Influence of Caponization on the Carcass Characteristics in Taiwan Country Chicken Cockerels**

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ABSTRACT : We determined the effect of caponization on the carcass and giblet characteristics, and skin and muscle color in Taiwan country chicken cockerels. Caponized birds were surgically altered at 10 weeks old and were fed growing and finishing diets *ad libitum* during an eighteen-week experimental period. The results showed that the percentage of dressing, heart, feet, thigh, head and neck were significantly ($p<0.05$) higher in the intact birds, while the capons had a higher ($p<0.05$) percentage of abdominal fat, intestine, back, wing and breast. Eviscerated weight, breast width, gizzard, liver and spleen ratios were not affected by the treatments. The breast skin color values for lightness (L*) and yellowness (b*) values in the capons were significantly ($p<0.05$) higher than in the intact birds, but the thigh and back skin were not significantly ($p>0.05$) different. Compared with the intact birds, the capons had a significantly ($p<0.05$) less redness (a*) values in the back skin, but were not significantly ($p>0.05$) different in the breast and thigh skin. The L* value of the thigh muscle was significantly ($p<0.05$) greater in the capons than in the intact birds, but were not significantly ($p>0.05$) different in breast and back muscles. The b* values in the breast, back and thigh muscles of the capons were significantly ($p<0.05$) greater whereas the intact birds had a higher ($p<0.05$) a* values in the breast, back, and thigh muscles. Moreover, our findings also indicate that the castration resulted in a significant alteration in dressing percentage, carcass region and organ percentage. ***(Asian-Aust. J. Anim. Sci. 2003. Vol 16, No. 4 : 575-580)***

Key Words : Caponization, Androgen, Carcass characteristic, Color, Giblet

INTRODUCTION

Androgens have high anabolic activities in a variety of tissues that can stimulate muscle (Yoshitaka et al., 1982; Lin and Hsu, 2002a), bone (Lin and Hsu, 2002b) and connective tissue (Griggs et al., 1989) growth and erythropoiesis (Burton and Smith, 1972); and high androgenic activities can stimulate the reproductive system (Fennell and Scanes, 1992a,b; Lin, 1999), behavioral (Lin, 1999; Wang, 2001), psychological and secondary sexual growth characteristics or induce changes (Fennell and Scanes, 1992a,b; Lin and Hsu, 2002b) in the male. Several studies have shown that androgen and estrogen receptors have been identified in the striated muscles of several animals (Snochowski et al., 1981; Sauerwein and Meyer, 1989). It has been demonstrated that castration causes a significant alteration in the carcass parts percentage in pigs (Siers, 1975), cattle (Champagne et al., 1969) and sheep (Prescott and Lamming, 1964; Kemp et al., 1970). The effects of surgical caponization on avian growth (Mast et al., 1981; Lin and Hsu, 2002a), sensory panels score (York and Mitchell, 1969; Mast et al., 1981), muscle content (York and Mitchell, 1969; Chen et al., 2000b), skin and muscle color values (Cason et al., 1987; Chen et al., 2000a), and other muscle physical properties (Lin, 1999; Lin and Hsu, 2002a) have been studied. Cason et al. (1987) reported that skin lightness (L*), redness (a*) or yellowness (b*) values were not different between the capons and the intact birds. However, Chen et al. (2000a) showed that the capons had a significantly greater a* and L* values than the intact birds when cockerels were caponized at 8 weeks of age and processed at 26 weeks of age. In the same manner, numerous studies have reported that there were differences in the carcass or shank pigmentation between the male and female chickens (Collins et al., 1955; Jaap, 1955). It has been demonstrated that the major factors considered to affect skin and muscle color values include fat and pigmentation contents (Solberg, 1968; Miltenburg et al., 1992; Troutt et al., 1992; Lyon and Cason, 1995; Hillebrand et al., 1996). However, little information is available on the influence and role of male sex hormones on the fluctuations in carcass part and organ percentage, and skin and muscle color value in chickens. Therefore, this study was designed to investigate the influence of surgical caponization on the dressing, abdominal fat, carcass part and organ percentage, and skin and muscle color in chickens.

