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EVALUATION OF CARCASS PERFORMANCE OF MATEBELE GOATS MANAGED EXTENSIVELY BASED ON THE ERUPTION OF PERMANENT INCISORS TEETH

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ABSTRACT

Matebele goats were slaughtered at different state of permanent incisors eruption 1st pair (I_1)(237records), 2nd pair (I_2)(312 records), 3rd pair (I_3)(237records), 4th pair (I_4)(232), Broken Mouth (BM)(214) and Smooth Mouth (SM)(218) over a period of 15 years (1989- 2004) and analysed for carcass performance. Performance parameters and weight of organs as a percentage of empty body weight (EBW) containing the effects of number of permanent incisors at I_1, I_2, I_3, $I_{4,}$, BM and SM were analysed using the General Linear Models. Live weight averaged 21.57 kg ± 0.02, 27.01± 0.02 kg, 28.40± 0.02 kg, 28.88± 0.02 kg, 36.92± 0.02 kg and 37.33± 0.02 kg for goats slaughtered at I_1, I_2, I_3, $I_{4,,}$, BM and SM, respectively. There was a significant ($p<0.01$) difference in slaughter weight at different periods of permanent incisors teeth eruptions. The goats slaughtered at I_1 and I_2 had significantly heavier hot carcass mass, cold carcass mass and rib barrel than those slaughtered I_3, $I_{4,}$, BM and SM. The goats slaughtered at I_3 had the highest dressing percentage and goats slaughtered at BM had the lowest dressing percentage (DP). For external non-carcass components, the proportion of the head did not change but it was the feet proportion that increased markedly from I_1 to I_3 which coincided with the decrease in pelt. The proportion of hind barrel, head and kidney fat seemed to be constant. There was a significant ($p< 0.01$) difference between mesenteric fat amongst teeth groups, which increased with increasing number of permanent incisors eruption representing age increase. The lower proportion of non-carcass components in I_3 may have contributed to a higher DP.

KEYWORDS: Permanent Incisors; Carcass; Matebele Goats.

INTRODUCTION

Most goats are raised in communal areas by smallholder farmers for subsistence and trading in informal markets in Zimbabwe (Agrisystems, 2000). Finishing goats in feedlot on high concentrate diets is not a wide spread practice as goats are generally used more efficiently when utilizing browse or forage (Wildeus et al 2007) a similar trend has been observed in Zimbabwe by Van Rooyen and Homman (2008) for small scale goat production. Africa's goat population increased by 75% between 1980 and 2005 and constitutes 30% of the world population. (Simela and Merkel, 2008). In the country, goat population is 4.4 million and rising (CSO, 2000) of which 90% of the national flock is owned by smallholder farmers (Homann et al 2007). Globally, the number of goats has also increased even in countries with high and medium income (Morand-Fehr et al 2004). Little has been done to improve goat productivity and management practices that might result in better quality and quantity meat production (Kebede et al 2008).

One of the major characteristic of the small scale goat production which supply the informal market is the unavailability of records to determine the age of animals for sell. Goats of unknown ages are on offer on the informal market and pricing of animal has been very difficult (van Rooyen et al 2007). Elsewhere, age determination of goats by means of dentition has generally been done using the norms accepted for sheep (Wilson and Durkin, 1984). Goats slaughtered or sold in the informal market are largely unquantified but are believed to have increased with the decrease in beef formal market opportunities (Hargreaves et. al., 2004). Deciduous teeth (milk teeth) erupt first and are replaced by permanent teeth. The time of eruption or breaking through the gums by the teeth is probably the most accurate aid criterion of determining the age of animals when no other accurate records are available. There is need to know the age of animals on offer because age has been known to affect carcass yield, edible body parts and meat offal's in goats (Skapetas et. al., 2006; Aduku et. al., 1991). Age of the animal will assist the local farmers to maximize on pricing of their goats. The aim of this study was to use the rate of permanent incisors eruption as a guide to estimate the age of animals and relate this to carcass performance of local goats which will accordingly assist in pricing the animals.

