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Weight gain, carcass characteristics and economic feasibility of Horro rams supplemented with different substitution levels of maize grain and molasses

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A total of forty Horro rams with an average initial body weight 19.5 kg were randomly assigned to one of the following five treatments with eight replicates: 184.2 g ground maize grain (T1), 140 g ground maize grain + 60 g molasses (T2), 90 g ground maize grain + 120 g molasses (T3), 50 g ground maize grain + 180 g molasses (T4), 240 g molasses (T5). In addition to the treatment diets, all groups were supplemented with equal amount of noug cake (190 g/d) and 1% of salt to provide the protein and minerals requirements, respectively. Cyndon dactyl hay was used *ad libitum* as a basal diet. There was a significant ($p<0.05$) difference between Treatments 1 and 5 for total weight gain and average daily weight gain of Horro rams but there was no significant difference between and within the reaming treatments. Rams fed on Treatment 1 showed higher daily weight gain (73.4 g/d/h) followed by Treatments 2, 3, 4 and 5 (59.1, 53.8, 51.9 and 40.9 g/d/h, respectively). Rams fed on Treatment 1 had higher carcass weight (11.6 kg) and dressing percentage (45.2%) followed by Treatments 2, 3, 4 and 5, respectively. The cost benefit analysis indicated that substituting 44.2 g of maize grain by 60 g molasses had showed higher net benefit of Birr 20.69 next to the previously recommended amount of maize grain in Treatment 1 with a net benefit of 30.71 Birr/head of animal. This indicates that fattening using Treatments 1 and 2 were found to be economical and increased a net return at least by 50.0%. The results showed that Horro rams fed on Treatment 2 had showed higher live weight gain, carcass traits and net benefit next to the already recommended Treatment 1. Thus, recommended levels of molasses can replace maize grain and one can use molasses as energy sources in a concentrate supplements for fattening Horro rams.

Key words: Weight gain, carcass, economic, Horro sheep, molasses, maize grain.

INTRODUCTION

Natural pasture and crop residues are the major sources of livestock feed in the western part of Ethiopia. Because of the steadily conversion of grazing lands into cropping fields, crop residues are becomes more important in livestock feed. However, crop residues are known for its low protein and fermentable carbohydrate levels. They can supply only sub-maintenance requirement of animals when they are fed alone (Seyoum and Zinash, 1998). Supplementation of crop residues and natural pasture hay by feeds of high protein and energy sources was for the efficient utilization of the former to enhance animal production and productivity (Lemma et al., 1996). Among the high nutrient density diets suggested for supplementation, noug cake and molasses are abundantly found in the western part of the country and hence small-scale farmers can easily get access to finish their animals by supplementation with this agro-industrial by products.

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High-energy concentrates are fed for energy. Grains and grain products commonly fed are shelled corn, sorghum, oats and wheat. Liquid feedstuffs, such as molasses, can also be used as a source of dietary energy. Alternative energy sources, such as fodder beet and sweet potato can be fed to growing and finishing sheep and goats. The use of these feeds depends on the price differential in utilizing them for fattening compared to other alternative uses. Fattening of sheep based on agro-industrial byproducts is also practiced in Ethiopia. Fattening using agro-industrial byproducts like sugar processing byproducts is feasible in places for instance in parts of Wellega where valuable feed resources such as molasses (from the Finchaa sugar factory) and corn (grain and residue) are widely available (Alemu, 2008).

Molasses had been used previously in animal feeds, but always at relatively low levels (usually less than 20% of the diet) (Preston and Leng, 1986). The most appropriate role for small amounts of molasses in ruminant diets is as a vehicle for other nutrients (e.g. urea and minerals). A drought feeding strategy based on the use of liquid molasses supplements containing from 8 to 10% urea is now an established practice in Australia (Nicol et al., 1984) and has been introduced successfully in Africa (Preston and Leng, 1986). The incorporation of urea and other nutrients in molasses-based (multi-nutritional) blocks promises to be an even more attractive technology, especially for smallholder-village farmers, for supplementation of locally available crop residues which are of low digestibility and also deficient in fermentable nitrogen (Sansoucy et al., 1986).

