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Research Article

Milk Yield and Composition of Fogera Cows Fed with Napier Grass and Concentrate Feed at Andassa Livestock Research Center

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ABSTRACT

The experiment was conducted at Andassa Livestock Research Center (ALRC) to evaluate the effect of Napier grass and concentrate supplementation on feed intake, milk yield, milk composition and economic feasibility of Fogera cows. Twenty-six cows above second parity were randomly assigned to three treatment groups; T1 = Grazing plus Grass hay, T2 = Grass hay plus Napier grass and T3 = Grass hay plus concentrate feed. The trial was conducted from calving until drying off dates (April 2018 to February 2019). Concentrate supplemented group had higher (P< 0.01) total dry matter intake than Napier grass supplemented and control groups. Milk yield of Fogera cows improved through concentrate and Napier grass supplementation. Concentrate supplemented group had higher (P< 0.01) average daily milk yield (4.39 liters) compared to Napier grass supplemented (2.73 liters) and control groups (1.75 liters). Except solid not fat and minerals other parameters of milk composition had no variation at concentrate and Napier grass supplementary feeding. Concentrate supplemented cows (T3) resulted in a net benefit of 6039.60 ETB and a cost-benefit ratio of 1.68. Thus, supplementation of concentrate feed is biologically efficient and potentially profitable in the feeding of Fogera cows.

Key words: Concentrate, Napier grass, Milk yield, Fogera cows

INTRODUCTION

In developing countries, cattle production is oriented towards multi-commodity production systems that produce milk, meat, manure, and draught power. Milk production is dominated by dual-purpose breeds and restricted suckling systems in which milk and calf production are combined (Preston and Vaccarro 1989). Fogera cattle are among the indigenous cattle breeds of Ethiopia, which are found in the Amhara National Regional State. The breed is well adapted to the marsh areas of the region around Lake Tana and known by its triple use: as a source of draught power, meat and milk (Bitew *et al.,* 2010). Fogera cows provide on average two liters of milk per cow per day at Andassa Livestock Research Center under an extensive management system. While, in 2012/13, the average milk yields per cow per day at the national level was about 1.32 liters under low levels of nutrition and management (CSA 2013).

The poor production may be attributed to the sub optimal performance of local cattle as a result of unplanned breeding, inadequate feeding, management and disease control measures. The environmental factors may suppress the animal's true genetic ability and create a bias in the selection of animals (Lateef *et al.,* 2008). Breeding programs alone are insufficient to meet this goal; therefore, animal management at the farm level, including feeding must improve. The search for strategies that can improve animal performance has been an on-going effort, and the use of energy or protein supplements is common (Silva *et al.,* 2011). Napier grass is cultivated at ALRC forage development site throughout the year (irrigated during dry season) to supplement milking cows. In addition, concentrate feed is prepared at ALRC feed mill and given as supplemental feed for milking cows. However, the level of supplementation and response in terms of milk yield to these feeds were not studied. Therefore, the objectives of the study were: -

- To evaluate the milk yield and milk composition of Fogera cows fed with Napier grass and concentrate supplementation.

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To evaluate the economic feasibility of feed supplementation on milk yield of Fogera cows.

MATERIALS AND METHODS

Description of Study Area

The study was conducted at Andassa Livestock Research Center (ALRC), located in Amhara National Regional State (ANRS), Ethiopia. It is south of Bahir Dar and 22 km far on the way to Tis Abay. The center is situated $11^0$29' N latitude and $37^0$29'E longitude at an altitude of 1730 meters above sea level. The mean annual rainfall is 1434 mm and the mean maximum and minimum temperature ranged from 27.9 to 13.1^{o}C and humidity ranged from 95% throughout the rainy season to 35% during the dry season. The topography of the area varies from river valley plain to gentle slope grassland. In general, the area is characterized by dark clay soil, which is seasonally water logged (Yihalem 2005).

