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Original Article

Effects of Supplementing Borana Dairy Cows with Local (*Vachelliatortilis pods*) and Conventional Feeds on Milk Yield and Milk Composition

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ABSTRACT

An experiment was conducted at Yabello Pastoral and Dryland Agricultural Research Center in Oromia National Regional State to evaluate the effects of local and conventional feed supplementation on milk yield and milk composition of Borana cows. Twelve lactating Borana cows of first parity and second parity with a similar stage of lactation were used. The experiment had four treatments with three replications using a randomized complete block design. Treatments included noug seed cake (NSK)+ wheat bran + free grazing (T1), *Vachelliatortilis* pods + wheat bran + free grazing (T2), *Vachelliatortilis* pods + free grazing(T3), and the control (free grazing) (T4). There were significant differences (P<0.05) in milk yield between cows fed in control and supplemented as well as within supplemented groups. Higher (P<0.001) significant interaction of parity with the treatment of milk yield was also observed. Significantly (P<0.001) higher (3.10 kg/cow/day) and lower (1.95 kg/cow/day) milk yield was obtained from cows fed T2 and T4, respectively. Except for solid not fat and lactose content all analyzed milk compositions were significantly different (P<0.05) among treatment groups. Higher fat (7.69%), protein (3.59%) and

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total solids (15.98%) and lower ash (0.73%) were recorded from cows fed T1, T2, T4, and T3, respectively. The treatment diets increased the net profit/cow/day by Ethiopian Birr (ETB) 16.35 (T1), 31.57 (T2), and 13.67 (T3) over the control (T4). In conclusion, supplementation of *Vachelliatortilis* pods with different feed to Borana cows on natural pasture improved milk yield, milk composition as well as net profit. Therefore, using *Vachelliatortilis* pods with different feeds as supplementation for lactating cows can be recommended for milk production in the pastoral and agro-pastoral areas.

Keywords: Cows, *Vachelliatortilis* pods, milk composition, milk yield, protein, wheat bran

INTRODUCTION

Feed is the most important input in livestock production, and its adequate supply (quantity and quality) throughout the year is an essential prerequisite for any substantial and sustained expansion in livestock production. The major livestock feed in the country is grazing and browsing natural pasture, crop residues and agro-industrial by-products, and cultivated pasture and forage crop species (Teklu, 2011).

In arid and semi arid regions of Ethiopia, livestock is kept under an extensive management system and depends on rangeland pastures that are often deficient in nitrogen and digestible nutrients. These low-quality feeds reduce intake, digestion, and utilization of nutrients. Most legume trees and shrubs have high protein content, which makes them promising supplements and are the practical solution to alleviate nutrient deficiencies in poor quality natural pastures (Kumar, 2011; Amata, 2014).

Among locally existing protein enrich feed resources, tree legume forages such as *Vachellia* species have an indispensable role as protein supplements (Bayssa, 2016). *Vachellia* toritlisis one of the dominant *Vachellia* species distributed in vast areas of South Omo, Afar and Borana rangelands and it is one of the important sources of fodder for ruminants (Berihe *et al*., 2014). *Vachellia* tortillas browse yields about 4-6 kg dry leaf and 10-12 kg pods per year per plant (Bekele, 2007). The previous study reported by Abdulrazak *et al.,* (2000) indicated that the CP content and DM digestibility of *Vachellia* tortilispods is about 18% and 46% respectively.

The low land of Borana is characterized by fragile weather and degraded land conditions and there has been a great shortage of animal feedstuffs, particularly during the dry season. The energy and protein-rich ingredients (mainly, cereal and oilseed products) are not available to the pastoralist community since they are introduced from the central part of the country at high costs compared with some of the products of locally grown trees and shrubs like acacia plants, which are available all year round in the low land area. *Vachellia tortilis* pods are seasonally available in plenty in the arid land and they are rich in protein and digestible nutrients.

Feeding of *Vachellia tortilis* pods improves digestibility, intake, and animal performance in small ruminants. *Vachellia tortilis* pods using commercial cereal milling machines available in most small rural towns and storing them as strategic protein concentrate feed. *Vachellia tortilis* feed can alleviate nutritional constraints in the dry season, increase milk yield and sustain the body conditions of pastoral goats in the arid rangelands, thereby improving livestock productivity and income generation (Moses, 2014).

