An On-Farm Study for Feeding Impact of Total Mixed Ration (TMR) in Milking Cow

ABSTRACT

Aims: To compare the compatibility of maize stover based Total Mixed Ration (TMR) over conventional feeding in terms of dry matter intake, milk production and composition and economic outcome from cows.

Study design: CRD

Place and duration of study: This field trial was carried out for a period of 60 days on 10 early lactating Holstein Friesian crossbred cows belonging to the farmers of Sirajgonj district.

Methodology: Cows were divided into two homogenous groups considering lactation status and yield. In control (T_0) group, cows were provided conventional feeds comprising of 20.0 kg Napier grass, 5.0 kg paddy straw, 2 kg pelleted feed and 10.0 kg concentrate mixture (composed of 5 kg wheat bran, 2 kg pulse bran, 2 kg red gram bran and 1.0 kg oil cake), while in another group (T_1), cows were fed TMR comprising of maize stover and concentrate with 50:50 proportions, according to their nutrient requirements. The DM and CP contents in concentrate mixture of T_0 and T_1 were 90.33% and 15.6% and 38.01% and 16.7%, respectively. The data were analyzed by "SPSS 20.0" statistical program.

Result: Fresh feed intakes were significantly (P<0.001) higher in T_0 (37.4±0.008) than those of animals in T_1; CP intakes were significantly (P=0.008) higher in T_1 (1.60±0.02). Differences were not significant (P=0.07) in case of DMI and DMI on %live weight between two treatment groups. Milk yield and fat content significantly (P=0.05) differed between groups. Highest milk yield (9.99±0.07 kg) and milk fat (3.62±0.06%) were observed in cows of T_1. However, milk protein, lactose and SNF did not vary significantly between groups. Considering milk price @BDT 60.0/ltr, profit gained maximum in T_1 group.

Conclusion: TMR improved substantial amount of milk yield and quality with concurrent reduction of milk production cost.

Keywords: *Densified TMR, crop residues, milk yield, milk composition.*

1. INTRODUCTION

Extensive use of crop residues in livestock feeding seems to be indispensable to meet the nutritional needs of livestock. However, the major constraint in the utilization of these crop residues is high cellulosic contents and poor nutritive value that even cannot support the maintenance nutrient requirement of the animals. Complete feed with the use of fibrous crop residue is a noble way to increase the intake and to improve feed utilization and animal production performance. Complete feeding system is being increasingly appreciated as it allows expanded use of agro-industrial by-products, crop residues and non-conventional feeds in livestock ration for maximizing production and minimizing feeding cost. To minimize feed costs, labor and to maximize production is the need of the time and can be achieved by blending concentrate, mainly comprised locally available by-products and roughage portions of the ration to form complete feed/diet, synonymously termed as total mixed ration (TMR).

The magnitude of profit from livestock can be further expanded by curtailing disproportionate expenditure on feed through exploration of nutrient-rich alternate feed resources, which do not compete with human food chain, coupled with proper feed-waste management. Incorporation of locally available crop residues, such as cereal stovers and straw, in the form of complete ration is a plausible option for ruminant feeding Schiere [1]; Venkateswarlu et al. [2] , because blend of feed ingredients offers little choice to the animal for selection of specific ingredients in feed Wadhwa and Bakshi, [3]. Among various available feed resources, maize (*Zea mays*) stover can be considered to be one of the important potential crop residues available for ruminants feeding in country. Maize is indigenous to Bangladesh (corn) belongs to the

Family: *Gramineae,* Genus*: Zea,* Species: *Mays*. The major residues obtained from this crop are maize husk (covering on seed), cob, shank and stover are by-products of maize crop and may be used as alternative feed resources for ruminants. Hence, maize stover can be efficiently utilized in total mixed rations. The objective of complete rations is to provide a blend of all the feed ingredients including roughages without giving any choice to the animal for selection of specific ingredient Khan et al. [4]. The merits of total mixed ration are related to the enhancement of utilization of low grade roughages, provides uniform feed intake, and reduces feed wastage, a stable environment for rumen fermentation, minimal fermentation losses and fluctuation in release of ammonia Rao et al. [5]. Feeding a TMR correctly balanced to nutrient specifications can increase milk production by 1 to 2.5 kg per cow per day for high yielding dairy animals compared to conventional rations Senani et al. [6]. Milk fat and other components can also increase because of the better rumen fermentation and balance of nutrients being consumed. The present study was undertaken to study the effect of feeding chopped maize stover based TMR on milk production in Holstein-Friesian crossbred lactating cows as compare to the conventional feeding system in the household premises of the farmers.

