Prospects for Commercial Feedlot Finishing of Sheep in Zanzibar

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Abstract*: Evaluation of growth and carcass performance of sheep under two feedlot finishing diets was done in Zanzibar. Fifty-four sheep aged 9-12 months with initial body weight 18.9±0.6kg) were divided into three treatments T1, T2 and T3 each with three replicates. T2 and T3 sheep were assigned randomly to two concentrate formulations (concentrate 1 and concentrate 2) while T1 of similar number used as control were grazing during the day and offered no supplements. All animals in T2 and T3 were offered 600g/day concentrates and free access of green forages as basal feed. The concentrates' principal energy ingredients were rice bran and wheat pollard included as 35% and 25% in T2 and 40% and 20% in T3 respectively while holding other ingredients constant. Feeding was done for 82 consecutive days; finally 6 animals were randomly picked from each treatment and slaughtered for carcass analysis. A taste panel was assigned to assess acceptability and ranking of mutton against beef and goat meat by consumers. The results revealed average daily gain of 19.8 ± 4.92, 90.2 ± 3.94 and 85.7 ± 3.85g/day for T1, T2 and T3, respectively. There were no significant differences on feed intake, growth performance, empty body weight and hot carcass weight between T2 and T3, however both (T2 And T3) were significantly superior ($P < 0.05$) to T1. The taste panellists ranked mutton as significantly superior ($P < 0.05$) in all quality parameters over beef and goat meat. Cash returns were significantly higher ($P < 0.05$) from animals receiving T2. It was concluded that concentrate 1 (T2) can profitably support an average daily gain of 90.2g for sheep entering the feedlot at 18kglive weight and producing carcasses acceptable to consumers in Zanzibar.*

Key words: Sheep, feedlot finishing, live weight gain, carcass characteristics and concentrate cost effectiveness.

INTRODUCTION

Zanzibar has a population over 350 people/km^2 which is increasing at a rate of 2.8% annually URT (2012). Local production of red meat is negligible with over 90% of meat reaching the market derived from either imports of live animals or meat from animals' slaughtered outside the Islands (NSCA, 2008). Intensive feedlot finishing of goats in Zanzibar has proven profitable (Mohammed, 2015) and many small scale farmers are attracted into this enterprise. Local demand for mutton in Zanzibar is rising following increase in tourist hotels. Studies by Gizwa *et al.* (2010) in

Ethiopia and Shirima, (2013) in Tanzania have both shown that local types of sheep may be raised profitably under feedlot yielding carcasses of acceptable quality. So far no studies have been made on feedlot finishing of sheep on Zanzibar islands. Therefore, the current study aimed at looking into the possibility of profitably finishing sheep of good carcass quality under feedlot by using locally available feed resources.

METHODOLOGY

The study was conducted at Kizimbani Agricultural Training Institute (KATI). A total of fifty four castrate *Black Head Persian* sheep at the age of 9-12 months were involved. The slated floor house was divided into fourteen pens (3m x 5m) sufficiently to hold 6 sheep at 2.5 m^2 floor allowances per each individual. The experimental period was 82 days, where grasses/fodders were used in the study as a basal diet. The experimental animals were randomly allotted into three treatment groups corresponding to T1 (Control) rose on free grazing of *Stenotaphrum dimidiatum* (Pemba grass) and *Brachiaria decumbens* (Signal grass) without supplementary feed. Concentrates formulated and offered to T2 and T3 animals at 600g/head/day. T2 contained (35% Rice bran + 25% Wheat pollard) and T3 (40% Rice bran + 20% wheat pollard) while all the other feed ingredients were included in the formulations on the same levels. Feeds analysis revealed 8.7& 7.4MJ/KgDM and 162g& 146g CP/KgDM respectively for T2 and T3. Each treatment had 18 individuals that were divided into three replicates of six animals each. After adaptation the animals were fasted on 13^{th} day and empty body weight recorded on the 14^{th} day ready for allotment. This weight was regarded as the initial weight that was later applied as a covariate for comparison of treatments effects. Feeds offered to the animals were weighed together with refusal and recorded. At the end of the feeding trial, two animals were randomly picked in each replicate making a total of six individuals from each treatment and were slaughtered after overnight fasting for carcass evaluation.