MATERIALS AND METHODS

Animals and diets

Two hundred day-old Taiwan country chicken

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cockerels（TLRI native chicken Taishi meat No. 13.）bred by the Taiwan Livestock Research Institute, were reared in an open-side broiler house and were fed a conventional country chicken diet（CP, 21%; ME, 3,100 kcal/kg）available *ad libitum*. At 10 weeks of age, the cockerels were individually weighed and randomly assigned to either caponized or intact male groups. Birds from each group were allocated into tetrareplicates with 22 birds in each pen (200×450 cm). All birds in four pens were deprived of feed for 24 hours followed by caponization for the designated caponized group. The down feathers of birds were removed from the lateral region just anterior to the thigh. The region was swabbed with a dilute disinfectant and the skin was incised. An incision was then made between the last two ribs and widened by a small spreader. The testis was exposed by blunt dissection and removed by simultaneously teasing its connective tissue supports and free and applying gentle suction. The incision was closed using surgical silk and the operation was then repeated on the opposite side. From 10 to 18 weeks of age, the birds were fed with 19% crude protein and 3,000 kcal/kg metabolizable energy growing diets. From 19 to 28 weeks of age, the birds were fed with 17% crude protein and 2,800 kcal/kg metabolizable energy finishing diets (Table 1).

Table 1. The composition of the experimental diets

Items	Grower (10-18 wks old)	Finisher (19-28 wks old)
Ingredients, %		
Yellow corn	65.07	62.77
Soybean meal (43.5%)	28.50	16.50
Fish meal (65%)	2.50	-
Corn gluten meal (61%)	-	5.00
Wheat bran	-	11.00
Alfalfa meal (17%)	-	1.80
Limestone, pulverized	1.40	1.35
Dicalcium phosphate	0.50	0.85
Salt	0.40	0.40
L-Lysine·HCL	-	0.10
DL-Methionine	0.03	0.03
Soybean oil	1.40	-
Premix*	0.20	0.20
Calculate value, %		
Crude protein	19.12	17.18
ME, kcal/kg	3,008	2,813
Calcium	0.82	0.81
Available phosphorus	0.30	0.30
Analyzed value, %		
Crude protein	19.56	17.07
Calcium	0.78	0.79
Total phosphorus	0.48	0.59

* Supplied per kilogarm of diet: Vitamin A, 100,000 IU; Vitamin D_3, 20,000 IU; Vitamin E. 15 mg; Vitamin K_3, 4 mg; Vitamin B_1, 2 mg; Vitamin B_2, 6 mg; Vitamin B_6, 4 mg; Vitamin B_{12}, 0.02 mg; Niacin, 40 mg; Pantothenic acid, 12 mg; Folic acid, 1 mg; Fe, 80 mg; Cu, 10 mg; Mn, 55 mg; Zn, 45 mg; I, 0.3 mg; Se, 0.1 mg.

Sample collection and analytical methods

Chicks received a daily photoperiod of 23 h light: 1 dark. Feed and water were provided *ad libitum*. At 28 weeks of age, after 24 h of feed deprivation, 20 birds from each group were weighed, sacrificed and cut using standard procedures as reported by Koch and Possa (1973). Weights obtained prior to and during the processing procedure include evisceration, heart, liver, spleen, gizzard, intestine, abdominal fat and testicle weight for each chicken. Dressed weight is equal to the eviscerated weight. Dressing, tissues and organs as a percentage of body mass were taken based on the fasting weight of the live birds. Carcass parts as a percentage of the body mass were taken based on the eviscerated weight. The skin and muscle color values were determined with a DrLange MC reflectance colorimeter using illuminant (natural daylight) with the specular and ultraviolet components included by the approach of Lyon et al. (1980). Bird was measured in the back, breast and thigh parts, and per part was measured at three points with 10 birds in each group. The color difference values of L*, a* and b* were recorded (L* = lightness, a* = redness, b* = yellowness).