Molasses is an agro-industrial by-product used as energy supplement for livestock in different parts of the world where sugar cane processing factories are available. From different works done in Ethiopia (Amsalu et al., 1998) and elsewhere in the world (Sibanda et al., 1987), promising results were obtained from livestock finishing studies where molasses was used as one of the major constituent of the ration. Maize grain, which is the constituent of the already recommended concentrate in the region, has become hardly possible to use as livestock feed due to increased competition as human food. In such system it is apparent to find alternative energy sources in livestock ration.

Thus, the objectives of this study were to determine the levels of molasses that substitute maize grain and to evaluate economic feasibility of fattening Horro rams supplemented with different substation level of maize grain and molasses.

MATERIALS AND METHODS

Description of the study area

Bako Agricultural Research Center is located 250 km west Addis Ababa at an altitude of 1650 masl. The center received mean annual rainfall of 1200 mm in a bimodal distribution, 80% of which falls from May to September. The area had a mean relative humidity of 59% and mean minimum and maximum temperatures of 13.5 and 27°C, respectively.

Animal feeding and management

A total of forty Horro rams with an average initial body weight of 19.5 ± 0.73 kg and similar age group were purchased from the nearby local markets. Rams were randomly assigned to the following five treatments (T) with eight replicates: T1 = 184.2 g/h/d ground maize grain; T2 = 140 g/h/d ground maize grain + 60 g/h/d molasses; T3 = 90 g/h/d ground maize grain + 120 g/h/d molasses; T4 = 50 g/h/d ground maize grain + 180 g/h/d molasses; T5 = 240 g/h/d molasses.

The treatments were based on previously recommended amount of 400 g/h/d concentrate (49% maize grain, 49% noug cake, and 1% salt) for finishing Horro rams (Solomon et al., 1991). In addition to the treatment diets, all groups were supplemented with equal amount of noug cake (190 g/h/d) and 1% of salt to provide the protein and minerals requirements respectively. Cyndon dactyl hay was used *ad libitum* as a basal forage diet. Water was also offered *ad libitum*. All animals were drenched and dipped against endo and ecto-parasites. A group of rams were kept in individual pens and fed the treatment diet for 90 days after 15 days adaptation period.

Statistical analysis

Data on daily feed intake and body weight of the rams were recorded fortnightly during the experimental period but for the edible and non-edible carcass traits four rams from each treatment were slaughtered at the final date of the trial. The data were analyzed using the general linear model of statistical analysis system (SAS, 1996). During analysis, treatment was considered as independent variable where as final body weight, total weight gain, daily weight gain, carcass traits and feed intake were considered as dependent variables. Pearson's correlation coefficient was used to assess interrelation ship of live body weight and some carcass traits.

Economic analysis

Three local live animal dealers were made estimation of the final price of rams and the average price of rams was used for cost benefit analysis. The cost benefit analysis was made using partial budget, dominance and marginal rate of return. The prices of rams, maize, molasses and noug cake were used for analysis. The price of noug cake and maize was taken as an average of five years market price. Besides, the stability of the result was complemented by sensitivity analysis by varying the prices of inputs.

RESULTS AND DISCUSSION

Growth performance of Horro rams

Least-square means of total weight gain and average daily weight gain of Horro rams fed on different levels of molasses and maize grain are indicated in Table 1. There was significant ($P < 0.05$) difference between Treatments 1 and 5 in total weight gain and average daily gain of Horro rams but there was no significant difference between and within the other treatments. Horro rams fed on Treatment 1 showed higher daily weight gain

Table 1. Least squares means (± SDE = Standard Error) of initial body weight (IWt), final body weight (FWt), total weight gains (TGain) and average daily weight gain (ADG) of Horro Rams fed on different levels of molasses and maize grain.

Treatment	IN Wt	F Wt	T Gain (kg)	ADG (g)
1	19.7 ± 0.73	27.0 ± 0.94	7.3 ± 0.74^{b}	73.4 ± 7.45^{b}
2	20.6 ± 0.73	26.5 ± 0.94	5.9 ± 0.74^{ab}	59.1 ± 7.45^{ab}
3	19.6 ± 0.73	25.0 ± 0.94	5.4 ± 0.74^{ab}	53.8 ± 7.45^{ab}
4	19.3 ± 0.73	24.5 ± 0.94	5.2 ± 0.74^{ab}	51.9 ± 7.45^{ab}
5	19.4 ± 0.73	23.5 ± 0.94	4.1 ± 0.74^{a}	40.9 ± 7.45^{a}

Means with different letters of superscription differ significantly (P<0.05).

