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Evaluation of Slaughter and Carcass Characteristics from Indigenous Beef Cattle in Six Abattoirs of Tanzania

Eligy J. M. Shirima[1*], Longin M. P. Nsiima[1], Anjello J. Mwilawa[2], Jeremiah Temu[1], Steven Michael[1] and Da D. Silva Mlau[1]

[1]Ministry of Livestock and Fisheries Development, Veterinary Complex, 131 Nelson Mandela Road, P.O.Box 9152, 15487 Dar-es-Salaam, Tanzania.
[2]Tanzania Livestock Research Institute (TALIRI), Mabuki-Mwanza, Tanzania.

Authors' contributions

This work was carried out in collaboration between all authors. Author EJMS designed the study, supervised the data collection and wrote the first draft of this manuscript. Author LMPN initiated the funding sources for conducting the trial, while authors AJM and JT managed the literature searches. Authors SM and DDSM performed the statistical analysis of the study. All authors read and approved the final manuscript.

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ABSTRACT

The objective of the present study was to examine the slaughter and carcass characteristics and overall market value of slaughtered beef cattle in six abattoirs from six agro-ecological zones of Tanzania. The study was carried out in three phases between June 2013 and September 2014. The information from 3,133 sampled animals revealed that slaughter characteristics, carcass quality and market value from beef cattle differed due to differences in regional origins, sub-breeds, age, sex and the grade of the animals. The overall market weight of indigenous herd ranged from 202 to 266 kg live weight and carcass weight ranged from 100 -129 kg. The Ankole sub-breed

**Corresponding author: E-mail: shirimamussa@yahoo.co.uk;*

produced the heaviest (P<0.05) carcasses while the Gogo and Maasai were the lightest (P<0.05) groups with 255 kg and 204 kg, respectively. The heaviest meat produced was observed from the Ankole group with 129 kg while from the Gogo were lowest up to 105 kg. The dressing percentage was not significant (P>0.05) in both breed and animal origins, and these ranged from 50-52. The highest (P<0.05) monetary value per animal was found to be from the Tanzanian special with USD 166 and lowest (P<0.05) from Tanzanian No. 3 with USD 117. It is concluded that, animals slaughtered in the abattoirs are producing carcass of low weight and monetary value and much is remained to be done to improve their carcass weight and quality and overall monetary value pre-slaughter.

Keywords: Carcass; live weight; meat yield; monetary value; slaughter; zebu cattle.

1. INTRODUCTION

Meat and dairy production in Tanzania are mainly comes from the traditional sector that is dominated by Tanganyika Short Horn Zebu (TSZ) which is distributed in different agro-ecological zones. The agro-pastoral system contributes 80% and pastoral system 14% of the livestock kept [1]. The remaining 6% comes from the commercial ranches and dairy farmers [1]. The average production coefficients for TSZ are generally low, with calving rate ranged from 40 – 50%, calving interval 18 – 24 months, pre weaning mortality 30– 40%, adult mortality 8 – 10%, mature weight 200 – 350 kg, offtake rate 8 – 10% per annum and carcass weight 100 – 175 Kg [1].

Slaughter characteristics and carcass quality from beef cattle differed due to diversity of breeds and crosses involved, differences in age, sex and the overall feeding systems and post-mortem handling of the carcass [2,3]. The available *Bos indicus* beef breeds showed that there are still some differences in carcass production and quality of meat even if the comparison is made at equal breed, weights, sex or age which is mainly associated with their differences in protein retention and rate of maturity [4,5]. There are also some distinct differences in chemical, physical, and organoleptic properties exist between beef cattle from different genetic backgrounds [6,7]. It was also reported by [6,8] that under tropical conditions, there is a seasonal loss of live body weight and condition of beef cattle, which is mainly associated with the differences in feeding intensity and feed shortages across the seasons, which ultimately affects the growth rate and carcass characteristics of the animals.

Despite the importance of indigenous beef cattle and the overall beef value chain, there is scant comparative data on slaughter and carcass characteristics and the overall cost-benefit from the slaughtered animals in abattoirs of Tanzania. This anomaly, creates difficulties in estimating the exact monetary obtained from indigenous beef animals of different sub-breed, age, sex or commercial grading. The little available information in livestock and fisheries basic data has been obtained largely from practical experience and from commercial recording schemes. It does not relate to characteristics of Zebu cattle sub-breeds, age, sex or the Tanzanian live cattle grading system.

