick and iodized salt in making salting media is done by mixing 1000 g of red brick, then beach sand is mixed with salt then also with red ginger powder and stirred until mixed, giving beach sand, salt, red ginger powder and water to taste.

2.6 Physical Quality Test

The physical quality of salted eggs includes texture, pH, and color. Texture is an important aspect for assessing the quality of food products. Texture is one of the factors that influences consumer acceptance of food products [6]. Measurement of albumen and yolk texture is carried out using a food texture analyzer which includes hardness and stickiness parameters. The texture measurement stage begins by installing a P/5S type probe on the texture analyzer. Furthermore, the egg sample that has been cut into two parts is placed directly under the probe by giving a distance of ± 1 mm above the egg sample. The egg sample will be pressed using a probe with a depth of 6 mm. The measurement results in the form of hardness and stickiness values will be displayed on the monitor screen in the form of peak force numbers in gram force (gf) units [7].

The pH measurement follows the modification of Widyastuti et al., (2018) using Mediatric. Approximately 5 grams of sample is homogenized in 20 ml of water, then the pH meter is standardized using buffers 4 and 9. The pH meter is rinsed with water and dipped into the sample to stabilize before use.

The measurement of albumen and yolk color is carried out using a colorimeter. The albumen and yolk color measurement stage begins by cutting each egg sample vertically into two parts. The colorimeter is turned on by pressing the On button, then the sensor part is attached to the surface of the albumen and the test button is pressed. The results displayed on the monitor screen include L* (brightness value), a* (red to green value), and b* (yellow to blue value) are recorded. Each egg sample is measured twice on each part of the egg. Yolk color measurement is carried out using the same procedure [7].

2.7 Chemical Quality Test

Determination of salt content: The testing procedure follows the procedure of Budiman et al. [8], first the sample is ground and weighed as much as 5 grams. The sample is put into a 1000 ml beaker and ±70 ml of hot distilled water (70-80ºC) was added. Filtered with filter paper that has been placed in a glass funnel and collected in a 250 ml measuring flask. The filtration was repeated several times (8-10 times). 250 ml of distilled water wa added and homogenized with a magnetic stirrer. 25 ml of extract liquid is taken, then 3 ml of 5% potassium chromate was

added and titrated with 0.1N $AgNO_3$ slowly until pink.

Determination of moisture content: The procedure for testing moisture content according to Ramdja et al. [9], first weigh a sample of 2 - 5 grams and put it into a dried porcelain cup. Put the cup in the oven for 1 hour at a temperature of 105 ° C or until the weight becomes constant. Remove the sample from the oven. Put the sample in a desiccator. Weigh the sample immediately after reaching room temperature. Put the material back in the oven until a constant weight is achieved (the difference between successive weighings is 0.20 grams).

2.8 Antioxidant Analysis

The working principle of the DPPH method is based on the presence of antioxidant compounds (HA) which will donate hydrogen (H) to DPPH so that it changes the purple DPPH free radical to a pale yellow color. The UV-Vis spectrophotometer measures its absorbance at a wavelength of 570 nm [10]. According to Maulida [10], the DPPH test has the following test analysis: The first procedure is to insert 2 grams of sample and extract it with 7 ml of ethanol in a test tube. Add 5 ml of DPPH (and vortex). Leave it at room temperature. Allowed at room temperature for 30 minutes and left until the color is formed, it will be orange or purple or blackish. Measure the absorbance at 570 nm, State the antioxidant activity in percentage inhibition against DPPH radicals.

2.9 Organoleptic Test

Organoleptic tests include color, taste, texture, and preference. Organoleptic tests was carried out using the hedonic quality test method [11]. The organoleptic evaluation techniques, first samples that have been given a code are placed on the table. Panelists are given an organoleptic test filling form. Panelists were explained about the procedure for filling out the form and are asked to fill out the organoleptic test form one by one. Panelists who have not had a turn to fill out the form are in the waiting room Forms are collected back for further data analysis. Color is an organoleptic property that can only be recognized by observation using the senses of taste, touch, and sight. Organoleptic testing of salted eggs uses semi-trained panelists with 5 participants. This test uses a hedonic scale based on Fajriana et al. [11], modified by Suharyanto et al. [12] and Surya et al. (2017).

2.10 Data Analysis

The observation data were analyzed using ANOVA at a 5% significance level. Different results between treatments were continued with the Duncan Multiple Range Test (DMRT).

