

Growth Performance of Jersey Calves fed Maize Stover Silage based Total Mixed Ration compared to Calves fed Hay and Concentrate Separately

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አሀፅርት

ይህ ጥናት የተካሄደው በ2011 ዓ.ም. በአዳበረጋ ንዑስ ምርምር ማዕከል ነበር። የጥናቱ ዋና ዓላማ የተፈጨ የቆሎ አገዳ ገፈራ ከተለያዩ የኢንዱስትሪ ተረፈ ምርቶች ማለትም ፋጉሎ፣ ፉርሽካ፣ ጥጥ ፍሬ፣ ሞላሰስ እና ጨውን እና በማዋህድ በታዳጊ የወተት ጥጆች የዕድገት መጠን ላይ የሚያሳድረውን ተፅዕኖ ማጥናት ነበር። ለዚህ ሙከራም በቆሎን በመዝራትና በእሸት ደረጃው በማጨድ፣ በቆሎውን እና አገዳውን በመለያየት በቆሎውን በፀሀይ በማድረቅ እና ርጥብ የበቆሎ አገዳውን በመፍጭት (ከ5-10 ሳ.ሜ) ሙከራው ተጀመረ። አንድ እጅ የተፈጨ የበቆሎ አገዳን (ከ5-10 ሳ.ሜ) ከሶስት እጅ ሞላሰስ እና ውኃ ጋር በማዋህድ ለተከታታይ 45 ቀናት በጉድጓድ በመቅበር የበቆሎ አገዳ ገፈራ ተዘጋጀ። ለዚህም 1ኛው አማራጭ 50 እጅ ያልተፈጨ የሳር ድርቆሽ እና 50 እጅ የኢንዱስትሪ ተረፈ ምርቶች ሳይቀላቀል መመገብ ሲሆን ሁለተኛው አማራጭ ደግሞ 50 እጅ የበቆሎ አገዳ ገፈራን ከ50 እጅ የኢንዱስትሪ ተረፈ ምርቶች ጋር በማዋህድ ውህዱን ለተከታታይ አንድ መቶ ሰማኒያ (180) ቀናት መመገብ ነበር። በሁለኛው አማራጭ የተሻለ ዕለታዊ የጥጃ እድገት መጠን የተመዘገበ ስለሆነ አርሶ አደሮች ይህን ዘዴ ቢጠቀሙ ምርታቸውን ማሳደግ ይችላሉ።

Abstract

The study was conducted in 2019 at Ada'abrega sub-centre of Holetta Agricultural Research. A total of eighteen posts weaned female Jersey calves (weighing, 72 ± 1.33 kg, mean \pm SE) were selected and randomly assigned in two sample T-test each having nine calves. The treatments were control diet consisting of natural pasture hay (50%) basal diet and concentrate mixture (50%) separately (T1) and dual purpose green maize stover silage (50%) and concentrate mixture (50%) based total mixed ration (TMR) (T2). The experiment took 180 days of feeding trial and 7 days of a digestibility trial. The daily dry matter intake of calves fed T2 (5.41 kg) was higher ($p < 0.05$) than those calves receiving T1 (4.64 kg). Daily nutrient intake of calves receiving the intervention diet (T2) followed a similar trend as for DM intake. Feed digestibility was significantly affected ($p < 0.05$) by diets and calves fed T2 showed higher ($p < 0.05$) apparent dry matter digestibility than calves fed T1 diets. A feed conversion ratio of the calves was not affected ($p > 0.05$) by diets but the average daily weight gain of calves in the T2 group (530g) was higher ($p < 0.05$) than those calves in a group (450g). In conclusion, the growth performance of calves fed the dual purpose green maize stover silage based total mixed ration diet was superior to calves fed natural pasture hay and concentrate mixture following the

conventional feeding practice. A follow up research is needed to investigate comparative advantages of using maize crop for dual purposes (food & feed) than as a food for human alone considering both biological responses and economic returns that arise thereof.

