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Research Article
Evaluation of Heating the Gambier Liquid Waste on the Quality of Raw Salted Eggs

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Abstract

Background and Objective: Tannins, a major component in gambier liquid waste, are very useful for the preservation of raw salted eggs. However, gambier liquid waste from Pesisir Selatan, Indonesia, is often low in tannins. This study aimed to determine the evaluation of heating the gambier liquid waste at various temperatures on tannin content, moisture content, total plate count and shelf life of the eggs. **Materials and Methods:** Gambier liquid waste was collected from Pesisir Selatan District, West Sumatra Province, Indonesia and duck eggs were collected from Anduring, Padang, Indonesia. This study used experimental methods with group randomized design, consisting of 5 treatments and 4 replicates of each treatment. The liquid waste treatments were as follows: A (control), B (heating temperature at 29°C), C (51°C), D (73°C) and E (95°C). Raw salted eggs were then soaked in the liquid for 10 min. Tannin content, moisture content, total plate count and the shelf life of the salted eggs were determined. **Results:** The results showed that the temperature to which the gambier liquid waste was heated had a significant impact on the tannin content, moisture content, total plate count and shelf life of the eggs. **Conclusion:** Gambier liquid waste, after heating to 95°C, will increase the preservation of raw salted eggs by 2.67 times longer than the control treatment and six times longer than untreated eggs (7 days).

Key words: Gambier liquid waste, heating, raw salted eggs, shelf life, tannin

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Competing Interest: The authors have declared that no competing interest exists.

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

INTRODUCTION

Egg can be classified as one of the cheapest animal-based proteins. This poultry product is an important food option for infants, pregnant and breast feeding women, as well as parents with high nutrition requirements. In addition to direct preparation as plain boiled eggs, that could be consumed directly, eggs are also commonly sold in markets as salted eggs.

To experience the best flavour, salted eggs should be consumed just after cooking when the egg is still warm. These days, raw salted eggs can be found in the market as ready-to-cook salted eggs, which give consumers the power to cook them by themselves at home anytime they want. In general, this raw product can remain at an acceptable quality up to 7 days if handled properly[1].

Duck eggs are more desirable for making salted eggs than chicken eggs. This is due to their larger pores, which facilitate the diffusion of salt into the egg. In West Sumatra, a popular type of salted eggs are produced in Sicincin, which is in the region of Padang Pariaman[2], but they have a short shelf life (2-3 days) at room temperature. Sometimes the producers reheat or reboil the eggs when they are unsold.

Many studies have been conducted on the application of plant extracts to raw eggs and raw salted eggs. Previous studies have reported that the application of acacia bark extract[3], pod husk extract[4] and gambier liquid waste could significantly extend the shelf life of raw eggs up to 1 month[5]. Some studies have reported on efforts to increase shelf life or to preserve the quality of salted eggs. Such efforts have included utilization of tannins from tea leaf extract[6], lemon juice[7], cinnamon bark extract[8], star fruit leaf extract[9] and onion skin solution[10]. Related to the present study, Novia *et al.*[1], reported that the application of gambier liquid waste from Payakumbuh District, West Sumatra, could extend the shelf life of cooked salted eggs up to 63 days.

Gambier liquid waste is a by-product obtained from gambier extract processing. This tannin-rich material is abundant in some regions in the province of West Sumatra, particularly in Payakumbuh and Pesisir Selatan[11]. It has been reported that gambier liquid waste from Pesisir Selatan District is composed of 0.33% tannins. This amount is lower than that of the waste from Payakumbuh, so it needs to be improved. In line with this, gambier liquid waste, especially the tannins, could be applied on the egg shells to inhibit microorganism growth and thus prolong the shelf life of salted eggs.

Juliatis[12] reported an increase in tannin concentration upon increasing the heating temperature of gambier. Moreover, the content is constant when heated at temperature of 95°C or greater. The purpose of this study was to extend the shelf life of raw salted eggs by optimizing the content of tannins after evaporation of the gambier liquid waste from Pesisir Selatan District by using various evaporation temperatures.

MATERIALS AND METHODS

Three hundred eggs from duck farms in Anduring, Padang, were collected within 48 h. Gambier liquid waste (32,500 mL) was obtained from District of Surantih, Regency of Pesisir Selatan. Other materials including brick powder, ash, salt and water (1:4:2:6.5) were obtained fresh from markets.

Research was conducted using a completely randomized design with 5 treatments and 4 replications. Gambier liquid waste was evaporated at 29°C (A), 51°C (B), 73°C (C), 73°C (D) and 95°C (E). Then, raw salted eggs were soaked in the evaporated solutions for 10 min. After that, the raw salted eggs were stored until control eggs had decomposed, at which point the moisture content and total plate count were determined. In particular, the shelf life was determined to be the point at which the quality was no longer acceptable.

