The Pharma Innovation Journal 2022; SP-11(3): 1332-1336

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(3): 1332-1336

www.thepharmajournal.com
Received: 14-01-2022
Accepted: 15-02-2022

Ramesh Kumar Mishra
Scientist, JNKVV, KVK, Katni, Jabalpur, Madhya Pradesh, India

RPS Baghel
Retd. Dean Faculty, NDVSU, Jabalpur, India

Pawan Sirothiya
Associate Professor and HOD, NRM, MGCGV, Satna, Madhya Pradesh, India

AK Tomar
Senior Scientist and Head, KVK, Katni, Jabalpur, India

Rahul Sharma
Assistant Professor, Department of Animal Nutrition, NDVSU, Jabalpur, India

Corresponding Author
Ramesh Kumar Mishra
Scientist, JNKVV, KVK, Katni, Jabalpur, Madhya Pradesh, India

Effect of balance diet containing bypass fat on performance of lactating buffaloes

Ramesh Kumar Mishra, RPS Baghel, Pawan Sirothiya, AK Tomar and Rahul Sharma

Abstract
Buffalo provide milk with high fat poor quality roughage limits the efficiency of nutrient utilization. Therefore a study was plan to see the effect of bypass fat on performance of lactating buffaloes. The 12 healthy Murrha buffalos of 3rd lactation were selected on the basis of body weight, milk yield and milk fat from the dairies around the Krishi Vigyan Kendra Katni (M.P.) and they were randomly divided into two groups of 6 buffaloes in each group. All animals were dewormed before start of experiment. They were assigned two dietary treatments. In farmer practice group (T1) buffaloes were fed with wheat straw 6.5 Kg + 12 Kg green berseem +1.5 Kg concentrate+ concentrate approximately half of the milk yield and Salt approximately 40g per buffalo per day. In treatment group (T2) feeding of roughage to the buffaloes were similar as T1 and balanced concentrate mixture were fed as per nutrient requirement. The isocaloric replacement of maize was done by adding bypass fat @4% in concentrate mixture.
The result data revealed that buffaloes of control (FP) group show greator loss of body weight during the experiment period. Whereas, buffaloes fed on treatment (BF) diet lost less body weight along with good production. The milk production in treatment group was recorded as 8.95 liter per day which was significantly higher (P<0.01) than control group of buffaloes in which average 8.21 liters production was recorded. Chemical composition of milk showed higher change for all constituents in treatment group but differences were non-significant among both the group except milk fat and TS per cent which were significantly (P<0.01) higher in treatment (7.07 & 16.40%) than in control (6.78 & 16.26%). The significant (P<0.05) difference in the concentration of serum Ca between two groups of buffaloes were recorded due to treatment effect. The significant effect was also observed in concentration of serum P in buffaloes of bypass fat group. Overall result clearly indicated that supplementation of bypass nutrient and balance diet was helpful in maintaining the good health as well as production performance in lactating buffaloes.

Keywords: Bypass fat, buffalo, performance, milk

Introduction
Improving productivity in a huge population of low-producing animals is one of the major challenges. Since the forage part of the ration consist of fibrous straws and crop residues, which are very poor sources of energy and almost devoid of minerals. For the concentrate part, the animals have to rely mostly on agro-industrial by products. Buffalo provides milk with high fat per cent but poor quality roughage limits the efficiency of nutrient utilization by buffaloes hence it is a constraint to the development of the industry. Therefore, It is necessary to strategically supplement these deficient nutrients in the animal ration for optimum reproduction and production of animals.
Feeding of protected nutrients is particularly important during early lactation help to achieve higher peak milk yield, minimize energy deficiency and increase economic benefits. It was noticed by previous workers that supplementation of bypass fat @ 1.4 to 2.5% of dry matter intake results significant increase in milk yield, some milk constituent (Sirohi *et al.*, 2010; Shelke and Thakur, 2011; Garg *et al.*, 2012; Sirohi *et al.*, 2012; Ramteke *et al.*, 2014) [27, 22-24, 7-8, 26, 18] and physiological response (Moty *et al.*, 2012) [15] in lactating cows and buffaloes without any advers effect on dry matter intake (Shelke *et al.* 2012) [25] of the animals. Improvement in body weight gain or reduction in body weight loss (Vahora *et al.*, 2013) [31] during lactation period was also reported by earlier researcher. The increased energy supply to the animals in negative energy balance responsible for increased milk yield and availability of low density serum triglyceride in plasma led to increased fat content (Barley and Baghel, 2009) [2].