3. RESULTS AND DISCUSSION

3.1 Physical Quality Test

The research results for the physical quality of the salted eggs obtained can be seen in the following Table 1. Physical testing of salted eggs includes texture, pH, egg white color and egg yolk color.

3.2 Texture

The results of the physical testing of salted eggs show that the texture parameters of salted eggs show a significant difference ($P<0.05$). Based on the results of the study, the highest texture value was obtained at P0, which was 15.71±0.54 N and the lowest texture value at P3, which was 12.88±0.30 N. The results showed that the higher the concentration of red ginger added, the lower the texture value of the salted eggs. This is because the addition of red ginger will slow down the rate of diffusion of the solution into the egg. Thus, the salt solution that enters the egg is getting less. The water that comes out of the egg is also getting less so that the more water contained in the egg causes the texture of the salted egg to become softer and vice versa.

3.3 pH

The results of the physical testing of salted eggs show that the pH parameter of salted eggs shows a significant difference ($P<0.05$). This shows that the addition of red ginger affects the pH level of salted eggs. Measuring the pH of eggs is very important so that we know the degree of acidity of the eggs. Aryani et al. [13] stated that pH is a way to measure the degree of acidity in an object. The results showed that the highest pH value was obtained at P0 and the lowest was P3. The decrease in pH value is thought to be due to the active substance in ginger suppressing CO2 loss which can lower the pH in egg white. According to Banurea et al. [14] the preservative content in ginger is zingerone and shogaol, which play an active role in egg white to suppress damage to albumen by suppressing bicarbonate breakdown so that CO2 loss can be minimized.

Table 1. Physical testing of salted eggs

Parameter	Treatment			
	P0	P1	P2	P3
Texture (N)	15.71±0.54[d]	14.04±0.31[c]	13.45±0.41[b]	12.88 ± 0.30[a]
pH	7.40±0.08[c]	7.31±0.06[b]	7.24±0.06ab	7.18 ± 0.05[a]
Color				
*L	65.83±1.87[c]	63.53±1.51[b]	61.21±1.11[a]	60.05 ± 1.87[a]
*a	39.52±1.90[a]	41.62±1.68[b]	43.97±1.04[c]	46.45±0.85[d]
*b	73.47±1.93[a]	74.63 ± 1.34[a]	73.51 ± 1.45[a]	73.50±1.72[a]

*Note: the numbers in the rows followed by different letters show significant differences (P<0.05). *L: Lightness; *a: redness; *b: yellowness*

Table 2. Chemical testing of salted eggs

Parameter	Treatment			
	P0	P1	P2	P3
Salt	3.38±0.17[b]	2.89 ± 0.13[a]	2.87 ± 0.11[a]	2.78 ± 0.10[a]
Water	45.58±0.87[c]	43.82±0.73[b]	43.08±1.08[ab]	42.52 ± 0.72[a]
Antioxidant	2.10 ± 0.39[a]	6.88±1.02[b]	9.53±0.49[c]	14.39±1.44[d]

Note: the numbers in the rows followed by different letters show significant differences (P<0.05)

3.4 Color

The results showed that the administration of red ginger had a significant effect (P <0.05) on the lightness (L *) and redness (a *) values of salted eggs. For the yellowness value (b *) the results of the study showed no significant difference (P> 0.05). The best treatment was obtained at P0, which was 65.83 ± 1.87, because it had the highest L * (lightness) color of the other treatments. The addition of ginger will reduce the L color in salted eggs. Ginger has a natural pale yellow coloring agent gingerol found in ginger oleoresin [15]. So that salted eggs added with red ginger will make the color of the salted eggs darker.

Based on the results of the analysis of variance, it shows that the addition of red ginger has a significant effect (P <0.05) on the a value (redness). This is thought to be the tannin content in ginger flour. According to Astriana et al. [16], the yellow, orange or red color of egg yolk is influenced by carotenoid pigments. Nugraha et al. [17] added that the cause of changes in the intensity of the color of salted egg yolk is influenced by the interaction of atoms and electron-rich bonds belonging to carotenoid pigments with Na + ions and Cl- ions. The b color value (yellowness) in the results of the study above did not show a significant difference in value (P> 0.05).

The color of salted eggs is one of the parameters for measuring egg quality and attracting consumer interest. According to Setyaningsih [18] in Wibowo et al. [19] that color is the most important quality attribute, even though a food product has high nutritional value, good taste and good texture, but if the color displayed is less attractive it will cause the food product to be less in demand by consumers.

