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Amino acid profile, *In Vitro* rumen degradability and Economics of feeding Extruded Full Fat Soybean as a partial replacement of Groundnut Cake in Lactating Cows

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ABSTRACT
For the present study fifteen early lactating cross bred cows (2nd to 4th lactation) were divided into three groups, based on their body weights and milk yield. All the animals were fed same basal ration consisting of wheat straw and concentrate in the ratio of 50:50 on dry matter basis along with 10 kg oats green fodder/animal/day. Animals in T1 and T2 groups were also fed same diet as that of control except that 50% of groundnut cake in their concentrate mixtures was replaced by extruded full fat or raw soybeans, respectively. The experiment was conducted for a period of 120 days during which milk production, voluntary feed intake and economics of milk production were recorded. Ground samples of the feed ingredients were analyzed for amino acid composition. The soybean (extruded or raw) had better amino acid composition than groundnut cake and maize. The in vitro rumen dry matter degradability ($IVDMD_R$) % was highest in C, (52.02±0.85) followed by T2 (49.28±0.76) and then T1 (46.5±0.49). The $IVOMD_R$ (%) was highest in control (59.26±1.78) and lowest in T1 (52.88±0.57) group. $IVCPD_R$ was significantly lower ($P<0.05$) in T1 (53.12±0.67) as compared to C (58.94±0.81) and T2 (56.7±0.60). The average dry matter intake (kg /day) was 13.3±0.4, 13.6±0.3 and 14.0±0.5 in C, T1 and T2 groups, respectively. The average milk yield (kg/d) was significantly ($P<0.05$) higher in T1 (14.4±0.5) as compared to control (13.0±0.3) and T2 (13.0±0.4) groups. Net return/income per animal /day (Rs) was 182.0, 222.3, 173.2 in C, T1 and T2 groups respectively, indicating that it was higher by Rs. 40.3 and Rs. 49.1 in T1 as compared to C and T2 groups respectively. Similarly net return/income per animal /day (Rs) on 4% FCM basis was 136, 160 and 126 in C, T1 and T2 groups respectively, indicating that it was higher by Rs. 24 and Rs. 34 in T1 as compared to C and T2 groups, respectively. Though the cost of extruded full fat soybean was higher compared to raw soybean or groundnut cake, but economics was better in ration substituted with extruded full fat soybean as a partial replacement of groundnut cake.
Key Words: *Amino acid, Rumen Degradability, Economics, Full Fat Soybean and Lactating Cows*

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INTRODUCTION

Amino acids required for dairy cattle production come both from dietary protein that escapes rumen fermentation (rumen undegradable protein) and the microbial protein synthesized during rumen fermentation. The young heifers and the high milk producing cows required more undegradable protein. Soybean is the most commonly used protein supplement in dairy rations. It is very palatable and is known to have a good amino acid balance. Soybean as a protein supplement is also an economical and convenient way to provide dietary fat. However, raw soybean and soybean meal (SBM) have relatively low protein efficiency because of extensive ruminal degradation. Therefore, improvement in ruminal escape characteristics of soybean (SB) and soybean meal (SBM) is of major importance to dairy producers and the soybean industry. Various methods of treating soybean (SB) and soybean meal (SBM) such as extrusion, roasting, expeller, lignosulfonate, formaldehyde have been successfully used to protect soybean (SB) and soybean meal (SBM) from ruminal degradation. When dairy cattle were fed diets containing the heat-treated soybean (SB) and soybean meal (SBM), milk production or feed efficiency were improved (Kumar *et al*., 2011). Extruded / heated Full fat soybean (FFSB) is high quality protein supplement having best amino acid balance, commonly used in growing and lactating animals. Apart from

eliminating the cost of oil extraction, the extruded full fat soybean also ensures that high protein-energy diet can be formulated thereby replacing part of the often scarce protein supplement.

Ground nut cake is a conventional protein supplement being used in cattle feed, but due to its poor storage quality which develops mycotoxins, a potent liver toxin and carcinogen, so growth rate and milk production is not optimum. However, full fat soybean leads to faster growth in calves and higher milk production in cows and buffaloes due to high protein and energy content. Enhanced milk production is important from economic point of view. As raw full fat soya is known to have anti-trypsin activity which is heat labile, so the heat treated or extruded full fat soybean may have an advantage over raw full fat soya. Keeping in view these facts the study was conducted to measure the *in vitro* protein degradability of diets having different concentrate mixtures, amino acid composition of feed ingredients and economics of feeding full fat soya in lactating animals.

