Bangladesh Journal of Animal Science
Journal homepage: http://www.banglajol.info/index.php/BJAS

Effect of bypass protein supplement on milk production in Jersey cow

MR Tiwari[1], PK Jha*[2, 3], SR Pant[4], MP Acharya[4], P Thapa[5] and BK Shrestha[1]

[1]Animal Nutrition Division, Khumaltar, Lalitpur, Nepal; [2]Animal Breeding Division, Khumaltar, Lalitpur, Nepal; [3]Department of Surgery and Obstetrics, Bangladesh Agricultural University, Bangladesh; [4]National Cattle Research Program, Rampur, Chitwan, Nepal; [5]Institute of Agriculture and Animal Science, Tribhuwan University, Kirtipur, Nepal

Abstract

Bypass protein is known to stimulate the voluntary feed intake, increase quality milk production and thereby improve economic status from dairy cows farming. This study was conducted to compare the responses of additional bypass protein as feed supplement on milk production performance in Jersey dairy cows, and its cost benefits per L of milk production. A total of 12 lactating Jersey dairy cows, apparently having similar reproductive and productive performances were selected. The cows were randomly grouped into 3 treatments groups; T1 (Control): 6 kg concentrate mixture, T2: 6 kg concentrate mixture plus 1.5 kg heat-treated soybean cake, and T3: 6 kg concentrate mixture plus 1.5 kg formalin treated soybean cake. An acclimatization period of 7 days, the experimental procedure was carried for the period of 62 days. Other management; feeding - adlib amount of straw and green grass such as oat, signal and local grass once a day, natural grazing average 3 hrs/ day), watering and housing remained as routinely done by the farm. The compound feed was procured from Fine Feeds Industries Pvt. Ltd., Chitwan, Nepal. Feed intake and milk production of individual animal was recorded daily. The straw and concentrate intake of experimental cows among the treatment groups differed significantly ($P<0.001$), whereas green grass intake among the diet groups differed insignificantly. The initial recorded milk production 5.4 L, 5.45 L and 5.62 L among the treatment groups found insignificant, whereas the final milk production 7.85 L, 6.12 L and 5.82 L among the treatment groups found highly significant ($P<0.001$). The economic analysis (its cost benefits per L of milk production) during the period of 62 days of experimentation, it was revealed that feeding package T2 is more beneficial than T3. The net income accounted for NRs 12152.11 and NRs 7457. 55 using T2 and T3 feeding package, respectively. Therefore, it is suggested that heat-treated soybean cake supplementation to early lactating (up to 3 months) dairy cows is one of the option to increase milk production and income of farmers. Further study needed to be carried out to ascertain the optimum level and duration of additional protein supplementation to dairy cows.

Key words: dairy cows, bypass protein, milk production, Nepal

Introduction

Livestock farming is a major component of the mixed farming system in Nepal. It contributes 31% of agriculture gross domestic product (AGDP). Dairy sector alone contributes 78% (APP, 1955). It is presently ongoing a transition phase from subsistence to commercial dairy farming in the various places of Nepal due to an increase of milk marketing facilities. Dairy farming has been helping the Nepalese farmers to earn cash, at the same time provides manure. The main problem facing by the farmers is the adequate nutrition for their dairy cows for optimum production. This could be overcome by the introduction of newer feed formulations including the efficient use of available feed resources and alternative feed technologies. Dietary proteins are mostly degraded in the rumen and transformed in microbial protein. The method to increase protein supply to the cows is termed as "bypass protein technology" (Preston and Leng, 1987; Garg *et al.,* 2007). The protected protein by-passes the rumen and provides additional essential amino acids for absorption at the small intestine (Walli, 2005). Bypass protein is known to stimulate the voluntary feed intake Preston and Leng(1987) and thereby improve milk quality and quantity and thereby increase the income from dairy cows farming (Garg *et al.*, 2005; Gulati *et al.,* 2005). There are several available natural bypass proteins (oilseed meal, fishmeal, cereal bran, tannin-containing legume, corn gluten meal and cottonseed meal) are naturally less degradable in

***Corresponding author**: drpankaj.np@gmail.com

the rumen, and thereby make available in sufficient quantity in the intestine for optimum absorption (Preston and Leng, 1980; Preston and Leng, 1987). Other are soluble protein meals, their bypass protein qualities can be improved by protecting from degradation in the rumen by "protection" processes which include heat and reactions with aldehydes, such as formaldehyde and glutaraldehyde or mixing with tannins or selection of plants with tannins (Leng, 1991). It is generally presumed that bypass protein is most beneficial to high yielding cows, however, in view of the positive results obtained in several studies in India on medium producing cows, the subject needs a rethinking on the part of ruminant nutritionists (Walli, 2005). Therefore, the present study was carried out with the aim to evaluate the effects of feeding concentrate mixture containing formaldehyde and heat treated protein meals on milk production in dairy cows in Nepalese context.

