Fattening and carcass traits of broiler genotypes with and without feathers under hot conditions

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Abstract Heat stress due to high ambient temperature hampers broiler production in the tropics and subtropics. This leads to depression in feed consumption and growth rates of birds and high mortality while at the same time reducing breast meat yield and quality. Adapting the environment to the demands of fast-growing broilers by means of high-cost cooling and ventilation systems is feasible, but in many cases is neither economical nor affordable by farmers in developing countries where electric power and water are not in constant supply. The problem of heat stress on broilers and the non-sustainable management practices used in combating it could be alleviated by introducing the scaleless (*sc*) gene. This major gene improves the adaptation to hot climates by eliminating feathers. Previous studies on the sc gene indicated that the relative weight of the breast was increased in featherless (*scsc*) birds. An experiment was set up involving 200 featherless chicks and 200 feathered sibs who were reared under hot conditions in two rooms (average temperature 29 to 33°C) divided into pens by genotype. Fattening and carcass traits considered were live and slaughter weights, and mortality. The studied breast meat quality traits post mortem (PM) were: colour (Lightness (L*) and redness (a*)), drip loss, thaw loss and drip-thaw loss. The quality traits were studied on 56 individuals from each genotype. Results confirmed statistically significant improvements in breast meat quantity and quality of featherless birds under hot conditions: breast meat yield was around 50% higher, mortality due to a heat wave of 38°C on day 45 was lower (2% vs 42 %), breast colour at 24h and 72h PM was better with lower L* values (52.8 vs 54.4, 53.2 vs 55.6, respectively) and higher a* values (3.2 vs 2.5, 4.2 vs 3.2), lower drip losses on day 4 PM (1.9% vs 2.6 %), lower thaw losses (2.3% vs 3.4%) and drip-thaw losses (4.1% vs 5.9%) on day 7 PM.

(*Keywords: Featherless broilers, heat stress, hot temperature, meat quality, meat yield*)

Introduction

High ambient temperature (AT) has been recognised as one of the major environmental factors hindering poultry production in hot climates (Daghir, 2008). Increased sensitivity of broilers to high ambient temperature may be due to continuous selection for increased growth rate (Cahaner et al., 1995). The negative effects of high AT on growth rate, feed intake, meat yield (Yalcin et al., 2001) and meat quality (Yadgary et al. 2006; Bianchi et al., 2007) of commercial broilers have been reported. Previous research findings established a more sustainable method as opposed to the costly artificial control of AT in broiler houses through genetic approaches which involve producing genetically reduced feathered birds with the help of major genes for broiler production in hot climates (Yalcin et al., 1997; Deeb and Cahaner 2001; Ajuh 2004). The present study aims at testing whether broiler production with featherless birds in hot climates can benefit the producer while securing the meat quality in preference to consumers' satisfaction. To this end the effect of high AT on the fattening and carcass traits of the featherless and their feathered sibs were evaluated.

Materials and Methods

Parental lines and husbandry: Mixed sperm of 20 scsc cocks which was used to artificially inseminate 80 +/sc hens (feathered carriers of sc), from which 200 featherless (*scsc*) chicks and 200 feathered sibs were used for the experiment. The chicks were reared under hot conditions in two rooms (average temperature from 29-33°C) divided into pens by genotype and diet (standard diet and 10%, 15% and 20% protein and energy reduction).

Measured and calculated quantity traits: Body weight at the day of hatch (BW 0d), during growth at days 10, 17, 34, 38, 41 and 50 as well as body weight at slaughter (BWS) on day 51 (after 10 hours (h) of feed withdrawal) was measured on 56 featherless and 39 feathered sibs using an electronic precision (0.1g) balance (Sartorius BP 6100) attached to a bar code scanner and portable data terminal (Symbol PDT 3100). The same instrument was used to measure breast meat yield in grams (BMYg) of the birds at 24h postmortem (PM) from which the percent breast meat yield (%BMY) at 24h PM was calculated and this was expressed as percent of BWS. The birds' losses were calculated from the onset of nutritional treatment (day 18) to the final day 50 (before the feed withdrawal), and were differentiated into those due to illness and intentional culling to reduce density as well as losses due to a heat wave.
Measured and calculated quality traits: Breast meat colour was measured at 24h and 72h PM on 56 featherless and 39 feathered sibs using Minolta CR-200 Chroma meter having a trichromatic system with lightness (L*) and redness (a*) values at both the upper and lower parts of the 'bone-facing' side of the *Pectoralis major* muscle. The drip loss at day 4 PM (96h PM) was assessed from the breast meat of 56 featherless and 39 feathered sibs packaged in a transparent polythene bag and stored in a chilling room at +5°C for 48h, after which the excess moisture was wiped out and the breast samples were weighed (at 96h PM) and the drip loss (24-96h) PM was calculated as percentage of breast meat yield in gram measured at 24h PM. The thaw loss from one-half of each breast sample used for the drip loss assessment was frozen for 72h at -20°C on day 4 PM and thawed on day 7 PM at room temperature (25°C) for 8 hours, after which the excess moisture was wiped out, and the breast was weighed. The thaw loss was determined by subtracting the weight after thawing from the initial weight before freezing. The drip-thaw losses were the combined drip and thaw losses on day 7 PM.
Statistical analysis: Analyses of variance were performed using the GLM procedure of SAS (SAS Institute Inc., Cary, NC) to test the effect of genotype, sex, room and diet on BWS, BMYg, %BMY, breast meat colour (Lightness (L*) and redness (a*)), drip loss, thaw loss and drip-thaw loss.