Table 2. Analysis of variance of final body weight (kg) and daily weight gain (g/d) of Horro Rams fed on different levels of molasses and maize grain.

Source of variation	Final body weight	Average daily weight gain
Treatment	25.29	55.81
Error mean square	2.66	21.07
Error DF	35.00	35
R-square (%)	21.67	22.55
CV (%)	10.5	17.74

(73.4 g/d/h) followed by those on diet 2, 3, 4 and 5 (59.1, 53.8, 51.9 and 40.9 g/d/h, respectively). In agreement with these results Nnanyelum and Bala (1981) reported that the results of average daily weight gain were improved with molasses replaced maize in fattening rations without detrimental effects (Table 2). Similar average daily weight gain was also reported by Solomon et al. (2000). Since, there was no significant ($p > 0.05$) difference observed from Treatment 1 through 4 in body weight gain it is possible to improve the use of fourth treatment as it has less cost to substitute more of the grain with molasses only looking at input costs but further economic result using sheep final price is more apparent as the final net benefit is not a mere result of body weight. These findings are in general agreement with those in the literature (Meyreles et al., 1982; Meyreles and Preston, 1982).

Feed intake

Almost all supplements offered to each group of treatments were completely consumed regardless of molasses level. This is probably due to the DM intake which was not materially affected by energy level, but it was rather significantly influenced by protein level. A better weight gains and body condition performances were observed as the level of molasses substitution decreased from 180 to 60 g of supplementation. Feed intake and conversion efficiency were higher for rams fed from diet 1 up to 4 in comparison to diet 5. Similarly, Nnanyelum and Bala (1981) revealed that the results of feed intake and feed conversion efficiency showed that molasses replaced 30% maize in fattening rations without detrimental effects. Preston and Leng (1986) also reported that molasses had been used previously in animal feeds, but always at relatively low levels (usually less than 20% of the diet). Molasses could seriously be considered as an alternative to cereal grains as a means of intensifying animal production in the tropics.

Carcass and non carcass components

Least square means of edible and non-edible carcass traits of Horro Rams are shown in Tables 3 and 4. There was significant ($P < 0.05$) difference in edible and non-edible carcass traits of Horro rams supplemented with different substitution level of molasses and maize grain between Treatments 1 and 5, but there was no significant difference observed between the remaining treatments. Rams fed on Treatment 1 had higher carcass weight (11.6 kg) and dressing percentage (45.2%) followed by Treatments 2, 3, 4 and 5 (10.5 kg and 43.2%, 10.5 kg and 42.2%, 10.9 kg and 43.7%, 8.8 kg and 41.6%, respectively). The carcass weight and dressing percentage of Horro rams fed on different level of molasses and maize grain was almost similar to the result reported by Ulfina et al. (2004) and Alemu (2008) who stated that there was improvement in carcass weight and dressing percentage with increased level of concentrates (Table 5). Nnanyelum and Bala (1981) also investigated that carcass data showed that rams which received the low and medium molasses diets had better

Table 3. Least square means (± SDE) of edible carcass traits of Horro rams fed on different levels of molasses and maize grain.

Traits	TRT				
	1	2	3	4	5
Carcass weight (kg)	11.6 ± 0.77^{b}	10.5 ± 0.77^{ab}	10.5 ± 0.77^{ab}	10.9 ± 0.77^{ab}	8.8 ± 0.77^{a}
Dressing percentage (%)	45.2^{b}	43.2^{ab}	42.2^{ab}	43.7^{ab}	41.6^{a}
Kidney fat free (g)	82.5 ± 4.25	73.8 ± 4.25	76.3 ± 4.25	88.8 ± 4.25	80.0 ± 4.25
Heart (g)	137.5 ± 10.54	131.3 ± 10.54	120.0 ± 10.54	130.0 ± 10.54	111.3 ± 10.54
Liver (g)	430.0 ± 24.43	396.3 ± 24.43	437.5 ± 24.43	500.0 ± 24.43	388.8 ± 24.43
Omental fat (g)	146.3 ± 36.99^{ab}	167.5 ± 36.99^{b}	105.0 ± 36.99^{ab}	103.8 ± 36.99^{ab}	50.0 ± 36.99^{a}
Kidney fat (g)	60.0 ± 9.03^{b}	50.0 ± 9.03^{ab}	57.5 ± 9.03^{ab}	51.3 ± 9.03^{ab}	30.0 ± 9.03^{a}
Tail weight (kg)	0.6 ± 0.10	0.6 ± 0.10	0.4 ± 0.10	0.6 ± 0.10	0.4 ± 0.10
Fat thickness at 12th rib area (mm)	0.4 ± 0.11	0.4 ± 0.11	0.3 ± 0.11	0.5 ± 0.11	0.3 ± 0.11
Rib eye area (cm $^{2)}$	9.9 ± 1.07	8.3 ± 1.07	8.2 ± 1.07	8.5 ± 1.07	7.8 ± 1.07
Visceral empty (kg)	1.7 ± 0.11^{ab}	2.0 ± 0.11^{b}	1.8 ± 0.11^{ab}	1.8 ± 0.11^{ab}	1.6 ± 0.11^{a}

