G.J.A.S.R

Global Journal of Animal Scientific Research

Journal homepage: www.gjasr.com

Print ISSN: 2345-4377 *Online ISSN: 2345-4385*

Original Article

Evaluation of Carcass Characteristics and Meat Quality of Indigenous Fowl Ecotypes and Exotic Broiler Strains Raised Under Hot Climate

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ARTICLE INFO

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How to cite this article:
Mondal, M., K.K. Baruah and C.Rajkhowa.2014.Applicatin of Biotechnology for Augmentation of Productivity in Mithun (*Bos frontalis*). *Global Journal of Animal Scientific Research.* 2(4): 365-371.

Article History:
Received: 18 August 2014
Revised: 31 August 2014
Accepted: 2 September 2014

ABSTRACT

This study was conducted to investigate the influence of genotype on growth performance, carcass characteristics and meat chemical composition traits of chickens under hot climatic conditions. Two exotic meat strains (Hybro and Hubbard) and three Sudanese native chicken ecotypes (Bare- neck, Large Baladi and Betwil) were used for this purpose. Data were analyzed using General linear model (GLM) of SAS (2007). Results revealed that genotype had significant (P<0.01) effect on traits studied, with the exotic strains exhibited higher average values for live body weight, eviscerated carcass, dressing percentage and carcass cuts percentages. On the other hand the native chicken ecotypes showed higher relative values for back, wings, visceral organs and feather. Chemical composition results were variable, with the highest levels of Protein and ether extract recorded for the exotic meat strain, Hybro and the lowest were recorded for the native chicken, Bare-neck. Moreover, significant differences (P< 0.01) among genotypes were observed for shank weight and shank length, with Hubbard being the highest and Large Beladi and Betwil being the lowest for shank weight and shank length respectively. Among the native chicken ecotypes, Bare-neck had the lowest relative feather weight indicating the effect of Na gene in reducing feather coverage around the body.

Keywords: Carcass Characteristics, Exotic Strain, Indigenous Chicken, Meat Quality, Hot Climate.

INTRODUCTION

Chicken comprises the major constituent of poultry species in Africa. Despite the wide spread of exotic strains, local chickens are known to be predominant in developing countries (FAO, 2004; Do, 2005; Bett *et al*., 2012). They play an important role in the economic development of rural communities and they are known to be relatively resistant to some infectious diseases, good converters of poor quality feeds and have products that are preferred by consumers (Mengesha, 2012). In villages and rural communities of the Sudan almost every

family owns a few numbers of chickens to satisfy their needs for eggs and meat. Desai **(**1962**)** described and classified local chickens of Sudan into main three ecotypes, Large Beladi, Bare neck and Betwil (dwarf). Large Beladi is considered as the most common ecotype which found almost everywhere in villages and town dwellings, with body weight at 8 weeks of age ranges from, 476 to 271.8 g **(**Yousif and Osman, 1994; Yousif *et al*., 2006; Yousif *et al*., 2010).

Several studies had been carried out to investigate the effect of high ambient temperature on the performance of exotic commercial broiler strains and to compare them with the indigenous breeds under tropical conditions (Tibin and Mohamed, 1990; Timothy *et al.,* 2003; Hassan *et al*., 2006; Munira *et al*., 2006). The results confirmed that exotic strains had superior performance when compared with indigenous breeds despite the negative impact of hot climate on exotic strains. However, Jaturasitha *et al*. (2008) found no clear differences in dressing percentage and in retail cuts obtained for Thialand local breed and exotic chickens. On the other hand, Castellini *et al*. (2002) reported that dressing percentage of the Italian breed (Padovana) was slightly lower than that reported for commercial broiler. In Sudan the history of importing the exotic temperate chicken breeds dates back to 1926 when a British Veterinarian introduced Wyandotte breed and distributed its fertilized eggs for incubation aiming at improving poultry production. Recently several new commercial strains are introduced to the country and consequently large scale poultry projects have been established to satisfy the increasing demand for poultry products. However, more research efforts are needed to evaluate genotype × environment interactions and to compare these modern strains with the native breeds under different managerial conditions. Therefore, the objective of this study was to evaluate the performance, carcass characteristics and meat quality of the exotic broiler strains in comparison with the local chicken ecotypes under hot climate of the Sudan.

