Effect of Additional Energy Supplement on the Productive Performance of Lactating Murrah Buffaloes

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Abstract

Energy is one of the most important nutritional factor that limit the production of dairy animals. It has been observed that the productivity of dairy animals are adversely affected because of lack of providing sufficient ration in early lactation stage which results into weight loss, anemia and various reproductive and metabolic disorders. Maximizing energy intake by increasing the energy density of the diet is a logical feeding strategy for early lactating buffaloes. Considering the need of energy in high yielding lactating animals especially in their early stage of lactation, the experiment was planned to investigate the effect of additional energy supplement (5% additional concentrate, soybean oil @ 100 ml/animal/day, bypass fat @ 100 g/animal/day and roasted soybean @ 100 g/animal/day) on productive performance of 30 apparently healthy lactating Murrah buffaloes for a period of 90 days post partum. Milk yield were recorded at monthly intervals and milk composition was analyzed at fortnight intervals. The average fat percent in milk has increased significantly ($p < 0.05$) throughout the study period in all the groups. There was no significant difference in the overall average protein, lactose, SNF and total solids percent were observed among the groups.

Introduction

India is the motherland for the superior milch breeds of buffalo's contributing 57.3% of world's population, having 109.85 millions in India (Livestock census, 2019). These buffaloes share 49% of the India's total milk production (BAHS, 2019). Hence, the contribution of buffaloes in the milk production of the country is significantly higher. Most of the animals in developing countries including India suffer shortage of feed resources and are fed on agriculture by-products and low quality crop residues, which have got inherent low nutritive value and digestibility responsible for low productivity of dairy animals. Energy is one of the most important nutritional factors that limit production in dairy buffaloes. The energy intake of high yielding buffaloes during initial lactation phase is almost lower than half of the energy required for production purposes. During early lactation buffaloes are unable to consume enough energy from the feed to meet their energy demand for lactation. Thus, the body reserves are mobilized, leading to the negative energy balance which adversely affects their peak milk yield and overall lactation yield. The additional energy in the diet of lactating animals has been found to affect the efficiency of animals as an output of a combination of caloric and non-caloric effects. Caloric effects are attributable to greater energy content of feed and energetic efficiency of lipids as compared to that of carbohydrates or proteins. The non-caloric effects include improved reproductive performance and altered fatty acids profile of milk. Supplementation of the ration with energy supplements such as maize, vegetable oil or Jaggary may be beneficial to correct the energy deficiency. Keeping in view the above facts and considering the need of energy in high lactating animals especially in their early stage of lactation, the experiment was planned to investigate the effect of additional energy supplement on the productive performance of lactating Murrah buffaloes for a period of 90 days post partum. The additional energy were supplemented in the form of concentrate ration, soybean oil, by pass fat and roasted soybean. Productive performance parameters

like milk yield, peak milk yield, lactation milk yield, persistency of milk production and milk components were recorded.

Materials And Methods

Location of work: The present experiment was conducted at Livestock Farm Complex, Adhartal, College of Veterinary Science & Animal Husbandry, NDVSU, Jabalpur (M.P.).

Selection of experimental animals: Thirty lactating Murrah buffaloes were selected on the basis of similarity in the body weight, parity and age, milk yield and stage of lactation and free from any anatomical, physiological and infectious disorders and were randomly distributed into five groups each containing six animals. The experiment was conducted as per the guidelines of Institutional Animal Ethics Committee (IAEC).

Feeding: All the animals were maintained under intensive system of farming. Basal diet was formulated using maize, cotton seed cake, mustard seed cake, wheat bran, rice polish, arahar chuni along with mineral mixture and salt, as per ICAR (2013) feeding standards. All supplementation was started from 15th day post partum and was continued upto 3 months post partum. The composition of basal ration is given in Table 01.

Table 01: Composition of basal ration used in the experiment

Ingredients	Parts (%)
Yellow maize	38.00
Cotton seed cake	13.00
Mustard cake	20.00
Wheat bran	9.00
Rice polish	8.00
Arhar chuni	9.00
Mineral mixture	2.00
Common salt	1.00
Total	100

Duration of the experiment: The experimental period was for one year i.e., from July 2018 to end of June 2019.

