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Assessing Breast and Thigh Meat Quality and Color of Ducks Fed a Diet Comprising Pelleted Sipjeondaebo-Tang by Product

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Abstract | Sipjeondaebo-tang (ST) is a traditional herbal medicine used widely for the treatment of human diseases. However, the antioxidant effect of ST has not been fully evaluated. This study was conducted to assess the quality and color during storage of breast and thigh meat from ducks fed a diet supplemented with pelleted ST. A total of 90 one-day-old Pekin ducks were divided into two groups: control group and T1 group (a basal diet + pelleted 1% ST powder). The birds were distributed among six cages, each containing 15 birds. At the end of the experiment, 18 ducks were slaughtered, and breast and thigh muscles were dissected from each carcass and stored at 4°C for 0 days and 7 days. The experiment was performed in triplicate. Following storage, there was significant difference (P<0.05) in pH, thiobarbituric acid reactive substances (TBARS), and 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical-scavenging activity of breast meat on Day 7. For thigh meat, the pH was significantly different on Day 7. In addition, significant differences between the two groups were detected (P<0.05) in the L* (lightness) and b* (yellowness) values of breast meat from 0 through 7 days, but not for a* (redness) values. For thigh meat, the supplementation of pelleted ST in the diet did not yield a significant difference (P>0.05) in L*, a*, and b* values on Days 0–7. In contrast, pelleted ST supplementation resulted in a significant difference (P<0.05) in b* values on Day 0. In conclusion, these results suggest that the supplementation of 1% ST to the diet of Pekin ducks improves the antioxidant capacity of meat tissue (increased DPPH radical-scavenging activity and decreased TBARS) to combat lipid oxidation in duck meat during storage.

Keywords | DPPH radical-scavenging activity, Meat color, Pelleting, Sipjeondaebo-tang, TBARS

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INTRODUCTION

For centuries, traditional oriental herbal products have been used in the treatment of diseases. They are consumed as supplements and considered to enhance the immune system (Yuan et al., 2016). One such product is Sipjeondaebo-tang (ST, Shi-Quan-Da-Bu-Tang in Chinese or Juzen-taiho-to in Japanese), which is made of 10 different natural herbs (Jeon et al., 2014). It is frequently prescribed for the treatment of depression, physical weakness, anemia, anorexia, and fatigue (Chino et al., 2005; Liu et al., 2008). In addition, ST has been reported to have beneficial *biological activities*, *including* the enhancement of antitumor, anti-inflammatory, and immunomodulatory activities (Chino et al., 2005; Jeon et al., 2014). In South Korea, ST is a by-product obtained from ST extract after repeated steaming, which is discarded as a waste product in soil or fields and not used further. Thus, it would be advantageous to investigate ways to improve the quality of ST so that it could be used as a feed additive to enhance poultry growth (Mateos et al., 2012). In general, poultry feed pellets containing a greater quantity of fine particles improve growth performance (average daily gain and feed-to-gain ratio), which can lead to a reduction in feed wastage (Saldaña et al., 2015). Thus, the inclusion of pelleted ST in the feed may improve the quality of duck meat; moreover, the benefits from pellets would be more pronounced than those from powder because of the greater quantity of

bioactive materials and their antioxidant effects. Until now, the antioxidant effect of ST has not been evaluated clearly, and there are no reports on whether the use of ST could improve duck meat quality during storage. The objective of this study was to assess the quality and color during the storage of breast and thigh meat from ducks fed a diet supplemented with pelleted ST.

