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# Research Article
# Coating Optimization Using Ashes and Salt for the Evaluation of Mineral Characteristics and Sensory Test Results of Salted Eggs

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## Abstract

**Background and Objective:** Salted eggs are famous for their salty flavour and high NaCl content. The salty taste originates from the salt and ash that are used as a salting medium which will affect the taste and acceptance of salted eggs. The purpose of this research was to evaluate the coating optimization using various ash and salt amounts to vary the mineral content and sensory value of the salted eggs. **Materials and Methods:** This study used a randomized block design of a 2×3 factorial pattern with three replications, where factor A is the type of ash, namely, either husk ash or wood ash and factor B is the addition of different amounts of salt, specifically, one, two and three parts salt. Observations about raw, salted eggs were made regarding albumen pH and water and ash content, as well as the NaCl, P, Ca, Mg and K content; observations about boiled, salted eggs were made regarding colour, aroma, texture and flavour. **Results:** This study found a possible inverse relationship between basicity and the amount of salt used in the coating process. The results of the study show that there is an interaction between ash type and the different amounts of salt with the albumen pH, NaCl, Ca, Mg, K content, aroma and texture but no significant effect was observed on colour and taste. Compared to wood ash, the use of husk ash with increased amounts of salt in conjunction with the salted egg coating method can decrease the NaCl and P content of the eggs and enhance the K content, albumen pH, aroma, texture and taste. **Conclusion:** The treatment of the salted eggs with the husk ash coating method and as much as three parts salt is optimal for producing salted eggs with low NaCl content, high mineral content and preferred sensory properties.

Key words: Coating method, mineral contents, rice husk ash, salted egg, sensory test

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Data Availability: All relevant data are within the paper and its supporting information files.

## INTRODUCTION

Salted eggs are made from eggs that are processed through a salting process to endow the egg with a distinctive, salty taste. The taste of a fishy duck egg will be more distinctive and favourable after the egg is salted. Sicincin in West Sumatra produced these eggs by using a salting method that consisted of soaking the eggs in a mixture of salt and wood ash. Another method used in the production of salted eggs is to coat the eggs with a mixture of salt and wood ash[1]. The advantage of the coating process is that it requires much less salt than the soaking process.

Coconut fibre ash is also used for making salted eggs because it contains salt[2]. However, the availabilities of coconut fibre and wood ash are more limited than rice husk ash. Rice husk ash, the waste from rice milling, is widely available because rice is the staple food in Indonesia. Thus, rice husk ash can be used as a replacement for wood ash. The basicity of wood ash is 1.95% while that of rice husk ash is 0.26%[3].

According to Eliche-Quesada *et al.*[4], rice husk ash and wood ash contain silica, Al, Fe, Ca, Mg, Na, K and P. The results of Milla *et al.*[5] study suggested that rice husk biochar (RHB) contains higher silica and Mg than wood biochar (WB); RHB contains 17 mg $kg^{-1}$ Si, 220 mg $kg^{-1}$ Ca, 175 mg $kg^{-1}$ K and 182 mg $kg^{-1}$ Mg and WB contains 10 mg $kg^{-1}$ Si, 273 mg $kg^{-1}$ Ca, 305 mg $kg^{-1}$ K and 72.23 mg $kg^{-1}$ Mg.

Salted foods have a salt content of more than 2%[6]. A high salt content in food, in particular NaCl, will trigger diseases such as hypertension. The Chinese government has limited excessive salt intake in the diet of people in China due to the increasing prevalence of diseases caused by the effects of excessive salt consumption[7]. The limit of salt intake per day, which is less than 5 g per day, is based on the WHO definition[8]. Salt consumption in China and Turkey is very high and study of Zhao *et al.*[9] revealed that the daily consumption of salt for children and adolescents in Beijing is 11 and 15.2 g, respectively. The salt intake in Turkey is $14.8\pm5.4$ g[10]. The NaCl content of a salted egg white, obtained by using a salt solution with a concentration of 25% and a salting time of 12 days, is $3.66\pm0.15\%$[11].

The high salt content in salted eggs must be lowered. It is now advised to consume salt that is low in sodium but has a high content of other minerals. The human body needs common salt (60% NaCl) and there is only 605 mg of sodium and 471 mg of potassium in 250 salt packs[12]. The results obtained by Ariviani *et al.*[13] indicate that the production of low-sodium salted eggs by adding KCl and NaCl (2: 1 w/w) can increase the total phenolic content and antioxidant activity. In addition to NaCl, salt also contains other minerals. According to Sulistyaningsih *et al.*[14], salt contains approximately 80.117% of NaCl and small quantities of other minerals such as $MgSO_4$, $MgCl_2$, $CaCO_3$, $CaSO_4$, KBr and KCl.