Means with different letters of superscripts differ significantly (P<0.01, 0.05).

Table 4. Least square means (± SDE) of some non-edible carcass traits of Horro rams fed on different levels of molasses and maize grain.

Traits	TRT				
	1	2	3	4	5
Head (kg)	1.5 ± 0.07^{b}	1.4 ± 0.07^{ab}	1.4 ± 0.07^{ab}	1.5 ± 0.07^{b}	1.3 ± 0.07^{a}
Fore legs (g)	267.5 ± 12.62^{ab}	261.3 ± 12.62^{ab}	287.5 ± 12.62^{b}	276.3 ± 12.62^{ab}	246.3 ± 12.62^{a}
Hind legs (g)	261.3 ± 13.46	257.5 ± 13.46	271.3 ± 13.46	246.5 ± 13.46	235.5 ± 13.46
Lungs +Trachea (g)	445.0 ± 42.16^{ab}	456.3 ± 42.16^{ab}	541.3 ± 42.16^{b}	450.0 ± 42.16^{ab}	398.8 ± 42.16^{a}
GIT full (kg)	5.1 ± 0.41^{ab}	5.8 ± 0.41^{ab}	6.3 ± 0.41^{b}	5.6 ± 0.41^{ab}	4.8 ± 0.41^{a}
Skin (kg)	2.4 ± 0.18	2.3 ± 0.18	2.4 ± 0.18	2.7 ± 0.18	2.1 ± 0.18
Spleen (g)	71.3 ± 7.99	76.3 ± 7.99	67.5 ± 7.99	60.0 ± 7.99	61.3 ± 7.99
Blood (kg)	1.0 ± 0.09	1.0 ± 0.09	1.0 ± 0.09	1.0 ± 0.09	0.9 ± 0.09
Testicles (g)	352.5 ± 34.09	343.8 ± 34.09	301.3 ± 34.09	292.0 ± 34.09	265.0 ± 34.09
Penis (g)	52.5 ± 6.19	48.8 ± 6.19	55.0 ± 6.19	61.3 ± 6.19	48.8 ± 6.19

*Means with different letters of superscripts differ significantly (P<0.01, 0.05).

Table 5. Analysis of variance of carcass weight (kg) and dressing percentage (%) of Horro rams fed on different levels of molasses and maize grain.

Source of variation	Carcass weight	Dressing percentage
Treatment	10.47	43.21
Error mean square	1.54	2.66
Error DF	15.0	15.0
R-square (%)	32.93	22.44
CV (%)	14.69	6.16

dressing percentage and wholesale cuts. Some non-edible carcass traits were not significantly differing except head, lung and trachea and visceral full. The result of correlations indicated that live body weight and some carcass traits of rams were positively correlated value except kidney fat and kidney fat free. There was a significant (P < 0.01) positive correlation of liver with carcass weight and final live weight, initial live weight with

Table 6. Correlations of live body weight and some carcass traits of Horro rams fed on different levels of molasses and maize grain.

Variable	CWT	DP	KFAT	OMFAT	FWT
LIV	0.56*	0.23	0.36	0.36	0.66**
HRT	0.69**	0.62**	0.71**	0.44*	0.60*
KFF	0.22	0.11	-0.04	0.02	0.25
IWT	0.52*	0.20	0.43	0.35	0.65**

** P< 0.01; * P< 0.05. CWT = Carcass weight; IWT = initial weight; DP = dressing percentage; FWT = final weight; KFAT = kidney fat; LIV = liver; OMFAT = omental fat; HRT = heart; KFF = kidney fat free.