Observations were carried out on raw salted eggs, including determining moisture content using an oven, the levels of tannins in the eggshells with the Lowenthal-Procter method, bacterial colony formation using the standard plate count and the shelf life of raw salted eggs based on sensory parameters (changes in colour, aroma). The limit for tolerated degradation was the emergence of white spots or mildew in the egg yolk and foul odours. Observations regarding shelf life were performed at intervals of 7 days until the salted eggs rotted.

Data were statistically analysed using the F-test and then significance at the 5% level ($p<0.05$) was determined using Duncan's test.

RESULTS AND DISCUSSION

Tannin content: The concentration of tannins in gambier liquid wastes and raw salted eggs are presented in Table 1.

Table 1: Tannin content of gambier liquid waste and salted eggs

Treatments	Tannin content of gambier liquid waste (%)	Tannin content in the tanned shell of raw salted eggs (%)
A	Control	Control
B	0.77	0.040 ± 0.0012^{b}
C	0.81	0.040 ± 0.0008^{b}
D	1.05	0.050 ± 0.0019^{a}
E	1.55	0.048 ± 0.0005^{a}

Different superscripts indicate significantly different ($p<0.05$) values

Table 2: Moisture content, total plate count and shelf life of raw salted eggs

Treatments	Moisture content (%)	Total plate count (1×10^5) CFU g^{-1}	Shelf life (days)
A	54.75±0.37^a	12.00±0.96^a	15.81±0.85^e
B	52.30±0.70^b	10.70±0.56^b	31.48±0.23^d
C	51.88±0.02^{bc}	10.55±0.70^b	33.73±0.76^c
D	52.15±0.06^{bc}	9.70±0.50^b	39.87±0.86^b
E	51.28±0.07^c	5.23±0.53^c	42.21±0.21^a

Different superscripts indicate significantly different ($p<0.05$) values

The concentration of tannins in gambier liquid waste was 0.33% in the untreated sample and that increased by factors of 2.3, 2.5, 3.2 and 4.7 times when the gambier liquid waste evaporated at 29, 51, 73 and 95°C, respectively. At the same time, the concentrations of tannins remaining in the egg shells were in the range of 0.040-0.050%. Application of tannin solutions treated at various evaporation temperatures significantly affected the tannin concentration in the egg shell ($p<0.05$).

Higher evaporation temperatures resulted in higher tannin concentrations and thus more tannin remained in the egg shells. This showed that higher heating temperatures of gambier liquid waste would lower the moisture contents of the raw salted eggs. This is consistent with the report by Julianis,[12] who found higher tannins content in gambir with warming process. This finding is also in line with Kasim,[13] who found skins could be quickly tanned with tannins from gambier. Moreover, Cannas[14] explained that phenolic tannins are excellent hydrogen bond donors and can form strong hydrogen bonds with carboxyl groups in proteins.

Treatments D (73°C) and E (95°C) resulted in higher tannin contents (0.050 and 0.048%, respectively) than those of treatments C and B (both 0.040%). In accordance with the report of Novia[15], the lowest tannin levels of gambier will produce high levels of tanning compounds (tannins) goat leather during tanning. Purnomo[16] stated that the level of tanning is influenced by the nature of the tanner substances used. Kasim *et al.*[17] found that the tannin content in gambier tanner increased the tied tannin level to leather.

Moisture content: The moisture content of the salted eggs is presented in Table 2. The moisture content of the samples ranged from 51.28-54.75%. The results showed a tendency to decrease when gambier liquid waste treated with higher evaporation temperatures were used.

The decrease in the moisture content is caused by the increase in the tannin content; this can be seen in the results of treatment A (95°C) which contained 1.55% tannin. Nazir[18] stated that gambier liquid waste could be used as a tanner. Moreover, during the tanning process, catechin and the tannin catechu acid may precipitate proteins from the skin. When the egg membrane protein keratin was tanned by tannin, the water level declined. Ibrahim *et al.*[19] reported that tannins will draw freely available water molecules away from proteins. Cannas[14] stated that stronger hydrophobic bonds are produced with higher ionic strength solutions (higher tannin/protein ratio) and at higher temperatures. Ultimately, this caused lower moisture contents in the samples.

Tannins can form complex compounds with proteins via hydrogen bonds. Once such a complex forms, the proteins denature and microbial metabolism was impaired[20]. Consequently, bacteria cannot use the nutrients in food as sources of carbon and energy for growth in which organic matter was broken down into water.

Zulaekah and Widyaningsih[6] mentioned that tannins play a role in covering egg shell pores and thus inhibit the ability of microorganisms to access the inner layers of the eggs. Therefore, this prevents the breakdown of organic substances that produce water as a by-product. Treatment group A was not treated with gambier liquid waste. As a result, there was no substance to inhibit the entry of microorganisms into the inner layers of the eggs. Purnomo[16] noted that water content determined the speed of food spoilage.

