INFLUENCE OF SLAUGHTER AGE ON CARCASS COMPOSITION AND BEEF YIELD OF WHITE FULANI CATTLE

SAM, Idorenyin Meme and USORO, Ofoninyene Okon
Department of Animal Science, Faculty of Agriculture, Akwa Ibom State University, Obio Akpa Campus, Oruk Anam Local Government Area, Akwa Ibom State, Nigeria.

Corresponding Author: Sam, I. M. Department of Animal Science, Faculty of Agriculture, Akwa Ibom State University, Obio Akpa Campus, Oruk Anam Local Government Area, Akwa Ibom State, Nigeria. **Email:** sidorenyin@yahoo.com **Phone:** +234 8029004857

Received *March 03, 2022;* ***Revised*** *May 08, 2022;* ***Accepted*** *June 04, 2022*

ABSTRACT

This study was conducted to investigate the influence of age and body weight on carcass composition of white Fulani cattle raised n Akwa Ibom State University, Obio Akpa, Nigeria. Nine male white Fulani cattle were used for the study, which were categorized into three age groups (3 – 3.5, 4 – 5 and 5.5 – 6.5 years) respectively. Data on the animal carcass composition and external offal (slaughter weight, carcass weight (CW) and dressing percentage) were obtained, predicting model for carcass composition were also generated. Data collected were subjected to analysis of variance. The results indicated that means for dressing percentages for the three age groups were 52.93 ± 1.18, 51.84 ± 0.53 and 53.92 ± 0.76 respectively. The results also indicated that age had significant influence (p<0.05) on live weight (LW), carcass composition and some external offal. The correlation between LW and carcass compositions were high with correlation coefficient ranging from 0.64 – 0.97, 0.90 – 1.00 and 0.71 – 0.99 for age groups 3 – 3.5 years, 4 – 5 years and 5.5 – 6.5 years respectively. However, the correlation between age, carcass composition and external offal were also positively high with correlation coefficient ranging from 0.50 – 1.00, 0.84 – 1.00 and 0.78 – 0.96 respectively across the different age group. Thus, this study revealed a strong and positive (p<0.001) relationship between animal age, LW, carcass composition and some external offal. The present study could be used as reliable indices for carcass composition and some external offal prediction or estimation as age strongly influenced animal LW and carcass trait.

Keywords: White Fulani, Slaughter age, Body weight, Live weight, Carcass weight, Carcass composition

INTRODUCTION

The knowledge of carcass composition of an animal is very important to consumers and processors. This is because it aids in solving the conflict that normally exist between processors, farmers and consumers in relation to beef yield of cattle as the dressing percentage does not always reflects the beef yield of an animal (Madziga *et al*., 2016). Carcass composition of various cattle species differs considerably in terms of carcass weight (CW), percentage of fat, muscle and bone (Irshad *et al*., 2013). The current need for animal protein in Nigeria, like any other developing countries of the world posed a serious challenge to the Nigeria livestock farmers and therefore calls for contributions from different species of livestock (Madziga *et al*., 2016). Beef carcass compositions is of high economic important to the beef industry and cattle command a prominent position in meat supply and livestock industry (Tarouco *et al.,* 2012). Beef is estimated to supply about 45 percent of total

meat consumed in Nigeria, followed by sheep and goat meat (Kubkomawa, 2017). It is a source of high-quality protein which makes it of high demand (Madziga *et al*., 2016). Considerable interest has arisen among meat research personnel over the years on the size of bone as an indicator of muscle development also with live weight (LW) as an indicator of carcass composition. In cattle, the relative carcass composition is best assessed by the use of two measures; muscle: bone ratio and percentage fat tissue in the carcass (Ellies-Oury *et al.*, 2020). Increase in animal age tend to be accompanied by non-fat, less muscle, less moisture and less portion in carcass (Madziga *et al*., 2016). The fat accumulation in carcass of bull is lower than steers (do Prado *et al*., 2008); hence the use of bull promotes a higher slaughter age. The yield and quality of beef carcass are two important determinants of profitability of beef cattle farming (Sultana *et al.,* 2017). As such the ratio of bone should not be underestimated as it is one of the factor influencing expected carcass yields. Beef carcass varies in composition due to genetic, age and sex of animal, nutritional and environment effect (Irshad *et al*., 2013). It has been reported that bone accounts for roughly 16 – 20 % of the CW and 75 % of hot CW (Mckiernan *et al*., 2007). According to Afolayan *et al*. (2002), the ability of the producers and buyers of livestock to relate objectively live carcass characteristics to actual carcass composition is essential for optimum production and value base trading system. Fatness level and carcass composition of various species might differ because of CW and slaughter age, as animal become older, the proportion of fat in their carcass increases and the proportion of muscles and bones decreases (Irshad *et al*., 2013). Nogalski *et al*. (2018) demonstrated that increasing slaughter age contributed to higher carcass fat content, particularly in heifers and steers, and to a lesser extent in bulls