Supplementation of bypass fat at 2.5% of DMI has observed reduced the time required for involution of uterus and commencement of cyclicity (Tyagi *et al.*, 2010) [30]. The receipt for sale of milk was significantly improved in bypass fat supplemented buffaloes compared to control (Vahora *et al*., 2013) [31].

Material and Methods

Material used in the research and various methodologies applied for the completion of research work has been described in detail in this part. The 12 healthy Murrha buffalos of 3rd lactation were selected on the basis of body weight, milk yield and milk fat from the dairies around the Krishi vigyan Kendra Katni (M.P.) and they were randomly divided into two groups of 6 buffaloes in each group. All animals were dewormed before start of experiment. They were assigned two dietary treatments, considering their body weight and milk yield. Feeding was made in the morning and evening before milking. The experiment was conducted for the period of four months.

Treatment Groups

Group: I (Control/T1)

The routine farmer's practiced was considered as control. The diet of this group consisted of wheat straw 6.5 Kg + 12 Kg green berseem + 1.5 Kg concentrate+ concentrate approximately half of the milk yield but farmers were neither fallowing feeding standard nor balancing diet of animal as per feeding standard. They do not change quantity of concentrate as the yield of animal change. They were not providing mineral mixture to the animals in this group and common salt approximately @ 40 g / animal / day was given through drinking water.

Group: II (Treatment/Bypass fat (BF)/T2)

The feeding of roughage to the animals in this group were similar as T1 and balanced concentrate mixture containing approx 20% CP and 75% TDN were formulated to fed as per nutrient requirement (Kearl, 1982) [11] feeding standard. The isocaloric replacement of conventional energy source which was maize was done by adding bypass fat @4% in concentrate mixture.

Sample collection

The representative samples of feed and fodder were also collected for the chemical analysis. Before start and at the end of experiment blood samples were collected aseptically from jugular vein of each buffaloes in the morning before feeding and watering. The 5 ml blood was collected in the heparinized vaccutainer for hemoglobin (Hb) and blood glucose estimation. 10 ml blood was collected in clean glass test tube without anticoagulant for serum for analysis of protein, calcium (Ca) and phosphorus (P).

Parameters for observation

During the experiment period observations regarding feed intake, milk production, and milk composition were recorded. Body weight of each animal was recorded at the start and at completion of experiment. The weight of animals was taken in the morning by the Mullick's formula for buffalo (Sastry *et al.*, 1982) [21]. Milk yield was recorded daily in the morning and evening.

Analysis of Sampels

Chemical analysis of feeds and fodders for Proximate principles as per AOAC (1990) [1] and minerals (Ca, P, Fe, Cu, Mn and Zn) with the help of atomic absorption spectrometer. The degree of protection of rumen protected fat was judged by estimating the degree of saponification of the Ca Soaps (Garg and Mehta 1998) [6].The blood haemoglobin was analysed by using Shali's method and blood glucose by Heamoglocunometer. The serum analysis for total protein, Ca and P was done by using Semiautomatic haemato-biochemical analyzer. Milk samples were analyzed for fat, milk protein, lactose, total solids (TS) and solids-not-fat (SNF) percentage in Milkoscan. The experimental data were statisticaly analyzed by t- test.

Table 1: Proximate composition of feed ingredients of Katni district (%)