Results

Body weight during growth: The mean BW at day 41 and 50 were significantly higher (P=0.0059 and P<.0001) in favour of the featherless broilers (Table 1). At early age no differences between the genetic groups appeared.

Table 1: Mean BW at 10, 17, 34, 38, 41 and 50 day of age of featherless and their feathered sibs averaged over sex and diet

Dependent variable	Genetic group	n	Mean	SE	P>|t|
BW 10	Featherless	56	183^{a}	4	0.4783
	Feathered	39	186^{a}	3	
BW 17	Featherless	56	405^{a}	7	0.4778
	Feathered	39	412^{a}	7	
BW 34	Featherless	56	1286^{a}	22	0.6477
	Feathered	39	1303^{a}	30	
BW 38	Featherless	56	1462^{a}	21	0.9846
	Feathered	39	1462^{a}	26	
BW 41	Featherless	56	1688^{a}	23	0.0059
	Feathered	39	1588^{b}	28	
BW 50	Featherless	56	2299^{a}	30	<.0001
	Feathered	39	1950^{b}	29	

SE= Standard error; $^{a-b}$Least square means (LSmeans) in the same column with no common superscript differ significantly at P<0.05.

Body weight at slaughter (BWS) and breast meat yield (BMY): The BWS, BMYg and %BMY were significantly different (P<.0001) between the genetic groups (Table 2) in favour of the featherless broilers.

Table 2: Effect of genotype on body weight at slaughter (BWS) and breast meat yield at 24h postmortem

Dependent variable	Genotype				
	Featherless		Feathered		
	LSmean	SE	LSmean	SE	P-value
BW slaughter (g)	2150.0^{a}	27.7	1847.3^{b}	29.1	<.0001
Breast meat yield (g)	389.7^{a}	8.0	263.6^{b}	8.4	<.0001
Breast meat yield (%)	18.1^{a}	0.2	14.2^{b}	0.3	<.0001

SE= Standard error; $^{a-b}$Least square means (LSmeans) in the same row with no common superscript differ significantly at P<0.05.

Mortality: The peak mortality incidence was on day 45, due to a heat wave of 38°C and very low relative humidity (about 25%) that led to the death of 52 birds. In featherless birds the mortality was 2%, and in the feathered sibs 42%. The overall mortality on day 45 was 15% with the featherless being significantly lower (P=0.0381) than their feathered counterparts as revealed by chi-square.

Breast meat quality traits: The breast meat quality traits colour (L* and a*), drip loss, thaw loss and drip-thaw loss were significantly different between the genetic groups (Table 3) in favour of the featherless broilers.

Table 3: Effect of genotype on breast meat quality traits measured postmortem (PM)

Dependent variable	Genotype				
	Featherless		Feathered		
	LSmean	SE	LSmean	SE	P-value
Lightness (L*) at 24h PM	52.8^{a}	0.4	54.4^{b}	0.4	0.0055
Lightness (L*) at 72h PM	53.2^{a}	0.4	55.6^{b}	0.4	<.0001
Redness (a*) at 24h PM	3.2^{a}	0.2	2.5^{b}	0.2	0.0093
Redness (a*) at 72h PM	4.2^{a}	0.2	3.2^{b}	0.2	0.0024
Drip loss (24-96) PM (%)	1.9^{a}	0.1	2.6^{b}	0.2	0.0003
Thaw loss (day 7) PM (%)	2.3^{a}	0.1	3.4^{b}	0.2	<.0001
Drip-thaw loss (day 7) PM (%)	2.3^{a}	0.1	3.4^{b}	0.2	<.0001

SE= Standard error; $^{a-b}$Least square means (LSmeans) in the same row with no common superscript differ significantly at P< 0.05

Discussion

The mean BW at day 41 and 50 were significantly higher in the *scsc* than in their feathered sibs indicating that under heat stress (≈ 32°C) the growth of the *scsc* broilers was increasing at an increasing rate while that of their feathered sibs was increasing at a decreasing rate; being consistent with the results obtained by Cahaner et al. (2008) and Yadgary et al. (2006). The BMYg of the *scsc* being 126g heavier than the 264g of their feathered sibs, represented an increase of almost 50% which is of economic importance and this is a derived benefit from the significantly higher BWS in favour of the *scsc* broilers. The percent BMY was 18 versus 14% in the *scsc* and feathered broilers, representing an increase of 4% points which was in accord with the result obtained by Cahaner et al. (2003). The significantly lower mortality (2% vs 42%) due to the heat wave of 38°C in favour of the *scsc* broilers is a proof that feather coverage in fast-growing broilers is limiting thermoregulation in hot climates leading to high mortality under hot conditions, what is in agreement with findings of Yunis and Cahaner (1999).

Truncation values for paler-than-normal meat vary in literatures. Applying the value as used by Qiao et al. (2001) of L*>53; the *scsc* broilers had normal breast meat colour while their feathered sibs had lighter than normal (pale). The better fattening and carcass traits in terms of BWS and specifically BMY in the *scsc* as compared to those of their feathered sibs under hot conditions were associated with other quality traits such as higher water holding capacity as assessed by significantly lower drip loss (1.9% vs 2.6%), thaw loss (2.3% vs 3.4%) and drip-thaw loss (4.1% vs 5.9%). Consistently, Yadgary et al. (2006) reported a reduced meat yield and meat quality in feathered versus featherless sibs under hot conditions.

Conclusion

In practise the welfare of *scsc* broiler is less or not dependent on costly cooling systems. Reduction in live BW, meat yield and quality of fast-growing normally feathered broilers under hot conditions can be counteracted by the introduction of the scaleless (sc) gene for sustainable and cost effective large-scale commercial production of high yield and quality of broiler meat in hot climates.

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