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Research Article

EFFECTS OF FEEDING MAIZE SILAGE AS A SOLE DIET AND PROTEIN SOURCES ON FEED INTAKE, MILK YIELD, MILK COMPOSITION, BODY WEIGHT CHANGE AND PRODUCT QUALITY

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ABSTRACT
The experiment was conducted at Debre Zeit Agricultural Research Center with the objective of evaluating the effects of feeding maize silage as a sole diet and protein sources on feed intake, milk yield, milk composition, body weight change and sensory quality of cow milk by products. Four holstein dairy-cows with similar lactation stage, exotic blood level, and parity were used. Four feed types were considered for the study; namely, maize silage, noug cake, cotton seed cake and linseed cake. Maize silage was used as a basal diet whereas the rest three were protein supplements. A change-over design was used for the feeding experiment with four dietary treatments assigned to each animals; maize silage (ms), maize silage + noug cake (ms+nc), maize silage + cotton seed cake (ms+cs) and maize silage + linseed cake (ms+ls). Treatment effect was highly significant ($p<0.05$) in affecting daily maize silage intake. The highest (32.5 kg) maize silage intake was recorded for the cows supplemented with linseed cake. The effect of dietary treatments on milk yield was highly significant ($p< 0.05$). The least (7.03 kg) milk yield was recorded from cows fed on maize silage alone while the highest (11.3 kg) milk yield was from those fed on maize silage with linseed cake. Treatment effects on milk fat, protein, solids- not- fat and total solids were not significant ($p>0.05$). The effects of dietary treatments on body weight change of cows were highly significant ($p< 0.05$) among the treatments. About 71.9% panelists preferred cow milk yoghurt made from cows fed on maize silage supplemented with cotton seed cake. However, among the treatments cheese made from cow fed on maize silage alone was preferred by the majority (71.9%) panelists. Supplementation of linseed cake to maize silage was found to be the best option to improve silage intake and milk production followed by cotton seed cake. Depending upon availability and price of these supplements, using linseed cake as a protein supplement for maize silage diets is the best one.

Keywords: *Cottonseed Cake, Dairy Cow, Linseed Cake, Noug Cake*

INTRODUCTION
Inadequate and unbalanced feed supplies are the major technical problems that result in low total milk output, reduce milk yield per cow and reduce replacement stock (Ahmed *et al.*, 2003). Dairy animals are generally given energy and protein concentrate supplements to increase milk production and stocking rates (Gracia *et al.*, 2000). Supplementation also helps to correct changes in the amount (increasing total dry matter intake) and quality of basal diet. The basal diet may contain all the essential nutrients for the animals but not in the quantity necessary to achieve the desired level of animal production. Under these circumstances a supplement would provide additional balanced nutrients preferably without reducing the intake of basal diets (Preston and Leng, 1984). Conserved feeds such as silages are an integral part of dairy cattle diet in intensively managed peri-urban dairy farms, although the availability of maize silage to such dairy farms has not been well documented. Utilization of low quality roughages could be improved with supplementation of energy and nitrogen sources, chemical and/or physical treatment, and selection together with breeding of crops, which ultimately depend on the economic benefits and applicability (Mcdonald *et al.*, 2002).
Excess forages can be conserved as hay or silage. Maize silage has low crude protein content and high energy content and ease of mechanization with which the whole plant can be ensiled to provide highly palatable source of energy and high quality forage (Mohamed *et al.*, 2003). Recently, utilization of corn silage as livestock feed has increased in many parts of the country. This increase can be related to its

relatively high energy content and ease of mechanization with which the whole plant can be ensiled to provide highly palatable source of energy and high quality forage (Mohamed *et al.*, 2003). Silage protein quality represents perhaps the most important determinant of silage nutritive value from an economic point of view. Therefore, protein supplementation is important to improve livestock performance and this clearly needs to be done according to requirements of the animal and the balance of other nutrients available. Therefore, this study was conducted with the objective of evaluating the effects of feeding maize silage as a sole diet and protein source on feed intake, milk yield, milk composition, body weight change and product quality.