Ingredients	DM	CP	EE	CF	NFE	Ash
Berseem	17.30 ±0.12	15.60 ±0.10	2.12 ±0.22	26.30 ±0.12	45.90 ±0.32	10.10 ±0.21
Sorghum Chari	25.60 ±0.06	07.91 ±0.06	3.31 ±0.10	26.21 ±0.06	54.16 ±0.25	08.42 ±0.33
Pasture grass	20.13 ±0.14	05.40 ±0.10	5.21 ±0.17	28.56 ±0.16	48.28 ±0.31	12.55 ±0.20
Wheat straw	90.80 ±0.10	03.12 ±0.04	1.14 ±0.07	38.55 ±0.11	45.68 ±0.22	11.57 ±0.25
Paddy straw	90.20 ±0.06	03.14 ±0.02	1.34 ±0.09	36.31 ±0.06	48.21 ±0.27	12.55 ±0.36
Maize	89.40 ±0.11	09.10 ±0.10	4.12 ±0.11	02.52 ±0.04	82.45 ±0.15	01.81 ±0.15
Mustard cake	91.50 ±0.07	34.78 ±0.06	9.86 ±0.06	10.16 ±0.06	36.10 ±0.21	09.10 ±0.22
Wheat bran	90.81 ±0.06	13.82 ±0.20	4.22 ±0.13	10.18 ±0.20	63.92 ±0.30	07.92 ±0.30
Rice bran	91.10 ±0.15	11.31 ±0.07	8.30 ±0.09	19.21 ±0,12	49.10 ±0.23	12.10 ±0.24
Rahar Chuni	91.31 ±0.11	14.35 ±0.15	2.34 ±0.10	22.14 ±0,07	54.03 ±0.19	07.19 ±0.19
Bypass Fat	-	-	84.24 ±0.06	-	-	12.05 ±0.17

Table 2: Mineral content of feed ingredients used in Katni district

Ingredients	Ca (%)	P (%)	Fe (ppm)	Cu (ppm)	Mn (ppm)	Zn (ppm)	Co (ppm
Berseem	1.80±0.06	0.19±0.07	494.71±0.31	03.54±0.06	84.29±0.15	12.38±0.03	0.06±0.01
Sorghum Chari	0.30±0.09	0.11±0.06	385.68±0.45	05.73±0.16	72.31±0.35	15.54±0.06	0.02±0.01
Pasture grass	0.44±0.15	0.09±0.07	225.01±0.51	06.12±0.11	46.81±0.27	24.14±0.08	0.15±0.02
Wheat straw	0.21±0.09	0.06±0.02	269.41±0.67	04.19±0.16	62.88±0.20	23.47±0.04	0.02±0.01
Paddy straw	0.40±0.11	0.09±0.03	478.52±0.33	01.44±0.10	126.06±0.76	17.84±0.02	0.01±0.02
Maize	0.02±0.01	0.40±0.01	010.20±0.56	03.10±0.05	08.16±0.88	27.90±0.09	0.02±0.01
Mustard cake	0.81±0.21	1.05±0.21	527.17±0.78	28.79±0.21	58.20±0.56	76.64±0.07	0.55±0.03
Wheat bran	0.17±0.07	1.26±0.15	139.38±0.33	11.44±0.22	89.53±0.37	56.76±0.04	0.10±0.01
Rice bran	0.12±0.04	1.36±0.25	648.37±0.86	17.81±0.15	104.26±0.39	61.08±0.02	0.07±0.03
Rahar Chuni	0.47±0.15	0.56±0.06	334.52±0.61	14.63±0.07	46.77±0.41	21.32±0.06	0.04±0.02
Bypass Fat	9.30±0.03	-	-	-	-	-	-

Results and Discussion

The effect of bypass fat in strategically balanced diet was studied in buffaloes of bypass fat (BF) group. The data in Table 3 revealed that the buffaloes of control (FP) group faced greator loss of body weight (7.91kg) during the experiment period. Whereas, buffaloes of treatment (BF) group lost less body weight (0.38Kg) along with good production. Dry matter intake during the experiment period was 2.89% and 2.87% of their body weights. The change in DMI per cent of body weight was 2.85% and 4.36% in treatment and control groups, respectively.

The milk production in treatment group was recorded as 8.95 liter per day which was significantly higher (P<0.01) than control group of buffaloes in which average 8.21 liters of milk production was recorded daily. The change in the production during experiment was 14.30% and 3.92% in treatment and control groups of buffaloes. The results regarding chemical composition of milk during experimental period showed higher change for all chemical constituents in treatment group of buffaloes as compared to control group but differences were non-significant among both the group except milk fat and TS per cent which were significantly (P<0.01) higher in treatment (7.07 & 16.40%) than in control (6.78 & 16.26%). The SNF, protein and lactose percentage during experiment was 9.39, 3.70 and 4.99% in buffaloes fed treatment diet whereas, it was only 9.47, 3.71and 4.94% in buffaloes received control diet respectively. The higher SNF% was noticed in control (9.47%) than treatment (9.39%) group of buffaloes during the experiment but the increase was not much significant (P<0.05). The milk protein% recorded during experimental period was also more or less similar indicating no effect of dietary supplementation on it.

