International Journal of Chemical and Biochemical Sciences
(ISSN 2226-9614)

Journal Home page: www.iscientific.org/Journal.html

Identifying the Quality of Preserved Eggs Using Soursop Leaf Extract (*Annona Muricata* L.)

***Nurul Aida Fadia Irsyam*[1], *Nahariah Nahariah*[2*], *Hikmah Hikmah*[2, 3]**

[1]*Student of Master, Animal Science and Technology Program Study, Faculty of Animal Science, Universitas Hasanuddin University, Makassar, Indonesia*

[2]*Departement of Animal Production, Faculty of Animal Science, Hasanuddin University, Makassar, Indonesia*

[3]*Halal Inspection Center, Institute of Research and Community Service Universitas Hasanuddin, Makassar, Indonesia*

Abstract

Eggs have a shelf life of 10-14 days at room temperature. After this time, the egg's external and internal quality will deteriorate. They were preserving needs to be done to maintain the quality of the eggs. This research aimed to identify the quality of eggs preserved with soursop leaf extract (*Annona muricata* L.). The research design used a completely randomized design with four levels of soursop leaf extract: 0, 15, 30, and 45 (%). The observation parameters included egg weight shrinkage, albumen index, yolk index, Haugh unit, pH, foamability, and foam stability of preserved eggs. The results showed that egg preservation with soursop leaf extract at 45% level had an egg weight shrinkage value of (0.012%), egg white index of (0.071 mm), yolk index of (0.382 mm), Haugh unit of (75) and pH value of (7.8), foamability of (491%) and foam stability of (95%). Preserved eggs have higher egg quality compared to uncured eggs. It was concluded that the 45% level was the best treatment to maintain egg quality.

Keywords: Eggs, Physical Properties, Soursop Leaves, Preservation.

Full-length article *Corresponding Author, e-mail: nahariah11@gmail.com Doi # https://doi.org/10.62877/88-IJCBS-24-25-19-88

1. Introduction

Eggs are a protein food product from chicken livestock and one of the most popular food ingredients. Egg whites contain 9.7-10.6% protein, with ovalbumin (54%) being the most abundant protein, ovomucoid (11%), and ovotransferrin (12%) [1]. The high nutritional content of eggs can become a medium for the growth of microorganisms. As a result, eggs have a short shelf life and are easily damaged [2].

Physical damage to eggs is a decrease in external quality (shrinkage of egg weight) and internal quality (decrease in albumen index, Haugh unit, yolk index, increase in pH). Shrinkage of egg quality is caused by the evaporation of water and gas from the egg due to environmental factors. In addition, the length of storage time also affects the decline in egg quality [3].

Preservation extends the shelf life of eggs through various strategies. Several ways of conservation can be used, namely coating eggs with solutions such as lime water, salt solution, or paraffin oil immersion [4] or soaking using natural ingredients or vegetable tanning agents containing tannins such as green tea [5]. Indonesia is rich in biodiversity, especially with many plant species that can be used as natural preservatives. One natural ingredient that can be used is soursop leaves (*Annona muricata* L.).

Soursop leaves have the potential to be natural preservatives because they contain antibacterial compounds. Soursop leaf extract contains steroid, flavonoid, tannin, and alkaloid compounds [6]. Soaking 4% soursop leaf extract as a preservative for duck eggs can maintain albumen and Haugh Unit quality for 35 days [7]. Egg white quality plays a vital role in producing functional properties of eggs, such as foamability and foam stability. Eggs with a long shelf life and still good quality can be processed into foods with high nutritional value. This research aimed to determine the quality of eggs preserved with soursop leaf extract at different concentrations.

2. Materials and methods

2.1. Materials

The materials used were 300 eggs of broiler chickens with an average weight of 55-65 g and an age of 1-2 days. They were obtained from broiler farm Toddopuli hamlet, Taddotoa Village, Pallangga District, Gowa Regency South Sulawesi, soursop leaves obtained from Ajanglaleng Village, Amali District, Bone Regency, solid paraffin (R) and 96% ethanol. The tools used were a stove, digital caliper (Gtechniq), digital scale (SF 400 with a capacity of 1000 g), vacuum rotary evaporator (HEA-02), and egg rack.

2.2. Method

This research used a completely randomized design (CRD). The treatment of soursop leaf extract levels was as follows: P0 (control without soursop leaf), P1 (15% soursop leaf extract), P2 (30% soursop leaf extract), and P3 (45% soursop leaf extract).

2.3. Process for the preservation of eggs using soursop leaf extract

2.3.1. Preparation of Soursop Leaf Extract

The soursop leaves are meticulously washed and dried in the sun, ensuring they are not exposed to direct sunlight. The dried soursop leaves were cut into small pieces and blended until a smooth consistency was achieved. They were then sieved and weighed in quantities of up to 4 kg. The extraction process was conducted using the maceration method. The soursop leaf powder was soaked in 96% ethanol for up to 10 liters, then tightly closed and left for three days. Subsequently, the mixture was filtered and then squeezed, and the process was concentrated using a rotary evaporator at a temperature of 65°C, resulting in the production of the soursop leaf extract [8].

2.3.2. *Application of Soursop Leaf Extract to Chicken Eggs*

The preservation process commences with the heating of the paraffin to a temperature range of 50-60ºC. Subsequently, the designated treatment level should prepare the soursop leaf extract solution. After that, the eggs will be immersed in the prepared soursop leaf extract solution, followed by a second immersion in paraffin until the egg's surface is fully coated. The coated eggs are lifted, drained, and placed on an egg rack. Finally, the coated eggs are stored for 30 days in a room with a temperature range of (28 to 30ºC) [9].

