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Evaluation of Effective Microbe Treated Barely Straw Supplemented with Bypass Protein as Intervention Diet for Crossbred Dairy Animal under Small Scale Farmer's Condition

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Abstract
The study was conducted at on farm level with crossbred lactating dairy cows, maintained under small scale mixed farming system at Kofele district, in West Arsi zone, Ethiopia to assess the effect of feeding intervention diet (EM treated barley straw) supplemented with a concentrate mixture (linseed cake 48%; wheat bran 50% and salt 2%). The study was conducted to asses feed intake, milk yield and profitability during the dry season. A total of 26 households having one or two lactating cows per house hold were selected. Twenty six cows in mid-to late lactation with an average body weight of 315.8±52.05 kg were selected and balanced for their parity, stage of lactation, level of milk yield and divided into two groups (13 cows per group). Thirteen cows were fed EM treated barley straw in addition to grazing and supplemented with a concentrate mixture at 0.5 kg /kg of milk yield/cow/day (T1), and the other 13 cows of one group were maintained as usually practiced by farmers (control) (T2). Feeding EM treated barley straw supplemented with linseed cake and wheat bran concentrate mixture significantly ($P<0.01$) increased feed intake and milk yield of the cows. Due to the improvement in daily milk yield by 2.31 kg (4.98 vs. 2.65 kg), the net profit increased from ETB 39.24/cow/day in the control group to ETB 49.05/cow/day in T1 group. This study indicated that the intervention diet increased the net profit for farmers to ETB 9.81/cow/day. Feeding EM treated barley straw with bypass protein source was found to be an effective approach to maximize the utilization of locally available feed resources for better animal productivity during the dry season in mixed farming system of Ethiopia.
Keywords: Effective Micro-organism, barley straw treatment, economic analysis, milk yield

Introduction

Crop and livestock production are commonly integrated in the mixed farming system of the mid and high lands of Ethiopia. In such systems the land is dominantly utilized by smallholder farmers for production of cereal and pulse crops and grazing land for livestock through rain fed agriculture. As more and more land is put under crop production, livestock feed becomes scarce and crop residues particularly cereal straws remain the major feed source for the animals particularly during the dry period of the year (Solomon, 2004). Crop residues such as cereal straws are low quality feeds which forms the basal feed in most parts of Ethiopia. They are deficient in nitrogen, energy, vitamins and minerals, of which fermentable nitrogen is usually the first limiting (Girma *et al*. 2014, Zewudie, 2010). The nutrient deficiencies affect microbial growth, microbial protein synthesis and overall fermentation in the rumen that further result in low voluntary intake and fiber fermentation and digestibility.

Barley straw is one of the major crop residues available in most cereal producing mixed farming systems. However, it contain high fiber and hence has low degradability in the rumen (530g/kg) (Zewudie, 2010). Therefore, the nutrient derived by feeding of barely straw hardly supports the maintenance requirement and leading to low production and productivity of dairy animals. There are various options reported to alleviate these constraints such as supplementation, chemical treatment, biological treatment and manipulation of the rumen ecosystem. Recently the treatment of crop residue with effective microbes (EM) is becomes one of the biological methods of improving feed quality. The treatment of crop residues with EM and supplementation with escape protein resulted in remarkable results in improving intake, digestibility and performances of animals.

Effective Microbes (EM) treated hay led to increased feed efficiency in stationed lactating dairy cows under Ethiopian condition (Mulugeta, 2015). Although such information was generated on research station, the efficacy of EM, particularly when used as under small scale farmers condition and treating or ensiling crop residues has not been well evaluated. Therefore, this study was aimed to evaluate the effect of EM-treated barely straw supplemented with bypass protein feed on feed intake and milk yield and economic benefit under on farm condition of small scale crossbreed dairy producers.

MATERIALS AND METHODS

Description of the study area

The study was carried out on-farm at West Arsi zone Kofele district, Wamigne Abosa Kebele which located 285 km to the South East of Addis Ababa along the main road from Shashamane to Bale Robe at 7^o 7' N latitude and 38^o 30' E longitudes. It has an altitude of 2670 meters above sea level (m.a.s.l). The area is a typical mixed crop livestock production system, where small scale dairying based on crossbred animals are found here and there. Cattle are dominant livestock species in the area while wheat, barley, potato, cabbage and Inset are the major crops produced.

Experimental Animal, Design and Treatments

The experiment was conducted on mid to late lactating dairy animals of interested sixteen farmers in the study area. Totally twenty six lactating cross breed dairy animals with average body weight of 315.8±52.05 kg and an average milk yield of 2.67±0.41 kg/cow/day were categorized equally in to two treatment to participate in the experiment.