The data on heamato-biochemical parameters (Table 4) revealed improvement in heamato-biochemical values in treatment group than control group. The hemoglobin (Hb) content of buffaloes of treatment group was 13.16 g/dl. Whereas, in control group Hb content was 11.86 gm/dl at the end of experiment. The glucose concentration in the blood was recorded as 62.58 mg/dl and 53.41 mg/dl in buffaloes of treatment and control group, respectively. The increase in glucose concentration due to dietary treatment was significantly (P<0.01) higher in treatment group of buffaloes than the control group but the increase was within the physiological range. The serum TP content was 6.27 mg/dl and 7.27 mg/dl at the end of experiment in control and treatment groups, respectively. The significant increase in the serum protein (12.74%) in treatment group of buffaloes indicated significant effect of dietary treatment on it whereas it has reduced in control group (0.63%) during experiment period. The higher (10.91 mg/dl) concentration of serum Ca was noticed in treatment group of buffaloes at the completion of experiment. Whereas, less value (8.96 mg/dl) was observed in control group. The significant (P<0.05) difference in the concentration of Ca between two groups of buffaloes were recorded due to treatment effect. The significant effect of dietary supplementation was also observed in concentration of serum P of buffaloes. The values were 5.99 mg/dl and 4.38 mg/dl with an increase of 37.07% and 3.06% in treatment and control groups, respectively.

The result revealed that supplementation of bypass fat in lactating buffaloes prevented the loss of body weight Vahora *et al.* (2013) [31] also reported great reduction in body weight of non-supplemented group and less loss in weight of buffaloes of bypass supplemented group. The probable reason of minimum weight loss in buffaloes of treatment group was due to supplementation of bypass fat which resulted in reduction in catabolic activity and minimum utilization of body reserves. In buffaloes of control group, more reduction in body weight was attributed to negative energy balance responsible for use of body reserves leading to weight loss.

The non-significant difference in daily dry matter intake (DMI) amongst buffaloes of treatment and control group was noticed. Other workers too have reported that daily DMI was not affected by supplementation of rumen bypass fat (Tyagi *et al*., 2009; Theurer *et al*., 2009; Shelke and Thakur, 2011; Garg *et al*., 2012; Haffize, 2012; Shelke *et al*., 2012; Mudgal *et al*., 2012; Ranjan *et al*., 2012 and Ramteke *et al*., 2014) [9, 28, 22-24, 7-8, 25, 16, 19, 18]. The higher change in DMI in control group during experimental period might be associated with less nutrient density of diet. The bypass fat available to buffaloes at lower digestive tract would have been better utilized by buffaloes, hence increase in the nutrient density of the ration could be the probable reason for less change in DMI of treatment buffaloes.

Higher peak yield and milk production observed in treatment group of buffaloes may be attributed to supplementation of bypass fat which increased the energy density of the ration and prevented the deleterious effect of negative energy balance. The present findings are in agreement with the findings of Fahey *et al*. (2002) [5], McNamara *et al*. (2003) [13], Mishra *et al*. (2004) [14], and Ben Salem and Bouraoui (2008) [3]. Energy supply in the form of bypass fat resulted to achieve high peak and sustained production for longer period. Contrary to it, buffaloes of farmer practice were stressed for certain nutrients including energy during peak production which caused poor milk yield as well as persistency of milk yield. The highly significant (P<0.01) effects of supplementing bypass fat on milk production and daily fat yield observed in lactating buffaloes have also been reported earlier by various workers (Barley and Baghel, 2009; Sirohi *et al*., 2010; Tyagi *et al*., 2010; Garg *et al*., 2012 Ramteke *et al*., 2014) [2, 27, 30, 7-8, 18].