The production of salted eggs involves the process of diffusion, i.e., the transition of $Na^+$ and $Cl^-$[15] and results in different osmotic pressures, which causes the water in the eggs to be removed so that the water content decreases[16]. Novia *et al.*[17] reported that the production of salted eggs by the soaking method using wood ash and husk ash increases the mineral content of the salted eggs. This study aimed to find the optimal amount of salt to use in the production of salted eggs by using a coating method that uses ash husk and wood ash, resulting in salted eggs that are low in NaCl but high in mineral salt and that are well-liked by the consumers.

## MATERIALS AND METHODS

A total of 180 Tegal duck eggs (*Anas javanica*) with a maximum age of 48 h and weight of 65-70 g per egg were the main material used in this research. The eggs were obtained from duck farms in Padang, West Sumatera, Indonesia. Other materials used were rice husk ash and salt was purchased at Pasar Raya Padang and wood ash obtained from a tofu factory in Sungai Sapih Village, Padang. For the analysis, an *Shimadzu*® atomic absorption spectrophotometer (AAS), pH meter, furnace, electric oven, analytical scales, stainless steel scoop, desiccator, porcelain cup, mortar and pestle, clip cup, funnel, pumpkin, distiller, glass cup and a set of tools for a sensory test were used.

This experiment was performed using a randomized block design in a 2×3 factorial pattern with three replications. Factor A is the type of ash, either rice husk ash or wood ash and factor B is the addition of different ash amounts, either 1, 2, or 3 parts. Data were analyzed using analysis of variance followed by Duncan's multiple range test. The linear model of experimental design is as follows:

$$Yijk = \mu+\alpha i+\beta j+\alpha\beta ij+\rho k+\varepsilon ijk$$

Where

- Yijk = Observation on the experimental unit to i which obtained a combination of the treatment level i from factor A and level to j from factor B
- $\mu$ = Population mean
- $\rho k$ = Influence of the k- level on group factors
- $\alpha i$ = The effect of i-level of factor A
- $\beta j$ = The effect of j-level of factor B
- $(\alpha\beta)$ ij = The effect of i-level of factor A and the j-level of factor B

εijk = The random effect of experimental unit to -k that received the combination treatment ij. εijk ~ N (0, σ2)

The parameters observed for raw salted eggs were the moisture content (oven method), albumen pH, ash (furnace method), NaCl (titration) and the contents of P, Ca, Mg and K (using AAS)[18]. Additionally, a sensory test using 30 panellists familiar with the sensory tasting procedure and the scoring scale, which ranged from 1 (dislike very much) to 5 (like very much), was conducted[19]. The research was conducted in the Animal Production Technology Laboratory, Faculty of Animal Husbandry and alas University, Indonesia.

The production process of salted eggs is as follows: (a) 60 raw duck eggs were washed and (b) a dough paste, i.e., water, salt and ash, was melted. Factor A is the type of ash, either rice husk ash or wood ash and factor B is the addition of a different amount of salt, either 1, 2, or 3 parts (c) The duck eggs were coated and then salted for eight days and (d) after the salting process, the raw salted eggs were analysed to measure their water content, albumen pH, ash content, NaCl content and P, Ca, Mg and K levels; then, the boiled, salted eggs were examined in the sensory test for colour, aroma, texture and taste.

## RESULTS AND DISCUSSION

The results of the study of salted egg production generated by using the coating method with different ash and salt quantities are shown in Table 1-3, which includes the

Table 1: Moisture content, albumen pH, ash content of raw salted eggs

| | Salt | | | |
|---|---|---|---|---|
| Ash | 1 part | 2 part | 3 part | Mean |
| **Moisture content (%)** | | | | |
| Husk ash | 77.44±5.36 | 81.55±4.87 | 82.53±5.26 | 80.51±2.70$^{b}$ |
| Wood ash | 83.65±1.06 | 86.14±2.53 | 86.17±2.23 | 85.32±1.45$^{a}$ |
| Mean | 80.55±4.39$^{b}$ | 83.85±3.25$^{a}$ | 84.35±2.58$^{a}$ | |
| **Albumen pH** | | | | |
| Husk ash | 8.57±0.43$^{bc}$ | 9.43±0.39$^{a}$ | 8.96±0.20$^{ab}$ | 8.99±0.43 |
| Wood ash | 9.12±0.77$^{ab}$ | 8.27±0.85$^{c}$ | 8.86±0.35$^{b}$ | 8.75±0.43 |
| Mean | 8.85±0.39 | 8.85±0.82 | 8.91±0.07 | |
| **Ash content (%)** | | | | |
| Husk ash | 3.60±2.15 | 3.51±2.34 | 2.45±0.32 | 3.18±0.64$^{a}$ |
| Wood ash | 1.64±0.63 | 1.17±0.43 | 1.44±0.52 | 1.42±0.23$^{b}$ |
| Mean | 2.62±1.38 | 2.34±1.65 | 1.94±0.71 | |