In agreement with the present study, Novia *et al.*[10] reported that the moisture content of salted eggs soaked in onion skin solution decreased from 69.00-67.09%. Similar to this, Novia *et al.*[1] reported the moisture contents of salted egg soaked in gambier liquid waste decreased from 70.07-62.67%.

Total plate count: The total plate counts of raw salted eggs are shown in Table 2. The results ranged from 5.23×10^5-12.00×10^5 CFU g^{-1}. Soaking the salted eggs in gambier liquid waste obtained from various evaporation temperatures significantly affected the total plate count ($p<0.05$). The absence of soaking in the untreated sample (treatment A) caused a higher total plate count. Lower total plate counts were observed with samples treated with solutions with higher tannin concentration obtained by using higher evaporation temperatures. This was due to higher tannin concentration in such sample which acted as antimicrobials.

Tannins have antibacterial effects[6] and thus could inhibit the growth of microorganisms[21]. This is associated with the fact that the tannins epicatechin and gallic epigallocatechin can damage the cytoplasmic membranes of bacteria[22]. In addition, cellulose pectinase and xylonase could also be toxic to cell membranes and ultimately damage bacteria.

In agreement with the present study, previous researchers also reported lower total plate counts when using extracts with higher tannin levels to treat boiled salted eggs[6]. By doing in depth analysis using diameter inhibition, Magdalena and

Kusnadi[23] found that phenolic derivates from the tannins and catechin in gambier might have a more significant effect on gram-positive bacteria (*Staphylococcus aureus* ATCC 29213, *Bacillus cereus*) than on gram-negative bacteria (*Escherichia coli* ATCC 25 922, *Salmonella typhimurium*).

Shelf life: The estimation of the shelf life of the raw salted eggs based on sensory evaluation is shown in Table 2. The shelf life of the samples ranged from 15.81-42.21 days. Utilization of gambier liquid waste on raw salted eggs significantly affected the length of the shelf life ($p<0.05$). The longest shelf life (42.21 days) was obtained with the sample that underwent treatment E (95°C), while the shortest shelf life was found in samples that underwent treatment A (control). Gambier liquid waste heated to 95°C will aid in preserving raw salted eggs by 2.67 times longer than the control treatment and 6 times longer than untreated egg (7 days).

The evaporation temperature of the gambier liquid waste had a significant impact on shelf life of raw salted eggs. The higher the evaporation temperature is, the longer the shelf life of the sample will be. This was consistent with previous reports that indicated an increase in the tannin content with higher heating temperatures. Moreover, the tannin content remains constant when heated at temperatures $\geq$95°C[9]. Decreasing quality in the eggs was defined as the appearance of a foul odour, watery egg albumin and white spot formation on the egg. These poor quality characteristics appeared faster in the samples that underwent treatment A (control) because microorganism grew faster in the absence of gambier liquid waste.

Tannins acted as antibacterial agents due to their ability to form complexes with proteins via hydrogen bonds. Once hydrogen bonds formed between the tannins and proteins, the proteins denatured, which interfered with microorganism metabolism[20].

The observation of high moisture content was consistent with the microbial colony formation. Microbial colony formation resulted the changes in the colour, texture and aroma of the raw salted eggs. Buckle *et al.*[24] explained that water content affects storage time. Moreover, higher water content in food material increased the possibility of the microorganism growth that is responsible for food spoilage. In line with the research of Novia *et al.*[1], soaking salted eggs in gambier liquid waste from Payakumbuh District for 1 h could reduce the moisture content and bacterial colony formation and extend the shelf life of the salted eggs up to 63 days. In other reports, Novia *et al.*[25] found the maximum shelf life of salted eggs was 84 days.

The tannin content in gambier liquid waste was increased by heating the liquid at increasing evaporation temperatures. This can be seen by the increasing tannin contents in the raw salted eggs, which improved the quality of the salted eggs; that is, decrease in moisture content and total plate count and an increase in shelf life. Gambier liquid waste, especially tannin compounds, can be applied to eggshells to inhibit microorganism growth and thus prolong the shelf life of salted eggs. Heating at temperature of 95°C is recommended for salted egg immersion to extend its shelf life.

CONCLUSION

The study found that increasing the evaporation temperature of gambier liquid waste could be used to increase the quality of salted raw eggs, which is beneficial to salted egg manufacturers. Higher evaporation temperatures resulted in higher tannin levels, lower moisture contents and bacterial colony formation. Soaking raw salted eggs in gambier liquid waste evaporated at 95°C could extend the shelf life up to 42.21 days with 51.28% moisture content, 0.048% tannin content in the egg shell and 5.23×10^5 CFU g^{-1} total plate count.

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