Therefore, this experiment aimed to study the effect of feeding the concentrates and pods of *Vachellia tortilis* on milk yield and milk composition of Borana cows under low lands of Borana condition.

MATERIALS AND METHODS

Location of the study

The study was conducted in the cool dry season for 63 days from June 29th to August 31th 2015 at Yabello Pastoral and Dryland Agricultural research center (YPDARC), situated in the Borana Zone of South-west Oromia. The area lies at an altitude of 1668 m above sea level. The location represents semiarid climatic conditions and receives a mean annual rainfall of about 700 mm (Hurst *et al.,* 2012). The average temperature of the study area is about 21.5°C ranging from 19°C to 24°C.

Experimental design and treatments

The experimental design was a randomized complete block design (RCBD). The experimental cows were randomly assigned to one of the four experimental treatments in each block.

Experimental Treatments where :

T1 = Control + Concentrate (wheat bran + Noug cake)

T2= Control + *Vachellia tortilis pod* + Wheat bran

T3= Control + *Vachellia tortilis pod*

T4 = Control (grazing)

NB*:* For all treatment, common salt was supplemented at a rate of 1%

Supplementation of either NSK or WB was based on the milk yield performance of experimental cows. Experimental feeds were selected based on their availability in the study area. Secondary data were used to formulate concentrate mixtures (Gemiyo *et al*., 2013). Concentrate rations were formulated based on the nutrient requirement of lactating cows in the tropics, which is 75% TDN and 17% CP on average, and the fact that most of the Ethiopian dry forages and roughage have a CP content of less than 9% (mean 6.2%) (Feyissa *et al.*, 2015). The concentrate ration was formulated to have 51% of wheat grain, 48% of noug seed cake, and 1% salt using the Pearson square balancing method.

Experimental animals and their management

A total of twelve Borana cows having two parities (parity one and two) were used for this experiment. Animals with parity one were only four and the rest were with parity two. Animals were blocked according to their body weight. Accordingly, the experimental cows were grouped into four groups of three animals in each block. During allocating of animals in each block with randomization, the animals with parity one were assigned in all bocks as chance. Therefore, there was no parity effect alone on the milk yield of animals. All cows were de-wormed with broad-spectrum anti-helminthics and sprayed to control internal and external parasites, respectively before the beginning of the experiment. The feeding trial was conducted for nine weeks including two weeks adjustment period before the commencement of actual data collection. The quantity of supplemental diet offered daily was at the rate of 0.25 kg/l of milk produced by each cow and offered twice a day with equal portions at 7:00 am and 5:00 pm during the morning and evening before milking time, respectively. During the daytime, all experimental cows were kept on a natural pasture for approximately about 9 hours per day (8:00 to 17:00). Water was provided free choice to experimental cows during the entire experimental period.

Feed analysis

Samples of feed offered were dried in an oven at 105ºC for 24 hours and analyzed for nitrogen (N), dry matter (DM), and ash according to AOAC (2005). The crude protein (CP) content was calculated by multiplying N content with a factor of 6.25. Neutral detergent fiber (NDF), acid detergent fiber (ADF), and acid detergent lignin (ADL) were determined by the methods of Van Soest (1994). Hemi-cellulose content was calculated as NDF minus ADF. The Chemical composition of experimental feeds was indicated in (Table 1).

Table 1: Chemical composition of experimental feeds

Parameters	VTP	NC	WB	CONC.
DM%	91.95	92.33	90.13	92.30
CP%	18.10	25.60	17.01	16.50
Ash%	6.14	92.33	4.93	3.80
NDF%	39.62	49.13	48.62	15.50
ADF%	33.36	42.06	16.20	8.90
ADL%	7.12	7.10	3.78	3.77
Hem%	6.26	7.07	32.42	6.60

Key: NC=Noug cake VTP = Vachellia tortilis pods; DM = Dry matter; CP = Crude protein; NDF = Neutral detergent fibre; ADF = Acid detergent fibre; ADL = Acid detergent lignin; Hem= Hemicelluloses; CONC= Concentrate

Milk sample and composition analysis

Sample of milk from each cow was collected three times in five days intervals (day 2, day 7, and day 12) during the milk data collection period. About 300 ml composite sample of milk from each cow was collected and taken to the Ethiopian Dairy and Meat Technology Institute for analysis. Chemical composition of milk: butterfat (BF), Crude protein (CP), total solids (TS), and ash were determined following the standard methods (AOAC, 2005).