Organoleptic test was conducted and samples of the mutton, goat meat and beef were used. Taste panel was divided into 2 groups of 15 individuals each. Group 1, was used for testing the organoleptic tastes among mutton, goat meat and beef (i.e. aroma, flavour, juiciness and softness). Group 2 was subjected to meat preference and recognition among mutton, goat meat and beef. Feed quantity and their costs were recorded to determine the overall cost of production in Tanzania shillings for each treatment. The net revenue was obtained by the difference between the sales less variable costs. The study data were subjected to analysis of variance (ANOVA)

using General Linear Model (GLM) procedure of Statistical Analysis System (SAS, 2002) with treatment as the main effect in the model. In the following Model, initial weight was subjected to Covariate analysis (Kaps and Lamberson, 2009) where b used to represent covariate analysis on initial body weight.

$$Yij = \mu + Ti + b\ (Xij - \sum x/n) + eij$$

Yij = Response variable

μ = General mean

Ti = Treatment effect

B = Regression coefficient of initial body weight of an animal on subsequent performance.

Xij = Mean of initial body weight of individual animal

$\sum x/n$ = Mean of initial body weight in the experiment

eij = Random error

RESULTS AND DISCUSSION

The experimental concentrate formulae and proximate analysis results are presented in Table 1 and 2. The chemical analysis for the experimental concentrates in terms of metabolizable energy and percentage crude protein are in line with those reported by Shirima *et al.* (2014). Proportionally increase in level of nutrients in the diets fed to the animals improves weight gain as reported by Geleta *et al.* (2013). The concentrate offered T2 had 1.3Mj/kgDM and 1.6%CP higher than that offered to T3 animals. With better nutritional value of the T2 diet, weight gain for T2 was numerically increased than for T3 animals, however the gain was not statistically significant as ($P > 0.05$).

Table 1: Concentrates formulae

S/N	Feed Ingredient (%)	Inclusion (as fed)	
		D1	**D2**
1	Rice Polishing	35.0	40.0
2	Wheat Pollard	25.0	20.0
3	Molasses	7.0	7.0
4	Fish Meal	12.0	12.0
5	Copra Cake	12.0	12.0
6	Blood meal	5.0	5.0
7	Bone meal	2.3	2.3
8	Limestone	1.5	1.5
9	Salt	0.2	0.2

Total percent	**100**	**100**
Mj/Kg	**8.7**	**7.4**
%Cp	**16.16**	**14.59**

Table 2: Feed ingredients' chemical composition

Feed ingredients (%)	DM	CP	CF	EE	ASH	MJ/KgDM
Rice bran	96.2	8.2	30.0	6.8	12.1	5.4
Wheat pollard	97.3	17.1	7.5	4.6	4.1	13.7
Copra cake	97.3	24.2	15.4	14.0	10.8	11.8
Fish meal	97.7	47.6	0.9	2.7	46.2	9.3
Blood meal	97.5	49.1	0.0	0.3	43.6	9.7
Molasses	66.3	2.5	0.0	0.0	7.6	9.5
Brachiaria decumbens	94.4	3.4	33.0	0.8	5.4	9.1
Pennisetum purperium	95.0	11.2	32.6	2.0	6.5	9.5
Stenotaphrum dimidiatum	95.3	6.2	29.5	3.7	8.5	5.7
Gliricidia sepium	94.7	21.5	18.4	2.2	6.9	11.6
concentrate 1 (T2)	90.9	16.2	12.8	3.1	17.0	8.7
concentrate 2 (T3)	91.2	14.6	15.3	3.4	20.9	7.4

DM = Dry matter, CP = Crude protein, CF = Crude fibre, EE = Ether extract, Ash = Minerals and Mj = Mega joule (Metabolizable Energy)