Keywords: Body weight gain, Digestibility, Intake, Maize Stover silage, Total mixed ration

Introduction

Major constraint to livestock production in Ethiopia is feeds and the art of feeding. Cattle are mainly fed on natural pasture hay and crop residues as a basal diet (Kitaba and Tamir 2007). Associated to increased human population and urbanization the need for crop cultivable land is putting pressure on the availability and cost of these conventional basal feed resources. To mitigate the problem it would be necessary to look into such alternative feed resources as dual purpose maize crop that can easily be integrated to the existing crop-livestock farming systems. Potentially, in Ethiopia, maize is planted on vast area of land (more than 2.4 million ha) according to recent, data from CSA, (2018/19). The crop is the food staple for several million families, the majority of whom also rear dairy cattle and other livestock species (Thorne *et al.*, 2002).

Nutritionally, it is well-documented that an increased maturity at harvest results in an increased grain filling for human consumption, starch-to-NDF ratio and increased fraction of rumen by-pass starch in maize silages. Inclusion of maize silage which is harvested at a more mature stage (>350 g DM/kg fresh weight, dough stage) in the diet of dairy cows could be an option to increase the supply of starch and rumen by-pass starch. Moreover, a related study in the near past indicated that maize silage harvesting at dough stage of the grain results in higher yields of dry matter, starch and energy (Zom *et al.*, 2012). Therefore, increasing maturity may also contribute to an increased self-sufficiency rate for feed and hence reduce the farm purchases of feeds and forage, and the food-for-feed competition. The crop has a relatively stable yield, high energy content, good ensiling characteristics, thus its inclusion in the total ration of dairy cows is also expected to increase feed intake.

In spite of the fact that whole crop maize silage is a major forage component in the ration of dairy cows, elsewhere outside Ethiopia, its utilization as a silage crop for dairy cattle feeding under local conditions is only limited to some government organizations (universities and research institution). As part of a solution to the problem a research project has been planned to use the green maize Stover for silage making at some later stage of grain maturity (i.e., after the grain was being harvested at dough stage with the assumption that the remaining grain moisture removed with sun drying for proper storage and use as a grain for human consumption). This research study being an innovative approach is proposed to evaluate and thereby improve the potential contribution of maize as food-feed to the livelihoods of dairy producers at farm level in Ethiopia. Therefore, the

objectives of this study was to evaluate feed intake, digestibility and growth performances of post weaned female Jersey calves fed green maize stover silage based TMR.

Materials and Methods

Description of the study area

The study was conducted at Adeaberga dairy farm sub-centre of Holetta agricultural research centre. The Adeaberga is located in the central highlands of Ethiopia at 9^o16'N latitude and 38^o23'E longitude, 70 km West of Addis Ababa and 35 km North West of Holetta on the main road to Muger. It lies at an altitude of 2500 meters above sea levels. It is characterized by cool sub-tropical climate with the mean annual temperature and rainfall of 18^oC and 1225mm, respectively.

Experimental animal's selection, design and calves' management

A total of eighteen post weaned calves weighing 72 ± 1.33 kg (mean \pm SE) were selected from the farm and randomly assigned to the treatment diets using two sample T-test with nine calves per treatment. The calves were drenched with broad spectrum anti-helminthic (Albendazole 2500 mg) prior to the commencement of the feeding trial according to the manufacturer's prescription. Calves were kept in individual pen in a well-ventilated barn with concrete floor, one sided wall, and corrugated iron roof to protect from rain with an appropriate drainage slope and gutter for urine removal and stall feeding inside the rearing shed. Approximate metabolizable energy and crude protein requirements of the calves were derived from NRC, (2001) recommendations. The calves were allowed to exercise from 8:00 PM to 8:30 PM to maintain previous exercise practice.

