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THE EFFECT OF SEX ON THE ACCURACY OF PREDICTING CARCASS COMPOSITION OF ROSS BROILER CHICKENS

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ABSTRACT

Linear regression equations predicting carcass composition by live body weight were developed using data from 40 males (M) and 40 females (F) of Ross broiler chickens at 33 days of age. Equations from M, F and combined sexes (M+F) were compared to examine the effects of sex on the precision of predicting carcass composition. M birds had higher live body weights and weights of carcasses, drumsticks and wings than F birds. Live body weight was positively correlated with all the carcass components in M and M+F (r=0.98 to 0.26) and all carcass components except abdominal fat in F birds (r=0.99 to 0.46). Prediction equations for carcass weight and carcass composition of breast, drumsticks, thighs, back and wings of F birds were slightly more variable in precision (R^2=98.3 to 21.2%) than those developed in M birds (R^2=96.9 to 63.4%), and equations developed from M + F birds were intermediate. Sex of bird significantly influenced the R^2 when predicting neck and wings weights. It can be concluded that prediction equations developed from live body weight can be useful to estimate carcass composition. Equations identified differences between sexes in predicting weights of wings and neck in the carcass of Ross broiler chickens.

Key words: Broiler, Chicken, Carcass components, Regression equations.

INTRODUCTION

The value of increasing our knowledge of carcass composition has been recognized for years for evaluation and marketing purposes. Estimating differences and predicting changes in carcass composition of birds are required now more than ever since the change in consumer preference from buying a whole chicken to cut-up parts of chicken (Ewart, 1993). Consumer demands for high quality cut-up chicken have driven the poultry industry to change its production priorities and marketing strategies (Roenigk and Pedersen, 1987; Watts and Kennett, 1995). Poultry meat producers are now highly focusing on carcass composition, especially with the payment of premiums for products satisfying the requirements of specific markets. Several factors are known to influence carcass composition. These include sex and strain (Singh and Essary, 1974; Broadbent *et al.*, 1981; Ahn *et al.*, 1995; Havenstein *et al.*, 2003; Musa *et al.*, 2006; Jaturasitha *et al.*, 2008; Horniakova and Abas; 2009).

Broiler carcasses are evaluated mainly through measuring the dressing percentage and quality of edible parts (Holcman *et al.*, 2003). This is achieved by slaughtering and dissection of the bird which is highly labor-intensive and time-consuming. There are few laboratory techniques known to measure carcass composition. Most of these addressed the chemical composition (Renden *et al.*, 1986; Valdes and Summers, 1986; Cozzolino *et al.*, 1996; Windham *et al.*, 2003; Kadim *et al.*, 2005; Faridi *et al.*, 2011), while others focused on prediction of carcass composition (Musa *et al.*, 2006, Ojedapo *et al.*, 2008; Raji *et al.*, 2009; 2010; Lorentz *et al.*, 2011). Several studies reported significant correlations between body weight and abdominal fat (Deeb and Lamont, 2002; Le Bihan-Duval *et al.*, 1998), and between carcass weight and weights of breast muscle, leg muscle, abdominal fat, heart and liver in broiler chickens (Musa *et al.*, 2006, Ojedapo *et al.*, 2008). However, correlations and driven equations of prediction are very specific to strain and age of bird and stage at which carcasses were processed for analysis (Musa *et al.*, 2006, Ojedapo *et al.*, 2008). In addition, most of the studies used single or mixed sex birds and the suitability of these equations for the prediction of body composition of different sexes is not fully clear. The proportions of major carcass parts such as breast, drumsticks and thigh are important parameters in determining broiler carcass quality when it comes to marketing and purchasing decisions for producers and consumers, respectively. A goal of poultry producers is to predict carcass characteristics that are determinants of carcass quality.

Keeping above in view, this study was therefore carried out to estimate the phenotypic correlations and regression coefficients between live body weight and carcass composition of male (M), female (F), and combined sexes (M+F) of Ross broiler chickens. Prediction equations using linear regression were developed separately for M, F, and M+F and compared with the purpose of examining the effect of sex of broilers on the precision of predicting carcass composition from their live body weight.

