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Short Communication

Effect of Herbal Marination on The Quality Characteristics of Broiler Meat

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Abstract | Broiler meat has some disadvantages such as antibiotic residues, low antioxidant and tenderness value, and protein instability upon heating, thus it needs special treatment. Marination is a flavored liquid that serves as the ingredients of the meat marinated, and is usually used to improve the yield and shelf-life of meat. The research aims to study the effect of herbal marination on the quality characteristics of broiler meat. The variables measured including antioxidants, protein, cholesterol, and chemical residues in meat, as well as meat tenderness and color. The study conducted with Completely Randomized Design (CRD) consisting of 3 treatments and 10 replications. Treatments includes: T0= meat marinated for 0 hour (unmarinated), T1= meat marinated for 3 hours, and T2= meat marinated for 6 hours. Our results indicated that herbal marination significantly improved the quality of broiler meat in terms of the antioxidant and protein content (P<0.05). It also demonstrated a significant increase in meat tenderness (P<0.05), however there was no significant effect on the cholesterol content. Six hours of marinated meat were pale pink and softer when compared to the 0 hour and 3 hours of herbal marination. Based on results obtained it could be concluded that 3 hours herbal marination of broiler meat has optimal effects to improve meat quality (including tenderness and protein contents), and antioxidant level.

Keywords | Marination, Herb, Broiler, Meat quality

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INTRODUCTION

A great source of protein, the chicken meat has always been linked to a favorite food source. In addition to its high protein content, ranges from 17.56 to 18.3% (Juntachote et al., 2006), it is affordable and easily obtainable. However, it can have some disadvantages, such as a lack of tenderness, low antioxidant content, the protein instability during cooking, and the presence of antibiotic residues, thus chicken meat shall require special treatment. In particular, the residues of veterinary medicines can represent short-term dangers in the form of allergies, digestive disorders, skin disorders, anaphylaxis, and hypersensitivity, as well as long-term danger in the form of carcinogenicity, mutagenicity, teratogenicity, and reproductive disorders (Birk et al., 2010). Consumption of foods of animal origin, such as chicken meat, that contain residues of antibiotics can also have a lot of negative impacts on health, ranging from allergic reactions to toxicity, effects on the intestinal flora and the immune response, and microbial drug resistance (Petracci et al., 2013).

Lack of antioxidants can also affect the quality of chicken, as antioxidants inhibit oxidation reactions that cause meat

discoloration and off flavor. High levels of antioxidants are also desirable in chicken meat for their health benefits, as antioxidants in the diet prevent cell damage by binding free radicals and other highly reactive molecules. The consumption of antioxidants in sufficient amounts has been reported to improve immunological status while inhibiting the onset of degenerative diseases due to aging (Liguori et al., 2018).

On account of such obvious matters, one specific treatment that can improve chicken meat quality is marination. Marination is a flavored liquid that is usually used to improve the yield and to extend the shelf life of meat (Nurohim et al., 2013). The principle of meat marination is to soak the meat in a solution or sauce that contains ingredients that slowly permeate passively from the marinade into the meat by osmosis (Berlian et al., 2016). At this point, Akhadiyah et al. (2012) reported that the benefits of marination are as follows: it improves the sensory quality of the meat-like flavor, enhancement of tenderness, increases water capacity, and extends the shelf life. Marinade ingredients that can improve the flavor and tenderness of meat include flavorings such as salt, soy sauce, organic acids (acetic acid/vinegar, lemon juice), enzymes (papain, bromelain, and ficin), and ginger. Two hours of marinating is usually consider sufficient for the meat to soak up the flavor, yet it still varies greatly, from several minutes to several hours, as excessive liquid uptake can cause the meat to become mushy and disintegrate. Marinating for a short period i.e., about 15 minutes to 2 hours can prevent such obvious issue. The use of a high-acid marinade is also not recommended because the meat can shrink and become hard. Meat tenderness can be enhanced by marination for about 6 to 24 hours, however the duration can be shortened by adding an enzyme to the marinade (Juntachote et al, 2006).

Chicken marinated meat with a mixture of several herbs can reduce the number of bacteria and extend the shelf life from10 days to 12 days at a storage temperature of 4°C (Nurwantoro et al., 2012). For example, marination of broiler chicken with different concentrations (0.4%, 8%, and 12%) of a garlic blend for 8 h had a significant positive effect (P <0.05) on the water binding capacity and decreased the cooking losses (Pratama et al., 2018). The aim of the present study was to determine the effect of herbal marination on the quality characteristics of broiler meat. The protein content, antioxidant levels, meat tenderness, cholesterol content, and chemical residue levels were investigated.