Meanings with different lowercase superscripts show significantly different effects ($p<0.05$)

Table 2: Minerals composition of raw salted eggs

| | Salt | | | |
|---|---|---|---|---|
| Ash | 1 part | 2 part | 3 part | Mean |
| **NaCl content (%)** | | | | |
| Husk ash | 2.65±1.76$^{b}$ | 3.59±2.05$^{b}$ | 3.83±1.41$^{b}$ | 3.36±0.63 |
| Wood ash | 5.61±1.78$^{a}$ | 3.93±0.69$^{b}$ | 2.81±0.54$^{b}$ | 4.12±1.41 |
| Mean | 4.13±2.10 | 3.76±0.24 | 3.32±0.72 | |
| **P content (%)** | | | | |
| Husk ash | 0.28±0.21 | 0.30±0.22 | 0.23±0.18 | 0.27±0.04$^{a}$ |
| Wood ash | 2.52±0.53 | 3.12±1.29 | 0.95±1.30 | 2.20±1.12$^{b}$ |
| Mean | 1.40±1.58 | 1.71±1.99 | 0.59±051 | |
| **Ca content(%)** | | | | |
| Husk ash | 1.09±0.18$^{c}$ | 1.04±0.25$^{c}$ | 1.46±0.35$^{a}$ | 1.20±0.23 |
| Wood ash | 1.52±0.40$^{a}$ | 1.45±0.25$^{ab}$ | 1.25±0.05$^{bc}$ | 1.41±0.14 |
| Mean | 1.30±0.31 | 1.25±0.28 | 1.35±0.15 | |
| **Mg content (%)** | | | | |
| Husk ash | 1.21±0.16$^{c}$ | 1.17±0.04$^{c}$ | 1.60±0.29$^{ab}$ | 1.33±0.24 |
| Wood ash | 1.72±0.42$^{a}$ | 1.66±0.13$^{a}$ | 1.38±0.29$^{bc}$ | 1.59±0.18 |
| Mean | 1.46±0.36 | 1.41±0.35 | 1.49±0.15 | |
| **K content (%)** | | | | |
| Husk ash | 0.86±0.10$^{b}$ | 0.90±0.07$^{b}$ | 1.09±0.11$^{a}$ | 0.95±0.12 |
| Wood ash | 0.86±0.07$^{b}$ | 0.91±0.07$^{b}$ | 0.85±0.02$^{b}$ | 0.87±0.04 |
| Mean | 0.86±0.00 | 0.91±0.01 | 0.97±0.17 | |

Meanings with different lowercase superscripts show significantly different effects ($p<0.05$)

Table 3: Sensory test of cooked salted eggs

| | Salt | | | |
|---|---|---|---|---|
| Ash | 1 part | 2 part | 3part | Mean |
| **Color** | | | | |
| Husk ash | 3.57±1.01 | 3.47±0.73 | 3.20±1.06 | 3.41±0.19 |
| Wood ash | 3.20±0.81 | 3.03±0.81 | 2.83±0.83 | 3.02±0.18 |
| Mean | 3.38±0.26 | 3.25±0.31 | 3.02±0.26 | |
| **Aroma** | | | | |
| Husk ash | 3.13±0.94[a] | 3.10±0.84[a] | 3.37±0.67[a] | 3.20±0.15 |
| Wood ash | 3.27±0.91[a] | 2.63±0.89[b] | 3.10±0.66[a] | 3.00±0.33 |
| Mean | 3.20±0.09 | 2.87±0.33 | 3.23±0.19 | |
| **Texture** | | | | |
| Husk ash | 3.13±0.97[b] | 3.23±0.73[b] | 3.67±0.71[a] | 3.34±0.28 |
| Wood ash | 3.40±0.77[ab] | 3.17±0.75[b] | 3.13±0.73[b] | 3.23±0.15 |
| Mean | 3.27±0.19 | 3.20±0.05 | 3.40±0.38 | |
| **Taste** | | | | |
| Husk ash | 3.47±1.04 | 3.40±0.81 | 3.40±1.00 | 3.42±0.04 |
| Wood ash | 3.33±0.80 | 3.30±0.92 | 3.53±0.63 | 3.39±0.13 |
| Mean | 3.40±0.09 | 3.35±0.07 | 3.47±0.09 | |