The fat content of the milk was estimated using the Gerber analytical method (AOAC, 2005), and the Kjeldahl method was used to determine the total protein content of milk (IDF standards 20B, 1993). To determine the total solids content, the oven-drying method was used (AOAC, 2005). The solid-not fat content was determined by subtracting the percent fat from total solids. The total ash content was determined by igniting the dried milk samples in a muffle furnace (AOAC, 2005).

Partial budget analysis

The economic analysis was based on the calculation of the total cost of supplemented feeds and considering milk sales price and labor cost incurred during the entire experimentation period. The price of milk in Yabello district was known in the dry season to calculate the income obtained per milk yield per day. The Partial budget analysis was employed to compute the total cost of production /cow/day, mean kg of milk/treatment day, cost of production/kg of milk, gross income from the sale of milk/treatment/day, net profit/cow/day, and net profit/treatment/day.

Statistical analysis

Data from milk yield and milk composition were subjected to the analysis of variance (ANOVA) procedure for RCBD (SAS, version 9.0). Treatment means were separated using Least Significant Difference (LSD) at $\alpha = 0.05$. The statistical model used was:

$Yij=\mu+ai+bij+eijk$

Where,

Y ij= the dependent variable (milk yield)

μ= the overall mean

aj= the effect of the i^{th} diet

bij= block effect of ij^{th} parity

eijk = random variation

RESULT AND DISCUSSION

Milk yield

The effect of dietary supplements, parities, and interaction of parity and treatment on average daily milk yield is presented in Tables 2, 4and 5, respectively. Results showed that supplemented cows (T1, T2, and T3) with local and conventional feed produced significantly higher (*P*<0.001) milk yield than cows grazed on natural pasture alone (T4). It was found that a significant difference (*P*<0.001) was also observed in milk yield between supplemented cows with local and conventional feed.

Even though T1 fed cows were expected to perform better than those on other treatments with higher milk yield, cows supplemented with T2 gave significantly higher (*P*<0.001) milk yield than T1, T3, and T4. This is due to a combination of wheat bran with roughage feed can increase the milk yield by 54 % (Hussien *et al*., 2013). Accordingly, cows fed T1, T2 and T3 increased milk yield by 46, 59, and 26%, respectively compared to cows fed control only (T4). The experiment conducted on the effect of Fogera lactating cows supplemented with different feeds revealed that cows fed hay with concentrate and hay with wheat bran increased milk yield by 76 and 54%, respectively compared to cows fed only hay (Hussien *et al*., 2013). The variation of this increment rate in milk yield compared with the present study may be due to the difference in breed, feed resources, and agro-ecologic zone.

Table 2: Mean milk yield (kg/day) of Borana cows supplemented with local and conventional feeds

Treatment	Milk Yield
T1	2.80^{b}
T2	3.10^{a}
T3	2.46^{c}
T4	1.95^{d}
P-value	***
Over all mean	2.58
SE	0.04
CV%	19.69

Means in the column with different superscript are significantly different at (****P<0.001)*; T1= Treatment 1 (Conventional concentrate + free grazing); T2= Treatment 2 (*Vachellia tortilis* pod + wheat bran+free grazing); T3= Treatment 3 (*Vachellia tortilis* pod + free grazing); T4 = Treatment 4 (free grazing); SE= Standard Error; CV = Coefficient of variation

In the present experiment, cows supplemented with Vachellia pod (T3) increased milk yield by 26% compared to cows fed control (T4) feed. It was observed that the Vachellia pod has the potential to increase milk yield when supplemented with a cow. Milk yield was significantly (*P*<0.001) lower in the first parity cows than in cows in the second parity (Table 3). It was stated that milk yield was lower in the first parity than other next parity and tended to increase until the fifth parity and then decrease (Jemila *et al*., 2012).