MATERIALS AND METHODS

A total of 120 day-old (60 M and 60 F) broiler chickens of Ross strain, available in Saudi Arabia, were individually weighed and were randomly assigned to 12 replicates (with 5 birds each per sex to minimize differences in body weight between replicates. They were housed in electrically heated battery cages (50 x 60 x 38 cm; length x width x height). Each cage was fitted with a front feeding trough allowing for 12 cm feeder space/bird. Water was provided by a water pipe suspended from the ceiling of the cage and fitted with 2 nipple drinkers for each cage. The height of the water pipe was adjusted to satisfy requirement of broilers at different stages of growth. Continuous incandescent lighting was provided throughout the experimental period. Birds were fed a starter diet (22% CP and 3000 Kcal/Kg/ME) up to 21 days, followed by a finisher diet (20%CP and 3200 Kcal/Kg/ME) up to 33 days of age. Feed and water were available *ad libtium*. At the end of the experiment, forty birds per sex were randomly selected and processed at King Saud University to determine carcass yield and cutups yield. The birds were weighed individually, and thereafter slaughtered, bled, scalded and plucked. The carcasses were eviscerated and dressed weights were recorded. The carcasses were separated into breast, drumsticks, thighs, wings, neck, back and abdominal fat. The different parts were separately weighed. The relationships between live body weight and carcass traits (weights of carcass, breast, drumsticks, thighs, wings, neck, back and abdominal fat) were investigated using SAS (2002). Pearson's correlation coefficients were determined between live body weight and carcass traits. Prediction equations of carcass traits from live weight were performed using the linear regression model, Y = a + mX, where: Y = predicted carcass trait; X= live body weight; m= slope acquired; a=intercept. Correlations and prediction equations were separately studied for M, F, and for combined sexes (M+F) and compared.

RESULTS

The live body weight and carcass traits of sexed broiler chickens (Ross strain) at 33 days of age are shown in Table 1. M birds had significantly (P<0.01) higher live weights and weights of drumsticks, wings and carcass (P<0.05) than F birds by approximately 8.47, 16.85, 12.47 and 7.34%, respectively.

Correlations coefficients (r) between live body weight and carcass traits of M, F and M + F birds are shown in Table 2. In M birds, significant positive correlations were obtained between live body weight and all the carcass traits and between carcass weight and all the carcass components except neck weight, with r ranging from moderate to high (0.342 to 0.984 and 0.384 to 0.967, respectively). The neck weight was not correlated with any of the other carcass components, and abdominal fat weight was also not correlated with drumsticks or wings weight. The other carcass components were positively correlated with breast, drumsticks, thighs, wings and back weights and their r ranged from moderate to high (0.349 to 0.867, 0.612 to 0.787, 0.368 to 0.867, 0.778 to 0.876 and 0.373 to 0.778, respectively). In F birds, abdominal fat weight was not correlated with live body weight or carcass traits. Live body weight and weights of carcass and breast were positively correlated to other carcass traits and their r ranged from moderate to high (0.460 to 0.991, 0.447 to 0.941 and 0.340 to 0.610, respectively). The weights of drumsticks, back and neck were correlated with other carcass components except thigh weight and their r ranged from 0.359 to 0.665, 0.359 to 0.428 and 0.321 to 0.603, respectively. Wings weight was correlated with other carcass components except thigh and neck weights. In M +F birds, live body weight and carcass weights were positively correlated with all the carcass traits and their r ranged from moderate to high (0.280 to 0.986 and 0.291 to 0.955, respectively). The neck weight was not correlated with wings weight, and abdominal fat weight was not correlated with breast, drumsticks or thighs weight. Whereas, other carcass components were positively correlated with breast, drumsticks, thighs, wings, back and neck weights and their r ranged from moderate to high (0.406 to 0.683, 0.374 to 0.751, 0.294 to 0.652, 0.317 to 0.751 and 0.333 to 0.623, 0.294 to 0.406, respectively).