2. MATERIALS AND METHODS

2.1 LOCATION AND DURATION OF EXPERIMENT

This field experiment was conducted at Alokdiar village in Baghabarighat of Shahzadpur upazilla in Sirajgonj district geographically located between 24°04' and 24°25' north latitudes and in between 89°31' and 89°31' east longitudes. (Source: http://en.banglapedia.org/index.Shahjadpur Upazila).The duration of the experiment was 60 days from 8th April to 8th June, 2018 on 10 Holstein Friesian crossbred early lactating cows belonging to the farmers of said village.

2.2 CLIMATE OF THE STUDY AREA

Climate of the study area is classified as tropical. According to meteorological data taken in Sirajgonj district (near the study site), the mean maximum temperature of 29.3^0 C was recorded in May, which was the hottest month of the year and the mean lowest temperature of 18.4^0 C was recorded in January, which was the coldest month of the year. The maximum temperature of 35.7^0 C was recorded in April and the lowest of 11.1^0 C in January. The total annual rainfall was 1722 mm and shows a unimodal distribution pattern, with the main precipitation from May to September. Precipitation was the lowest in December, with an average of 6 mm. Most precipitation falls in July, with an average of 372 mm. The mean relative humidity ranged from 45 to 81% (Source: https://en.climate-data.org/asia/bangladesh/rajshahi-division/baghabari-969529/).

2.3 COMPOSITION OF FEED, DIETARY TREATMENTS AND LAYOUT OF THE EXPERIMENT

The selected cows were in 1st to 3rd lactation at early stage (1-2 months) of production and were divided into two homogenous groups. In control group (T_0), animals were provided conventional feeds comprising of 20.0 kg Napier grass, 5.0 kg paddy straw, 2 kg pelleted feed (Provita®) and 10.0 kg concentrate mixture (composed of 5 kg wheat bran, 2 kg pulse bran, 2 kg red gram bran and 1.0 kg oil cake), while

animals in other group (T_1) were fed with a complete ration comprising of chopped maize stover and concentrate with 50:50 proportions according to their nutrient requirements. The dry matter (DM), crude protein (CP), organic matter (OM), ash, neutral detergent fiber (NDF), acid detergent fiber (ADF) contents were 90.33, 14.75, 89.8, 10.2, 39.1 and 21.3 percent, respectively in the concentrate mixture (T_0), and 38.01, 15.89, 89.58, 10.42, 45.2 and 35.7 percent, respectively in TMR (T_1).

In each 100 kg TMR mixture, the amount of maize stover was 50 kg and rest 50 kg was concentrate feed composed with 25 kg soybean meal, 10 kg molasses, 8 kg wheat bran, 4 kg pulse bran, 2.5 kg di-calcium phosphate and 0.5 kg table salt. The formulation of T_0 ration (fresh basis) was composed with 53.33 kg Napier/Jumbo, 13.33 kg paddy straw, 13.33 kg wheat bran, 5.33 kg pulse bran, 2.67 kg oil cake, 5.33 kg ready feed (provita®), 5.33 kg red gram bran and 0.5 kg table salt. ME of 56.71 MJ/d and 52 MJ/day were supplied for T_0 and T_1 groups, respectively.

Table 1: Dietary and ingredient's composition

Feed Ingredient	DM%	CP%	Amount in 100 kg (T_0)	Amount in 100 kg (T_1)
*Napier/ Jumboo	16.38/15.92	09.30/10.11	53.33	-
Paddy straw	89.00	03.40	13.33	-
Maize stover	88.96	05.72	-	50.00
Wheat bran	87.43	15.06	13.33	8.00
Pulse bran	86.55	12.22	05.33	4.00
Soybean meal	85.78	44.13	-	25.00
Oil cake	85.19	35.27	02.67	
Molasses	80.19	05.20	-	10.00
Pellet feed	87.80	10.25	05.33	-
Red gram bran	89.36	07.21	05.33	-
Salt	99.5	-	00.50	0.5
DCP	98.01	-	-	2.5
DM (%) in diet	-	-	47.91	58.21
CP (%) in diet	-	-	14.75	15.89
ME (MJ/kg DM)	-	-	10.01	10.56
ME requirement (MJ/day/animal)	-	-	50.13	50.09
ME consumed (MJ/day/animal)	-	-	56.71	52.00

DM- Dry matter; CP- Crude protein; ME- Metabolisable energy; MJ- Mega Joule DCP- Di calcium phosphate

2.4 FEEDING AND MANAGEMENT OF ANIMALS

The animals in both control and treatment groups were housed in well ventilated, conventional stalls maintained under hygienic conditions with individual feeding and Water was available adlibitum to the cows throughout the experimental period.