Statistical analysis

Data were subjected to analysis of variance using the General Linear Models (GLM) procedure of SAS (SAS Institute Inc., 1988). When significant ($p<0.05$) differences were detected, means were separated using Least Squares Means (LSMeans).

RESULTS AND DISCUSSION

Table 2 summarizes data of carcass traits and percentage of carcass parts. The dressing percentage of the capons was lower than that of the intact birds ($p<0.05$). In contrast to the results from this study, York and Mitchell (1969), and Chen et al. (2000b) showed that the dressing percentage was higher in the capon than in the intact birds. Wismer-Pedersen (1968), Watson (1969), and Kemp et al. (1970) also reported that castration caused a slight increase in the dressing percentage in pigs, cattle and sheep. The reduction in the dressing percentage of the capons is probably due to the increased deposition of lipids around giblets. Pearce (1977) demonstrated that androgen could decrease lipogenic enzyme activity in fowl.

No treatment differences ($p>0.05$) were associated with chest width between the capons and the intact birds. Compared with the intact birds, the capons had a significantly ($p<0.05$) higher abdominal fat percentage. This is in agreement with reports by Fennell and Scanes (1992a), and Chen et al. (2000a). Fennell and Scanes (1992b) also indicated that androgen implantation could decrease the amount of abdominal fat in male turkeys. Similarly, Prescott

Table 2. Effects of caponization on the carcass characteristics and carcass part rates in Taiwan country chicken cockerels

Items	Caponized	Intact	S.E.
Slaughtered weight, g	2,387[a]	2,188[b]	51.0
Eviscerated weight, g	1,960	1,849	42.2
Dressing, %	82.12[b]	84.37[a]	0.288
Breast width, mm	94.0	93.0	1.07
Abdominal fat			
weight, g	58.9[a]	13.8[b]	3.87
% B.W.	2.44[a]	0.61[b]	0.141
Head and neck			
weight, g	219.2	241.0	4.68
% E.W.	11.24[b]	13.02[a]	0.178
Back			
weight, g	408.0[a]	346.5[a]	10.83
% E.W.	20.76[a]	18.70[b]	0.244
Breast			
weight, g	385.6[a]	329.5[b]	9.11
% E.W.	19.68[a]	17.81[b]	0.206
Wing			
weight, g	251.8[a]	225.7[b]	6.29
% E.W.	12.79[a]	12.27[b]	0.136
Thigh			
weight, g	569.6	560.3	13.386
% E.W.	29.00[b]	30.32[a]	0.181
Feet			
weight, g	83.6	83.7	2.193
% E.W.	4.27[b]	4.52[a]	0.066

[a,b] Means in the same row without the same superscript are significantly different ($p<0.05$).
E.W.=Eviscerated weight.

and Lamming (1964) showed that castration caused an increase in the back fat depth in pigs, cattle and sheep. The reduction in abdominal adipose tissue weight of the intact birds may be due to the effects of androgen on the total lipid tissue content or due to decreased lipogenic enzyme activity, as suggested by Pearce (1977). On the other hand, the reduction in the percentage of abdominal fat of the intact birds is also probably due to a higher thyroxine concentration, as suggested by Stewart and Washburn (1983). The results from this study showed that the plasma thyroxine concentrations were lower in the capons than in the intact birds (1.48 vs 1.91 μg/dL, $p=0.08$).