2.4. Variable Analysis

2.4.1. Egg Weight Loss

The percentage of egg weight shrinkage was calculated using the formula [5]:

$$\text{Egg Weight Loss} = \frac{\text{A}-\text{B}}{\text{A}}\ x\ 100\%$$

Description:
A: Weight of egg before storage
B: Weight of egg after storage

2.4.2. Albumen Index

The egg white index can be calculated using a caliper with the height of the condensed egg white divided by the average egg white centerline using the formula [10]:

$$\text{Albumen Index} = \frac{\text{AH}}{\frac{\text{DAL}+\text{DAG}}{2}}$$

Description:
AH: Albumen height (mm)
DAL: Dense albumen length (mm)
DAG: Dense albumen width (mm)

2.4.3. Yolk Index

The yolk index component can be determined where the height of the yolk is divided by the width of the yolk. The Yolk index is measured using a caliper with the formula [10]:

$$\text{Yolk Index} = \frac{\text{a}}{\text{b}}$$

Description:
a: Yolk height (mm)
b: Yolk diameter (mm)

2.4.4. Haugh Unit

The components for measuring Haugh Units (HU) are measuring the height and weight of the egg white. Egg weight is calculated using a balance after carefully breaking the egg on a flat glass surface. The thickness (height) of the albumen (mm) was measured with a caliper. The value of the Haugh unit was calculated using the following formula [11]:

$$\text{Haugh Unit} = 100\ x \log\ (h + 7{,}57 - 1{,}7\ W^{0{,}37})$$

Description:
h: Egg White Height (mm)
W: Egg Weight (grams)

2.4.5. pH value

The pH value of the albumen was determined using a pH meter, which was calibrated using pH buffers 4 and 7. The pH meter was cleaned with distilled water and dried with a tissue. The egg albumen samples were measured without dilution by placing the electrode on the thick egg white [12].

2.4.6. Foamability

The foaming power of an egg white can be quantified by measuring the volume of the liquid before beating. Subsequently, the egg white should be beaten using a hand mixer in a 500 ml measuring cup at medium speed for five minutes or until foam is formed. The volume of the foam was subsequently determined. The foamability was calculated using the formula [13] as follows:

$$\text{Foambility} = \frac{\text{Volume foam}}{\text{Volume liquid}}\ x\ 100\%$$

Description:
V-foam: Volume of the foam formed.
V-liquid: Volume of the liquid egg white before whipping.

2.4.7. Foam Stability

The foam was left for one hour, after which the volume of the drain formed was measured. The stability of the foam was determined by measuring the drain formed in one hour. The stability of the foam was calculated using the formula [14]:

$$\text{Percentage of drainage (\%)} = \frac{\text{Volume drainage}}{\text{Volume foam}}\ x\ 100\%$$

$$\text{Foam Stability} = 100\% - \text{percentage of drainage}$$

2.5. Data Analysis

The data were processed using analysis of variance based on a complete randomized design (RAL) with the aid of the SPSS Statistics 26 software. Should the results indicate a significant effect ($P < 0.05$), the LSD (least significant difference) test was employed [15].

3. Results and Discussions

3.1. Egg Weight Loss

The results demonstrate a statistically significant impact (P <0.01) of egg preservation using soursop leaf extract on egg weight loss. The most significant average egg weight loss was observed at the 0% level (0.046 g), while the lowest was noted at the 45% level (0.012 g) (Figure 1). The results of the BNT further test demonstrated that the 0% level exhibited a statistically significance increase in egg weight loss relative to the addition of other levels. This is because eggs that have not undergone a preservation process lack the protection afforded by the shell. As a result, the continuous evaporation of gas and water through the shell's pores causes a reduction in the egg's weight. The same thing was also stated by [16]: as the eggshell pores become more extensive, gas exchange inside the eggs becomes much more accessible. With more extended storage, the percentage of weight loss of eggs increases.

Similarly, the preservation of eggs with soursop leaf extract did not result in a discernible difference in effect with increasing amounts of soursop leaf extract. This phenomenon is attributed to the inherent properties of tannin, which, when attached to the eggshell, directly tannates the eggshell. This finding aligns with the research conducted by Tooy et al. (2021), which demonstrated that the reduction in egg weight observed at 40%, 50%, 60%, and 70% tea leaf concentrations exhibited a similar magnitude and was lower than that observed in the control group. This is due to the reaction of the tannin content with the protein present in the eggshell, which results in the tanning process of the eggshell. Eggs are impervious to gas and air, thereby preventing the evaporation of water and carbon dioxide to the greatest extent possible, suppressing the decrease in egg weight [5].

3.2. Albumen Index

The results demonstrate that adding soursop leaf extract to the preservation process statistically impacted the egg white index (P <0.01). The highest mean egg white index was observed at the 45% level (0.071 mm), while the lowest was recorded at the 0% level (0.033 mm) (Figure 2). The BNT further test results demonstrated that the absence of soursop leaf extract preservation resulted in a lower egg white index. This phenomenon is attributed to the disruption of the egg white gel structure, which reduces the viscosity of the egg white due to the lack of protection on the eggshell. This, in turn, facilitates the evaporation of water and gas. According to [17], the albumen quality deteriorates more rapidly with prolonged storage, resulting in its expansion and subsequent reduction in height and diameter. This phenomenon, known as albumen spreading, ultimately leads to a decline in the index.

Similarly, the 15% level did not exhibit a statistically significant difference from the 30% level. Still, it did demonstrate a significantly higher difference when the soursop leaf extract was added at the 45% level. This is due to the lower tannin content failing to function effectively. At higher levels, the tannin content has been observed to function optimally. The greater the quantity of soursop leaf extract added, the more effective it is in maintaining egg quality. This finding aligns with the observations of [7], who noted that eggs soaked in soursop leaf extract with a low extract concentration produce minimal tannin-active substances, resulting in insufficient coverage of the eggshell pores by the protective layer of a less concentrated solution. Conversely, higher extract concentrations have been shown to safeguard the eggshells effectively, attributed to the active substances in the eggs from the soursop leaf extract and the enhanced extract level.