Materials and Methods

This experiment was conducted at National Cattle Research Program (NCRP), Rampur, Chitwan, Nepal for the period of 62 days after an acclimatization period of 7 days from December 2017 to February 2018. The chemical analysis and feed formulation were performed in the laboratory of Animal Nutrition Division, Khumaltar, Lalitpur, Nepal.

Cows and management

The selected cows were managed under the semi-intensive system. They were provided adlib amount of straw and green grass such as oat, signal and local grass once a day, natural grazing average 3 hrs/ day), watering and housing remained as routinely done by the farm. They were routinely dewormed against internal and external parasites and vaccinated against Tetanus, Foot and Mouth disease.

Chemical analysis and feed formulation

Compound feed and soybean cake were procured from Fine Feed Industry, Chitwan and Kisan Feed Industry, Patan industrial estate, Lalitpur, respectively and subjected for proximate and detergent analysis. Representative samples were analyzed for dry matter (DM), organic matter (OM), total ash (TA), crude protein (CP), ether extract (EE) and crude fiber (CF). Dry matter was determined by drying samples at temperature 105°C in a hot air oven for 12 hrs. Crude protein, ether extract was analyzed by using the Kjeldahl method and Soxhlet apparatus, respectively. Total ash was determined by ashing at a temperature 550°C in a muffle furnace for 16 hrs (AOAC, 1980). The crude fiber of the sample was determined using the Van Soest method (Goering and Van Soest, 1970).

Formaldehyde and heat treatment of soybean cake

Soybean cake was treated with 1-1.2 ml formalin (40%) per 100g CP as suggested by (Thomas and Burroughs, 1979). At first, one part of formalin was diluted in nine part of water. After that formalin diluted solution was sprayed over cake and mixed manually that after the cake was packed in a plastic bag for 7 days. Similarly, heat treatment of cake was done by using hot air oven for 2-4 hours at temperature 125-150°C.

Experimental diet

Three types of experimental diets were composed for experimental cows as presented in Table 1.

Table 1: Experimental diet of the cows

Treatment Group	Diet
1	Adlib roughages + 6 kg concentrate mixture + 3 hrs grazing
2	Adlib roughages + 6 kg concentrate mixture + 1.5 kg heat treated soybean cake + 3 hrs grazing
3	Adlib roughages + 6 kg concentrate mixture + 1.5 kg formalin treated soybean cake + 3 hrs grazing

Green grass (oat, signal and local grass)

Feeding regime

Half dose of concentrate mixture provided in the morning and a half dose in the evening before milking. After milking cows were allowed to graze for 3 hours in the NCRP premises. In the evening, after milking experimental cows were provided adlib amount of green grass and rice straw. In the daytime, cows were kept in the open yard and they had easy access to drinking water.

Observation and data recording

The experimental cows were strictly monitored for the entire experimentation period of 62 days after an adaptation period of 7 days. Total feed, concentrate mixture, straw intake and milk yield was recorded daily during the entire trial period.

Economic analysis

Economics of feeding under different treatments was calculated from the records of daily feed consumption and by considering the procurement cost of feeds and straw used for the feeding of experimental. Gross returns from the sale of milk from different groups were worked out considering average milk production per animal over 62 days' period and price of milk was taken selling price of milk in the local market to the consumers. Gross profit per cow, from different groups, was worked out taking into account, average feeding expenses and labor cost per animal and selling price of milk.

Experimental design

A total of 12 lactating Jersey dairy cows, apparently having similar reproductive and productive performances were selected. The cows were randomly grouped into 3 treatments groups; T1 (Control): 6 kg concentrate mixture, T2: 6 kg concentrate mixture plus 1.5 kg heat-treated soybean cake, and T3: 6 kg concentrate mixture plus 1.5 kg formalin treated soybean cake.

Data analysis

Data of feed, grass and straw intake and milk yield were analyzed for mean±SD, and P value by one way analysis of variance (ANOVA*)* by using computer statistical package SPSS version 16.

Results

Chemical composition of feedstuffs and feed intake

The chemical composition of feedstuffs used for preparing feed formulation is presented in Table 2 and average feed intake of experimental cows is presented in Table 3.