Grouping of the animals: The grouping of the animals was based on the dietary treatments and is described in the table 02 as follows

Table 02: Experimental design of the animals

Groups	Animals	Treatment
T1	6	Basal diet (Control)
T2	6	Basal diet + 5% additional concentrate feeding
T3	6	Basal diet + Soybean oil supplementation @ 100 ml/animal/day
T4	6	Basal diet + By pass fat energy @ 100 g/animal/day
T5	6	Basal diet + Roasted Soybean supplementation @ 100 g/animal/day

Production performance parameters to be studied includes:

1. **Milk yield:** Daily milk yield (Kg) of the animals was measured in the morning and evening usually at a fixed time.

2. **Peak milk yield:** The peak milk yield of the animals was recorded from their daily milk record.

3. **Lactation yield:** The lactation yield of the animals was recorded from their milk yield during 305 days.

4. **Persistency of milk production-** Persistency is defined as the milk yield at one test expressed as a percentage of milk yields at an earlier test, adjusted to a 30-day interval between tests. Therefore, if two tests are exactly 30 days apart persistency can be simply calculated as follows using the formula given by Sastry and Thomas (2005).

Persistency % = (Milk kg at later test **/**Milk kg at earlier test) x 100

5. **Milk components -** The milk components, including fat, protein, lactose, total solids and solid not fat (SNF) were analyzed after 21 days of calving to 305 days postpartum at fortnightly intervals. The representative milk samples from individual buffaloes of different groups were collected in plastic sample bottles during the study period. The milk samples were analyzed for various parameters using lacto scan (Netco, Pvt. Ltd.).

Results

The present experiment was planned to investigate the effect of additional energy through use of either 5% additional concentrate (T2) or soybean oil @ 100ml/animal/day (T3) or bypass fat @100/ animal/day (T4) or roasted soybean @100g/ animal/day (T5) on the productive performance in lactating Murrah buffaloes. The data recorded during the study was analysed statistically and has been presented and discussed in the following different heads-.

Daily Milk Yield (MY)

The average daily milk yield (lit.) in lactating Murrah buffaloes offered different dietary treatments at monthly intervals after post-partum to 305 days lactation is presented in Table 03.

The data clearly indicated that the average daily milk yield (lit.) in lactating Murrah buffaloes at the start of experiment in T1, T2,T3,T4 and T5 groups were 8.84±0.24, 9.12±0.24, 8.86±0.08, 8.52±0.44 and 8.52±0.44, respectively. While, the average daily milk yield (lit.) at the end of the lactation length in T1,T2,T3,T4 and T5 groups were 1.08±0.10, 2.22±0.09, 2.5±0.07, 2.4±0.11 and 2.2±0.12, respectively. Statistically, there was no significant difference in the average daily milk yield (lit.) in lactating Murrah buffaloes among the groups; however the overall average daily milk yield was numerically higher in T3 group followed by T4 and T5 groups and was lowest in T1 group. Continuous decrease in average daily milk yield (lit.) was observed in all the groups at the end of the lactation length. The percent increase in average daily MY up to the lactation length in T2,T3,T4 and T5 groups in comparison to T1 were 15.7, 21.2, 18.1 and 17.1, respectively. Highest increase in average daily MY was seen in T3 group of buffaloes.

Critical perusal of the data clearly revealed that the overall average daily MY significantly varied among the groups and was higher in buffaloes of T3 group followed by T4 and T5 group and was lowest in T2 group. While, the percent increase in average daily MY in T2, T3, T4 and T5 group in comparison to T1 was 14.30, 19.72, 16.56 and 15.81. Thus, the maximum percent increase in the milk yield was noted in buffaloes of T3 group.