Meanings with different lowercase superscripts show significantly different effects ($p<0.05$)

results of the moisture content, egg white pH, ash content, NaCl, P, Ca, Mg and K contents and the sensory test. Based on the results of the analyses of variance, there was a significant interaction between the different ash and salt amounts on the albumen pH, content of NaCl, Ca, Mg and K, aroma and texture but there was no interaction between moisture content, ash content, P content, colour and taste of raw salted eggs. The treatments with different ash produced significant differences for moisture, ash and P content.

**Moisture content:** Table 1 shows that the moisture content of raw salted eggs ranged from 77.44±5.36% to 86.17±2.23%. The results of Duncan's test showed that the A1 treatment (rice husk ash) was significantly lower than that of the A2 treatment (wood ash) and the B1 treatment was significantly different from the B2 and B3 treatments. As the amount of salt increases, the use of wood ash increases the water content of raw salted eggs (Fig. 1).

Rice husk ash contains silica that serves as a water absorber[20]. The silica content of husk ash is much higher than that of wood ash by a factor of approximately 1.58[4]. Therefore, the water content in the coating process using rice husk ash (A1) was lower than that observed when coating process used wood ash. During the salting process, silica will absorb water from the eggs through the pores of the egg shells. Differences in the salt content lead to differences in the water content of the produced salted eggs[21]. The increasing amount of salt will increase the water content of the salted eggs. Increased moisture content is influenced by hygroscopic salt characteristics[22] that also affects the albumen pH, NaCl content and ash content. During the salting process, the salt granules melt into a salt solution[22]. The moisture content of raw salted eggs was higher (77.44±5.36%) than that reported by Novia *et al.*[23] (54.75±0.37%) who preserved raw salted eggs using gambier liquid waste.

**Albumen pH:** The lowest pH of salted egg white was found in the A2B2 treatment, which was 8.27±0.85 and the highest pH was found for the A1B2 treatment, which was 9.43±0.39 (Table 1). The results of Duncan's test further showed that the A1B1 treatment (ash husk with 1 part salt) was significantly different from the A1B2 treatment and was not significantly different from the A1B3, A2B1, A2B2 and A2B3 treatments. The use of 1 part salt resulted in the highest albumen pH when wood ash was used but was the lowest when rice husk ash was used. The use of 2 parts salt resulted in the highest albumen pH when used with husk ash and the lowest value when used with wood ash. However, the addition of ash husk and wood ash with 3 parts salt showed similar albumen pH (Fig. 1).

The increase in pH is due to the $CO_2$ content in the egg. Wulandari[15] found that the value of albumen pH at higher pressure is lower than that of the albumen pH obtained after immersion without the application of pressure. A reduction in the $CO_2$ presence in eggs causes an increase in pH.

**Ash content:** The ash content of raw salted eggs with different ash and salt amounts ranged from 1.17±0.43 to 3.60±2.15%, as shown in Table 1. The ash content resulting from treatment A1 was higher than that of A2 based on Duncan's test. The ash content of the ash husk treatment was higher than the ash content of the ash wood treatment (Fig. 1).

This is the opposite trend which was observed regarding the moisture content of the produced raw salted eggs. The

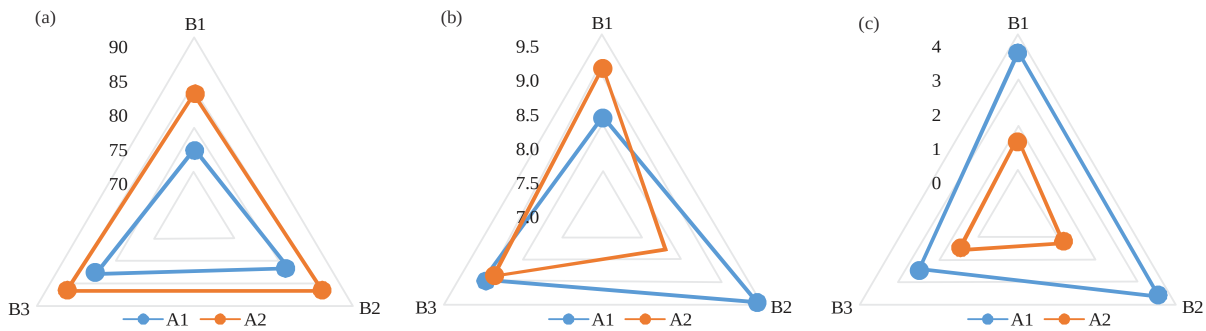


Fig. 1(a-c): Radar Diagram of (a) Moisture content, (b) Albumen pH and (c) Ash content of raw salted eggs
A1: Husk ash, A2: Wood ash, B1: 1 part salt, B2: 2 parts and B3: 3 part