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MATERIALS AND METHODS

Study location

Matopos Research Station (20 ^{0} 23$^{'}$ S, 31^0 30$^{'}$ E) situated 30 km South West of Bulawayo in Zimbabwe. Altitude is low (800m) experiences low erratic rainfall (<450) per annum (Homann et. al., 2007). Very high summer temperatures, maximum and minimum mean temperatures of hottest months are 21.6 ^{0} C and 11.4 ^{0} C, respectively. Possibility of severe droughts (Hagreveas et. al. 2004). The most common type of vegetation is sweet veldt with comparatively high nutritional value of browse and annual grass species (Ward et al 1979). Managed properly, the rangelands should be able to meet the nutritional requirements of goats (Ncube, 2005) and other livestock (van Rooyen et. al., 2007). However due to communal grazing system, significant proportion of the rangeland are now degraded, resulting in low biomass and thus limited feed resource of poor quality, particularly during the dry season (Hlatshwayo, 2007). Day et al (2003) and Gambiza and Nyama (2000) give a detailed description of the climate and vegetation type, respectively. The management of flock and slaughter method was described by Assan (2007).

Matebele goats were slaughtered at different state of permanent incisors teeth eruption over a period of 15 years at Matopos Research Station and their carcass and non carcass characteristics were analysed. The state of permanent incisors teeth eruption were 1st pair (I_1)(237records), 2nd pair (I_2)(312 records), 3rd pair(I_3)(237records), 4th pair (I_4)(232), and the age beyond 4 years was estimated by wear, where Broken Mouth (BM)(214) referred to the group of goats which had one or two teeth worn out or missing, and Smooth Mouth (SM)(218) had over two teeth missing. This forms the grounds for salvage of animal (Wilson and Durkin, 1984). The table below (Table 1) gives the rule of thumb in terms of estimation of age using permanent incisors eruption in goats.

Table 1: Estimation of age using permanent incisors eruption in goats

State of incisors teeth:	Rule of thumb
1st or centre pair of permanent teeth-2- tooth	12 to 18 months
2ndpair of permanent teeth -4- tooth	18 to 24 months
3rd pair of permanent teeth-6- tooth	24 to 33 months
4th pair of permanent teeth-full mouth or 8 tooth	33 to 38 months

Carcass performance parameters and weight of organs as a percentage of EBW were analyzed using the General Linear Models (GLM) procedure of the Statistical Analysis System (SAS) (1999- 2000) for effects of number of permanent incisors eruption on carcass performance. The general statistical model used:

$Y_{ij}=u+A_i+e_{ij}$

Y_{ij}=traits analyzed (performance traits, weight of organs as a percentage of EBW);
u=general mean;
A_i=fixed effect of number of permanent incisors eruption;
$i^{th}=I_1, I_2, I_3, I_4$, BM, SM;
e_{ij}=residual error;