3.3. Yolk Index

The results demonstrated a statistically significant effect (P <0.01) of egg preservation with the addition of soursop leaf extract on the yolk index. The highest mean yolk index was observed at the 45% level, with a value of 0.382 mm, while the 0% level exhibited the lowest value, at 0.200 mm (Figure 3). The results of the BNT further test demonstrated that the 0% level resulted in a notable reduction in the yolk index relative to the addition of other levels. This is because of the evaporation of water and gas due to the lack of protection afforded to the shell. This allows the egg white to become diluted, with the water entering the yolk, thus causing a decrease in the yolk index. According to [18], as eggs age, a biochemical process involving the breakdown of carbonic acid occurs, deteriorating protein quality. This leads to releasing carbon dioxide and water, making albumin more fluid and allowing water to diffuse into the yolk. This phenomenon results in the stretching of the vitelline membrane and the flattening of the yolk.

Similarly, adding varying quantities of soursop leaf extract to the preservation process did not result in a discernible difference in the observed effect. However, the yolk index decreased slower than in the non-preserved samples. This is because the tannin level needs to be optimally effective, resulting in a consistent quality regardless of the level of soursop leaves utilized. This finding aligns with the results of previous research [19], which demonstrated that the concentration of soursop leaves at 10%, 20%, and 30% yielded less optimal results regarding the IKT value. This is because the active tannin content in each treatment remained relatively consistent, leading to minimal changes in osmotic pressure due to water migration from the white to the yolk. Consequently, the IKT value remained relatively unchanged across all treatments.

3.4. Haugh Unit

The results demonstrate that adding soursop leaf extract to the egg preservation process had a statistically significant impact on the Haugh unit (P <0.01). The highest mean Haugh unit was observed at the 45% level at 75, while the lowest value was noted at the 0% level (Figure 4). The BNT further test results demonstrated that eggs without preservation exhibited a lower haugh unit. This was due to the evaporation of water, particularly in the egg white, and to a lesser extent, the evaporation of gases due to the lack of protection afforded by the shell. The evaporation process accelerates the ovomucin mesh's breakdown, resulting in an egg's watery consistency characteristic and a correspondingly low Haugh unit value. According to [20], the HU value declined as the storage time increased, with carbonic acid undergoing a conversion to CO_2 (carbon dioxide). The elevated CO_2 loss reduced egg white height, accompanied by a decline in viscosity and thickness.

Similarly, eggs preserved with soursop leaf extract demonstrated no discernible difference in effect between the 15% and 30% levels but exhibited a notable increase at the

45% level. This is due to the lower extract level, whereby the tannin content could be more effective, resulting in a comparable quality. The greater the quantity of soursop leaf extract added, the more effectively it inhibits the evaporation of water and gas from the egg, thereby maintaining the strength of the ovomucin mesh bond. As reported by [21], the 40% level of soursop leaf extract exhibits a higher HU value than other treatments. This is attributed to tannins, which protect the eggshell, thereby maintaining the egg quality better. The small concentration of tannins causes dilution to occur faster due to the low tannin level.

3.5. pH Value

The results demonstrate that adding soursop leaf extract to the egg preservation process statistically impacted the pH value ($P < 0.01$). The highest mean pH value was observed at the 0% level, with a value of 9.4, while the lowest was at the 45% level, with a value of 7.8 (Figure 5). The BNT further revealed that eggs without any preservation process exhibited a more pronounced increase in pH value. This phenomenon can be attributed to the lack of protection afforded by the shell, which allows for the evaporation of water and CO_2 gas. The evaporation of gas from the egg white will change the pH of the egg white from acidic to alkaline, thereby causing the pH value to rise. According to [22], during the storage period, albumen protein decomposes, resulting in the progressive loss of water and carbon dioxide from the egg. This phenomenon increases the pH and decreases the albumen height.

Similarly, eggs preserved with soursop leaf extract demonstrated no discernible difference in effect between the 15% and 30% levels but exhibited a notable increase at the 45% level. This is due to the lower level of tannin content failing to function optimally, resulting in an equivalent product quality. At higher levels, the tannin content effectively prevents the evaporation of water and gas, thereby maintaining the acidic pH value. This finding aligns with the results of research [4], which demonstrated that the pH value of melinjo leaf cooking water at a concentration of 45% is lower than that of 15% and 30%. It can be observed that as the percentage of melinjo leaf cooking water increases, the pH value also decreases. This phenomenon can be attributed to tannins, which tan the eggshell, thereby reducing evaporation and lowering the pH.

3.6. Formability

The results demonstrate that adding soursop leaf extract to the egg preservation process statistically significantly impacted the foambility ($P < 0.05$). The highest average foaming power value was observed at the 0% level, with a value of 574%. Conversely, the lowest foaming power was observed at the 45% level, with a value of 491%. The results of the BNT further test demonstrated that the 0% level exhibited no statistically significant difference from the 15% level. However, a statistically significant reduction was observed in the addition of 30% and 45%. The results demonstrated that eggs preserved with soursop leaf extract exhibited reduced foamability, whereas those without such preservation exhibited enhanced foamability. The lack of tannin content in unpreserved eggs renders the eggshell vulnerable to the effects of evaporation, particularly the loss of water and CO_2 gas. This process leads to the stretching of ovomucin bonds, ultimately resulting in a dilution of the egg. The substance readily absorbs air upon agitation, forming a substantial foam volume. According to [23], prolonged storage of eggs may decrease emulsion and foam stability but increase air absorption.