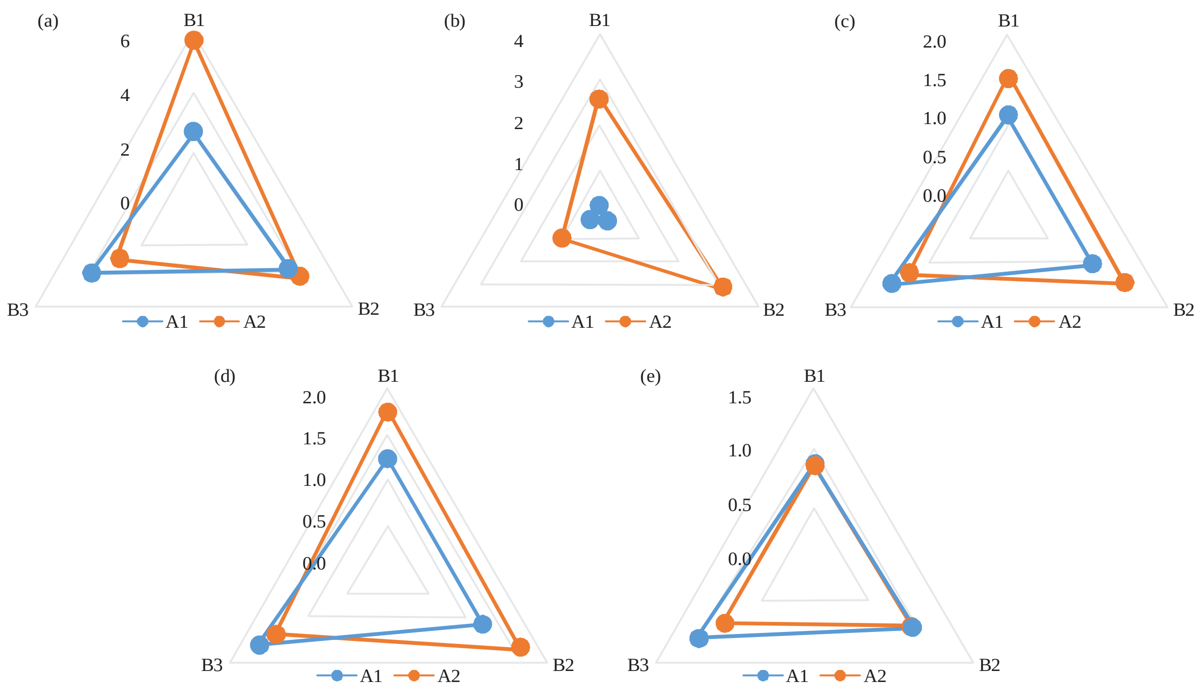


Fig. 2(a-e): Radar diagram (a) NaCl, (b) P (%), (c) Ca, (d) Mg and (e) K content of raw salted eggs
A1: Husk ash, A2: Wood ash, B1: 1 part salt, B2: 2 parts and B3: 3 part

moisture content of salted eggs produced by the ash wood treatment was higher than the moisture content obtained using the rice husk ash treatment for all of the tested salt amounts. The increase in the ash content and the content of the other minerals contained in the ash is due to the addition of salt to the salting process, which causes $Na^+$ (sodium) ions and $Cl^-$ (chlorine) ions to enter the egg and increase the concentration of the minerals in the egg.

## Mineral composition

**NaCl content:** Raw salted eggs have NaCl content between 2.65±1.76 and 5.61±1.78% (Table 2). Duncan's test shows that, with the exception of A2B1, the average NaCl content obtained using the A1B1 treatment was not significantly different from those obtained using the other treatments. All of the treatments except for A2B1 met the SNI requirement for the salt content of salted eggs, which is at least 2% w/w. The addition of salt with wood ash decreases the NaCl content of the salted eggs. By contrast, the NaCl content increased with the addition of husk ash. A higher concentration of salt leads to the diffusion of a greater amount of the NaCl ions into the egg, resulting in an increased NaCl level[11]. Further details can be seen in Fig. 2.

