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Effect of Feeding Different Levels of Degummed Fenugreek *(Trigonella foenum-graecum L.)* Seed Meal on Palatability, Nutrient Utilization and Milk Yield in Lactating Crossbred Cows

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Abstract

The effect of replacing soybean meal with feeding of different levels of degummed fenugreek seed meal (DSFM) in the concentrate mixture on palatability, nutrient utilization and milk yield in lactating crossbred cows was investigated. Eighteen lactating Karan Fries cows were divided into three groups based on milk yield and body weight. All the cows were offered a diet consisting of conventional concentrate mixture in the control group, replacing 33% of soybean meal (SBM) by DFSM for T_1 and replacing 50% of soybean meal by DFSM for T_2. All cows were fed concentrate mixture, green maize fodder and wheat straw in the ratio of 60:30:10 on DM basis, respectively. The duration of study was 150 days. Average dry matter intake and total milk yield was higher ($P<0.05$) in T_1 and T_2 groups as compared to control group even though the nutritive evaluation of rations in terms of %DCP and %TDN were same. The digestibility coefficiencies of DM, OM, EE, CF and ADF increased significantly ($P<0.05$) in treatment groups than control, although the digestibility of CP and NFE were remained similar. It was concluded that 50% replacement of SBM with DFSM in concentrate mixture having cost effectiveness and did not have any adverse effect on palatability, productive performance and nutrient digestibility in lactating cows.

Keywords: Degummed Fenugreek Seed Meal (DFSM), Soybean meal, crossbred cows, milk yield.

Introduction

In India, the livestock sector alone contributes nearly 25.6% of value of output at current prices of total value of output in agriculture, fishery & forestry sector. The overall contribution of livestock sector in total GDP is nearly 4.11% at current prices during 2012-13 (Birthal and Jha, 2014). The total livestock population consisting of cattle, buffalo, sheep, goat, pig, horses & Ponies, mules, donkeys, camels, mithun and yak in India is 512.05 million numbers within that the total Bovine population (cattle, buffalo, mithun and yak) is 299.9 million, the number of milch animals (in-milk and dry) in cows and buffaloes is 118.59 million (MoA, 2012).

India is facing huge shortage of feeds and fodders for livestock population due to limited area under fodder

crops, poor availability of good quality fodder varieties and increase in number of livestock led by genetically upgraded animals (Ramachandra *et al.,* 2007). In 2020, India may require 526 million tonnes of dry matter, 56 million tones of concentrate feed and 855 million tones of green fodder for feed (Dikshit and Birthal, 2010). So, there is a need to augment the indigenous feed resource base by tapping on locally available non-conventional feed resources.

Fenugreek (*Trigonella foenum-graecum L.)* is an annual plant from the member of a legume family that is cultivated in various parts of world particularly in India, Middle East, North Africa and South Europe (Acharya *et al.,* 2008). Fenugreek seeds have pungent aromatic properties and used as a spice (Max, 1992) and is most commonly used for seasoning. The seeds are used in India as a condiment, in Egypt as a supplement to wheat and maize flour for bread making, and in Yemen it is considered to be one of the essential dietary components of the general population. For centuries fenugreek has been used in folk medicine to heal a range of ailments (Fazli and Hardman, 1968). Fenugreek seeds have been shown to have hypocholesterolemic activity in rats (Singhal *et al.,* 1982; Sharma, 1984, 1986; Stark and Madar, 1993; Khosla *et al.,* 1995), dogs (Valette *et al.,* 1984) and humans (Madar and Odes, 1990; Sharma *et al.,* 1991). These activities were associated with the defatted fraction (Ribes *et al.,* 1984; Valette *et al.,* 1984) and implicating a Saponin rich sub-fraction (Ribes *et al.,* 1987; Sauvaire *et al.,* 1991). In addition, the seeds and some of its fractions have a hypoglycaemic effect in experimentally induced diabetes (Shani *et al.,* 1974, Madar, 1984; Ribes *et al.,* 1984) and in diabetic patients (Madar *et al.,* 1988; Sharma *et al.,* 1991). The seeds of this herb have been used in traditional medicine to promote lactation in lactating women (Shane-McWhorter, 2001 and Tiran, 2003). Also, has been shown to influence the lactation performance in ruminants. In buffaloes, fenugreek seeds feeding increased milk yield without any effects on milk composition except for a tendency to lower fat content (El-Alamy *et al.,* 2001). In goats, feeding 10 g per day of fenugreek seeds increased milk yield (Kholif and Abd-El-Gawad, 2001).

