International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; 9(12): 259-263
www.biochemjournal.com
Received: 15-09-2025
Accepted: 18-10-2025

Parimal D Patel
Animal Nutritionist, Panchamrut Dairy, Gujarat, India

Prakash M Joshi
Animal Nutritionist, Dudhsagar Dairy, Gujarat, India

Ravindra B Khant
Veterinary Officer, Panchamrut Dairy, Gujarat, India

Corresponding Author:
Parimal D Patel
Animal Nutritionist, Panchamrut Dairy, Gujarat, India

Effect of feeding bypass fat on productive performance of Surti buffaloes

Parimal D Patel, Prakash M Joshi and Ravindra B Khant

DOI: https://www.doi.org/10.33545/26174693.2025.v9.i12d.6482

Abstract
An experiment was conducted to evaluate the effect of feeding bypass fat on dry matter and nutrient intake, milk production, milk composition, efficiency of feed conversion, economics of milk production of Surti buffaloes. Fourteen advanced pregnant Surti buffaloes were selected based on their records of daily milk yield and milk fat percent. The buffaloes were divided into two groups: Control (T_1) and Treatment group (T_2) with seven animals in each group. The buffaloes in control group were fed with green fodder, dry fodder and concentrate mixture as per ICAR requirements, while animals of treatment group received the same ration but were supplemented with bypass fat @ 130 g/d prepartum for one month and 30 g/kg milk yield for three months postpartum. The average daily DM, DCP and TDN intake (kg/day) during the prepartum phase were non-significant while during postpartum phase DM and TDN intake were significantly ($p<0.05$) increased in the bypass fat supplemented group but DCP intake was similar in both group. The average daily whole milk yield (kg/head/day), fat percent and total solid% were significantly ($p<0.05$) increase in bypass fat group however, SNF% was lower in bypass fat supplemented group but calcium% and phosphorus% were statistically non-significant. The average daily yield (kg/head) of fat, total solid, 6% FCM, SCM and ECM were significantly ($p<0.05$) higher in bypass fat supplemented group while SNF yield was non-significant. The feed conversion efficiency of DMI (kg intake/kg milk) to whole milk and DMI, DCPI and TDNI (kg intake/kg 6% FCM) to 6% FCM were higher ($p<0.05$) in bypass fat feeding group as compared to control group while DCPI and TDNI (kg intake/kg milk) to whole milk were numerically higher in bypass fat group. The average daily returns per buffalo ₹ 64.83 was higher ($p<0.05$) in bypass fat supplemented group as compared to control group.

Keywords: Bypass fat, Surti buffaloes, milk yield, milk composition, feed efficiency, economics

Introduction

Livestock is an integral part of Indian agricultural economy and has plays a versatile role through providing livelihood support to the rural population. Agricultural by products and low quality crop residues are the major animal feedstuffs in developing countries like India, which have inherent lower nutritive value and digestibility (Gulab, 2016) [9]. In high producing buffaloes, during early lactation stage energy demand is markedly high, but nutrient supply does not parallel with demand due to limited dry matter intake which resultant decreased production potential in terms of the milk production (Goff and Horst, 1997; Sirohi *et al.*, 2010) [8, 30]. Owing to this, dairy animals are enforced to draw up body reserves to full fill energy needs, and this state is known as "negative energy balance" (Rohila *et al.*, 2019a) [23]. Due to enormous use of cereals for human and mono-gastric animals, to cope up it the alternate source of energy in the form of fat in dairy ration has been reported by researchers (Saijpaul *et al.*, 2010; Rohila *et al.*, 2019a) [25, 23]. Fat supplementation beyond 3% might interfere with the digestibility of dry matter and fiber in the dairy animal ration (NRC, 2001) [15]. To alleviate this issue, best alternate way is the most energy dense nutrient called "bypass fat". It is the nutrient, which is inert in the rumen and gets absorbed directly in the lower gastro intestinal tract particular to abomasum (Katiyar *et al.*, 2019) [11]. In high producing animals, bypass fat reduces the state of negative energy balance. Moreover, it also helps to lower down the adverse impacts of fat on feed intake, fiber digestibility and magnesium and calcium absorption (Gajera *et al.*, 2013) [7]. Bypass fat inclusion in ration, not only increased milk yield, but also the milk fat composition specially the unsaturated fatty acid content in buffaloes and resultant increased economic return to dairy farmers (Parnerkar *et al.*, 2010) [16]. Bypass technology for fat has more significance in the high yielding dairy animals; Oil seeds, casein-formaldehyde protected fat, crystalline fat, fatty acyl amide's hydrogenated tallow or triglycerides and calcium salts of long chain fatty acids (LCFA-Ca) are the most commonly utilized form of bypass fats sources. Earlier, ruminal inert fat was only be stated as a source of considerable amount of extra energy, during the transition phase of dairy animals to betterment of reproductive and productive performance but the actual mechanism was unknown. Therefore, the present study was planned to evaluate the effect of feeding bypass fat on productive performance of Surti buffaloes.