Similarly, eggs preserved with soursop leaf extract exhibited low foamability and did not demonstrate a discernible difference between the 15%, 30%, and 45% levels. This phenomenon can be attributed to the tannin content that coats the eggshell, which causes protein coagulation and prevents the release of water. The egg white remains viscous due to the persistence of the ovomucin mesh, which impedes the formation of air bubbles even when the egg is agitated. The bond between water and protein remains robust, preventing air trapping. This finding aligns with the assertion in reference [4] that tannins possess polyphenol groups, enabling them to bind and precipitate proteins from eggs. Additionally, the observation that frothing power increases in aged eggs, as documented in reference [24], can be attributed to protein denaturation in egg white, which enhances air absorption.

3.7. Foam Stability

The results demonstrate that adding soursop leaf extract to the egg preservation process has a statistically significant impact on foam stability ($P < 0.01$). The highest average foam stability was observed at the 45% level, with a stability value of 95%. Conversely, the lowest stability was observed at the 0% level, with a value of 87% (Figure 7). The BNT further revealed that eggs that had not undergone any preservation process exhibited a markedly reduced stability. This is due to the egg's ovomucin bond stretching, which makes the egg runny. Upon agitation, the Solution readily absorbs air, forming large foam particles that facilitate rapid water drainage—a more excellent drain reduces foam stability.

Similarly, eggs preserved with soursop leaf extract demonstrated no discernible difference between the 15% and 30% levels but exhibited an increase at the 45% level. This phenomenon can be attributed to the tannins that tan the eggshell, coat the pores, and cause the protein to coagulate, strengthening the bond between protein and water. Upon agitation, no air is permitted to enter while water is prevented from escaping, resulting in a minimal drain and high foam stability. This finding aligns with the assertion made in reference [25] that tannins are polyphenolic compounds that facilitate the binding and precipitation of proteins. [26] subsequently reported that the addition of increasing quantities of soursop leaf extract resulted in a reduction in the aW value. This phenomenon can be attributed to the presence of catechin compounds in the extract, which possess numerous hydroxyl groups (OH) capable of reacting with water (H_2O). Consequently, as the concentration of soursop leaf extract increases, the binding affinity for water also rises.

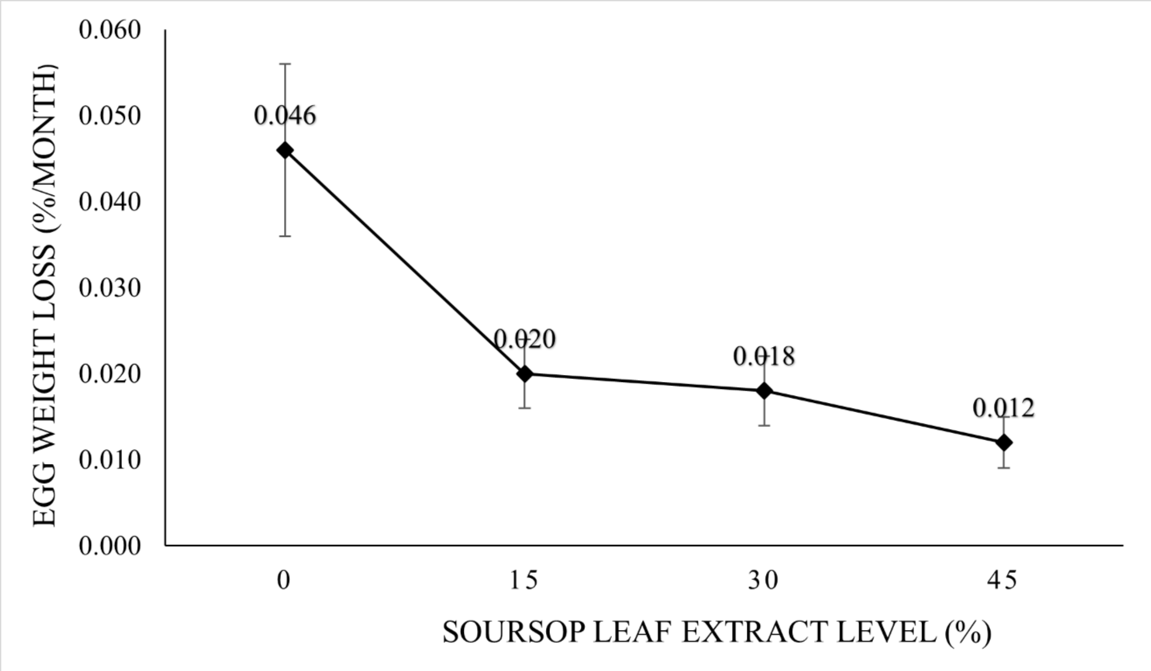

Figure 1. Average Results of Egg Preservation with Soursop Leaf Extract on Egg Weight Loss