MATERIALS AND METHODS

Fifteen Lactating Karan Fries (KF) cows in their 2^{nd} to 4^{th} lactation (30 to 69 day after calving) were randomly allocated into 3 groups of 5 each in a complete randomized block design (CRD) based on their body weights, age and days in lactation. Karan Fries cows kept on diets according to NRC (2001) feeding standards. A weighed quantity of control or experimental diets were offered to the cows as total mixed ration (TMR) consisted of concentrate mixture and Wheat straw in ratio of 50:50 on dry matter basis along with 10 kg oats green fodder to each animal per day. In control group the cows were fed with wheat straw, chaffed green oats fodder and compounded concentrate mixture and to Group T1 and T2 same ration as that of control but 50% of groundnut cake in concentrate mixture was replaced by extruded full fat or raw full fat soybean, respectively (Table 1). Throghout the experimental period the lactating cows were maintained in an open asbestous sheeted shed with pucca floor having arrangement for individual feeding. The animals were provided with fresh and clean tap water free choice thrice a day.

Representative ground samples of the feed ingredients were analyzed for proximate principles (A.O.A.C.1990), fibre fractions (Van Soest *et al.*1991) and amino acid composition through HPLC. An *in vitro* rumen degradability study of different diets was also undertaken to determine the rumen degradability of DM, OM, and CP *in vitro* Tilly and Terry (First stage) technique (1963). Daily dry matter intake (DMI) was observed by recording the daily feed offered and residue left throughout the experimental period. Milking was done thrice a day and daily milk yield was recorded for individual animal. Economics of feeding under different treatments was worked out from daily feed intake and by considering the cost of feeds and fodders used. The cost of milk was worked out based on the price of local market based on SNF%. The data was analyzed by one way ANOVA considering different groups as treatments as per Snedecor and Cochran (1980).

RESULTS AND DISCUSSION:

The concentrate mixture of three experimental groups, wheat straw and oats fodder were also analyzed for proximate principles and fiber fractions (Table 2). The DM, OM, CP, CF, EE, TA, NDF, and ADF percent were similar in control (C), extruded soybean (T1) and raw soybean (T2) groups, respectively. The percent chemical composition of green oats observed in this study was similar to as reported by earlier researchers (Sehgal and Makkar, 1994; Tripathi *et al*., 2007).

There was a wide variation in the concentrations of different amino acids in different feed ingredients (Table 3). The soybean (extruded or raw) had better amino acid composition than groundnut cake and maize. The values of methionine, alanine, valine, leucine, proline and tyrosine obtained in the present study were also comparable to that reported by NRC 1995.

The *in vitro* rumen nutrient degradability of different dietary treatments is presented in table 4. The *in vitro* rumen dry matter degradability ($IVDMD_R$) was significantly ($P<0.05$) different in all the three groups and was highest in C, followed by T2 and then T1. The $IVOMD_R$ was highest in control and lowest in T1 group. $IVCPD_R$ was significantly lower ($P<0.05$) in T1 as compared to C and T2. The decrease in *in-vitro* DM, OM and CP degradability in T2 group was attributed to the heat treatment of extruded soybean, which makes these nutrients resistant to microbial attack in rumen and these bypasses the rumen. Keela *et al*. (1989) compared the ruminal protein degradation of extruded soybean and whole cottonseed, and observed 13% lower ruminal protein degradability for diets containing extruded full fat soybean. Aldrich *et al*. (1995) however, reported that *in vivo* whole tract organic matter degradability was not affected significantly by heat treatment of soybean. This may in part, be due to soybean NDF and ADF being more digestible than the fibre constituents of the basal diet.

The average dry matter intake (kg /day) from concentrate, wheat straw and oats green was similar in all the three groups and the average milk yield was significantly ($P<0.05$) higher yield in T1 in comparison to

control and T2 groups (Table 5). These results clearly showed a positive effect of extruded full fat soybean on milk yield. Stern *et al*. (1985) reported similar dry matter intake in different groups of lactating cows fed with soybean meal, raw soybean and extruded soybean. Li *et al.* (2009) also observed an increase in the percent feed efficiency of lactating cows by incorporating extruded full fat soybean in their diet, however, they did not find an increase in dry matter intake of these cows.