Animals, Experimental Feeds and Feeding

The experimental animals were twenty-six cows at the second and above lactations that selected from ALRC Fogera cattle improvement herd. The cows were checked for major contagious diseases and drenched with anthelmintic and sprayed against external parasites periodically. The experimental cows were kept under individual pens. Calves were allowed to suckle their dams for the first four days to get colostrum, and thereafter they suckled their dams for about 1-2 minutes to stimulate milk letdown.

Natural pasture hay was harvested from ALRC pasture land, baled and stored for feeding to Fogera cows. In this pasture land, the dominant grass species were Cynodon, Hyperhenia, Andropogon, Paspalum, Cetaria, Elusin, Eragrostis, Sporobulus, and Trifolium (Yihalem 2005). Napier grass was harvested on average at the one-meter height from the forage multiplication site of ALRC. The Napier grass was irrigated once per week during the dry season for better biomass production. The Concentrate mixture (maize grain 40%, wheat bran 28%, noug seed cake 30% and salt 2%) was prepared at ALRC feed mill. Animals were given fifteen days adaptation period to the experimental house and feed. The experimental cows were randomly assigned under the three (control, Napier grass, and concentrate supplemented) dietary treatments.

Treatment feeds used were:

- ✓ T1 = Grazing + Grass hay
- ✓ T2 = Grass hay + Napier grass
- ✓ T3 = Grass hay + Concentrate mix

The treatment feeds were offered in two equal portions twice a day at 7:00 am and 5:00 pm. The experimental animals were given water freely. Basal diet (hay) was offered ad libitum and adjusted daily by allowing 20% of refusals from the previous day's intake (Treatment 2 and 3). For treatment 1, hay was offered on average 3 kg/cow for the group. A periodic adjustment of treatment feeds offer was made for each cow as per the average milk production. The level of experimental feeds was adjusted a half kilogram of concentrate with one liter of milk and one kilogram of Napier for one liter of milk on a dry matter basis. Cows were given one kg of concentrate feed above their requirement for an anticipated increase in milk yield. Cows in treatment 1 were allowed to graze throughout the whole experimental period, while cows in treatment 2 and 3 were allowed to graze during the wet season only in the morning.

Chemical Composition Analysis of Feeds

The feed samples were analyzed for dry matter by AOAC (2000). The neutral detergent fiber (NDF) and acid detergent fiber (ADF) were determined according to the method of (Van Soest *et al.*, 1991). The Crude Protein (CP) content was calculated as N x 6.25 after determining the total nitrogen and carbon of the feed stuffs by dry combustion in a carbon and nitrogen, CN-coder, Yanagimoto Co. Ash content was determined by incineration at 600 °C for 2 hours in a muffle furnace (AOAC 1990). The contents of minerals were analyzed by Inductive Coupled Plasma Mass Spectrometer (ICP MS) after digestion of the feed samples with a mixture of nitric acids according to the procedures described by AOAC (1995). Chemical analysis of feed samples was conducted at Shimane University Animal Nutrition Laboratory, Japan.

Milk Composition Analysis

Fresh milk samples of 100 ml taken from each experimental cow using graduated bottles were used to analyze milk composition using a Lacto scan at the ALRC animal health laboratory room.

Partial Budget Analysis

Partial budget analysis was conducted to select a cost-effective feeding technology among the three feed treatments. The direct market price of milk, concentrate, and labor was used to compute the partial budget analysis. The real market price of Napier grass and grass hay was not used while their estimated market prices were taken from the report done by Misganaw *et al.*, 2018 in the same area. The labor costs for Napier grass harvesting, feeding, milking, and data collection were considered in the analysis.

Data Collection and Statistical Analysis

Basal and supplementary feeds offered and refused were weighed daily. All the cows were hand milked twice a day (at 7:00 am and at 5:00 pm) from calving until drying off dates (April 2018 to February 2019). Milk yield measurements were taken using graduated jars during the entire study period. Lactation length ranged from 238 days to a maximum of 329 days. Feed intake, milk yield, and milk composition data were subjected to the analysis of variance using the General Linear Model (GLM) procedure of SPSS (2011). The least significance difference (LSD) test was used to determine any significant difference between means. The models used for data analysis were: -

$Y_{ijk} = \mu + T_i + e_i$ (for feed intake and milk composition)