Materials and Methods

The present experiment was conducted at Reproductive Biology Research Unit, College of Veterinary Science and Animal Husbandry, Anand Agricultural University, Anand, Gujarat during the year 2019. Fourteen surti buffaloes were used to evaluate the effect of feeding bypass fat starting from 15-30 days before parturition up to the 90 days of lactation period on productive and reproductive performance of buffaloes. Fourteen pregnant buffaloes (2nd, 3rd and 4th lactation) were selected based on stage of pregnancy, daily milk yield and milk fat%. The selected buffaloes were on an average at last trimester of pregnancy, reached at 30 days to arrival of parturition and having 4.00-5.00 kg and 5.00-6.00%, the average daily milk production and milk fat content, respectively in previous lactation. The buffaloes were fed with green fodder, dry fodder and concentrate mixture as per ICAR (2013) [10] feeding standard supplied in both control (T_1) group and treatment (T_2) group. The buffaloes in T_2 group were fed additional supplement of bypass fat with the concentrate @ 130 g/d prepartum for one month and 30 g/kg milk yield for three months postpartum. Composite samples of green fodder, dry fodder, concentrate mixture and bypass fat were collected. Green samples were dried in oven at 100 ± 5 °C for 24 h and ground to pass through 2 mm sieve. Ground samples of fodder, concentrates mixture and bypass fat were kept in airtight bags until chemical analysis. The amount of DM and TDN available to buffaloes were calculated from the records of intake of feeds and fodder, using digestibility coefficients/nutritive values given by Sen *et al.* (1978) [26], Ranjhan, (1991) [20] and Anonymous, (2005) [1]. The samples of feeds and fodder were analyzed for proximate constituents by the methods of AOAC (2005) [2]. The milk samples were collected at biweekly intervals from individual animals during both times of milking. After mixing of both samples of milk, representative sample (100-150 ml) of each buffalo was taken by means of a dipper and transferred to a sample bottle with rounded corners (to avoid lodging of the milk solids) up to 3/4th level, and then the bottle was corked tightly. The sample bottles were labelled and dispatched to laboratory on same day for further analysis of milk components i.e. fat, total solids, SNF and protein contents as per BIS (1981). The data were analyzed following completely randomized design (CRD) and the level of significance was decided using method of Snedecor and Cochran (1994) [31].

Results and Discussion

The average daily DMI (kg/head) in control (T_1) and Treatment (T_2) group was 9.66 ± 0.11 and 9.86 ± 0.10, respectively. The result has shown that there was no significant difference between Control and Treatment group. Likewise, the interaction effect of treatment and period and period effect was also statistically non-significant. The postpartum daily DMI in T_1 and T_2 was 12.33 ± 0.14 and 12.73 ± 0.15 kg/day, respectively. The postpartum DMI was significantly ($p<0.05$) increase due to supplementation of bypass fat in diet of surti buffaloes. The period effect was also significant but the interaction effect of treatment and period was non-significant.