Understanding how much meat to expect from a beef carcass is the problem currently existing between farmers, meat processors and consumers of beef carcass in Nigeria, Akwa Ibom State precisely, as the price of animal is based on LW or visual body conformation assessment other than on beef yield which is of interest to meat industries and consumers. Consumers who purchased live cattle often have problem with the processor as they at times feels that their meat was not enough when the dressing percentage of the animal does not relate with their take home meat. This question often comes "where are my beef", this the meat processor finds it difficult to answer. Therefore, the objective of this study was to investigate the effect of slaughter age on carcass composition and beef yield of white Fulani cattle, thus facilitate the operation of a payment based on meat yield which would reward consumers and beef industries equitably.

MATERIALS AND METHODS

Experimental Site: This researched was carried out at the Akwa Ibom State University Commercial Farm Abattoir, Obio Akpa Campus, Oruk Anam Local Government Area, Akwa Ibom State. The experiment lasted for three month (May to July 2021). Obio Akpa campus is situated between latitudes $4^0$30N and $5^0$30N and longitude $7^0$30N and $8^0$00E of the Greenwich meridian with an annual rainfall ranging from 3500 – 5000 mm and average monthly temperature of 25 ± 4^0C, and relative humidity between 60 – 90 % (Wikipedia, 2017).

Experimental Animal: The animals used in the study were nine White Fulani beef cattle (bull) of different ages at slaughter. The animals were obtained from the Akwa Ibom State University Commercial Cattle Farm.

Management of the Animal: The animals were grass finished prior to slaughter and managed under semi-intensive system of animal husbandry at Akwa Ibom State University Commercial Farm. The cattle grazed on natural mixed pastured that were available in and around the university environment.

Slaughter Procedure: Prior to slaughter the abattoir was normally swept and washed with clean water in order to get rid of dirt and sand. The animals were usually walked down to the abattoir area during early morning grazing in

which the animal to be slaughter were carefully restrain using halter restrain and fell down, while others were always return to the pen. The animals were usually rinsed with clean water in order to get rid of sand and other contaminant, after which, they were carefully slaughtered by the Commercial Farm butcher, by severing both jugular veins and carotid arteries with a sharp knife without stunning. After complete bleeding the head were removed at the atlanto-occipital joint and weighed. Blood was usually collected and weighed after the animal stopped bleeding, the hide was cut along the limbs and down the abdomen then removed manually and weighed. The fore and hind feet were removed with knife at the proximal end of the metacarpal and metatarsal joints, respectively and each of them was weighed with its hide cover. The tail was separated at the first inter-coccygeal articulation and weighed. After dressing and evisceration, the internal organs and offal were individually weighed. The carcass was usually dissected into different parts (left and right thigh, rib cage, pelvic, waist, cervix etc.) of which were later trimmed or debone to separate the beef from the bones. The weight of the different body parts was carefully weighed alongside with the weight of the blood, alimentary tract (gut filled), internal and external offal were usually added to obtain the LW of the animal as there was none availability of scale to take the weight of the animal before slaughter. The CW was usually obtained by subtracting the weight of alimentary tract, internal and external offal weight by the LW.

Age Determination Method: The age of the animal was estimated through dental identification method by carefully counting the number of permanent incisor teeth as described by Torell *et al.* (2003).

Data Collection: The different parts of the beef carcass were weighed using weighing scale. The beef, bone, visceral organs (gut filled and empty) were carefully weighed. The animals were weighed in parts, the head, the neck, the hind limb and forelimb, pelvic, lower and upper ribcage, hump back. The different parts of the carcass were carefully deboned and weighed followed by the visceral organs.

