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Evaluation of ensiled brewery spent grain as a substitute for protein source concentrate in the diet of Lactating crossbred dairy cows at Adami Tullu Agricultural Research Center

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Abstract

Feeding different substitution levels of Noug seed cake with ensiled brewery spent grain on milk yield and milk composition of crossbred dairy animals and its net benefit was done at Adami Tulu Agricultural Research Center on Ten early lactating crossbred dairy cows (HF with Arsi) with an average daily milk yield of 5.04 liter and 272.5 kg body weight were selected from nucleus herd at dairy farm. They were randomly assigned to 5 x 2 Latin Square Design composed of five dietary treatments. Each period being split to 15 days of adaptation and 15 days of measurement. The experiment was conducted from January 2024 to June 2024. Concentrate feed Noug seed cake and Wheat bran was purchased from Adama suppliers and brewery spent grain was purchased from nearby local suppliers. Brewery spent grain was allowed to cool under aerated shade for 24 hrs then manually pressed and packed into airtight plastic drum without any preservatives. Rhodes grass hay produced at on station was used as basal diet. The substitution has four levels and compared with previously recommended ration for lactating crossbred cows. The dietary treatments were T1= 66 % wheat bran + 33 NSC + 1% salt (Control), T2= 66 % wheat bran + 24.75 NSC+8.25 BSG + 1% salt, T3= 66 % wheat bran + 16.5 NSC+16.5 BSG + 1% salt, T4= 66 % wheat bran + 8.25 NSC+24.75 BSG + 1% salt and T5= 66 % wheat bran + 33 BSG + 1% salt. Daily feed offered and refused, milk yield and body weight change per 15 days, milk composition at initial and end of each feeding period were collected. The result reveals that the total dry matter intake and body weight gain doesn't differ among the treatments. The milk yield and composition of lactating animals fed feeds with varying amounts of brewery spent grain did not differ significantly. The highest net benefit was obtained from animals fed on dietary treatment 5(100%) replacement of Noug seed cake by ensiled brewery spent grain which was 272.4 ETB/cow/day. Dietary treatment 5 (wheat bran + Brewery spent grain+ salt) was recommended for further evaluation and intervention at on farm level for dairy producers who kept crossbred cows and have access for brewery spent grain especially for urban and peri urban dairy producers.

Key words: *Brewery spent gain, early lactating, crossbred cows, net benefit*

Introduction

In Ethiopia, the major constraint for low productivity of dairy cows is the shortage of livestock feeds in terms of quantity and quality, especially during the dry season (Ahmed *et al.*, 2010). Agro-industrial by-products such as flour mill and oil extracting factories by-products have been widely used as energy and protein supplements in ruminant ration (FAO, 2012).

The rising cost of agro-industrial by-products, especially oil seed cakes such as groundnut and noug seed cake made it less reliable (Goswami *et al.*, 2013). Therefore, it is imperative to search for cheap, nutritious and easily available non-conventional feed resources.

With the increasing cost of concentrate feeds and growing demand for dairy products, alternative feedstuffs have become a great necessity in the dairy industry. Due to the rapid expansion of brewery factories and their environmentally friend nature, brewery by-products have become an option for dairy managers looking for alternative feedstuffs (Bell *et al*, 2012).

In Ethiopia, there were 12 beer factories producing an estimated 26,722.8 tons brewery spent grains (SBGs) on DM basis and 360,758.1 hectoliter (hl) of brewery spent yeast (BSY) in 2016 that can be used as animal feed (Amare, 2016). It was reported by Alvarez Aranguiz *et al*. (2019) that the BSG produced can be enough to feed 60,000 cows with 10 kg/day throughout the year. The average price of spent brewery grain is still very attractive compared with other available feed (Alvarez Aranguiz *et al*., 2019).

Wet brewery grain is a good source of protein with a crude protein content that ranges from 25 to 34% (Thomas *et al.*, 2016). The protein is mainly placed in the germ portion of the spent grain and is digested to a partial amount in the rumen and to a greater amount in the small intestinal tract. The concentration of rumen degradable protein ranges from 28-43% (mean 35%), indicating that wet brewery grains are good sources of rumen un-degradable, or "bypass-protein" and it has 20-32 % dry matter (Thomas *et al.*, 2016). Feeding wet brewery spent grain to dairy

cows is a worthwhile opportunity for dairy farmers to offer additional rumen un-degradable protein and energy to dairy cows, with equal or enhanced milk production (Zanton, 2016).