Table 2: Nutrient content of used feedstuffs

Feedstuffs	DM	OM	TA	CP	CF	NDF	ADF	ADL	Hemi cellulose	Cellulose
Concentrate mixture	84.4	91.97	8.03	14.76	8.71	NA	NA	NA	NA	NA
Heat treated soybean cake	97.3	89.49	10.51	27.08	10.21	NA	NA	NA	NA	NA
Formalin treated soybean cake	87.25	90.92	9.08	34.86	10.91	NA	NA	NA	NA	NA
Straw	85.42	88.14	11.86	4.93	16.96	72.69	51.91	12.76	20.78	39.15
Oat grass	28.27	86.39	13.61	11.76	NA	63.23	43.51	33.81	19.72	9.7
Signal grass	59.61	89.83	10.17	14.43	NA	71.61	45.19	13.36	26.42	31.83
Local grass	88.66	89.41	10.59	17.4	8.91	67.11	46.36	26.86	20.75	19.5

Table 3: Feed intake of experimental cows/day, kg (Mean±SD)

Treatment	Straw	Grass	Concentrate	DM intake / day, kg
1	2.86±0.80	11.47±3.80	5.5±0.50	10.32
2	2.92±0.84	11.65±3.63	7.49±0.92	13.06
3	3.39±0.75	11.81±3.71	6.74±0.43	12.1

Table 3 showed that straw and concentrate intake of experiment cows was highly significant (P<0.001) among diet groups whereas green grass intake of experimental was found to be non-significant (P>0.05). Highest straw intake was observed for T3 (3.39 kg) followed by T2 and T3 (2.92 and 2.86 kg, respectively). Green grass intake of experimental cows was almost similar (11 kg). Similarly, highest concentrate intake was noted in T2 (7.49 kg) followed by T3 and T1 (6.74 and 5.5 kg, respectively. Likewise, dry matter intake was higher in T2 (13.06 kg) followed by T3 (12.1 kg) and T1 (10.32 kg) which was also highly significant (P<0.001) among diet groups.

Milk production

Average milk production performance of experimental cows is given in Table 4.

Table 4: Milk production performance of experimental cows / day/liter

Treatment	Initial	Final	Milk increment
1	5.40±1.27	5.82±1.82	0.42
2	5.45±2.58	7.85±3.92	2.4
3	5.62±1.96	6.12±2.18	0.5

At the beginning of the experiment, milk production level of experimental cows was almost similar (5 L). By the end of research (in 62 days) milk production level of T2 increased significantly (P<0.001) and reached 7.85 L in comparison to other two groups (6.12 and 5.82 L, for T3 and T1, respectively. Figure 1 clearly showed that T2 was leading in milk production over other two groups from the beginning to the end of the experiment. The milk increment of T2 group was higher (2.4 L) from the base level than that of T2 and T1 (0.5 and 0.42 L, respectively). The experiment proved that heat treatment of soybean cake was found to be more effective than formalin treatment.

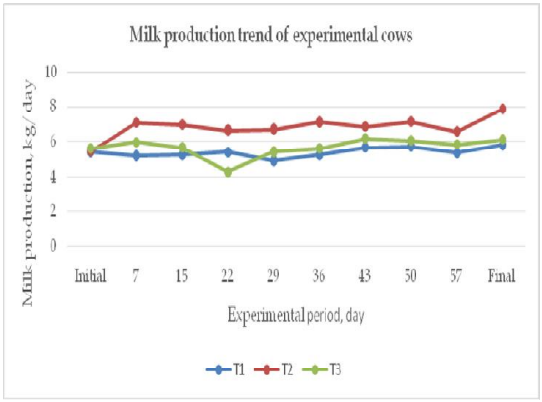

Figure 1: Milk production performance of experimental cows

Economic analysis

Cost benefit analysis of the experiment is presented in Table 5

Table 5: Cost benefit analysis

Parameter	Treatment group		
	T1	**T2**	**T3**
Total milk production/ animal, L	339.95	446.93	367.58
Milk cost, NRs	70	70	70
Income, NRs	23796.5	31285.1	25730.6
Feed cost, NRs	341 kg x 31.5 = 10741.5	372 kg x 31.5 = 11718	341 kg x 31.5 = 10741.5
Soybean cost, NRs	0	93 kg x 50 = 4650	93 kg x 50 = 4650
Straw cost, NRs	177.32 kg x 4 = 709.28	181.04 kg x 4 = 724.16	210.18 kg x 4=840.72
Labor cost, NRs	2040.83	2040.83	2040.83
Total cost, NRs	13490.78	19132.99	18273.05
Net income, NRs	10305.72	12152.11	7457.55

