The Effect of Adding Kaffir Lime Leaf Powder (*Citrus hystrix*) and Citronella (*Cymbopogon nardus*) on the Salt Content, Water Content, Water Activity (Aw), and L*A*B* Color of Salted Egg Yolk

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Abstract. The purpose of this research was to determine the effect and optimal percentage of adding kaffir lime leaf flour and citronella to salted eggs. The research method was experimental method used a Completely Randomized Design (CRD) with 4 treatments and 4 replications, the curing time for salted eggs was 10 days. The treatments given were (P0) 0%, (P1) 2.5%, (P2) 5% and (P3) 7.5% with the addition of kaffir lime leaf powder and citronella leaves with different percentages. The parameters studied were salt content, water content, water activity and L*a*b* color. The results showed that this treatment had no effect ($P > 0.05$) on salt content, water content and L*a*b* color, this treatment had a significant effect ($P<0.05$) on water activity. Average value of salt content (1.45-2.37%), water content (63.40-71.68%), water activity (0.88-0.96), color L*(68.80-71.30), color a* (16.88-19.90) color b* (34.80-40.85). It can be concluded that the best treatment was obtained from adding 2.5% powdered kaffir lime leaves and citronella with salt content 1.45%, water content 68.98%, water activity 0.91, color L* 68.80%, color a* 19.90 and color b* 40.85. This treatment are better than other treatments and are in accordance with Indonesian National Standard (SNI 01-4277-1996) regarding salted eggs.

Keywords: citronella, egg product, herbs, lime, salted egg.

1 Introduction

Eggs are a food product from poultry that has a source of animal protein and has a delicious taste, is easy to digest and nutritious [1]. Duck eggs are a type of egg that is popular with the public as a side dish or as an ingredient in various types of processed foods. Duck eggs are a good source of nutrition, with a protein content of 13.1%, higher calories and fat than chicken eggs [2]. Duck eggs are easily damaged, both natural damage, chemical damage and microorganism attacks through the pores in the egg shell, so duck eggs are very commonly salted. Damage that occurs to eggs will affect the quality and shelf life of the eggs. In addition, duck eggs have a sharp fishy smell so that the use

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of duck eggs in various foods is not as widespread as chicken eggs [2]. Salted eggs are a product of eggs that are treated by salting [3]. Good salted eggs generally have a salt content of at least 2%. An effort to carry out the salting process on duck eggs has the aim of increasing the saltiness level and causing the egg protein to denature. Addition of salt to a material in a certain amount can increase osmotic pressure which causes plasmolysis in microbial cells, reduces oxygen solubility, inhibits proteolytic activity and enzymes and the hydroscopic nature of salt causes Aw to decrease, all of which can make food ingredients durable including eggs [4]. The manufacture of salted eggs generally uses duck eggs because duck eggs have larger pores compared to other poultry eggs, making it easier for salt to be absorbed into all parts of the egg when salted [5]. Salted egg preservation technology has begun to develop with modifications to manufacturing techniques and flavor innovations. Modifications in the manufacture of salted eggs can utilize spices and herbal plants to reduce the fishy smell, improve the taste of salted eggs and extend the shelf life of salted eggs. The addition of citronella powder (*Cymbopogon nardus*) and kaffir lime leaf powder (*Citrus hystrix*) in the process of making salted eggs is expected to improve the quality of duck eggs and extend the shelf life of salted eggs. Citronella (*Cymbopogon nardus*) and kaffir lime (*Citrus hystrix*) are one of the horticultural plants commonly used as natural flavorings in various food products [6].

Citronella (*Cymbopogon nardus*) is one of the plants that has many benefits. The main compound components of citronella oil consist of citronellal, citronellol, and geraniol. The content of citronellal, geraniol, and citronellol in citronella oil can also inhibit bacterial activity. Citronella leaf essential oil is able to produce an inhibition zone against S. aureus and E. coli and the antibacterial activity of citronella leaf essential oil is greater against S. aureus bacteria [7]. The citronellal content in citronella (*Cymbopogon nardus*) can function as an antimicrobial and antioxidant agent [8].

