Feedlot weight gain and carcass production efficiency of Washer sheep under concentrate supplementation

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Abstract

The objective of this study was to evaluate the fattening potential of Washera ram lambs and to determine economic level of concentrate feed for fattening. Sixty nine month old ram lambs were used for the experiment. Animals were allocated to six feeding treatment groups: a control group maintained on grazing alone and five groups supplemented with 300, 400, 500, 600 and 700 g day^{-1} of concentrate feed in addition to grazing. Two feeding durations (3 and 4 months of feeding) were considered. Extending the feeding period to 4 months resulted in a decline of 12.6% in overall average daily gain (ADG) and an insignificant increase of 2.8% in final weight (FW) compared to 3 month feeding. Over a 3 month feeding period, FW and ADG varied from 24.9 to 32.9 kg and from 38 to 126 g day^{-1}, respectively. Supplementation of 500 g day^{-1} resulted in higher ADG and FW compared to lower levels of concentrate feeding. However, there was no difference among groups supplemented with 500 g day^{-1} and above. Similarly, the supplemented groups had significantly higher carcass weight, dressing percentage, fat thickness and rib eye muscle area compared to the non-supplemented group, though differences among the different levels of supplementation were not consistent. The highest net economic benefit (ETB 151.6 per sheep) was obtained from sheep fattening based on 500 g day^{-1} concentrate feeding for 3 months. Sensitivity analysis indicated that profitability of this treatment would remain positive up to 20% output price reduction and input price increment. The current results show that Washera sheep has a high feedlot performance and meets an export market demand of around 30 kg at yearling age. Supplementation of 500 g day^{-1} concentrate feed for 93 days during the dry season for an economic feedlot operation targeting local markets is recommended. The proportion of the tail to the total carcass weight was significantly higher in the supplemented groups than in the non-supplemented group indicating wastage of energy on the less edible portion of the carcass. Thus future research could focus on diverting the energy expenditure in fat deposition in the tail region to the leg and shoulder region. Ration formulation based on locally available forage and/or cheaper feed resources to replace the concentrate feed recommended here could result in a more profitable feedlot operation. Demonstration to Washera sheep farmers and commercial feedlot operators is recommended in order to promote these feeding technologies.

Key words: Carcass, concentrate feeding, economic ration, Washera sheep, weight gain.

Introduction

Washera, also known as Agew or Dangla, is a short-fat-tailed, short-haired, predominantly brown, and polled sheep breed indigenous to Ethiopia. It is one of the most productive sheep breeds in the country with large body size (Solomon *et al*., 2008) and litter size of 1.11 (Mengistie, 2008). The breed mainly inhabits the wet, warmer mid-highlands (1600-2000 m. a.s.l.) of the Amhara Regional State (W. Gojjam, E. Gojjam, and Awi zones, and Alefa Takusa district in N. Gondar zone) and Benishangul-Gumz Regional state (Dangur and Madura districts), in northwestern highlands of Ethiopia (Solomon *et al*., 2008; Sisay 2009). The sheep are an important source of livelihoods for the local farmers with a potential to support the national economy because of its fast growth potential.

Though Washera sheep is known for its fast growth and large body size, the feedlot performance of the breed has not been studied. Under traditional smallholder management system yearling weight of Washera sheep is reported to be 24 kg (Mengiste, 2008).The predominant fattening practice followed in the area is to castrate the lambs at 8-12 months of age and supplement with grass pea (*Lathyrus sativus*) and maize grain. However, the daily amount and frequency of supplementation is inadequate resulting in a longer period of fattening that might render the activity less economical. Moreover, the potential of the breed might be under exploited. Thus management interventions such as improved feeding practices need to be devised to exploit the breed potential. The objectives of this study were to assess the feedlot performance, carcass production efficiency and potential of Washera sheep to meet export sale weight of requirement of 30 kg around yearling age and to identify optimum concentrate feed level for feedlot operators.

Material and methods

Animals and their management

The experiment was conducted at Andassa Livestock Research Center. Sixty ram lambs of about 9 months old bought from the local markets were used for the experiment. The experimental animals were allocated into six feed treatment groups randomly after

stratifying by their initial body weight. The first treatment group was control which was maintained with grazing only while the rest 5 groups were supplemented with 300, 400, 500, 600 and 700 g $head^{-1}$ day^{-1} concentrate feed, respectively in addition to grazing. All animals were grazed together during the day and the supplementary concentrate feed was provided individually twice a day before and after grazing. The concentrate mix was grass pea (*Lathyrus sativus)* and maize grain *(Zea maize)* at a ratio of 4:1. The concentrate feed had 21% crude protein and 14 MJ kg^{-1} metabolizable energy on dry matter basis.