Feed intake for the experimental sheep is presented in Table 3. The estimated feed intake parameters for free grazed sheep (T1) were significantly lower ($P < 0.05$) as compared to T2 and T3 that were offered experimental diets. However, there were no significant difference ($P > 0.05$) of the feed intake parameters between T2 and T3. The total DM intake for T2 and T3 from the diets, translate the ratio of concentrate to forage as 2:1. Such level is lower than that reported in a study by Shirima *et al.* (2014) on fat-tail sheep in Dodoma, who recommended a ratio of 3:1 in favour of concentrates for finishing partially grazed sheep. The present study involved confined sheep, factor which would suggest that confined animals may not need higher intake of concentrate in daily allowances. Changing the relative proportions of rice bran and wheat pollard in concentrate 1 and concentrate 2 seem not to have significantly affected the voluntary intake despite a slight increased metabolizable energy and crude protein intake from T2. Similar observations were reported by Nalini *et al.* (2013) who finished lamb with different levels of roughage and concentrates during a period of 180 days.

Table 3: Feed intake across treatments in experimental sheep

	Treatments				
Parameters	**T1**	**T2**	**T3**	**SE**	**P-Value**
DMIg/day	576.27[a]	798.29[b]	804.27[b]	9.473582	<.0001
CPIg/day	27.66[a]	110.04[b]	109.00[b]	1.495994	<.0001
ME(MJ/day)	4.73[a]	13.86[b]	12.03[b]	0.383385	<.0001
DMI(%BWT)	3.5	3.45	3.53	0.051556	0.4944
DMI/KgW$^{0.71}$	77.42[a]	85.47[b]	87.33[b]	1.298763	<.0001
CPI/KgW$^{0.71}$	3.72[a]	11.86[b]	11.83[b]	0.187119	<.0001

[ab] Means in the same row with different superscript are significantly different (P<0.05)

DMI (g/d) = Dry Matter Intake (gram per day), CPIg/day = Crude Protein intake (grams per day), ME (MJ/d) = Metabolizable Energy (Mega Joule per day), DMI (%BWT) = Dry Matter Intake as Percentage live Body Weight, DMI/KgW$^{0.71}$ = Dry Matter Intake per Kilogram Metabolic Body Weight, CPI/KgW$^{0.71}$ = Crude Protein Intake per Kilogram Metabolic Body Weight,

Growth performance of the experimental sheep is presented in Table 4. The initial weight was subjected to covariate analysis. There was significant difference ($P < 0.05$) that animals in T1 had lower values in all growth performance parameters. Statistically there were no difference between T2 against T3 at ($P > 0.05$). However, sheep on T2 and T3 achieved daily weight gain of between 85-90g, the values closer to other indigenous sheep in Tanzania (Shirima *et al.,* 2014) and those in Sudan by Mohammed *et al.* (2012). This would mean that both formulations of diets were able to support animals of small frame size intended to finish at light weight class (25-30kg) and yield carcasses between 10-15kg. The FCR observed in this study i.e. 9.7kgDMI/kg gain is within the range to that reported by Shirima *et al.* (2014) on long fat tailed sheep in Tanzania under feedlot finishing.

Table 4: Growth performance

Parameters	Treatments			P-Value
	T1	T2	T3	
IBWT(Kg)	16.3±0.80[a]	18.9±0.64[b]	18.9±0.62[b]	0.0246
FBWT(Kg)	17.9±0.75[a]	26.1±0.60[b]	25.7±0.59[b]	<.0001
TWG(Kg)	1.6±0.39[a]	7.2±0.32[b]	6.8±0.31[b]	<.0001
ADG(g)	19.8±4.92[a]	90.2±3.94[b]	85.7±3.85[b]	<.0001
FCR(DMI/TWG)	29.5±4.37[b]	9.7±3.51[a]	9.9±3.41[a]	<.0001

[ab] Means in the same row with different superscript are significantly different (P<0.05)

INBWT = Initial Body Weight, FBWT = Final Body Weight, TWG = Total Weight Gain, ADG = Average Daily Gain, FCR = Feed Conversion Ratio, FCE = Feed Conversion Efficiency.