The chemical composition of milk showed improvement in the chemical components under study in buffaloes of treatment group than control. The significant effect of supplementation with bypass fat on milk production and per cent fat was also reported by earlier workers (Barley and Baghel, 2009; Sirohi *et al.*, 2010; Tyagi *et al*., 2010; Garg *et al*., 2012, Vahora *et al*., 2013 and Ramteke *et al*., 2014) [2, 27, 30, 31, 18]. The milk fat percent was recorded significantly (P<0.01) higher in bypass fat supplemented group due to more availability of fatty acids for absorption from the intestine due to presence of protected fat. These absorbed fatty acids as such had been incorporated in milk fat after absorption which resulted in to increase in their milk fat (Shelke *et al*., 2012 and Ramteke *et al*., 2014) [25, 18]. The milk protein content was found to increase in buffaloes of T2 group but it was non-significant. Other researchers had also reported that supplementation of bypass fat in lactating animals do not affect much on the protein content of the milk (Tyagi *et al*., 2009; Garg *et al.*, 2012) [29, 7-8]. Decrease in milk protein in buffaloes of treatment group was in agreement with the findings of Wu and Huber (1994) [33] and Rodriguez *et al.* (1997) [20]. It may be due to absorption of certain fatty acids that might have altered the uptake of amino acids by the mammary gland (Chow *et al.*, 1990) [4] and the dilution effect as a result of increase milk yield (Grummer, 1991) [9]. The SNF percent was statistically lower in bypass fat

supplemented group (Ramteke *et al*., 2014) [18]. The positive change in the milk constituents might be because of higher nutritional status of lactating buffaloes which had led to higher concentration of nutrients in their blood circulation as a result maximum nutrients reached their mammary glands for synthesis of milk, hence increased concentration of chemical constituents had occurred in their milk. The concentration of milk constituents was also associated with the lactation stage and milk yield of animals. Probably that was the reason why, the lactose revealed towards the negative side from the values obtained before the start of the experiment in the same buffalo. The less reduction of lactose in buffaloes fed treatment diet than those fed control diet might be because of positive response to dietary treatment.

Significant effect of treatment on the blood HB, glucose and serum protein (12.74%) of treatment buffaloes was noticed. The significant (P<0.01) improvement in concentration of calcium among buffaloes of two groups was recorded due to dietary treatment. The significant (P<0.05) improvement in serum P was also found because of bypass fat supplementation. The increase in serum Ca and P was probably attributed to their appropriate ratio in the diet which led to their better absorption from the digestive tract of buffaloes of treatment group but increase was maintained in the normal range because of physiological mechanism of animal body.

In the study, days of postpartum heat have recorded reduced in buffaloes supplemented with bypass containing balance diet than the control groups. This was probably because of good physiological status of buffaloes. Result of my work was in agreement with the findings of Tyagi *et al.* (2010) [30]. Similar observation of reduction in service period through feeding of bypass fat was also recorded by Ben Salem and Bouraoui (2008) [3] and Lopes *et al.* (2009) [12]. In buffaloes with poor nutritional status, body stores depleted after calving especially in early stage of lactation as a result deficiency of nutrients deficiency nutrients would have impaired the normal physiology of buffaloes which ultimately delayed their postpartum heat.

Corroborating our results, increase in economic returns due to increase in milk yield and per cent fat due to incorporation of bypass fat in lactating animals was also reported by Vidhate *et al.* (2006) [32], Parnerkar *et al.* (2010) [17] and Garg *et al.* (2012) [7-8]. They also noticed increased economic returns due to incorporation of bypass fat in lactating animals.

Table 3: Effect of balance diet containing bypass Fat on performance of lactating buffaloes

Parameters	Control		Treatment		t- value
During experiment		Change (%)	During experiment	Change (%)	
Body weight (Kg)	451.14 ±4.84	-7.91 kg (-1.72)	456.57±4.83	-0.38 kg (-0.08)	1.04^{NS}
DMI (% B. W.)	02.87±0.01	4.36	02.89 ±0.02	02.85	
Milk yield (L/day)	08.21 ±0.09	3.92	08.95 ±0.10	14.30	5.63**
Fat	06.78 ±0.05	1.19	07.07 ±0.05	04.59	4.39**
SNF	09.47 ±0.04	0.32	09.39 ±0.03	00.64	1.81^{NS}
Protein	03.71 ±0.04	2.49	03.70 ±0.02	04.82	0.48^{NS}
Lactose	04.94 ±0.03	-3.52	04.99 ±0.03	-01.58	1.01^{NS}
Total solid	16.26 ±0.02	0.62	16.40 ±0.02	01.74	3.78**

Note:* = Significant (P<0.05), ** = Highly Significant (P<0.01) and = Non-significant difference (P<0.05%)

Table 4: Effect of balance diet containing bypass fat (BF) on blood hematobiochemical parameters of lactating buffaloes

