Citrus Aurantiifolia Extract as a Green Technology Marination with Vacuum Marinator to Increase Physical Quality of Duck Meat

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Abstract. This study aims to determine the effect of *citrus aurantiifolia* extract as a green technology marination with vacuum marinator to increase physical quality of duck meat based on pH, Electrical Conductivity (EC), tenderness, aroma and color. The material used is duck meat marinated with *citrus aurantiifolia.* The method used in this research is experimental laboratory using Completely Randomized Design (CRD) with 4 treatments and 4 replications consisting of marinating treatment for 0 min (P1), 20 min (P2), 40 min (P3), and 60 min (P4). Parameters observed were pH, Electrical Conductivity (EC), tenderness, aroma and color. Data were analyzed using Analysis of Variance (ANOVA), if the data showed a significant difference, continued with Duncan's Multiple Range Test (DMRT). The average pH value is 3.42–3.95; EC was 0.66–0.76; tenderness was 5.15–18.03; aroma was 1.15–3.75; color was 1.45–3.70. The results showed that *Citrus aurantiifolia* as a green technology marination in vacuum marinator with a different time had no significant or no significant effect ($P > 0.05$) on the pH, EC, aroma and color values of duck meat but could have a very significant effect on the tenderness value of duck meat. Aroma although it does not have a significant effect, but the distinctive smell of the duck meat has decreased due to the vacuum marinator process using *Citrus aurantiifolia* in different time.

Keywords: duck meat · marination · physical · tenderness

1 Introduction

Meat is one of the livestock products with a high source of animal protein and is widely consumed by the public to meet the body's essential amino acids [1]. Ducks are one of the most widely cultivated and kept among other species of poultry to be used for their meat, eggs and feathers yet still few in processing [2]. One of the factors which causes the least processing of duck meat is because it has characteristics that could differentiate it from other meats, which are fishy aroma and the texture tends to be tough, compared to chicken meat. The distinctive aroma of ducks is due to the food, consumed by ducks, having a high content of fat and protein [3]. One way to suppress the shortage of duck meat is by doing vacuum marination using lime (*Citrus aurantiifolia)* extract. The active

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ingredients of lime include energy iron, calcium, vitamin A, phosphorus, carbohydrates, vitamin B1 and Vitamin C [4]. Another content in lime is citric acid which is ten times more than the citric acid in tangerines, or six times more than sweet oranges [5]. The use of vacuum marination technology by creating a vacuum to speed up the marinating process using lime (*Citrus aurantiifolia)* to improve the physical properties of duck meat.

2 Materials and Tools

The ingredients used in this research were: duck meat, lime (*Citrus aurantiifolia*), distilled water, and buffer solutions 4 and 7. The tools used in this research were: vacuum marinator, cutting board, erlenmeyer, measuring cup, analytical balance, beaker glass, stirrer, label, filter, EC meter, knife, warner-blatzler and pH meter.

2.1 Research Time and Location

This research was conducted in September 2022 at the Meat Processing Laboratory Division of Animal Products Technology, Faculty of Animal Science, Brawijaya University.

2.2 Experimental Design

The experimental design used in this research was a completely randomized design (CRD) consisting of four treatments with four replications. Use of 30 ml of lime (*Citrus aurantiifolia*) extract with the treatment given was:

P1: 0 min
P2: 20 min
P3: 40 min
P4: 60 min

2.3 Data analysis

Data analysis results were performed by using ANOVA (Analysis of Variance). If the data showed a real or very real test, then it was continued with the multiple distance duncan test.

2.4 Sample Preparation

Duck meats were purchased from a duck breeder in Lawang. Then, the samples were closely wrapped in a plastic box. The samples were stored in the freezer ($\leq$-18 °C). Before that, the skin and fat were separated so that only the meat remained, then the duck meat was cut into $1 \times 1 \times 2$ cm^3.

2.5 Lime Extract

The lime was purchased from Pasar Blimbing. The lime (*Citrus aurantiifolia*) were sliced and squeezed until the lime extract came out. Then filtered through a cloth sieve to produce the lime extract.

2.6 Marinating Process

The marinating process used a vacuum marinator with a sample of 50 g duck meat and 30 ml lime (*Citrus aurantiifolia*) extract. The sample was put into a tube with lime extract then a vacuum was created in the tube and then the vacuum tube will be carried out rotary with the length of time according to the treatment that had been determined P1(0 min), P2 (20 min), P3 (40 min) and P4 (60 min).