Table 03: Daily milk yield (lit.) in lactating Murrah buffaloes in different treatment groups

Trts/Months	T1	T2	T3	T4	T5
1	8.84±0.24	9.12±0.24	8.86±0.08	8.52±0.44	8.64±0.37
2	9.25±0.29	9.84±0.33	10.11±0.34	9.48±0.36	9.78±0.39
3	8.82±0.38	9.27±0.41	9.74±0.38	9.16±0.35	9.36±0.39
4	8.01±0.39	8.72±0.38	9.26±0.32	8.86±0.29	8.95±0.33
5	7.76±0.24	8.17±0.25	8.74±0.57	8.53±0.34	8.51±0.34
6	6.71±0.23	7.61±0.40	8.09±0.76	8.14±0.22	7.99±0.36
7	5.77±0.10	6.85±0.10	7.34±0.33	7.58±0.32	7.22±0.39
8	4.39±0.27	6.18±0.15	6.61±0.41	6.62±0.26	6.33±0.13
9	3.44±0.15	5.46±0.25	5.76±0.28	5.75±0.24	5.47±0.36
10	3.37±0.08	4.71±0.30	4.96±0.28	4.74±0.36	4.63±0.43
Average	6.64±0.10	7.59±0.15	7.95±0.20	7.74±0.20	7.69±0.29
Increase in daily milk yield in comparison to T1	-	0.95	1.31	1.10	1.05
Increase in daily milk yield (%)	-	14.30	19.72	16.56	15.81

Peak milk yield and persistency of lactation

The peak milk yield in lactating Murrah buffaloes of different treatment groups is presented in Table 04. The highest average peak milk yield (lit.) was recorded in T3 group (11.83±0.17) followed by T4 (11.42±0.24), T5 (11.33±0.30), T2 (11.17±0.24) and T1 (10.92±0.21) groups, respectively. There was no significant difference in the average peak milk yield of lactating Murrah buffaloes among the groups; however the percent increase in peak milk yield in T2, T3, T4 and T5 groups were 2.29, 8.33, 4.58 and 3.75, respectively in comparison to T1 group.

In the present study, percent increase in average daily milk yield in T3 group as compared to T2, T4 and T5 groups were 5.91, 3.59 and 4.41, respectively and was attributed to better utilization of nutrients, more availability of energy and improved reproductive performances. Whereas, less MY in T1 group as compared to T2, T3, T4 and T5 groups was mainly because of non-availability of fat supplements in their ration resulting in to reduced energy intake in comparison to body requirements.

The peak milk yield (days) was attained earlier in T3 group (47.33±4.76) followed by T5 (49.33±6.21), T4 (51.83±3.52), T2 (54±2.42) and T1 (61.33±7.98) groups of buffaloes, respectively. No significant difference was observed among the groups but clearly there was reduction in days to attain the milk yield in different groups in comparison to control. The percent decrease in days to attain peak milk yield in T2, T3, T4 and T5 groups as compared to T1 was 11.95, 22.83, 15.49 and 19.57, respectively.

Table 04: Effect of different treatments on peak milk yield and day to attend peak milk yield in lactating Murrah buffaloes

Treatments	T1	T2	T3	T4	T5
Peak milk yield (lits.)	10.92±0.21	11.17±0.24	11.83±0.17	11.42±0.24	11.33±0.30
Increase in milk yield in comparison to T1	-	0.25	0.91	0.5	0.41
Increase in milk yield (%) in comparison to T1	-	2.29	8.33	4.58	3.75
Days to attain peak milk yield	61.33±7.98	54.00±2.42	47.33±4.76	51.83±3.52	49.33±6.21
Decrease in days to attain milk yield	-	7.33	14.00	9.50	12.00
Decrease in days (%) to attain milk yield	-	11.95	22.83	15.49	19.57

Table 05: Effect of additional energy on persistency of lactation (%) in lactating Murrah buffaloes