RESULTS

Descriptive statistics of data sets of major carcass parameters are given in table 2. There was a significant ($p<0.05$) difference between I_1, I_2 group and I_3, I_4, BM, SM group on major carcass parameters (Table 3 and 4). The pre-slaughter weight tended to increase drastically from I_1 to I_2 after which it remained a bit constant up to I_4 and then increased thereafter. Pre-slaughter weight averaged 21.57 kg, 28.40 kg, 27.01 kg, 28.88 kg, 36.92 kg and 37.33 kg for goats slaughtered at I_1, I_2, I_3, I_4, BM and SM, respectively. The goats slaughtered at I_3 years of age had the highest ($p<0.01$) mean DP and goats slaughtered at BM had the lowest ($p<0.01$) mean DP. The trend of the dressing percentage were from highest $I_3 > I_1 > I_2 >$ BM > SM. The goats slaughtered at I_3 had significantly heavier hot carcass mass, cold carcass mass and rib barrel than those slaughtered at I_1 and I_2 (Table 4). Number of permanent eruption differences did not influence the size of the hind barrel. However there was a significant ($p<0.01$) difference between I_1 to I_3 and I_4, to SM in the size of the front barrel. Carcass length had non-significant effect in I_1 and I_2 but there was a significant ($p<0.01$) difference as from 1_3 to SM. Kidney fat in all categories (I_1, I_2, I_3, I_4, BM and SM) were almost similar and there was a significant ($p<0.01$) difference in omental fat and mesenteric fat between lower (I_1,I_2) and higher (BM, SM) categories of dentition (Table 5). A similar and significant ($p<0.01$) trend was observed in carcass score. This indicates probably that the lean carcass can be obtained when goats have less than four permanent incisors teeth. As a percentage of EBW goats slaughtered after I_3 had a lower proportions of pelt, and kidneys, had a higher proportions of liver (Table 5). There was also a tendency of the proportion of feet to increase up to where the animal have three permanent incisors and then decline later. The proportion of head, lungs, heart seemed to be constant. The fat trend from I_2 through I_3 group maintained a similar pattern from highest kidney fat> omental fat> mesenteric fat and thereafter was observed where kidney fat contributed the least to total fat. It seems reasonable to assume that the sudden change in fat proportion may be associated with feed efficiency utilization for weight gain which may be different at early stage of growth than at advanced permanent eruption of incisors. There was a significant ($p< 0.01$) difference on mesenteric fat between among other groups, except I_4 and BM. The proportion of fat increased as number of permanent incisors teeth eruption increased (Fig 1). Kidneys weight and liver had highest proportion to the EBW when the animals had broken mouth. The eruption of the three permanent incisors acted as a major cut off point for changes in the proportion of non-carcass components (i.e. offal) which may have contributed to higher DP at this stage.

Table 2: Descriptive statistics of data sets of carcass parameters in indigenous Matebele goat of Zimbabwe

Item	R-square	CV%	Mean	se
HCM	0.90	9.14	12.82	0.02
CCM	0.85	11.47	12.42	0.01
CL	0.73	5.84	50.10	0.05
DP	0.34	8.92	41.46	0.01
CS	0.39	32.90	1.93	0.02
EBW	0.96	5.26	24.50	0.11
FG	0.82	15.42	8.71	0.05
EG	0.66	17.24	2.15	0.09
GUT	0.79	19.59	6.56	0.01
DPS	0.50	10.70	27.01	0.03
LGL	0.51	9.64	22.83	0.03
HBL	0.36	32.88	5.33	0.02
RBL	0.54	42.31	1.57	0.11
FBL	0.62	23.68	4.93	0.10

HCM=Hot Carcass Mass; CCM=Cold Carcass Mass; CL= Carcass Length; CS=Condition Score; DP=Dressing Percentage EBW=Empty Body weight; FG= Full Gut; EG=Empty Gut; FS=Fat Score, DPS=Deep Side; LGL=Leg Length; HBL=Hind Barrel; RBL=Rib Barrel; FBL=Front Barrel.

Table 3: Least squares means and standard errors of major carcass parameters based on different permanent incisors eruption in indigenous Matebele goat of Zimbabwe

PI	n	HCM	CCM	CL	DP	EBW
I_1	237	10.37^{a}± .36	10.08^{a}± .43	49.44^{a}± .89	42.74^{a}± 1.13	16.91^{a}± .40
I_2	312	13.66^{a}± .18	13.28^{a}± .22	48.69^{a}± .44	41.85^{a}± .56	22.27^{a}± .20
I_3	237	14.66^{b}± .25	13.80^{a}± .30	51.52^{b}± .62	45.53^{b}± .78	21.19^{a}± .27
I_4	232	13.80^{b}± .43	13.26^{a}± .53	48.26^{c}± 1.08	41.71^{c}± 1.36	21.02^{b}± .48
BM	214	13.00^{b}± .51	12.47^{b}± .62	53.26^{d}± 1.29	40.29^{c}± 1.63	28.16^{b}± .57
SM	218	13.02^{b}± .57	12.25^{b}± .69	50.27^{d}± 1.43	40.48^{c}± 1.81	28.43^{b}± .63

^{a,b,c}Means with different superscripts in the same column differ significantly ($p<0.01$).