3.5 Chemical Quality Test

Chemical testing of salted eggs includes salt content, water content, fat content, protein content and antioxidants. The research results for physical testing of salted eggs obtained can be seen in the following Table 2.

3.6 Salinity

The results of the analysis showed that red ginger had a significant effect (P<0.05) on the salt content of salted eggs. The addition of red ginger to salted eggs had a lower salt content compared to without the addition of red ginger. The highest salt content was found in the treatment without the addition of red ginger (P0), which was 3.38±0.17. The P3 treatment had the lowest salt content, which was 2.78±0.10. According to SNI 01-4277-1996 concerning the quality standards of salted eggs, the salt content in salted eggs should not be less than 2.0% of the egg weight (National Standardization Agency, 1996).

The salt content was higher in the treatment without the addition of red ginger compared to

the treatment with the addition of red ginger. The decrease in the salt content of salted duck eggs was also influenced by the increase in the concentration of red ginger used during the salted egg making process. This is thought to be due to the use of ash as one of the media in making salted eggs. According to Yuniati and Almasyhuri [5], that scouring ash has small particles so that scouring ash, salt and water when mixed into one mixture, the scouring ash will bind iodized salt particles. The scouring ash particles that bind iodized salt will diffuse into the egg through the pores of the egg shell.

According to Nursiwi et al. [20], during the egg incubation process, salt will enter the egg through osmosis so that the salt content in the egg will increase. In the process of making salted eggs, salt functions as a salty aroma giver and preservative because it can reduce oxygen solubility, inhibit the action of proteolytic enzymes, and absorb water from the egg so that the nutritional content is not damaged or lost much [21].

3.7 Water Content

The water content in the research results obtained shows that the highest water content was in the P0 treatment, namely 45.58 ± 0.87 and the lowest was in the P3 treatment, namely 42.52 ± 0.72. This indicates that the administration of red ginger to salted eggs can affect the water content in salted eggs ($P < 0.05$). Ginger has a better ability to bind water due to the hygroscopic properties of ginger so that it is more effective in reducing the water content of salted eggs [19]. Water content is one of the keys to the success of a food processing process. The high water content in salted eggs is the best medium for the growth of microorganisms, so that microorganisms will easily damage the inside of the egg. Analysis of the water content of salted eggs is needed as a benchmark for the shelf life of eggs [7].

3.8 Antioxidant Levels

The results of the analysis showed that red ginger had a significant effect ($P<0.05$) on the antioxidant levels in salted eggs. The average antioxidant levels obtained in this study for the highest antioxidant levels were in treatment P3, which was 14.39±1.44. Previous studies have shown that there is an effect of increasing antioxidant content in salted eggs with the addition of ginger extract compared to ordinary salted eggs, namely in salted eggs with the addition of ginger extract 28.718%, while in ordinary salted eggs it was 1.585% [22]. This is supported by the opinion of Irawan and Septiana [23] in Faiz et al. [24] which states that the use of medicinal plants temulawak and ginger in the salting solution can increase lipase enzyme activity because the antioxidant content in ginger is quite high.

Salted eggs without the addition of ginger extract contain antioxidants because in general salted egg yolks contain antioxidants even though in small amounts. The antioxidant in eggs that is already known is β-carotene which gives orange pigment to egg yolk [25]. According to research, the total phenol in ordinary salted eggs is 2.4 mg GAE/g, while salted eggs with the addition of ginger extract showed a significant increase in total phenol and antioxidant activity [22].

3.9 Organoleptic Test

The research results for physical testing of salted eggs obtained can be seen in the following Table 3. The organoleptic assessment aims to determine the panelists' acceptance of a product produced. The organoleptic test carried out in this research was the hedonic test. Organoleptic testing consists of egg white color, yolk color, smell, taste, flavor, and general acceptability.