Statistical Analysis: Data collected during the experiment were subjected to one way analysis of variance (ANOVA) using SPSS version 23.0 (SPSS, 2005). Significant means were separated using Duncan multiple Range Test of the same package. The degree of correlations between carcass composition and body parts of cattle were generated using correlation statistics. The linear regression model adopted was; $Y_{ij} = a + bx + E_{ij}$ to establish linear relationship among the body parts, where Y_{ij} - the dependent variable body weight, age, beef, bone and carcass, a - the intercept of the regression line on the Y- axis and it is the estimate of Y (dependent variable) when X is zero, b - the regression coefficient associated with the independent variable, x - Independent variables and E_{ij} - represent the random error around the regression line. The differences between the actual and estimated values were separated using the student's t-test.

RESULTS AND DISCUSSION

The effect of slaughter age on carcass parts of White Fulani cattle shown in Table 1 indicted that all the carcass parts studied (head, tail, beef, bone, neck and humpback) were significantly affected ($p<0.05$) by slaughter age except for the weight of neck. Animals slaughter at the age between 5.5 – 6.5 years had higher significantly ($p<0.05$) values of head (22.50 ± 1.32 kg), tail (5.83 ± 0.76 kg), beef (122.00 ± 2.65 kg), bone (72.00 ± 4.50 kg) and humpback (5.33 ± 1.04 kg) than those slaughtered at 3 – 3.5 and 4 – 4.5 years. The weight of the neck was similar in all age groups. Tefera *et al*. (2019) had similar results when they compared carcass and meat characteristics of three breeds of cattle of different age class. The finding of this study was in agreement with reports of Polidori *et al*. (2015) who concluded that CW increase in animals slaughtered at an older age. Thus, the differences in the CW of different age class are expected because each class differs from the other with at least one and a half years.

Table 1: Effect of age on carcass parts of White Fulani cattle studied

Carcass parts	Age (years)		
	3 – 3.5	4 – 5	5.5 – 6.5
Head (kg)	13.67 ± 0.57[a]	17.17 ± 4.19[a]	22.50 ± 1.32[b]
Tail (kg)	3.53 ± 0.92[a]	4.33 ± 1.04[ab]	5.83 ± 0.76[b]
Beef (kg)	70.00 ± 2.00[a]	80.00 ±33.05[a]	122.00 ± 2.65[b]
Bone (kg)	47.63 ± 3.60[a]	57.73 ± 2.65[a]	72.00 ± 4.50[b]
Neck (kg)	9.17 ± 0.29	11.00 ± 1.00	10.50 ± 1.80
Humpback (kg)	1.73 ± 0.68[a]	2.37 ± 1.53[a]	5.33 ± 1.04[b]

This result was also in line with reports of Franco *et al*. (2013) and Lorenzo *et al*. (2014) in foals receiving a finishing diet and slaughtered between 15 and 18 months of age. Although, Lorenzo *et al.* (2014) reported lower values of CW in foals raised in extensive production system and slaughtered at 18 months of age.

The effect of slaughter age on LW, CW, dressing percentage and carcass part weights are shown in Table 2. The results indicated that LW, CW and carcass parts weight were significantly affected by slaughter age. Animals slaughtered at 5.5 – 6.5 years of age had significantly higher ($p<0.05$) values of LW (389.20 ± 14.45 kg) and CW (209.80 ± 5.11 kg) than those slaughtered at 3 – 3.5 years of age (248.97 ± 23.35 and 128.50 ± 5.71 for LW and CW respectively) and 4 – 5 years of age (284.73 ± 73.81 and 151.10 ± 43.12 kg for LW and CW respectively). Polidori *et al*. (2015) had earlier reported that LW and CW increase as the animal slaughter age increases. Thus, the differences observed in LW and CW may be due to the fact that animals from each age class differ from each other with at least one year. This result of this study was in line with the reports of Franco *et al.* (2013) and Lorenzo *et al*. (2014) in foals receiving a finishing diet and slaughtered between 15 and 18 months of age.

The results indicated that dressing percentage was not affected by slaughter age (52.93 ± 1.18, 52.84 ± 0.53 and 53.92 ± 0.95 %) from animals slaughtered at 3 – 3.5, 4 – 5 and 5.5 – 6.5 years respectively). This was an indication that animals under different ages yielded similar proportion of their LW as CW. It also showed that age had no effect on dressing percentage of the animals studied.