The average daily TDNI (kg/head) during prepartum phase was 4.36 ± 0.17 and 4.67 ± 0.15 in T_1 and T_2 groups, respectively. The prepartum TDNI was statistically non-significant but numerically higher in bypass fat supplemented group as compared to control group. The interaction effect between treatment and period and period effect was also statistically non-significant.

The average daily TDNI (kg/head) during the postpartum phase was 6.71 ± 0.17 and 7.29 ± 0.14 in T_1 and T_2 groups, respectively. The postpartum TDNI was significantly ($p<0.05$) higher in Bypass fat fed group as compared to control group. The Period effect was also statistically significant but interactive effect of treatment and period was non-significant. Ramteke *et al.* (2014a) [19] recorded the TDNI (6.89 vs. 7.17 kg/day) was higher ($p<0.05$) in buffaloes supplemented with bypass fat @ 100 g/d for 30 days prepartum and 15g/kg milk yield per day for 120 days postpartum. Mane *et al.* (2016) [13] reported that the TDNI (7.11, 7.86, 7.93 and 8.32 kg/day) was greater ($p<0.05$) in crossbred cows supplemented with protected protein, bypass fat (99%) @ 10 g per liter milk production and combination of protected protein and bypass fat.

The milk fat percent of experimental buffaloes was 6.38 ± 0.16 and 7.57 ± 0.07 in control and treatment group, respectively. Result shown that the fat percent was found to be significantly ($P<0.0.5$) higher in bypass fat fed group due to supplementary availability of fatty acids for absorption in intestine due to protection of fat and these fatty acids are directly assimilated in milk fat after absorption from intestine, leading to increase in milk fat (Ramteke *et al.*, 2014a) [19]. The findings of the present study are in agreement with Barley and Baghel (2009) [3]. They recorded the milk fat percentage (5.74 vs 6.42%) was significantly ($p<0.05$) higher in the bypass fat (100 gm once in a day/animal) supplemented Murrah buffaloes. Parnerkar *et al.* (2010) [16] observed that the average daily milk fat was significantly ($p<0.05$) higher in buffaloes fed with 20g bypass fat/kg milk yield.

The solid not fat percent was 11.60 ± 0.15 and 10.52 ± 0.06 in T_1 and T_2 group, respectively. The value for SNF percentage was significantly ($p<0.05$) lower in bypass fat supplemented group as compared to control group. The results of the present study are in agreement with Desai, (2012) [5]. He observed that the SNF percent (9.22 vs 8.44% in Panchmahal district and 9.28 vs 8.91% in Vadodara district) was significantly ($p<0.05$) lower in buffaloes supplemented with bypass fat @ 15g/kg milk yield. Prajapati and Patel, (2019) [17] reported that the SNF percent (11.32 vs 10.68%) was significantly ($p<0.05$) lower in buffaloes supplemented with bypass fat at 20 g/d/kg of milk yield for 90 days. Contrary to our results Shelke and Thakur, (2010) [10] observed that the solids-not fat percent was non-significant in Murrah buffaloes supplemented with Ca salts of soyabean oil fatty acids. Sirohi *et al.* (2010) [30] observed

SNF percent was not affected in crossbred cows supplemented with 300g/day bypass fat.

The total solid percent was 17.98 ± 0.03 and 18.09 ± 0.04 in control and treatment group, respectively. The total solid percent was significantly ($p<0.05$) higher in bypass fat fed group as compared to control group. Safimahmad and Parnerker (2013) [24] observed that the total solid percent (16.81 vs 17.67%) was higher ($P<0.01$) in Mehsani buffaloes supplemented with bypass fat. Katiyar *et al.* (2019) [11] observed that the total solid percent was increase in Murrah buffaloes supplemented with 15 g bypass fat (Ca salt of long-chain fatty acids) per kg milk yield. Contrary to our results, Shelke and Thakur (2010) [10] recorded that the total solids percent was non-significant in Murrah buffaloes fed with bypass fat. Desai *et al.* (2017) [6] observed that the total solid percent was not affected by supplementation of bypass fat in Mehsani buffaloes.

