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Meat Yield Prediction of Cattle (*Yakanaji*) Slaughtered at the Abattoir Unit of University of Benin Teaching and Research Farm, Benin City, Nigeria

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ABSTRACT: This study investigated the meat yield of cattle (*Yakanaji*) slaughtered at the abattoir unit of University of Benin Teaching and Research Farm, Benin City, Nigeria. Data from 74 Cattle to measure body length longitudinal, body length oblique, withers height, hip height ,hip length, heart girth, chest width, chest depth, hip width and shin circumference. Results obtained show the average longitudinal body length of 130.15cm, withers height value was 124.82cm, heart girth 143.65cm having. The highest correlation between meat yield and body measurements was in hip width (0.78), heart girth (0.74), hip length (0.72) and chest depth (0.71). The high values for coefficients of determination between meat yield and the linear body measurements of the entire cattle in this study indicated that the variables or their combination could be used to estimate or predict the live body weight of these cattle. Results of the OLS regression with R^2=0.75, showed that the explanatory variables explain 75% of the changes in the dependent variable, meat yield and it showed significant positive relationship for hip length and hip width, while other variables were insignificant ($p \geq 0.05$) with the prediction equations derived being Y= a+0.05HLT+1.20 HPW. Using factor analysis, two factors were extracted and accounted for 64% of total variance in the present study with the first component accounting for 54% of total variance. The results indicated the use of morphometric traits as reliable independent predictors of meat yield and can be used in abattoirs as well as breeding programs.

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The most common food producing animal is cattle (FAO, 2008)**.** The flesh of cattle called beef is a much desired meat item (Yakaka *et al.*, 2011). Meat has played a central role in our diets throughout evolution and there is good evidence that over the last 2 million years, the human ancestral line has been consuming increasing quantities of meat (Mann, 2000). Beef is widely cherished and consumed in households almost on a daily basis. It is a source of high quality protein (Aduku and Olukosi, 2000; Oloyede, 2005). Protein from animal is nutritionally superior to that of plant origin (Adeolu, 1996) because they include a complete range of amino acids that are essential for good health and body development. The diet of most of Nigeria populace is often low in protein, and according to FAO (2008), its average animal protein consumption per person per day is 7.9g which is far below Food and Agriculture Organisation recommendation of 35g as the average animal protein consumption per person per day (FAO, 2000). The value of beef cattle lies in their ability to efficiently produce a carcass composed of optimal proportions of muscle, bone, and fat at market weight (Tatum *et al*., 1986) or market specifications. Beef carcass composition is of high economic importance for the beef industry; hence it will be desirable if farmers could determine from pre-slaughter measurements carcass traits when animals are suitable for slaughtering. This will help to eliminate the use of animals yielding small amount of meat and also essential for optimum production and

value based trading systems. In this study, the economic value of a carcass is maximal when the portion of lean is maximal and both bone and fat proportions are minimal. Use of body linear measurements offers advantages over subjective methods of judging cattle such as visual assessment and scoring (Essien and Adesope, 2003).Reports on body weight and linear body measurements had been documented and was found useful in quantifying body size and shape (Ibe and Ezekwe, 1994). Linear body measurements have been used to predict live weights in poultry (Chhabra *et al.*, 1972; Monsi, 1992; Okon *et al.*, 1997; Gueye *et al.*, 1998), goat (Hassan and Ciroma, 1992; Ozoje and Herbert, 1987), sheep (Kandasamy and Gupta, 1983) and cattle (Orheruata and Olutogun, 1994). Body measurements are important data sources in terms of reflecting the breed standards (Riva *et al.*, 2002) and are also important in giving information about the morphological structure and development ability of the animals. These measurements can be taken at lower costs with a simple measuring tape and may provide relative accuracy and consistency (Guilbert and Gregory, 1952; Heinrichs *et al.*, 2007).The objective of the study was to determine meat yield of white Fulani (*Yakanaji*) slaughtered at the abattoir unit of the University of Benin Teaching and Research Farm, Benin City Nigeria.

MATERIALS AND METHODS

Study area: The experiment was carried out at the Abattoir Unit of the University of Benin Teaching and Research Farm, Benin City, Nigeria, located between latitudes 6º and 6.30 º North and longitudes 5.40º and 6º East in the humid rainforest zone of Nigeria. Annual temperature ranges between 24.5 º and 32.7º C, with annual rainfall which ranges from 1498 to 3574 mm with a mean value of 2162mm and relative humidity and daily sunshine are between 63.3 and 81.71% and 5.85 and 7.5 hours respectively (NAA, 2010). The animals used for this experiment were bought by the University Farm project for slaughter. On arrival to the farm which is usually in the evenings, the animals were housed close to the abattoir as shown in Plate 1 and 2. Animals were taken off feed from time of arrival to time of slaughtering, but provided with abundance of clean, fresh water during the pre-slaughter holding period to avoid restlessness.