This result was at variance with the reports of Bures and Barton (2012) who reported that increasing LW was associated with increased carcass fatness, reduced meat and bone proportion in high priced joint of bull heifer. The results of the present study may be due to diets of the studied animal. There was no significant difference observed in fat content of the cattle across the different age class ($p<0.05$) rather 5.5 – 6.5 age group was observed to possess the lowest percentage of fat. The result of this study differs from the reports of Ishad *et al*. (2013) who stated that as animals became older, the proportion of the fat in their carcass increases and the proportion of muscles and bones decreases. However, the results obtained from this study could be due to the animal's diet. The White Fulani cattle used in this study were fed solely on tropical pasture till slaughter. The result of this study is also not in agreement with Mckiernan *et al.* (2007), who reported that bone accounted for roughly 16 – 20 % of CW in cattle, in the present study bone accounted for 37.01 ± 1.19, 37.21 ± 5.31 and 34.29 ± 1.40 % in the 3.0 – 3.5, 4.0 – 5.0 and 5.5 – 6.5 age class respectively.

Models for the prediction of carcass composition and some external offal of white Fulani cattle grazed on tropical pasture from live body weight indicated that the regression equation gave the estimate of carcass characteristics and carcass parts across the age groups (Table 3). LW had high positive ($p<0.001$) correlation with all the carcass parameters measured in all the three age groups. This result was in agreement with the reports of Seo *et al.* (2021) who reported mean carcass weight of Hanwoo steers to be significantly correlated with live weight. This indicates that selection or improvement in LW will lead to corresponding improvement in carcass traits.

The coefficient of determination (R^2) values in all the age groups for all the parameters measured were very high (0.64 – 1.00) indicating that LW explains the variability in those parameters very well.

Table 2: Effect of age on live weight, carcass weight and dressing percentage of White Fulani cattle studied

Carcass weight and dressing percentage	Age (years)		
	3 – 3.5	4 – 5	5.5 – 6.5
Live weight (kg)	248.97 ± 23.35[a]	284.73 ±78.81[a]	389.20 ± 14.45[b]
Carcass weight (kg)	128.50 ± 5.71[a]	151.10±43.12[a]	209.80 ± 5.11[b]
Dressing percentage	52.93 ± 1.18	52.84 ±0.53	53.92 ± 0.95
Beef (kg)	70.00 ± 2.00[a]	80.00 ± 33.05[a]	122.0 ± 2.65[b]
Beef dressing percentage (%)	54.48 ± 0.90	51.78 ± 6.19	58.15 ± 1.28
Bone (kg)	47.63 ± 3.60[a]	57.73 ± 7.77[a]	72.00 ± 4.50[b]
Bone dressing percentage (%)	37.01 ± 1.19	37.21 ± 5.31	34.29 ± 1.40
Fat (kg)	10.90 ± 0.53[a]	13.37 ± 2.37[ab]	15.83 ± 0.76[b]
Fat dressing percentage (%)	8.49 ± 0.46[a]	9.0± 0.89[ab]	7.55[a] ± 0.51[b]

Table 3: Carcass composition and some external offal prediction using live weight

Age (years)	Parameters	Regression equation	r	R^2
3 – 3.5	Head	HD = 24.261 – 0.044LW	0.99***	0.97
	Tail	T = 14.581 – 0.045LW	0.64**	0.41
	Beef	BF = 35.00 + 0.144LW	0.91***	0.88
	Bone	BN = -16.102 + 0.262LW	0.95***	0.90
	Skin	SK = 25.261 – 0.044LW	0.99***	0.97
	Neck	NK = 3.869 + 0.022LW	0.99***	0.97
	Carcass weight	CW = 31.37 + 0.400LW	0.91***	0.83
4 – 5	Head	HD = 2.005 + 0.053LW	0.99***	0.98
	Tail	TA = 0.597 + 0.013LW	0.99***	0.97
	Beef	BF = -40.42 + 0.422LW	1.00***	0.99
	Bone	BN = 29.554 + 0.099LW	0.99***	0.99
	Skin	SK = -20.425 + 0.134LW	0.99***	0.99
	Neck	NK = 7.727 + 0.011LW	0.90***	0.81
	Carcass weight	CW = -6.113 + 0551LW	1.00***	1.00
5.5 – 6.5	Head	HD = -12.913 + 0.091LW	0.99***	0.99
	Tail	TA = -14.601 + 0.052LW	0.99***	0.99
	Beef	BF = 63.38 + 0.151LW	0.83***	0.68
	Bone	BN = -13.712 + 0.220LW	0.71**	0.50
	Skin	SK = -7.466 + 0.095LW	0.90***	0.81
	Neck	NK = 54.76 – 0.109LW	0.87***	0.76
	Carcass weight	CW = 83.901 + 0.323LW	0.92***	0.85

P<0.01;P< 0.001 Significant level. HD= Head, TA= Tail, BF= Beef, BN= Bone, SK= Skin, CW= Carcass weight, LW= Live weight, Wt= Weight, r = correlation coefficient, R^2=coefficient of determination*

In the age class 3 – 3.5, the highest R^2 (0.99) was obtained with LW predicting Head. Similar trend was observed in the other two age classes. This result was in agreement with the reports of Abdelhadi and Babiker (2009), who were led to similar results in Zebu cattle.