MATERIALS AND METHODS

Animals, diets, and slaughter procedure

All experimental procedures complied with the guidelines for animal care of Gilhong Farm, Geochang (South Korea). The ST sample materials obtained from Yusim company (South Korea) were converted into pellets using the methods of Chung et al. (2018). In total, 90 1-d-old Pekin ducks were randomly allocated to one of the two groups: the control group (a basal diet) and the T1 group (a basal diet + pelleted 1% ST powder). The birds were distributed in six cages with 15 birds per cage, and the experiment was performed in triplicate. A starter diet with 22% crude protein was provided to all ducks for the first 21 days, and a finisher diet with 17% crude protein was provided from Days 22 to 42. *Ad libitum* access to food and water was provided during the study. At the end of the experimental period, the ducks were put on a fast for 12 h and transferred to the slaughterhouse in accordance with conventional Korean procedures. Eighteen ducks, randomly collected from each cage, were electrically stunned. After stunning, the neck blood vessels were cut, and exsanguination occurred. After slaughter, the carcasses were deboned, and the breast and thigh muscles were isolated. All visible skin and excessive connective tissues were removed before the evaluation of the meat quality and color parameters. All samples were packed in sealable plastic bags and stored between 0 and 7 days at 4°C for measurement of pH, thiobarbituric acid reactive substances (TBARS), 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical-scavenging activity, and meat color. The measurements were performed in triplicate. The pH measurement was determined by using the Association of Official Analytical Chemists (AOAC Methods, 2000): after a 10 g sample had been homogenized with 90 mL distilled water, the mean pH values were calculated from three repeated measurements determined using a pH meter (model 520A, Orion, Beverly, MA). The TBARS were assessed using the modified method described by Witte et al. (1970) to evaluate the lipid oxidation. The absorbance at 532 nm was measured with a UV-visible spectrophotometer (UV-24D1(PC) 5, Shimadzu, Kyoto, Japan). The results are expressed as milligrams of malonaldehyde (MA) per kilogram of fresh meat.

The DPPH radical-scavenging activity was measured using the method described by Blois (1958), with a slight modification. The *absorbance* of the test *solution at 517 nm was measured using* a UV–visible spectrophotometer (UV-24D, Shimadzu, Tokyo, Japan). The percentage of DPPH radical scavenging was calculated using the following equation:

$$DPPH\ radical\ scavenging\ (\%) = [1 - (absorbance\ of\ sample\ solution/absorbance\ of\ control)] \times 100$$

For color measurements, each sample of breast and thigh muscle meat was cut and exposed to air for 30 min. The color values (CIE L*, a*, and b*) were measured at the surface of every meat sample by using a Minolta chromameter (Minolta CR-300, Osaka, Japan), and the results were expressed as L* (lightness), (a*) redness, and b* (yellowness).

Statistical analysis

Selected ducks from each cage were used for the experimental analysis of meat quality and color. All data were analyzed using SAS statistical software (SAS, 2002). Student's *t*-test was performed to check whether the differences between the means were significant at the 5% level.

RESULTS

Table 1 shows the breast and thigh meat quality during refrigerated storage of the duck that had been fed on pelleted ST. In breast meat, there was no significant difference ($P>0.05$) between the two groups in the pH, TBARS, and DPPH radical-scavenging activity on day 0, in contrast to day 7, after adding pelleted ST to the diet. However, only pH was affected in thigh meat ($P<0.05$) on day 7, while pH, TBARS, and DPPH radical-scavenging activity were not affected from day 0 to 7 after adding pelleted ST to the diet. The results for meat color are shown in Table 2. Significant differences ($P<0.05$) were observed in L* and b* values of breast meat from day 0 through 7 between the two groups, but not for a* values. However, for thigh meat, feeding pelleted ST did not show any significant difference ($P> 0.05$) in L*, a*, and b* values from day 0 through 7 between the two groups. In addition, a single observation on day 0 provided significantly different b* values ($P<0.05$).

DISCUSSION

In the current study, we found that the antioxidant effect of a diet supplemented with ST on breast meat quality differed from days 0-7. This supported a similar study in rats (Jeon et al., 2014). Prior to ethanol administration, pretreatment with Sipjeondaebo-tang water extract (SDTW) significantly increased glutathione (GSH) content and antioxidant enzyme activity and decreased malondialdehyde (MDA) concentration in the rat tissue in comparison to the tissue of rats administered with ethanol

alone. In our study, although the thigh meat quality did not change with respect to these particular parameters, tissues from the ducks fed the ST-supplemented diet showed stronger antioxidant activity than the ducks fed the control diet. Both the breast meat and thigh meat had higher DPPH radical-scavenging activity and lower TBARS, which are important indices for determining the antioxidant properties during storage. The antioxidant effects of ST may be attributed to the constituent herbs, which are also known to exhibit *various* other important *biological effects* (Lu et al., 2004; Ramesh et al., 2012; Jeon et al., 2014). However, the underlying mechanism of action remains unclear. In general, most research on ST has focused on its pharmacological action. Jeon et al. (2014) proposed that owing to its antioxidant effects, SDTW may also play a role in gastroprotection. In the current study, antioxidant properties of ST may be a major contributor to the observed difference and, therefore, we assessed whether the antioxidant effects of ST affected the breast and thigh meat of ducks during refrigerated storage.

