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Carcass Quality of Different Meat - Typed Chickens When Achieve a Common Physiological Body Weight

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Abstract: This experiment was conducted to compare carcass characteristics of native quality chicken white Lueyang (WL), modern commercial broiler strain Arbor Acres breeder (AA) and their respective F_1 cross when achieve a common live body weight. A total of 300 day-old chicks were allotted to three groups and reared under the same conditions until they reached market weight (1800±20 g) respectively, then ten of individual male birds from each group were killed for measuring. There were significant differences in carcass and meat characteristics for breeds at a common market weight. WL had a large age to market weight, lower abdominal fat weight, lower breast meat yield, higher leg meat yield (P<0.05 or P<0.01). moisture and lipids of both breast muscle and thigh muscle were lower for WL than AA (P<0.01), but protein and ash components of both breast muscle and thigh muscle were higher for WL than AA (P<0.05 or P<0.01). Muscle pH_{24h} was higher for WL than AA (P<0.05). WL had a lower L* value than AA and their F_1 (P<0.05), but a higher a* value and b* value (P<0.01). The F_1 crosses appeared to have characteristics more like AA for carcass and meat characteristics.

Key words: Meat-typed chickens, physiological age, carcass traits, meat quality

Introduction

Foods derived from animal products are an important source of nutrients in the human diet and play an increasing role in the human nutrition in future (Givens, 2005). In all aspects of animal products, poultry meat production growth, in particular chicken meat, has been very speedy over the last decades and up to now occupies second place in volume in the world just following pork, becoming a type of the most cheapest food derived from animals worldwide. However, more and more concerns have being focused on poultry meat quality and its food safety (Le Behan-Dval, 2004).

The quality of the meat is mainly influenced by genotype of animals and its environment, especially either nutrients or stress undergone during growing period or before slaughter. The number of researches were undertaken in order to specify impact of various breeds or strains of poultry on post-mortem carcass quality and subsequent technological meat quality (Siegel and Dunnington, 1987). Most of these studies have emphasized upon comparison at a set point in time. Chronological time as a standard for comparison has been a commonly accepted method to examine differences in growth and carcass characteristics (Chambers, 1990). However, because both time and mass are components of growth, either could be effectively utilized in comparative growth trials. Calder (1982) suggested that the concept of physiological time, rather than chronological time, might be a better measure because it relates growth to other physiological processes. Zelenka *et al.* (1987) used both physiological (body weight) and chronological (age) measures to compare mature and immature pullets. Katanbaf *et al.* (1988b) compared organ growth for chickens at both a common weight and age and reported that biological functions at a specific age may not reflect the situation at a common body weight. Wall and Anthony (1997) had systematically compared inheritance of carcass variables when Giant Jungle Fowl and modern commercial broiler achieve a common body weight and reported that there are significant differences in meat yield, abdominal fat pad and some function organs.

Physiological age as a point of reference for genotype of birds may obtain an objective evaluation of difference in body weight growth pattern and may offer new insights into where true differences among breeds or strains occur. The objective of this study was to measure and compare carcass characteristics of native quality chicken: White Lueyang (WL), modern commercial broiler strain: Arbor Acres breeder (AA) and their respective F_1 cross (F_1 crossed by AA♂×WL♀) when achieve a common live body weight.

Materials and Methods

Animals: A total of 300 day-old chicks (WL, AA and F_1 was 100 birds respectively) were allotted to three groups. All Birds were reared in cages, provided feed and water for *ad libitum* and managed according to guidelines approved by Arbor Acres Farm. The experimental diet was based on yellow corn-soybean meal and formulated to meet or exceed all NRC requirements (NRC, 1994). Due to the great disparity of chronological age among breeds to a common market live body weight (approximate 1800g), ten male birds from each breed were placed in common floor pen (0.421 m^2/bird) when the birds of AA, F_1 and WL were 5,8 and 15 week of age respectively. Then birds were individually weighed at regular intervals to monitor the day that approximate market live weight for the individual bird was obtained.