Ensiling of wet brewery grain either alone or along with other feed is ecologically and economically feasible, and easily applicable from a technological viewpoint to dairy farmers in Ethiopia. The selection of the right conservation method is crucial for storing and utilizing this feed without spoilage.

In Ethiopia most of previous studies done on wet BSG mainly focus on mechanism of extending shelf life but the rate at which the feed to be included in the ration of dairy cattle not yet studied (Alvarez Aranguiz *et al*. 2019; Getu, 2019). The study was conducted to address the following objectives:

Objectives

- To evaluate the effect of feeding different substitution levels of Noug seed cake with ensiled brewery spent grain on milk yield and milk composition of crossbred dairy animals
- To evaluate the net benefit of feeding different substitution level of ensiled brewery spent grain in the ration of crossbred dairy animals

Materials and methods

Description of the study area

The study was conducted at Adami Tulu Agricultural Research center located at 167km south of Addis Ababa at latitude of 70 9' N and 3807'E longitude in semi-arid middle rift valley of Ethiopia. The area is situated 1500 meters above sea level and the soil type of the area is fine, sandy loam with sand, clay in the proportion of 34:48:18 respectively. The average annual rainfall is 760mm. The minimum and maximum temperature are 12.6 and 27^0c, respectively (ATARC, 2003).

Experimental feed preparation

The concentrate mix was prepared based on the recommendation of dairy animals' nutrient requirement (Kearl, 1982; ARC, 2001). The concentrate mix was formulated to furnish 12 MJ of energy per kg of feed and to contain 20 % total protein. Furthermore, feed provision was adjusted fortnightly depending on milk production of the animals. As wheat bran is the most common source of energy and sustainably available, it was used as a source of energy while noug cake was used as protein source. The roughages were provided ad libitum adjusted to 10% refusal daily from the previous day offer on a DM basis. Studies in Ethiopia have revealed that the daily concentrate allowance can be calculated at the rate of 0.5 kg/liter of milk and can be offered twice a day in the morning and afternoon hours. Water was available free of choice.

Brewery spent grain Ensiling/preserving methods used:

Simple ensiling methods were used. Brewery spent grain was ensiled alone. Fresh brewery spent grain was acquired from local suppliers and stored under shade for 24hrs at room temperature which allows to cool brewery spent grain. After 24hr brewery spent grain were stored in airtight plastic drum. A quintal of brewery spent grain divided into three portions and compressed manually by using human labor into 400-liter plastic water drum to keep airtight and the procedure repeated until the drum filled at its full capacity. We took daily the amount required and kept closed the plastic drum.

Feed offered and refusals were measured and recorded for each cow daily to determine the dry matter as a difference between the offered and refused feed for both silage, roughage and concentrate mix. Body weight measurements were taken for each dietary treatment over two consecutive days at the beginning and end of each period using weighing scale. The animals were made to fast overnight and body weight measurements were taken at 06:00A.M before feed and water being served to the animals. The cows were hand-milked twice a day in the morning and afternoon at (6:00 am and 6:00Pm) and milk yield will be measured using graduated plastic cylinder and recorded for each animal.

Experimental design and animal management

Ten early lactating crossbred dairy cows (Holstein Frisian with Arsi) with an average daily milk yield of 5.04 liter and 272.5 kg average body weight were selected from ATARC dairy farm. All experimental animals were treated for internal and external parasites before feeding started. Animals were assigned to one of the dietary treatments randomly. They were randomly blocked in 5 x 2 Latin Square Design composed of five dietary treatments. Each period being split to 15 days of adaptation and 15 days of measurement. The experiment was conducted from January 2024 to June 2024. The cows were individually stall-fed in well-ventilated houses/barns with well dried floors and appropriate drainage slope and gutters.

Milk composition analysis

Milk composition was analyzed by collecting milk samples at initial and at end of each feeding period. Milk samples (100 ml) from the morning and evening milking were collected in sterile plastic containers. Composite samples were used for analysis of milk composition. Milk sample was analyzed by using a Lactoscan milk analyzer for milk fat, protein, lactose total solids and pH.