$Y_{ijk} = \mu + T_i + L_j + S_k + e_{ijk}$ (for milk yield)

Where;

Y = the observation on feed intake, milk yield and milk composition

μ = the overall mean

T_i = effect of i^{th} feed treatment

L_j = effect of the j^{th} lactation stage

S_k = effect of the K^{th} season of lactation

e_{ijk} = random error

RESULTS AND DISCUSSION

Chemical Composition of Experimental Feeds

The chemical composition of grass hay, Napier grass and concentrate mixture used in the study is shown in Table 1. The chemical analysis results of the present study showed a considerable difference in CP content between the basal and supplemental diets. The supplemental diets (Napier grass, 128 g/kg DM and concentrate mix, 152 g/kg DM) have better CP content than the basal diet (66.5 g/kg DM). The grass hay and concentrate feed CP content in the present study were found comparable to the value reported by Yihalem (2005) and Misganaw *et al.,* (2018) respectively, whereas the CP content of the Napier grass (12.8% of DM) is higher than the value of CP content (9.9% of DM) reported by Misganaw *et al.* (2018) in the same area. The CP content of the grass hay was less than the critical value (70 g/kg) required by ruminant animals for optimum activity of rumen micro-organisms (NRC 2001) and thus supplementing animals with other feed ingredients is essential. However, the Napier grass and concentrate feed that used in the farm have a higher CP level than the minimum CP level (70 g/kg) required for an adequate rumen function in ruminants (Van Soest *et al.,* 1991).

The fiber component, NDF and ADF content was higher in the grass hay than the Napier grass and concentrate feed. The NDF content of grass hay was close to the value reported by Misganaw *et al.* (2018), while the NDF content of Napier grass was lower to the value reported by Misganaw *et al.* (2018) in the same area and Muia (2000) in Kenya. The threshold level of NDF in tropical grass beyond which dry matter intake of cattle affected is 600 g/kg (Meissner *et al.,* 1991) suggesting that Napier grass and concentrate feed in the present study have below, while grass hay has NDF content above the threshold level (Table 1). The macro and micro mineral composition of the experimental feeds are shown in Table 2. The concentration of calcium, magnesium, potassium, and phosphorus was sufficiently high to meet the requirements of the cows in all feed types, while sodium concentration was low and therefore needs to be supplemented. The micro minerals; iron, manganese, cobalt and zinc were found in high concentrations in the feed ingredients, while copper was found in low concentrations (0.7 mg/kg DM in hay to 2 mg/kg DM in grazing pasture). Copper concentration should be 12 mg/kg of dietary DM to meet the daily copper requirement of a cow (NRC 2001).

Feed Intake (kg/day) of Fogera Cows

Summary of the mean dry matter intake (DMI) (kg/day/cow) of Fogera cows fed on Napier grass and concentrate mixture is presented in Table 3. Total dry matter intake varied ($P \leq 0.01$) among treatment groups. The concentrate supplemented group had higher total dry matter intake than the Napier supplemented group. However, there is no significant difference in grass hay dry matter intake between Napier and concentrate supplemented groups. Similar low total dry matter intake was reported by Misganaw *et al.* (2018) in cows given fresh Napier grass ad libitum, which had higher moisture content, than those given grass hay and concentrate mixture. The cows' lower dry matter intake may be attributed to the lower dry matter content of the Napier grass.