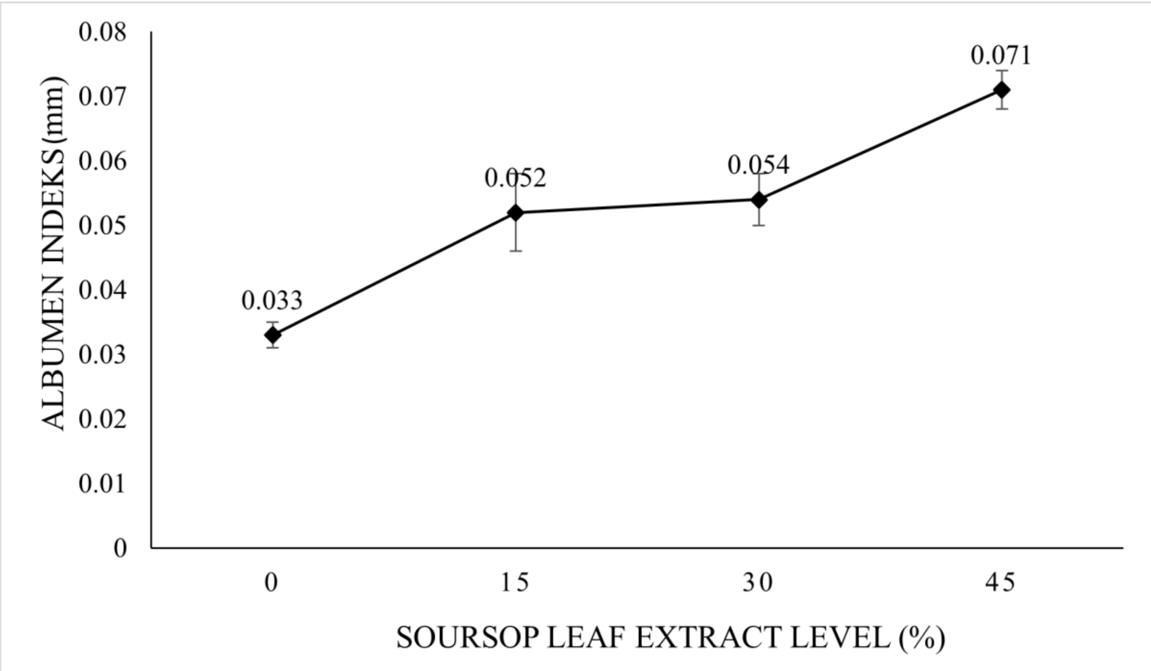

Figure 2. Average Results of Egg Preservation with Soursop Leaf Extract on Albumen Index

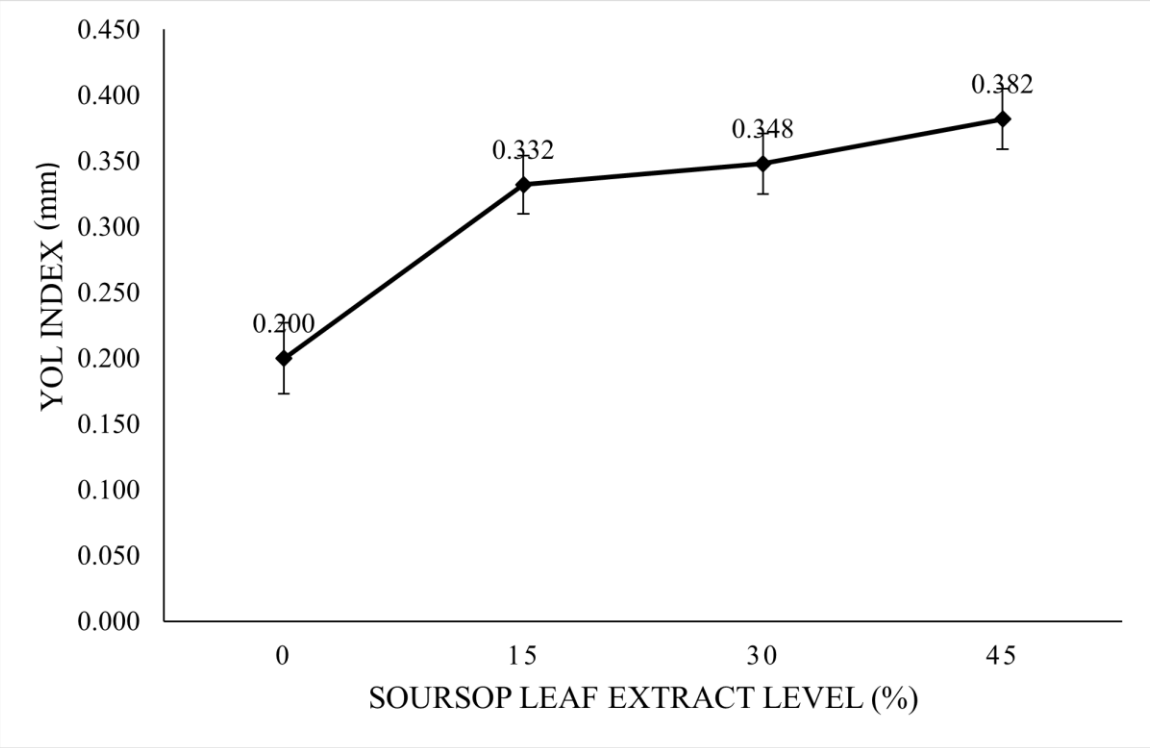

Figure 3. Average Results of Egg Preservation with Soursop Leaf Extract on Yolk Index

