

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

Getenesh Teshome¹, Ashenafi Mengistu², Adey Melesse³ and Kassahun Melesse⁴

Abstract

*The experiment was conducted at DebreZeit Agricultural Research Center with the objective of evaluating the effects of feeding maize silage as a sole diet and mixed with some protein sources on feed intake, milk yield, milk composition, body weight change and quality of cow milk by-products. Four Holstein dairy-cows with similar lactation stage, exotic blood level, and parity were used for the study. Four feed types, namely, maize silage (MS) alone, MS mixed with noug (*Guizotia abyssinica*) cake, MS mixed with cotton seed cake and MS mixed with linseed cake were evaluated. Maize silage was used as a basal diet, whereas, the remaining three were considered as protein supplements. A change-over design was used for the feeding experiment with four dietary treatments assigned to each animal: 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(non 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. Among the panelists, 71.9% preferred cow milk yoghurt obtained 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 diet is the best alternative.*

Keywords: Cottonseed cake, Dairy cow, Linseed cake, Noug cake, silage

^{1, 2, 3, 4} Ethiopian Institute of Agricultural Research, Institute, Holeta Agricultural Research Center, P.O.Box 2003, Addis Ababa, Ethiopia;
Contact Address: gete.tesh@gmail.com

Introduction

Inadequate and unbalanced feed supplies are the major technical problems that result in low total milk output, reduction in milk yield per cow and reduction in 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. Thus, 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 silage mixed with various protein sources 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 DebreZeit Agricultural Research Center (DZARC). DebreZeit 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 24.3⁰C and 8.9⁰C, 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 amount 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 fed in two portions, at 8:00 AM in the morning and 3:00 PM in the afternoon. Clean water was made available at all 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 2). 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.

Table 3. Treatment arrangements for experimental animals

Cow ID	Feeding Period			
	1 st	2 nd	3 rd	4 th
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.*

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 the 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.

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°C for 72

hours. Nitrogen content of feed was determined by Micro-Kjeldahal method from which the crude protein (CP) values were calculated as $CP = N \times 6.25$.

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:

$$Y_{ijk} = \mu + S_i + C_{ij} + P_k + T_t + E_{ijk},$$

Where,

Y_{ijk} = 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 4. 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 intake by the experimental animals is presented on Table 4. There were statistically significant differences in daily maize silage intake among the four dietary treatments. A considerable increase (32.5 kg) in maize silage intake was observed as a result of supplementation of linseed cake, followed by cotton seed cake (30.5 kg). The lowest (27.3 kg) maize silage intake was observed by cows fed without supplement (Table 4).

Table 5. Effect of treatments on maize silage intake

Treatment	Means (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

Cows fed maize silage with linseed cake gave the highest milk yield followed by 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. According to Preston and

Leng(1987), 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. The least (7.03 kg) milk yield was recorded from cows fed on maize silage alone. However, from among the three protein supplemented group, the least (9.21 kg) daily milk yield was recorded from cows fed on maize silage with noug cake.

In one 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. In this study, however, the milk of cows fed on maize silage supplemented with linseed cake and cotton seed cake had shown higher lactose content, 4.67% and 4.60%, respectively (Table 5).

Table 6. 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

Body Weight Change of Cows

Most dietary treatments had shown some changes in 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 cows fed silage supplemented with cotton seed cake, whereas, cows fed silage supplemented with noug cake and linseed seed cake gained equal weight (23.8 kg) (Table 6).

Table 7. Effects of feeding maize silage and protein sources on body weight change of cows

Treatment	Number of cows	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

Among the panelists participated in evaluating the quality of yoghurt by taste, 71.9% had reported that yoghurt from cows supplemented with cotton seed cake had excellent flavor (Table 7). Ironically, the same percentage of

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).

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

Results for cheese evaluation as a sensory quality attribute had shown that cheese made from cow fed on maize silage alone was more preferred by the majority (71.9%) of the 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).

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

Based on this study, cow milk production and quality of milk products are affected by the type of protein sources used for supplementing in silage feeding. In general, protein supplements 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. However, cow milk constituents were not affected by dietary treatments except the 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 alternative. The findings of the study had also revealed that sensory quality of cow yoghurt and cheese were relatively affected by dietary treatments. Yoghurt extracted from milk of cows fed on maize silage with cotton seed cake was highly preferred than that made from cows supplemented with linseed and *noug* cake. However,

cheese made from milk of cows fed on maize silage alone had excellent flavor than supplemented groups.

Acknowledgement

The financial and research materials support of Ethiopian Institute of Agricultural Research is gratefully acknowledged.

References

- Ahmed M, Ehui M S, Assefa Y (2003). Dairy Development in Ethiopia. Socio economics and Policy Research Working Paper 58. ILRI (International Livestock Research Institute), Nairobi.
- El-Ashry M A, Abou-Selim I A, El- Sayed H M, El-Aidy A A (2003). Effect of maize silage with berseem on the productive performance of dairy buffaloes. Egyptian Journal of Nutrition and Feeds. 6 (1) : 25-36.
- Garcia C, Santini F J, Elizalde J C (2000). Sites of digestion and bacterial protein synthesis in dairy heifers fed fresh oats with or without corn or barley grain. Journal of Dairy Science. 83 :746-755.
- McDonald P, Edwards R A, Greenhalgh J F D, Morgan C A (2002). Animal Nutrition (6thed.). Pearson Educational Limited. Edinburgh, Great Britain, pp. 544
- Mohamed S A, Mohsen M K, Bendary M M, Abdel-Raouf E M, Gaafar H M A (2003). Performance of growing Friesian calves fed rations containing corn silage. 2- Blood constituents and carcass traits. Egyptian Journal of Nutrition and Feeds. 6: 727
- Petit H V (2010). Review feed intake, milk production and milk composition of dairy Cows fed flaxseed. Journal of Animal Science. 90: 115-127
- Preston T R, Leng R A (1984). Supplementation of diets based on fibrous residues and by-products. In: Straw and other fibrous by-products as feed. Sundstol F. and Owen E.(eds). Elsevier, PP. 373- 413

Preston T R, Leng R A (1987). Matching Ruminant Production Systems with Available Resources in the Tropics and Sub-Tropics. Penambul books, Armidale, New South Wales.

SanzSmpelayo M R, Chilliard Y, Schmidely P H, Boza J (2007). Influence of type of diet on the fat constituents of goat and sheep milk. Small Ruminant Research. 68: 42-63