Measurement Method and Standard of Measurement: Each animal was restrained and calmed before measurements to ensure they were not unnecessarily stressed. Measurements were taken from the animals in a standing posture. The animal dorsal line and cheek must make a straight line and its four hooves must make a rectangle before measurements were taken. Lydtin's rod was the instrument used to measure the widths; it has two adjustable arms which aids the process. The instrument was also used in measuring the height at the withers, hip height and body lengths, chest depth, hip width. A tape was used for measuring shin circumference and for measuring body lengths. All body measurements were taken in centimetres. Measurement processes was replicated three times to reduce errors.

Body Measurement / Data Collection: Data was collected on the following measured parts of the live animal in this study 1. Body length horizontal length (BLL). The body length of the cattle was measured from the joint of the scapular to the pin bone using a measuring tape. 2. Body length oblique length (BLO).The distance in between the dewlap and the throat to the pine bone. 3. Withers height (WHT). The distance from the tip of the withers straight down to the ground. 4. Hip height (HHT). This will be determined using a measuring tape. It is the distance from the platform on which the animals stands to the point of its shoulder. 5. Heart girth (HGT).This is measured as the body circumference immediately posterior to the front leg. 6. Chest Depth (CHD). 7. Hip length (HLT). The distance between the rump from the thurl area down to the pine bone. 8. Shin circumference (SHC). Distance around the shin, just above the hoof. 9. Chest width CHW).This was the greatest width of the chest just behind the shoulders. 10. Hip width (HPW). The distance between the thurl of both hind limbs. 11. Tail length (TLT).The distance of the tail measured in cm from attachment of the tail to the body up to the tip.

After slaughter, bones were removed and the flesh/meat cut in various sizes. The meat was chopped into smaller sizes and the weighed in portions according to each animal. The weighing scale was recorded in kilogram (kg). All measurements and weightings were taken with proven scales and rules to eliminate variation.

Statistical Analysis: Data obtained were analysed using descriptive, correlation and regression procedures, and one way ANOVA in a completely randomized design.

RESULTS AND DISCUSSION

The morphometric traits of the beef cattles slaughtered in this experiment is presented in Table 1. Meat yield, WHT Withers height , HHT hip height , HLT hip length , TLT tail length ,HGT heart girth, CHW chest width, CHD chest depth, HPW hip width, BLL body length horizontal, BLO body length oblique, SHC shin circumference). The mean meat yield of 142.54kg

was recorded, with a maximum of 188kg and a minimum of 100.5kg.The body length and height at withers of 130.15cm and 124.82cm which was in close agreement with the reports of (Pundir *et al*., 2011) who reported 123.44cm and 124.49cm, respectively, but not in tandem with estimates of heart girth standing at 162.56cm compared to 143.65cm in the study. The seeming difference though negligible may be as a result of differences in breed, type or even the age of the slaughtered animals. Verma *et al*. (2015) reported 101.80cm for body length which was way smaller than recorded values in this study and 137.38cm for heart girth which is slightly lower than those reported in this study. Body length value obtained in this study was higher than the reported values for north Bengal Gray cattle in Bangladesh (Bhuiyan, 2007) which ranges from 99-105cm. Sudanese Kenana (123cm) (Aamir *et al*., 2010) and Red Chittagong (125cm) (Bhuiyan, 2007) cattle respectively. The average withers height values of 124.82cm and rump height values of 125.5cm indicated that the bulls are taller at the rump than at the withers. Sawanon *et al*. (2011) reported the means heart girth and body length of 173.02cm and 136.49cm and, withers height of 124.86cm agreed with the results of the present study and shine circumference of 20.08cm which was lower than that recorded in the present study. Orheruata and Olutogun (1994) reported wide variations in the body measurement of N'dama cattle at different ages. This could have been if data collected were on age basis. The withers height, rump height heart girth values were comparable to those reported by Nwacharo (2006) for Maisei and Kamba Zebu in Kenya of which large variations observed within certain measurements could be ascribed to absence of selection. The body length, heart girth and rump height as reported by (Pundir *et al*., 2013), these values could be differences resulting from differences in age as typical lengthening and rump enlargement in cattle has a direct correlation with age.

Table 1: Morphometric traits of seventy four (74) cattle slaughtered.

