Research Article

Animal Science Journal, 1(1): 23-27, 2010
Available online at **www.isisn.org**

Effect of slaughter weight on growth of wholesale cuts of Sudan Western Baggara bull carcass

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To evaluate the relative growth pattern of beef carcass cuts, eighty fattened Baggara bulls were divided into four slaughter weight groups (200 - 250, 251 - 300, 301 - 350 and 351 – 400 kg) of twenty animals each. The chilled carcass left side was partitioned into 14 cuts. One way analysis of variance was used to examine the effect of slaughter weight on the cuts percentages. The equation $y=ax^b$ was used to study the growth of the cuts relative to carcass. Linear regressions were used to predict carcass weight from weights of cuts. Proportions of leg, shin, top side and silver cuts, thick flank, clod and sirloin cuts decreased with increase of slaughter weight. Neck and chuck and blade, thick ribs cuts proportions in the two heavy groups were higher than that in the two light groups. Chuck and blade, neck, thick ribs, thin ribs, extended roasted ribs and hind quarter flank had growth coefficients more than 1. Leg, clod, shin, brisket, thick flank, top side and silver, rump and sirloin cuts had growth coefficients less than 1. The study concluded that the percentages of the forequarter cuts increased with the increase of slaughter weight. Chuck and blade is the fastest growing cut with increase of 1.39% for each 1% increase in carcass weight. Top side and silver or clod cuts weights can precisely predict carcass weight using the equations: carcass weight = 14.1 top side and silver weight – 28.1 or carcass weight = 8.74 + 30.9 clod weight.

Key words: Carcass cuts growth, carcass weight prediction

Western Baggara cattle are the major beef animals in the Sudan. They provide the bulk of meat consumed in Northern Sudan and contribute considerably to the export of beef cattle (Eltahir, 2007). Trading channels of beef cattle in the country are presently insufficient for ensuring reasonable quality grades and establishing differential prices. Carcass grading system is used to describe the value of beef carcass in terms of lean meat yield and quality. Carcasses are normally broken down into wholesale cuts which correspond closely to the unit that retail butcher might order from wholesale seller or abattoir (Prior *et al*., 1977). Most of variations in the wholesale cuts percentages are associated with differences in total lean and fat yield that is mainly dependant on slaughter weight (Koch *et al.*, 1982). Mukhoty and Berg (1971) found that the proportion of limbs and loin decreased and that of thorax, ribs and flank increased with the increase in slaughter weight. An understanding of growth and development of beef animal body is very important to improve beef production and produce more desirable meat products. Mathematical equations were developed to characterize growth of animals, organs or tissues when discussing growth responses and maturity measurement. The function $y = ax^b$ has been widely used to relate the change in weight of the tissue or compositional component to the weight of the whole entity as empty body weight, slaughter weight or carcass weight (Wanger *et al*., 1979). Mohammed (2004) observed that bones grew at a lower rate than did the whole carcass (b = 0.62), while total carcass fats showed the highest rate of growth (b = 1.53). He also reported that forequarter growth pattern was higher and that of the hindquarter was lower than the growth of the whole carcass. Traditional butchers in the Sudan, with the absence of carcass weighing machines, are used to estimating carcass weight as ten times the weight of the forelimb starting from the scapular. This practice does not follow the known carcass wholesale cuts.

The objectives of this study are to examine changes in the proportions of carcass wholesale cuts when Western Baggara bulls are slaughtered over the

weight range of 200 to 400 kg and to characterize the relative growth patterns of the wholesale cuts. The study also aims at evaluating the most reliable cut for prediction of the whole carcass weight.

MATERIALS AND METHODS

This research was done at the Department of Livestock Fattening Research of the Animal Production Research Centre, Khartoum North. The fattening herd of the department was accommodated in groups and fattened on concentrate diet (19.6% CP and 11.60 MJ/Kg, M.E) consisting of molasses (52%), wheat bran (39%), ground nut cake (5%), urea (3%) and common salt (1%). In addition sorghum straw was offered. The feed was offered *ad libitum* at the ratio of 80% concentrate and 20% sorghum straw. Fresh water was freely available for animals.

For the purpose of this experiment eighty fattened Baggara bulls were selected. The animals were divided into four groups of twenty animals each according to their slaughter weights (200 - 250, 251 - 300, 301 - 350 and 351 – 400 kg body weight groups). Before slaughtering the animals were overnight fasted from feed. Animals were slaughtered according to Muslims practice by severing both jugular veins and carotid arteries by a sharp knife without stunning. After complete bleeding the head was removed at the atlanto-occipital joint. After dressing, evisceration and chilling (at 4^{o}c for 24 hours), the left side of the carcass was partitioned into 14 joints (wholesale cuts) according to method II described by Meat and Livestock Commission (MLC 1974) for cutting and preparing beef carcass.