Chemical composition of experimental ingredients used

Table 1. Chemical composition (% DM) and metabolizable energy (MJ/kg DM) contents of experimental feed ingredients

Feeds offered	DM	OM	CP	NDF	ADF	Lignin	ME (MJ Kg^{-1} DM)
Noug seed cake	92.2	89.08	32.1	34.7	26.7	7	9.5
Brewery spent grain	94.1	93	26.9	63.2	24	5	10.3
Wheat bran	90.5	95.7	17	38.2	9.4	2.54	11.7

Treatments

T1= 66 % wheat bran + 33 NSC + 1% salt (Control)
T2= 66 % wheat bran + 24.75 NSC+8.25 BSG + 1% salt
T3= 66 % wheat bran + 16.5 NSC+16.5 BSG + 1% salt
T4= 66 % wheat bran + 8.25 NSC+24.75 BSG + 1% salt
T5= 66 % wheat bran + 33 BSG + 1% salt

Data analysis

Collected data were coded and processed into MS excel and analysis was done undertaken using the GLM procedure of SAS (SAS, 2009). Significance level was tested at $P < 0.05$.

Partial budget analysis

The partial budget analysis and net return were calculated to determine the profitability of the four different supplemental feeds that were fed to the lactating cows under on station management conditions. According to (Ehui *et al*., 1992) Net income (NI) is calculated as the amount of money left when total variable cost (TVC) is subtracted from total returns (TR). In this experiment the variable costs included estimated purchase price of the basal and supplemental feed cost and labor cost for preparation of the supplemental feed and cost for medicaments and treatments. While total return (TR) was estimated average sale price of milk produced during the experimental period per animal per day within treatment (NI= TR- TVC). Change in net income (ΔNI) was computed as the difference between change in total return (ΔTR) which was total return of the given treatment minus total return of the control treatment (T1) and change in total variable cost (ΔTVC) Total variable cost of the treatment minus total variable cost of the control. ΔNI = ΔTR - ΔTVC.

Results and Discussions

Feed intake

The result indicates that the total dry matter intake and body weight gain doesn't differ among the treatments. It is in line with the findings of Christa L M., 2010 who replaced brewery spent grain with corn silage in the diet of lactating cows in which the dry matter intake was not different across the treatments.

The current result is contradicting with the findings by Getu K. *et al.* in 2019 who reported the total DM and body weight of the animals decreased as the level of BSG substitution increased. The difference might be due to the blood level of crossbred cows used for the experiment where they use high grade crossbred cows.

The result was inconsistent with the findings of AL-Talib *et al.*, 2014 who reported significant improvement in amount of concentrate feed intake in increasing levels of dried brewery grain in feeding lactating dairy cows. The difference might be attributed by the type of brewery grain used as they use dried one.

Table 2. Mean (±SE) feed intakes of HF x Arsi crossbred cows fed on different levels of brewery spent grain substitute Noug seed cake protein sources

Parameters	Treatments					Sig
	T1	T2	T3	T4	T5	
Feed offered (kg/day)	8±0	8±0	8±0	8±0	8±0	Ns
Feed leftover (kg/day)	.4±.1	.6±.1	.6±.2	.8±.1	.7±.1	Ns
Feed intake (kg/day)	7.6±.1	7.4±.1	7.4±.2	7.2±.1	7.3±.1	Ns

Milk production and Composition

The findings showed that the daily milk output of lactating F1 HF X Arsi cows did not significantly differ across the treatments which is consistent with the findings of Christa L M., 2010 who replaced brewery spent grain with corn silage in the diet of lactating cows. The table shown below shows the average daily milk yield per cow, with an overall mean of 7.5 ± 0.2 liters per cow. The results contradict the findings of Getu K *et al.,* 2019and Endale Y *et al.,* 2024, which showed that milk output increased with an increase in the amount of brewery leftover grain included. The result was inconsistent with the findings of AL-Talib *et al.,* 2014 who reported milk yield were highly significant among the milking Frisian cows feeding different levels of dried brewery grain. The difference might be due to the difference in the form of brewer grain used as we use fresh ensiled brewery spent grain.

Our findings suggested that spent brewery grain can replace the Noug seed cake in the feed of lactating F1 HF X Arsi cows without reducing milk yield. This result is consistent with that of Getu K. *et al.,* 2019 and Endale Y *et al.,* 2024, who discovered that crossbred dairy cows' diets may incorporate brewery spent grain in place of the protein source present in oilseed cake.