Citronella leaves (*Citrus hystrix*) have the potential to produce essential oils, the use of kaffir lime leaves has been known by the public since ancient times as a traditional medicine and as a flavoring [9]. Essential oils in kaffir lime and citronella as antioxidants are expected to reduce the water content in salted eggs. The tannin and flavonoid content in kaffir lime and citronella as antioxidants and antibacterials can inhibit bacteria that enter the egg through the pores of the duck egg shell, so it is expected to increase the quality of the shelf life of salted duck eggs and find out the best treatment between the addition of citronella powder (*Cymbopogon nardus*) and kaffir lime leaf powder (*Citrus hystrix*) with various different percentages. Based on the advantages of kaffir lime leaves and citronella, it is necessary to conduct research on making salted eggs with the addition of kaffir lime leaf powder (*Citrus hystrix*) and citronella powder (*Cymbopogon nardus*) which is reviewed in terms of salt content, water content, water activity and L*a*b* color of salted egg yolk. Based on the description above, Citronella (*Cymbopogon nardus*) and Citronella leaves (*Citrus hystrix*) have essential oil components that function as antimicrobial agents so that they help inhibit the growth of bacteria and fungi, extend shelf life, provide a unique taste and aroma. These ingredients can also help improve the quality of salted eggs by inhibiting fat oxidation and maintaining the freshness of salted eggs. It should be noted that the use of Citronella (*Cymbopogon nardus*) and Citronella leaves (*Citrus hystrix*) as additional ingredients

in the process of making salted eggs must be in the right amount to obtain the quality of salted eggs according to standards.

2 Materials and Methods

The research took place at the Animal Product Technology Laboratory, Faculty of Animal Science, Universitas Brawijaya for making salted eggs and parameter testing salt content, water content, water activity and L*a*b* color of salted egg yolk.

The materials used in this research were fresh duck eggs (*Anas domesticus*) (Mr. Nur Laying Duck Farm in Bakung Udanawu Village, Blitar Regency, East Java) aged 1 day with the age of the ducks around 1 year as many as 100 eggs with a blue-green color and egg weight between 60-70 g which are made into salted eggs. The research materials for the incubation process used a paste of scouring ash, fine salt (Segitiga), water, powdered kaffir lime leaves (*Citrus hystrix*) (Mustika Djamue Herbal) and powdered citronella leaves (*Cymbopogon nardus*) (Mustika Djamue Herbal). The materials used for the analysis included 0.1 N AgNO3 solution, distilled water, KCl, K2CrO4, 1% potassium chromate, BaCl2 liquid and H2O.

The equipment used in making salted eggs includes digital scales (SF-400), measuring cups, pans, gas stoves, stirrers, plastic basins, jars and egg containers. The equipment used for analysis includes analytical scales (Radwag), 1000 mL beaker glass, filter paper, measuring flasks, volume pipettes, erlenmeyer flasks, crucible pliers, weighing bottles, ovens (WTC Binder), desiccators (Duran), analytical scales (Mettler Toledo), portable Aw meter (Aqualab Pawkit), color reader model Conica Minolta (CR-10).
The method used in the study was a laboratory experiment with a Completely Randomized Design (CRD) of 4 treatments and 4 replications with a 10-day incubation period for salted eggs with the addition of kaffir lime leaf powder (*Citrus hystrix*) and citronella powder (*Cymbopogon nardus*). Data were analyzed by analysis of variance (ANOVA) and if differences were found, continued with Duncan's Multiple Range Test (DMRT) [10]. Best treatment is calculated by the Effectiveness Index [11].

The treatments given were P0 (without the addition of kaffir lime leaf powder and citronella), P1 (addition of kaffir lime leaf powder 2.5%, citronella powder 2.5%), P2 (addition of kaffir lime leaf powder 5%, citronella powder 5% and P3 (addition of kaffir lime leaf powder 5%, citronella powder 7.5%. Variables include salt content test, water content, water activity, and L*a*b* color test of salted egg yolk color. The salt content test procedure used the Mohr method [12], the water content test [13], the water activity test (Aw) was measured using an Aw meter [13], color test used the L*a*b* test used the Conica Minolta CR-10 model color reader with the hunter system method [14].