The experimental cows were divided into two treatment groups (thirteen cows in each group). Cows of the first group (T1) graze for 8 hours and supplanted with intervention diet (EM2 treated barley straw supplemented with a concentrate mixture composed of 48% linseed cake, 50% wheat bran and 2% salt). Cows in the second group (T2, control) graze for eight hours and they feed on untreated barley straw with wheat bran as supplements which is common practices in the study area. During allocation of animals into experimental treatments the level of milk yield, stage of lactation, body condition and parity were also considered. All the cows were weighed and drenched with broad-spectrum anti-helminthes (Albendazole 2500mg) prior to the start of the experiment.

Preparation of EM2 treated Barley straw

To prepare EM2 solution for ensiling barley straw; 1liter of EM1 (stock solution) was mixed with 1liter of molasses and 18 liters of chlorine free water. The solution was then stored in an air tight plastic container of capacity 20 litter for 12 days. After 12 days the activated EM2 solution was thoroughly mixed with chopped barely straw (in the ratio of 1liter EM2:1kg straw) and compacted in an airtight plastic bag of capacity 20 kg. The mix was allowed to ferment for 10 hours before fed to the animals. Stock EM solution (EM1) to be used for this study was purchased from the recognized distributer (Woljejii PLC, Debrie-Zeit, Ethiopia).

The supplement in the intervention diet was fed at the level required to fulfill nutrient requirement of the cows based on NRC (1989). The amount of supplement fed to each cow in T1 during the adaptation period of two weeks was at the rate of 0.5 kg per kg of milk production/day and 4kg of EM2 mixed barley straw early in the morning before grazing and 2kg in the afternoon. Hence, adjustment of the concentrate supplement and mixed straw was made weekly based on the milk yield of each cow and voluntary intake at the rate of 0.5kg per kg of milk production/day. It was fed in the morning and evening milking times, by dividing the daily allowances into two equal parts.

Data collection, monitoring of experimental animals

The data was recorded over a period of 105 days including an adaptation period of two weeks. Field visits were carried out every two weeks to monitor the feed intake and milk yield of the animals. The body weight of cows were measured each fifteen days by using heart girth measurement. Adjustment of roughage offered was made weekly based on the amount of refusal weighed and recorded every morning. All the cows were hand milked twice a day, in the morning and in the evening. Milk yield was measured daily and recorded right at milking. The animals had free access to water throughout the experimental period. The enumerators daily recorded the intake of roughage and concentrate and milk yield on pre-designed data recording sheet. These sheets were checked at each visit for precision and regularity.

Statistical and economic analysis

General Linear Model (GLM) procedure of SAS (2004) was used for analyzing data collected during monitoring. Mean comparison was done using the Least Significant Difference (LSD) for parameters with significant difference. Differences were considered statistically significant at 5% level of significant. Data generated form monitoring study was analyzed using the following model:

$Y_{ij} = \mu + r_i + e_{ij}$

Yij is the dependent variable (feed intake, milk yield, body weight gain),

μ overall mean, r_i effect of diet

Xij the record of live weight/milk yield of the jth cow on the ith diet,

eij random variation.

The economic analysis was based on calculations of the total cost of production and the income from milk sales. The price of feeds and the price of milk were obtained from the market price prevail in the area during experimental period. The net profit/cow/day was calculated for the whole experimental period by reducing the cost of production from income generated from milk sales.

Results and discussion

Socio-economic characteristics of participating farmers

The average family size of the selected farmers was 8.42 members per household out of which 48.2% were male and 51.8% were female members. Among the participant farmers, 92.3% were male headed households while 7.7% were female headed households.

The size of land holding of the participant farmers ranged from 10 ha to 14 ha. The average land holding 12.58ha out of which 62% is allocated for grazing and the rest 38% was used for crop production.

Available Feeds and feeding systems of milking dairy animals

In this study three major feed types used by dairy producers were identified: natural grazing, crop residue (barley straw and wheat straw) and agro-industrial by product (wheat bran). Two types of feeding systems (Extensive and semi-intensive) were used by dairy producers in the area.

Chemical composition and in-vitro organic matter digestibility (IVOMD) of feeds

The chemical composition and in-vitro organic matter digestibility (IVOMD) of feeds offered to experimental animals is presented in Table 1. The basal diet (natural pasture and untreated barley straw) available for feeding during the dry season was low quality and do not meet production requirement of animals (Table 1).