Body weight and carcass measurements

Initial live weight and fortnightly weights were recorded for each animal. Weights recorded at the 93rd (3 month feeding period) and 121st (4 month feeding period) day of feeding were used for analysis of weight gains. Body condition score was recorded for each animal at the end of the experiment. At 121 days, 5 sheep from each treatment were randomly selected for carcass evaluation. Carcass dissection was done as follows. After bleeding and removal of digestive tract and non-carcass components, hot carcass weight was recorded. The whole carcass was separated into two halves (fore and hind quarters) between 12th and 13th rib. Then the whole carcass was divided into five commercial cuts (shoulder, ribs, loin, leg and tail) after removal of the flank part and weighed separately. Tail was removed from the hind quarter. The loin and legs are separated just in front of the hip bones by cutting through the back where the curve of the leg muscles blends into the loin. Finally foreleg, shoulder and neck separated from the ribs. Fore leg, shoulder and neck was measured together and considered as shoulder. Dressing percentage was calculated on hot carcass weight basis and expressed as proportion of final weight before slaughter. Fat thickness and rib eye muscle area were measured at the longissimus between 11th and 12th rib using plastic ruler and planimeter, respectively.

Data analysis

The data were analyzed fitting a general linear model using SAS (2003), with concentrate level as main effect and final weight, average daily gain, carcass weight and dressing percentage as response variables and initial live weight as covariable. The covariate was kept in the model only when significant. Least square means were separated using adjusted

Tukey-Kramer test. Partial budget and sensitivity analysis was employed to assess profitability and sensitivity of the recommendations with fluctuations in feed cost and sheep price. Carcass weight gain at 93 and 121 days for cost benefit analysis was estimated based on the dressing percentage obtained for each feed level. The carcass price used in this analysis was ETB 45 kg^{-1} for the non-supplemented and ETB 50 kg^{-1} for supplemented group considering the current sheep mutton price. Only feed cost was considered as a variable cost in the analysis since the other costs (like labor and medicine costs) were similar for all treatment groups.

Results and discussion

Feedlot weight gain

The effect of concentrate supplement for 93 and 121 days on weight gain of Washera sheep is presented in Table 1. There were no difference between feeding for 93 and 121 days in final body weight and average daily gain. In both feeding durations, final body weight and average daily gain significantly increased ($P<0.05$) as feed amount increased from 0 to 500 g. There was no difference in final live weight and average daily gain among groups supplemented 500 g and above. Final weight and average daily gain of the control group was 3 folds lower than the 500 g supplemented group. Thus 500 g concentrate day^{-1} $head^{-1}$ was the optimum level of supplement for fattening of Washera sheep. At this level of supplement, final weight and average daily gain at 93 days were 32.0kg and 119 g day^{-1}, respectively. Improvement of live weight, average daily gain and body condition through concentrate supplement is in agreement with other studies in sheep (Solomon *et al*., 2006; Archimede *et al*., 2008). Final weight and average daily weight gain attained by Washera sheep in this study is higher than the result for yearling Menz sheep (26.1 kg and 70 g day^{-1}, respectively) fed on 500 g $day^{-1}$of concentrate supplement (Solomon *et al*., 2006). The daily weight gain by Washera sheep in the current study is comparable with the gain by Awassi x Menz crossbred sheep (101.4 g) supplemented with a similar amount of 500 g concentrate day^{-1} (Solomon *et al*., 2006).