Table 4: Least squares means and standard errors of major carcass parameters based on different permanent (PI)incisors eruption in indigenous Matebele goats of Zimbabwe

PI	HBL	FBL	RBL	FG	GUT	CS
I_1	5.95^{a}± .53	5.46^{a}± .36	1.55^{a}± .20	9.20^{a}± .41	6.67^{a}± .39	1.63^{a}± .19
I_2	5.55^{a}± .26	5.47^{a}± .18	1.42^{a}± .10	8.35^{a}± .20	6.13^{a}± .20	1.7^{a}± .10
I_3	6.21^{a}± .37	5.92^{a}± .25	1.98^{b}± .14	8.04^{a}± .29	5.82^{a}± .27	2.26^{b}± .13
I_4	5.26^{a}± .65	4.95^{b}± .43	1.94^{b}± .25	10.11^{b}± .50	7.86^{b}± .47	2.08^{b}± .23
BM	5.65^{a}± .78	5.36^{b}± .52	1.40^{b}± .29	10.30^{b}± .59	7.96^{b}± .56	2.92^{c}± .28
SM	5.70^{a}± .85	5.37^{b}± .57	1.44^{b}± .33	10.69^{b}± .66	8.90^{b}± .63	2.72^{c}± .31

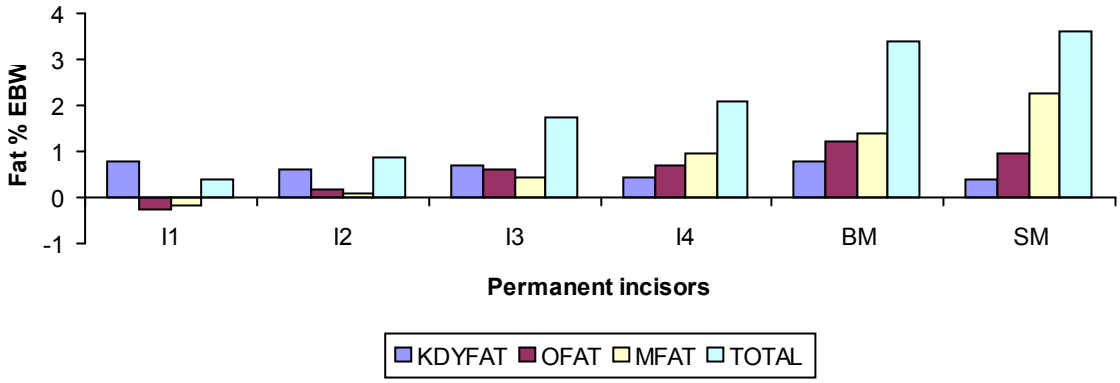
Means with different superscripts in the same column differ significantly ($p<0.01$).

Table 5: Least squares means with standard error of edible body parts and meat offals (%EBW) based on number of permanent incisors eruption in indigenous Matebele goats of Zimbabwe

	Permanent incisors					
Item	I_1	I_2	I_3	I_4	BM	SM
Head	6.83^{a}± .25	6.71^{a}± .13	6.71^{a}± .18	7.12^{a}±.31	6.41^{a}± .37	6.23^{a}±.41
Pelt	7.39^{a} ±.36	7.09^{a}±.18	8.07^{a}±.25	5.88^{b}±.43	6.39^{b}±.51	6.82^{b}±.57
Feet	2.54^{a}±.15	2.67^{b}±.08	2.95^{c}±.11	2.70^{c}±.18	2.62^{c}±.22	2.46^{c} ±.24
Liver	1.58^{a}±.11	1.88^{b}±.06	0.08^{b}± .01	1.47^{d}± .13	2.00^{d}± .16	1.82^{d}±0.18
Lungs	0.93^{a}±.07	0.95^{a}±.04	0.84^{a}±.05	0.95^{a}±.09	0.91^{a}±.10	0.95^{a}±.11
Kidney	0.34^{a}±.02	0.31^{a}±.01	0.30^{a}±.02	0.19^{c}±.03	0.37^{d}±.04	0.30^{d}±.04
Heart	0.42^{a}±.03	0.40^{a}±.01	0.40^{a}±.02	0.31^{b}±.03	0.49^{c}±.04	0.45^{c}±.04
Blood	0.53^{a}±.26	0.25^{b}±.13	1.74^{c}±.18	2.38^{c}±.32	4.50^{d}±.38	4.59^{d}±.42
KidFat	0.85^{a}±.13	0.63^{a}±.07	0.71^{a}±.09	0.42^{a}±.16	0.79^{a}±.19	0.41^{a}±.21
OmFat	-0.24^{a}±.16	0.17^{b}±.08	0.61^{c}±.11	0.71^{c}±.20	1.21^{d}±.23	0.95^{d}±.26
MesFat	-0.16^{a}±.15	0.09^{b}±.08	0.43^{c}±.10	0.96^{d}±.18	1.40^{d}±.22	2.25^{e}±.24