Table 1. Chemical composition, in-vitro organic matter digestibility and estimated metabolizable energy of feeds (Mean ± standard deviation)

Variables	Untreated barley straw	Treated barley straw	Wheat bran	Linseed cake
Dry matter %	93.4	90.09	90.06	93.23
Organic matter	92.39	89.93	95.72	91.5
Crude protein	2.3	4.95	16.98	29.8
NDF	80.05	57.97	38.19	25.1
ADF	59.56	40.66	9.39	9.52
ADL	11.05	8.03	2.52	5.14
IVOMD (%)	33.1	51.7	77.7	67.1
EME(MJ/kg)	5.29	8.27	11.65	10.06

Source: Mulugeta Abera (2015) and Girma Chalchissa (2014)

CP= crude protein; ADF=acid detergent fiber; NDF=Neutral detergent fiber; MJ=Mega joule; IVOMD =In vitro organic matter digestibility; EME= Estimated metabolizable energy (0.16*IVOMD)

Dry matter intake (DMI)

The daily feed intake and milk yield of cross breed cows treated in the experiment is presented in table 2.

Table 2. Effect of feeding EM treated barley straw supplemented with concentrate on feed intake and milk yield of lactating crossbred dairy cows (LS-means and SE)

Variables	**Intervention diet (T1)**	**Control (T2)**	**SE**
Dry matter intake (DMI), kg/day			
Grazing, hour/day	8h	8h	±0.081
EM treated /untreated barley straw	6.68^{a}	4.64^{b}	±0.152
Concentrates	3.25^{a}	1.56^{b}	±0.021
Total DMI, kg/day	9.93^{a}	6.20^{b}	±0.072
% Roughage	67.2^{b}	74.8^{a}	±0.015
% Concentrate	32.8^{a}	25.2^{b}	±0.012
Average milk yield, kg/cow/day	4.98^{a}	2.65^{b}	±0.470
Increase in milk yield, kg/cow/day	2.31	-	

a,b means in the same row for each parameter with different superscripts are significantly different (P<0.05); LS-means: Least square means; SE: Standard error

*The dry matter intake through grazing was not considered

Significant (P<0.01) improvement in DMI was observed due to feeding of the intervention diet in lactating crossbred cows over farmers practice or control diet. This was in agreement with the observation reported by Adebabay (2009) in treated rice fed indigenous breed cows, which may be due to improved palatability.

Milk yield

There was no variation between the two treatments in initial average milk but treating barely straw with bypass protein supplementation improved the performance of cross breed dairy animals. Feeding of intervention diet resulted in a significant (P<0.01) increased in daily milk yield by 2.31 kg (4.98 vs. 2.67 kg). Similar results also reported Dejene *et al*. (2009) indicated that cows in urea treated *teff* straw supplemented diet had significantly higher milk yield than for un-supplemented animals. This is due to the bypass protein through linseed cake supplementation in addition to increased palatability, N content, digestibility, nutritive value of the straw as a result of EM treatment. It has been accepted that intake and exploitation efficiency of crop residues are influenced by the rate of rumen fermentation (Van Soest, 1982) and the balance of nutrients absorbed in the intestines.

Economic analysis
The cost of grazing for the control groups was not considered while the total cost of production (feeds, EM, labor for treating straw and material including plastic sheet used for sealing the treated straw) was considered since other variable cost (medicaments) was the same for both groups. The net profit increased from ETB 39.24/cow/day in the control group (T2) to ETB 49.05/cow/day in T1 group due to the improvement in milk yield. Hence, this study demonstrated that feeding the intervention diet to crossbred dairy cows increased the net profit for farmers to ETB 9.81/cow/day over the farmers' practice (Table 3).

Table 3. Economic evaluation of feeding EM treated barley straw supplemented with concentrates in lactating crossbred dairy cows

Variables	Intervention diet (T1)	Untreated diet (T2)
Cost of untreated straw, Ethiopian birr (ETB)	0	0
Cost of straw treatment		
Cost of molasses	103.85	0
Cost of EM	576	0
Cost of plastic	54	0
Cost of labor	315	0
Cost of grazing	0	0
Cost of supplement (linseed cake & wheat bran), ETB#	2166.45	0
Total Variable cost, ETB	3215.3	819
Cost /cow/day	30.62	7.8
Cost /cow/kg of milk	6.14	2.94
Gross income from sale of milk, ETB"	8366.4	4939.2
Net profit, ETB	5151.1	4120.2
Net profit/cow/day, ETB	49.05	39.24
Net profit over control, ETB	9.81	

#cost of concentrate: 8 ETB/kg of linseed cake, 5 ETB/kg of wheat bran, 1.50 ETB/kg of molasses, 3 ETB/kg of salt, labor cost (man day) was 35 ETB while cost of plastic sheet per meter was 18 ETB
"Selling price of milk was 16 ETB/kg of milk, $1 USD~ 24 ETB

Costs of barley straw and grazing cost were not considered because farmers produce barley straw and uses their own grazing lands.

