

Color's Profile of Duck Meat Marinated with different Levels of Liquid Smoke and Papain Enzyme

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Abstract

Duck meat is a livestock product favored by Indonesians, especially in South Sulawesi. The papain enzyme contains a protease enzyme that breaks down meat's protein in meats as a meat tenderizer. Liquid smoke contains phenolic compounds as antioxidants, antibacterial agents, and a binder. The study was designed completely randomized with a 5 x 5 factorial pattern with 3 replications. The first factor was the combination of papain enzyme (PE) levels and liquid smoke (LS); factor A = (A1 = PE: 100%, A2 = LS: 25%, A3 = LS: 50%, A4 = LS 75%, A5 = LS: 100%) and the second factor was the marinated times; factor B = (B1 = 0, B2 = 30, B3 = 60, B4 = 90, and B5 = 120 minutes). There was no significant effect ($P > 0.05$) of the combination of liquid smoke and enzyme levels on the (L^*) brightness value, but 120 minutes of marinated time there was a significant effect ($P < 0.01$). Also was no significant effect ($P > 0.05$) from the combination of levels on the (a^*) redness value, but at 90 minutes of marinated time, there was a significant effect ($P < 0.05$) on the redness (a^*) value, especially at 90 minutes. There was a significant effect ($P < 0.05$) of the combined levels on the (b^*) yellowness value, and at 90 minutes of marinated time. The results showed that the addition of the combined level of the liquid smoke and papain enzyme at the brightness (L^*) and redness (a^*) value didn't present a significant effect, while the yellowish value (b^*) had an increase in its value at a concentration of 75% of liquid smoke. Marinated time gives a value that increases with increasing marinated times on the resulting color value.

Keywords : Papain enzyme, liquid smoke, marinated times, duck meat

INTRODUCTION

Meat is a food of animal origin favored by the whole society (Spers *et al.*, 2021). The meat tastes delicious and is high in protein, iron, and B complex vitamins. Meat protein can help stimulate the intestinal wall in the absorption of minerals (Abustam and Ali, 2010). Meat

contains complete and balanced essential amino acids it is easily digested by the body (Ahmad *et al.*, 2018). The meats that are mostly consumed by Indonesian people are goat (Murray-Prior *et al.*, 2010), beef, buffalo meat, and poultry (chicken, duck, and bird).

Ducks' development can be achieved in an intensive maintenance system; it produces good quality duck meat (Starcevic *et al.*, 2021). Duck meat is tough and rancid smelling, and the color is different from other poultry meat (Matitaputty and Suryana, 2010); therefore the marinated process will be carried out on duck meat using a certain solution to obtain good quality of the physical characteristics (Suryanti *et al.*, 2015), such as a tenderness value, eliminate rancidity and improve color. The addition of papaya sap will increase the tenderness value because it will break down the protein in the meat (Yogiraj *et al.*, 2014), while the addition of liquid smoke will increase the taste, antioxidants, and can improve the color of the meat. The addition of papain enzymes and liquid smoke can change the color characteristics of meat caused by carbonyl compounds that are family by liquid smoke which can improve the color of meat, while the papain enzyme can break down proteins in meat which helps the activity of liquid smoke to work to change the color characteristics of meat.

MATERIALS AND METHODS

Sample Preparation

Boneless duck meat is obtained from smallholder farms in Pinrang Regency. The boneless duck meat is then transported to Makassar using a cooler. After that the meat is put into a plastic clip, then papain enzymes and liquid smoke are added in a combination way (A1 = 100% papain enzyme, A2 = 75% papain enzyme + 25% liquid smoke, A3 = 50% papain enzyme + 50% liquid smoke, A4 = enzyme papain 25% + 75% liquid smoke, A5 = 100% liquid smoke), soaked for 0, 30, 60, 90, and 120 minutes. The variables measured were Brightness (L*), Redness (a*), Yellowish (b*). Measuring the color value of the meat used a digital color meter test (T 135) which measured the values of L*, a* and b*. Color value L* = 0 - 100 (black - white); a* = -60 (green) to +60 (red); and b* = -60 (blue) to +60 (yellow) (Bae *et al.*, 2008; Maruddin *et al.*, 2020).

Data Analysis

The data obtained were analyzed for variance based on a completely randomized design (CRD) (Wahid *et al.*, 2017) with a 5 x 5 factorial pattern with 3 replications. The analysis of variance is based on the design mathematical model used, as follows:

$$Y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk}$$

RESULTS AND DISCUSSION

The Brightness Value L*

The results showed that the combination of the liquid smoke and the papain enzyme had no significant effect (P>0.05) on the brightness level of the duck meat as showed in Table 1.

However, marinated time produced a significant effect ($P < 0.05$), their interaction was also not significant ($P > 0.05$) in the combination and timing marinated to brightness * L of duck meat.