The protein percent was 3.74 ± 0.07 and 3.69 ± 0.03 in control (T_1) and treatment (T_2) group, respectively. Result shown that the protein content of milk was statistically similar. This is corroborate by the findings of Shelke and Thakur (2010) [10]. They reported that the milk protein was not influenced by supplementation of 4% Ca salts of soyabean oil fatty acids in Murrah buffaloes. Shelke *et al.* (2012) [29] recorded that the protein percent (3.76 vs 3.79%) was statistically similar in Murrah buffaloes fed with 2.5% bypass fat and formaldehyde treated mustard or groundnut cakes. Rohila *et al.* (2016) [23] observed that the milk protein content (4.34, 4.32 and 4.35%) was non-significant in Murrah buffaloes supplemented with bypass fat @ 0, 100 and 150g/day/animal. Katiyar *et al.* (2019) [11] recorded that the milk protein percent was significantly higher in Murrah buffaloes fed 15 g bypass fat (Ca salt of long-chain fatty acids) per kg milk yield.

The average daily fat yield (kg/head) was 0.45 ± 0.02 and 0.60 ± 0.02 in T_1 and T_2, respectively. The average daily fat yield was significantly ($p<0.05$) increase in bypass fat supplemented group as compared to control group. The effect of periods on fat yield was significantly improved. The findings of the present study are in agreement with Parnerkar *et al.* (2010) [16]. They reported that the fat yield (kg/day/animal) was significantly increased due to bypass fat supplementation. Kumari *et al.* (2018) [12] reported that the milk fat yield was significantly increased due to supplementation of bypass fat @ 10g and 15g/kg milk yield.

The average daily TS yield was 1.27 ± 0.04 and 1.44 ± 0.04 in control and treatment group, respectively. The total solid yield was significantly ($p<0.05$) increase in treatment group as compared to control group. The average daily SNF yield was 0.82 ± 0.02 and 0.84 ± 0.03 in T_1 and T_2 group, respectively. The SNF yield was numerically higher in bypass fat supplemented group but statistically non-significant. Similar results was reported by Desai, (2012) [5] the SNF yield (0.55 vs 0.58 kg/day in Panchmahal district and 0.60 vs 0.61 kg/day in Vadodara district) was significantly higher in buffaloes supplemented with bypass fat @ 15 g/d/kg milk yield.

The average daily 6% FCM (kg/day) was 7.39 ± 0.35 and 9.37 ± 0.27 in control and treatment group, respectively. The 6% FCM yield was significantly ($p<0.05$) increase by 26.79% in T_2 group. The period effect was also statistically significant. The findings of the present study are in agreement with Shelke and Thakur (2010) [10]. They observed 13.40% increased 6% FCM yield in lactating Murrah buffaloes supplemented with 4% Ca salts of soyabean oil fatty acids. Prajapati and Patel (2019) [17] reported that the 6% FCM yield was significantly ($p<0.05$) increased in buffaloes supplemented with bypass fat @ 20 g/d/kg of milk yield for 90 days. Katiyar *et al.* (2019) [11] recorded the FCM yield was increased by 14.5% in Murrah buffaloes fed with 15 g bypass fat (Ca salt of long chain fatty acids) per kg milk yield.

The average daily SCM yield was 10.41 ± 0.39 and 12.29 ± 0.36 in control and treatment group, respectively. The SCM yield was significantly ($p<0.05$) higher by 18.06% in T_2 group. Prajapati and Patel (2019) [17] reported that the SCM yield (6.23 kg/day in T_1 and 7.83 kg/day in T_2) was significantly higher by 25.68% in buffaloes supplemented with bypass fat @ 20 g/d/kg of milk yield for 90 days. In present study, average daily ECM yield was 9.96 ± 0.48 and 12.35 ± 0.36 in control and treatment group, respectively. The ECM yield was significantly ($p<0.05$) higher by 24% in T_2 group. Prajapati and Patel (2019) [17] recorded that the ECM yield (5.99 vs 7.78 kg/day) was significantly higher by 29.88% in buffaloes supplemented with bypass fat @ 20 g/d/kg of milk yield for 90 days.