Trts/ Months	T1	T2	T3	T4	T5
2	94.53	94.22	96.35	96.60	95.74
3	92.26	94.07	95.07	96.75	95.61
4	92.18	93.66	94.36	96.27	95.03
5	86.57	93.00	92.53	95.41	93.96
6	85.97	90.20	90.72	93.11	90.30
7	76.13	90.11	90.08	87.32	87.76
8	74.34	89.70	87.10	86.86	86.40
9	68.88	78.34	78.86	75.45	77.92
10	48.00	51.09	55.08	55.35	53.94
Persistency of lactation (%)	79.87	86.04	86.68	87.01	86.30
Increase in comparison to T1		6.17	6.81	7.14	6.43
Increase (%) in comparison toT1	-	7.73	8.53	8.94	8.05

Lactation yield

The average lactation yield in lactating Murrah buffaloes under different treatment groups is presented in Table 06. The lactation yield (lit./lactation/animal) based on full lactation length of 305 days was significantly ($p<0.05$) higher in T3 group (2383.50±65.78) followed by T4 (2320.92±64.63), T5 (2306.51±94.01), T2 (2278.07±49.96) and T1group (1990.67±33.42), respectively. Significant difference was observed between T1 and T3 group but no significant difference was observed between T2 and T3 groups, T4 and T3 groups and T5 and T3 groups. In comparison to T1, increase in milk yield in T2, T3, T4 and T5 groups was 287.4, 392.83, 330.25 and 315.84 litres respectively. While the percent increase in lactation yield in T2, T3, T4 and T5 groups as compared to T1 group of buffaloes was 14.44, 19.73, 16.59 and 15.87 respectively. Thus the maximum increase in percent milk yield was in T3 group followed by T4, T5 and T2 groups.

Table 06: Effect of different treatments on lactation yield (lit./lactation/animal) in lactating Murrah buffaloes

Treatments	T1	T2	T3	T4	T5
Lactation yield	1990.67^{b} ±33.42	2278.07^{a} ±49.96	2383.50^{a} ±65.78	2320.92^{a} ±64.63	2306.51^{a} ±94.01
Increase in comparison to T1	-	287.4	392.83	330.25	315.84
Increase in comparison to T1 (%)	-	14.44	19.73	16.59	15.87

Mean bearing different superscript (a and b) within row differ significantly ($p<0.05$)

Milk components

Milk fat: The average fat percent in milk of lactating Murrah buffaloes under different treatments at fortnightly intervals after 21 days post-partum to 305 days lactation length study is presented in Table 07.

The fortnightly average fat percent in lactating Murrah buffaloes at the start of experiment was 6.74±0.15, 6.98±0.36, 7.04±0.31, 6.74±0.33 and 6.65±0.35 in T1, T2, T3, T4 and T5 groups, respectively. The fortnightly average fat percent at the end of experiment i.e. after 21 days post partum to 305 days in T1, T2, T3, T4 and T5 groups was 8.28±0.38, 8.53±0.20, 9.55±0.13, 9.35±0.24 and 9.27±0.37, respectively. The overall average fat percent was significantly ($p<0.05$) differ among the groups and the values were higher in T3 group (8.10±0.23) group followed by T5 (7.89±0.23), T4 (7.71±0.26), T2 (7.44±0.20) and T1 group (7.10 ±0.17). The average fat percent in milk has increased throughout the study period in all the groups. The percent increase in milk fat from 21 days post partum to end of the lactation period in T2, T3, T4 and T5 groups were 4.62, 14.41, 8.95 and 11.33, respectively in comparison to T1 group.

Table 07: Fortnightly average fat percent in milk of lactating Murrah buffaloes in different treatment groups