The objective of the current study was to give basic data on slaughter and carcass characteristics and monetary value from indigenous Zebu cattle in Tanzania.

2. METHODS

2.1 Location of the Study

Data was gathered from slaughter facilities (abattoirs) located in six agricultural zones of Tanzania including Northern (Arusha Meat Company-Arusha), Central (Dodoma Modern Abattoir-Dodoma), Eastern (Morogoro Municipal Abattoir-Morogoro), Western (Kariakoo Abattoir-Tabora), Southern highlands (Mbeya Slaughter House - Mbeya) and Lake (Nyakato Abattoir-Mwanza). The procedures for data collection, handling of the animals and carcasses and non-carcass components measurements were similar, same equipment and conducted at the same period/weeks in all the six abattoirs.

2.2 Duration of the Study, Sampling Units, Size and Procedures

A total of 56 days in three phases (14 days for phase I conducted in June 2013; 21 days each for phases II January 2014 and III in September 2014) were used for data collection. During these phases, a total of 3133 animals were sampled

and measured for data collection. These animals were brought for slaughter by the traders who purchased the animals directly from different primary livestock markets auctions within the country and transported them by truck or trekking them to the abattoir for slaughter. Slaughter facility was used as sampling unit and each individual animal passed and selected for slaughter was used as an observation unit. From the animals selected for slaughter, relative proportion of females and males were established. The males selected were either castrates or entire (bulls) whereas females were either empty or pregnant. Owners of sampled animals were the respondent in the interview for respective animal. The sample size for the study was at least 20% of the ante-mortem inspected animals that were passed for daily slaughter. The animals passed for slaughter were kept in lairage for 16 hours before slaughter and starved for feed. Prior to slaughter, animals were stunned using electrical stunner.

2.3 Data Collection

Data were collected through interviews and physical measurement of individual animal. Interviews were conducted by administering structured questionnaires to the slaughter facility managers and traders. Data gathered included general information about slaughter facilities, animal history from the traders and owners who bought the animals from the primary markets. Selected animals for this study were given unique slaughter identification number and graded using the Field Guide developed by [9] and Tanzania Live Cattle and Carcass grades set by the Meat Industry (Livestock and Carcass grading) Regulations 2010 [10].

2.3.1 Live weight (LW) estimation and grading of animals

Physical measurements involved live weight estimation of individual animal, carcass and non-carcass component weights. Live weights (LW) of sampled animals were estimated immediately after selection. The LW was determined from the heart girth using a special Measuring Tape for Cattle for an approximate evaluation of the weight of living animals. In determining the LW of cattle, the chest circumference of the animal was measured behind the humps of the elbow-joints. After measuring the circumference in centimetres, the corresponding LW in kilograms was directly read on the reverse side of the measuring tape as per manufacturer guidance. The weighed animals were graded according to the Tanzanian Live Cattle Grading System developed by the Ministry of Livestock Development, Tanzania of 1982 [10]. Grading of cattle in Tanzania was done based on mature slaughter cattle as Tanzanian Special (SP), Tanzanian No.1, Tanzanian No. 2, Tanzanian No. 3 and Tanzanian No. 4.

2.3.2 Carcass and non- carcass measurements

Immediately after slaughter, the animals were suspended in the Archilles tendon for puncturing the jugular vein before skinned and dressed. Following the removal of internal organs, a dressed carcass was immediately weighed and recorded as hot carcass weight (HCW) using digital Mini Crane Scale.

Non carcass component (NCC) measurements included weighing of the internal organs [Gastro-Intestinal Track - GIT, pluck (trachea, heart, liver and kidney), head, legs and hides] were taken, using digital Mini Crane Scale (Model OCS-03-L) with maximum capacity 300kg (Chinese GB/T 11883-2002 Class III Equivalent to OIML R76). Also, the weights of full gut content and empty gut content were weighed using the same equipments. The value of the animals were computed from the existing market prices in Tanzania per kilogramme in USD values (1USD=2000 TAS) i.e. Live weight price as 1.3 USD/kg, Carcass as 3.0 USD/kg and NCC as 1.5 USD/kg. These prices were used to all levels of beef animals as there is no grading system for meat consumed in local abattoirs. Abattoir Costs were included as handling fees, storage/chilling costs, trekking/transportation of cattle from the secondary market to the abattoir, and these amounted to USD 20/animal. The following parameters were also derived from the live weight, carcass and non-carcass components:-