The data regarding the economics of feeding and milk production are presented in Table 6. The cost of concentrate mixture was 1390, 1489 and 1462 Rs/100 Kg in C, T1 and T2 groups respectively. Cost of green fodder was Rs 100/100 Kg, and that of wheat straw was taken as Rs.250/100 Kg. The cost of total feed intake for 120 days varied in different groups due to variation in its intake, and the cost was 8208.0±606, 8457.7±749 and 8739.7±612 rupees in C, T1 and T2 groups respectively. Cost incurred on feeding of total green fodder for 120 days was similar in all three groups as the quantity was fixed in all treatments and this was Rs. 6000. Cost on total concentrate mixture for 120 days was Rs. 61145.9±3364, 67130±4465 and 67654.9±3590 in C, T1 and T2 groups respectively, showing higher values for T1 and T2 groups due to costly raw and extruded full fat soybean than GNC. The total input cost (Rs) was 75353, 81588 and 82394 in C, T1 and T2 groups respectively. Milk Yield of 5 animals for 120 days was 7381.7±208, 8598.5±173 and 7453.7±208 kgs in C, T1 and T2 groups respectively, which was significantly higher in T1 group as compared to C and T2 groups ($P<0.05$). Cost of milk was fixed as Rs. 25/kg and the amount from the total milk realized was Rs. 184541.5±5202, 214961.6±4333 and 186343.5±5206 in C, T1 and T2 groups respectively, indicating significantly higher ($P<0.05$) profit in T1 as compared to C and T2 groups ($P<0.05$). Net return per animal /day (Rs) was 182.0, 222.3, 173.2 in C, T1 and T2 groups respectively, indicating that it was higher by Rs. 40.3 and Rs. 49.1 in T1 as compared to C and T2 groups respectively. Similarly net return per animal /day (Rs) on 4% FCM basis was 136, 160 and 126 in C, T1 and T2 groups respectively, indicating that it was higher by Rs. 24 and Rs. 34 in T1 as compared to C and T2 groups respectively. Shelke and Thakur (2011) reported that feeding rumen protected fat and protein to high yielding lactating buffaloes during early lactation period was cost effective and indicated that net return over feed cost of milk yield per animal per day was higher by Rs. 32.51 in treatment group over that of control group.

CONCLUSION

Feeding of extruded full fat soybean in comparison to raw soybean as a partial replacement of GNC in lactating cows @ 9% level of replacement of concentrate mixture was found to be helpful in enhancing milk production in early lactating cows. Though the cost of extruded full fat soybean was higher compared to raw soybean or GNC but economics of milk production was better in ration substituted with extruded full fat soybean compared to raw soybean as a partial replacement of GNC.

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Table 1: Ingredient compositions of the concentrate mixture

Ingredient	Control (%)	Extruded FFS T1 (%)	Raw soybean T2 (%)
Groundnut Cake	18	9	9
Extruded soyabean	0	0	9
Raw Soyabean	0	9	0
Maize	33	33	33
Bajra	5	5	5
Mustard oil cake	10	10	10
Guar meal	5	5	5
Wheat bran	20	20	20
Deoiled rice bran (DORB)	6	6	6
Mineral mixture	2	2	2
Common salt	1	1	1
Total	100	100	100

Table 2: Chemical composition (% DM basis) of concentrate mixtures, green oats and wheat straw

Parameters	Concentrate mixtures			Wheat straw	Green Oats
	Control	Extruded soya bean (T1)	Raw soya bean (T2)		
Dry matter	90.12	89.88	89.73		
Organic matter	91.88	92.05	92.13	87.84	90.39
Crude protein	21.30	20.71	20.56	2.30	12.03
Crude fiber	7.32	7.68	7.90	42.44	27.30
Ether extract	4.31	4.69	4.63	0.67	2.92
Nitrogen free extract	58.95	58.97	59.04	45.43	48.14
Total ash	8.12	7.95	7.87	9.16	9.61
Acid insoluble ash	1.92	1.86	1.82	5.61	4.71
Neutral detergent fiber	42.35	39.80	40.50	76.50	66.32
Acid detergent fiber	21.48	17.91	18.35	59.60	42.52
Acid detergent lignin	6.73	6.37	6.45	8.39	2.93
Cellulose	14.75	11.54	11.90	51.21	39.59
Hemicellulose	20.87	21.89	22.15	16.9	23.8

Table 3: Amino acid composition (% of crude protein) of different feed ingredients.