2.7 Analysis Procedure

2.7.1 pH Test

pH or potential of hydrogen is an indication of meat quality based on the degree of acidity to express acid or base. A method to determine the pH value using the value principle electrodes calibrated with pH 4 and 7 [6]. Samples of 3 g duck meat were crushed then 30 ml distilled water was added and stirred until it became homogeneous then measured using a pH meter.

2.7.2 Electrical Conductivity Test

EC or Electrical Conductivity is the total content of ions in meat using 3 g of duck meat sample then 30 ml of distilled water added to it, stirred until homogeneous and waited for 15 min, then measured using an EC meter.

2.7.3 Tenderness Test

The tenderness test used a sample of duck meat that has been marinated and has been cut $1 \times 1 \times 2$ cm^3 Measurement of tenderness value used the warner Bratzler tool.

2.7.4 Organoleptic Test

The organoleptic test in this research, namely the aroma and color, was carried out after the duck meat finished marinating process. The used method in organoleptic testing used the test of hedonic quality by giving scoring (1–4). This method was used to find out how far the level of the rating scale for duck meat was. This organoleptic test was carried out subjectively (panelist test) using 5 panelists.

3 Results and Discussions

3.1 pH Test

Table 1 showed that the result of the pH test on duck meat had no significant effect ($P > 0.05$) ranging from 3.42 to 3.95. The lowest average pH value was 3.42 at P4

(with marinating time of 60 min) and the highest average was 3.95 at P1 (with marinating time of 0 min). The pH meter was calibrated by using buffer pH 4 and 7 [7]. pH value is influenced by several factors, namely extrinsic factors which include treatment, before cutting, ambient temperature, and treatment after cutting while Intrinsic factors include muscle type, variability among livestock, species and muscle glycogen [8]. In this research, the difference in pH values was obtained from the use of lime and the length of the marinating time was different from the pH value of lime, which was 2.3, therefore because lime had a pH that tends to be slightly acidic so it could affect the value the pH of the duck meat used was around 6.15 according to the SNI standard pH at normal duck meat ranged from 6.12–6.71. In addition to the effect of the use of lime, different marinating times affected the difference in pH values, which is supported by the opinion in Gunanda, *et. al*., [9] who stated that the longer the meat is marinated, the lower pH value will decrease.

3.2 Electrical Conductivity Test

Table 1 showed that the result of the research value of EC (Electrical Conductivity) on duck meat had no significant effect ($P > 0.05$) ranging from 0.66 - 0.76. The highest average EC value of 0.76 was at P4 (with marinating time of 60 min) and the lowest average was 0.66 at P1 (with marinating time of 0 min) and P2 (with marinating time of 20 min). The electrical conductivity is the total ion content in the meat, the high and low conductivity values are related to concentration and ionic mobility in meat [10]. The conductivity measurement is an indicator of the completeness of the membrane. The value of research results experienced an increase in the conductivity value from P1 (0 min) to P4 (60 min) because presence of additional calcium and hydroxyl ions of lime apparently increased the electrical conductivity of the duck meat [11]. That means the ability to hold water decreases, causing droplet loss a membrane structure fluid that functions for movement between the intracellular space and the extracellular [10].

3.3 Tenderness Test

Table 1 showed that the result of the research value of tenderness of duck meat had significant effect ($P < 0.05$) ranging from 5.15–18.03. The lowest average tenderness value was 5.15 at P4 (with marinating time of 60 min) and the highest average was 18.03

Table 1. Effect of lime extract marinating using a vacuum marinator on pH, EC, tenderness, aroma and color values