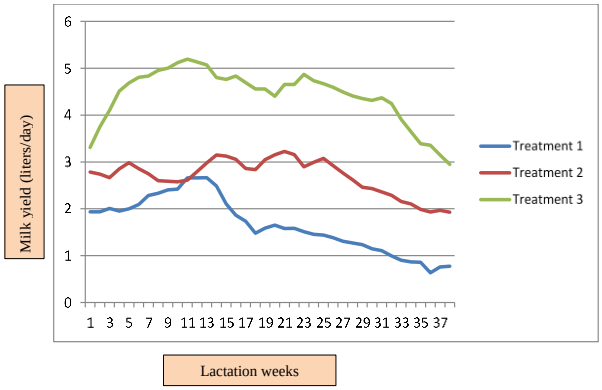

Fig. 1: Lactation curve of Fogera cows at different feed treatments

Fig. 2: Highest milk yielder Fogera cow during the experiment

Milk Yield

Milk yield of control (grazing), Napier and concentrate supplemented groups is shown in Table 4. The concentrate supplemented group had higher milk yield (4.39 liters/day) than the Napier supplemented (2.73 liters/day) and control groups (1.75 liters/day). The difference in milk yield between concentrate supplemented and control (grazing) groups is more than double, which indicates the Fogera cow's milk yield could be improved through concentrate feed supplementation. Similar to the present study, Sairanen (2014) reported milk yield of cows increased when the amount of concentrate supplementation increased. Adebabay *et al.* (2011) and Sallam *et al.* (2017) also reported that supplementation of cows with concentrate feed ingredients resulted in increment of milk production compared with those left on natural grazing alone. The daily milk yield of Fogera cows has also been affected by lactation stages and seasons (Table 4). The average daily milk yield was higher at early and mid-lactation stages and declined at the late lactation stage. Cows could be dried earlier in the late lactation stage, when the level of milk production is low which will have an effect on the onset and intensity of post parturient oestrus (Addisu and Hegde 2003). The average daily milk yield was higher during the wet season compared to the dry season of lactation. The difference in milk yield was attributed to the availability of green feed because cows were allowed to graze on pasture land during the wet season. The 200 days milk yield between control (grazing), Napier and concentrate supplemented groups is presented in Table 4. Feed supplementation increased the 200 days milk yield which implies calves will suckle more milk and therefore will have better growth.

Table 1: Chemical composition of the experimental feeds

Feed characteristics	Grass Hay	Napier grass	Concentrate Mix
DM (g/kg product)	864	974	910
Crude protein (g/kg DM)	66.5	128	152
Crude ash (g/kg DM)	140	146	104
NDF (g/kg DM)	694	423	412
ADF (g/kg DM)	398	341	178

Table 2: Macro and micro mineral composition of the experimental feeds

Feed types	Macro Mineral (g/kg DM)					Micro Mineral (mg/kg DM)					
	Ca	K	Na	Mg	P	Al	Mn	Fe	Co	Cu	Zn
Concentrate	5.01	27.7	20.6	7.35	12.9	202	17	60	1.0	1.0	77
Hay	2.82	32.1	0.27	5.63	3.74	188	45	65	1.2	0.7	24
Napier grass	2.80	24.1	0.46	10.1	4.48	355	9	62	1.4	1.1	14
Grazing Pasture	4.06	48.4	1.11	7.08	9.71	594	29	766	5.0	2.0	36

Table 3: DM feed intake (kg/day/cow) of Fogera cows

Treatment	Grass Hay	Napier grass	Concentrate	Total
	NS			**
1	3.0 ± 0.03			3.0 ± 0.03^{c}
2	3.38 ± 0.03	2.48 ± 0.01		5.86 ± 0.03^{b}
3	3.43 ± 0.03		3.35 ± 0.01	6.78 ± 0.03^{a}
LSD (0.05)				5.81

Means within column with different letters are significantly different; ** = significant at p<0.01

Table 4: Milk yield of Fogera cows at different feed treatments

Treatment	Number of records	Average milk yield (liters/day)	200 days milk yield (liters)
Overall	6901	2.96 ± 0.01	647 ± 29.5
Feeding group		**	**
1 (Grazing)	1630	1.75 ± 0.02^{c}	376 ± 54.9^{c}
2 (Napier grass)	2411	2.73 ± 0.01^{b}	571 ± 47.5^{b}
3 (Concentrate)	2860	4.39 ± 0.01^{a}	993 ± 50.8^{a}
Lactation stage		**	
1 (Early)	1959	3.40 ± 0.02^{a}	
2 (Mid)	2288	2.98 ± 0.02^{a}	
3 (Late)	2654	2.50 ± 0.01^{b}	
Lactation season		**	
1 (Dry)	3494	2.66 ± 0.02^{b}	
2 (Wet)	3407	3.26 ± 0.02^{a}	
CV		23.3	

Means within column with different superscripts are significantly different; ** = significant at p<0.01.