Participants observed that besides increase in milk production, most of the cows in intervention diet showed symptoms of heat at the proper time in contrast to the cows in T2. Considering the positive long-term impact of the intervention diet on production, reproduction, body condition and general health of the animals, the economic returns may be higher by using the intervention diet. Furthermore, considering the cost of production and the market price of milk prevailed in the area during experimental period, the intervention diet was found to be economical compared to farmers practice.

Conclusion
Substantial increase in milk production per animal per day and net benefit derived from the increased milk produced indicated that the use intervention diet is a sound technology for cross breed dairy animals under small scale farmer's condition. Thus it is possible to substantially improve the productivity of crossbred dairy cows in similar production systems by feeding EM2 treated cereal straw and supplementing with bypass protein. However, the extent of improvement might need further investigation. The effect of EM on digestibility of OM or fermentation of fiber should be investigated further. Finally, promotion of effective infrastructure for technology transfer, further refinement of EM treatment technique and ensuring either on-farm or nearby availability of supplies necessary for straw treatment are important elements for ensuring impact of the technology.

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References

Adebabay K., 2009: Characterization of Milk Production Systems, Marketing and On- Farm Evaluation of the Effect of Feed Supplementation on Milk Yield and Milk Composition of Cows at Bure District, Ethiopia. MSc. Thesis, Bahir Dar University, Ethiopia. 64p.

Aemiro K., Getu K., Getinet A., Dereje F. and Zewdie W. 2012. Growth performance of Boran Friesian (F1) crossbred calves supplemented with Effective Micro-organism (EM) fermented wheat bran. Promoting Effective Micro-organisms Technology. Proceedings of National Workshop on Effective Microorganisms in Ethiopia, 20 March 2012, Addis Ababa, Ethiopia.

Dejene M, Bediye S, Kehaliw A, Kitaw G and Nesha K 2009: On-farm evaluation of lactating crossbred (Bos taurus x Bos indicus) dairy cows fed a basal diet of urea treated teff (Eragrostis tef) straw supplemented with escape protein source during the dry season in crop- livestock production system of north Shoa, Ethiopia. Livestock Research for Rural Development. Volume 21, Article #61. Retrieved May 23, 2017, from http://www.lrrd.org/lrrd21/5/deje21061.htm.

Girma C., Yoseph M. and Mengistu U. (2014). Feed Resources Quality and Feeding Practices In Urban and Peri-Urban Dairy Production of Southern Ethiopia. Tropical and Subtropical Agroecosystems, Volume 17: page 539 – 546, Year 2014.

Kehaliew A., Getu K., Getnet A., Dereje F. & Zewdie W. 2014. Growth Performance of F1 Friesian X Boran Crossbred Dairy Calves Supplemented with Effective Micro- Organism (EM) Fermented Wheat Bran (Bokashi) in the Central Highlands of Ethiopia. Global Journal of Science Frontier Research: D Agriculture and Veterinary, Volume 14 Issue 9 Version 1.0 Year 2014.

Mulugeta A., 2015. Evaluation of effective microbes (EM) treatment on chemical composition of crop residues and performance of crossbred dairy cows). MSc. Thesis, Haramaya University, Dire Dawa, Ethiopia. 23p.

National Research Council, 1989. Nutrient Requirement of Dairy Cattle. 6th ed., National Academy Press, Washington, D.C. 157p.

SAS, 2004. Statistical Analysis System software, Version 9.0, SAS Institute, Inc., Cary, NC, USA.

Solomon Bogale, 2004. Assessment of Livestock Production Systems Feed Resource base in Sinana Dinsho district of Bale highlands, Southeast Oromia, An MSc. Thesis, Alemaya University, Dire Dawa, Ethiopia.

Van Soest, P. J., 1982. Nutritional Ecology of the Ruminants: Ruminant metabolism, Nutritional strategies, the cellulolytic Fermentation and the Chemistry of Forages and Plant Fibers. Ithaca, New York. 373p.

Zewdie, W. 2010. Livestock Production Systems in Relation with Feed Availability in the Highlands and Central Rift Valley of Ethiopia. MSc. Thesis, Haramaya University, Dire Dawa, Ethiopia. 160p.