3 Results and Discussion

The results of the study of salted eggs with the addition of kaffir lime leaf powder (*Citrus hystrix*) and citronella (*Cymbopogon nardus*) can be seen in Table 1.

Table 1. The average value of salted eggs Indonesia.

Treatment	Salt content (%)	Moisture content (%)	Water activity (Aw)	Color			Best Treatment
				L*	a*	b*	
P0	2.37 ± 0.955	71.68 ± 7.59	0.88 ± 0.019[a]	71.18 ± 1.152	18.48 ± 2.57	38.30 ± 4.14	0.67
P1	1.45 ± 0.035	68.98 ± 9.73	0.91 ± 0.051[a]	68.80 ± 2.190	19.90 ± 0.80	40.85 ± 4.83	**0.68**
P2	1.88 ± 0.385	65.20 ± 7.24	0.94 ± 0.028[a]	69.08 ± 1.141	18.88 ± 1.94	39.68 ± 4.62	0.38
P3	1.57 ± 0.238	63.40 ± 7.00	0.96 ± 0.017[b]	71.30 ± 1.267	16.88 ± 1.82	34.80 ± 1.86	0.19

Description: [a,b]Different superscripts in the same column indicate significant differences ($P < 0.05$) and P1 is the best treatment.

3.1 Salt Content

Based on the analysis results in Table 1. shows that the salt content of salted eggs with the addition of kaffir lime leaf powder and citronella from P0 to P3 decreased at different concentrations. The decrease in salt content in salted eggs is due to the addition of kaffir lime leaf powder and citronella inhibiting the penetration process of salt entering the egg during the incubation process. The tannin compound content in kaffir lime leaves and citronella can cover the pores of duck egg shells, thereby preventing evaporation of H2O and CO2. The tannin compound contained in lime is 1.8% and citronella is 8.17%. The process of closing the pores occurs due to tannin compounds reacting with proteins in the cuticle in the duck egg shell, resulting in tanning of the egg shell to a yellowish brown color, so that salt does not enter optimally during incubation [15].

Soaking duck eggs in the P0 control treatment without the addition of kaffir lime leaf powder and citronella has a higher salt content. This is because salt penetrates the egg more easily. Salt will enter more easily because there is no tannin tanning process that closes the pores of the egg. The mechanism that occurs in the incubation of salted eggs with the addition of Javanese turmeric (*Curcuma zanthorrhiza*) ± 75% is that the NaCl solution ionizes into Na + and Cl -. Na + and Cl - ions diffuse through the cuticle layer, sponge layer, mammillary layer, membrane layer, egg white, vitelline membrane and egg yolk, producing a salt content of 1.31% [16]. The incubation process of salt soaking for 14 days of salt solution will enter the egg through the process of osmosis, namely the process of moving solute molecules from low concentrations (hypotonic) to high concentrations (hypersonic), so that the salt content in the egg increases by 2.73%. In addition to providing a salty taste, salt also functions as a water absorber in eggs and also the role of chlorine ions as an inhibitor of bacteria in salted eggs [17].

Based on the research results, the salt content value that is in accordance with SNI is only in the treatment (P0) control salt content value of 2.37% without the addition of kaffir lime leaf powder and citronella. Treatments (P1-P3) with the addition of different kaffir lime leaf powder and citronella have not require by SNI, salt content of salted eggs of at least 2% [18]. The salt content of salted eggs will increase if there is no addition of kaffir lime leaf powder and citronella, but if the manufacture of salted eggs

with the treatment of adding kaffir lime leaf powder and citronella with different concentrations will decrease the salt content of salted eggs. The results obtained are possible because the kaffir lime leaf powder and citronella can absorb moisture from the salted eggs, thus reducing the salt content of the salted eggs. Water will come out of the salted eggs to dilute the salt concentration.