Animal Body Parts	Range	Mean	Std. Dev
MY	100-188	142.54	21.02
BLL	100-150	130.15	9.35
BLO	90-151	127	9.14
WHT	98-140	124.82	6.95
HHT	117-145	125.5	5.34
CHD	60-86	71.38	5.84
HLT	32-60	44.08	5.96
TLT	79-111	97.32	6.33
HGT	120-172	143.65	12.15
CHW	21.5-65	51.22	9.30
HPW	34.5-74	58.76	8.96
SHC	20-29	25.64	1.56

The average heart girth and height at withers measures for cattle found in this study were generally lower compared to 176–223cm and 125–150cm reported for Holstein Friesians cows in a developed country context (Yan *et al*., 2009), likely due to the fact that there's a difference in raring and management practices, which ultimately makes the animals raised in this part of the world to be disadvantaged nutritionally. The coefficient of variation for different biometric traits ranged from 4.25cm (hip height) to 18.15cm (chest width). It was observed that hip length, chest width and hip width had more variability which may be due to the fact that selection was not applied for these traits or that these parts respond more to the environment than others.

Table 2: Correlation coefficients for the body measurements of entire sample.

	KG	BODYL	BODLOB	WITHERH	HIPH	CHESTD	HIPL	TAILL	HEARTG	CHESTW	HIPW	SHINC
KG	**1.00**											
BLL	0.59***	1.00										
BLO	0.53***	0.84***	1.00									
WHT	0.52***	0.56***	0.51***	1.00								
HHT	0.28**	0.51***	0.44***	0.56***	1.00							
CHD	0.71***	0.64***	0.55**	0.59***	0.34***	1.00						
HLT	0.72***	0.68***	0.59***	0.64***	0.52***	0.67***	1.00					
TLT	0.08	0.00	0.01	0.13	0.11	0.05	0.20*	1.00				
HGT	0.74***	0.70***	0.59***	0.60***	0.37***	0.94***	0.69***	0.03***	1.00			
CHW	0.70***	0.58***	0.57***	0.53***	0.30***	0.64***	0.59***	- 0.08***	0.69***	1.00		
HPW	0.78***	0.58***	0.54***	0.46***	0.27**	0.62***	0.63***	0.03	0.63***	0.70***	1.00	
SHC	0.48***	0.37***	0.32***	0.29**	0.16	0.38***	0.35***	0.16	0.40***	0.55***	0.43	1.00

*Notes: *, **, *** indicates significant at 10%, 5%, and 1%, respectively*

(WHT Withers height , HHT hip height , HLT hip length , TLT tail length ,HGT heart girth, CHW chest width, CHD chest depth, HPW hip width, BLL body length horizontal, BLO body length oblique, SHC shin circumference)

The high standard deviations observed for heart girth and height at withers are also in line with previous studies (Yan *et al*., 2009), and would largely reflect the diversity of cattle management practices within the study site. The standard deviation for different biometric traits ranged from 1.56cm (shin circumference) to 12.15cm(heart girth).In this study, the average withers height values of 123.76cm and rump height values of 125.5cm recorded for white Fulani animals indicate that the cattle are taller at the rump than at the withers. This agrees with (Yakubu *et al*., 2009) with report of average withers height values

of 111.84cm and rump height value of 120.34cm recorded for 2.5-3.6 years old White Fulani. The differences in physical measurements among various studies may possibly be explained by the management, nutritional and agro climatic factors (Mokherjee *et al.* (1981).

Table 3: KMO and Bartlett's Test on body measurements of cattle

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.855
Bartlett's Test of Sphericity	Approx. Chi-Square	567.942
	Df	55
	Sig.	.001

The meat yield was highly correlated with majority of traits measured (P < 0.01 and 0.01) suggest high predictability among the different traits. Tail length had negative correlation with heart girth (-0.03) and chest depth (-0.08). These findings were consistent with those reported by Heinrichs *et al*., (1992); Adeyinka and Mohammed (2006); Ojedapo *et al*.,(2007); Samuel and Salako (2008) and Sownade and Sobola (2008). Body measurements were positively and significantly correlated (p<0.05). Correlations among conformation traits ranged from -0.08 - 0.94. The highest correlation was between chest depth and heart girth 0.94, while the lowest was observed between chest width and tail length.