The total milk production per animal during 62 days of the experiment was 339.95 L, 446.93 L and 367.58 L for T1, T2 and T3, respectively. The milk selling rate of the local market was NRs 70/L. Income from the selling of milk was calculated based on the selling rate of the local market which accounted for NRs 23796.5, NRs 31285.1 and NRs 25730.6 for T1, T2 and T3, respectively. Feed, soybean cake and the straw cost was taken from the market whereas green grass cost was not accounted because of grazing and cultivated in the land of NCRP. One labor was hired for 12 lactating cows milking, feeding, grazing and others. Therefore, the cost of labor for one cow accounted for NRs 2040.83. The total cost of production was accumulated NRs 13490.78, NRs 19132.99 and NRs 18273.05 for T1, T2 and T3, respectively. Net income was calculated by deduction of the total cost from income of milk selling. The highest net income was noted in T2 (NRs 12152.11) followed by T1 (NRs 10305.72) and T3 (NRs 7457.55).

Discussion

This study was carried out to evaluate the effects of different methods of treated soybean cake feeding on milk production performance in lactating Jersey cows. The present study revealed that supplementation of heat-treated soybean cake in the diet significantly ($P<0.001$) increased the milk production (2.4 L) than that of formaldehyde treatment (0.5 L).

Voluntary intake of straw was found highly significant ($P<0.001$) in formaldehyde-treated soybean cake fed group (T3) (3.39 kg) than that of the heat-treated soybean cake fed group (T2) (2.92 kg). Similarly, heat treatment of soybean cake significantly ($P<0.001$) affect the concentrate mixture intake (7.49 kg for T2) than that of formaldehyde-treated cake group (T3) (6.74 kg). Green grass intake of all group was almost similar (11 kg). Due to the unavailability of the cows of early lactation, this experiment was conducted on cows which were an almost late period of lactation. Preston and Leng (1987) noted that response of supplementation of additional protein source can be seen in early lactation (up to 3 months) of lactation rather than mid and late lactation in high yielding cows. Bypass protein usually increases feed intake and as a consequence promotes milk production. The increase in milk production may be attributed to more availability of protein for digestion in the intestine, thereby increasing the supply of precursors of milk production (Mishra *et al*, 2006). Also, it was suggested that the improved milk production may be due to the supply of required amino acids and metabolisable energy to the host animal at a cellular level (Bugalia and Chaudhary, 2010). Faldet and Satter (1995) conducted an experiment on lactating cows during week 1 and 2 postpartum by feeding heat-treated soybean cake. In their experiment, they noted that feeding heat-treated soybeans supported more milk (4.5 L/d), 3.5% FCM (4.0 L/d), and milk protein (0.09 kg/d) than soybean meal or raw soybeans. Vahora *et al.* (2012) reported that feeding buffaloes under farm conditions with protein meal treated with heat led to a 15% increase in milk yield of 6% FCM compared with feeding untreated protein meals. Chandrasekharaiah *et al.* (2008) conducted an experiment on crossbred cows and found a significant increase in milk production in medium producing crossbred cows on the feeding of cottonseed extraction as a bypass protein. Yadav and Chaudhary (2004) also found an increase in milk and FCM yield in dairy cows fed with heat treated groundnut cake as a bypass protein. Likewise, Bugalia and Chaudhary (2010) reported that the average milk yield was significantly improved in lactating crossbred cows fed with heat treated sesame cake in place of untreated sesame cake in the concentrate mixture. Sampath *et al.* (1997) also found an increase in FCM in crossbred cows supplemented with heat treated groundnut cake. Throat *et al.* (2016) reported that supplementation of 1kg of heat treated rapeseed meal (bypass protein) replacing 2 kg of homemade concentrate mixture to crossbred cows yielding daily 20-21kg milk. Kunju *et al.* (1992) conducted an experiment on 25 lactating cows about 400 kg of body weight of 2nd and 3rd lactation which were distributed into 5 groups. The experimental cows were supplemented bypass feed at the level of 0, 1, 2, 3 and 4 kg for six weeks. The findings revealed that milk production response on the feeding of bypass protein was almost linear. The maximum response of bypass protein feed was observed in cows fed 3 kg bypass protein level. Garg *et al.* (2002) fed 250, 500 and 1000g bypass fat/protein to cows in 3 groups and recorded 0.4, 0.8 and 1.1kg, respectively, the average increase in milk yield under three groups as compared to base level milk yield at an initial stage of experimental feeding. The increase in milk yield was significantly ($P<0.05$) higher for the cows fed 500 and 1000g bypass supplement than other