Regression equations for predicting carcass traits by live body weight are shown in Table 3. The coefficients of determination (R^2) for predicting carcass weight and carcass composition of breast, drumsticks, thighs, and back were significant (p<0.001) for M and F birds (varied from R^2=96.89 to 63.45 and 98.32 to 27.73%, respectively), R^2 predicting the weights of wings and abdominal fat were significant (p<0.001 and p<0.05; R^2=84.4 and 11.67%, respectively) in M birds, and those predicting weights of wings and neck were found significant (p<0.01 and p<0.001; R^2=21.18 and 51.24%, respectively) in F birds. R^2 for predicting neck weight in M birds and abdominal fat weight in F birds were not significant. Comparing the regression coefficients among M, F and M + F indicated that the regression coefficients between live body weight and carcass weight or carcass components of breast, drumsticks, thighs, back and abdominal fat in M and F birds did not significantly differ (F=2.68, p=0.1036; F=0.00, p=0.9919; F=0.48, p=0.4915; F=0.89, p=0.3457; F=1.19, p=0.2762 and F=1.16, p=0.2835 for M and F, respectively). The similar results were obtained by comparing the regression coefficients of M or F birds with M + F groups. However, there were significant differences in regression coefficients across the three groups (M, F, M + F) between live body weight and carcass neck weight (F=17.52, p=0.0001 (M *vs.* F), F=4.99, p=0.0269 (M *vs.* M + F) and F=7.13, p=0.0084 (F *vs.* M + F, respectively)), and between live body weight and carcass wings weight in F compared with M and M + F (F=12.86, p=0.0004 and F=7.67, p=0.0063, respectively).

Table 1. Live weight and carcass composition of male (M) and female (F) Ross broiler chickens at 33 days of age

	M			F			
	Min.	**Maxi.**	**Mean + SE**	**Min.**	**Maxi.**	**Mean + SE**	**Prop>F**
Live weight (LW, g)	1165.0	2200.0	1643.9+ 35.98	1210.0	1990.0	1515.4 + 30.96	**
Carcass weight (CW, g)	806.9	1639.0	1190.7 + 29.23	880.2	1463.0	1109.3+ 23.43	*
Breast weight (BRW, g)	295.0	670.0	487.0 + 14.74	331.0	624.4	456.8 + 12.32	NS
Drumsticks weight (DRW,g)	116.1	220.0	162.8 + 3.55	57.9	175.4	139.4+ 4.63	**
Thighs weight (TW, g)	138.1	270.3	191.7 + 5.41	126.6	279.6	186.8 + 6.48	NS
Wings weight (WW, g)	90.1	165.9	123.9 + 2.76	85.0	136.7	110.2+ 2.05	**
Back weight (BKW, g)	97.0	281.9	151.6+ 5.32	95.2	221.1	144.8+ 4.43	NS
Neck weight (NKW, g)	36.8	74.0	51.9 + 1.33	22.7	90.4	47.9 + 2.38	NS
Abdominal fat weight (ABFW, g)	3.5	35.6	15.1+ 1.08	6.5	28.2	13.4+ 0.84	NS

* = P.0.05; ** = p<0.01;NS = Not significant (P>0.05).

Table 2. Pearson correlation coefficients among all characteristics of M, F and M +F birds