3.2 Water Content

The percentage of addition of kaffir lime leaf powder and citronella did not affect ($P > 0.05$) the water content of salted eggs. Based on the results of the analysis above, it shows that the water content of salted eggs with the addition of kaffir lime leaf powder and citronella from P0 to P3 experienced successively. The decrease in water content in salted eggs is due to the osmosis diffusion process during the incubation of salted eggs, this occurs because the salt solution is absorbed into the eggs and there is a decrease in water content. Incubation of duck eggs with mangosteen fruit media (*Garcinia mangostana Linn*), salt turns into sodium ions (Na+) and chlorine ions (Cl-), the salt solution enters by penetrating the pores of the duck egg shell towards the white part to the yolk of the duck egg and produces a water content of 68.02 for 7 days. Chlorine ions (Cl-) will absorb water (H2O), so that the water content in salted duck eggs decreases. This water release continues until a balance of solution concentration (isotonic) is achieved [19].

Incubation of duck eggs with the addition of ginger extract (*Zingiber officinale*) at a salt concentration of 35% can reduce water content by ±10% [20]. The decrease also occurs due to the addition of kaffir lime leaf powder and citronella which have dry ingredients in the powder that can absorb water during incubation. Dry ingredients are able to absorb liquids from the environment by absorption and adsorption [21]. Dry ingredients that were hygroscopic. Liquid absorption occurs faster in materials with high water binding capacity [22]. The decrease in water content of salted duck eggs is due to the heating process when steaming raw eggs. Heating causes changes in egg components from liquid (sol) to semi-solid (gel) which is called coagulation [23]. The decrease in water content in salted eggs shows good because the lower the water content of salted eggs, the more bacterial growth is inhibited and extends the shelf life of salted eggs. The average value in the P0-P3 treatment obtained a water content value of 71.68% to 63.40%.

The results of previous studies on salting chicken eggs, the water content of eggs obtained ranged from 63-69% [24]. Based on research on salted duck eggs with the addition of kaffir lime leaf powder and citronella showed the same water content value according to previous research using chicken eggs. Treatment without addition (P0) showed a high water content value, this can cause the development of bacteria, fungi and mold to be easier and faster. The water content in food determines the freshness and durability of the food, with high water content making it easy for bacteria, mold and yeast to grow, resulting in changes to the food [25]. The results obtained are possible because the addition of kaffir lime leaf powder and citronella can absorb moisture from salted eggs, thereby reducing the water content of salted eggs. In the process of osmosis, water molecules will move from areas with low concentrations to areas with

high concentrations. The kaffir lime leaf powder and citronella are used in the salting process, then water comes out of salted eggs.

3.3 Water Activity (Aw)

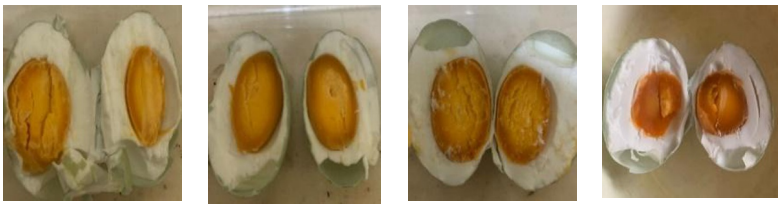
The percentage of addition gave a significant difference ($P < 0.05$) on the Aw of salted eggs. Based on Table 1. shows that the average Aw value ranges from 0.88±0.019 to 0.96±0.017. The P3 treatment value has the highest Aw because it has a high percentage of kaffir lime leaf powder and citronella with a percentage of 7.5% each. This is due to the tannin and flavonoid content contained in the kaffir lime leaf powder and citronella. Incubation with a 30% concentration solution of kaffir lime found that the tannin and flavonoid content contained in kaffir lime leaves closed the pores of the egg shell so that it could inhibit the entry and exit of CO2 gas and microbes into duck eggs, with a total of 101x103 cfu/g microbes [26]. This opinion is supported by previous research that the nature of tannin compounds in the treatment of adding green tea extract and guava leaves can tan the duck egg shell by closing the pores of the duck egg shell which causes protein coagulation, so that it does not affect water activity with a value of 0.982 [27].