MATERIALS AND METHODS

Material used

The meat materials used for this study were 600 grams of chicken breast for each test. The herb marinade contained 1 cm ginger, 1 cm galangal, 20 cumin seeds, 5 garlic cloves, 1 blade of lemongrass, and 2 cm of lemon in 150 mL distilled water. Before marination, the chicken meat was cleaned properly, and the marinade ingredients were mashed using a blender. All mashed marinated ingredients were mixed thoroughly in the water and then marinade with meat.

Methods

The study employed a completely randomized design (CRD) in which it consisted of 3 treatments and 10 replications. T0 represented meat marinated for 0 h (non-marinated). Group T1 was marinated for 3 h and T2 for 6 h. The measured variables were antioxidant, protein, cholesterol, and chemical residue levels in the meat, meat tenderness, and meat color. Meat color measurements involve two basic methods: human visual appraisal and instrumental analyses. Data was processed using a Likert scale (AMSA, 2012). Chemical residues were analyzed by chromatographic gas method (Alen et al., 2015). Antioxidant was analyzed by DPPH (1,1-difenil-2-pikrilhidrazil) (Bhat et al., 2020). Cholesterol was analyzed with the Lieberman–Burchard method, protein with the Kjeldahl semimicrobial method, and meat tenderness with a penetrometer (Wulaniriky, 2011). Data were analyzed by analysis of variance (ANOVA), and to seek significant effects we employed the Duncan Multiple Range Test.

RESULTS

The analysis of variance results revealed that the herbal marination treatment of broiler meat showed a very significant effect on the antioxidant content and protein content in the meat (P <0.01) and had a significant effect (P <0.05) on meat tenderness. However, it had no significant effect on the content of cholesterol or meat chemical residues (P>0.05) (Table 1).

Table 1: Antioxidant levels, protein content, cholesterol content, tenderness, and chemical residue levels in marinated broiler meat

Variable	Treatment		
	T0 (0 h)	T1 (3 h)	T2 (6 h)
Antioxidant content (%)**	20.34±2.17^{a}	28.48±2.33^{c}	25.59±1.78^{b}
Protein (%)**	15.67±1.67^{a}	17.77±1.23^{C}	16.58±0.89^{b}
Cholesterol(mg/g)^{ns}	0.75±0.08^{a}	0.76±0.06^{a}	0.83±0.07^{a}
Meat tenderness (kg/cm^{2})*	1.48±0.79^{a}	2.37±0.56^{b}	2.43±0.49^{b}
Chemical residues(µg/ml)*	0.19±0.03^{a}	0.02±0.01^{b}	0.09±0.03^{b}

^{a,b,c}Different superscripts in the same row indicate significant differences at *(P<0.05) or ** (P <0.01). ns: Not

significant

Antioxidant Content

Table 1 showed that marination of broiler meat had a significant effect on the antioxidant content (P<0.01). The effect at T1 (3 h marination) was better than the effect at T0 (no marination) and T2 (6 h marination).

Protein Content

The analysis of variance results also showed that marination had a significant effect on the protein content of broiler chicken meat (P <0.01). The meat protein value was higher after 3 h marinating than after 6 h marinating (Table 1).

Cholesterol Content

The analysis of variance results revealed no significant difference in the cholesterol content of broiler meat for either 3 h or 6 h marinating (P >0.05; Table 1).

Meat Tenderness

The analysis of variance results showed that marination had a significant effect on the tenderness of broiler chicken (P<0.05). The tenderness of broiler chicken marinated for 3 h (2.37 kg/cm^2) did not differ significantly from the tenderness of meat marinated for 6 h (2.42 kg/cm^2), but it was significantly different from the tenderness of the non-marinated control treatment (1.48 kg/cm^2).

Chemical Residues

The analysis of variance results showed that marination provided no significant effect on the chemical residues of the tetracycline group (P> 0.05). The lowest average chemical residue was observed after 3 h marination (0.02 µg/ml), followed by 6 h marination (0.09 µg/ml). The unmarinated meat had the highest residue content, at 0.198µg/ml by gas chromatographic method.

Meat Color

Chicken meat marinated for 3 h and 6 h differed macroscopically from unmarinated meat. The 3 h marinated meat had a pale pink color, and the meat fibers were softer. The 6 h marinated meat was pale pink but softer than the 3 h marinated meat (Figure 1). Meat color measurements involve two basic methods: human visual appraisal and instrumental analyses (Table 2). Data is processed using a Likert scale associated with meat color evaluation in color guidelines handbook (AMSA, 2012). Statistical analysis showed significant differences in the color levels of marinated broiler chicken meat (P <0.05), with scores of 2.20 (slightly pale) for unmarinated meat, 3.30 (reddish) for meat marinated for 3 h, and 3.60 (reddish) for meat marinated for 6 h (Table 2).