Trts/Fortnights	T1	T2	T3	T4	T5
Initial	6.74±0.15	6.98±0.36	7.04±0.31	6.74±0.33	6.65±0.35
1st	6.04±0.11	6.37±0.38	6.74±0.34	6.05±0.32	6.46±0.36
2nd	6.05±0.16	6.51±0.28	6.83±0.38	6.16±0.30	6.54±0.44
3rd	6.24±0.22	6.44±0.26	6.78±0.40	6.42±0.38	6.64±0.39
4th	6.50±0.18	6.50±0.20	7.07±0.39	6.71±0.41	7.02±0.38
5th	6.53±0.16	6.52±0.20	7.38±0.36	6.93±0.41	7.27±0.37
6th	6.72±0.21	6.58±0.19	7.64±0.35	7.1±0.40	7.40±0.38
7th	6.79±0.21	7.06±0.24	7.83±0.32	7.26±0.37	7.61±0.45
8th	7.02±0.28	7.13±0.23	8.02±0.28	7.45±0.37	7.74±0.46
9th	7.12±0.30	7.45±0.21	8.19±0.26	7.71±0.34	8.03±0.44
10th	7.16±0.27	7.78±0.180	8.36±0.24	7.92±0.34	8.23±0.40
11th	7.32±0.31	8.00±0.16	8.55±0.25	8.17±0.35	8.49±0.39
12th	7.52^{b}±0.34	8.23±0.16	8.82±0.20	8.47±0.34	8.66±0.38
13th	7.60^{b}±0.37	8.37^{ab}±0.16	8.95^{a}±0.19	8.70^{a}±0.34	8.76^{a}±0.38
14th	7.85^{b}±0.38	8.43^{ab}±0.17	9.20^{a}±0.18	9.02^{a}±0.30	8.98^{a}±0.36
15th	8.10^{c}±0.47	8.48^{bc}±0.16	9.47^{a}±0.17	9.30^{ab}±0.25	9.15^{ab}±0.37
16th	8.17^{c}±0.46	8.47^{bc}±0.11	9.47^{a}±0.14	9.30^{ab}±0.26	9.22^{ab}±0.39
17th	8.28^{c}±0.44	8.53^{bc}±0.16	9.55^{a}±0.13	9.35^{ab}±0.24	9.27^{ab}±0.37
18th	8.29^{c}±0.45	8.51^{bc}±0.17	9.53^{a}±0.11	9.34^{ab}±0.22	9.28^{ab}±0.38
Average	7.15^{c}±0.18	7.48^{bc}±0.3	8.18^{a}±0.24	7.79^{abc}±0.27	7.96^{ab}±0.24
Increase in comparison to T1		0.33	1.03	0.64	0.81
Change in Fat (%)	-	4.62	14.41	8.95	11.33

Mean bearing different superscript (a, b and c) within row differ significantly ($p<0.05$)

The fat percentage in milk varied significantly among the groups and the values were higher in T3 group (8.1±0.24) followed by T5 (7.89±0.49), T4 (7.71±0.27), T2 (7.44±0.20) and T1 (7.1 ±0.18) groups.

Milk protein:

The average protein percent in milk of lactating Murrah buffaloes under different treatments at fortnightly intervals after 21 days post-partum to 305 days lactation length is presented in Table 08.

The fortnightly average protein percent in milk of lactating Murrah buffaloes at the start of experiment was 3.63±0.63, 3.68±0.04, 3.63±0.05, 3.58±0.04 and 3.55±0.06 in T1, T2, T3, T4 and T5 groups, respectively. The fortnightly average protein percent at the end of experiment i.e. after 21 days post partum to 305 days in T1, T2, T3, T4 and T5 groups was 4.05±0.08, 4.20±0.06, 4.03±0.04, 4.12±0.04 and 4.07±0.07, respectively. There was no significant difference in the overall average protein percent among groups and the values were numerically higher in T1 group (3.86±0.11) followed by T2 (3.81±0.08), T5 (3.79±0.07), T4 (3.77±0.05) and T3 (3.75±0.05) groups. In comparison to control (T1) in energy supplemented groups (T2, T3, T4 and T5) there was reduction in the milk protein content. Thus, in comparison to T1 group, percent reduction in milk protein was 1.30, 2.85, 2.33 and 1.81 in T2, T3, T4 and T5 groups respectively, although these differences were non-significant.