MATERIALS AND METHODS

Description of the Study Area

The study was conducted at Debre Zeit Agricultural Research Center (DZARC). Debre Zeit is located at 45 km south east of Addis Ababa. The area has an altitude of about 1900 m above sea level with maximum and minimum temperatures, and average annual rainfall of 24.3^{0}C and 8.9^{0}C, and 851mm, respectively.

Experimental Animals and Management

In the four months of feeding trial, four Holstein dairy-cows with similar lactation stage, exotic blood level, and parity were used. The cows were vaccinated against Foot and Mouth Disease (FMD), Blackleg, Anthrax and Bovine Pasteurellosis. California Mastitis Test (CMT) was conducted for all the experimental animals prior to the feeding trial and all the cows were found free of mastitis. The cows were fed and watered individually. Every morning the animals were visually inspected for signs of illness. Milking was done twice per day (at 6:00 AM in the morning and 4:00 PM in the evening) manually following recommended hygienic procedures.

Experimental Diets

Four feed types were considered for the study; namely, maize silage, noug cake, cotton seed cake and linseed cake. Maize silage was used as a basal diet whereas the rest three were protein supplements. The amounts of supplements were determined based on the protein requirements and milk yield of individual cows filling the protein gap from an average intake of maize silage in relation to average daily milk yield. The details of the experimental diets are presented in (Table 1).

Table 1: Experimental Treatments Used in the Study

Treatments	Basal Diet	Protein Supplement
MS	Maize silage	Control
MS+NC	Maize silage	Noug cake (NC)
MS+CS	Maize silage	Cotton seed cake (CS)
MS+LS	Maize silage	Linseed cake (LS)

The protein supplements were offered in two portions at 8:00 AM in the morning and 3:00 PM in the afternoon. Clean water was made available at all the times

Experimental Design

A change-over design (cross over design) was used for the feeding experiment with four dietary treatments assigned to each animal, but one dietary treatment per period (Table 1). The dairy cows were assigned and fed with four feed treatments for a period of 21 days to collect actual data feeding with an adaptation period of 7 days prior to each period.

Data Recording

The amounts of feed offered and refused were measured and recorded daily from which daily feed intake was calculated by difference. Daily milk yields of experimental animals were measured and recorded. Moreover, composite milk samples were collected at the beginning and final week of each dietary treatment period for milk composition analysis. The body weight changes were calculated by difference from recorded initial and final weights of the experimental animals.

Table 2: Treatment Arrangements for Experimental Animals

Cow ID	Feeding Period			
	1st	2nd	3rd	4th
64.2	MS	MS+NC	MS+CS	MS+LS
92.7	MS+NC	MS+CS	MS+LS	MS
68.6	MS+CS	MS+LS	MS	MS+NC
65.4	MS+LS	MS	MS+NC	MS+CS

***NB**: MS=Maize Silage; NC= Noug Cake, CS=Cotton Seed Cake LS=Linseed Cake*

Chemical Analysis of Feed Samples

The chemical analyses were done at the Holeta Agricultural Research Center. Silage sample was taken in duplicate from the silo to analyze the chemical composition of the silage. Dry matter contents of the feed samples were determined after drying in an oven at a temperature of 65 ^{o}C for 72 hours. Nitrogen content of feed was determined by Micro-Kjeldahal method from which the crude protein (CP) values were calculated as CP = N*6.25.

Milk Yield Data and Milk Composition Analysis

Milk yield of each cow was recorded twice per day for the whole duration of the experimental period. At the beginning and the end of each dietary treatment of individual cows, milk samples were placed in a clean plastic cup, immediately after milking, placed in icebox and compositions were analyzed. The milk samples were analyzed for fat, solid-non-fat, total solid, protein and lactose contents using Lactoscan: (milk analyzer).

Sensory Quality Evaluation of Cheese and Yoghurt

Sensory evaluations of yogurt and cheese were carried out by eight experienced panelists selected from among DZARC staff.

Evaluation sessions conducted at the end of each experimental period. The sensory quality attributes under consideration were taste and flavor after 2 days of storage at room temperature. Each panelist scored samples independently and recorded the scores on the sheets provided.

Statistical Analysis

Quantitative data were analyzed according to the General Linear Model (GLM) procedure of version 9.0 SAS, (2000) employing the following model:

$Yijk = \mu + Si + Cij + Pk + Tt + Eijk,$

Where,

Yijk = response during the k^{th} period of the j^{th} cow in the i^{th} sequence group

i = 1, 2, 3, 4;

j = 1 to 4;

k = 1, 2, 3, 4

μ = population mean

S_i = sequence effect (Seq.)