Figure 1: Macroscopic changes in broiler chicken breast meat. T0: unmarinated; T1: marinated for 3 h; T2: marinated for 6 h.

Table 2: Meat color level in marinated broiler chicken meat

Variable	Treatment		
	T0 (0 h)	T1 (3 h)	T2 (6 h)
Meat color level	2.20[a] (sightly pale red)	3.30[b] (reddish)	3.60[c] (reddish)

[a,b,c]Different superscripts in the same row indicate significant differences at (P<0.05).
Color level scores: 1: pale pink; 2; sightly pale red; 3: reddish; 4: red; 5: bright red

DISCUSSION

Marinating broiler chicken meat for 3 h and 6 h increased the antioxidant content. This could reflect a greater absorption of marinating with longer marination duration and there was an effect on the balance of the chemical components in meat. Higher antioxidant levels indicated lower rates of oxidation reactions, as an inversely proportional relationship exists between antioxidant activity and antioxidant concentrations (Fastawa et al., 2016). With regard to this issue, Tristanto et al. (2014) also found that a higher concentration of antioxidants indicated lower oxidation activity. Karseno et al. (2013) reported that malonaldehyde (MDA) levels are inversely proportional to antioxidant activity, so higher malondialdehyde levels indicate low levels of antioxidants. MDA is one of the aldehyde compounds generated from the oxidation of fat.

Antioxidants are chemical compounds that can donate one or more electrons to free radicals to deactivate them. Higher concentrations of antioxidants increase the likelihood that electrons from antioxidants can react with free radicals. Marinating the broiler chicken meat increased the antioxidant content, thus it possibly indicated that a greater absorption of the marinade liquid by the broiler chicken meat affected the balance of the chemical components in the meat and increased the antioxidant content and thus the oxidation activity in the marinated meat was getting decreased (Eleazu et al., 2012). As well, Arkoub–Djermoune et al. (2015) discovered that the active components

that play a role as a source of antioxidants include phenols such as Nasunin, as well as beta carotene, chlorogenic acid, and caffeic acid. The process of heating can extract active antioxidant components from the marinade vegetables and meats

The meat that was marinated for 6 h showed an increase in the antioxidant content caused by a decreased protein content. This is in accordance with previous work showing that a lower protein concentration results in high antioxidant activity (Nahariah et al., 2014). The concentration of antioxidants in native chicken eggs is higher than in broilers because of their high protein content, but this results in lower antioxidant activity. The flavonoids and phenols contained in galangal also function as antimicobials (Juntachote et al., 2006) and can suppress the growth of protein-degrading microorganisms, such as *E. coli*, *Staphylococcus aureus*, *Rhizopus* sp., *Penicillium* sp., and *Neurospora* sp., in meat, thereby it prevents significant changes in broiler meat protein. The protein content of meat can change due to protein degradation by proteolytic microorganisms that require protein for growth and metabolism.

The addition of 1–15% ginger resulted in a higher protein content of 61.15 (Wahyuni et al., 2018). Research shows that ginger at this concentration permeates throughout the chicken meat and activates the proteolytic enzymes that work as catalysts in the tenderness process. The addition of mashed elephant ginger has a significant effect on the protein content of native chicken meat (Nurohim et al., 2013). A higher level of ginger paste increased the ability of the proteolytic enzymes to hydrolyze the protein.

Substances contained in the marinade can also be bacteriostatic or able to inhibit the growth of protein-degrading microorganisms. Microorganisms can also inhibit the growth of other microbes that affect the protein content or meat quality. The amounts of marinade ingredients are also important, as the quality of the meat can be decreased if the required marination time is too long and the meat becomes mushy (Akhadiyah et al., 2012).

The failure to reduce cholesterol content in broiler chicken meat by marinating may be due to already decreased cholesterol levels in the live animals, as well as ongoing metabolic processes in the meat. Earlier findings by Ni Wayan et al. (2017) indicated that cholesterol could be reduced in broiler chicken meat by feeding broiler a ration containing noni fruit flour. In this regard, Tarigan et al. (2016) also argued that feeding a combination of 2.5% garlic powder and ZnO (120 ppm) tended to reduce cholesterol levels in broiler chicken carcasses. Research conducted by Wahyuni et al. (2016) showed that the addition of 1.2% lime juice in a step-down protein feed could reduce the cholesterol levels in broiler chickens.