Degummed fenugreek seed meal (DFSM) is obtained after extraction of gum from fenugreek (*Trigonella foenum-graecum L.)* seed. Fenugreek is a leguminous summer crop grown in semi-arid to arid regions of India (about 80% of global fenugreek production). The states of Rajasthan (more than 60% of total production in the country) followed by Gujarat, Haryana and Punjab being the major producers (Acharya *et al.,* 2008). The crop is grown in marginal lands mainly rainfed, thus, production fluctuates from 0.2 million tonnes to 1.5 million tonnes annually with the level and intensity of monsoon rainfall in the major fenugreek producing

areas. Its main use is in the production of fenugreek gum, a galactomannan, which is used as thickener and stabilizer in the food industry, textile, cosmetic and pharmaceuticals due to its strong gelling and adhesive properties (Morris and Ross-Murphy, 1981). The residue obtained in the processing of fenugreek gum is called degummed fenugreek meal which has high crude protein (CP) content (33 to 36%). Due to the higher price of guar seeds (*Cyamopsis tetragonoloba)*, the gum industry has started degumming methi seeds and making large quantity of the meal available which could be incorporated in feed ration of both cattle and poultry (Abaza, 2007; Abbas, 2010). DFSM rich in protein content is the residue obtained after the extraction of gum from roasted methi seeds and can be substituted for conventional protein supplements. It is being produced in commercial quantities in India. DFSM has tremendous scope in animal feed industry as market rates of GNC and SBM have increased tremendously and DFSM is relatively cheap. Though DFSM is not a traditional protein supplement in dairy cattle ration but it can be tried as an alternative to costly protein supplements. Therefore, this study was undertaken to evaluate the level of replacing SBM with DFSM on milk production performance of lactating crossbred cows.

Materials and Methods

Description of the study area

The experiment was carried out at Livestock Research Center in Cattle Yard of the National Dairy Research Institute (NDRI), Karnal, Haryana, India. Karnal is situated in eastern zone of Haryana state and in the trans-gangetic plain region of India at an altitude of 250 meters above mean sea level, latitude and longitude position being 29°42″N and 79°54″E respectively. There are four major seasons in the year viz. winter (December to March), summer (April to June), rainy (July to September) and autumn (October to November). The maximum ambient temperature in summer goes up to 48°C in May to June months of summer and minimum temperature in winter falls near to freezing point with a diurnal variation in the order of 15 to 20°C. The annual rainfall is close to 700 mm and most of it is received from July to September. The climate of the farm is typically subtropical and the land area is very productive with sufficient irrigation facilities for growing green fodder for animals year round.

Animals and feeding management

Karan Fries (KF) crossbred cows (Tharparkar X Holstein Friesian) maintained at Livestock Research Centre of NDRI were utilized for the study. Eighteen healthy lactating crossbred cows in their mid lactation