One way analysis of variance was used to examine the effect of slaughter weight on the percentages of wholesale cuts of the left half of the carcass. The equation $y=ax^{b}$ in the log-transformed form ($\log_{10}y= \log_{10}a+b\log_{10}x$) was used to study the growth of wholesale cuts relative to the carcass, where y is the weight of the wholesale cut and x represents the carcass half weight, *a* and *b* are constants. Linear regressions were used to predict carcass weight from the wholesale cuts weights (StatSoft, 2010).

RESULTS

Table (1) represents the carcass wholesale cuts as a percent of the (chilled) half carcass weight. The percentage of leg, shin and top side and silver cuts decreased significantly ($P<0.05$) with the increase of the slaughter weight. The percentage of clod and sirloin cuts had the same trend but the differences between groups 2, 3 and 4 were not significant. The neck and chuck and blade wholesale cuts percentages in the two heavier groups (3 and 4) were similar and they were significantly higher than those in the two light groups (1 and 2) which were also similar. Regarding the percentage of the thick ribs cut, group 1 was significantly lower than the other groups (2, 3 and 4) which were similar. Thick flank cut percentage of groups 3 and 4 was lower than that of groups 1 and 2. The other wholesale cuts (thin ribs, extended roasted ribs, brisket, hind quarter flank and rump) showed no significant differences between the slaughter weight groups.

The logarithmic regression of wholesale cuts weight (y) on carcass left half weight (x) is shown in table (2). All the regressions were significant ($P<0.001$) and had coefficient of determinations (R^2) ranging between 83 and 94. Chuck and blade, neck, thick ribs, thin ribs, extended roasted ribs and hind quarter flank had regression coefficient more than 1. Leg, clod, shin, brisket, thick flank, top side and silver, rump and sirloin wholesale cuts had regression coefficients less than 1.

All the correlations of cold carcass weight with the different wholesale cuts (Table 3) were significant ($P<0.05$) with the highest coefficients for top side and silver, clod and thick ribs cuts. The linear regressions of cold carcass weight on these cuts were:

$y = 14.1x – 28.1$, of 9.65 error of estimate and 0.92 coefficient of determination (1)

$y = 8.74 + 30.9x$, of 10.1 error of estimate and 0.92 coefficient of determination (2)

$y = 15.4 + 13.3x$, of 5.42 error of estimate and 0.91 coefficient of determination (3) Where: y is the cold carcass weight; x is the top side and silver, clod and thick ribs cuts weights for equations (1), (2) and (3), respectively.

DISCUSSION

The percentages range of all wholesale cuts of the carcass half weight of Baggara bulls under this study were comparable to that reported by Mohammed (2004) and Fadol and Babiker (2010) for the same type of animals. The present study revealed that the percentages of neck, chuck and blade

Table 1: Percentages of the wholesale cuts of the experimental slaughter weight groups

Component	Group 1	Group 2	Group 3	Group 4	SE	L.S
No. of animals	20	20	20	20		
Slaughter weight (kg)	222^{d}	276^{c}	330^{b}	377^{a}	3.18	S*
Clod	6.5^{a}	6.2^{b}	6.3^{ab}	6.1^{b}	0.08	S*
Neck	7.2^{b}	7.4^{b}	8.4^{a}	8.7^{a}	0.17	S*
Shin	3.5^{a}	3.3^{b}	3.2^{b}	3.0^{c}	0.05	S*
Chuck and blade	10.4^{b}	10.8^{b}	12.7^{a}	12.8^{a}	0.26	S*
Thick ribs	5.8^{b}	6.2^{a}	6.4^{a}	6.4^{a}	0.10	S*
Thin ribs	3.1	3.0	3.1	3.2	0.06	N.S
Extended roasted ribs	6.7	6.8	6.8	6.9	0.17	N.S
Brisket	7.9	8.1	7.6	7.8	0.15	N.S
Leg	5.8^{a}	5.5^{b}	5.0^{c}	4.8^{d}	0.08	S*
Thick flank	5.2^{a}	5.1^{a}	4.8^{b}	4.8^{b}	0.08	S*
Hind quarter flank	5.8	6.1	6.1	6.2	0.11	N.S
Top side and silver	18.6^{a}	18.1^{b}	16.7^{c}	16.1^{d}	0.18	S*
Rump	6.7	6.8	6.6	6.7	0.09	N.S
Sirloin	6.8^{a}	6.7^{a}	6.3^{b}	6.6^{ab}	0.12	S*

SE = standard error of means. L.S = level of significance. N.S = treatment effect is not significant (P>0.05). S* = treatment effect is significant (P<0.05). a, b, c, d = means on the same row of different superscript are significantly (P<0.05) different