2.5 CHEMICAL ANALYSIS

The feed samples, leftover and faeces were analyzed by the method of AOAC [7] for determination of DM, CP, OM and Ash, while, ADF and NDF by Van Soest et al. [8]. All the samples were analyzed in duplicate and mean values were recorded.

2.6 MILK ANALYSIS

Milk yield was estimated on the basis of two complete milking of the animals daily at 5.00 AM and 5.00 PM, and 3.5% fat corrected milk yield was computed. Representative samples of milk were collected in sterile bottles once in a week to estimate the milk constituents, *viz*., fat, protein, lactose, SNF by Funk Gerbar.

2.7 DESIGN AND STATISTICAL ANALYSIS

There were two treatments with 10 replications (animals) in each group. Thus the design of the experiment was completely randomized design (CRD). Data were analyzed using the "SPSS 17.0" [9] statistical program. Least significant difference (LSD) test was also done to compare the significant difference between treatment means for various parameters.

3. RESULTS AND DISCUSSION

3.1 FEED INTAKE

The feed intakes of animals supplied with two dietary groups are shown in Table 2.Fresh feed intake in T_0 group was significantly higher (P<0.001) than T_1 group. There was no significant (P=0.07) difference between T_0 and T_1 in case of DM intakes but the values were lower in the T_0 group than T_1 group. This variation might be due to the voluntary feed intake, feed processing of TMR. The dry matter intake of control group was 11.39 kg/cow/day while it was 11.46kg/cow/d for TMR feeding group.

This conformed to the findings of Kishore et al. [10], who had reported that palatability of complete ration was as good as the conventional ration. Fan et al. [11] also reported similar DMI in cows and buffaloes, respectively on TMR and conventional feeding, while a contradictory result were obtained by Verma *et al.* [12], Pandya et al. [13], Lee et al. [14], Pachauri et al. [15] and Khan et al. [4]. All of them reported increased DMI in TMR fed cows and buffaloes because of its higher palatability and the reduced particle size. Total DM intake depends on the live weight of the animals. The live weights of all experimental animals were closely alike with each other. That could be the reason for similar DM intake during the experimental period which also reflected on the calculated DMI on %live weight of the animals.

Table 2: Feed intake of cows fed on conventional and complete ration (TMR) during on-farm trial

Parameter	T_0	T_1	Significance level

	(mean ±SE)	(mean ±SE)	
Fresh feed intake (kg/day)	37.4±0.008	16.42 ±0 .02	***
DM intake (kg/day)	11.39±0.48	11.46±0.16	NS
CP intake (kg/day)	1.25±0.05	1.60±0.02	**
DMI on %LWT	2.41±0.05	2.46±0.03	NS

DM-Dry matter; CP- Crude protein; DMI- Dry matter intake; LWT-Live weight of animal; SE- Standard error, NS-Non significant; **-p<0.01; ***-p<0.001.

The CP intake of animals differed significantly between groups. Significantly higher (*P*=0.008) CP intakes were obtained in animals of T_1 group than those animals in other group. The CP intake of control group was 1.25 kg/cow/day while it was 1.6 kg/cow/d for TMR feeding group. This finding is in accordance with the findings of Chander [16]. Khan et al. [4] found that the feeding of total mixed ration in the form of pellets increased the CP intake as compared to conventional feeding system (feeding roughage and concentrate separately) which also corresponds with this study. Pachauri et al. [15] observed that wheat straw based total mixed ration and urea ammoniated based total mixed ration increased the dry matter, DCP intake as compared to feeding of wheat straw and concentrate fed separately (conventional feeding) which conforms with this study. Sharma et al. [17] conducted to discern the effect of feeding complete ration as mash or block form in comparison to conventional feeding system on feed intake, growth, nutrient utilization in growing crossbred female calves for a period of 90 days and observed DM/kg $W^{0.75}$ and DCP intake (g/kg $W^{0.75}$) was significantly higher in mash group in comparison to conventional feeding system and also with complete feed in block form which contradicts with this study.

3.2 MILK YIELD

Milk production of cows for animals of two groups are shown in Table 3. Significantly higher (*P*=0.05) average daily milk yield was observed in T_1 group than T_0 group. The cows fed with TMR produced more milk than those in separate diet of conventional ration. In the present finding, TMR increased DMI which resulted in increased CPI compared to the separate feeding diet (control group).The difference in milk yield between treatment groups is attributed to the differences in crude protein intake.