The DM kg/kg 6% FCM was 1.71 ± 0.06 kg in control group and 1.38 ± 0.03 kg in bypass fat supplemental group. It was found that dry matter required for production of 1 kg 6% FCM was significantly ($P<0.0.5$) lower in treatment group as compared to control which implies that bypass fat supplement has increased feed conversion efficiency. The effect of periods was also significant but the interaction effect between period and treatment was non-significant. Raval *et al.* (2017) [21] recorded that the DMI kg/FCM yield (2.62, 1.93 and 2.14 kg/FCM yield) was significantly ($p<0.05$) lower in surti buffaloes fed with bypass fat (@ 0, 100 and 200 g/d). Prajapati, (2018) [18] reported that the DMI kg/6% FCM (2.46 vs 1.85 kg/kg 6% FCM) was significantly lower in buffaloes fed with bypass fat (@ 0 and 20 g/d/kg of milk yield). Kumari *et al.* (2018) [12] reported that the DMI kg/kg FCM (1.29, 1.18 and 1.18 kg/kg FCM) was non-significant in crossbred cows fed with bypass fat (@ 0, 10 and 15g/kg milk yield).

The DCP g/kg 6% FCM was 114.93 ± 2.83 g in control group and 95.43 ± 1.19 g in bypass fat supplemental treatment group. It was found that DCP required for production of 1 kg 6% FCM was significantly ($p<0.05$) decrease in treatment group which implies that bypass fat supplement has increased feed conversion efficiency. Similar results were also observed by Sirohi *et al.* (2010) [30]. They reported the DCPI kg/kg FCM was lower ($p<0.05$) in cows supplemented with 300 g of bypass fat than the unsupplemented group. Desai, (2012) [5] observed that the CPI g/kg FCM (199.69 vs 173.61 g/kg FCM in Panchmahal district and 194.56 vs 166.63 g/kg FCM in Vadodara district) was significantly lower in buffaloes fed with bypass fat (@ 0 and 15g/kg of milk yield).

The daily cost of feeding (₹/head) during prepartum phase was 58.99 ± 1.92 and 76.01 ± 1.61 in T_1 and T_2 group, respectively. Which was significantly ($p<0.05$) higher in bypass fat supplemented group as compared to control group. However, the effect of periods and interaction effect of period and treatment was found to be non-significant. The daily cost of feeding (₹/head) during postpartum phase was 103.56 ± 2.38 and 135.27 ± 3.18 in T_1 and T_2 group, respectively. Which was significantly ($p<0.05$) higher in bypass fat supplemented group as compared to control group. The effect of periods was also significant but interaction of period and treatment effect was non-significant. Similar results were also reported by Shelke and Thakur, (2011) [28]. The cost of feeding of lactating buffaloes was higher in bypass fat and protein supplemented group (₹ 210.01) as compared to control group (₹ 177.50). Prajapati and Patel (2019) [17] reported that the daily feed cost of buffaloes in T_1 (control) and T_2 (bypass fat fed group) were 92.98 ± 0.64 and 101.66 ± 0.45, respectively which was statistically (p<0.05) higher in T_2 (bypass fat fed group).

The milk calcium and phosphorus percent of experimental buffaloes was 0.18 ± 0.00 and 0.19 ± .00; 0.12 ± 0.00 and 0.12 ± 0.00 in control and treatment group, respectively. Results shown that the milk calcium percent was numerically higher in bypass fat supplemented group but it was non-significant. Likewise, interaction effect between treatment and period was also non-significant, only period effect was significant for milk calcium percent. The milk phosphorus percent was similar in both the group. However, the period effect and interaction between treatment and period effects were significant for milk phosphorus. Similar results were also reported by Prajapati and Patel, (2019) [17]. They observed no significant changes in milk calcium (0.16 vs 0.17%) and phosphorus percent (0.08 vs 0.09%) in bypass fat supplemented buffaloes.