MATERIALS AND METHODS

Experimental Site

This experiment was conducted at the poultry house of the Faculty of Animal Production, University of Khartoum, Sudan. The lowest and the highest average ambient temperature during the experimental period were 22° C and 44° C respectively.

Collection and Incubation of Experimental Eggs

Fertile eggs of the native chicken ecotypes, Bare- neck (BN) and Betwil (BT) were collected from the Indigenous Chicken Research Unit (ICRU) at the Faculty of Animal Production, University of Khartoum, whereas the Large Beladi ecotype eggs were obtained from an experimental stock at the Faculty of Agriculture, Omdurman Islamic University. The exotic strains (Hybro and Hubbard) eggs were obtained from Arab Poultry Breeders Company (OMMAT) farm which located 40 miles west Omdurman city. Eggs were transported to the Hatchery Unit at the Faculty of Animal Production, University of Khartoum by a car with cooling system. An automatic turning device incubator (Funki model) with capacity of 4608 eggs was used for eggs incubation. Throughout the incubation period, temperature inside the incubator was adjusted to 99-100^0 F and the relative humidity was kept at 60-65% using moisture trays allocated at the bottom of the hatchery. In the 15th day of incubation candling of the incubated eggs was practiced to determine fertility and early and late embryonic deaths. Later in the 18th day of incubation eggs of each strain or ecotype were set separately in hatchery trays, fumigated using 30g. potassium permanganate and 90 ml. formaldehyde solutions and then transferred to the hatching unit below the same incubator. Humidity was raised substantially to facilitate eggs hatching. In the morning of the 22nd day of incubation the hatched chicks were released, graded, weighed, wing banded, and transferred to brooders. A total of 516 one -day old chicks (105 Hybro, 105 Hubbard, 102 Bare- necks, 129 Large Baladi and 75 Betwil) were obtained and reared up to eight weeks of age.

Brooding and Rearing Management

Before chick's arrival, brooders were cleaned, incinerated and disinfected using potassium permanganate and formaldehyde solution in a ratio of 1g: 2ml. Each brooder (3.5 ×3.0×3.0 m dimensions) was divided internally into 8 brooder units and covered with 5 inches depth wooden shaving litter. Chicks were placed randomly in brooders (10-15 chicks/genotype/ brooder unit), thus representing a complete randomized design (CRD) with 9 replicates. A starter ration containing 24.1% CP and 3123 K cal/kg ME was provided *ad- libitum* (table 1). Vitamins and minerals were added to drinking water at weekly interval. Chicks were vaccinated against New Castle disease at first and third weeks of age, whereas Gumboro vaccine was administered at the second weeks of age. At the end of the 4th week of age, chicks were transferred to an open sided poultry house (10×4×3 m dimensions) which divided internally into 15 pen units. Each pen unit was covered with 5 inches depth wooden shaving litter and equipped with cleaned and disinfected feeders and drinkers. Finisher ration containing 21.4% CP and 3180 K cal /kg ME was provided *ad-libitum* during the second 4 weeks of age. Artificial light was provided continuously throughout the experimental period using 100- watt bulbs lams. Experimental birds were reared and treated in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Table 1: formulation of starter and finisher ration

Ingredients	Starter %	Finisher %
Sorghum	58	63.23
Groundnut meal	19	15
Sesame meal	14.03	12.3
Super concentrate	5	5
Dcal	1	1
Oyster shell	1.5	1.5
Nacl	0.3	0.3
Lysine	0.1	0.1
Meth.	0.07	0.07
V. oil	1	1.5
Total	100	100

Chemical Composition of starter and finisher ration

Constituents	Starter ration Amounts	Finisher ration Amounts
Crude protein %	24.12	21.35
ME (K cal/ kg)	3123	3180
Dry matter %	93.14	93.46
Ether extract	7.40	7.39
Ash %	7.29	8.35

*Broiler concentrate 5 % Hendrix contains : crude protein 40%; crude fiber,4.52%; fat 5.20%; Ash, 3.20%; M.E. 2200; kcal/kg lysine 8.75%; Methionine, 1.6% spp. Methionine + cystine 2.0%; calcium 7.6%; phosphorus (av.) 4.8%.
Source: AOAC 1990
*ME = Metabolizable energy.