Table 1. Brightness (L*) Value of Duck Meat Using a Combined Concentrations Levels of Liquid Smoke and Papain Enzyme at Different Marinated Time

Marinated Time (minutes)	Liquid Smoke and Papain Enzyme Combine Concentration (%)					Average
	A1	A2	A3	A4	A5	
0	42.57±2.28	43.89±6.13	42.66±3.80	47.14±9.85	42.03±1.11	43.66±5.08 ^a
30	48.23±6.43	52.20±3.54	45.47±6.29	48.11±10.26	49.41±3.63	48.68±5.94 ^b
60	48.52±2.31	49.60±7.78	45.54±4.60	46.83±3.55	47.58±7.92	47.61±5.03 ^{ab}
90	50.45±8.93	49.21±5.83	48.12±2.74	43.73±4.98	48.22±5.77	47.94±5.58 ^{ab}
120	53.84±6.17	47.13±4.72	47.93±6.53	50.17±10.58	50.37±2.29	49.89±6.15 ^b
Total	48.72±6.22	48.40±5.66	45.94±4.71	47.19±7.41	47.52±5.10	

Description: ^{ab}superscript follow the average value in the same column indicates highly significant difference ($P < 0.01$). (A1 = 100% papain enzyme, A2 = 75% papain enzyme + 25% liquid smoke, A3 = 50% papain enzyme + 50% liquid smoke, A4 = 25% papain enzyme + 75% liquid smoke, A5 = 100% liquid smoke).

There was a significant difference in the brightness level of the duck meat components for each level of the combination of the liquid smoke and papain enzyme, which did not change the level of brightness significantly. There are several factors that influence the brightness level of the duck meat, one of which is the age of the livestock. Soeparno (2005) explains that the brightness level of meat is influenced by age, feed, genetics, species, stress level (activity level and muscle type), pH, and oxygen. Lawrie and Ledward (2006) added that a high final pH of meat changes the properties of myoglobin absorption, making the surface of the meat darker. The color of duck meat is different from chicken meat and is influenced by the concentration of myoglobin (Lawrie and Ledward, 2006). This is in accordance with the opinion of Lawrie (2003), who argued that the color of meat is influenced by the presence of myoglobin and hemoglobin and other components such as protein, fat, vitamin B 12, and flavin.

The brightness L* value generated at the time of marinated changes during the marinated process. The role of the papain enzyme and the liquid smoke can change the brightness of L* in marinated meat at 30 minutes with a value of 48.68. Meanwhile, the immersion time for 120 minutes had an increase of a value of 49.89 at the brightness level. This is due to the reaction that the two materials produce. Liquid smoke contains phenol and carbonyl compounds that can change the color and flavor of meat and can provide antibacterial and antioxidant properties to the meat (Sari *et al.*, 2014). The change in meat color occurs because of storage that makes metmyoglobin appears on the meat surface (Orkuzs *et al.*, 2017).

The Redness Value a*

The level of redness (a*) in duck meat combined with the papain enzyme and the liquid smoke at the time of marinated is shown in Table 2.

The combination of the papain enzyme and liquid smoke in this study did not have a significant effect ($P > 0.05$) on the redness of (a*) duck meat produced. There was no significant difference in the level of redness in the components of duck meat for each level of the combination of the enzyme papain and liquid smoke and did not experience a significant change in the level of redness. Because the nature of duck meat itself has a red color compared to

chicken meat which has white meat (Mafruchati, 2020). This meat has myoglobin absorption so the color of the flesh is dark (Suman and Joseph, 2013). Zulfahmi *et al.* (2013), explained that the color of the meat is influenced by meat pigment which consists of two kinds of protein, namely hemoglobin, and myoglobin. The higher the protein content in the meat, the better the meat color will be.

Table 2. The Redness of a* Duck Meat on the Combination of Papain Enzyme Levels Liquid Smoke at the Time of Marinated.

Marinated Time (minutes)	Liquid Smoke and Papain Enzyme Combine Concentration (%)					Average
	A1	A2	A3	A4	A5	
0	13.76±1.26	14.98±2.03	12.85±1.01	14.30±1.09	12.32±1.85	13.64±5.08 ^{AB}
30	13.65±1.74	14.97±1.40	15.29±0.44	14.38±1.75	13.78±2.10	14.41±1.50 ^B
60	10.71±0.89	14.50±1.92	13.88±2.51	10.03±0.94	11.68±0.33	12.16±2.23 ^A
90	13.59±2.12	14.31±2.39	14.31±2.24	12.89±2.41	13.84±3.08	13.79±2.16 ^B
120	12.99±2.56	13.90±2.53	12.74±1.75	12.79±2.17	14.94±2.61	13.47±2.17 ^{AB}
Total	12.94±1.94	14.53±1.82	13.81±1.79	12.88±2.21	13.31±2.22	

Description: ^{AB}superscript follow the average value in the same column indicates highly significant difference (P<0.01) (A1 = 100% papain enzyme, the enzyme papain A2 = 75% + 25% liquid smoke, A3 = enzyme papain 50% + of smoke liquid 50%, A4 = 25% papain enzyme + 75% liquid smoke, A5 = 100% liquid smoke).