The highest NaCl content in the A2B1 treated eggs was obtained by salting using wood ash with 1 part salt, leading to an NaCl content that is 2.1 times higher than that of the A1B1 treatment. This shows that the addition of wood ash with 1 part salt gives rise to maximum diffusion of NaCl into the eggs compared to the other treatments, Scrubs have a low adsorption power for NaCl solubility (the absorbing ability of NaCl is 1.6088 mg $g^{-1}$) because they are dominated by the hydrophobic silicate atoms; however, NaCl is a hydrophilic compound. The high levels of NaCl in the sample obtained by the A2B1 treatment were in line with the high pH of albumen, which was 9.12±0.77%. The ingredients used in the salting also affect the content of NaCl in salted eggs. The NaCl content of wood ash was 0.81%[17], ash husk was 0.87% and salt was 88.41%.

The lowest NaCl content for the A1B1 treatment was obtained by using husk ash with 1 part salt but this value was not significantly different from the NaCl content obtained with A1B2, A1B3, A2B2 and A2B3 treatments. This result was due to the addition of salt with different levels of husk ash or wood ash, conditions which were already optimal for producing a typical salted egg. The NaCl content of the A2B2 treatment with ash and as much as 2 parts salt (3.93%) is almost same as Novia *et al.*[17] observed in a previous study, in which the combination of wood ash-lime (4-0) produces NaCl content of 3.79%.

**P content:** It was found that the P content of salted eggs was between 0.23±0.18 and 3.12±1.29% (Table 2). The highest P content was obtained for the A2 treatment (wood ash) that was significantly different from that of the A1 treatment (ash husk). The P level in eggs treated with wood ash was 8.1 times higher than that eggs treated with husk ash for all salt additions (1, 2 and 3 parts, Fig. 2).

**Calcium content:** The Ca content of the salted eggs in this study ranged from 1.04±0.25 to 1.52±0.40% (Table 2). The result of Duncan's test for the A1B1 treatment was significantly different from the A1B3, A2B1 and A2B2 treatments and was not significantly different from the results of the A1B2 and A2B3 treatments. The resulting Ca content has the same trend as the NaCl and Mg content, i.e., the wood ash treatment with 1 part salt addition yields the highest Ca levels and the Ca amount decreases with the use of increasing salt amounts. Conversely, for the ash husk treatment, the Ca content increases with increased salt addition (Fig. 2).

High Ca levels were obtained by the A2B1 treatment but the differences were not significant for the A2B2 and A1B3 treatments. This was caused by the presence of Ca in wood ash, husk and salt, which lead to increased Ca diffusion into the egg. The results of the analysis for the Ca content of the samples obtained using wood ash, rice husk ash and salt were 0.22, 0.93 and 0.29% respectively. In a previous study, Novia *et al.*[24] evaluated a combination of wood ash-lime (4-0) and found the Ca content to be 1.59%; this finding is in agreement with the A2B1 treatment (wood ash, 1 part salt) results, which found Ca content to be 1.52%.

**Mg content:** The results of Duncan's test for the A1B1 treatment were significantly different from the A1B3, A2B1 and A2B2 treatments and was not significantly different from the A1B2 and A2B3 treatments. The lowest Mg concentration (1.17±0.04%) was found in the A1B2 treatment sample and the highest Mg concentration (1.72±0.42%) was obtained for the A2B1 treatment (Table 2). Greater salt addition will increase the Mg level for the rice husk ash treatment. On contrary, greater salt addition in the wood ash treatment will decrease the Mg content of salted eggs (Fig. 2).

The highest Mg content of salted eggs made by coating method was found in the samples treated with wood ash and 1 part salt. High levels of Mg observed in the A1B1 treatment were caused by the higher Mg content of wood ash. The Mg content of ash was found to be 1.54% for wood ash and 1.41% for rice husk ash[17]. In addition, the salt used also contains Mg that will diffuse into the egg. The Mg content of the salt used in the salting process was 0.25%.

**K content:** The K content of the raw salted eggs obtained using the coating method with different amounts of ash and salt are presented in Table 2. The A1B3 treatment had the highest K content of 1.09±0.11%, which was significantly different from the values obtained by the other treatments. The lowest K content values were obtained for the A2B3 treatment. Treatments adding 1 and 2 parts salt with wood or husk ash yielded almost the same K content but husk ash treatment with 3 parts salt yielded the highest K content, as shown in Fig. 2.