	LW	CW	BRW	DRW	TW	WW	BKW	NKW	ABFW	
M										
LW	**1.00**	0.984*** 0.946***	0.835***	0.917***	0.919***	0.796***	0.261*	0.342*		
CW		**1.00**	0.967*** 0.833*** 0.919***	0.921***	0.825***	0.219	0.384*			
BRW			**1.00**	0.786*** 0.867***	0.841***	0.726***	0.100	0.349*		
DRW				**1.00** 0.706***	0.787***	0.612***	0.085	0.075		
TW					**1.00**	0.876***	0.688***	0.231	0.368*	
WW						**1.00**	0.778***	0.270	0.290	
BKW							**1.00**	0.288	0.373*	
NKW								**1.00**	0.082	
ABFW									**1.00**	
F										
LW	**1.00**	0.991*** 0.909***	0.643*** 0.527***	0.460**	0.647***	0.716***	0.125			
CW		**1.00**	0.941***	0.640***	0.531*** 0.447**	0.625***	0.687***	0.082		
BRW			**1.00**	0.610*** 0.466**	0.340*	0.406**	0.603***	-0.031		
DRW				**1.00**-0.192	0.665***	0.359*	0.455**	0.280		
TW					**1.00**	-0.191	0.203	0.321*	-0.280	
WW						**1.00**	0.415**	0.090	0.290	
BKW							**1.00**	0.428**	0.246	
NKW									**1.00**	0.136
ABFW									**1.00**	
M + F										
LW	**1.00**	0.986***	0.746***	0.695***		0.763***	0.730***	0.524***	0.280*	
CW		0.927***	0.955***	0.729***		0.708***	0.756***	0.745***	0.479***	0.291**
BRW		**1.00**	**1.00**	0.683***		0.647***	0.406***	0.213		
DRW				0.652***		0.595***	0.751***	0.469***	0.374***	0.210
TW				**1.00**		0.170	0.442***	0.294**	0.063*	
WW						0.356**	**1.00**	0.623***	0.205	0.317**
BKW						**1.00**		**1.00**	0.358**	0.333**
NKW									**1.00**	0.124
ABFW			**1.00**							

* = P.0.05; ** = p<0.01; *** = P<0.0001.

Table 3. Prediction equations of carcass composition of broiler chickens

				Coefficients		
Variables	**Sex**	**Equations**	**SE**	**R^2**	**Adj. R^2**	**Prop>F**
CW	M	-123.91825 + 0.79974LW	0.0230	0.9689	0.9681	***
	F	-27.89370 + 0.75040LW	0.0159	0.9832	0.9827	***
	M + F	-60.54008 + 0.76635LW	0.01464	0.9723	0.9720 ***	
BRW	M	-106.92738 + 0.36133LW	0.02011	0.8947	0.8919 ***	
	F	-91.28841 + 0.36167LW	0.02697	0.8256	0.8210 ***	
	M + F	-82.00478 + 0.35066LW 0.01604	0.8597	0.8579	***	
DRW	M	27.51743 + 0.08232LW	0.00881	0.6965	0.6885	***
	F	-6.49693 + 0.09625LW	0.01858	0.4140	0.3986	***
	M + F	-1.11364 + 0.09636LW	0.00974	0.5567	0.5510	***
TW	M	-34.83506 + 0.13779LW	0.00975 0.8401 0.8359	***		
	F	19.71039 + 0.11028LW	0.02888	0.2773	0.2583 ***	
	M + F	2.06896 + 0.11849LW	0.01387	0.4834	0.4768	***
WW	M	8.23655 + 0.07037LW	0.00491	0.8440	0.8399	***
	F	63.88364 + 0.03055LW	0.00956 0.2118	0.1911	**	
	M + F	25.38493 + 0.05803LW	0.00556	0.5828	0.5775	***
BKW	M	-41.89666 + 0.11770LW	0.01449 0.6345	0.6248 ***		
	F	4.33023 + 0.09269LW	0.01772 0.4186	0.4033 ***		
	M + F	-13.59272 + 0.10242LW	0.01086	0.5327	0.5267	***
NKW	M	36.02273 + 0.00968LW	0.00579 0.0684	0.0439	NS	
	F	-35.49793 + 0.05503LW	0.00871	0.5124	0.4996	***
	M + F	3.81760 + 0.02918LW	0.00537	0.2745	0.2652	***
ABFW	M	-1.82925 + 0.01028LW	0.00459 0.1167	0.0934 *		
	F	8.31851 + 0.00338LW	0.00435 0.0157 - 0.0102	NS		
	M + F	1.93651 + 0.00780LW	0.00302	0.0787	0.0669	*

* = P.0.05; ** = p<0.01; *** = p<0.01; NS = Not significant (P>0.05).