Table 1. Performance of Washera sheep supplemented with different feed levels of concentrate mix

Trait	R^2	CV (%)	Feeding level (g head^{-1} day^{-1})					
			0	300	400	500	600	700
INWT*	0.60	14.8	20.5(0.98) [af]	20.7(0.98) [a]	21.2(0.98) [a]	20.0(1.04) [a]	21.2(1.04) [a]	22.4(1.04) [a]
WT93	0.90	4.7	24.9(0.45)[a]	29.1(0.45)[b]	30.7(0.45) [c]	32.0(0.48)d	32.8(0.48)[d]	32.9(0.49)[d]
WT121	0.88	5.9	24.4(0.57)[a]	29.2(0.57)[b]	31.0(0.57)[c]	32.9(0.61)d	33.8(0.61)[d]	34.7(0.62)[d]
ADG 93	0.79	17.1	38.0(5.3)[a]	88.0(5.3)[b]	101.0(5.30)[b]	119.0(5.60)c	126.0(5.60)[c]	126.0(5.60)[c]
ADG121	0.77	17.8	34.0(5.1)[a]	74.0(5.1)[b]	86.0(5.10)[b]	104.0(5.40)[c]	112.0(5.40)[c]	113.0(5.40)[c]
BC	0.67	18.1	1.2(0.13)a	1.9(0.12)b	1.9(0.12)b	2.4(0.13)c	2.6(0.13)c	2.9(o.13)c

**INWT = Initial live weight, WT93 and WT121 = Live weight at 93 and 121 days of feeding and ADG93 and ADG 121 = Average daily gain at 93 and 121 days of feeding. [£]Means within the same row followed by different letters are different at $p<0.05$.* Numbers in parenthesis are standard errors.

Carcass weight and characteristics

Results indicated that generally, supplementation resulted in increased carcass weight, dressing percentage, fat thickness and rib eye muscle area with increasing level of concentrate supplementation (Table 2). However, trends were not consistent with weight gains regarding feeding levels as carcass weights are expected to correlate well with body weights. This could be due to differences between animals in the different groups in non-carcass components (such as skin and lower leg part) and gut fill. On average the supplemented groups produced 15.7 kg of carcass as compared to 10.6 kg for the control group. Supplementation of 500 g concentrate gave a carcass weight of 15.6 kg with a dressing percentage of 48.5%. Washera sheep appeared to be more efficient in carcass production with dressing percentage of 47.8 to 51.5% in this study as compared to Menz sheep with a dressing percentage of 37 to 47% (Abebe *et al*., 2006) under different similar levels of concentrate supplementation and slaughter age. The current results are comparable with findings on different fat-tailed Turkey sheep breeds with dressing percentage of 43.1% to 50.6% (Esenbuga *et al*., 2001) and Moroccan Sardi and D'man sheep breeds with dressing percentage of 46.9% to 47.1% (Boujenane *et al*., 2003). However, Washera sheep seemed to be less efficient in carcass production compared to specialized European meat breeds with dressing percentage of 52 to 59% (Perez *et al*., 2002). However, these differences in efficiency could be due to differences in feed type and feeding level.

Table 2. Least square mean (standard error) of carcass characteristics and retail cuts of Washera sheep supplemented different feed levels of concentrate.

Trait	R^2	CV (%)	Feed level (g head^{-1} day^{-1})					
			0	300	400	500	600	700
Carcass (kg)	0.94	5.22	10.6(0.35)$^{a£}$	13.5(0.35)^{b}	14.7(0.35)^{c}	15.6(0.35)^{c}	16.9(0.32)^{d}	17.6(0.75)^{d}
DP (%)	0.60	4.96	44.2(1.08)^{a}	47.8(1.08)^{b}	48.6(1.08)^{b,c}	48.5(1.08)^{b,c}	51.5(1.22)^{c}	51.0(1.09)^{b,c}
Shoulder (kg)	0.93	4.99	3.6(0.10)^{a}	4.1(0.10)^{b}	4.4(0.10)^{b}	4.7(0.10)^{c}	4.9(0.10)^{d}	5.0(0.10)^{d}
Rib (kg)	0.82	8.73	2.0(0.11)^{a}	2.6(0.11)^{b}	2.6(0.11)^{b}	3.0(0.11)^{c,d}	2.9(0.10)^{b,c}	3.2(0.10)^{d}
Loin (kg)	0.70	12.8	1.7(0.12)^{a}	1.9(0.12)^{a,b}	2.2(0.12)^{b,c}	2.3(0.12)^{c,d}	2.4(0.11)^{d}	2.5(0.13)^{d}
Leg (kg)	0.83	8.33	2.6(0.12)^{a}	3.0(0.12)^{b}	3.3(0.12)^{b,c}	3.5(0.12)^{c,d}	3.8(0.11)^{d}	3.7(0.13)^{d}
Tail (kg)	0.77	23.6	0.6(0.19)^{a}	1.6(0.19)^{b}	1.8(0.19)^{b}	1.8(0.19)^{b}	2.4(0.17)^{c}	2.6(0.19)^{c}
FT (mm)	0.69	27.2	3.6(0.94)^{a}	5.8(1.05)^{a,b}	6.3(1.05)^{a,b}	8.6(1.05)^{b,c}	10.9(0.94)^{c}	10.6(0.94)^{c}
REM cm^2	0.69	10.1	10.9(0.56)^{a}	10.9(0.64)^{a}	11.6(0.64)^{a,c}	14.0(0.78)^{b}	14.2(0.57)^{b}	12.9(0.63)^{b,c}