Means with different superscripts in the same row differ significantly ($p<0.01$). KidFat= kidney fat; OmFat= omental fat; MesFat= mesenteric fat

Figure 1. Carcass fat trends as a percentage of EBW at different permanent incisors eruption in local Matebele goat of Zimbabwe.



DISCUSSION

The non significant effects in the size of front barrel, carcass length and kidney fat between I_1 and I_2 confirm the results of Simela et. al., (1999) in another flock of the same breed, who found carcass of milk teeth and two teethed goats tended to be similar in dimension and composition to those of four teethed ones. The goats slaughtered at I_3 (2.5 - 3 yrs) had the highest DP and goats slaughtered at BM had the lowest dressing percentage. Similar observation were reported where as age progressed there was decrease in dressing percent or heavier weights reduces DP (Ryan et. al., 2007). In a related study in sheep Skapetas et. al., (2006) reported that age significantly affected dressing percentage and higher slaughter weights improved DP, though DP tends to be higher in sheep than goats (Sen et. al., 2004). Although the present study was carried out under range management in semi arid tropics, the DP range obtained (40.29 to 45.53) was almost similar to those reported by Dadi et. al., (2005)(41.0 to 45.90) working with Borana and Arsi-Bale goats under different durations of feedlot management. Elsewhere estimated dressing percentage for local Matebele goats correspond with the reports of Nsoso et al., (2004) and Warmington and Kirton (1990). This coincidence may not be expected because apart from age differences in these studies and management conditions (Mahgoub et. al., 2005; Mourad et. al., 2001; Kasava Rao et. al., 2003; Lupton et. al., 2008) genotype may also influence differences in dressing percent in goats (Dhanda et. al., 1999; Mahgoub and Lodge, 1996); Amin et. al., 2000). In our case goats on range tend to have low DP than those on intensive management (Ryan et. al., 2007) possibly due to low slaughter weights and high proportion of non carcass components (Mahgoub, 1997). Owen et al., (1983) reported that as slaughter age increases the proportion of internal body organs minus gut content increased relative to external components which may have reduced the DP. Comparable DP to the range obtained in the present study were reported for Borana and Arsi-Bale by Dadi et al.,2005 (41.0 to 45.9 %) and Boer crossbred goats on range by Ryan et al., (2007) (41.8 %), however in the same study concentrate fed goats had higher DP (48.2 to 51.3 %) (Ryan et al (2007). Elsewhere higher DP than in the present study based on EBW were reported for Capretto and Chevon goats carcasses of 50 to 55% by Dhanda et. al., (1999). There was no relationship between dressing percent and kidney fat in different teeth groups, and this partially agrees with what was reported by Kirton and Morris (1989) who found differences among age groups. Results obtained with Matebele goats confirmed that high estimates found in literature for DP can be particularly explained by differences in production systems (i.e. range vs. intensive) (Johnson and Mc Gowan, 1998). The DP for goats slaughtered at the age of 1 year which is equivalent to 1st permanent incisors eruption and 3 year which is equivalent to 3rd permanent incisors eruption were within the range reported in small stock (Mahgoub et. al., 1998). It was interesting to note that there was an increase in dressing percentage with advanced permanent incisors eruption and a similar pattern of results was also observed by Mourand et. al., (2001) with increased in age. The low DP and high percentage ratio of offals weight to EBW may negatively affect Matebele goat's potential for large scale production under feedlot condition. Carcass score for the I_1 and I_2, I_3 and I_4, and BM and SM groups were almost similar. A similar and significant ($p<0.01$) trend was observed in omental fat and blood. This indicates probably that the lean carcass can be obtained when goats are slaughtered when there is an eruption of 3rd permanent incisors (I_3) eruption or less