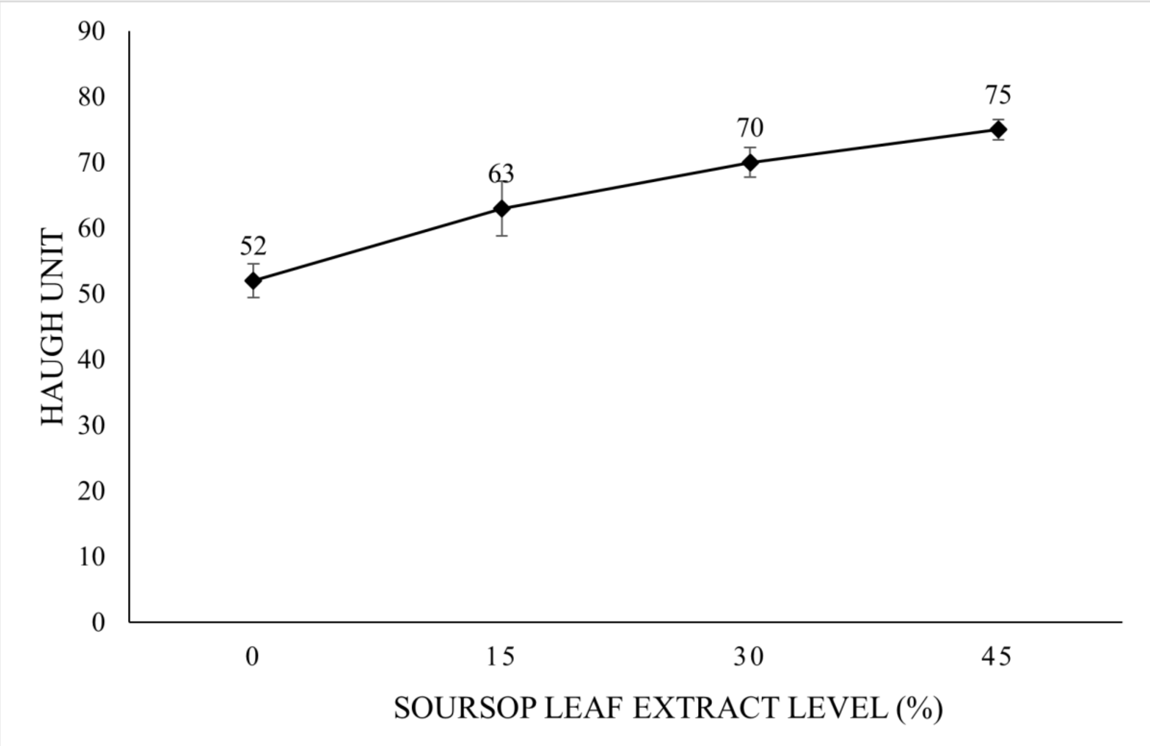

Figure 4. Average Results of Egg Preservation with Soursop Leaf Extract on Haugh Unit

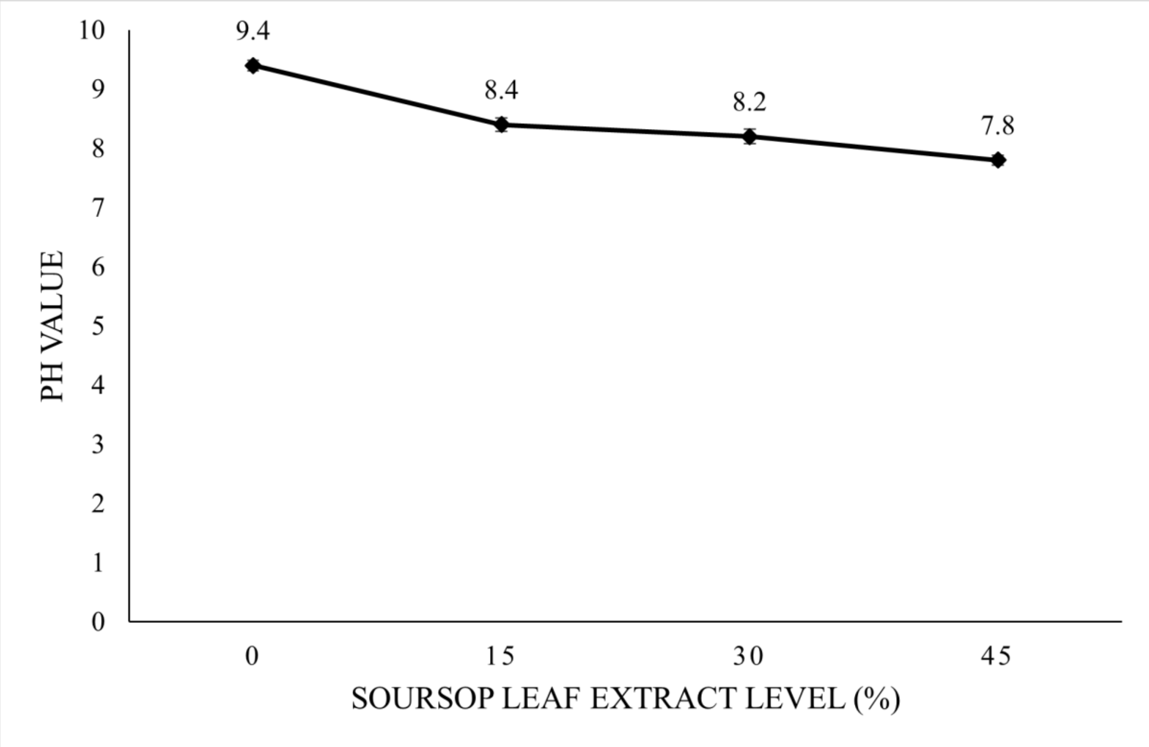

Figure 5. Average Results of Egg Preservation with Soursop Leaf Extract on pH Value

