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Effects of Papaya Leaf Meal, Pineapple Skin Meal and Vitamin D_3 Supplementation on Meat Quality of Spent Layer Chicken

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Abstract: A study was undertaken to improve meat quality of spent layer chicken through supplementing the old layer birds diet with vitamin D_3, papaya leaf meal and pineapple skin meal a few days prior to slaughter. Forty spent layers were obtained to conduct this study after a period of laying for 80 weeks. About 4 diets which were fed to the chicken included diet 1: control diet (based on NRC recommendation level to meet or exceed the bird requirements at finisher stage), diet 2: control + (1×10^5)I.U. Vitamin D_3, diet 3: control + 1% Pineapple Skin Meal (PSM) and diet 4: control + 1% Papaya Leaf Meal (PLM). Chicken were kept in an individual cage and fed for 7 days. At day 7, the chicks were scarified, breast muscle was taken for meat color, shear force, pH of the muscle, CP, fat, Ca, drip loss and cooking loss analysis. The results indicated that both vitamin D_3 and papaya leaf meal were potent additives to improve tenderness, drip loss, cooking loss and meat color. However, Vitamin D_3 appeared to be the most effective one in improving meat quality of spent layers.

Key words: Vitamin D_3, papaya leaf meal, pineapple skin meal, meat quality, spent layer, chicken

INTRODUCTION

The poultry industry is one of the most important sectors of the livestock industry in Malaysia. This industrial section is faced with a large number of spent layer hens which are usually sold as old chicken and fetch lower price than the broiler chickens. Globally, there are about 2.6 billion spent birds that are served in pet food industry and not much for human consumption (Kalaikannan *et al*., 2007). Meat from those chickens tends to be tough, non-juicy and low in fat. In Malaysia and most developing countries, these sorts of layer are also consumed by the lower income group. If the spent hens can be improved in terms of quality, farmers can sell them at a better price which will increase their income. Thus, it was considered essential and economy viable to improve meat quality of the birds. So, attempts to improve meat quality through improving tenderness via post-slaughter manipulation are attracted many attentions. Most researchers agreed that a high ultimate muscle pH (6.0 or greater) is related to a more tender muscle (Dransfield, 1981; Dutson *et al*., 1981). Koohmaraie *et al*. (1988) demonstrated that post mortem meat tenderization could be manipulated and improved through the elevation of intracellular calcium level at post mortem either by calcium chloride marinating in fusion or injection. The rate and extent of pH drop in post mortem muscle is extremely important from the standpoint of muscle tenderness. Research by Schroeder *et al*.(1982) provided evidence of an association between the pre slaughter feeding regimens, rate of post mortem temperature decline and meat tenderness. It appears that intensive pre slaughter feeding exerts an indirect influence on meat tenderness via its effect on carcass weight, fatness and postmortem chilling rate.

To the best of the knowledge, study related to the evaluation of additives such as Papaya Leaf Meal (PLM), Pineapple Skin Meal (PSM) and vitamin D_3 on meat quality in the spent layer chicken before slaughtering is not much. Therefore, the current study was carried out to assay the influence of the foregoing additives on meat color, shear force, pH of the muscle, CP, fat, Ca, drip loss and cooking loss of those layers.

MATERIALS AND METHODS

Forty spent layer hens ISA-Brown were provided from layer farm at University Putra Malaysia after a period of laying for 80 weeks. They were kept in an individual cage on an optimal condition. Feeding 10 days adaptation and thereafter, 7 day for experiment have undertaken and the diets were put individually in the feeders with a specified weight every morning. About Four diets which employed in this study were diet 1: control diet (based on

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NRC recommendation level to met or exceeded the bird requirements at finisher stage), diet 2: control + (1×10^5) I.U. Vitamin D_3, diet 3: control+1% Pineapple Skin Meal (PSM) and diet 4: control + 1% Papaya Leaf Meal (PLM). Each treatment diet replicated 10 times.

To obtain PLM, papaya leaves were collected from local plants and separated from the stems, dried in a 65°C oven until constant weight. The dry leaves were grinded and passed through a sieve of 1 mm. For PSM, the pineapples were purchased from a local market. The skins were removed from the fruits, dried at 65°C for 5 days, powdered using blender and properly mixed with the diet. The samples (PLM and PSM) were analyzed for crude protein, crude fiber, fat, dry matter, ash (AOAC, 1995) and calcium content using atomic absorption spectrophotometer.