The more the addition of kaffir lime leaf powder and citronella in making salted eggs, the higher the Aw value. The water activity value of whole salted eggs is around 0.912, while the average Aw value with the addition of kaffir lime leaf powder and citronella produced in this study was 0.88-0.96 [28]. This shows that the Aw value of salted eggs is higher. However, the Aw value in treatment P1 (0.91) shows that the Aw value is still standard according to previous research. The increase in the Aw value of salted eggs is also influenced by room temperature storage during incubation. This increase is because basically storing a food ingredient in an open space increases CO2 levels, affecting water activity so that Aw in salted eggs increases during incubation [29]. This is also thought to be influenced by the large particle size of the ash so that the rate of diffusion into the egg will be faster and greater. The ability of the egg diffusion rate during incubation results in more water entering the egg [30].

The Aw value in the P2-P3 treatment was 0.94-0.96, indicating that salted eggs are still susceptible to bacterial and fungal attacks. The minimum water activity for the growth of microorganisms such as bacteria is 0.90; yeast; 0.8-0.9 and mold 0.6-0.7 [31]. So, the treatment of adding kaffir lime leaf powder and citronella to salted eggs shows that it is not good for storage because it has the potential for the growth of bacterial and fungal microorganisms. The higher the water activity value in egg yolk, the more it can cause fat oxidation which causes rancidity and damages the texture during the storage process, and if the water activity value is low it will maintain the physical quality of the egg [32]. The treatment of salted eggs with the addition of kaffir lime leaf powder and citronella has a high average Aw value, affecting the shelf life and damage to the eggs.

3.4 Color of Egg Yolk

The percentage of addition of kaffir lime leaf powder and citronella did not affect ($P > 0.05$) the L*a*b* color of salted egg yolk. The documentation of the results of incubating salted duck eggs with the addition of kaffir lime leaf powder and citronella in different treatments is showed in Fig. 1.



P0 P1 P2 P3

Fig. 1. The color of salted egg yolk

L* (lightness). Based on Table 1 shows that the average value of the statistical analysis of the L* color value with the addition of different powders and kaffir lime and citronella ranges from 68.18 ± 2.190 to 71.30 ± 1.267. The administration of different kaffir lime and citronella powders did not have a significant effect on the color of salted egg yolks ($P > 0.05$). The decrease in L* color in salted eggs is thought to be due to the tannin content in the kaffir lime and citronella powder. Kaffir lime leaves contain 1.8% tannin, steroids, triterpenoids, and 1-1.5% essential oils. Kaffir lime peel contains saponins, tannins and 2-2.5% essential oils [33]. Tannins in citronella is one of the chemical contents in citronella is tannin of 18.6 mm [34]. Factors that make the L* value darker according to the results of tannin tests on kaffir lime produce a blackish green color [35].

A good color in salted egg yolk is orange, the darker the L* value, the salted egg yolk is more salty. If the L* value is higher, the color of the egg yolk shows a bright color because the egg yolk is not too salty and salty. The decrease in color is thought to be due to the physical properties of tannin which is yellowish white to light brown depending on the source of the tannin. Tannin gives a dark color if exposed to direct light or is in an open room[36]. The increase in salted eggs that occurred in the P2-P3 treatment was because salt did not contain color and did not affect the L* (Lightness) color. Factors that affect the L* color are the type of egg, steaming time and the addition of other ingredients. The L* value of salted duck eggs with the addition of 75% turmeric extract (*Curcuma domestica*) stated that the L* value was 61.75 brighter than without the addition of any ingredients, which was 55.43 [37].