Table 08: Fortnightly average protein percent in milk of lactating Murrah buffaloes in different treatment groups

Trts/Fortnights	T1	T2	T3	T4	T5
Initial	3.63±0.06	3.68±0.04	3.63±0.05	3.58±0.04	3.55±0.07
1st	3.48±0.05	3.56±0.03	3.57±0.04	3.48±0.03	3.5±0.04
2nd	3.60±0.07	3.53±0.03	3.53±0.04	3.51±0.06	3.48±0.06
3rd	3.65±0.06	3.53±0.06	3.52±0.05	3.53±0.07	3.53±0.05
4th	3.72±0.08	3.56±0.09	3.53±0.06	3.59±0.07	3.58±0.04
5th	3.72±0.09	3.58±0.08	3.55±0.04	3.60±0.05	3.58±0.04
6th	3.80±0.08	3.61±0.07	3.59±0.03	3.61±0.04	3.75±0.08
7th	3.87±0.08	3.68±0.10	3.64±0.04	3.62±0.04	3.78±0.09
8th	3.88±0.07	3.73±0.1	3.67±0.04	3.65±0.03	3.80±0.09
9th	3.98±0.07	3.80±0.10	3.74±0.05	3.77±0.05	3.81±0.08
10th	3.88±0.11	3.82±0.10	3.78±0.05	3.8±0.06	3.84±0.08
11th	3.90±0.11	3.88±0.11	3.80±0.06	3.82±0.05	3.85±0.08
12th	3.95±0.07	3.90±0.11	3.82±0.07	3.85±0.06	3.87±0.08
13th	4.01±0.07	4.03±0.11	3.94±0.07	3.93±0.06	3.95±0.08
14th	4.02±0.07	4.06±0.10	3.97±0.08	3.98±0.07	4.00±0.08
15th	4.03±0.07	4.09±0.10	4.00±0.05	4.03±0.06	4.02±0.07
16th	4.04±0.07	4.11±0.09	4.01±0.05	4.09±0.05	4.03±0.07
17th	4.05±0.07	4.12±0.07	4.02±0.05	4.10±0.04	4.07±0.07
18th	4.06±0.08	4.20±0.08	4.03±0.06	4.12±0.05	4.08±0.06
Average	3.86±0.04	3.81±0.06	3.75±0.05	3.77±0.04	3.79±0.05
Decrease in comparison to T1	-	0.02	0.11	0.09	0.07
Decrease in Protein (%)	-	1.30	2.85	2.33	1.81

Milk lactose:

The average lactose percent in milk of lactating Murrah buffaloes under different treatments at fortnightly intervals after 21 days post-partum to 305 days lactation study is presented in Table 09.

The fortnightly average lactose percent in milk of lactating Murrah buffaloes at the start of experiment was 4.83±0.07, 5.22±0.06, 5.02±0.09, 4.85±0.08 and 4.85±0.35 in T1, T2, T3, T4 and T5 groups, respectively. The fortnightly average lactose percent at the end of experiment i.e. after 21 days post partum to 305 day was 5.31±0.06, 5.39±0.06, 5.30±0.05, 5.30±0.07 and 5.29±0.20 in T1, T2, T3, T4 and T5 groups, respectively. There was no significant (P>0.05) difference in the overall average lactose percent among groups and the values were numerically higher in T2 (5.21±0.03) followed by T1 (5.13±0.04), T4 (5.11±0.04), T5 (5.06±0.05) and T3 (5.04±0.04) group, respectively. The percent change was also recorded. It was observed that in comparison to control T1, in T2 and T5 group there was increase in lactose percent to the extent of 1.56 and 1.36 percent, respectively. While, in T3 and T4 groups there was reduction in milk lactose percent as compared to control and it was 1.75 and 0.39 percent.