(3rd to 4th lactation; 110.56±1.74 DIM) were selected and divided into three groups of six cows each on the basis of milk production (average 15.35±0.04 kg/day) and body weights (average 384.90±2.15 kg/cow) using randomized complete block design (RCBD). **Control group (C)** was fed a ration having concentrate mixture (maize 28, groundnut cake 10, soybean meal 15, mustard cake 13, pearl millet 5, rice polish 11, wheat bran 15, mineral mixture 2 and common salt 1part), wheat straw and non leguminous fodder in the ratio of 60:30:10 to meet the nutritional requirement ICAR (2013). **Treatment group 1 (T_1)** was fed a ration as in above, but 5 parts of soybean meal of 100 kg concentrate mixture of control was partially replaced by degummed fenugreek seed meal. **Treatment group 2 (T_2)** was fed with a similar ration as in control except that the soybean meal concentrate mixture was partially replaced by 7.5 parts degummed fenugreek seed meal (Table 1). All cows were fed on isonitrogenous diet formulated to meet or exceed the predicted requirements of Indian Council for Agricultural Research (ICAR, 2013); and offered fresh chaffed green maize fodder 15 kg provided in 3-4 installments throughout the day and wheat straw 4 kg per cow/day. Water was provided as an ad lib. The cows were kept under asbestos sheet roofing in the Livestock Research Center of NDRI. They were housed in a well ventilated stall having facilities for individual feeding. Healthy surroundings and proper sanitary conditions were maintained throughout the experimental period. Before starting the experiment, mangers, floor, sewage channels and surrounding were properly cleaned and it was continued regularly till completion of the experiment, so as to keep the cows free from any infection. All the cows were fed total mixed ration consisting of concentrate mixture (Table 1), wheat straw and maize fodder. The total concentrate mixture offered to each cow was divided into three portions and fed at 4:30am, 9:30am and 4:30pm. The feed intakes were individually recorded daily for all the cows. The cows were provided with fresh and clean drinking water free choice thrice daily at 6:00am, 11:30am and 6:30pm.

Invivo and *invitro* studies

Amino acid profiles of SBM and DFSM were estimated using High Performance Liquid Chromatography (HPLC) fitted with absorbance detector (254 nm) and PICO TAG column (15.0 cm ×3.9 mm) as per AOAC (2005). The feeding trial was done from April to August, 2014 lasted for 150 days during which DM intake was recorded daily and body weight taken fortnightly. A digestibility trial of 7 days was conducted at 105 days of experimental period. Feed, residues and faecal samples were analyzed for proximate principles (AOAC, 2005) and cell wall constituents (VanSoest *et al*., 1991). The milk yield was recorded daily for 150 days while milk was analyzed

fortnightly for fat, protein, lactose and SNF using ultrasonic milk analyzer (Lactoscan MCC).

Table 1: Ingredient composition of concentrate mixtures fed to experimental cows

Ingredients	Parts in concentrate mixture		
	0 part DFSM control (C)	5 parts DFSM (T_1)	7.5 parts DFSM (T_2)
Maize grain	28	28	28
Pearl millet	5	5	5
Mustard oil cake (expeller)	13	13	13
Groundnut Cake	10	10	10
Soybean meal	15	10	7.5
Degummed fenugreek seed meal	0	5	7.5
Wheat bran	15	15	15
Rice polish	11	11	11
Mineral mixture	2	2	2
Common salt	1	1	1
Total	100	100	100
Urea (g/100kg)	0	243	417

SBM = Soybean meal, DFSM = Degummed Fenugreek Seed Meal.

Statistical analysis

All data collected were subjected to a one way analysis of variance (ANOVA) (Snedecor and Cochran, 1994) for Randomized Completely Block Design using the Procedure General Linear Model (GLM) of SAS (SAS institute, 2002). The model used was:

$Y_i=\mu + T_i + e_i$

Where,

Yi= mean of individual observation,

T_i = the effect of treatment,

e_i= random error effect

Significance was declared at $P \leq 0.05$ and a trend at $0.05 < P \leq 0.1$, unless otherwise stated. Where there exist a significant difference among means, the Turkey's honestly significant difference (HSD) procedure was used for mean comparison.