Experimental feed preparations and feeding management

Dual purpose maize (food-feed) was planted following on station recommended planting and agronomic practices. Harvesting was made at some stage of grain maturity (dough stage) when residual moisture and soluble sugar is left for silage fermentation and after the cobs have been already removed for use as food for human consumption. The partially green maize Stover (35% DM) was subjected to chopping (3-5 cm in length) and ensiled in the above ground silo of dimensions LxWxD in the presence of molasses additive added at the rate of 3% on DM basis. The Stover was kept tight to ferment inside the silo for 45 days during the dry season (from December 15 /2016 to January 30/2017) up until the start of the feeding trial.

Table 1: Proportion of feed ingredients in the dietary treatments (DM basis)

Feed	Treatment groups	
	T1	T2
Hay	50	0
Maize stover silage	0	50
Wheat bran	19	19
Cotton seed cake	10	10
Noug seed cake	8	8
Molasses	12	12
Salt	1	1

T1 = 50% natural pasture hay *ad libitum* + 50% concentrate mixture, T2 = TMR (50% Maize stover silage: 50% concentrate mixture).

Feeding trial

The initial body weights of weaned Jersey calves were measured by using fixed cattle weighing balance at the beginning of the experiment. The feeding trial was carried out for 180 days during which time daily feed and nutrient intake and fortnightly live weight changes were measured for individual calves. Natural pasture hay for the control group and maize stover based silage for the TMR groups were offered *ad-libitum* while the concentrate mixture for the control group was offered twice a day at 6.00 AM and 2:00 PM. Feed offer per each dietary treatment was periodically subjected to revision with changes in live body weight. Water was provided free of any choice. The amount of the feed consumed and refused per each calves was recorded to calculate feed and nutrient intake of the calves throughout the experiment. All the weaned calves were individually weighed at every 15 days before offering the morning meal. The average daily body weight gain was calculated by dividing the difference in final and initial live weight changes of the calves' weight to the total experimental duration i.e. 180 days.

Digestibility trial

At the end of the experiment, faeces from each animal were collected using the total faecal collection method, measured and recorded for seven consecutive days. To avoid cross contaminations with urine farm personnel were assigned to scoop the faeces into a plastic bucket upon defecation around the clock. Faecal sample for laboratory feed chemical analysis was obtained through direct rectal grabbing's at six time intervals a day. The faecal samples were stored in deep freezer (-20°C) until ready for subsequent lab analysis.

Chemical analysis

Maize Stover silage, natural pasture hay, TMR feed and faecal samples were dried at 55°C for 48 h, ground using a Wiley mill to pass a 1-mm sieve size. Feed and faecal samples were analysed for DM, Ash and N (AOAC, 1990), ADF, permanganate lignin and NDF (Van Soest and Robertson, 1985), *in vitro* organic matter digestibility (two stage procedures of Tilley and Terry, 1963), metabolizable energy was estimated from DOMD as ME (MJ/kg) = 0.16 * *in vitro* organic matter digestibility (McDonald *et al.*, 2002)

Statistical analysis

The data was subjected to analysis of a single factor ANOVA using the SAS procedure (SAS, 2002). Tukey mean separation test at 5% level of significance was used.

Results and Discussion

Chemical composition of feeds

The average chemical composition of maize Stover silage based mixed ration and the feed ingredients is presented in Table (2). Among feed ingredients the two protein sources (Cotton seed cake & Noug seed cake) have the highest CP and the lowest IVDOMD and NDF compared to the energy source (wheat bran). In the current finding, the DM, ash and CP contents of maize Stover silage based mixed ration is comparable with other findings (Raja *et al.*, 2013 and Habtie *et al.*, 2019) while the fiber fractions (NDF, ADF and lignin) were higher than the values reported by other researchers (Pachauri *et al.*, 2010 and Arto *et al.*, 2014). The possible reason for the variation of the current result and the previous reports could be related to difference in chemical compositions and proportion of the ingredients used in the total mixed ration. The current finding is consistent with the study of Raja (2013) and Habtie *et al.*, (2020) who reported maize Stover use as roughage source in TMR could increase nutritive value of the diet.