DISCUSSION

The findings of this study indicating higher live body and carcass weights in M broiler chickens are in full agreement with those of Merkley *et al.* (1980), Melo *et al.* (1996), Lazzari and Paganini (1999), Bogosavljevic-Boskovic *et al* .(2006), Shafey *et al.* (2001, 2007). The results showing higher drumsticks weight in M carcass and non-significant differences in weights of breast, thighs and abdominal fat between M and F carcasses were in quite agreement with the findings of Bogosavljevic-Boskovic *et al.* (2006) and Rondelli *et al.* (2003). On the contrary, Nikolova *et al.* (2007) reported that F carcasses of Hubbard and Cobb strains had bigger proportion of abdominal fat than that of M. Merkley *et al.* (1980) observed significant difference in the yield of all carcass parts between sexes (F had greater breast and back and smaller legs than M) in Ross and Hubbard strains. Differences in carcasses composition between the sexes could be attributed to metabolic differences between them (Shafey *et al.*, 2001). Whereas, differences between the results of this study and others might be due to differences in genetic makeup and age of birds used in the experiments.

The correlation and regression analyses made during this study indicated that live body weight can be a good indication for predicting carcass weight and carcass components in broilers (Tables 2 and 3). Significant positive correlations between live body weight and carcass traits (breast, drumsticks, thighs, wings, back, neck, abdominal fat) in M and between body weight and all carcass traits except abdominal fat in F birds were recorded in this study. In addition, results from R^2 indicated that live body weight of broilers of both sexes has significant (P<0.01) positive association with carcass weight and carcass component including breast, drumsticks, thighs, wings, and back (varied from R^2=96.89 to 63.45 and 98.32 to 21.18%, in M and F, respectively). The similar correlation between live body weight and carcass composition has also been reported in different strains of chickens (Rance *et al.*, 2002; Musa *et al.*, 2006; Yang *et al.*, 2006; Ojedapo *et al.*, 2008; Yakubu, 2009). Musa *et al.* (2006) reported significant positive correlations between live body weight and carcass weight (0.968) and breast weight (0.840) in Anka strain and between live weight and carcass weight (0.759) in Ruago strain. Ojedapo *et al.* (2008) reported significant positive correlations between live weight and carcass weight (0.95) and breast muscle weight (0.97) in Anka strain but found significant negative correlation (-0.78) between live weight and carcass weight in Wadi Ross strain. Also, Peter *et al.* (2007) reported significant positive regression coefficients for live weight and body measurements in chickens. Differences in r of live body weight and carcass components of different strains of birds are more likely related to differences in genetic makeup and age of birds.

The findings of this study indicated that carcass weight and breast weight could be predicted with very high accuracy in both sexes of broilers. However, some carcass components such as drumsticks (R^2=0.6965 *vs.*0.414, and adjusted R^2=0.6885 *vs.*0.3986), thighs (R^2=0.8401 *vs.* 0.2773 and adjusted R^2=0.8359 *vs.* 0.2583), wings (R^2=0.844 *vs.* 0.2118, and adjusted R^2=0.8399 *vs.* 0.1911) and back (R^2=0.6345 *vs.* 0.4186, and adjusted R^2=0.6248 *vs.* 0.4033) were predicted with higher accuracy in M compared with F. The results of the present study indicating small difference between the actual and predicted values of carcass components are in agreement with those of Kleczek *et al.* (2006). Generally, all models for predicting weight of major carcass traits (carcass weight, and weights of breast, drumstick, thighs, wings and back) were significant and had high r between live body weight and carcass components and consequently, high R^2 and adjusted R^2 values. Khosravinia *et al.* (2006) made similar observations in their study with broilers finished at six week of age. The non-significant differences in regression coefficients among the three groups (M, F, M + F) for predicting carcass weight and carcass composition of breast, drumsticks, thighs, back and abdominal fat suggested that sex of birds did not influence the prediction equations of these carcass traits. However, the significant differences in regression coefficients of predicting neck and wings weights suggested that sex of birds influenced the prediction equations for these traits. The results further indicated that live body weight of broilers did not strongly predict wing weight in F (0.030) as for M (0.070) and M + F (0.058), and neck weight as strongly in M + F (0.029) as in F birds (0.055). The relationships between live body weight and carcass weights of wings and neck differed statistically between sexes, however, these differences are of little commercial significance.

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