Table 09: Fortnightly average lactose percent in milk of lactating Murrah buffaloes in different treatment groups

Trts/Fortnights	T1	T2	T3	T4	T5
Initial	4.83±0.09	5.22±0.06	5.02±0.09	4.85±0.35	4.85±0.08
1st	4.85±0.05	5.09±0.06	4.97±0.07	4.83±0.24	4.72±0.08
2nd	4.95±0.04	5.03±0.06	4.92±0.05	4.85±0.12	4.75±0.08
3rd	4.95±0.03	5.08±0.06	4.80±0.09	4.91±0.12	4.70±0.10
4th	5.03±0.04	5.17±0.08	4.78±0.11	5.02±0.12	4.82±0.10
5th	5.03±0.02	5.17±0.08	4.82±0.11	5.03±0.17	4.90±0.10
6th	5.09±0.05	5.15±0.09	4.87±0.11	5.08±0.21	5.03±0.08
7th	5.11±0.04	5.16±0.09	4.93±0.09	5.07±0.19	5.06±0.08
8th	5.11±0.04	5.16±0.07	5.02±0.06	5.13±0.19	5.07±0.08
9th	5.18±0.05	5.16±0.09	5.04±0.06	5.14±0.20	5.11±0.09
10th	5.23±0.06	5.19±0.08	5.04±0.06	5.15±0.20	5.13±0.09
11th	5.24±0.05	5.22±0.07	5.08±0.06	5.17±0.20	5.23±0.09
12th	5.23±0.05	5.26±0.07	5.15±0.06	5.21±0.20	5.24±0.09
13th	5.25±0.06	5.30±0.08	5.17±0.07	5.24±0.20	5.25±0.08
14th	5.27±0.06	5.32±0.07	5.20±0.07	5.30±0.20	5.26±0.07
15th	5.29±0.06	5.33±0.07	5.23±0.08	5.30±0.20	5.26±0.07
16th	5.31±0.06	5.34±0.06	5.24±0.05	5.30±0.20	5.27±0.07
17th	5.30±0.06	5.37±0.06	5.28±0.05	5.30±0.20	5.28±0.07
18th	5.31±0.07	5.39±0.07	5.29±0.06	5.30±0.21	5.29±0.08
Average	5.13±0.04	5.21±0.03	5.04±0.04	5.11±0.04	5.06±0.05
Increase or decrease in comparison to T1		+0.07	-0.09	-0.02	- 0.07
Change in Lactose (%)	-	1.56	-1.75	-0.39	1.36

Milk solid not fat:

The average SNF percent in milk of lactating Murrah buffaloes allotted different dietary treatments at fortnight intervals after 21 days post-partum to 305 days lactation length is presented in Table 10.

Table 10: Fortnightly average solid not fat (SNF) percent in milk of lactating Murrah buffaloes in different treatment groups

Trts/Fortnights	T1	T2	T3	T4	T5
1st	9.47±0.10	9.58±0.11	9.54±0.13	9.04±0.08	9.16±0.07
2nd	9.27±0.07	9.38±0.10	9.40±0.10	8.98±0.08	9.09±0.05
3rd	9.50±0.12	9.37±0.13	9.35±0.09	9.15±0.09	9.30±0.11
4th	9.45±0.16	9.26±0.18	9.24±0.08	9.20±0.13	9.24±0.11
5th	9.53±0.23	9.25±0.19	8.95±0.42	9.43±0.11	9.45±0.09
6th	9.65±0.15	9.38±0.19	9.08±0.31	9.42±0.06	9.47±0.09
7th	9.72±0.13	9.57±0.21	9.18±0.23	9.45±0.07	9.45±0.12
8th	9.75±0.12	9.63±0.17	9.32±0.17	9.50±0.06	9.46±0.12
9th	9.80±0.13	9.76±0.13	9.50±0.11	9.58±0.07	9.60±0.16
10th	9.87±0.14	9.83±0.11	9.53±0.10	9.62±0.05	9.63±0.15
11th	9.91±0.13	9.88±0.11	9.55±0.10	9.67±0.06	9.70±0.17
12th	9.95±0.14	9.90±0.12	9.70±0.11	9.72±0.07	9.80±0.19
13th	9.95±0.15	9.92±0.12	9.73±0.10	9.85±0.06	9.88±0.20
14th	10.03±0.17	9.95±0.10	9.78±0.11	9.85±0.06	9.90±0.19
15th	9.99±0.15	9.95±0.10	9.83±0.11	9.88±0.05	9.97±0.17
16th	10.15±0.18	10.00±0.10	9.95±0.11	9.98±0.06	10.00±0.16
17th	10.14±0.17	10.05±0.11	9.97±0.11	10.03±0.05	10.17±0.18
18th	10.20±0.17	10.07±0.10	9.95±0.07	10.07±0.06	10.17±0.19
Average	9.83±0.10	9.71±0.11	9.53±0.11	9.58±0.04	9.63±0.11
Decrease in comparison to T1	-	0.12	0.30	0.25	0.20
Decrease in SNF (%)	-	-1.22	-3.05	-2.54	-2.03