Table 2. Chemical composition of the ingredients and total mixed ration (%DM basis)

	DM	Ash	CP	NDF	ADF	Lignin	IVOMD	ME (MJ/KgDM)
Hay	92.12	6.52	5.45	62.24	40.89	7.50	50.41	8.07
Maize Stover silage	36.89	7.21	5.92	64.03	37.67	8.65	59.56	9.53
Wheat bran	88.82	5.14	16.50	48.03	18.89	4.43	69.89	11.18
Cotton seed cake	91.20	5.80	27.00	43.70	23.90	5.30	62.90	10.10
Noug seed cake	90.89	8.10	33.60	41.35	30.19	8.50	63.40	10.14
Concentrate mixture	90.24	5.49	20.87	42.23	14.88	5.24	67.02	10.72
Total mixed ration	62.07	8.12	12.88	54.15	25.65	6.28	62.89	10.08

Dry matter (DM), Crude protein (CP); Neutral detergent fibre (NDF); Acid detergent fibre (ADF); Acid detergent lignin (ADL); Invitro organic matter digestibility (IVOMD) and Metabolizable energy (ME)

Dry matter and nutrient intake

The average daily DM and nutrient intakes of the experimental calves are presented in Table 3. There was significant ($P < 0.05$) difference in average total DM and nutrient intakes among experimental calves. While total feed DM intake remained non-significant calves maintained on the intervention diet consumed considerably higher nutrient intakes than those on the control groups. In the current finding partial inclusion of green maize Stover in the total ration of dairy calves noted to have increased feed and nutrient intake is in agreement with the previous finding of Habtie *et al.*, (2020) who observed higher daily DM and nutrient intakes in total mixed ration than separate feeding. The higher total DM, OM and CP intake in T2 was due to the higher DM, OM and CP concentration in the diets.

Table 3. Average dry matter and nutrient intake of calves (Kg, cow, d⁻¹)

Intake	Treatments		SEM	P- value
	T1	T2		
Hay	2.34	-	-	-
Maize Stover silage	-	2.72	-	-
Concentrate mixture	2.27 ^b	2.66 ^a	0.07	0.05
Total DM	4.64 ^b	5.41 ^a	0.21	0.05
Organic matter	4.34 ^b	4.98 ^a	0.4	0.01
Crude protein	0.65 ^b	0.74 ^a	0.05	0.05
NDF	2.42 ^a	2.88 ^b	0.18	0.000
ADF	1.29 ^b	1.45 ^a	0.14	0.001

^{ab}Means in each row with different letters have a significance difference, SEM=standard error of the mean , T1 = 50% natural pasture hay ad libitum + 50% concentrate mixture, T2 = TMR (50% maize Stover silage: 50% concentrate mixture).

Apparent dry matter and nutrient digestibility

The mean apparent dry matter and nutrient digestibility of calves fed the control and the intervention diet is presented in Table (4). The DM, OM, CP, NDF and ADF apparent digestibility were significantly ($P<0.05$) affected by dietary treatments with calves receiving the intervention diet digesting 5.80, 4.74 and 9.92% more CP, NDF and ADF, respectively than cows on the control diet. The higher apparent digestibility of, CP, NDF and ADF in the maize Stover silage based total mixed ration groups (T2) observed in the present study is in agreement with the finding of Habtie et al. (2020) who suggested that utilization of green maize Stover silage made from maize crop harvested at late grain maturity could increase nutritive value and digestibility of the feed.

Table 4. Apparent dry matter and nutrient digestibility of calves fed different diet.

Apparent digestibility (%)	T1	T2	SEM	P value
DM	58.64 ^b	64.03 ^a	2.68	0.05
OM	56.26 ^b	62.81 ^a	2.14	0.05
CP	60.76 ^b	64.50 ^a	2.33	0.05
NDF	64.98 ^b	68.22 ^a	1.77	0.01
ADF	50.12 ^b	55.64 ^a	1.79	0.05

Means in each row with different letters have a significance difference, SEM=standard error of mean, DM= Dry matter, OM= Organic matter, CP= Crude protein, NDF= Neutral detergent fiber, ADF= Acid detergent fiber, T1 = 50% natural pasture hay ad libitum + 50% concentrate mixture, T2 = TMR (50% MS: 50% CM).