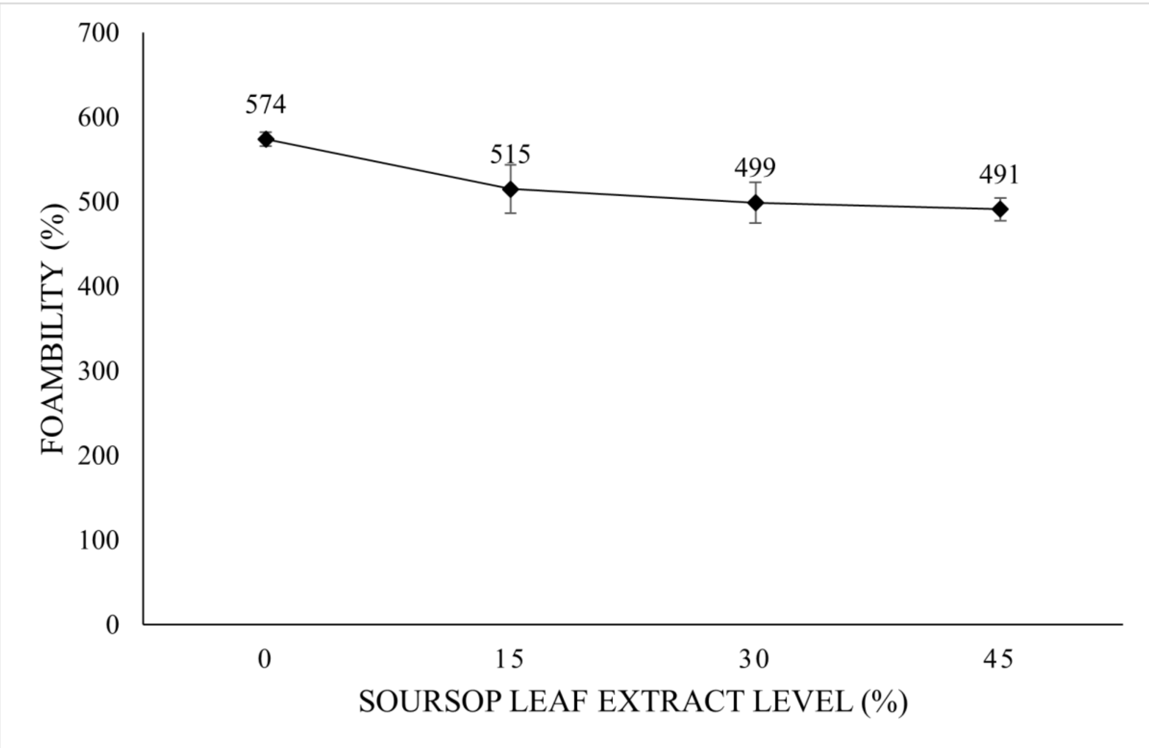

Figure 6. Average Results of Egg Preservation with Soursop Leaf Extract on Foamability

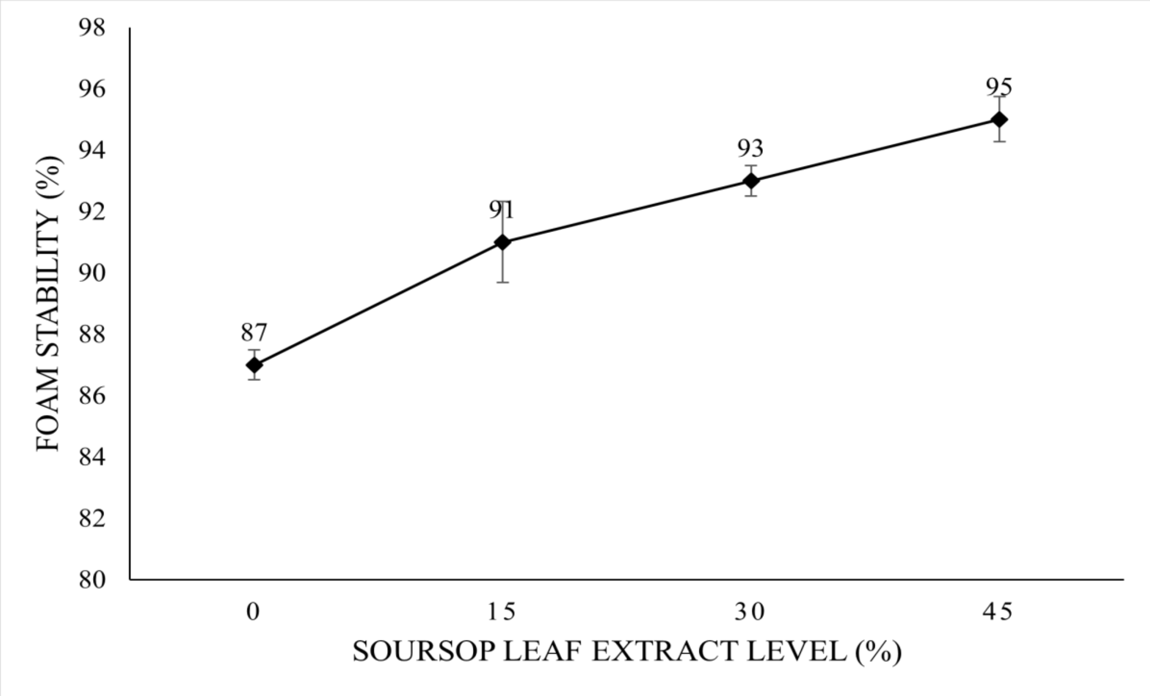

Figure 7. Average Results of Egg Preservation with Soursop Leaf Extract on Foam Stability

4. Conclusions

The results showed that using 45% soursop leaf extract was the best treatment to maintain the quality of chicken eggs regarding egg weight shrinkage, egg white index, egg yolk index, high unit, and pH value but reduced egg foamability but high foam stability.

Acknowledgments

The authors would like to thank the Livestock Product Technology Laboratory technicians who have assisted in conducting the research.

References

[1] H. Xue, M. Xu, M. Liao, W. Luo, G. Zhang and Y. Tu. (2021). Food Hydrocolloids Effects of Tea and Illicium Verum Braise on Physicochemical Characteristics, Microstructure, and Molecular Structure of Heat-Induced Egg White Protein Gel. Food Hydrocolloids. 110. 106181.

[2] W. Liu, Z. Jing, G. Ailing, C. Qian, G. Lihong, R. Yao and Z. Xinshui. (2021). The Specific Biological Characteristics of Spoilage Microorganisms in Eggs. LWT.135:110069.