Table 3. Organoleptic testing of salted eggs

Parameter	Treatment			
	P0	P1	P2	P3
Egg white color	1.64 ± 0.17^{a}	1.44 ± 0.09^{b}	1.36 ± 0.09^{b}	$3{,}92 \pm 0{,}23^{c}$
Yolk color	3.24 ± 0.17^{a}	3.72 ± 0.27^{b}	3.96 ± 0.26^{bc}	$4{,}28 \pm 0{,}23^{c}$
Smell	3.80 ± 0.24^{b}	3.16 ± 0.26^{a}	3.20 ± 0.24^{a}	$3{,}76 \pm 0{,}50^{b}$
Flavor	3.44 ± 0.17^{a}	3.64 ± 0.17^{ab}	3.72 ± 0.11^{b}	$3{,}80 \pm 0{,}24^{b}$
General Acceptability	3.28 ± 0.11^{a}	3.76 ± 0.17^{b}	4.00 ± 0.32^{b}	$4{,}32 \pm 0{,}18^{c}$

Note: the numbers in the rows followed by different letters show significant differences (P<0.05)

Color plays an important role in food acceptance, because according to Winarno [26], visually the color factor appears first so that it determines whether the food is delicious or not in terms of its color. The results of the analysis of variance in the organoleptic test for albumin color showed that the addition of ginger in making salted eggs had a significant effect ($P < 0.05$) on the level of preference for the color of albumen and salted egg yolk. However, the value obtained was low. This is possible because of the penetration of the salt solution with the addition of ginger extract to the eggs.

According to the results of Duncan's further test in Table 3, the number of organoleptic test values for the yolk color parameter was significantly different ($P < 0.05$). This shows that based on the hedonic test on salted eggs using red ginger (*Zingiber officinale*) it produces an orange yolk color, the P3 treatment is more preferred by the panelists. It is suspected that this is because egg yolks have a high fat content, gingerol is likely to be able to reduce the level of fat absorption, so that the decrease in the color of the egg yolk which is increasingly pale is the impact of fat-soluble vitamin A not being absorbed perfectly.

The results of the analysis of variance showed that the addition of red ginger had a significant effect ($P < 0.05$) on the aroma of salted eggs. From these results, it can be seen that panelists preferred salted eggs with the P3 treatment. The P3 treatment was carried out by adding 6% red ginger, this level was higher than the other treatments. The values shown in each treatment showed that the higher the level of ginger addition, the more preferred the aroma produced.

This can be caused because ginger extract contains essential oils which are volatile compounds (easily evaporated) that give a distinctive aroma to ginger such as limonene, zingeberene, geraneol so that the fishy taste of salted eggs disappears because the aroma of ginger is more dominant [27]. According to Zulfikar [28], the aroma of ginger is caused by the osmosis process that occurs in eggs in a salt solution with the addition of ginger extract. So the higher the percentage of ginger added, the lower the fishy aroma of the eggs will be because of the essential oils contained in it.

In addition, it is also caused by the process of adding ash to the dough that is too thick so that it can reduce the distinctive aroma of ginger in salted eggs [27]. This is in accordance with the opinion of Winarno and Koswara [26], stating that the level of aroma in salted eggs is influenced by time factors, even pasta dough, and salt concentration also affects the characteristics of the aroma of salted eggs. Salted eggs with the addition of ginger will provide a more distinctive aroma, besides that the aroma can also be used as an indicator of damage to food products.

Taste is one of the important factors in food products, generally salty according to the level of salt given in making salted eggs. The results of the study showed that the taste preferred by the panelists was the treatment given red ginger. The data above shows the results of the organoleptic test of the level of preference for the taste parameter of salted eggs at P2 has the highest value. The addition of red ginger in making salted eggs can provide flavor innovation.

The addition of red ginger at different doses with the boiling cooking method has a significant effect on the taste of salted eggs. The preference for salty and red ginger tastes varies for each panelist. This is caused by the essential oils in red ginger changing the taste of salted eggs, resulting in a salted egg taste that is dominated by ginger, because ginger contains non-volatile compounds (not easily evaporated) in the form of oleoresin compounds which are also components that give a spicy and bitter taste to ginger such as gingerol and shagaol (Ulfah et al., 2023). Oleoresin still provides flavor even though some of the essential oils have evaporated [28]. According to Winarno [26], the taste of food ingredients consists of three components, namely smell, taste and stimulation from the mouth. In general, food ingredients do not only consist of one type but are a combination of various flavors in an integrated manner so as to create a complete taste. General appearance is one of the hedonic testing parameters that affects consumer acceptance. The general appearance of eggs describes the entirety of boiled salted eggs after being split into two parts. The average value of the general appearance parameters in this study ranged from 3-4, and was statistically significantly different ($P < 0.05$). This value illustrates that the panelists' preference level is more inclined towards treatment P3 [29-31].

4. CONCLUSIONS

The use of red ginger can improve the texture of eggs, reduce water content, improve the color of

eggs, reduce pH, reduce salt and water content, increase antioxidant levels, and improve the taste of salted eggs.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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