Results and Discussion

Chemical composition and cell wall contents

The chemical composition and cell wall contents of concentrate mixtures of the experimental groups; green maize fodder and wheat straw is presented in Table 2. The result clearly depicts that the three concentrate

mixtures i.e. control group 'C' having 15 parts soybean meal and treatment group 'T_1' and 'T_2' having soybean meal from which 5 and 7.5 parts partially replaced with degummed fenugreek seed meal had good level of crude protein, ether extract, nitrogen free extract showing not much variation in chemical compositions. Thus all these concentrate supplied higher level of nitrogen as well as readily available energy to the lactating cows for milk production and growth.

Table 2: Chemical compositions (% DM basis) of experimental feeds used during experiment

Parameters	0 part DFSM control (C)	5 parts DFSM (T_1)	7.5 parts DFSM (T_2)	Maize fodder	Wheat straw
Dry matter	89.38	90.44	90.69	24.47	89.87
Organic matter	91.68	91.67	91.98	90.14	87.78
Crude Protein	21.74	21.77	21.82	8.14	2.89
Crude fiber	9.06	9.13	9.66	25.80	34.75
Ether extract	6.13	6.37	6.55	2.38	0.76
Nitrogen free extract	53.15	53.99	54.77	53.82	49.38
Total ash	8.32	8.02	8.31	9.86	12.22
Acid insoluble ash	1.87	1.83	1.93	3.27	6.02
Neutral detergent fibre	32.22	31.99	34.40	69.77	83.50
Acid detergent fibre	19.41	19.98	21.25	40.84	54.05
Hemicellulose	12.81	13.14	13.23	28.93	29.44

DFSM = Degummed fenugreek seed meal.

Body weight

The average body weight at the beginning of the experiment in control, T_1 and T_2 groups were 383.23±8.00, 386.35±6.26 and 385.11±14.53 kg respectively while the average body weight at the end of 150 days experimental period were 418.72±8.56, 437.06±5.79 and 435.41±14.04 kg respectively (Table 3). The increment in body weight as a result of feeding 5% and 7.5% inclusion of DFSM in concentrate mixture was observed in T_1 and T_2 respectively as compared to the control group. During the experimental period of 150 days, the body weight of the cows showed an increasing trend in both treatment groups and significant ($P<0.05$) difference in the final average body weight among the three groups due to DMI was more in T_1 and T_2 groups as compare to control.

Table 3: Effect of partial replacement of soybean meal with degummed fenugreek seed meal on body weight (kg) of lactating crossbred cows

Fortnight	0 part DFSM control (C)	5 parts DFSM (T_1)	7.5 parts DFSM (T_2)
0	383.23±8.00	386.35±6.26	385.11±14.53
1	386.23^{a}±7.95	395.61^{b}±6.21	390.00^{a}±14.77
2	388.58^{a}±7.82	400.36^{c}±6.84	394.21^{b}±14.73
3	392.36^{a}±7.62	404.95^{b}±6.85	399.31^{b}±14.59
4	395.54^{a}±7.68	409.53^{b}±7.18	405.55^{b}±14.60
5	398.31^{a}±7.40	414.61^{b}±7.55	411.21^{b}±14.35
6	401.51^{a}±7.57	418.23^{b}±7.58	416.42^{b}±14.34
7	405.51^{a}±7.53	424.29^{b}±7.09	421.75^{b}±14.48
8	411.02^{a}±9.21	427.92^{b}±6.25	427.30^{b}±14.66
9	414.64^{a}±8.81	432.31^{b}±6.24	431.72^{b}±14.16
10	418.72^{a}±8.56	437.06^{b}±5.79	435.41^{b}±14.04
Overall mean	**399.60^{a}±8.01**	**414.25^{b}±6.71**	**410.73^{b}±14.48**

*a, b and c values bearing different superscripts in a row differ significantly (P<0.05).