Killing out characteristics of the experimental sheep is presented in Table 5. There is significant difference (P < 0.05) in all killing out characteristics T1 had lower values compared to T2 and T3. Among the two treatments there were insignificant difference as (P > 0.05) in all killing out characteristics.

The characteristics were far superior to sheep that were grazed without additional supplements. This clearly demonstrates the practical need for supplemental feeding for finishing sheep in Zanzibar. Sheep in the present study had a dressing percentage close to those reported by Shirima *et al.* (2014) on long-fat tail sheep and Alemu *et al.* (2014) on Ethiopian Menz sheep. Sheep in T2 and T3 had most of the surplus energy directed towards fat deposition an observation that corresponds to the findings reported by Ríos-Rincón et al. (2014) and Oramari *et al.* (2014).

Table 5: Killing out characteristics of experimental sheep across treatments

Parameters (kg)	Treatments			SEM	P-Value
	T1	T2	T3		
SW	18.25[a]	27.63[b]	26.45[b]	0.90	<0.0001
EBW	13.57[a]	23.24[b]	21.38[b]	0.90	<0.0001
HCW	6.45[a]	11.52[b]	10.87[b]	0.90	<0.0001
DP	47.37[a]	49.50[b]	50.84[b]	0.90	0.0232

[ab] =Means in the same raw with difference superscript are significant at (P<0.05)

SWT = slaughter weight; EBW = Empty body weight; HCW = Hot carcass weight and DP = Dressing percentage.

Organoleptic test of mutton versus beef and goat meat are presented in the Table 6. All the organoleptic parameters were significantly (P < 0.05) higher ranked for mutton versus beef and goat meat. Additionally, softness for mutton was highly significant (P <. 0001) superior than the rest of the meat types. Sensory evaluation of different meat types revealed that mutton had higher scores especially in softness, however statistically was insignificant as reported by (Zhang, 2015). The current study revealed similar results to that reported by Abubakar *et al.* (2011), where mutton ranked higher on the aspects of organoleptic and acceptability parameters than goat's meat, though it was statistically insignificant. Softness of the mutton in the current study was attributed to low level of collagen contained in mutton as reported by Naveena (2013).

Table 6: Organoleptic taste

Parameters	Beef	Goat meat	Mutton	SEM	P-Value
Aroma	2.80^{b}	2.27^{a}	3.33^{b}	0.22	0.0058
Flavour	2.67^{a}	2.73^{b}	3.33^{c}	0.18	0.0272
Juiciness	2.40^{a}	2.67^{b}	3.47^{c}	0.21	0.0028
Softness	2.33^{a}	2.80^{b}	3.87^{c}	0.20	<.0001

^{abc}Means in the same row with different superscript differ significantly at (P <0.05). Preference and recognition of mutton versus beef and goat meat is presented in the Table 7. Panellists preferred mutton to beef significantly (P < 0.05) however they were unable to recognise the meat types. On the other hand, panellists were significantly unable to establish preference between mutton and goat meat (P > 0.05). Moreover, the panellists were able to recognise mutton (P < 0.05) but couldn't do the same for goat meat. This could probably be attributed to higher content of ether extract (fatty) and ash (minerals) in mutton than the other meat types. A study conducted by Lijalem *et al.* (2015) on proximate analysis, result of boiled meats (mutton, chevon and beef) revealed that high percentage of fat in beef increases flavour of the meat (Lida *et al.,* 2015).

Table 7: Meat preference and recognition by test pannelists

Parameters	Beef	Mutton	P-value
Preference	1.86±0.47^{a}	4.00±0.44^{b}	0.0023
Recognition	3.57± 0.52	2.25±0.49	0.0746
Parameters	**Goat meat**	**Mutton**	**P-value**
Preference	2.86±0.53	3.13±0.53	0.7263
Recognition	1.80±0.48^{a}	3.40±0.48^{b}	0.0251

^{ab}Means in the same row with different superscript differ significantly at (P <0.05).