The high K content of raw salted eggs obtained by the A1B3 treatment is affected by the rice husk ash, for which a higher K content is obtained relative to the treatment with wood ash. The salt used also contains K, which diffuses into the egg. The availability of K from the salting dough increases with greater salt addition. The K content of rice husk ash is 1.26%, wood ash is 1.08%[17] and salt is 0.21%.

**Sensory test:** The sensory test results evaluating the duck salted egg using the coating method with ash and different salt amounts are presented in Table 3. Based on the results of the analysis of variance, there was an interaction between the ash and different amounts of salt for aroma and texture but there was no significant effect for colour and taste.

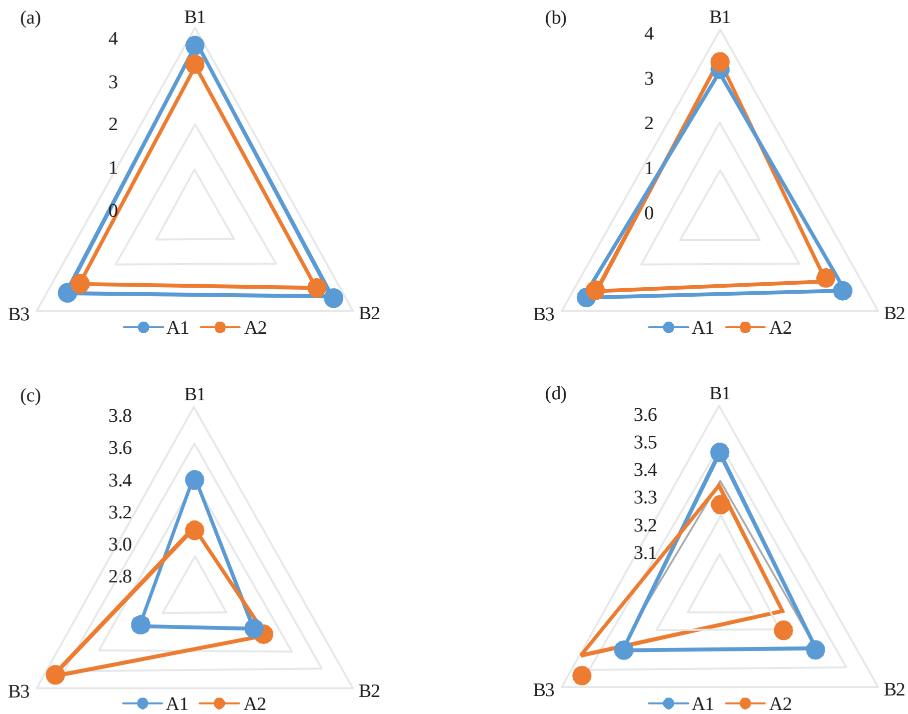


Fig. 3(a-d): Radar diagram (a) Color, (b) Aroma, (c) Texture and (d) Taste of cooked salted eggs
A1: Husk ash, A2: Wood ash, B1: 1 part salt, B2: 2 parts and B3: 3 part

**Colour:** The average sensory test result of colour ranged from 2.83±0.83 to 3.57±1.01 (from "rather like" to "like"). The results of the colour assessment are almost identical to the results of the assessment of ash content (Fig. 3).

The non-significant differences in the colour of the boiled salted eggs were due to the method used and the diffusion process. The coating method was used so that the dough was present in the form of a paste that was in direct contact with the egg. This gives rise to the slow process of mineral diffusion into eggs that affects the chemical content of eggs but not the colour. The tendency for the positive response to the colour of salted eggs when using the wood ash salting medium compared with the ash husk medium was due to the fact that wood ash in the marinating solution serving as an adsorbent during the salting process[17].

**Aroma:** The lowest value for the sensory test of the cooked salted eggs (2.63±0.89) was found for the A2B2 treatment, which corresponded to "rather fond"; this value is significantly different from the results for the other treatments based on the results of Duncan's test. The results are presented more clearly in Fig. 3. The low score of the aroma of the cooked salted eggs for the A2B2 treatment (wood ash with the addition of 2 parts salt) was consistent with the low albumen pH, ash content, texture and taste. The highest scent value of 3.37±0.67, corresponding to "somewhat like", was obtained for the A1B3 treatment.