The high phenotypic correlations between traits suggest appropriateness of PCA to classify the variables. The KMO observed in the present investigation was 0.855 and showed suitability of data. The value was comparatively higher than earlier reports by (Tolenkhomba *et al*., 2012) on hill cattle of Assam (0.60), whereas (Pundir *et al*., 2013) reported slightly lower estimate (0.81) for Kankrej cattle. Verma *et al*. (2015) reported 0.75 KMO value which is lower than that observed in present study. The Bartletts Test of sphericity result of 567.942 which is lower than that observed by Yakubu *et al*., (2009) who reported values of 1,948.84 and 1,977.59. Tolenkhomba *et al.,* (2012) reported an overall significance of the correlations tested with Bertlett's test of Sphericity for the biometric traits at 372.99. The values of Bartlett's Test of Sphericity (.001) and Kaiser-Meyer-Olkin (.855) suggest that the data on the Body measurements of the cows were appropriate for factor analysis.

Table 4: Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.940	54.003	54.003	5.940	54.003	54.003
2	1.162	10.559	64.563	1.162	10.559	64.563
3	1.043	9.480	74.043	1.043	9.480	74.043
4	.696	6.324	80.367			
5	.607	5.521	85.888			
6	.476	4.326	90.214			
7	.375	3.412	93.626			
8	.274	2.492	96.118			
9	.242	2.203	98.321			
10	.132	1.200	99.521			
11	.053	.479	100.000			

Factor analysis (Principal Component) using Promax yielded three factors or components. The criterion for extraction was based on eigenvalue minimum of 1.00. The three components together accounted for approximately 74% of the variance with the lowest and highest eigen values of 1.043 and 5.940, respectively. The third component was then dropped considering only one item loaded and then the factor analysis was re-estimated to provide results for two components. Subsequently three items with cross loadings (hip length, wither and tail length), loaded in more than one component which was dropped. These results met the criteria set for factor analysis, and, as a result, construct validity for the body measurement of the Cattle may be assumed. The two components extracted from the analysis made up of eight (8) items: heart girth, chest width, chest depth, hip width, body length longitudinal, body length oblique shin circumference and hip height were combined indicators of the ''body form'' constructs. Once the factors were combined, the body measurement of the cows was fairly represented. In this study, the main concern was the body measurement construct and not on each of the dimensions and, for this purpose, factors

extracted from the analysis were summated to obtain the total scale. Another criterion for determination of number of component is scree plot that could be used to decide the actual number of component to be retained for analysis. Scree plot can depict various components and the component having eigen value up to the bent of elbow are usually considered. Two factors were extracted and accounted for 64% of total variance in the study. Yakubu *et al*. (2009) reported two factors extracted accounting for 85.37% and 86.47% for cattle of different ages using 14 morpo-structural traits. Salako (2006) extracted two factors from 10 biometric traits in sheep which represented 75% total variance which is in tandem with this result. Sadek *et al*. (2006) extracted three factors for Arabian mares and stallions separately by studying 14 different traits and these explained 66% and 67% of total variation. Tolenkhomba *et al*. (2012) also reported seven factors extracted with eigen values greater than 1 and accounted for 64.31% of total variance and also showed high loadings for heart girth and height at withers. In similar findings, Fumio *et al*. (1982) and Hammock (1986) reported that the first principal component was a measure of overall size in Japanese black cattle sires and yearling performance in beef cattle respectively. The first factor explaining maximum/highest variation was in accordance with those of the Pundir *et al*. (2011); Yakubu *et al*. (2009); Salako (2006); Sadek *et al*. (2006) and Karacaroen *et al*. (2008). The proportion of total variance explained by the first component was more in present investigation, 54%, compared to earlier study in Assam hill cattle (21.93%) and in Gojri buffalo (31.4%). The second factor which account for10% of variation. The third factor explained 9% of variation. The first component describes the general body size of cattle slaughtered for beef at the university of Benin teaching and research farm. It revealed significantly high loading for heart girth characteristics together with chest width, chest depth, hip width, body length oblique and longitudinal which explained the circumference and longitudinal value of the animal. Its higher than earlier studies by Tolenkhomba *et al*. (2012) in Assam hill cattle (17.74%) and by Vohra *et al*.(2015) in Gojri buffalo (31.4%).

The second factor which account for 10.5% of variation revealed significantly high loading for tail characteristics and for explaining the anterior parts of the cattle, with hip height being important also. This work agrees with Verma *et al*. (2015) who reported a second factor which account for 10.3% of variation revealed also high loading for tail characteristics.

Conclusion: The high values for coefficients of determination between meat yield and the linear body measurements of the entire cattle in this study indicates that the variables or their combination could be used to estimate or predict the live body weight of these cattle. The results in this study proves that the use of morphometric traits as a reliable independent predictors of meat yield and can be used in abattoirs as well as breeding programs.

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