[3] W. Bilyaro, D. Lestari and S. A. Endayani. (2021). Identification of Internal Quality of Eggs and Factors of Quality Deterioration During Storage. Journal of agriculture and animal science 1.

[4] L. Novitanti, Suharyanto, E. Soetrisno and Warnoto. (2021). Organoleptic Characteristics and Total Microbes of Broiler Eggs Soaked in Melinjo Leaf (Gnetum Gnemon L.) Boiled Water Tropical Livestock Bulletin 2(1): 65-75.

[5] M. D. Tooy, N. N. Lontaan and I. Wahyuni. (2021). Physical Quality of Broiler Eggs Soaked in Commercial Green Tea (Camellia sinensis) Solution. Zootec 41(1): 283-90.

[6] F. Asfahani, Halimatussakdiah and A. Ulil. (2022). Phytochemical Analysis of Soursop (Annona Muricata Linn.) Leaf Extract from Langsa City. *Science and Applied Chemistry* 4: 18-22.

[7] M. A. Tamal. (2016). Soaking Soursop Leaf Extract (*Annona Muricata* Linn) as a preservative for duck egg quality. *Journal of Integrated Agriculture* 4(2): 81-92.

[8] I. B. A. Kresnapati and S. W. Sofya. (2023). Antimicrobial Activity of Ethanol Extracts of Soursop Leaf Egative Escherichia Coli. 7: 477-83.

[9] A. Zulfatunnisa, Susilo and I. Thohari. (2015). Effect of Paraffin Cured Eggs and Sodium Bicarbonate on Physical, Chemical and Organoleptic Properties of Egg Crackers. *Science and Technology of Animal Products* 10(1): 54-72.

[10] J S. Inca, D. A. Martinez and C. Vilchez (2020). Phenotypic Correlation Between External and Internal Egg Quality Characteristics in 85-Week-Old Laying Hens. *int.j.of poultry science* 8(19): 346-55.

[11] Y. Shan, D. Tang, R. Wang, A. Tu, Y. Yi, X. Wang, B. Liu, Y. Zhou, Q. Huang and X. Lu. (2020). Rheological and Structural Properties of Ovomucin From Chicken Eggs With Different Interior Quality. Food Hydrocolloids. 100 (105393): 1-10.

[12] R.D.S. Araujo, S.V. Borges, M.V. Dias, R.H. Piccoli, E. Jos´e Fassani and E.M.C. da Silva. (2021). Impact of Whey Protein Isolate/Sodium Montmorillonite/Sodium Metabisulfite Coating On The Shelf Life Of Fresh Eggs During Storage. LWT - Food Science and Technology. 139(110611): 1-6.

[13] Ozer, Cagla and C. Agan. (2020). The Influence of Aging Egg on Foaming Properties of Different Meringue Types. Journal of Culinary Science &

Technology 00(00): 1-10.
[14] D. Kurniawan, E. Soetrisno and Suharyanto. (2021). Effect of Soaking Broiler Eggs in Melinjo Leaf (Gnetum Gnemon L.) Boiling Water on Oxidation, Frothing Power and Internal Quality. Scientific Journal of Integrated Animal Husbandry 9(3): 311-27.
[15] N. Diwangkari, R. Rahmawati and D. Safitri (2016). Analysis of Missing Data Diversity in Balanced Lattice Design. J. Gaussian 5(1):153-162.
[16] F. A. Revanda and O. R. Puspitarini. (2024). The Effect of Eggshell Dipping with Various Types of Oils and Storage Duration on The Weight Loss and Shell Thickness of Table Eggs. BIO Web Conferences 88, 00005.
[17] L. Amisah and F. Fahrullah. (2024). Internal Quality of Broiler Eggs with Gelatine-Based Edible Coating at Different Storage Times, JSST. 2(2):55-66.
[18] K. Mathew. (2024). The Effect of Storage Temperature and Time on The Quality Traits and Evaluation of Fatty Acid Profile of Backyard Produced Eggs. Int. J. Veterinary Sciences and Animal Husbandry, 9(2):705-709.
[19] R.A. Pradila, D. Septinova, Riyanti and K. Nova. (2023). Effect of Kersen (Muntingia Calabura) Leaf Solution on Low Sodium Salted Egg Yolk Quality. Livestock Research and Innovation 7(2): 133-40.
[20] S. Siripongvutikorn, W. Usawakesmanee, P. Sudon. (2024). Effect of Egg Typ and Storage Conditions on The Quality of Crispy Thai Pancake (Thong-Phap). Italian Journal of Food Science, 36(1):68-79.
[21] I. J. Liur. (2020). Effect of Soursop Leaf Extract Concentration on the Decrease in the Quality of Broiler Eggs During Storage. Journal of Food Quality: Indonesian Journal of Food Quality 7(2): 85-89.
[22] K. Bozbay. (2024). Quality Traits of Table Eggs as Affected by Management Practices and Storage Periods. J. Anim. Sci. South Africa, 54.
[23] M.J. Abuk, Y. Karmila and B. P. Utama. (2024). Effect of Red Ginger Extract on Duck Egg Quality. Journal of Murabanungo University.
[24] L. Mirmoghtadaie, S.S. Aliabadi and S.M. Hosseini (2016). Recent approaches in 401 physical modification of protein functionality. Food Chemistry, 199, 619-627.
[25] T. Desinta. (2015). Qualitatively determined tannin type and tannin content of rambutan fruit peel (*Nephelium lappaceum* L.) by permanganometry. Student scientific journal. 4 (1).
[26] N.M. Prawitasari, I.K. Suter and N.K. Putra (2015). Utilization of Soursop Leaf Extract (Annona Muricata L.) in Increasing the Shelf Life of Dodol. Journal of Food and Industrial Technology, 2(2):111-118.