The result indicated that in all the age classes 64 - 100 % of the variance in the carcass parts was explained by the model. Thus, suggesting that carcass parts could be estimated accurately by the use of LW. Hence, the equations generated (Table 3) may be used to predict the carcass characteristics of white Fulani cattle at different ages.

This finding was similar to reports of Abdelhadi *et al.* (2011) who high prediction ability of carcass part weights from LW in Zebu cattle. Rahman *et al.* (2012) explained that when live weight is known, an estimation of the dressed carcass weight could be made according to the condition of the live animal. Abdelhadi *et al.* (2011) also indicated the importance of live weight as an indicator of commercial value based on assumption that carcasses with better live weight had advantages in terms of lean meat content, proportion of higher price cuts and possibly greater muscle size or area.

Table 4: Carcass composition and some external offal prediction using age

Age	Parameters	Regression equation	r	R^2
3 – 3.5	Head	HD = 20.00 – 2.00AGE	1.00***	1.00
	Tail	TA = 8.60 – 1.600AGE	0.50*	0.25
	Beef	BF = 51.00 + 6.00AGE	0.87***	0.75
	Bone	BN = 12.80 + 11.00AGE	0.88***	0.78
	Skin	SK = 21.00 – 2.00AGE	1.00***	1.00
	Neck	NK = 6.00 + 1.00AGE	1.00***	1.00
	Carcass weight	CW = 76.60 + 16.40AGE	0.83***	0.69
4 – 5	Head	HD = 14.33 + 7.00AGE	0.84***	0.70
	Tail	TA = -4.67 + 2.00AGE	0.96***	0.92
	Beef	BF = -190.00 + 60.00AGE	0.91***	0.82
	Bone	BN = -1.67 + 13.20AGE	0.85***	0.72
	Skin	SK = -63.17 + 18.00AGE	0.85***	0.73
	Neck	NK = 2.00 + 2.00AGE	1.00***	1.00
	Carcass weight	CW = -196.75 + 77.30AGE	0.90***	0.80
5.5 – 6.5	Head	HD = 7.50 + 2.50AGE	0.95***	0.89
	Tail	TA = -3.17 + 1.50AGE	0.98***	096
	Beef	BF = 92.00 + 5.00AGE	0.95***	0.89
	Bone	BN = 45.00 + 4.50AGE	0.50*	0.25
	Skin	SK = 11.33 + 3.00AGE	0.98***	0.96
	Neck	NK = 31.50 – 3.50AGE	0.97***	0.94
	Carcass weight	CW = 161.83 + 8.00AGE	0.78**	0.63

p<0.05;P<0.01;***P<0.001 Significant level, HD = Head, TA = Tail, BF = Beef, BN = Bone, SK = Skin, CW = Carcass weight, Wt = Weight*

The summary of carcass composition and some external offal prediction using age are shown in Table 4. The result indicates very strong and positive ($p<0.001$) significant relationship between the age classes studied. All parameters in age class 3 – 3.5 years were found to be strongly correlated with age ($p<0.001$) with a range between 0.83 – 1.00 exception of tail which correlation coefficient was 0.50. In age class 4 – 5 years all parameters were strongly correlated with age $p<0.01$ (with a range of 0.84 – 1.00), while in age bracket 5.5 – 6.5 years, head, tail, beef, skin and neck (r = 0.95, 0.98, 0.95, 0.98 and 0.97) respectively were observed to have strong correlation with age. The correlation coefficient showing the relationship between age and CW was r = 0.78 while for bone was r = 0.50. Contrary observation was made by Pečiulaitienė *et al.* (2015) who reported that in all the different groups of ages of cattle studied, age had weak correlation with carcass parameters. The authors also observed that as age of cattle increased, there were also moderate increase in carcass yield and other external offals. The coefficient of determination R^2 in the three age classes were significantly $p<0.001$ high (with a range of 0.25 – 1.0) in 3.0 – 3.5 age class, 0.70 – 1.0 in 4.0 – 5.0 age class. The standard error of estimate in the three age classes were relatively low with a range of 0.00 – 27.07. The results from the above indicate that age can also be used to predict carcass characteristics of White Fulani cattle. Thus, age can be used as a reliable selection index for improvement of carcass characteristics in White Fulani cattle.