Body weight gain and feed conversion efficiency

Table 5 describes the growth performances, feed conversion ratio and crude protein utilization efficiencies of the heifers. The final live weight, average live weight changes and daily weight gain for calves in T2 group was higher ($P<0.05$) than those T1 group. However, feed conversion ratio and protein efficiency did not varied with treatments ($P>0.05$). In general, calves receiving the TMR diet gained 80 g more body weight over those calves in the control group while consuming same amount of feed DM and CP for each daily gram body weight growth. The higher daily weight gain in the total mixed ration observed in the current study is in par with that reported by Nissanka *et al.* (2010), O'Neil et al. (2011) all of whom have found higher daily body weight gain for animals maintained on TMR based diets than those fed on concentrate and roughage following

conventional feeding practices (i.e. the roughage and the concentrates were fed separately). Positive growth responses of calves to TMR based diet in the current study could be attributed to the higher dry matter and nutrient intake as well as apparent NDF and ADF fibre digestibility.

Table 5. Growth performance and feed conversion ratio of experimental calves fed with either the control or TMR based diets

Growth Parameters	Treatments		SEM	P value
	T1	T2		
Initial live weight (kg)	72	72	1.33	NS
Final live weight (kg)	153.84 ^b	167.31 ^a	2.51	0.05
Average live weight changes (kg)	81.84 ^b	95.42 ^a	3.68	0.05
Average daily body weight gain (kg)	0.45 ^b	0.53 ^a	0.14	0.01
Dry matter intake (kg day ⁻¹)	4.61 ^b	5.38 ^a	0.21	0.05
Crude protein intake (kg)	0.65 ^b	0.74 ^a	0.05	0.05
Feed conversion ratio (DMI/DWG)	10.24	10.15	1.01	NS
Protein efficiency	0.69	0.71	0.02	NS

^{ab}Means within a row with different letters have a significance difference, Ns= Non significance; SEM=standard error of mean, T1 = 50% natural pasture hay ad libitum + 50% concentrate mixture, T2 = TMR (50% MS: 50% CM), DMI = dry matter intake, DWG = daily weight gain

As can be seen from figure one below those calves fed the intervention diet (T2) consistently gained more weight compared to calves receiving the control diet (T1) throughout the growth period.

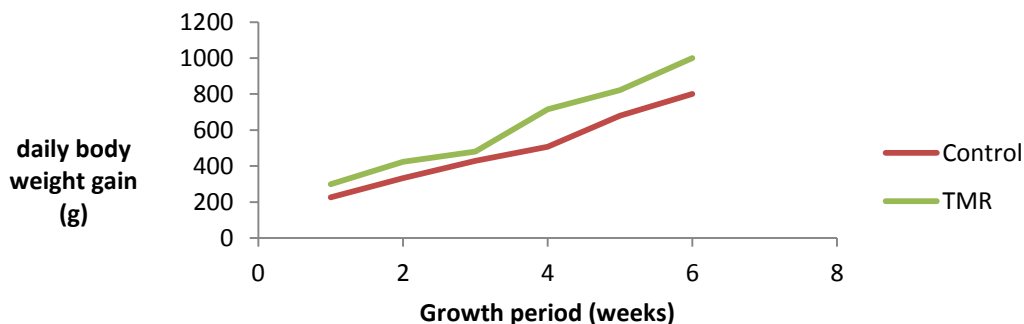


Figure 1: Trends in daily body weight gain of calves during the experiment

Conclusions and Recommendations

It can be concluded that the growth performance of calves fed dual purpose green maize Stover silage based total mixed ration diet were superior than calves fed natural pasture and concentrate mixture separately. Raising calves by using dual purpose maize stover silage based total mixed ration can be recommended for wider use at field levels once comparative advantage of using maize crop for food-feed rather than for food alone is verified with further study under actual farm conditions.

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