Parameters	Control		Treatment		t- value
At end		Change (%)	At end	Change (%)	
Hemoglobin (gm/dl)	11.86 ±0.23	1.37	13.16 ±0.31	11.62	3.34**
Glucose (mg/dl)	53.41 ±1.16	4.09	62.58 ±1.86	21.21	4.18**
Total protein (mg/dl)	06.27 ±0.13	-0.63	07.27 ±0.05	12.71	7.23**
Ca (mg/dl)	08.96 ±0.28	1.36	10.91 ±0.24	20.82	5.28**
P (mg/dl)	04.38 ±0.16	3.06	05.99 ±0.63	37.07	2.5*

Summery and Conclusion

The results revealed that maximum weight loss occurred in buffaloes of control group. The milk yield was maximum in buffaloes of treatment group while it was minimum in those of control group. The value of both the group differ significantly (P<0.01). The milk composition like fat, SNF, protein, lactose and TS were found to improve in due to dietary treatments. Hemato-biochemical data clearly indicated the effect of dietary treatments on buffaloes. The concentration of serum Ca and P was significantly higher in treatment group of buffaloes while it was lowest in control group. The shortest postpartum heat was noticed in buffaloes of treatment group. Total income from daily sale of milk as well as return over feed cost was highest in buffaloes of treatment group. Overall results clearly indicated that supplementation of bypass nutrient in balance diet was very much helpful in maintaining the good health and production performance of lactating buffaloes.

References

1. AOAC. Official Methods of Analysis. 15th Ed. Association of Official Analytical Chemists, Arlington, Virginia, USA. 1990.
2. Barley GG, Baghel RPS. Effect of bypass fat supplementation on milk yield, fat content and serum triglyceride levels of Murrah buffaloes. Buffalo Bulletin. 2009;28(4):173-175.
3. Ben Salem M, Bouraoui R. Effects of calcium salts of palm fatty acids and protected methionine supplementation on milk production and composition and reproductive performances of early lactation dairy cows. International Journal of Dairy Science, 2008;3:187-193.
4. Chow JM, De Peters EJ, Baldwin RL. Effect of rumen-protected methionine and lysine on casein in milk when diets high in fat or concentrate are fed. Journal of Dairy Science. 1990;734:1051.
5. Fahey J, Mee JF, Callaghan DO, Murphy JJ. Effect of