Soaking broiler chicken meat in the marinade for 3 h and 6 h resulted in a less tender meat compared to non-marinated meat. The reduced meat tenderness after a long marination time of 3–6 h, indicated by values of 2.37–2.42 kg/cm^2, could be caused by marinade ingredients, such as limes, which contain acids that can reduce meat tenderness. Following guidance outlined by Nieminen et al. (2012) reported that the function of limes, in addition to eliminating the fishy smell, is to absorb moisture from the meat so that when eaten, the texture feels hard. Longer marination increases the hardness of the meat. Nasir et al. (2017) reported tenderness as the amount of pressure required to cut each unit area (kg/cm^2) of the product; therefore, a smaller number indicates a softer product. Nurwantoro et al. (2012) suggested that tenderness is the most important factor in determining the quality of meat.

The quality of the meat is influenced by several factors, such as before cutting examination /ante mortem and after cutting examination/post mortem. Previous results showed that the average tenderness of native chicken meat stored at a cold temperature (40°C) for 24 h had a texture value of 3.1,while meat treated with 25% ginger paste had a texture value of 3.1,and meat treated with 50% ginger paste had a texture value of 3.9 (Arni et al., 2016). Tarigan et al. (2016) stated that meat compression can be achieved by marinating for about 6 to 24 h and that the time can be shortened by adding enzymes to the marinade. Ni wayan et al. (2017) stated that meat tenderness is a complex quality attribute, with the primary structures affecting meat tenderness being the integrity of myofibrils (known as the actomyosin effect) and the contribution of connective tissue (collagen and elastin). Although small, the fat content in the meat (marbling) also contributes to the tenderness of the meat.

The chemical residues in chicken meat investigated by gas chromatographic method (Alen et al., 2015) exhibited reduced values in marinated groups as compared to T0 group. This could be due to the herbal ingredients in the marinade (turmeric, curcuma, ginger, galangal, and garlic) that have high antioxidant contents. Antioxidants are substances that can delay, slow down, and prevent oxidation processes. Antioxidants are very beneficial for health and play an important role in maintaining the quality of food products. Ermelia et al. (2020) reported that antioxidants inhibit oxidation reactions and prevent cell damage by binding to free radicals and highly reactive molecules. Consumption of antioxidants in adequate amounts has been reported to reduce the incidence of degenerative diseases. Consumption of foods containing antioxidants is also known to improve the immunological status and inhibit degenerative diseases due to aging. Therefore, it is necessary to take the

optimal intake of antioxidants.

The xanthine content of the marinade affects myoglobin in the meat, so it can change the color of the meat. Bassole et al. (2011) stated that methylxanthine can affect energy metabolism, fat metabolism, sugar metabolism, glycogen reserves, calcium metabolism, and meat quality. Different marinating times can affect the color of the meat, indicating differences in the ability of the meat to reduce myoglobin. If the fresh meat is cut, the color is purplish-pink. In an oxygen environment, the surface of fresh meat will turn reddish due to the oxygenation of myoglobins to oxymyoglobin (Ekawati et al., 2019). Meat color is influenced by feed, species, geographic location, age, sex, stress, pH, and oxygen level (Mudalal et al., 2014). The statistical analysis presented here showed that marination of broiler chicken meat affected the color level ($P < 0.05$), with scores of2.20 (slightly pale) to 3.30 (reddish) and 3.60 (reddish).

The ability to bind marinade solutions and retain liquid during cooking in both non-marinated and marinated meat is also severely impaired by heating (Mudalal et al, 2014). A nearly study revealed that white-striped fillets exhibited higher cooking losses and lower marinade yields (Petracci et al., 2013). The significant differences revealed inmarinated meat can be associated with lower marinade yield rather than with a direct effect on the meat abnormality. High amounts of liquid losses during cooking are usually associated with increased toughness of meat. The inclusion of tough breast meat in chicken sausages and nuggets increased the shear force and binding strength to some extent (Jafari et al., 2012).

CONCLUSION

Based on results obtained in this research, it should be concluded that herbal marination of meat for 3 hours have optimal potential to improve meat quality. Marination increased antioxidant level (25.58%), and maintain protein in meat (17.76%), even the meat softness was still high (2.73 kg/cm3). The meat color in 6 hours of marination were pale pink and the meat structure was softer when compared to the 0 hour and 3 hours of marination.

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CONFLICT OF INTEREST

The authors declare that they have no competing interest.

AUTHORS CONTRIBUTION

NP, SS, BPW are researcher. NP is the leader of this study. BPW and NP prepared and managed meat marinated. SS prepared samples. NP, SS, and BPW, managed and examined the experiment and interpreted the result. SS and NP analyzed data. BPW prepared data and literature for manuscript. NP, BPW and SS wrote the manuscript.

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