Average daily income from individual buffaloes and total income from entire trial period of 90 days by sale of milk receipt was calculated on basis of price offered by co-operative dairy (₹/kg fat). Average daily income of individual buffaloes was ₹ 293.63 ± 16.14 for control group and ₹ 390.17 ± 11.29 in treatment group, which was significantly (p<0.05) higher in bypass fat fed group as compared to control group. Likewise, the effect of biweekly periods was also significant. The results of the present study are in agreement with Desai, (2012) [5] observed that the realizable receipt from sale of milk (182.17 ± 2.99 vs 213.17 ± 2.56 (₹/head) in Panchmahal district and 195.68 ± 6.23 vs 219.21 ± 3.42 (₹/head) in Vadodara district) was higher in bypass fat supplemented buffaloes. Safimahmad and Parnerker, (2013) [24] reported that the combination of bypass fat and protein followed bypass protein alone supplemented group had greater (P<0.01) realizable receipt from sale of Mehsani buffaloes milk (₹/head) over control group. Mobeen *et al.* (2019) [14] recorded that the milk sale values (₹/day) was significantly higher in lactating cows and buffaloes.

The return over feed cost (₹/head/day) was 190.07 ± 13.93 and 254.90 ± 8.43 in T_1 and T_2 group respectively. The ROFC was significantly (p<0.05) higher in bypass fat supplemented group as compared to control group. Likewise, the effect of biweekly periods was also significant but the interaction effect of period and treatment was non-significant. Mobeen *et al.* (2019) [14] reported 31.40% more profit in bypass fat fed group than control group. Prajapati and Patel (2019) [17] reported that the average daily profit increased per buffalo was ₹ 56.56 due to feeding of bypass fat.

References

1. Anonymous. Research highlights of Animal Nutrition Research Station (July 1973-April 2004). Anand: Anand Agricultural University; 2005.
2. AOAC. Official methods of analysis. 18th ed. Washington DC: Association of Official Analytical Chemists; 2005.
3. Barley GG, Baghel RPS. Effect of bypass fat supplementation on milk yield, fat content and serum triglyceride levels of Murrah buffaloes. Buffalo Bull. 2009;28(4):173-175.
4. BIS. Handbook of food analysis (XI), dairy products. New Delhi: Bureau of Indian Standards; 1981. p. 15-182.
5. Desai VR. Effect of feeding bypass fat on milk production from buffaloes of tribal areas in Panchmahal and Vadodara districts. MVSc thesis. Anand: Anand Agricultural University; 2012.
6. Desai VR, Padheriya YD, Rabari PD, Waghela CR, Parnerkar S. Effect of feeding bypass fat on milk composition of buffaloes from tribal areas in Panchmahal and Vadodara. Indian Vet J. 2017;94(1):41-43.
7. Gajera AP, Dutta KS, Parsana DK, Savsani HH, Odedra MD, Gajbhiye PU, *et al.* Effect of bypass lysine, methionine and fat on growth and nutritional efficiency in growing Jaffrabadi heifers. Vet World. 2013;6:766-769.
8. Goff JP, Horst RL. Effects of potassium or sodium addition to prepartum rations on milk fever. J Dairy Sci. 1997;80:176-186.
9. Gulab NS. Effect of supplementation of bypass protein with or without bypass fat on lactation performance of crossbred cows. PhD thesis. Nagpur: Maharashtra Animal and Fishery Sciences University; 2016.
10. ICAR. Nutrient requirements of cattle and buffalo. New Delhi: Indian Council of Agricultural Research; 2013.
11. Katiyar GS, Mudgal V, Sharma RK, Bharadwaj A, Phulia SK, Jerome A, *et al.* Effect of rumen-protected nutrients on feed intake, body weights, milk yield and composition in Murrah buffaloes during early lactation. Trop Anim Health Prod. 2019;51(8):2297-2304.
12. Kumari S, Kumar D, Mandal SK, Sahu R. Effect of feeding bypass fat on milk yield, composition, efficiency of nutrients and economics in crossbred cow. Int J Curr Microbiol Appl Sci. 2018;7:3095-3102.
13. Mane SH, Kankhare DH, Wakale MB. Effect of feeding protected protein and fat on milk yield, composition and fatty acid profile of crossbred cow. Int Res J Multidiscip Stud. 2016;2(7).
14. Mobeen A, Riaz M, Raza SH, Sharif M, Yaqoob MU. Effect of bypass fat supplementation on milk yield in lactating cows and buffaloes. Pak J Agric Sci. 2019;56(3):743-746.
15. NRC. Nutrient requirements of dairy cattle. 7th ed. Washington DC: National Academy Press; 2001.
16. Parnerkar S, Kumar D, Shankhpal SS, Thube H. Effect of feeding bypass fat to lactating buffaloes during early lactation. Proc VII Biennial Animal Nutrition Association Conference; 2010 Dec 17-19; Bhubaneswar, India. p.126-131.
17. Prajapati DC, Patel DC. Effects of feeding bypass fat on milk yield and cost of milk production in buffaloes in Dahod district. Int J Agric Sci. 2019;11(6):8027-8029.
18. Prajapati DC. Effect of feeding bypass fat on productive and reproductive performance of dairy animals in Dahod district. MVSc thesis. Anand: Anand Agricultural University; 2018.
19. Ramteke PV, Patel DC, Parnerkar S, Shankhpal SS, Patel GR, Katole SB, *et al.* Effect of feeding bypass fat prepartum and during early lactation on productive