The process of incubating eggs with salt paste also affects the level of brightness of the egg yolk after the incubation process is complete. The longer the incubation process, the more water content in the egg will bind to the metal ions from the salt, so that the egg structure will be thicker, including the color of the egg yolk. The color of salted duck egg yolk is orange [38]. The formation of this orange color is caused by the egg yolk losing water during the soaking process in a solution with a salt concentration of

30% with an L* color value of 56.93. The reduction in water contained in the egg causes the color of the egg yolk to change to orange.

a* (redness). Based on Table 1 shows that the average value of the statistical analysis of the a* color value with the addition of different powders and kaffir lime and citronella ranges from 18.48 ± 2.57 to 19.90 ± 0.80. The addition of different kaffir lime and citronella powders did not have a significant effect on the color of salted egg yolks ($P > 0.05$). The higher the a* color value, the more the salted egg yolk color is and the better it is, conversely, if the a* color is lower, the color of the salted egg yolk becomes greenish, indicating that the egg is not good. The color of salted duck eggs can be used as an indication of chemical treatment in a food ingredient, in previous studies salted duck eggs with the addition of potassium iodate (KIO3) gave a significant color change in food ingredients that were heated by reducing the a* color of salted egg yolks by 23.50 [39]. The a* (redness) color for the a* notation indicates a mixed color of red and green with an a* (+) value of 0 to +80 for red, while the a* (-) value of 0 to -80 for green in the treatment of salted duck eggs with the addition of NaOH produces an a* color of 11.33 [40].

Treatments P1-P3, the a* color value decreased successively. It is known that the addition of different kaffir lime leaf powder provides a decrease and a positive a* value color which indicates the color intensity tends to be red, resulting in the egg yolk color becoming increasingly greenish yellow. The heating process at a certain temperature will produce a browning process and produce a greenish yellow color [41]. Treatment P3 has an egg yolk color that tends to be dark due to the addition of the most kaffir lime leaf powder and citronella, respectively (7.5%). Differences in treatment and percentage of kaffir lime leaves and citronella give different results and the a* color value decreases if the addition is greater. The addition of red galangal (*Alpinia purpurata K.Schum*) to salted duck egg mixture by 40% reduces the a* color by 18.48, this shows that the difference in the concentration of additional treatment will reduce the a* value [42].

The greater the concentration of additional treatment, the greater the concentration of essential oil added, thus reducing the a* color of salted duck eggs. The decrease in the a* color value causes the color of the egg yolk to change slightly to greenish. The essential oil extract in kaffir lime leaves and citronella produces a dark green to blackish color. The green color that comes from leaf chlorophyll is the main pigment of plants [43]. The wet method when salting salted duck eggs produces a color of a* 50.3 on 15 days of salting, this shows that the color of salted egg yolk is greatly influenced by carotenoid dyes. Pigments from carotenoids will reflect yellow, orange or red, and if adding a scale to the color a*, namely red compared to green, where positive numbers indicate red and negative numbers indicate green [44]. The color a* indicates that a reddish or greenish color material with a range of numbers (-80) for greenish and (+80) for reddish.

b* (yellowness). Based on Table 1 shows that the average value of the results of the statistical analysis of the color value b* with the addition of powder and kaffir lime leaves and different citronella ranges from 34.80 ± 1.86 to 40.85 ± 4.83. The provision

of different kaffir lime leaves and citronella powders did not have a significant effect on the color of salted egg yolks ($P > 0.05$). The color value b* (yellowness) is generally pale yellow, yellow to orange. The higher the color value b* of the egg yolk makes the appearance of the salted egg attractive and creates a salty and salty taste. The increase in the P0 control treatment to P1 was because the salt that entered the egg was not too much so that the color of the egg yolk b* was less than optimal. Incubation of duck eggs with 80% salt concentration produces a very orange egg yolk color with a b* color value of 38.15, while salted eggs with a salt concentration of 20% produce a yellow color that is not too orange with a value of 23.16 because the salt in salted eggs causes the water content to decrease which results in a change in the color of the egg yolk [45].