Nutrient intake and utilization

The result of nutrient intake and utilization in crossbred cows is presented in Table 4. The incorporation of DFSM in the concentrate mixture did not show any effect on the DM intake. Average DM intake in control, T_1 and T_2 groups was 12.94±0.22, 13.29±0.23 and 13.19±0.22 kg/day respectively indicating that the palatability of diet was not adversely affected by DFSM even at 7.5 parts (50%) replacement of soybean meal. Average CP intake was 1.95±0.06, 1.90±0.06 and 1.91±0.07 kg/day in 15 parts SBM (control), 5 and 7.5 parts replaced groups (T_1 and T_2) respectively. The average TDNI was 8.08±0.77, 8.65±0.54 and 8.41±0.61 kg/day in control, T_1 and T_2 groups respectively. The CP and TDN intake in T_1 and T_2 groups was numerically higher than control (15 parts SBM fed) group. The digestibility of DM, OM, EE, CF and ADF increased significantly (P<0.05) in T_1 and T_2 groups of cows than control, however, the digestibility of CP and NFE remained similar. Percent DCP and TDN intakes also did not vary in different dietary treatments, indicating that DFSM at 7.5 parts (50%) replacement level of soybean meal did not have any adverse effect on nutrients digestibility (Table 4).

Table 4: Nutrient intake and utilization in crossbred cows in different treatment

Parameter	0 part DFSM control (C)	5 parts DFSM (T_1)	7.5 parts DFSM (T_2)
Nutrient intake and utilization			
TDN%	58.18±4.95	60.30±4.66	60.20±3.96
DCP%	10.05±0.14	9.63±0.07	9.88±0.09
DMI (kg/day)	12.94^{a}±0.22	13.29^{b}±0.23	13.19^{b}±0.21
DMI (kg/100kg body weight)	3.24±0.04	3.22±0.04	3.22±0.04
CPI (kg/day)	1.95±0.06	1.90±0.06	1.91±0.07
DCPI (kg/day)	1.27±0.05	1.24±0.04	1.27±0.04
TDNI (kg/day)	8.08±0.77	8.65±0.54	8.41±0.61
Digestibility coefficient (%)			
DM	62.70^{a}±0.62	63.88^{b}±0.51	64.43^{b}±1.48
OM	64.15^{a}±1.18	65.96^{b}±0.92	66.33^{b}±1.02
CP	65.69±0.49	66.21±0.74	66.76±1.18
EE	77.24^{a}±0.77	80.70^{b}±0.82	81.12^{b}±0.73
CF	52.20^{a}±1.37	54.34^{b}±2.15	54.78^{b}±2.38
NDF	57.60^{a}±1.68	58.03^{a}±1.23	60.36^{b}±1.36
ADF	54.29^{a}±1.29	56.71^{b}±1.01	58.39^{c}±1.59
NFE	71.38±2.76	71.55±2.71	71.71±2.28

*a, b and c values bearing different superscripts in a row differ significantly (P<0.05).

Milk production, milk composition and feed conversion efficiency

The average milk production in control, T_1 and T_2 groups was 15.11±0.05, 15.78±0.06 and 15.84±0.09 kg/day respectively over 150 days experimental period (Table 5). The milk yield in 5 and 7.5 parts DFSM replaced groups (T_1 and T_2) was comparable to 15 parts soybean meal control group (without having any DFSM). Milk fat (%) was higher (P<0.05) and milk protein (%) was lower (P>0.05) by feeding DFSM. Lactose, SNF and TS (%) were not influenced significantly (P>0.05) by the inclusion of degummed fenugreek seed meal and replacement of soybean meal in their diet. Nutrient intake per kg milk produced was also similar in all the groups (Table 5).

Table 5: Average milk yield, milk composition and feed conversion efficiency of experimental cows

Parameter	0 part DFSM control (C)	5 parts DFSM (T_1)	7.5 parts DFSM (T_2)
Milk yield (kg/day)	15.11^{a}±0.54	15.78^{b}±0.59	15.84^{b}±0.60
4% FCM (kg/day)	14.58^{a}±0.27	15.34^{b}±0.18	15.45^{b}±0.11
Fat %	3.77^{a}±0.03	3.82^{b}±0.04	3.84^{b}±0.05
Protein %	3.27±0.02	3.22±0.01	3.24±0.02
Lactose %	4.70±0.03	4.71±0.02	4.67±0.03
SNF %	9.08±0.03	9.07±0.03	9.05±0.04
Total solids %	12.85±0.06	12.89±0.06	12.89±0.05
DMI kg/kg milk yield	0.86±0.03	0.84±0.04	0.83±0.03
CPI g/kg milk yield	129.05±10.19	120.40±9.52	120.58±9.56
TDNI kg/kg milk yield	0.53±0.04	0.55±0.03	0.53±0.04

*Observations with different superscripts [a and b] differ significantly (P<0.05) between the group.