C_{ij} = the effect of the j^{th} cow on the i^{th} sequence

P_k = period effect,

T_t = treatment effect (t = 1, 2, 3, 4) and

E = residual err

The Duncan's Multiple Range Test procedure was used to separate treatment means.

RESULTS AND DISCUSSION

Chemical Composition of Feeds

The chemical compositions of experimental feeds are shown in (Table 3). The CP content of maize silage used in this experiment (6.93%) was lower than what was reported by El-Ashry *et al.,* (2003) where the value was 8.72%.

Table 3: Chemical Composition of Maize Silage and Protein Sources

Experimental Diet	DM%	CP%	OM%	Ash%
Maize silage	91.8	6.90	91.0	8.9
Noug cake	93.7	35.0	89.9	10.0
Cotton seed cake	93.8	31.0	92.8	7.10
Linseed cake	93.5	29.9	91.3	8.70

***NB**: DM=Dry Matter; CP=Crude Protein; OM=Organic Matter*

Feed Intake

The observed average daily maize silage intakes by the experimental animals are presented in (Table 4). In the present study, there were statistically significant differences in daily maize silage intake among the four dietary treatments. The study also showed a considerable increase in maize silage intake as a result of supplementation of linseed cake was highest (32.5 kg) followed by cotton seed cake (30.5 kg). The lowest (27.3 kg) maize silage intake was observed for cows fed without supplement while the lowest (29.5 kg) maize silage intake from among the supplemented group was observed for cows supplemented with noug cake.

Table 4: Effect of Treatments on Maize Silage Intake

Treatment	Means Maize Silage (kg/day)
MS	27.3^{c}
MS+NC	29.5^{b}
MS+CS	30.5^{b}
MS+LS	32.5^{a}
SE	3.35

Means not followed by the same superscript letters in the same column are significantly different ($p<0.05$).
NB: MS=Maize silage; NC= Noug cake; CS=Cotton seed cake; LS=Linseed cake; SE= Standard Error

Milk Yield and Composition

Daily milk yield and milk composition of cows fed on maize silage and supplemented with protein sources are presented in (Table 5). Cows fed maize silage with linseed cake gave the highest milk yield followed those supplemented with cotton seed cake.

These findings were similar to the report of Sanz Sampelayo *et al.,* (2007) where goats supplemented with linseed cake produced more milk than those supplemented with extracted rapeseed meal. This explained that productivity of ruminants is influenced primarily by feed intake, which in turn was determined by the digestibility and capacity of the diet to supply the correct balance of nutrients required (Preston and Leng, 1987).

The least (7.03 kg) milk yield was recorded from cows fed on maize silage alone. However, from the three protein supplemented group, the least (9.21 kg) daily milk yield was recorded from cows fed on maize silage with noug cake.

Similar with the present study, Petit (2010) reported that feeding diets with whole or crushed or micronized linseed had no effect on the milk protein content in mid lactation of dairy cows. Cows fed on maize silage supplemented with linseed cake showed the highest (4.67%) lactose content followed by cotton seed cake (4.60%) whereas the least (4.40%) was recorded for those cows fed on maize silage alone.

Body Weight Change of Cows

The body weight changes of cows are presented in (Table 6). Dietary treatments were showed gain or no loss of weight to the experimental cows. The loss of weight was recorded in cows fed on maize silage alone (-20 kg). Highest (28.8kg) weight gain was recorded in cotton seed cake supplemented cows compare to noug cake (23.8 kg) and linseed seed cake (23.8 kg) supplemented cows.