The percentages of feet, thigh, head and neck were higher ($p<0.05$) in the intact birds whereas the capons had higher ($p<0.05$) back, wing and chest percentage. These results agree with Mickelberry (1968) and Megally et al. (1969), who indicated that chickens implanted with estradiol monopalmitate had significantly greater chests and backs than the controls. Yoshitaka et al. (1982) demonstrated that androgen could stimulate muscle growth and deposition, and this action was most pronounced in the thigh meat. Similarly, Chen et al. (2000a) found that the thigh percentage in the intact males was significantly higher than in the capons, but no treatment differences were associated with the breast percentage. Siers (1975) also reported that boars had a significantly higher ham percentage than barrows. The rams or bulls, did have slightly heavier or greater percentage of neck and shoulder, chuck , rib loin, round and forequarter than the wethers or steers, as reported in several studies (Prescott and Lamming, 1964; Champagne et al., 1969; Kemp et al., 1970). Androgen can act by either binding to androgen receptors or, following aromatization, by binding to estrogen receptors. Androgens and estrogens have been demonstrated to have high anabolic activities in chickens (York and Mitchell, 1969; Yoshitaka et al., 1982). Sauerwein and Meyer (1989) indicated that there was no significant difference between the androgen and estrogen receptor concentrations in the neck, shoulder and hind legs, but receptor concentrations were lower in the abdominal muscles of male calves. Lobley et al. (1987) demonstrated that individual tissues may respond differently to the administration of androgen. Why capons showed an increase in the wing, back and chest regions and a decrease in the feet, thigh, head and neck regions in this study is unclear. However, this may be due to the difference receptor concentrations and sensitivity among the carcass regions. We suggest that endogenous androgen may act to reduce adipose accumulation and to vary the carcass region percentage.

The giblet weight and giblet weight as percentage of B.W. are shown in Table 3. The heart and testicle percentages were significantly higher ($p<0.05$) in the intact birds whereas the capons had higher ($p<0.05$) intestine percentage. However, both treatment groups were not significantly different in the liver, spleen and gizzard percentage. This is in agreement with Miller et al. (1985) and Fennell and Scanes (1992a, b), who found that castrated males had lower heart weight than castrated males

Table 3. Effects of caponization on the organ weights in Taiwan country chicken cockerels

Items	Caponized	Intact	S.E.
Gizzard			
weight, g	38.91[a]	33.40[b]	0.980
% B.W.	1.64	1.58	0.041
Heart			
weight, g	10.90[b]	12.94[a]	0.304
% B.W.	0.46[b]	0.59[a]	0.010
Liver			
weight, g	29.46	27.23	0.915
% B.W.	1.24	1.24	0.031
Spleen			
weight, g	5.45	4.84	0.325
% B.W.	0.23	0.22	0.015
Intestine			
weight, g	53.58[a]	43.22[b]	1.596
% B.W.	2.26[a]	1.97[b]	0.058

[a,b] Means in the same row without the same superscript are significantly different ($p<0.05$).
B.W.=Body weight.

implanted with androgens in chickens or turkeys. The androgen treatments, however, did not influence the liver or spleen weight. On the other hand, in the heart, which has also been shown to contain androgen receptors, cardiac muscle development was associated with the circulating testosterone concentration (Dube and Trembley, 1974). Mast et al. (1981) showed that the liver percentage was higher with partial and complete caponization. The result for liver percentage in this study is inconsistent with these reports. We suggest that androgens are required for the growth and development of cardiac muscle.