Economics of soybean meal replacement with DFSM

The economics of feeding DFSM and milk production are presented in Table 6. The increased cost of concentrate in control group was due to higher proportion of costly soybean meal. Net return per cow/day for total milk yield was USD 2.92, 3.19 and 3.25 in control, T_1 and T_2 groups respectively, indicating a difference of USD 0.28 and 0.34 in T_1 and T_2 groups respectively when compared to control group. Similarly net return per cow/day on 4% FCM basis was USD 3.39, 3.74 and 3.83 in control, T_1 and T_2 groups respectively, indicating an increase of USD 0.35 and 0.44 in T_1 and T_2 groups respectively when compared to the control group. Thus, suggesting that the partial replacement of soybean meal with 5 and 7.5 parts DFSM in the ration of lactating crossbred cows during lactation was cost effective.

Table 6: Economics of feeding* soybean meal and partial replacement with degummed fenugreek seed meal to lactating crossbred cows

Particulars	0 part DFSM (C)	5 parts DFSM (T_1)	7.5 parts DFSM (T_2)
Dry matter intake (kg/cow/day)	12.94	13.29	13.19
Price of concentrate mixture (US$/100 kg)	29.61	28.60	28.08
Price of wheat straw (US$/100 Kg)	6.24	6.24	6.24
Price of green maize fodder (US$/100 kg)	2.34	2.34	2.34
Intake of wheat straw	2628	2637	2637
Cost on wheat straw (US$)	163.99	164.56	210.61
Intake of concentrate (kg)	7790	8011	8030
Cost on concentrate (US$)	2306.51	2290.74	2255.42
Intake of green maize fodder (kg)	9000	9000	9000
Cost on green maize fodder (US$)	210.61	210.61	210.61
Total Input cost (US$)	**2681.11**	**2665.90**	**2630.58**
Total feed cost/cow/day (US$)	2.98	2.96	2.92
Milk yield/cow/day (kg)	15.11	15.78	15.84
Milk yield of 6 cows for 150 days (kg)	13599	14202	14256
Cost of milk produced @ US$ 0.39 per kg	5303.83	5539.01	5560.07
Net return for milk yield (gross income-feed cost) (US$)	2622.72	2873.11	2929.49
Net return per cow/day on total milk yield basis (US$)	**2.92**	**3.19**	**3.25**
4% fat corrected milk yield	13122	13806	13905
Return from 4%FCM @ US$ 0.44 per kg	5731.92	6030.71	6073.95
Net return for FCM yield (gross income-feed cost) (US$)	3050.81	3364.81	3443.37
Net return per group/day on 4% FCM yield basis (US$)	20.34	22.43	22.95
Net return per cow/day on 4% FCM yield basis (US$)	**3.39**	**3.74**	**3.83**

* 150 days experimental period

Conclusion

Based on the present findings, it is concluded that 50% replacement of soybean meal with degummed fenugreek seed meal (i.e. 7.5 parts of DFSM) in concentrate mixture increases dry matter intake, nutrient digestibility and milk production. The replacement of soybean meal with degummed fenugreek seed meal as a protein ingredient in concentrate mixture did not have any adverse effect on palatability, productive performance and nutrient digestibility without affecting milk composition. Soybean meal could be satisfactorily replaced by degummed fenugreek seed meal up to 50% level of concentrate mixture to make an economic ration of dairy cows.

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