After 7 days of feeding, the birds were slaughtered and left and right breast muscle of each bird were taken to assay shear force, meat color, CP, fat, Ca, pH of the muscle, drip loss and cooking loss analysis. Samples were kept in 80°C for later analysis (Table 1). To measure the cooking loss, 50 g breast muscle was weighed before chilling, vacuumed immediately, packed and cooked in 80°C water bath.

A 21-gauge needle was used to insert the thermometer probe into the geometric centre of a steak. Thereafter when the sample's core temperature reached 80°C, the thermometer was removed. The sample was taken out of the water bath and weighed. The cooking loss was then calculated based on the following formula: cooking loss % = [Pre-cook meat weight – post-cook meat weight/Pre-cook meat weight]×100%.

Table 1: Composition of basal diet

Ingredients (%)	Values
Corn grain	63.80
Soybean meal	22.01
Palm oil	1.50
Limestone	7.90
Dicalcium phosphate	2.04
Salt	0.40
Mineral premix[1]	0.25
Vitamin premix[2]	0.25
Choline chloride	0.15
DL Met	0.10
Chemical composition	
ME (Kcal kg^{-1})	2850.00
Crude protein	16.60
Ca	3.80
Crude fiber	3.04
Ether extract	3.62

Supplied per kg diet: Fe, 35 mg; Mn, 70 mg; Cu, 8 mg; Zn, 70 mg; I, 1 mg; Se, 0.25 mg ; Co, 0.2 mg; calcium-D-pantothenate, 8 mg; folic acid, 0.5 mg; D-biotin, 0.045 mg; vitamin C, 50 mg; vitamin A, 8000 IU; vitamin D, 1000 IU; vitamin E, 30 IU; vitamin K3, 2.5 mg; vitamin B1, 2 mg; ; vitamin B2, 5 mg; vitamin B6, 2 mg; vitamin B12, 0.01 mg and niacin, 30 mg

To determine drip loss, 10 g breast muscle was weighed immediately after slaughtering. After 3 days the breast muscle was weighed again and based on the recorded weight the drip loss was calculated. Drip loss% = [Pre-chilling meat weight-post-chilling meat weight/Pre-chilling meat weight]×100%.

Postmortem muscle pH was measured by using a pH meter (Mettler Toledo, model 320). Colour quantity was obtained by a Hunter-Lab model D-25 color and color difference meter (Hunter Associates Laboratory, Fairfax, VA). Readings were taken on both the bottom (the bone side) and upper (the skin side) surface of each sample. The colorimeter was standardized with a standard plate (# 6274; L = 92.4, a = -0.7, b = -0.9). After calibration, the sample was put on the plate and at three different angles the color was measured. Meat tenderness was determined by Warner-Bratzler shear force analysis which was according to the mechanical force necessary to shear the muscle fibres of a cooked meat sample. The Atomic Absorption Spectrometer (AAS) was employed to measure calcium after digestion of the sample with 6 M HCl.

The experimental data were subjected to analysis of variance by the GLM procedure of SAS (SAS Institute, 1990) in a completely randomized design. Duncan multiple-range test (Duncan, 1955) was used to analyze the difference between means. Significant differences among means were according to $p<0.01$. Cages were considered as the experimental unit.

RESULTS AND DISCUSSION

Effects of pineapple skin meal, papaya leaf meal and vitamin D_3 on drip loss, shear force, meat color and cooking loss are shown in Table 2. As the results indicated, drip loss affected by treatment groups and control group displayed the highest value ($p<0.01$) among all treatments while those treatments containing PLM and vitamin D_3 were significantly ($p<0.01$) lower than other groups. For shear force, vitamin D_3 indicated the best value ($p<0.01$) among the other experimental groups. Although, PLM showed a good potential to improve shear force as well, however it was not as effective supplement as vitamin D_3. Pineapple skin meal demonstrated the highest value ($p<0.01$) for cooking loss compare to others. Meat color for groups received PSM and vitamin D_3 were comparable with the control which all were significantly ($p<0.01$) higher than PLM inclusion group. Pineapple leaf meal failed to display any impact on this parameter.