performance in buffaloes. Int J Livest Res. 2014;2:63-67.
20. Ranjhan SK. Chemical composition of Indian feeds and feeding of farm animals. New Delhi: ICAR; 1991.
21. Raval AJ, Sorathiya L, Kharadi VB, Patel MD, Tyagi KK, Patel VR, *et al.* Effect of calcium salt of palm fatty acid supplementation on production performance and blood metabolites in Surti buffaloes. Indian J Anim Sci. 2017;87(9):1124-1129.
22. Rohila H, Chhikara SK, Sihag S, Dhiman D, Kumar R, Kumar R, *et al.* Effect of bypass fat supplementation on milk yield and composition in Murrah buffaloes. Haryana Vet. 2016;55(2):192-194.
23. Rohila H, Shroha A, Kumar R. Effect of rumen-protected fat supplementation on nutrient utilization and body condition in dairy animals: a review. J Entomol Zool Stud. 2019;7(1):1439-1442.
24. Safimahmad V, Parnerkar S. Effect of feeding bypass nutrients on milk production and composition in buffaloes. Indian J Anim Nutr. 2013;30(1):67-71.
25. Saijpaul S, Naik PK, Neelam R. Effects of rumen protected fat on *in vitro* dry matter degradability of dairy rations. Indian J Anim Sci. 2010;80:993-997.
26. Sen KC, Ray SN, Ranjhan SK. Nutritive value of Indian feeds and feeding of farm animals. Bulletin No.25. New Delhi: ICAR; 1978.
27. Shelke SK, Thakur SS. Effect of supplementing bypass fat on milk yield and nutrient utilization in Murrah buffaloes. Indian J Anim Sci. 2010;80:354-357.
28. Shelke SK, Thakur SS. Economics of feeding rumen protected fat and protein to lactating Murrah buffaloes. Indian J Anim Nutr. 2011;28(3):278-282.
29. Shelke SK, Thakur SS, Amrutkar SA. Effect of feeding protected fat and proteins on milk production, composition and nutrient utilization in Murrah buffaloes. Anim Feed Sci Technol. 2012;171:98-107.
30. Sirohi SK, Walli TK, Mohanta RK. Supplementation effect of bypass fat on production performance of lactating crossbred cows. Indian J Anim Sci. 2010;80:733-736.
31. Snedecor GW, Cochran WG. Statistical methods. 8th ed. Ames, Iowa: Iowa State University Press; 1994.