Table 7. Partial budget, dominance and marginal analysis of Horro rams fed on different levels of molasses and maize grain.

Item	Treatments				
	1	2	3	4	5
Av. Inwt	19.66	20.63	19.63	19.28	19.38
Av. Fwt.	27.00	26.53	25.00	24.47	23.47
Adjusted wt.	26.73	26.26	24.75	24.23	23.24
Gross benefit/head	163.88	153.00	135.50	125.63	117.13
Costs that vary					
Maize	14.59	11.09	7.13	3.96	0
Molasses	0	0.39	0.59	0.89	1.19
Noug cake	6.58	6.58	6.58	6.58	6.58
Initial price	112.00	114.25	109.38	107.63	103.13
TCV	21.17	18.06	14.3	11.43	7.77
Net benefit/head	30.71	20.69	11.82	6.57	6.23
Dominance analysis using tabular method (NB are arranged in descending order)					
NB in descending order	30.71	20.69	11.82	6.57	6.23
TC for each treatment	133.17	132.31	123.68	119.06	110.9
Dominance analysis	ND		D	D	D
MRR (%)	50				

D, Dominated; ND, non dominated.

carcass weight and final body weight and heart with carcass weight, dressing percentage, kidney fat, omental fat and final weight as indicated in Table 6. Ulfina et al. (2004) reported similar results on finishing old Horro ewes on concentrate. The correlation between final body weight, carcass weight, dressing percentage and kidney fat were positive and high. There was no significant (P > 0.05) difference observed from Treatment 1 up to 4 in carcass traits.

Economic feasibility

The partial budget analysis indicated that substituting 44.2 g of maize grain by 60 g molasses had higher net benefit of Birr 20.69 next to the previously recommended amount of maize grain in Treatment 1 with a net benefit of 30.71 Birr/head of animal (Table 7). Similar net benefit was reported by Solomon et al. (1991) and Solomon et al. (2000). Nnanyelum and Bala (1981) also indicated that the economic advantage in the use of molasses in fattening rations is attractive, given the wide price differential between maize and molasses. The net benefits of Treatments 1 and 2 were at least twice higher than the net benefit of the other treatments. This indicates that fattening using Treatments 1 and 2 were found to be economical and increased a net benefit at least at minimum acceptable return (50.0%). Since Treatment 1 was already recommended, the marginal rate of return (MRR) in treatment 2 be accepted and gave the highest net benefit as compared to Treatments 3, 4, and 5. The recommended rate of feeding is economically feasible if each of the prices of maize and molasses per kilogram is not exceeding Birr 0.99 and 0.55, respectively (Table 8). Besides, information of market price in the area is also important to decide when to start the

Table 8. Sensitivity analysis for changing prices of maize and molasses in fattening Horro rams on different levels of molasses and maize grain.

Item	Treatments				
	1	2	3	4	5
Average initial price of young rams (Birr/kg)**	5.79	5.54	5.57	5.58	5.32
Average final price of young rams (Birr/kg)*	6.07	5.77	5.42	5.13	4.99
Average price of maize (Birr/kg)**		0.99			
Average price of molasses (Birr/kg)**		0.55			

*Changes greater than the indicated figure are acceptable; **Changes less than the indicated figure are acceptable; Data of feed prices during experimental period: Maize grain price = 0.90 Birr/kg; Noug cake price = 0.36Birr/kg; Molasses price = 0.05 Birr/kg; weight down adjusted to: 1%

fattening activities.

CONCULUSION AND RECOMMENDATIONS

The results showed that Horro rams fed on Treatment 2 had showed higher live weight gain, carcass traits and net benefit next to the already recommended Treatment 1. Fattening with the amount of molasses in Treatment 2 can be economical and recommended. It is also advisable and economical to plan the start of fattening program immediately after maize harvest. The stability of this recommendation was supplemented by sensitivity analysis by varying the prices of inputs. It could be advisable and economical to conduct the fattening of rams with the recommended level of molasses with maize grain as compared to using only maize grain since there was no significant difference observed between Treatments 1 and 2 in live weight gain, carcass traits and net benefit also use of molasses can reduce the increased competition of human being with livestock for maize grain. Thus, recommended level of molasses can replace maize grain and one can use molasses as energy sources in a concentrate supplements for fattening Horro rams.

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