Table 3: Parity effect on milk yield of Borana cows supplemented with local and conventional feeds

Parity	Milk Yield ±SE
PAR_1	$2.25±0.03^b$
PAR_2	$2.74±0.02^a$
P-value	***

Means in the column with different superscripts are significantly different at (****P<0.001);* PAR_1= Parity one; PAR_2= Parity two, SE= Standard Error;

Table 4: Mean milk yield (kg/day) of interaction between treatment and parity of Borana cows

Factors	Label	Milk Yield ±SE
Parity*Treatment	PAR_1* T1	$2.65±0.06^c$
	PAR_1* T2	$2.76±0.06^{bc}$
	PAR_1* T3	$1.73±0.06^e$
	PAR_1* T4	$1.85±0.06^{de}$
	PAR_2* T1	$2.88±0.04^b$
	PAR_2* T2	$3.27±0.04^a$
	PAR_2* T3	$2.83±0.04^b$
	PAR_2* T4	$2.00±0.04^d$
P-value		***

Means in the column with different superscript are significantly different at (****P<0.001);* PAR1= Parity one; PAR2= Parity two, SE= Standard Error, PAR*T= Interaction between parity and treatment; T1= Treatment 1 (conventional concentrate + free grazing); T2= Treatment 2 (*Vachellia tortilis*pod + wheat bran free grazing); T3= Treatment 3 (*Vachellia tortilis* pod + free grazing); T4 = Treatment 4 (free grazing); SE= Standard Error; CV = Coefficient of variation

The finding of this study also showed milk yield of the experimental cows was significantly (P<0.001) affected by an interaction between parity and treatment (Table 5). Higher milk yield was recorded from the interaction of $parity_2$ with T2, whereas lower milk yield was obtained from the interaction of $parity_1$ with T3, $parity_1$ with T4, and $parity_2$ with T4. Moreover, intermediate results of milk yield were recorded from the interaction of $pariy_1$ with T1, $parity_1$ with T2, $parity_2$ with T1, and $parity_2$ with T3.

Milk composition

The mean values of milk fat, protein, solid not fat (SNF), ash, total solids (TS), and lactose are indicated in Table 5. Except for SNF and lactose content, all analyzed milk compositions were significantly (P<0.05) different. Cows fed T4 gave a significantly higher (P<0.001) milk fat than cows fed T1, T2, and T3. This is since, Rations with more concentrates may result in changes in the proportion of ruminal VFA, which in turn can result in the reduction of milk fat in T1 and T2. But the difference between T3 and T4 in fat percent might be due to the type of forage and its effect on milk fat percentage is influenced by forage particle size, maturity, and fiber content of the forage. A significantly lower (*P*<0.01) content of milk protein was obtained from cows fed T4 than from cows fed T1, T2, and T3. This is due to cows grazing on poor pasture which had lower protein percentages. A significantly lower (*P*<0.05) milk ash and a significantly higher (*P*<0.01) TS was observed from cows fed T4. In the present study higher mean of milk fat, protein, ash, and TS were recorded compared to Fogera cows fed on different treatments reported by Hussien *et al*., (2013), who found 5.01, 3.07, 0.70, and 14.23 milk fat, protein, ash, and TS, respectively. However, in this experiment, a lower grand mean SNF of milk was obtained compared to an earlier report by Hussien *et al*., (2013) that stated 9.22% SNF of milk.

Table 5: Chemical composition of milk of Borana cows supplemented with local and conventional feeds

Treatment	Fat g/100g	Protein g/100g	SNF g/100g	Ash g/100g	TS g/100g	Lactose g/100g
T1	6.92^{bc}	3.59^{a}	8.64	0.79^{a}	15.55^{b}	4.25
T2	6.83^{c}	3.52^{b}	8.45	0.80^{a}	15.28^{b}	4.13
T3	7.05^{b}	3.57^{ab}	8.51	0.78^{a}	15.56^{b}	4.15
T4	7.69^{a}	3.47^{c}	8.27	0.73^{b}	15.98^{a}	4.08
P-value	***	**	NS	*	**	NS
Grand mean	7.12	3.54	8.47	0.78	15.59	4.15
SE	0.04	0.01	0.06	0.01	0.07	0.08
CV%	0.76	0.51	1.00	1.82	0.64	2.57