Table 8 provides a summary of costs and revenues calculated from the present study. Sheep in T2 and T3 were significantly higher ($P < 0.05$) in all cost-benefit parameters compared to T1 animals. Total revenue, net income and percentage return to investment were significantly ($P < 0.05$) higher for T2 as compared to T3. Sheep in T2 produced extra net profit of 6 229.98 Tanzanian shillings per head when compared to T3. This result between the two treatments was attributed to concentrate 1 (offered to T2) having higher nutritive values than concentrate 2 (offered to T3) while other factors were maintained constant. The current study result is in-line with those reported by Shirima *et al.* (2012) who noted that an increase in level of concentrate improves profitability of feed. However, the total feed cost for concentrate 1 was higher than that of concentrate 2, the overall returns to feed cost was higher in concentrate 1 than that from sheep which received concentrate 2. This margin of difference translates into net return to investment for concentrate 1 against concentrate 2. The most important determinant of change in cost was the content of Wheat Pollard (WP) in the formulations.

Table 8: Cost-benefit

Parameters	T1	T2	T3	P-Value
FWT	18.27±0.59^{a}	27.62±0.47^{b}	26.5±0.46^{b}	<.0001
TC	63,586.95±874^{a}	79,656.32±703^{b}	79,196.30±683^{b}	<.0001
CWT	6.5±0.32^{a}	11.53±0.26^{b}	10.87±0.25^{b}	<.0001
TREV	71,880.03±1579^{a}	121,110.00±1270^{c}	114,420.00±1234^{b}	<.0001
NIC	8,293.03±733^{a}	41,453.68±590^{c}	35,223.70±573^{b}	<.0001
PRI	13.03±0.52^{a}	53.04±0.42^{c}	44.48±0.41^{b}	<.0001

^{abc}Means in the same row with different superscript differ significantly at ($P < 0.05$).

INWT= Initial weight, TC = Total Cost, FWT = Final weight, CWT = Carcass Weight, TREV = Total Revenue, NIC = Net Income and PRI = Percentage Return to Investment.

CONCLUSIONS

It is concluded that the formulation concentrates 1 containing rice bran and wheat pollard at a ratio of 1.4:1 in favour of rice bran can profitably support an average daily gain (ADG) of at least 90.2g for sheep entering the feedlot at 18kglive weight. It was also shown that mutton can be

readily acceptable to consumers if animals are raised to produce carcases of superior quality.

References

Abubakar, M. M., Bube, M. M., Adegbola, T. A. and Oyawoye, E. O. (2011). Assessment of Four Meat Products (Kilishi, Tsire, Dambu and Balangu) in Bauchi Metropolis. *Journal of Veterinary World* 6892(8108): 9485.

Alemu, B., Animut, G. and Tolera, A. (2014). Effect of Millettiaferruginea (Birbra) foliage supplementation on feed intake, digestibility, and body weight change and carcass characteristics of Washera sheep fed natural pasture grass hay basal diet. Journal of *SpringerPlus* 3(1), 50 – 60.

Geleta, T., Negesse, T., Abebe, G. and Goetsch, A. L. (2013). Effect of supplementing grazing Arsi-Bale sheep with molasses-urea feed block on weight gain and economic return under farmers' management condition. *J. Cell Anim. Biol*, *7*(10), 125-131.

Gizaw, S., Tegegne, A., Gebremedhin, B. and Hoekstra, D. (2010). Sheep and goat production and marketing systems in Ethiopia. International Livestock Research Institute, Nairobi. Working Paper 23. 58pp.

Hossain, M. E., Sultana, S., Shahriar, S. M. S. and Khatun, M. M. (2012). Nutritive value of rice bran. *Online Journal of Animal Feed Research* 2: 235 - 239.

Iida, F., Saitou, K., Kawamura, T., Yamaguchi, S. and Nishimura, T. (2015). Effect of fat content on sensory characteristics of marbled beef from Japanese Black steers. *Animal Science Journal*, *86*(7), 707-715.

Kaps, M. and Lamberson, W. R. (2009). *Biostatistics for animal science*. CABI.