- *Dressing percentage (DP) = (Dressed hot carcass weight (kg) /estimated live weight (kg)) x 100*
- *Weight of empty gut – GITempty (kg) = Weight of full Gut (kg) - Weight of gut content (kg)*
- *Live Weight Value (USD) = Live weight (kg) x 1.3 USD/kg*
- *Hot Carcass Value (USD) = Weight of hot carcass (kg) x 3 USD/kg*
- *NCC Value (USD) = Weight of NCC (kg) x 1.5 USD/kg*

- *Total Animal Value (USD) = Hot Carcass Value (USD) + NCC Value (USD)*
- *Net Value of an animal (USD) = Total Animal Value (USD) - Live Weight Value (USD)-Abattoir Costs*

2.4 Data Analysis

The data collected from the interviews and physical measurements were recorded in a structured questionnaire and checked for completeness. Data from the questionnaire were entered into Excel spread sheets. All the data were analyzed using the General Linear Model procedure of statistical package of SAS [11]. For all analyses, when least square means were significantly different (*P<0.05),* they were separated by Least Significant Difference test [11]. This was done to demonstrate the relevance of classifying cattle into zones, strains, grading and sex.

3. RESULTS AND DISCUSSION

3.1 Slaughter Characteristics and Market Values of Slaughtered Animals

Table 1 shows the overall market weight of traditional herd ranging from 202 to 266 kg live weight and carcass weight ranging from 101-129 kg. The results also showed that there was a breed difference in terms of live weight, carcass and non-carcass components produced (Table 1). The Ankole and Ufipa cattle were heaviest (P<0.05) while the Gogo and Maasai were the lightest (P<0.05) groups. From these results, there are substantial heterogeneities between breeds in terms of cattle weight as well as carcass and non-carcass components production. For instance, Ankole cattle are heaviest (P<0.05) both ante- and post-mortem, with carcasses weighing 24% and net values 25% more than Gogo animals. The differences in sub-breed differences might be associated with rate of growth, feed intake and efficiency [12]. These results are almost similar to those reported by [13] who showed the market weights of Ankole to be 273 kg and Ufipa being 262 kg from the selected six abattoirs which represented seven agro-ecological zones of Tanzania. There was slight interaction (P<0.05) between regions and breed of animals slaughtered in terms of non-carcass components yield and total animal value which might be explained by longer transportation from far distant markets to the slaughter houses. The differences in animals live weight could be attributed to differences in breed and even within the breeds due to differences in pre-slaughter management systems where some of the animals might have consumed different feeds found from the regions they originated [4,5]. Similar information was reported by [6,7] who reported a positive influence of feeding intensity, grazing and finishing regimes on slaughter and meat quality of cattle.

Table 2 shows the slaughter ages of different breeds, indicated that animals slaughtered above four years have the highest (P<0.0001) slaughter weights ranging from 195 to 264 kg from younger (<1.0 yr) to oldest (>4.0 yrs) groups, respectively. The oldest group had the highest Total Animal Value (TAV) due to the fact that this group produced the heaviest carcass and NCC, and the fact that meat in Tanzania is sold unclassified in most of the abattoirs [14]. Despite the highest TAV in the oldest group of slaughtered animals, the net monetary values (NEV) did not differed (P>0.05) among the age groups slaughtered. From these results, it can be revealed that, the animals brought in the abattoirs were heterogeneous in age ranging from less than one year to above four years old despite the fact that pricing was not determined by quality of meat in most of the Tanzanian abattoirs, but rather a size of the cut [5,14]. Such meat from very old animals could fetch low price when subjected to external markets or tourist hotels within the country [13]. The low price could be associated with the age of the animals such that older animals had low grading quality which might be the reason for yielding poor meat quality.

The observed live and carcass values in the age groups of the slaughtered animals are within the reported values by [5,14,15] who showed mature weight of indigenous cattle to be 200-350 kg LW with carcass weight 100-175 kg. These values from Zebu are far below those reported in exotic breeds of cattle due to their differences in genetic traits [16,17,18] and at the same time low slaughter values due to pre-slaughter treatments of the animals such as low finishing regimes [8,19] and longer transportation where in some abattoirs animals were transported in trucks over 700 km road distance [4,20]. Similar to this, poor feeding and delayed farming practices in Zebu cattle from Tanzania have been reported to cause delayed slaughter age for equivalent carcass weight and overall poor meat quality [5,14].