The findings showed that the milk composition of lactating animals fed feeds with varying amounts of brewery spent grain did not differ significantly. The result is consistent with findings of Endale Y. *et al.,* 2024 who reported the composition of milk remain unchanged except the fat which exhibited a declining trend. The outcome differed with the research conducted by Getu K. *et al.,* in 2019, who found that the replacement levels of ensiled BSG to cotton seed cake varied in their reports' effects on milk composition. The observed variation in the protein source feed could potentially be attributed to the substitution of brewery spent grain.

In contrast to the current result AL-Talib *et al.,* 201 reported milk composition of the milking Frisian cows feeding different levels of dried brewery grain were highly significant. The difference might be due to the difference in the form of brewer grain used as we use fresh ensiled brewery spent grain.

Table 3. Milk yield and composition of crossbred cows fed on different levels of brewery spent grain substitute Noug seed cake protein sources

Variables	Treatments						
	T1	T2	T3	T4	T5	SEM	P value
Milk yield Kg/day	7.5	7.37	7.67	7.47	7.64	0.44	0.98
Fat %	4.14	4.25	4.07	3.98	4.01	0.20	0.95
Protein %	3.09	3.16	3.17	3.14	3.15	0.05	0.45
Lactose %	4.67	4.74	4.71	4.72	4.74	0.07	0.82
SNF %	8.45	8.68	8.59	8.62	8.63	0.14	0.16
pH	6.45	6.43	6.51	6.46	6.42		0.80
BW (Kg)	292.5	293.3	289.6	294.0	293.8	11.2	0.99

Partial budget analysis

Partial budget analysis indicated that the net benefit is high for animals receiving dietary treatment 5 (100%) replacement of Noug seed cake by ensiled brewery spent grain followed by treatment 3 and 4. The current result is similar with the findings of Endale Y. *et al.* (2024), who reported that the net benefit was high for cows receiving the highest inclusion rate of brewery spent grain. The highest net benefit was obtained from animals fed on dietary treatment 5 which was 272.4 ETB/cow/day.

Table 4. Partial budget analysis of crossbred cows fed on different levels of brewery spent grain substitute Noug seed cake protein sources

Variables	Treatments				
	T1	T2	T3	T4	T5
Milk yield (lit/cow/d)	7.5	7.4	7.7	7.5	7.6
Gross benefit (ETB /cow/d)	450.0	442.2	459.0	448.2	458.4
Cost of BSG (ETB/cow/d)	0.0	3.7	7.5	11.2	14.9
Cost of NSC (ETB/cow/d)	47.5	35.6	23.8	11.9	0.0
Cost of wheat bran (ETB/cow/d)	60.7	60.7	60.7	60.1	60.1
Cost of common salt (ETB/cow/d)	1.0	1.0	1.0	1.0	1.0
Cost of Rhodes grass hay (ETB/cow/d)	60.0	60.0	60.0	60.0	60.0
Labor cost (ETB /cow/d)	50.0	50.0	50.0	50.0	50.0
Total variable cost (ETB /cow/d)	219.4	211.1	202.9	194.1	186.0
Net benefit (ETB /cow/d)	230.6	231.1	256.1	254.1	272.4

Note: WB: 23ETB/Kg, NSC: 36 ETB/kg, BSG: 11.3ETB/kg, Hay: 15ETB/Kg, salt: 25ETB/kg, Milk: 60ETB/liter

Conclusions and Recommendations

Overall, incorporating BSG into dairy cow diets can be beneficial for both milk production and farm economics, but it requires careful management to ensure consistent supply and proper adaptation.
Inclusion of brewery spent grain in diet of lactating crossbred cows has no negative effect on milk yield and composition.
The highest net benefit was obtained from animals fed on dietary treatment 5 which was 272.4 ETB/cow/day.
Ensiled brewery spent grain can substitute biological and economical protein source noug seed cake in the diet of lactating crossbred dairy cows without affecting milk yield and composition.
Based on partial budget analysis, Dietary treatment 5 (wheat bran + Brewery spent grain+ salt) was recommended for further evaluation and intervention at on farm level for dairy producers who kept crossbred cows and have access for brewery spent grain especially for urban and peri urban dairy producers.

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