DP = Dressing percentage, FT = Fat thickness, REM = Rib eye muscle. £Means within the same row followed by different letters are different at p<0.05.

Table 3 presents the proportion of the different commercial cuts as percentage of the total carcass. Leg and shoulder proportion of the supplemented groups was significantly ($p<0.05$) lower than the non-supplemented group. In contrast, tail proportion of in the supplemented groups was significantly ($p<0.05$) higher than in the non-supplemented group. The leg part represented 21.1 to 24.6 % of the total carcass in Washera sheep in this study, which is comparable with different fat-tailed breeds of Turkey (Esenbuga *et al*., 2001), but lower than reported for the meat breeds of European and crosses of fat-tailed and thin-tailed breeds of Iran with leg proportion of 28 to 35% (Archimede *et al*., 2008; Titi *et al*., 2007; Kashan *et al*., 2005; Pena *et al*., 2005; Perez *et al*., 2002). Proportions of leg and shoulder cuts represent an important character of meat production potential of specialized meat breeds. The current results suggest that Washera sheep tends to expend proportionally much energy in fat deposition in the tail region under high supplementation. Given the higher tail proportion in the supplemented group compared to the non-supplemented group in the current study which is comparable with other fat-tailed breeds but lower than the thin-tailed European breeds as discussed above, it can be hypothesized that fat-tailed sheep tend to deposit fat in the tail rather than the leg/shoulder region under high level of supplementation. This seems waste of energy (although large fat tail fetches higher price in local markets). Selection against fat tail or crossbreeding or tail docking of feedlot animals may be considered to further improve the meat production potential of Washera sheep depending on the target market.

Economics analysis

Results of the economic analysis of Washera sheep fattening are presented in Table 4. Treatment 4 (grazing + 500g concentrate mix) gave the highest net return and marginal rate of return to investment in both 93 and 121 days of feeding. Feeding for 93 was found to be more economical than feeding for a prolonged period of 121 days.

Table 3. Least square mean (standard error) of proportion of different commercial cuts.

Trait	R^2	CV (%)	Feed level					
			0	300	400	500	600	700
Tail (%)	0.51	21.00	6.3(0.01)$^{a£}$	11.6(0.01)^{b}	12.3(0.11)^{b}	11.6(0.11)^{b}	14.2(0.01)^{b}	14.4(0.11)^{b}
Shoulder (%)	0.65	4.35	33.6(0.01)^{a}	30.2(0.01)^{b}	29.6(0.01)^{b,c}	29.8(0.01)^{b,c}	29.2(0.01)^{b,c}	28.4(0.01)^{c}
Rib (%)	0.42	6.27	19.4(0.01)^{a}	19.1(0.01)^{a,b}	17.9(0.01)^{b,c,d}	19.3(0.01)^{a,d}	17.0(0.005)^{c,d}	18.4(0.01)^{a,d}
Loin (%)	0.21	7.99	15.8(0.01)^{a}	14.4(0.01)^{a}	14.9(0.01)^{a}	14.5(0.01)^{a}	14.1(0.005)^{a}	14.4(0.01)^{a}
Leg (%)	0.38	6.58	24.6(0.01)^{a}	21.9(0.01)^{b}	22.3(0.01)^{b}	22.4(0.01)^{b}	22.2(0.01)^{b}	21.1(0.01)^{b}

$^{£}$Means within the same row followed by different letters are different at $p<0.05$.

Table 4. Cost benefit analysis of Washera sheep fattening under different level of concentrate supplement and two fattening durations.