The decrease in the b* color value of salted egg yolk is thought to be due to the concentration of kaffir lime leaf powder and citronella. The successive decrease gives the b* (yellowness) color increasingly yellow. The average b* (yellowness) value in citronella and kaffir lime leaves ranges from 20.03-21.10% which does not significantly affect the addition treatment and drying time [46]. The content of essential oils that have chlorophyll content is thought to be able to affect the color of the b* value. The physical properties of essential oils and tannins in kaffir lime leaves and citronella have a greenish color that is slightly blackish. Experiments on the treatment carried out by adding kaffir lime leaf powder and citronella with tannin content extraction in it produced a blackish green color [35].

The b* color intensity turned out to present a blue to yellow color with a scale of -100 to +100. This is where negative values indicate a tendency towards blue, while positive values indicate a tendency towards yellow. Color changes in duck egg yolks can be influenced by increasingly concentrated dyes, in previous studies salting duck eggs with the addition of potassium iodate (2000 ppm) showed a b* color value of 30.80, because the longer the incubation and the addition of the concentration of the egg yolk dye, the paler it is, because more and more water is drawn by the hydrate ion, so that the material will become concentrated including the dye [39]. Salting duck eggs with the addition of 4.2% NaOH concentration showed a b* color value (yellowness) of 26.77 [40]. This also shows that in the salting of duck eggs with the addition of kaffir lime leaf powder and citronella which is increasing in P3 (7.5%) the b* color has the lowest value of 34.80. The b* color notation indicates a blue-yellow mixture with a b*(+) value of 0 to +70 for yellow, while the b*(-) value is from 0 to -70 for blue.

3.5 Best Treatment

Determination of the best treatment in the quality test of salted eggs with the addition of kaffir lime leaf powder (*Citrus hystrix*) and citronella (*Cymbopogon nardus*) can be done using the De Garmo method, and determination of the best treatment can use the Effectiveness Index. Effectiveness itself is a measure that states how far the objectives of the study (quantity, quality, and time) have been achieved. The greater the target achieved, the higher the effectiveness [47]. Then effectiveness can also be interpreted as an effort to achieve the desired or previously planned targets. The formula for calculating the best treatment is as follows [48].

$$Effectiveness\ Value = \frac{Treatment\ Value - Worst\ Value}{Best\ Value - Worst\ Value} \quad (1)$$

The results of the calculation of the effectiveness index using the De Garmo method, where the best treatment is determined based on the assistance of 10 respondents for the provision of value weights adjusted to the level of importance while the value is obtained from the effectiveness value [49]. The best treatment value can provide the average value of the relationship between the quality of salted eggs and the largest treatment value. Based on the results of the calculation of the De Garmo effectiveness index, the best treatment for the quality of salted eggs can be seen from the salt content, water content, water activity, and L*a*b* color contained in Table 2.

Table 2. The value result of the best treatment on salted chicken eggs.

Best Treatment	Value
P0 (0%)	0.67
P1 (2.5%)	0.68*
P2 (5%)	0.38
P3 (7.5%)	0.19

Based on Table 2 shows that the treatment with the addition of 2.5% of kaffir lime leaf powder (*Citrus hystrix*) and citronella (*Cymbopogon nardus*) (P1) is the best treatment, because it has the highest best yield value (NH) than treatments P0, P2, and P3. From these results, it can be shown that the addition of 2.5% of kaffir lime leaf powder (*Citrus hystrix*) and citronella (*Cymbopogon nardus*) can produce good quality salted eggs, with each salt content value of 1.45%; water content 68.98%; water activity 0.91%; color L* 68.80%; color a* 19.90%; and color b* 40.85%.

4 Conclusion

Salted duck eggs with the addition of kaffir lime leaf powder (*Citrus hystrix*) and citronella (*Cymbopogon nardus*) can reduce the salt content and L*a*b color and increase the water content and water activity. The best treatment based on the effectiveness index of salted duck eggs with the addition of kaffir lime leaf powder and citronella was 2.5% with a salt content of 1.45%; water content 68.98%; water activity 0.91%; L* color 68.80%; a* color 19.90%; and b* color 40.85%.

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