Means in the column along treatments with different superscript are significantly different at (*$P<0.05$, **$P<0.01$, ***$P<0.001$). T1= Treatment 1 (Wheat bran + oil seed cake + free grazing), T2= Treatment 2 (*Vachellia tortilis*pod + wheat bran free grazing), T3= Treatment 3 (*Vachellia tortilis*pod + free grazing), T4 = Treatment 4 (free grazing), SE= Standard Error and CV = Coefficient of variation, SNF= solid non fat, TS= total solids

It was stated that breeds and individuality of the cow, as well as environmental effects, show obvious differences in their milk composition and yield. Differences among individuals are often greater than differences within breeds (Mosu *et al*., 2013). Such differences are due to breed, parity, lactation stage, and environmental factors. The milk from indigenous cows contains 6.1% fat, 3.3% protein, 4.5% lactose, and 0.7% ash (Mosu *et al*., 2013).

An economic evaluation of treatment feeds

The cost of grazing for the control group was not considered; while the total cost of production was considered since other variable costs (medicaments) were the same for the entire treatment groups. The gross profit from the sale of milk per treatment per day increased from 58.44 ETB to 84.00, 93.00, and 73.8 ETB /cow/day in T1, T2, and

T3, respectively. The net profit increased from ETB 58.44/cow/day in T4 to ETB 74.85/cow/day in T1; ETB 90.07/cow/day in T2 and ETB 72.17 in T3 (Table 6).

Table 6: An economic evaluation of experimental feeds fed to lactating Borana cows

Costs and benefits	T1	T2	T3	T4
Cost of *Vachellia tortilis* pods (ETB)	-	252.00	252.00	-
Cost of noug seed cake (ETB)	487.62	-	-	-
Cost of wheat bran	319.41	319.41	-	-
Cost of concentrate	807.03	-	-	-
Total variable cost (ETB)	4842.18	1714.23	0.00	0
Cost /cow/experimental period (ETB)	1614.06	571.41	252.00	0
Cost/cow/day (ETB)	25.62	9.07	4.00	0
Mean kg of milk per treatment per day	2.80	3.10	2.46	1.95
Cost /cow/kg of milk (ETB)	9.15	2.93	1.63	0.00
Gross income from sale of milk/treatment/day (ETB)*	84.00	93.00	73.80	58.50
Net profit (ETB)	74.85	90.07	72.17	58.50
Net profit over the control/treatment/day (ETB)	16.35	31.57	13.67	-

*The average price per liter of milk fixed at 30 ETB (Ethiopian Birr) during dry season; T1 = (wheat bran + Noug seed cake); T2 = (*Vachelliatortilis* + Wheat bran), T3 = (*Vachelliatortilis+Control);* T4 = Control group

Hence, this study demonstrated that feeding the local and conventional diets to local milk cows increased the net profit for pastoralists to ETB 16.35/cow/day (T1), ETB 31.57/cow/day (T2), and ETB 13.67 /cow/day (T3) over the control (T4) group. The higher net profit gained from feeding (*Vachellia tortilis* + wheat bran) (T2) is an advantage for smallholder pastoralists who have better access to these *Vachellia tortilis* pods. This higher net profit gained might be because a higher milk yield per day was recorded from cows fed *Vachellia tortilis* pods with wheat bran supplementation than other feed treatments.

CONCLUSIONS

Supplementation of Borana cows maintained on natural grass pasture with local (*Vachelliatortilis and wheat bran*) and conventional feed has significantly improved milk yield, milk composition (fat, protein, total solids), and net profit than the control group. *Vachellia tortilis* pods are local feed ingredients having the potential to replace the conventional protein sources in concentrate mixture for lactating cows.

RECOMMENDATIONS

- Supplementation of *Vachellia tortilis* pods with wheat bran to cows was recommended since it gave higher milk yield and economic returns.

- Therefore, pastoralists and agro-pastoralists can use *Vachellia tortilis* pods with wheat bran on poor pasture, especially during the dry season for improving milk production.
- Additional trials should be investigated on processed *Vachellia tortilis* pods than when fed whole on the animal performances.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding the publication of this paper.

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