Sample collection: When reached a common live body weight (1800±20g) respectively, ten of individual male birds from each breed were killed by cervical dislocation, and then were immediately bled. The abdominal fat, breast and leg muscle were removed and weighed. For qualitative determinations, 2 samples of breast *(Pectoralis superficialis* muscle) and leg muscle (*gastrocnemius*) were obtained; one was stored individually in plastic bags at 4°C for analysis of muscle pH and color. The other sample was stored at -80°C for chemical analysis.

Muscle pH: At 30 min and 24 h post-mortem, the breast and leg muscle pH was respectively determined at a depth of 2.5 cm below the surface by using a Model PH-211 Meter equipped with a spear electrode.

Color measurement: The surface color of chicken rolls was measured in package using a Hunter LabScan colorimeter and expressed as color L*- (lightness), a*- (redness) and b*- (yellowness) values. A color reading was taken from both sides of rolls. The same packaging materials were used to cover a white standard plate in order to eliminate the influence of packaging material on meat color.

Chemical analysis: Chemical analysis of moisture, fat, protein and ash contents of muscle were performed in accordance with tandards of the Association of Official Analytical Chemists (AOAC, 1990).

Statistical analysis: All results obtained in this study were subjected to statistically analyze by using Statistical Analysis Systems Institute (SAS, 1988).

Results and Discussion

In the current study, significant differences between parental breeds were observed in age, abdominal fat pad, breast meat yield and leg meat yield (Table 1). Although Age to market live weight of AA averaged 85d fewer than WL to the same market weight (P<0.01), AA had over three times as much abdominal fat as WL (P<0.01). Breast meat yield without bone and skin of AA was higher than that of WL (P<0.05). Whereas leg meat yield without bone and skin in AA was very significant lower than that in WL (P<0.01) .The F_1 crosses appeared to have characteristics more like AA for age and abdominal fat weight to market weight. Also, a greatly negative heterotic effect for the F_1 was observed in age to a common weight(average -22.2%), whereas a large positive heterotic effect for the F_1 was observed in abdominal fat to a common weight(average +36.3%). Both breast and leg meat yield for the F_1 were near to their average parents and no obvious heterotic effects. The results mentioned above agreed with a study conducted by Wall and Anthony (1995).

Table 1: Comparison of age, meat yield and abdominal fat in different breeds and their F1 cross at a common physiological body weight

	Breeds			
Variables	WL	AA	F1	P
Age (d)	126±2.5^A	41±1.0^B	71±1.2^C	**
Body weight (g)	1808±8	1815±10	1810±12	NA
Abdominal fat (g)	8.8±1.0^A	28.9±3.5^B	25.7±3.0^B	**
Breast meat[1](g)	219.4±5.0^a	240.9±4.2^b	225.6±3.6^{ab}	*
Leg meat1(g)	325.8±2.8^A	285.0±2.0^B	306.2±2.2^C	**

[1]Weights include bone and skin removed. *P=0.05; **P=0.01

Table 2: Comparison of chemical compositions of muscle in different breeds and their F1 cross at a common physiological body weight

	Breeds			
Variables	WL	AA	F1	P
Breast muscle:				
Moisture (%)	71.68±0.22^A	72.97±0.28^B	72.12±0.19^A	**
Protein (%DM)	92.22±0.15^a	90.16±0.22^b	91.71±0.17^{ab}	*
fat (%DM)	1.85±0.18^A	5.69±0.23^B	2.96±0.22^C	**
Ash (%DM)	5.93±0.21^a	4.15±0.15^b	5.33±0.15^a	*
Thigh muscle:				
Moisture (%)	68.35±0.24^A	69.97±0.22^B	69.12±0.20^C	**
Protein (%DM)	73.26±0.31^A	63.12±0.28^B	68.90±0.23^C	**
fat (%DM)	22.68±0.34^A	33.25±0.56^B	27.14±0.33^C	**
Ash(%DM)	4.12±0.17^a	3.63±0.21^b	3.96±0.18^{ab}	*

Moisture, fat, protein and ash contents of breast and thigh muscle were showed in Table 2. At a same market body weight, moisture and fat of both breast muscle and thigh muscle were lower for WL than AA (P<0.01).Whereas Protein and ash components of both breast muscle and thigh muscle were higher for WL than AA (P<0.05 or P<0.01).