Table 5: Milk composition of Fogera cows at different feed treatments

Variable	Fat	Lactose	SNF	Protein	Minerals
Overall mean	4.24±0.07	4.33±0.03	7.86±0.05	2.87±0.02	0.64±0.01
Feed groups	NS	NS	*	NS	*
1 (Grazing)	4.06±0.15	4.33±0.05	7.86±0.09^{ab}	2.89±0.05	0.64±0.01^{ab}
2 (Napier grass)	4.22±0.11	4.26±0.04	7.72±0.07^{b}	2.82±0.04	0.62±0.01^{b}
3 (Concentrate)	4.42±0.12	4.41±0.04	8.0±0.07^{a}	2.88±0.04	0.65±0.01^{a}
CV	11.8	7.2	7.1	6.9	7.3

Means within column with different superscripts are significantly different; * = significant at p<0.05.

Table 6: Partial budget analysis at different feed treatments of Fogera cows (200 days)

Costs	Unit	Amount used and costs					
		T1		T2		T3	
		Amount	Cost ETB	Amount	Cost ETB	Amount	Cost ETB
Concentrate	Kg	0	0	0	0	670.00	4690.00
Napier grass	Kg	0	0	496.00	1736.00	0	0
Hay	Kg	600.00	1800.00	676.00	2028.00	686.00	2058.00
Labor cost	ETB		1842.00		2546.00		2108.00
Total cost (A)	ETB	-	3642.00	-	6310.00	-	8856.00
Gross benefit (B)	Liter & ETB	375.75	5636.25	570.79	8561.85	993.04	14895.60
Net benefit (B-A)	ETB	-	1994.25	-	2251.85	-	6039.60
Cost benefit ratio (B/A)	ETB	-	1.54		1.35	-	1.68

T1 = Grazing + Grass hay, T2 = Grass hay + Napier grass, T3 = Grass hay + Concentrate, ETB = Ethiopian birr.

The Fogera cow's lactation curve over different feed treatments is shown in Figure 1. The peak average daily milk yield was attained between weeks 11 to 13, 20 to 22, and 10 to 12 for treatment 1, 2 and 3, respectively, and declined thereafter. In contrast to this study, Rekik *et al.* (2003) reported that multiparous cows reach their peak of production earlier in the lactation (5–6th weeks of lactation). The highest milk yielder cow was from concentrate supplemented group with an average daily milk yield of 5.37 liters/day through a lactation length of 329 days (Figure 2). This result indicated the presence of elite Fogera cows in the herd that respond to feed supplementation.

Milk Composition

Milk composition of Fogera cows at different feed treatments is presented in Table 5. There was no variation between feed treatment groups for milk composition parameters, except solid not fat and minerals. Concentrate supplemented group had higher ($p<0.05$) solid not fat and minerals than Napier supplemented group. In an on-farm feeding trial conducted in Bure district, Adebabay *et al.* (2011) reported a significant difference between control and supplemented group in terms of increased milk-fat and total solids while treatment effects were not significantly different for increased milk protein, solids-not-fat and ash contents.

Partial Budget Analysis

The partial budget analysis result showed that T3, T2, and T1 gave an average net benefit from milk sales 6039.60, 2251.85 and 1994.25 ETB, respectively in two hundred days (Table 6). Concentrate feeding gave the highest benefit compared to other treatments.

Conclusions

Milk yield of Fogera cows improved through concentrate and Napier grass supplementation. The difference in average daily milk yield between concentrate supplemented and control (grazing) group is more than double which indicated milk yield of Fogera cows could be greatly improved through concentrate supplementation. Feed supplementation also increased the 200 days milk yield which implied calves will suckle more milk and therefore will have better growth. Except solid not fat and minerals other parameters of milk composition had no variation at concentrate and Napier grass supplementary feeding. Concentrate feeding gave the highest benefit compared to other treatments. Thus, supplementation of concentrate is biologically efficient and potentially profitable in the feeding of Fogera cows.

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