Table 3: Milk production of cows fed on conventional and complete ration (TMR) during on-farm trial

Parameter	T_0 (mean ±SE)	T_1 (mean ±SE)	Level of significance
Initial milk yield (ltr)	9.30±0.29	9.35 ±0.11	NS
Final milk yield (ltr)	9.60±0.2	9.99±0.07	*

NS-p>0.05; *-p<0.05.

The result obtained in this study is coincided with Reddy et al. [18]. Feeding complete feeds significantly increased milk production in buffaloes and crossbred cows as compared to conventional rations Reddy and Reddy [19]. Holter et al. [20] reported that feeding with the blended diet resulted in more milk with higher efficiency of ME utilization for milk production. Das et al. [21] reported higher average milk yield in

complete feed block fed than in mash fed lactating buffaloes during an on-farm trial and farmers were of opinion that complete feed blocks not only enhanced milk yield but were also easy at feeding and storage. However, Rakes [22] concluded that complete rations containing 13-14% CP supported milk production at par with that obtained with conventional ration in dairy animals. Furthermore, Kumar et al. [23] reported that feeding of TMR to lactating buffaloes had no significant effect on milk yield compared to those fed the diet in conventional form, which is not in agreement with this study. It was observed that the increase in milk yield per cow per day for cows fed TMR varied from place to place and from country to country which could be related to the difference in ingredients mix, amount of concentrate mix, roughage to concentrate ratio, quality of feed, feed conversion efficiency and breeds of the lactating cows.

3.4 MILK COMPOSITION

Changes of milk compositions for two groups of cows are given in Table 4, which shows that significant difference was observed for fat% in milk between groups. However, there were no significant variations of protein, lactose and SNF contents in milk between groups. Significantly higher (P=0.05) fat% was obtained in cows of T_1 group than T_0.

Table 4: Milk composition of cows fed on conventional and complete ration (TMR) during on-farm trial

Parameter	T_0 (mean ±SE)	T_1 (mean ±SE)	Significance level
Fat (%)	3.51±0.04	3.62± 0.06	*
Protein (%)	3.62±0.04	3.69±0.27	NS
Lactose (%)	4.96 ±0.29	5.04±0.32	NS
SNF (%)	9.57±0.5	9.79±0.08	NS

SNF-Solids not fat; NS- Non significant *-p<0.05; NS-p>0.05.

Feeding complete diets to dairy animals has variable results on milk composition. Nagalakshmi and Reddy [24] reported higher (p<0.01) milk fat and 6% FCM yield in buffaloes fed expander-extruder processed complete diet compared to those fed conventional diet in one on-farm trial, with no effect on milk solid-not-fat (SNF) content. Bargo et al. [25] in their study found highest milk fat percentages in cows fed TMR compared to cows fed partial TMR and pasture plus concentrate which is in agreement with this study. The result also similar with the study of White et al. [26] who reported that cows fed on TMR had higher total milk fat percentage than those grazed on pasture, while the protein percentage did not differ between the two groups. Gaafar et al. [27] observed highest milk fat in cow fed with TMR. O'Neil et al. [28] concluded that cows offered TMR had higher fat yield as compared to those fed ryegrass. Their results are in accordance with this study. It is evident that lots of genetic and non-genetic factors are responsible for variability of milk composition like breed, heredity, dietary regime, time and frequency of milking, season etc.

3.5 ECONOMIC ANALYSIS

At the end of the whole experiment, economic analysis was also conducted based on benefit cost ratio (BCR) of two treatment groups as shown in Table 5. The average feed cost for animals in T_0 group was

higher as compared to animals in T_1 group fed TMR. The net profit over feed cost was higher in cows fed TMR compared to those fed on conventional ration.

Table 5: Economic analysis for two feeding groups

Cost analysis	T_0	T_1
Feed cost (BDT/day/animal)	384	320
*Income from milk (BDT/day)	559	594
Net profit earned in a day/cow (BDT)	175	265
Benefit cost ratio (BCR)	1.45	1.86

*Considering milk price @BDT 60.0/ltr.

This result is similar with earlier reports on feeding of jowar, wheat and bajra straw based complete rations to cattle and buffalo, that reduced the cost of feeding animals for milk production, compared to conventional ration Lailer et al. [29] , Kishore et al. [10] .

4. CONCLUSION

Feeding ruminants with total mixed ration is comparatively better option than conventional feeding of concentrates and roughages separately or grazing plus supplementation. This has advantages in provision of balanced diet to the ruminants and helping better utilization of the locally available feed resources, resulting in higher productivity along with reduction in feed cost and labor. Thus, the concept of feeding system with complete feed is becoming increasingly popular. However, lots of efforts are still needed to be taken for extending the concept extensively to the field.

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