From former research, it appears that intensive pre-slaughter feeding exerts an indirect influence on meat tenderness. Based on the result, drip loss was affected by

Table 2: The effect of Papaya Leaf Meal (PLM), Pineapple Skin Meal (PSM) and vitamin D_3 on drip loss, shear force, meat color and cooking loss

	Parameters			
Treatments	Drip loss (%)	Shear force	Cooking loss (%)	Meat color
PLM	1.20 ± 0.01^{c}	3.06 ± 0.2^{c}	35.2 ± 1.07^{d}	58.1 ± 1.2^{b}
PSM	1.26 ± 0.03^{b}	3.90 ± 0.3^{a}	39.6 ± 1.20^{a}	62.0 ± 1.8^{a}
Vitamin D_3	1.20 ± 0.03^{c}	2.80 ± 0.1^{d}	38.2 ± 1.10^{b}	61.7 ± 1.3^{a}
Control	1.30 ± 0.04^{a}	3.70 ± 0.3^{b}	37.7 ± 1.10^{c}	62.0 ± 1.8^{a}

$^{a-d}$Means within a column with different letter (s) differ significantly ($p<0.01$) (mean±SEM)

Table 3: The effect of Papaya Leaf Meal (PLM), Pineapple Skin Meal (PSM) and vitamin D_3 on Ca muscle and pH muscle

	Parameters	
Treatments	Ca Muscle	pH
PLM	3.700 ± 0.02^{b}	6.05 ± 0.07 NS
PSM	3.300 ± 0.09^{d}	6.04 ± 0.08 NS
Vitamin D_3	4.004 ± 0.03^{a}	6.07 ± 0.05 NS
Control	2.005 ± 0.04^{c}	6.20 ± 0.08 NS

$^{a-d}$Means within a column with different letter (s) differ significantly ($p<0.01$) (mean±SEM)

PLM and vitamin D_3 and these two supplements showed the lower loss than other groups. It could be due to ability of these additives to maintain the water in the muscles which would goodly improve nutritional value, consumer appeal and/or technological properties of porcine meat. There are some different methods which might be effective in the improving the drip loss in meat (Hansen *et al.*, 2003) that additives are one of those approaches. Regarding shear force which reduced in the group treated with vitamin D_3 the explanation could be related to the ability of this vitamin in increasing Ca of the muscle that subsequently increases meat tenderness, the positive effect of calcium on meat tenderness has been studied and proven extensively (Geesink *et al.*, 1994; Lansdell *et al.*, 1995). Pineapple skin meal showed best value for cooking loss compare to the other supplements in the present research. It could be enlightened by increase in vitamin D_3 after cooking the meat (Clausen *et al.*, 2003).

Poultry meat color is influenced by factors such as age, sex, strain, diet in tramuscular fat, meat moisture content, preslaughter conditions and processing variables. Color of meat depends upon the presence of the muscle pigments myoglobin and hemoglobin. Discoloration of poultry can be related to the amount of these pigments that are present in the meat, the chemical state of the pigments or the way in which light is reflected off of the meat.

The discoloration can occur in an entire muscle or it can be limited to a specific area, such as a bruise or a broken blood vessel. When an entire muscle is discolored, it is frequently the breast muscle. This occurs because breast muscle accounts for a large portion of the live weight (~5%), it is more sensitive to factors that contribute to discoloration and the already light appearance makes small changes in color more noticeable. Extreme environmental temperatures or stress due to live handling before processing can cause broiler and turkey breast meat to be discolored. The extent of the discoloration is related to each bird's individual response to the conditions. Result related to meat color obtained from the study indicated that PSM and vitamin D_3 are able to maintain meat color in normal level and comparable with control value (Fletcher, 1999). In the present study, no meat color changes appeared by the additives, however PLM fed group showed significant difference with other groups and the meat looked paler than the rest.

Related to the results, supplementation of vitamin D_3 in feed increased Ca level in chicken meat because vitamin D_3 takes Ca from bone and intestines and improve Ca content of meat (Sazili *et al.*, 2006). Calcium and pH of muscle are shown in Table 3. There was a significant difference among the treatments for Ca of the muscle where vitamin D_3 showed the highest value ($p<0.01$) for this parameter. There was no significant difference among the treatments for pH of the muscle. The rate and extent of pH drop in postmortem muscle is important from the standpoint of muscle tenderness. However, no remarkable difference was observed among the treatments for pH of the muscle resulting that this criteria will not differ after treating with the corresponding additives.

According to the findings, vitamin D_3 and PLM are able to improve meat quality. This ability might be explained by the positive feedback of vitamin D_3 for Ca which enhances meat quality. Papaya leaf meal can also improve tenderness due to the secretion of papain, a sulfhydryl protease that increases the digestibility of Ca, releases this element and then increases the absorption of Ca and finally increasing rate of Ca in the muscle which consequently improves meat quality.

CONCLUSION

It could be finded that among all three additives, papaya leaf and vitamin D_3 proved to have good potential as feed additives for improving the quality of meat in spent layer hens before slaughtering. However, vitamin D_3 appeared to be the most effective one in improving meat quality of spent birds.

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