Table 2: Regression of cuts weights (y) on carcass left half weight (x) according to $\log_{10} y = \log_{10} a + b \log_{10} x$

y	R^2	$\log_{10} a$	b ± SE	p
Clod	0.93	-1.09	0.93± 0.03	0.00
Neck	0.91	-1.70	1.31± 0.05	0.00
Shin	0.89	-0.99	0.73± 0.03	0.00
Chuck and blade	0.92	1.68-	1.39± 0.05	0.00
Thick ribs	0.94	-1.51	1.15± 0.03	0.00
Thin ribs	0.89	-1.63	1.05± 0.04	0.00
Extended roasted ribs	0.83	-1.22	1.02± 0.05	0.00
Brisket	0.87	-0.94	0.91± 0.04	0.00
Leg	0.85	-0.62	0.65±0.03	0.00
Thick flank	0.89	-1.03	0.85± 0.03	0.00
Hind quarter flank	0.91	-1.41	1.09± 0.04	0.00
Top side and silver	0.93	-0.29	0.75± 0.02	0.00
Rump	0.93	-1.09	0.95± 0.03	0.00
Sirloin	0.87	-1.04	0.92± 0.04	0.00

R^2 = Coefficient of determination. P = Probability of error indicating the significance of the relation

Table 3: Correlation coefficient (R) of cold carcass weight with the examined whole sale cuts weights.

Wholesale cut	R
Clod	0.96
Neck	0.95
Shin	0.92
Chuck & blade	0.95
Thick ribs	0.96
Thin ribs	0.94
Extended. roasted ribs	0.88
Brisket	0.92
Leg	0.92
Thick flank	0.93
Hind quarter flank	0.94
Top side and silver	0.96
Rump	0.95
Sirloin	0.93

cuts (the most fleshy parts in the hump area) were higher in the heavy group (slaughter weight between 351 – 400 kg), whereas the percentage of cuts with higher proportion of bones (the limbs, back bone and ribs) as shin, leg, top side and silver, thick flank and sirloin cuts were highest in group 1 (slaughter weight between 200 – 250 kg).

Consistently, Lawrence and Fowler (1997) noted that the skeletal tissues are early maturing whereas the soft tissues are late maturing, therefore after maturity the latter tissues are the most variable with body weight. In the same context, Eltahir (2007) observed that muscle to bone ratio

increased significantly from 3.27 to 4.19 as the slaughter weight increased from 200 kg to 400 kg. The current findings were in agreement with Gumma (1996) who noted that the well-developed thoracic hump in tropical cattle could have contributed to the heavy weight of forequarter wholesale cuts.

The logarithmic regression coefficient is the percentage increase of the dependent variable at each 1% increase of the independent variable. Gaily and Nour (1980) used this regression coefficient (b) to relate the growth of each wholesale cut to the whole carcass growth. They stated that when the value of b is less than 1 the organ or tissue grows at a lower rate than the whole body weight does; but when the value of b is more than 1 then the organ or tissue grows at a higher rate than the whole body weight does. They also mentioned that the difference in growth is significant ($P<0.05$) if the error of b is less than the difference between b and 1. The present results revealed that most of the fore quarter cuts (anterior; the cut between 10^{th} and 11^{th} ribs at right angle with thoracic vertebrae) as chuck and blade, neck, thick ribs, thin ribs, extended roasted ribs increased in weight at significantly faster rate than the whole carcass. Whereas the hindquarter cuts as the leg, thick flank, top side and silver, rump and sirloin had the significantly lower relative growth coefficient. Mohammed (2004) reported similar observations. He noted that forequarter growth pattern was recorded to be at a significantly ($P<0.01$) higher rate ($b = 1.11$) and hindquarter grew at significantly ($P<0.001$) lower rate ($b = 0.86$) with coefficient of determination ($R^2 = 0.99$) for both forequarter and hindquarter. Eltahir (2007) also mentioned that the relative forequarter growth was significantly higher than the whole carcass ($b = 1.10 \pm 0.01$), whereas, that of the hindquarter is significantly lower (0.85 ± 0.01). The two authors attributed this to the observation that the mentioned forequarter cuts are fleshier than that of hindquarter and contain larger proportion of muscles. This also explained the present high growth rate of the fleshy hind quarter flank cut and the low growth rate of the boney forequarter shin cut.

The highest correlation coefficients of carcass weight with cuts weight were observed for top side and silver, clod and thick ribs cuts ($R = 0.96$ for the three cuts). Similar observations were reported by Mohammed (2004), however, he noted lower coefficient for thick rib cut ($R = 0.98$, 0.97 and 0.92 for top side and silver, clod and thick ribs, respectively). He concluded that top side and silver cut weight was the most reliable for the prediction of carcass yield. Similarly, the present study proposed tope side and silver or clod cuts weights to be used for prediction of whole carcass weight because of their highest coefficient of determination ($R^2 = 0.92$).

The study concluded that the percentages of the fleshiest cuts increased with increase of Baggara bulls slaughter weight. It also concluded that the chuck and blade is the fastest growing wholesale cut with increase of 1.39% for each 1% increase of carcass weight. Top side and silver side or clod cuts weight can precisely predict carcass weight using the equations: carcass weight = 14.1 top side and silver weight – 28.1 or carcass weight = 8.74 + 30.9 clod weight.

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