Table 1: Breast and thigh meat quality in duck fed diets with pelleted sipjeondaebo-tang by product during refrigerated storage.

Item		Storage days	Treatment1		SEM²	Significance
			CON	T1		
Breast	pH	0	6.04	6.01	0.045	NS
		7	6.12	6.05	0.084	*
	TBARS (mgMA/kg)	0	0.17	0.20	0.065	NS
		7	0.19	0.11	0.094	*
	DPPH radical scavenging (%)	0	82.3	83.5	2.500	NS
		7	83.9	85.7	0.734	*
Thigh	pH	0	6.81	6.93	0.253	NS
		7	6.89	6.79	0.069	*
	TBARS (mgMA/kg)	0	0.35	0.15	0.058	NS
		7	0.32	0.11	0.157	NS
	DPPH radical scavenging (%)	0	82.1	83.4	1.258	NS
		7	84.9	86.9	1.338	NS

[1]Control: basal diet; T1: 1% ST by product with pelleting; [2]Results are reported as means ± SE; [3]NS: not significant. *p<0.05.

The color of the breast and thigh meat from the ducks that were fed the diet supplemented with pelleted ST varied in L*, a*, and b* values during refrigerated storage. In breast meat, increases in the L*, a*, and b* values were observed compared with the control groups. In contrast, thigh meat showed an opposing trend for L* and b* values. This result may be attributable to the constituent herbs, which may delay the formation of metmyoglobin owing to their natural antioxidant properties. The herbs have color suppression and antioxidant effects; consequently, an increase in a* and decrease in L* values could be observed (Fernandez-Lopez et al., 2005). Interestingly, neither the antioxidant properties nor factors such as meat pH, feeding pellets, and components of the ST affected meat color. The meat pH and color are primary indicators of freshness, which are two most important criteria in determining consumer choice (Baker et al., 2004).

Table 2: Breast and thigh meat color in duck fed diets with pelleted sipjeondaebo-tang by product during refrigerated storage.

Item		Storage days	Treatment[1]		SEM²	Significance
			CON	T1		
Breast	L (Lightness)	0	41.1	43.5	1.300	*
		7	41.2	45.2	1.240	*
	a (redness)	0	17.8	16.5	0.984	NS
		7	16.7	17.6	0.757	NS
	b (Yellowness)	0	4.05	4.89	0.321	*
		7	3.28	4.80	0.399	*
Thigh	L (Lightness)	0	43.0	40.5	1.332	NS
		7	43.5	42.9	1.278	NS
	a (redness)	0	16.9	17.9	1.358	NS
		7	17.1	18.3	1.422	NS
	b (Yellowness)	0	5.40	5.37	0.267	*
		7	5.69	5.42	0.558	NS

[1]Control: basal diet; T1: 1% ST by product with pelleting; [2]Results are reported as means ± SE; [3]NS: not significant. *p<0.05.

CONCLUSION

The results of the study indicated that dietary supplementation with ST pellets conferred additional antioxidant activity on breast meat. The supplementation with ST pellets increased DPPH radical-scavenging activity and reduced the TBARS values in both the breast and thigh meat of ducks. However, there were no changes in the color of breast and thigh meat of ducks fed the ST supplemented diet, which may be due to a reduction in lipid peroxidation. Overall, the dietary supplementation with ST pellets may improve antioxidant capacity and contribute to better meat quality.

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AUTHORS CONTRIBUTION

Gee-Dong, Lee contributed to this study for analyzing the data and revising the manuscript. In Hag, Choi as corresponding authors supervised the experiment and wrote the manuscript.

CONFLICT OF INTEREST

The authors should state no conflict of interest.

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