calcium salts of fatty acids and calcium salt of methionine hydroxy analogue on reproductive responses and milk production in Holstein-Friesian cows. Journal of Animal Science. 2002;74(1):145-154.
6. Garg MR, Mehta AK. Effect of feeding bypass fat on feed intake, milk production and body condition of Holstein Friesian cows. Indian Journal of Animal Nutrition. 1998;15:242-245.
7. Garg MR, Bhanderi BM, Sherasia PL. Effect of supplementing bypass fat with rumen protected choline chloride on milk yield, milk composition and metabolic profile in crossbred cows. Indian Journal of Dairy Science. 2012;65(4):319-323.
8. Garg MR, Sherasia PL, Bhanderi BM. Effect of supplementing bypass fat with and without rumen protected choline chloride on milk yield and serum lipid profile in Jaffarabadi buffaloes. Buffalo Bulletin. 2012;31 (2):91-98.
9. Grummer RR. Potential for modifying milk composition through feeding practices. Proc., CDR Cheese Res. Tech. Conf, 1991, 69-77.
10. Hafez YM. Enhancing milk production in periparturient buffalo fed protected fat with and without vitamin AD_3E treatment. Egyptian Journal of Animal Production. 2012;49(3):249-256.
11. Kearl LC. Nutrient Requirements of Ruminants in Developing Countries. International Feedstuffs Institute, Utah Agricultural Experiment Station, Utah State University, USA. 1982.
12. Lopes CN, Scarpa AB, Cappellozza BI, Cooke RF, Vasconcelos JLM. Effects of rumen-protected polyunsaturated fatty acid supplementation on reproductive performance of Bos indicus beef cows. Journal of Animal Science. 2009;87:3935-3943.
13. Mc Namara S, Butler T, Ryan DP, Mee JF, Dillon P, O'mara FP, Butler, *et al*. Effect of offering rumen-protected fat supplements on fertility and performance in spring-calving Holstein-Friesian cows. Animal Reproduction Science. 2003;79:45-46.
14. Mishra S, Thakur SS, Tyagi N. Milk production and composition in crossbred cows fed calcium salts of mustard oil fatty acids. Indian Journal of Animal Nutrition. 2004;21:22-25.
15. Moty AKI, Soliman, Abd El EB, Fahmy STM, Ibrahim EM. Some productive and physiological responses of lactating Egyptian buffaloes as affected by dietary supplementation of protected fat. *Egyptian* Journal Animal Production. 2012;49:47-55.
16. Mudgal V, Baghel RPS, Ganie A, Srivastava S. Effect of feeding bypass fat on intake and production performance of lactating crossbred cows. Indian Journal of Animal Research. 2012;46:103-104.
17. Parnerkar S, Kumar D, Shankhpal SS, Thube H. Effect of feeding bypass fat to lactating buffaloes during early lactation. Proceedings of VII Biennial Animal Nutrition Association Conference, (December 17-19,) OUAT, Bhubaneswar, India, 2010, 126.
18. 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. Livestock Research International. 2014;2(3):63-67.
19. Ranjan A, Sahoo B, Singh VK, Srivastava S, Singh SP, Pattanaik AK. Effect of bypass fat supplementation on productive performance and blood biochemical profile in lactating Murrah (*Bubalus bubalis*) buffaloes. Tropical Animal Health Production. 2012;44(7):1615-21. DOI:10.1007/s11250-012-0115-3.
20. Rodriguez LA, Stallings CC, Herbein JH, Mc Gilliard ML. Effect of degradability of dietary protein and fat on ruminal, blood and milk components of Jersey and Holstein cows. Journal of Dairy Science. 1997;80:2353.
21. Sastry NSR, Thomas CK, Singh RA. Farm Animal Management and Poultry Production, 2nd edition Vikas Publishing House Pvt. Ltd., New Delhi. 1982.
22. Shelke S, Thakur SS, Amrutkar SA. Effect of prepartum supplementation of rumen protected fat and protein on performance of Murrah a buffaloes. Indian Journal of Animal Sciences. 2011;81:946-950.
23. Shelke SK, Thakur SS. Economics of feeding rumen protected fat and protein to lactating Murrah buffaloes. Indian Journal of Animal Nutrition. 2011;28:278-282.
24. Shelke SK, Thakur SS. Effect of the quality of milk and milk products in Murrah buffaloes (Bubalus bubalis) fed rumen protected fat and protein. International Journal of Dairy Science. 2011;6:124-133.
25. Shelke SK, Thakur SS, Amrutkar SA. Effect of feeding protected fat and proteins on milk production, composition and nutrient utilization in Murrah buffaloes (*Bubalus bubalis*). Animal Feed Science and Technology. 2012;171(2-4):98-100.
26. Sirohi SK, Pandey P, Singh B, Goel N, Mohini M. Effect of malic acid supplementation on rumen fermentation, digestibility and methanogens in wheat straw sorghum based total mixed diets *in vitro*. Indian Journal Animal Science. 2012;82(9**)**:1038-1045.
27. Sirohi SK, Walli TK, Mohanta RK. Supplementation effect of bypass fat on production performance of lactating crossbred cows. Indian Journal of Animal Science. 2010;80(8):733-736.
28. Theurer ML, Block E, Sanchez WK, Mc Guire MA. Calcium salts of salts of polyunsaturated fatty acids deliver more essential fatty acids to the lactating dairy cow. Journal of Dairy Science. 2009;92:2051-2056.
29. Tyagi N, Thakur SS, Shelke SK. Effect of feeding bypass fat supplement on milk yield, its composition and nutrient utilization in crossbred cows, Indian Journal of Animal Nutrition. 2009;26(1):1-8.
30. Tyagi Nitin, Thakur SS, Shelke Sachin K. Effect of bypass fat supplementation on productive and reproductive performance in crossbred cows. Tropical Animal Health Production. 2010;42:1749-1755.
31. Vahora SG, Parnerkar S, Kore KB. Productive efficiency of lactating buffaloes fed bypass fat under field conditions: Effect on milk yield, milk composition, body weight and economics. Iranian Journal of Applied Animal Science. 2013;3(1):53-58.
32. Vidhate PG, Kokane RD, Hande ST. Economic impact of feeding bypass fat in crossbred cows. Journal of Bombay Veterinary College. 2006;14:68-72.
33. Wu Z, Huber JT. Relationship between dietary fat supplementation and milk protein concentration in lactating cows-a review. Livestock Production Science. 1994;39:141.