There was no significant difference of pH in breast muscle at 30 min post-mortem among breeds and their F_1 when reached a common weight. However, a significant difference of pH in breast muscle was observed after 24 h among breeds and their F_1 and pH for AA was lower (P<0.05) compared with WL and their F_1. The results indicated that genotype between breeds could affect on declining rate of post-mortem muscle pH. The muscle pH value is a direct reflection of muscle acid content and has been associated with numerous other meat quality attributes such as color, water-holding capacity, tenderness, juiciness, or microbial stability (Fletcher, 1999). High final pH produces dark, firm and dry (DFD) meat with a poor storage quality due to a faster rate of off-odor production and accelerated microbiological growth (Allen *et al.,* 1997). On the

Table 3: Comparison of pH and color of breast muscle in breeds and their F1 cross at a common physiological body weight[1]

	Breeds			
Variables	WL	AA	F1	P
pH_{30min}	$6.57±0.11^{a}$	$6.54±0.12^{a}$	$6.53±0.14^{a}$	NS
pH_{24h}	$6.02±0.10^{A}$	$5.65±0.07^{B}$	$6.05±0.11^{A}$	**
L*	$44.68±0.38^{A}$	$48.64±0.42^{B}$	$47.15±0.32^{B}$	**
a*	$29.11±0.51^{A}$	$18.25±0.33^{B}$	$21.12±0.42^{C}$	**
b*	$18.36±0.33^{a}$	$16.98±0.36^{b}$	$17.27±0.42^{b}$	*

[1]pH_{30min} = pH at 30 min post-mortem; pH_{24h} = pH at 24 h post-mortem. L* = lightness; a* = redness; b* = yellowness.

contrary, low final pH leads to meat with an improved shelf-life but a pale and reduced water-holding capacity either for chicken or turkey meat (Barbut, 1997). As well known in pigs, a rapid pH decline early post-mortem, when muscle temperature is still high, enhances protein denaturation, leading to pale, soft and exudative (PSE) meat (Briskey and Wismer-Pedersen, 1961; Pietrzak *et al.,* 1997) and effecting on the technological quality of turkey meat (Babile *et al.,* 2002).

Comparison of muscle color for genotypes was placed in Table 3. WL had a lower L* value than AA and their F_1 (P<0.05), whereas a higher a* value and b* value (P<0.01) at a common market weight. The F_1 crosses appeared to have characteristics more like AA for muscle color. Berri *et al.* (2001) reported that there were significant differences in muscle color including L*, a* and b* value of broilers between the experimental line selected for improving of body composition on muscle and meat characteristics and control line at 7 weeks of age. However, it has been no reports that muscle and meat characteristics for color was affected by breeds or lines when achieves a common market body weight, because most of such studies conducted before were as a comparison criterion when reached a common chronological time (Szalkowska and Meller, 1999; Fletcher, 1999; Berri, *et al.,* 2001; Debut, *et al.,* 2003).

Conclusion: At a common market body weight, genetic breeds showed high differences in abdominal fat, meat yield, chemical and color characteristics of muscle. We also suggest that physiological age, rather than chronological age, may be a better measurement for comparing technological meat quality among different genetic breeds of chickens, because only can either modern commercial broiler strains or native quality breeds be slaughtered for consumption on fresh or further-processing when they reach market live body weight.

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