Carcass Processing and Data Recording

At the end of the 8th week birds were weighed individually after an overnight fasting (except from water), slaughtered, scalded in hot water at temperature of 53^{o} C for 2 minutes and de-feathered by hand picking. For each bird feather was weighed after being dried for 24 hours using sun ray during the day. Head and shanks were removed close to the scull and at the hock joints respectively and weighted whereas shanks lengths were measured using robber

metric. Evisceration was accomplished by posterior ventral cut, thus a complete removal and weighing of the visceral organs. Abdominal fat including fat surrounding the gizzard and leaf fat was carefully removed using forceps and weighted. Hot carcass (HC) weight (without neck) was recorded individually and then all carcasses were chilled in chilling refrigerator at 4^oC for 24 hours. In the morning of the next day the carcasses were taken out from the refrigerator, allowed 4 hours thawing at room temperature and weighed individually to determine the cold carcass (CC) weight. Each carcass was dissected into different cuts including breast (BR), drumstick (DR), thigh (TH), and back (BK). The sum of the drumstick and thigh comprised the leg (LG). Carcass cuts were recorded as percentages of CC whereas HC, feather, shank and visceral organs were expressed as proportions of live body weight. Carcass cuts were kept in a freezer under -10^o C for one day before processing.

Chemical Composition Analysis

In the next day the frozen meat from breast and thigh of each strain or ecotype was thawed in a refrigerator at temperature of 4^o C for 24 hours, minced, mixed, and then random samples were taken for chemical analysis. Moisture, protein, ash and fat contents were determined according to AOAC (1990)**.** Six replicates were done for each parameter. The moisture was determined by weighing meat sample, dried in an oven at 100^o C for 18 hours, and then moisture percentage was calculated as: **(Loss in weight ÷sample weight)×100**

Protein percentage was determined by Kjeldahl method. For ash determination, 5 g. of meat sample was dried in a weighed crucible and placed inside muffle furnace at 150^o C, thereafter temperature was increased gradually up to 600^o C. The sample was heated at this temperature for 3 hours before the crucible was taken out, cooled and weighted. Percentage ash was calculated as :**(Crucible weight with incinerated ash - empty crucible weight) ÷ Sample weight × 100**

Crude fat was determined by extracting fat serum from a meat sample for 6 hours using petroleum ether. After extraction the ether petroleum was evaporated in an extraction flask by using a rotary evaporator, the flask was then dried at 100^o C for 30 minutes, cooled and weighted. Crude fat percentage was determined as**: (Fat weight ÷ sample weight) × 100**

Statistical Analysis

Data sets consisted of 498 observations were subjected to statistical analysis using the General Linear Model (GLM) of the Statistical Analysis System (SAS, 2007**)**. Differences among genotype means were compared by Duncan's Multiple Range (DMR) test.

RESULTS AND DISCUSSIONS

In this experiment, the results showed that exotic meat strains, Hybro and Hubbard had significantly ($P<0.01$) higher average values for growth, carcass weight, dressing percentage and carcass cuts percentages (breast, thigh and drumstick) in comparison with the local chicken ecotypes, Bare-neck, Large Beladi and Betwil (Table 2). These are in agreement with the previous studies conducted by Chhabrad and Sapra (1973); Sharma *et al*. (1971); Tibin and Mohamed (1990) ; Hassan *et al*. (2006)**.** However in contrast with the present result, Franco *et al*. (2012) in their work with the native Mos rooster and the hybrid Sasso T-44 concluded that although live weight and carcass weight were higher in the hybrid line, Mos breed had a significantly higher percentage of edible products than Sasso T-44. This was also confirmed by Rizzi *et al*. (2007) who found that at 44 week of age, 2 Italian dual-purpose breed had significantly heavier breasts, thighs, and drumsticks than hybrid hens. In this study, although Hubbard exhibited higher dressing percentage than Hybro, the two strains showed similar results for breast, drumstick and leg. As proportion of hot carcass, abdominal fat of the exotic strains was significantly higher than the local chicken ecotypes. Excessive fat deposition in commercial broiler strains is undesirable for consumers because it is considered as waste and tedious in processing in addition to the fact that it is associated with heart

problems. Furthermore, the native chicken ecotypes showed higher wing, back and visceral organs percentages than the exotic strains. The higher percentages of the less valued carcass parts (wings, back and neck) and the non edible portions (visceral organs, feather, heads and shanks) may reflect the fact that native chickens are genetically unimproved, therefore the proportion of the highly valued edible carcass cuts (breast, thigh and leg) is relatively low. On the other hand, significant differences ($P < 0.01$) were observed among the local ecotypes, Bare-neck, Large Beladi and Betwil for live weight, drumstick and back percentages. This variation indicates that selection for increased body weight and carcass characteristics among the indigenous chickens is possible.