The high value of aroma in A1B3 treatment is consistent with the high values of Ca, Mg, K and texture, medium pH value and low NaCl and moisture contents. The value of the aroma of cooked salted eggs prepared using husk ash with 3 parts salt is due to the optimum preparation condition in which husk ash absorbs the unpleasant aroma of the duck eggs during the process of marinating; maximum mineral ash and salt diffusion is obtained, particularly for the Ca, Mg and K, while NaCl levels were not too high and the moisture content was low. All of these effects led to the egg texture being favoured by the panellists. In line with the research of Novia *et al.*[17], it was found that soaking in salt and husk ash solutions are optimal for absorbing the unpleasant of the salted eggs.

**Texture:** The texture value obtained in the sensory test of cooked salted eggs ranged from 3.67±0.71 (toward "like") to 3.13±0.73 ("rather like"). Duncan's test result for the boiled salted egg texture for treatment A1B1 was significantly different from the results for of the A1B3 and A2B1 treatments and A1B1 results were not significantly different from the results obtained for the A1B2, A2B2 and A2B3 treatments (Table 3).

The high texture value for the A1B3 treatment (rice husk ash with 3 parts of salt) is in line with the high ash, Ca, Mg and K contents, NaCl and albumen pH were low. The higher value of the texture was due to the action of the hygroscopic salt compounds (water absorption activity)[25] such as Ca, Mg, K and others, in ash and salt. The ability of the salt to absorb water increases with higher Ca and Mg content in the salt.

**Taste:** The taste value of cooked salted eggs ranged from 3.30±0.92 to 3.53±0.63 ("rather like" to "like"), as shown in Table 3. The tendency of the A2B3 treatment to have the highest taste scores is influenced by having the lowest albumen pH and the ash content, as well as by the salinity of salted egg and the medium NaCl level, as shown in Fig. 1-3.

The non-significant difference between the taste of the boiled salted eggs is caused by the level of the albumen pH and the ash content. The albumen pH ranged from 8.27±0.85 to 9.43±0.39 and remained below 9.52. Novia *et al.*[17] stated that egg salting in an ash solution produces an egg white pH of 9.52, which produces the lowest flavour value, equivalent to the criteria "dislike."

Figure 4 shows that the A1B3 treatment (rice husk ash with 3 parts of salt) obtained the best results for aroma, texture, colour and flavour but it is not significantly different from the A2B1 treatment (wood ash with 1 part of salt). In line with the research of Novia *et al.*[17], the egg salting process using one part salt was the most favoured by the panelists. Nuruzzakiah *et al.*[26] found that the higher concentration of salt in the eggs increased the saltiness, eliminated the smell of fish and resulted in a more chewy texture.

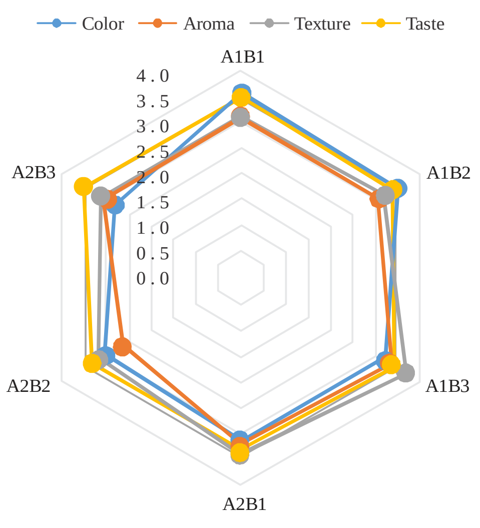


Fig. 4: Radar diagram sensory test of cooked salted eggs
A1: Husk ash, A2: Wood ash, B1: 1 part salt, B2: 2 parts and B3: 3 part

The highest sensory assessment values obtained for the A1B3 treatment, which were consistent with the higher levels of Mg, Ca and albumen pH; however, these values are significantly higher for the A1B3 treatment. The results for K content were significantly different from the NaCl content results in the A2B1 treatment. The A2B1 treatment, with lower moisture content and NaCl of more than 4%, led to this treatment not meeting the salty food requirement, which has a criterion of 2-4% salt content.

## CONCLUSION

The production of salted eggs by using the coating method with ash and different amounts of salt had a significant interaction with albumen pH, the content of NaCl, Ca, Mg and K,aroma and texture of raw salted eggs. The treatment of husk ash with 3 parts salt was the best treatment, the sensory test results for husk ash with 3 parts salt were in the range of "rather like" to "like". Increasing the amount of salt with the addition of husk ash increases albumen pH (except for treatment B2), NaCl, Ca, Mg, K, aroma and texture levels. Conversely, an increased amount of salt with the addition of wood ash led to the decreasing albumen pH, NaCl, Ca, Mg, K, aroma and texture levels.

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