Table 1. Slaughter characteristics of different breeds of cattle slaughtered in six regions of Tanzania

Trait	Region (R)						SE	Breed (B)								SE	Significance		
	ARA	MZA	MBY	MOR	TBR	DOM		ANK	GOG	IRA	MSA	SNG	SUK	TAR	UFI		R	B	RxB
LW (kg)	266^{a}	225^{c}	202^{d}	254^{b}	214^{cd}	213^{d}	8.2	255^{a}	204^{c}	224^{b}	208^{c}	236^{b}	236^{b}	227^{b}	245^{a}	9.2	***	**	ns
HCW (kg)	129^{a}	123^{bc}	101^{d}	129^{a}	113^{bc}	110^{c}	4.2	129^{a}	105^{c}	115^{b}	107^{c}	118^{b}	120^{b}	114^{b}	122^{a}	4.5	**	**	ns
DP	49^{c}	52^{a}	50^{b}	51^{a}	53^{a}	51^{a}	0.6	51	52	51	50	50	51	51	50	0.6	*	ns	ns
NCC (kg)	62^{b}	55^{c}	70^{a}	62^{b}	74^{a}	54^{c}	2.3	69^{a}	54^{c}	62^{b}	60^{c}	67^{ab}	62^{b}	62^{b}	64^{b}	2.4	***	**	*
TAV ($)	479^{a}	429^{a}	406^{a}	478^{a}	447^{a}	408^{a}	15.5	491^{a}	395^{d}	437^{c}	409^{d}	454^{b}	454^{b}	435^{c}	452.3	17	***	*	*
NEV ($)	126^{c}	129^{c}	134^{bc}	143^{b}	161^{a}	123^{c}	6.8	151	121	138	132	140	140	131	137	8.0	*	ns	ns

*^{abcd}Means with different letter script within a row are significantly different (P=0.05); SE= Standard error; ns=not significant; *=P<0.01; **=P<0.001; ***=P<0.0001; ARA=Arusha; MZA=Mwanza; MBY=Mbeya; MOR=Morogoro; TBR=Tabora; DOM=Dodoma; ANK=Ankole; GOG=Gogo; IRA=Iringa Red; MSA=Masai; SNG=Singida White; SUK=Sukuma; TAR=Tarime; UFI= Ufipa; LW=Live weight; HCW=Hot carcass weight; DP=Dressing percentage; NCC=Non-carcass components; TAV=Total Animal Value; NEV=Net monetary value; $=USD*

Table 2. Slaughter characteristics of different stages of maturity in cattle

Trait	Age (yrs)				SE	Sign.
	<1.0	1-2	2-3	>4		
Live weight (kg)	195^{c}	216^{ab}	241^{bc}	264^{a}	3.8	***
Hot carcass weight (kg)	99^{c}	107^{bc}	123^{b}	135^{a}	1.5	*
Dressing percentage	51	50	51	51	0.2	ns
Non-carcass component weight (kg)	56^{c}	68^{a}	59^{b}	67^{a}	0.8	*
Total Animal Value ($)	381^{b}	422^{b}	459^{b}	503^{a}	5.5	**
Net Animal value ($)	118^{c}	134^{b}	138^{b}	155^{a}	2.4	*

*^{abc}Means with different letter script within a row are significantly different (P=0.05); SE= Standard error; Sign.= Significance; ns=not significant; *=P<0.01; **=P<0.001; ***=P<0.0001*

Pre-slaughter and post-motem handling had also been reported to affect carcass yield and quality in Zebu cattle from Tanzania and other East African countries especially when the animals were subjected to poor plane of nutrition and stress during transportation [6,14,21]. The results in Table 2 also showed that, the oldest animals to have more (P<0.05) TAV in terms of breed and age, but have overall similar (P>0.05) NEV. This implies that, there is no additional monetary value of slaughtering the animals from all the breeds studied when they at the older ages as far as NEV is concerned. Similar results have been reported in beef cattle raised under agro-pastoral communities of Uganda [22].