The time of marinated had a significant effect (P<0.05) on the redness of a * duck meat produced, average, 30 minutes of marinated time, gives a redness value of 14.41 which is higher than 0, 60, 90, and 120 minutes. This is because the optimal time to produce a reddish color to the duck meat during the marinated process is 30 minutes. Abustam (2010) states that the change in meat color occurs because of the storage that changes the metmyoglobin on the surface of the meat. Lawrie (2003) added that the pigment oxymyoglobin is an important pigment in fresh meat, this pigment is only on the surface of the meat which is a consumer measurement value.

The combination between the papain enzyme and liquid smoke had a significant effect (P<0.05) on the yellowish level of the duck meat produced. The results of the Duncan test showed that the level of the combination of PE (75%) + LS (25%), PE (50%) + LS (50%), and PE (25%) + LC (75%) was significantly different. This is because liquid smoke has phenol compounds that retain and give color to the meat. Whereas the papain enzyme has a protease that can break down the protein in the meat so that the absorption of liquid smoke can help maintain the color of the meat. This is in accordance with the opinion of Setiadji (2000) and Yunus (2011) which states that liquid smoke plays a very important role in giving color to meat because liquid smoke has phenolic compounds that can be used as antioxidants, antimicrobials, and as binders. Liquid smoke also can retain color and flavor to food ingredients. Aditama, *et al.* (2017) said that the papain enzyme is a protease enzyme in the papaya plant that can break down meat protein in muscle fibers and hydrolyze it into smaller peptides, so that the meat becomes tender.

The Yellow value b*

The yellowish level (b*) in duck meat combined with the enzyme papain and liquid smoke at different marinated time is shown in Table 3.

Table 3. The Yellowish Level (b*) in Duck Meat at Different Marinated Time and Using a Combination of Papain Enzyme and Liquid Smoke

Marinated Time (minutes)	Liquid Smoke and Papain Enzyme Combination Concentration (%)					Average
	A1	A2	A3	A4	A5	
0	6.04±0.68	6.45±1.64	4.93±3.23	6.99±1.71	7.28±0.84	6.34±1.78
30	6.12±1.50	6.94±1.15	6.18±1.25	7.09±0.14	7.29±1.50	6.72±1.09
60	3.69±0.76	7.30±2.73	8.39±1.29	6.89±0.51	7.09±0.76	6.67±2.03
90	6.99±1.12	7.12±1.45	7.02±1.31	8.82±3.57	7.31±1.12	7.45±1.16
120	5.16±0.42	8.32±2.53	8.73±0.70	7.79±0.53	6.39±0.42	7.28±1.53
Total	5.60±1.40 ^A	7.22±1.56 ^B	7.05±2.09 ^B	7.51±1.03 ^B	7.07±2.22 ^B	

Description: ^{AB}superscript following the average value in the same column indicates highly significant difference (P<0.01). (A1 = 100% papain enzyme, A2 = 75% papain enzyme + 25% liquid smoke, A3 = 50% papain enzyme + 50% liquid smoke, A4 = 25% papain enzyme + 75% liquid smoke, A5 = 100% liquid smoke).

Table 3 shows that the time of marinated has a significant effect (P<0.05) on the yellowish level of the duck meat. The Duncan test resulted very different between marinated with 100% of papain enzyme and combination 75% papain enzyme and 25% liquid smoke, in fact, when the marinated has a yellowish value (b*) of 6.35%, then it continues to increase until 90 minutes, that is 6.72; 6.67; 7.45% and in 120 minutes it decreased 7.28%. This is due to the optimum level of marinated time at 90 minutes because it gives the meat a yellowish value of 7.45% and is influenced by the combination level of the two ingredients. Carbonyl compounds have the main influence in producing a color while the effect on the taste is less prominent. Ruiter (1979) argues that the carbonyl-amino reaction plays an important role in the formation of the color of the absorbed product. This reaction is like the Millard reaction.

CONCLUSION

The addition of the combined of the liquid smoke and the papain enzyme with different levels did not give a significant effect on the brightness (L*) and redness (a*) value, while the yellowish value (b*) gave an increase in the yellowish value at a concentration of 75% of liquid smoke. Increasing marinated time has a significant influence on the resulting color value.

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