Treatment	pH	EC (m/s)	Tenderness (N)	Aroma	Color
P1	3.95 ± 0.36	0.67 ± 0.08	18.03 ± 3.46^{b}	3.75 ± 0.44	1.45 ± 0.51
P2	3.48 ± 0.40	0.67 ± 0.10	11.63 ± 3.09^{ab}	2.45 ± 0.60	2.45 ± 0.60
P3	3.46 ± 0.14	0.66 ± 0.14	7.73 ± 2.83^{ab}	1.50 ± 0.61	3.20 ± 0.41
P4	3.42 ± 0.17	0.76 ± 0.18	5.15 ± 2.22^{a}	1.15 ± 0.37	3.70 ± 0.47

a: average redness; b: average yellowness

at P1 (with marinating time of of 0 min). Tenderness is one of the determinants of meat quality, this is influenced by several factors, namely ante mortem (before cutting) and post mortem (after cutting) [12]. According to Soeparno [13] the factors before cutting include management, age, gender, stress, and genetics while after cutting include cooking/processing methods, withering, refrigeration, freezing, chilling and the addition of tenderizers. The addition of lime marination shows different results between treatments due to lime which contains high citric acid. According to Ke, *et al*.,[14], one of the food acidifiers is acid citrate which can be used to tenderize meat because the meat marinated with citric acid will have a softer texture. In addition to tenderizing ingredients, long marination also affects the difference in the value of the research because the longer the marination, the more acidic the organic content in lime will absorb into the meat so that it will take longer marination, the lower the tenderness value.

3.4 Aroma Test

Table 2 showed that the result of the aroma test on duck meat had no significant effect ($P > 0.05$) ranging from 1.15 to 3.75. The lowest average pH value of 1.15 was at P4 (with marinating time of 60 min) and the highest average was 3.75 at P1 (with marinating time of 0 min). The organoleptic test result in the table showed that the fishy smell of duck meat, that was given the extract lime, decreased with the length of marinating time. The result showed that there was a change in the aroma of the meat after the lime extract marinating process with different marinating times. Inhibitors such as organic acids or sugar contained in the lime will absorb into the duck meat with the length of marinating time carried out so that it will form a very acidic atmosphere that will affect the decrease in the pH value [15]. This corresponds to research conducted on the fishy aroma of ducks will be decreased along with a decrease in pH. The decrease in the fishy aroma is also influenced by the characteristic of lime aroma which could cover the distinctive aroma of the duck such as the fishy aroma because lime contains essential oils [16].

Table 2. Effect of lime extract marinating using a vacuum marinator on aroma value

Treatment	Aroma	Criteria
P1	3.75 ± 0.44	Fishy – Very Fishy
P2	2.45 ± 0.60	Slightly fishy – Fishy
P3	1.50 ± 0.61	Not fishy – Slightly fishy
P4	1.15 ± 0.37	Not fishy – Slightly fishy

3.5 Color Test

Table 3 showed that the result of the color test on duck meat had no significant effect ($P > 0.05$) ranging from 1.45–3.70. The highest average pH value of 3.70 was at P4 (with marinating time of 60 min) and the lowest average was 1.45 at P1 (with marinating

Table 3. The effect of lime extract marinating using a vacuum marinator on the color value

Treatment	Color	Criteria
P1	1.45 ± 0.51	Reddish – Reddish brown
P2	2.45 ± 0.60	Reddish brown – Brown
P3	3.20 ± 0.41	Brown – Whitish brown
P4	3.70 ± 0.47	Brown – Whitish brown

time of 0 min). Differences in color values in duck meat could be influenced by several factors, namely, nation, sex, feed, pH, age, species and oxygen [17]. Based on the results of research conducted, a decrease in pH is also followed by a change in the color of the meat, the meat begins to turn pale due to protein denaturation [18]. In addition, the use of a vacuum marinator with a different length of marination time can affect the color of the duck meat because it is based on the opinion Ismanto and Basuki [19] regarding temperature, type of packaging, and color of meat can also be affected by long storage time. The main determinant of color in meat is the myoglobin content changes in the color of the meat can occur along with changes in the condition of the meat myoglobin, because according to Ismanto and Basuki [19] changes in the shape of myoglobin can occur when various chemical reactions are exposed to air exposure, the myoglobin pigment that changes will be oxidized to oxymyoglobin which can give off a red color light on the meat and over time the color of the meat will turn brown.

4 Conclusion

This research using lime extract as a marinade in a vacuum marinator showed that there was a change in the physical appearance of duck meat along with the longer marinating time, namely a decrease in the pH of duck meat, and a lower tenderness value, which means it could reduce people's dislike of duck meat that is tough or hard. The increasing EC value, changing color of duck meat and the decreasing aroma value prove that the distinctive smell of duck, namely the fishy smell, is one of the weaknesses of duck meat.

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