Lijalem, T., Beyan, M. and Banerjee, S. (2015). Quality of beef, chevon and mutton at Hawassa, Southern Ethiopia. *African Journal of Food Science*, *9*(5), 301-306.

Madsen, J., Kimambo, A. E., Hvelplund, T. and Laswai, G. H. (2008). Opportunities for production of tender high-quality beef in Tanzania. In *The 5th All Africa Conference on Animal Agriculture and the 18th Meeting of the Ethiopian Society of Animal Production (ESAP)*. 34pp.

Mohammed, K. (2015). Assessment of Rations Formulated Using Locally Available Feed Resources for Finishing Goats in Zanzibar.

Dissertation for awarded of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania.94pp.

Mohammed, M. D., Elamin, K. M., Amin, A. E., Hassan, H. E. and Khalid, A. F. (2012). Effects of feeding Beta *Vulgaris saccharifera* bulb for finishing desert lambs under tropical conditions of Sudan. *Journal of Veterinary World* 5(6): 330 - 334.

Nalini Kumari, N., Ramana Reddy, Y., Blummel, M., Nagalakshmi, D., Monika, T., Reddy, B. V. S. and Reddy, C. R. (2013). Growth performance and carcass characteristics of growing ram lambs fed sweet sorghum bagasse-based complete rations varying in roughage-to-concentrate ratios. *Tropical Animal Health and Production*, *45*(2), 649-655.

Naveena, B. M., Sen, A. R., Muthukumar, M., Girish, P. S., Praveen Kumar, Y. and Kiran, M. (2013). Carcass characteristics, composition, physico-chemical, microbial and sensory quality of emu meat. *British poultry science*, *54*(3), 329-336.

NSCA, (2008). National Sample Census of Agriculture. Smallholder Agriculture. Volume VIII: Livestock Sector-Zanzibar Report 244pp.

Ríos-Rincón, F. G., Estrada-Angulo, A., Plascencia, A., López-Soto, M. A., Castro-Pérez, B. I., Portillo-Loera, J. J. and Dávila-Ramos, H. (2014). Influence of protein and energy level in finishing diets for feedlot hair lambs: Growth performance, dietary energetics and carcass characteristics. *Asian-Australasian Journal of Animal Sciences* 27(1): 55 – 60.

Shirima, E. J. M., Mtenga, L. A., Kimambo, A. E., Laswai, G. H., Mgheni, D. M., Mushi, D. E. and Safari, J. G. (2012). Economic analysis of Tanzanian long fat-tailed sheep with different ages at entry to the feedlot and level of molasses concentrate diet. *Livestock Research for Rural Development* (24):138 - 143.

Shirima, E. J. M., Mtenga, L. A., Kimambo, A. E., Laswai, G. H., Mgheni, D. M., Mushi, Shija, D. S. and Safari, J. G. (2014). Influence of age at entry and level of concentrate feeding on growth and carcass characteristics of feedlot-finished Tanzanian long-fat-tailed sheep. *Tropical Animal Health and Production* 46(5): 815 – 822.

Shirima, E.J. (2013). Evaluation of appropriate entry-age and period of stay in feedlot for optimal production of quality meat from Tanzania Long

Fat tailed sheep. PhD Thesis Sokoine University of Agriculture, Morogoro, Tanzania.

URT, (2012). *United Republic of Tanzania. Population and human settlements census report*. Government printers, Dar-es-Salaam. 471pp.

Zhang, R. (2015). *Characterisation of bresaola products made from beef, veal, wagyu, mutton and lamb* (Doctoral dissertation, Auckland University of Technology).

ACKNOWLEDGMENT

I would like to acknowledge the Commission for Science and Technology for financial support that enabled me to undertake the research. Further, thanks to Kizimbani Agricultural Training Institute (KATI) for providing permission and material support that allowed me to conduct my research smoothly. Many thanks to my Director, Department of Animal Production (Mr. Hafidh Said Baalawi), Director KATI (Mr. Mohammed Khamis Rashid) for additional financial support to accomplish the study.