This report was similar to the observation of Obott (2019) who reported very high coefficient of determination (R^2) when age of cattle was used to predict carcass characteristics.

The comparison of actual carcass characteristics base on LW and age as predictor are demonstrated in Tables 5 and 6 respectively. There were no significance ($p>0.05$) differences between the actual weights of carcass parts and those predicted by both age and live weight. These results suggest that carcass characteristics and parts can be predicted from live body weight and age of the animal with accuracy.

Table 5: Comparison of actual values of carcass characteristics and predicted values from live body weight

Age	Actual value	Estimated value
3 – 3.5		
Head	13.65 ± 0.57	13.31 ± 0.11
Tail	3.53 ± 0.92	3.378 ± 0.14
Beef	70.00 ± 2.00	70.85 ± 1.85
Bone	47.63 ± 3.60	49.13 ± 0.31
Neck	9.17 ± 0.29	9.34 ± 0.30
carcass weight	128.50 ± 0.68	130.96 ± 0.44
4 – 5		
Head	17.17 ± 4.19	17.10 ± 0.44
Tail	4.33 ± 1.04	4.29 ± 0.20
Beef	80.00 ± 33.05	79.74 ± 0.33
Bone	57.73 ± 2.65	57.74 ± 1.01
Neck	11.00 ± 1.00	10.85 ± 0.28
Carcass weight	151.10 ± 1.53	159.77 ± 0.21
5.5 – 6.5		
Head	22.50 ±1.32	22.50 ± 0.00
Tail	5.83 ± 0.76	5.64 ± 0.05
Beef	122.00 ± 2.65	122.15 ± 0.57
Bone	72.00 ± 4.50	71.91 ± 0.28
Neck	10.50 ± 1.80	12.33 ± 0.44
Carcass weight	209.80 ± 1.04	209.61 ± 0.33

No significant difference (p>0.05) occurred between the actual and estimated values using student's t-test

Table 6: Comparison of actual values of carcass characteristics and predicted values from age

Age	Actual value	Estimated value
3 – 3.5		
Head	13.65 ± 0.57	13.31 ± 0.11
Tail	3.53 ± 0.92	3.378 ± 0.14
Beef	70.00 ± 2.00	70.85 ± 1.85
Bone	47.63 ± 3.60	49.13 ± 0.31
Neck	9.17 ± 0.29	9.34 ± 0.30
Carcass weight	128.50 ± 0.68	130.96 ± 0.44
4 – 5		
Head	17.17 ± 4.19	17.10 ± 0.44
Tail	4.33 ± 1.04	4.29 ± 0.20
Beef	80.00 ± 33.05	79.74 ± 0.33
Bone	57.73 ± 2.65	57.74 ± 1.01
Neck	11.00 ± 1.00	10.85 ± 0.28
Carcass weight	151.10 ± 1.53	159.77 ± 0.21
5.5 – 6.5		
Head	22.50 ±1.32	22.50 ± 0.00
Tail	5.83 ± 0.76	5.64 ± 0.05
Beef	122.00 ± 2.65	122.15 ± 0.57
Bone	72.00 ± 4.50	71.91 ± 0.28
Neck	10.50 ± 1.80	12.33 ± 0.44
Carcass weight	209.80 ± 1.04	209.61 ± 0.33

No significant difference (p>0.05) occurred between the actual and estimated values using student's t-test

The result of this study was in agreement with Afolayan *et al.* (2002) who indicated that there were no significant differences between actual carcass characteristics and the predicted weights.

Conclusion: The study indicated that there was no significant difference in the dressing percentage of the studied White Fulani bulls, across the three age classes. Increase in beef yield was accompanied with advancement in age. Carcass characteristics as well as the

weights of carcass part were predicted accurately using the live weight and age as predictors. Thus, suggesting that LW and age are reliable indices for improvement of carcass characteristics in White Fulani bull.

ACKNOWLEDGEMENTS

The authors wish to thank the Head of Department Animal Science, Akwa Ibom State University for releasing the facilities used for the study. The contributions of staff of Cattle Research and abattoir Unit are acknowledged.

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