Skin and muscle color values

The skin and muscle color values obtained in this study are displayed in Table, 4 and 5. The L* value in the breast skin of the intact birds was significantly ($p<0.05$) lower whereas the capons had a significantly ($p<0.05$) lower a* values in the breast skin. However, the L* and a* values were not significantly ($p>0.05$) different in the back and thigh skin between two samples. A significantly ($p<0.05$) greater b* value in the back skin was found in the capons than in the intact birds, but were not significantly ($p>0.05$) different in the breast and thigh skin. The L* values in the thigh muscle of the capons was significantly ($p< 0.05$) greater than that of the intact birds, but the breast and back muscles were not significantly ($p>0.05$) different. However, the capons had a significantly ($p<0.05$) lower a* values and significantly ($p<0.05$) greater b* values in the breast, back and thigh muscles than the intact birds. Cason et al. (1987) reported that there were no differences in the L*, a* and b* values of the shank and breast skin between the capons and intact birds. Chen et al. (2000a) also showed that the breast muscle of capon had a significantly greater a* and L* values than intact birds. The results for skin and muscle L*, a* and b* values in this study are not completely consistent with these reports. Muscle color values has been found to be affected by fat and pigmentation contents (Hillebrand et al., 1996). Similarly, Hill and Dansky (1951) found that a positive relationship between the muscle color and carcass fat or pigmentation. Solberg (1968) also reported that meat color values were influenced by muscle myoglobin and myohemoglobin contents. An increase in muscle fat which led to a reduction in muscle myoglobin and could reflected major illuminant, resulting in smaller a* values and greater L* values in meat have been reported in several studies (Troutt et al., 1992; Lyon and Cason, 1995). Similarly, Miltenburg et al. (1992) found that a negative relationship between the muscle ferrous and hematin contents, and L* values, but a positive relationship between muscle ferrous and hematin contents, and a* values. Yoshitaka et al. (1982) found that the capons had a significantly higher fat contents in skin than the intact birds. Similarly, male turkeys had a higher myoglobin content than female turkeys (Froning et al., 1968). The result from this study showed that the abdominal fat and muscle fat contents（4.01 vs 1.15%）in the capons were significantly greater than in the intact birds, but the blood packed cell volume（PCV） was lower (29.2 vs 37.9%). Accordingly, the reduction in skin and muscle a* values and increase in skin and muscle L* and b* values may be due to the effect of androgens on total lipid content in skin and muscle and to decreased erythropoiesis action. These results indicated that the castration resulted in a significant alteration in the dressing, carcass region and organ percentage. Androgens are required for the growth and development of cardiac muscle, but induced decreasing fat deposition. Castrated male chickens are also associated with marked increase in skin and muscle L* and b* values and decrease in skin and muscle a* values.

Table 4. Effects of surgical caponization on the skin color values in Taiwan country chicken cockerels

Items	Caponized	Intact	S.E.
	L* values		
Back skin	73.86	71.24	0.711
Breast skin	73.16[a]	69.17[b]	0.878
Thigh skin	75.16	75.40	0.614
Average	74.41[a]	71.94[b]	0.488
	a* values		
Back skin	5.22	5.95	0.428
Breast skin	2.44[b]	5.23[a]	0.543
Thigh skin	0.82	0.96	0.303
Average	2.82	4.05	0.400
	b* values		
Back skin	15.04[a]	12.44[b]	0.358
Breast skin	13.15	13.23	0.504
Thigh skin	10.84	9.24	0.733
Average	13.01[a]	11.64[b]	0.421

[a,b] Means in the same row without the same superscript are significantly different ($p<0.05$).

Table 5. Effects of surgical caponization on the muscle color values in Taiwan country chicken cockerels

Items	Caponized	Intact	S.E.
	L* values		
Back muscle	52.04	50.47	1.055
Breast muscle	59.73	57.10	1.165
Thigh muscle	56.68[a]	52.36[b]	1.043
Average	56.14[a]	53.31[b]	0.488
	a* values		
Back muscle	4.11[b]	5.29[a]	0.214
Breast muscle	0.89[b]	2.44[a]	0.296
Thigh muscle	3.08[b]	5.07[a]	0.295
Average	2.70[b]	4.27[a]	0.263
	b* values		
Back muscle	7.02[a]	5.89[b]	0.344
Breast muscle	7.67[a]	5.56[b]	0.413
Thigh muscle	5.34[a]	2.41[b]	0.435
Average	6.68[a]	4.62[b]	0.421

[a,b] Means in the same row without the same superscript are significantly different ($p<0.05$).

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