Table 5: Daily Milk Yield and Composition from Cows Fed on Maize Silage Supplemented with Different Protein Sources

Treatments	Mean Milk Yield (kg/day)	Milk Composition				
		Fat (%)	Protein (%)	SNF (%)	TS (%)	Lactose (%)
MS	7.03[c]	3.79[a]	2.98[a]	8.12[a]	11.9[a]	4.40[b]
MS+NC	9.21[b]	4.18[a]	3.05[a]	8.35[a]	12.6[a]	4.58[ab]
MS+CS	10.9[a]	4.15[a]	3.05[a]	8.36[a]	12.5[a]	4.60[a]
MS+LS	11.3[a]	3.94[a]	3.09[a]	8.50[a]	12.5[a]	4.67[a]
SE	1.80	0.39	0.13	0.39	0.72	0.18

Means not followed by the same superscript letters in the same column are significantly different ($p<0.05$).
NB: MS= Maize silage (control); NC= Noug cake; CS=Cotton seed cake; LS=Linseed cake; TS = Total Solids; SNF= Solid-Non-Fat; SE= Standard Error

Table 6: Effects of Feeding Maize Silage and Protein Sources on Body Weight Change of Cows

Treatment	Number of Cow	Bw Change(kg/day)
MS	4	-20.0[c]
MS+NC	4	23.8[b]
MS+CS	4	28.8[a]
MS+LS	4	23.8[b]
SE		7.90

Means not followed by the same superscript letters in the same column are significantly different ($p<0.05$).
NB: MS=Maize silage (Control); NC= Noug seed cake; CS= Cotton seed cake; LS=Linseed cake; BW= Body Weight

Sensory Quality Evaluation of Yoghurt and Cheese

Yoghurt Quality Evaluation

Results for yoghurt as a sensory quality attribute are presented in table 7. About 71.9% panelists reported that yoghurt from cows supplemented with cotton seed cake had excellent flavor (Table 7). Yoghurt made from cows fed on maize silage with noug cake was the next good quality yoghurt which is preferred by 25% of panelists.

However, about 71.9% panelists not preferred cow milk yogurt made from cows fed on maize silage supplemented with linseed cake followed by maize silage without supplements (59.4%).

Table 7: Effects of Maize Silage Supplemented with Protein Sources on Yogurt Flavor as Rated by Panelists (%)

Treatments	Yoghurt Flavor		
	Excellent	Very Good	Good
MS	9.38	30.1	59.4
MS+NC	25.0	50.0	25.0
MS+CS	71.9	15.6	12.5
MS+LS	6.25	21.9	71.9

NB: MS=Maize silage; NC=Noug cake; CS=Cotton seed cake; LS=Linseed cake

Cheese Quality Evaluation

Result for cheese as a sensory quality attribute is presented in table 8. Among the treatments, cheese made from cow fed on maize silage alone was preferred by the majority (71.9%) of the panelists. Cheese made from cow fed on maize silage with noug cake was the next good quality cheese which is preferred by

28.1% of panelists. However, about 81.3% of panelists not preferred cheese made from cows supplemented with linseed cake followed by cotton seed cake (78.1%).

Table 8: Effects of Maize Silage Supplemented with Protein Sources on Cheese Flavor as Rated by Panelists (%)

Treatments	Cheese Flavor		
	Excellent	**Very Good**	**Good**
MS	71.9	25.0	3.12
MS+NC	28.1	40.6	31.3
MS+CS	0	21.9	78.1
MS+LS	0	18.8	81.3

NB: MS=Maize silage; NC=Noug cake; CS=Cotton seed cake; LS=Linseed cake

Conclusion and Recommendations

From this study, it is conclude that cow milk production and composition are affected by different protein sources. Efficient protein supplement improved feed dry matter intake and milk production. The protein source had the largest impact on dry matter intake of lactating cows. Supplementation of linseed cake to maize silage was found to be the best option to improve silage intake and milk production followed by cotton seed cake that could be translated into significantly improved profitability.

However, cow milk constituents were not affected by dietary treatments except lactose content which was highest for cows supplemented with linseed followed by cotton seed cake. Depending upon availability and price of these supplements, using linseed cake as a protein supplement for maize silage diets is the best one.

Protein supplementation should consider prices of added protein supplement versus increases in milk yield and also availability of those protein sources. The findings of the study have revealed that sensory quality of cow yoghurt and cheese were relatively affected by dietary treatments. Yoghurt made from cows fed on maize silage with cotton seed cake was highly preferred than that made from cows supplemented with linseed and noug cake while linseed cake supplemented yoghurt was least preferred. However, cheese made from cows fed on maize silage alone had excellent flavor than supplemented groups.

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