Amino Acid	Wheat Bran	Maize grain	Ground nut cake	Mustard oil cake	Raw soybean	Extruded full fat soybean	Bajra	Guar meal
ASP	5.75	6.62	10.22	2.12	8.56	9.34	6.77	4.85
GLU	7.43	12.85	14.75	1.96	4.24	5.13	7.21	13.23
SER	3.04	4.19	4.02	2.66	7.76	7.28	9.78	2.85
GLY	1.33	3.77	4.60	2.27	6.08	6.10	8.77	4.10
HIS	1.05	2.01	1.82	1.95	2.98	2.78	3.98	2.45
ARG	4.66	6.08	9.14	6.32	3.87	7.02	4.99	6.21
THR	3.23	3.25	2.29	1.12	3.91	3.19	3.89	4.21
ALA	6.12	5.18	2.98	3.38	5.02	4.87	6.55	3.34
PRO	9.21	9.39	4.38	2.61	2.71	2.65	7.55	4.65
TYR	6.41	5.37	3.70	1.49	9.12	10.33	4.65	1.95
VAL	3.18	5.72	3.60	3.78	4.76	5.25	6.13	3.40
MET	1.25	1.24	1.53	1.12	2.01	1.78	1.95	2.67
CYS	1.89	1.29	0.68	1.78	1.66	1.76	2.05	1.54
ILEU	3.87	3.43	2.94	3.84	3.76	3.98	4.56	4.67
LEU	5.23	8.67	5.25	5.45	6.87	7.03	4.18	5.60
PHE	3.65	4.73	4.38	2.78	5.13	4.76	5.99	4.86
LYS	4.14	2.47	2.83	3.55	4.98	6.01	5.75	6.96

Table 4:*In vitro* ruminal dry matter, organic matter and crude protein degradability of different dietary treatments at 48 hrs of incubation.

Parameters	Control	Extruded full fat soybean (T1)	Raw Soybean (T2)	CD value (P≤0.05)
Dry matter	52.02±0.85[a]	46.5±0.49[c]	49.28±0.76[b]	2.75
Organic matter	59.26±1.78[a]	52.88±0.57[b]	56.23±0.87[ab]	6.37
Crude protein	58.94±0.81[a]	53.12±0.67[b]	56.7±0.60[a]	2.70

a, b, c superscripts in a row differ significantly (P≤0.05)

Table 5: Average dry matter and milk production in lactating cross bred cows.

Particular	Control	Extruded FF soybean (T1)	Raw soybean (T2)	CD value (P≤0.05)
Number of Animal	5	5	5	
Dry Matter Intake (kg/d)				
From WS	4.9 ±0.9	5.1±0.87	5.2±0.9	NS
From conc. Mixture	6.7±0.3	6.8±0.2	6.99±0.4	NS
From oat green	1.7±0.2	1.7±0.2	1.7 ±0.2	NS
Avg.DMI/d	13.3±0.4	13.6±0.3	14.0±0.5	NS
Total DMI*(kg)	1600.8±2.0	1639.5±2.0	1678.0±3.8	NS
Milk yield				
Avg. milk yield during 120 days of experiment (kg//animal/day)	13.0±0.3 [a]	14.4±0.3[b]	13.0±0.3[a]	1.20
Avg Total Milk Yield*	1556.3±1.0[a]	1719.8±0.9[b]	1557.4±1.0[a]	161.0

*120 days experimental period; NS: Non-significant, means with different superscripts in a row differ significantly (P≤0.05)

Table 6: Economics of milk production on feeding concentrate with or without extruded full fat or raw soybean

Attributes	Control	Extruded FF soybean (T1)	Raw soybean (T2)
Cost of concentrate (Rs/100 Kg)	**1390.5**	**1489.5**	**1462.5**
Cost of Wheat straw (Rs/100 Kg)	250	250	250
Cost of Green oats (Rs/100 Kg)	100	100	100
Intake of WS	**3283.2±242.4**	**3383.1±299.8**	**3495.8±245.1**
cost on WS	**8208.0±606.0**	**8457.7±749.4**	**8739.7±612.9**
Intake of Concentrate	**4397.4±241.9**	**4506.9±299.8**	**4626.0±245.5**
cost on concentrate	**61145.9±3364.0**	**67130±4465.8**	**67654.9±3590.7**
Intake of green oats	6000.0	6000.0	6000.0
cost on Green oats	6000.0	6000.0	6000.0
Total Input cost(Rs)	**75353.8**	**81588.0**	**82394.5**
Milk Yield of 5 animals for 120 days	7381.7±208.1[b]	8598.5±173.3[a]	7453.7±208.2[b]
Cost of milk produced @Rs 25/Kg	184541.5±5202.8[b]	214961.6±4333.2[a]	186343.5±5206.1[b]
Net return (Gross income-Feed cost)	109187.7	133373.6	103949
Net return per animal / day (Rs)	**182.0**	**222.3**	**173.2**
4% fat corrected milk yield	7860	9060	8180
Return from 4%FCM @Rs20/kg	157200.	181200	163200
Net Return (Gross income-Feed cost)	81846.4	99612	80806
Net return per animal / day (Rs)	**136.4**	**166**	**134.7**

Means with different superscripts in a row differ significantly (P≤0.05);

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