As a percentage of EBW goats slaughtered at BM had the highest proportion of most edible body parts and meat offal. Internal organs (liver, heart, kidney, lungs) contributed on the average 3 % of EBW and elsewhere including the spleen internal organs contributed 4.9 % of the gross value of goat carcass (Aduku et. al., 1991). The proportion of head did not change within groups but it was the feet proportion that increased markedly from I_1 to I_3 which coincided with the decrease in pelt and kidney fat seemed to be constant with respect to the gut contents in relation to number of incisors eruption, there were not much differences amongst teeth groups and gut content as percentage of

live weight ranged from 2l % - 27%.The gut fill value as a proportion of live weights obtained in the present study for the local Matebele goat confirms the results by Hatendi et al., (1992) of 10 % to 23 % but were greater than 6% to 18 % and 15 % to 18 % recorded for finished Sudan Desert goats and, indigenous Malawi and Boer goats by Gaili et al (1972) and Owen and Norman, (1977), respectively.

There was a significant ($p< 0.01$) difference between mesenteric fat amongst teeth groups which increased with increasing number of incisors eruption. The fat trend from I_2 through I_3 group tended to maintain a similar pattern from highest kidney fat> omental fat> mesenteric fat while reverse pattern was thereafter observed where kidney fat contributing the least to total fat. It seems reasonable to assume that the sudden change in proportion of fat deposition may be related to the differences in the ability to convert feed efficiently into weight gain at an early growth than at advanced permanent eruption of incisors. This is an indication of excessive fat deposition as age progresses and this conforms to what was reported in the literature, (Skarda, 1998). Mahgoub and Lodge, (1996) also reported an increase in weight of kidney and intestinal fat as slaughter age increase which is equivalent to the increase in number of permanent incisors teeth. Kidneys and heart weight were non-significant amongst I_1, I_2 and I_3 and this partially agrees with reports by Singh et. al., (1994) who obtained non-significant difference between age and percentage of offal. However cited percentage decrease of offal with increasing body weight, which may apply as from the BM group in the present study. The lower proportion of non carcass components in the I_3 may have contributed to higher dressing percentages which is in agreement with the literature findings (Mahgoub and Lodge, (1996) in goats and Mahgoub et. al., (1998) in Omani sheep. Prasad et. al., (1992) reported partially similar findings than in the present study where the proportion of non-carcass components (particularly the alimentary canal and contents) decreased in the heavier weight range (increased permanent incisors eruption).

In local Matebele goat slaughtered at different permanent incisors eruption stages (26.57 to 37.33 kg) there were not much differences in the total saleable percentage of different teeth groups according to local criteria which ranged from 72 to 78. Mahgoub and Lodge (1996) found 69 to 71 total saleable percentage for different sex groups of Omani Batina goats slaughtered at 28kg while Owen and Norman (1977) reported 78 to 81 of saleable percentage for indigenous Malawi goats and Boer goats.

CONCLUSION

This study indicated marked effects of state of permanent incisors eruption representing the age of slaughter on carcass performance in goats. Optimum price may be obtained by selling animals with less than 6 tooth which coincides with highest carcass yield including edible body parts and meat offal. Disposing goats after 3rd pair of permanent incisors eruption would compromise carcass quality due to increased total fat content. It was suggested that marketing of goat carcasses could be improved by classifying animals according to number of permanent incisors eruption which is a near estimate of the age of the animals and marketing goats in uniform or consistent groups will generally increase live animal value

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