Table 2: Average hot and cold carcass weights, dressing percentage and carcass cuts percentages of the exotic strains and native chicken ecotypes

Trait	Hybro Means ± SD	Hubbard Means ±SD	Bare- neck Means ± SD	Large Beladi Means ± SD	Betwil Means ± SD
BW	1273^{a} ± 232	1268 ^{a}± 244	349 ^{b}±57.6	287^{c} ± 59.3	301^{bc} ±70.6
HCW	910^{a} ± 243	970^{a} ± 279	189^{b}± 57.6	153^{b} ± 35.0	163^{b} ±40.1
HC%	71.5	76.5	54.1	53.2	54.1
CCW	852^{a}± 166	842^{a}± 173	175^{b}± 38.9	144^{b}± 37.2	152^{b}± 36.7
CC %	66.9	66.4	50.3	50.3	50.6
Breast %	27.3^{a} ± 3.60	27.2^{a} ± 3.80	22.7^{b} ± 3.4	23.7^{b} ± 3.2	23.1^{b} ± 3.6
Drumstick%	16.1 ^{a}± 1.40	16.1^{a} ± 2.90	16.1^{a} ± 1.3	15.4 ^{b}± 1.1	15.4^{b}± 1.6
Thigh %	18.9^{a} ± 2.20	18.6 ^{a}± 2.60	16.9^{b} ± 1.4	17.4^{b} ± 1.3	17.0^{b} ± 1.8
Leg %	35.0	34.7	33.0	32.8	32.4
Back %	23.5^{c} ± 2.20	23.8^{c} ± 3.20	26.8 ^{ab}± 3.3	25.2^{b} ± 3.9	27.3^{a} ± 3.6
AF %	2.30	2.40	1.30	1.10	2.00
Wings %	14.1 ^{b}± 1.30	13.7 ^{b}± 1.20	17.5^{a} ± 1.90	17.5 ^{a}± 1.80	17.1^{a} ± 1.60

*Means with the same super script letter in a row are not significantly different; while means with different super script letter in a row are significantly different (P< 0.01).
BW= Live body weight, HCW= Hot carcass weight, CCW= Cold carcass weight
HC and CC % are calculated as proportion of BW, Carcass cuts % are calculated as proportion of CCW, AF % is calculated as proportion of HCW.

The average weights of visceral organs, shank and feather weights and shank length of the exotic and local birds are presented in table 3. The results showed that there were significant differences ($P < 0.01$) among genotypes.

Table 3: Carcass evisceration, shank and feather weights (g) and shank length (cm) of exotic strains and native chicken ecotypes