treatment. The effect of feeding heat-treated soybean meal on milk production was studied by Atwal *et al.* (1995) and found that increase in milk production was 2.2 L in the cows fed the diet with 15% CP and 1.9 L in the cows fed the diet with 17% CP. They concluded that the milk production was significantly increased during week 7 to 16 of lactation for cows fed with heat-treated soybean meal diets. Such positive responses of higher milk yield due to feeding bypass protein to lactating cows were also reported by (Ramachandra and Sampath, 1995; Akbar *et al*., 1999; Chaturvedi and Walli, 2001; Garg *et al.,* 2003 and Garg *et al.,* 2005). Aasiwal *et al.* (2015) also conducted an experiment on 27 lactating Jersey cows in their different parity groups' viz. 1st - 3rd parity, 4th - 6th parity and above 7th parity at different stages of lactation i.e. early (1-3 months), mid (4-6 months) and late (7-9 months) in each parity groups lactating cows for 40 days. They noted that milk yield was increased in early lactating which was in the line of Sherasia *et al.* (2010) who observed significantly ($P<0.05$) higher milk yield from 9.85 L to 10.72 L/day when 1 kg of heat treated rapeseed meal was fed to crossbred cows. Shelke *et al.* (2012) also reported significantly ($P<0.01$) higher milk yield up to 19% in early lactating Murrah buffaloes fed with concentrate mixture of heat treated mustard and groundnut cakes.

Economic analysis of the experiment showed that supplementation of additional protein source is beneficial in late lactation in some extent (Table 5). The net income was observed higher in T2 (NRs 12152.11) followed by T1 and T3 (NRs 10305.72 and 7457.55, respectively). It might be due to the late lactation period of experimental cows. Moreover, the experiment also proved that heat treatment is more effective than formaldehyde treatment.

Conclusion

The findings of the study revealed that heat-treated soybean cake had more bypass ability than that of formaldehyde in improving milk production cows. Therefore, it is suggested that under those circumstances where cows' basal diet is mainly comprising from straw, stover and grasses which are poor in nutritive value then additional protein supplementation of high bypass value in early lactation period (up to 3 months) could be one of the option to increase milk production of high yielding cows rather than mid and late period of lactation.

Acknowledgement

Authors are thankful to Nepal Agricultural Research Council for providing the fund for this research work. Authors are also grateful to all scientific, technical staffs and finance staffs of National Cattle Research Program, Rampur, Chitwan and, Animal Nutrition Division, Khumaltar, Nepal.

References

Aasiwal DP, BS Meena, MS Mahesh, K Sharma and C Lalremuta (2015). Effect of feeding formaldehyde treated rapeseed and cottonseed cakes on milk yield and composition at various stages of lactation and parity in Jersey cows. *Journal of Animal Research* 5:15-20.

Akbar MA, K Kuldip, R Kumari and N Singh (1999). Effect of feeding bypass protein with and without biopromotors on milk production, and certain rumen and blood metabolites in lactating Murrah buffaloes. *The Indian Journal of Animal Sciences* 69:967-971.

AOAC (1995). Official methods of analysis 16th Ed. *Association of official analytical chemists*. Washington DC, USA.

APP (1995). Agriculture prospective plan of Nepal. Kathmundu, Nepal.

Atwal AS, S Mahadevan, MS Wolynetz and Y Yu (1995). Increased milk production of cows in early lactation fed chemically treated soybean meal. *Journal of dairy science* 78: 595-603.

Bugalia HL and JL Chaudhary (2010). Effect of feeding different levels of formaldehyde treated sesame cake on nutrients intake, milk production and economic returns in lactating crossbred cows. *Indian Journal of Animal Sciences* 80:152-155.

Chandrasekharaiah M, KT Sampath and US Praveen (2008). Effect of feeding bypass protein on milk production performance in crossbred cows. *Indian Journal of Animal Sciences* 78: 527-530.

Chaturvedi OH and TK Walli (2001). Effect of feeding graded levels of undegraded dietary protein on voluntary intake, milk production and economic return in early lactating crossbred cows. *Asian Australasian Journal of Animal Sciences* 14:1118-1124.