Table 3 shows slaughter characteristic of different sex of the animals slaughtered. The sex of the animal had significantly (P<0.001) affected the live weights, carcass and non-carcass component yields, and the overall net monetary value. Female groups had the lowest net monetary values as compared to castrate and entire animals slaughtered. The lowest net monetary values in females was associated with their lowest LW, HCW and NCC and ultimately lowest saleable carcass and non-carcass components. Similar information was observed in slaughtered steers and cows of similar age in Ethiopian zebu [23] The highest net monetary value were observed in castrates due to observed heaviest (P<0.001) LW, HCW and NCC than those other sex groups [2,4]. These results are due to highest live weights, and significantly (P<0.05) higher production of saleable NCC of the castrates brought at the market. Similar observations were reported by [13,14] who showed NCC to significantly increase the saleable parts in slaughtered zebu cattle castrates in Tanzania. The sex of the animal has been reported to affect live weight and meat yield in tropical beef cattle genotypes [24,25,26].

Table 4 shows that Tanzanian Special is almost 31.4% more (P<0.05) weight that Tanzanian No. 3, and they had far better conformation and higher (P<0.05) net value of 30%. Better quality animals have a higher carcass weight and saleable NCC. Findings from [5,14] reported higher quality carcass weights from Tanzanian Special than those in Tanzanian No. 3 or Tanzanian No. 4 in animals slaughtered in six agro-ecological zones of Tanzania. The genetical background of the animals was also reported by [2,24,27] to influence meat production from beef animals with different genotypes. The observed results are in agreement with those reported by [28] who reported a positive correlation between live body weight and grading score on yield and value from cull beef cows in Ethiopia.

Table 3. Slaughter characteristics of different sexes of cattle slaughtered in six abattoirs of Tanzania

Trait	Sex (S)			SE	Sign.
	Castrate	Entire	Female		
Live weight (kg)	258[a]	229[b]	199[c]	7.7	***
Hot carcass weight (kg)	130[a]	117[b]	101[c]	4.1	***
Dressing percentage	51	51	51	0.6	Ns
Non carcass component (kg)	68[a]	61[b]	55[c]	2.2	***
Total Animal Value ($)	492[a]	441[b]	385[b]	13.6	***
Net Animal value ($)	151[a]	136[b]	116[c]	6.8	***

*[abc]Means with different letter script within a row are significantly different (P=0.05); SE= Standard error; Sign. = Significance; ns=not significant; ***=P<0.0001*

Table 4. Slaughter characteristics of different grades of cattle slaughtered in six abattoirs of Tanzania

Trait	Grade of animals				SE	Sign.
	1	2	3	4		
Live weight (kg)	281[a]	236[b]	207[c]	193[d]	8.5	***
Hot carcass weight (kg)	141[a]	119[b]	105[c]	99[c]	4.0	**
Dressing percentage	51	51	51	52	0.6	Ns
Non carcass component (kg)	76[a]	65[b]	56[c]	53[c]	2.1	*
Total Animal Value ($)	533[a]	454[b]	400[c]	377[c]	13.5	*
Net Animal value ($)	166[a]	140[b]	122[c]	117[c]	6.6	**

*[abcd]Means with different letter script within a row are significantly different (P=0.05); SE= Standard error; Sign.=Significance; ns=not significant; *=P<0.01; **=P<0.001; ***=P<0.0001*

Overall, while the data point to significant heterogeneities in multiple livestock-related dimensions between breeds, sex, slaughter age and grades of animals, part of these differences might be due to differences in management systems within agro-pastoral communities, where the majority of the slaughtered animals were obtained. The collected information for instance did not classify exactly the type of management system employed to each animal before brought to the abattoir, whether the animals brought to market were purely extensive or semi-finished as most of the zebu cattle under traditional system of Tanzania are slaughtered without feedlot finishing, partly because of knowledge and poor supply of quality feeds in the range lands.

4. CONCLUSION AND RECOMMENDATIONS

There is great variation in live weight, carcass and non-carcass components yield within the sub-breeds, sex, and grade of animals and slaughter age of the animals in Tanzania. The pricing of carcass and non-carcass components do not follow grading system or cuts, as most meat was sold at USD 3/kg as mixed meat. The selling of meat in cut grading could however increase the net value of the slaughtered animals if such an exercise was employed in the surveyed abattoirs.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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