Trait	Hybro Means ± SD	Hubbard Means ±SD	Bare- neck Means ± SD	Large Beladi Means ± SD	Betwil Means ± SD
LW	1273^{a} ± 232	1268^{a}± 244	349^{b}±57.6	287^{c} ± 59.3	301^{bc} ± 70.6
Head	36.5^{a} ± 5.50	36.2^{a} ±7.70	17.7^{b} ± 2.50	15.9^{c} ± 2.50	16.2^{bc} ± 2.60
Neck	70.3^{a} ± 13.2	69.6^{a} ± 18.3	18.9^{b} ± 4.50	16.9^{b} ± 4.7	17.9^{b} ± 5.10
SW	62.2^{a} ± 12.0	63.2 ^{a}± 15.2	18.8^{b} ± 4.90	14.4^{c} ± 3.60	14.9^{c} ± 3.90
Spleen	1.10^{a} ± 0.60	1.10 ^{a} ± 0.70	0.80^{ab} ± 0.40	0.60^{b}±0.30	0.70^{ab} ± 0.30
Liver	26.3^{a} ± 6.60	27.2^{a} ± 6.80	8.90 ^{b} ± 1.80	7.40^{c} ±1.06	7.40^{c} ± 1.90
Heart	6.80 ^{a} ± 3.30	7.60 ^{a} ± 6.40	1.90^{b} ± 0.80	1.60^{b} ± 0.50	1.70 ^{b} ± 0.50
Gizzard	27.9^{a} ± 6.40	26.5^{a} ± 8.60	16.7^{b} ± 5.20	12.2^{c} ± 2.30	13.5^{c} ± 3.10
Intestine	67.3 ^{a}± 14.5	65.6^{a} ±13.8	28.7^{b} ±5.60	23.2^{c} ± 5.0	21.6 ^{c} ± 4.40
AF	21.1^{a} ± 12.0	23.0 ^{a}± 9.92	2.4$^{\mathbf{b}}$ ±2.30	1.7^{b} ± 1.5	3.20 ^{b} ±1.90
Feather	30.7^{a} ± 8.10	29.7^{a} ± 8.70	14.3^{b} ±3.30	13.5^{b} ±3.2	15.1$^{\mathbf{b}}$ ± 4.60
SL	5.50^{a} ± 0.60	5.30^{b} ± 0.60	4.30^{c} ± 0.50	3.90^{d} ±0.6	3.50^{e} ± 0.60

*Means with the same super script letter in a row are not significantly different; while means with different super script letter in a row are significantly different (P< 0.01).
LW= Live Weight, SW= Shank Weight, AF= Abdominal Fat, SL = Shank Length

Feather weight expressed as percentage of body weight was significantly higher in the native chickens compared to the exotic strains. In tropical area low feather density is favorable because it helps in heat dissipation. Among the native chicken ecotypes, the lowest feather percentage was recorded for the Bare-neck chicken; this may express the effect of the Na gene which tends to reduce the whole feather coverage weight percentage in the neck and breast areas by about 20-40% as compared to normal feather chicken (Yalcin *et al*., 1997). Comparing the exotic strains, there were no significant differences between Hybro and Hubbard for all visceral organs examined. Similar results were also obtained for the native chickens.

Table 4 shows the meat chemical composition of the exotic and native chickens. Significant differences ($P < 0.01$) among genotypes were reported. The highest crude protein and ether percentages were reported for the exotic, Hybro and lowest were found for the native Betwel and Large Beladi chickens respectively. These results are in accordance with those found by Tibin and Mohamed (1990) and Ganabadi *et al*. (2009)**.** Moreover, the highest and the lowest moisture content was found in the native Betwil and Bare-neck respectively. However Zhao *et al*. (2009) reported higher moisture and protein contents in Beijing-You, a Chinese non improved line than in Arbor Acores, a distinct commercial line.

Table 4: Chemical composition traits of the exotic strains and native chicken ecotypes

Trait (%)	Hybro Means ± SD	Hubbard Means ±SD	Bare- neck Means ± SD	Large Baladi Means ± SD	Betwil Means ± SD
Moisture	75.5^{b} ± 0.60	75.6^{b} ± 0.40	74.5^{c} ± 0.70	75.6^{b}±0.70	76.5^{a} ± 0.20
Ash	1.20^{b}± 0.60	1.30^{a} ± 0.10	1.10^{b} ± 0.10	1.30^{a} ±0.10	1.10^{b} ± 0.80
C.P	22.7^{a} ± 0.10	22.5^{ab}±0.20	21.3^{c} ± 0.20	21.5^{c}±0.30	22.2^{b} ± 0.50
E.E.	2.30^{a} ± 0.10	2.00^{b} ±0.40	2.00^{b} ± 0.20	1.50^{c} ±0.10	2.00^{b} ± 0.10

*Means with the same super script letter in a row are not significantly different; while means with different super script letter in a row are significantly different (P< 0.01).
CP = Crud Protein
EE = Ether Extract

CONCLUSIONS

In conclusion genotype affected significantly the performance, carcass characteristics and meat quality of chickens reared under hot climate. Exotic commercial strains seemed to be affected negatively by high ambient temperature even though their performance was higher than that of the native chickens which are more tolerant to harsh management. Phenotypic variations among the native ecotypes indicate that selection procedures can be applied to improve their performance and meat quality.

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