Faldet MA and LD Satter (1991). Feeding Heat-Treated Full Fat Soybeans to Cows in Early Lactation1. *Journal of Dairy Science* 74: 3047-3054.

Garg MR, PL Sherasia, BM Bhanderi, SK Gulati, TW Scott and PS George (2005). Economic

evaluation of feeding bypass protein feed on milch cows in Vadodara district of Gujarat. *Indian Journal of Dairy Science* 58: 420-425.

Garg MR, PL Sherasia, BM Bhanderi, SK Gulati and TW Scott (2002). Effect of feeding rumen protected nutrients on milk production in crossbred cows. *Indian Journal of Animal Nutrition* 19:191-198.

Garg MR, PL Sherasia, S Bhanderi, SK Gulati and TW Scott (2007). Milk production efficiency improvement in buffaloes through the use of slow ammonia release and protected protein supplement. *Italian Journal of Animal Science* 6:1043-1045.

Goering HK (1970). Forage fiber analysis Apparatus, reagents, procedures and some applications. *Agriculture Handbook* 379: 20.

Gulati SK, MR Garg and TW Scott (2005). Rumen protected protein and fat produced from oilseeds and/or meals by formaldehyde treatment; their role in ruminant production and product quality: a review. *Australian Journal of Experimental Agriculture* 45:1189-1203.

Kunju PJ, AK Mehta and MR Garg (1992). Feeding of bypass protein to cross bred cows in India on straw based ration. *Asian-Australasian Journal of Animal Sciences* 5:107-112.

Leng RA (1991). Application of biotechnology to nutrition of cows in developing countries. Food and Agriculture Organization (FAO) of the United Nations, Via delle Terme di Caracalla, 00 100 Rome, Italy. http://www.fao.org/DOCREP/004/T0423E/T0423E05.htm#ch5.1.2

Mishra BB, RK Swain, BK Sahu and DP Sawantaray (2006). Effect of bypass protein supplementation on nutrient utilization, milk production and its composition in crossbred cows on paddy straw based ration. *Animal Nutrition and Feed Technology* 6:123-133.

Preston TR and RA Leng (1987). Matching ruminant production systems with available resources in the tropics and sub-tropics. *Penambul Books.* Armidale, Australia. http://www.utafoundation.org/P&L/preston&leng.htm

Preston TR and RA Leng (1980). Utilization of tropical feeds by ruminants. In: Digestive physiology and metabolism in ruminants (Editors: Y. Ruchebush and P. Thivend) MTP Press, Lancaster. Pp. 621–640.

Ramachandra KS and KT Sampath (1995). Influence of two levels of rumen undegradable protein on milk production performance of lactating cows maintained on faddy straw based ration. *Indian Journal of Animal Nutrition* 12:1-6.

Sampath KT, CS Prasad, KS Ramachandra, K Sundareshan and AS Rao (1997). Effect of feeding of undegradable dietry protein on milk production of crossbred cows. *Indian Journal of Animal Sciences* 67:706-708.

Shelke SK, SS Thakur and SA Amrutkar (2012). Effect of feeding protected fat and proteins on milk production, composition and nutrient utilization in Murrah buffaloes (Bubalus bubalis). *Animal Feed Science and Technology* 171:98-107.

Sherasia PL, MR Garg and BM Bhanderi (2010). Study on the effect of incorporating rumen protected de-oiled rice bran on milk production in the ration of crossbred cows. *Indian Journal of Dairy Science* 63:205-208.

Thomas E, A Trenkle and W Burroughs (1979). Evaluation of protective agents applied to soybean meal and fed to I. Laboratory measurements. *Journal of Animal Science* 49: 1337-45.

Throat SK, RS Gupta, S Shankhpal and S Parnerkar (2016). Effect of Supplementing Formaldehyde Treated Rape Seed Meal on Milk Production, Gross Milk Composition, Digestibility of Nutrients and Feed Conversion Efficiency in High Producing Crossbred Cows. *Livestock Research International* 4:68-74.

Vahora SG, KB Kore and S Parnerkar (2012). Feeding of formaldehyde-treated protein meals to lactating buffaloes; effect on milk yield and composition. *Livestock Research for Rural Developmen*t 24:2012.

Walli TK (2005). Bypass protein technology and the impact of feeding bypass protein to dairy cows in tropics: A review. *The Indian Journal of Animal Sciences* 75:135-142

Yadav CM and JL Chaudhary (2004). Effect of feeding protected protein on nutrient utilization, milk yield and milk composition of lactating crossbred cows. *Indian Journal of Dairy Science* 57:394-399.