Description	Feeding level (g head^{-1} day^{-1})											
	93 days of feeding						121 days of feeding					
	0	300	400	500	600	700	0	300	400	500	600	700
FWT (kg)	24.9	29.1	30.7	32.0	32.8	32.9	24.4	29.2	31.0	32.9	33.8	34.7
INWT (kg)	20.5	20.7	21.2	20.0	21.2	22.4	20.5	20.7	21.2	20.0	21.2	22.4
TWG (kg)	4.4	8.4	9.5	12.0	11.6	10.5	3.9	8.5	9.8	12.9	12.6	12.3
TCG (kg)	1.9	4.1	4.5	5.8	5.6	5.1	0.0	3.7	4.7	6.1	6.1	5.9
CSP (Birr kg^{-1})	45.0	50.0	50.0	50.0	50.0	50.0	45.0	50.0	50.0	50.0	50.0	50.0
GR (Birr head^{-1})	86.1	202.6	223.3	291.1	278.4	254.8	0.0	184.9	236.4	303.2	305.6	295.2
FC (Birr head^{-1})	0.0	83.7	111.6	139.5	167.4	195.3	0.0	108.9	145.2	181.5	217.8	254.1
NB (Birr head^{-1})	86.1	118.9	111.7	151.6	111.0	59.5	0.0	76.0	91.2	121.7	87.8	41.1
MRR (%)		39.2	-25.8	142.9	-145.4	-184.5	30.5	69.8	41.9	84.1	-93.4	-128.7

FWT = Final weight, INWT = Initial weight, TWG = Total weight gain, TCG = Total carcass gain, CSP = Carcass sell price, GR = Gross return, FC = Feed cost, NB = Net benefit, MRR = Marginal rate of return.

Sensitivity analysis (Table 5) showed that profitability of the current fattening practice holds under varying input and output prices of up to 20% variation. However, the marginal rates of return to investment decline from 119.7% when the expectation for input price increase and output price decrease is 5% to 61.9% when the expected price variations are 20%.

Table 5. Sensitivity analysis of Washera sheep fattening based on concentrate supplements for a fattening duration of 93 days.

Description	Feed level (g head^{-1} day^{-1})					
	0	300	400	500	600	700
+ 5% fattening cost (ETB head^{-1})	0.0	87.9	117.2	146.5	175.8	205.1
-5% selling Price (ETB kg^{-1})	42.8	47.5	47.5	47.5	47.5	47.5
Gross return (ETB head^{-1})	81.8	192.5	212.1	276.5	264.5	242.1
Net benefit (ETB head^{-1})	81.8	104.6	95.0	130.0	88.7	37.0
MRR		25.9	-32.9	119.7	-141.1	-176.4
+ 10% fattening cost (ETB head^{-1})	0.0	92.1	122.8	153.5	184.1	214.8
-10% selling Price (ETB kg^{-1})	40.5	45.0	45.0	45.0	45.0	45.0
Gross benefit (ETB head^{-1})	77.5	182.3	201.0	262.0	250.6	229.4
Net benefit (ETB head^{-1})	77.5	90.3	78.2	108.5	66.4	14.5
MRR		13.9	-39.3	98.7	-137.1	-169.1
+ 20% fattening cost (ETB head^{-1})	0.0	100.4	133.9	167.4	200.9	234.4
-20% selling Price (ETB kg^{-1})	36.0	40.0	40.0	40.0	40.0	40.0
Gross benefit (ETB head^{-1})	68.9	162.1	178.6	232.8	222.7	203.9
Net benefit (ETB head^{-1})	68.9	61.6	44.7	65.4	21.8	-30.5
MRR		-7.2	-50.6	61.9	-130.3	-156.3

MRR = Marginal rate of return.

Conclusion and Recommendations

Feedlot performance of Washera sheep is higher than some other local breeds studied and is comparable with Awassi X Menz crossbred sheep. Supplementation of 500 g day^{-1} concentrate feed for 93 days would be both biologically and economically the optimum level for feedlot operation. Further research could focus on diverting the energy expenditure in fat deposition in the tail region to the leg and shoulder region. Ration

formulation based on locally available forage and/or cheaper feed resources to replace the concentrate feed recommended here could result in a more profitable feedlot operation. Demonstration to Washera sheep farmers and commercial feedlot operators is recommended in order to promote these feeding technologies.

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