The fortnightly average SNF percent in milk of lactating Murrah buffaloes at the start of experiment was 9.47±0.10, 9.58±0.11, 9.54±0.13, 9.04±0.08 and 9.16±0.07 in T1, T2, T3, T4 and T5 groups, respectively. The fortnightly average SNF percent at the end of experiment i.e. after 21 days post partum to 305 day was 10.20±0.17, 10.07±0.10, 9.95±0.07, 10.07±0.06 and 10.17±0.19 in T1, T2, T3, T4 and T5 groups, respectively. There was no significant difference in the overall average SNF percent among the groups; however the numerical values were higher in T1group (9.83±0.10) followed by T2 (9.71±0.11), T5 (9.63±0.11), T4 (9.58±0.04) and T3 (9.53±0.11) groups, respectively. In comparison to control there was 1.22, 3.05, 2.54 and 2.03 percent reduction in SNF content of milk in T2, T3, T4 and T5 groups of buffaloes, respectively.

Milk total solid:

The average total solids percent in milk of lactating Murrah buffaloes under different treatments at fortnight intervals after 21 days post-partum to 305 days lactation length is presented in Table 11.

The fortnightly average total solids percent in milk of lactating Murrah buffaloes at the start of experiment was 16.21±0.16, 16.55±0.28, 16.58±0.23, 15.78±0.32 and 15.81±0.4 in T1, T2, T3, T4 and T5 groups, respectively. The fortnightly average SNF percent at the end of experiment i.e. after 21 days post partum to 305 day was 18.49±0.55, 18.60±0.18, 19.50±0.16, 19.42±0.29 and 19.43±0.49 in T1, T2, T3, T4 and T5 groups, respectively. There was no significant difference in the overall average total solids percent among the groups; however the numerical values were higher in T3 group (17.64±0.30) followed by T5 (17.54±0.45), T4 (17.32±0.32), T2 (17.23±0.18) and T1(17.22±0.40) groups, respectively.

Table 11: Fortnightly average total solid percent in milk of lactating Murrah buffaloes in different treatment groups

Trts/ Fortnights	T1	T2	T3	T4	T5
Initial	16.21±0.16	16.56±0.28	16.58±0.23	15.78±0.32	15.81±0.40
1st	15.31±0.14	15.75±0.33	16.14±0.33	15.03±0.58	15.55±0.40
2nd	15.55±0.17	15.88±0.25	16.18±0.38	15.31±0.36	15.84±0.43
3rd	15.80±0.27	15.70±0.31	16.02±0.44	15.62±0.32	15.88±0.42
4th	16.12±0.38	15.75±0.27	16.02±0.74	16.04±0.38	16.37±0.43
5th	16.18±0.37	15.90±0.28	16.46±0.61	16.31±0.40	16.68±0.41
6th	16.44±0.39	16.05±0.21	16.82±0.52	16.55±0.38	16.85±0.46
7th	16.54±0.47	16.69±0.23	17.05±0.42	16.76±0.35	17.07±0.49
8th	16.82±0.49	16.89±0.20	17.43±0.29	16.98±0.38	17.24±0.59
9th	16.99±0.50	17.23±0.21	17.72±0.27	17.27±0.36	17.66±0.53
10th	17.07±0.50	17.66±0.21	17.91±0.24	17.54±0.37	17.90±0.51
11th	17.27±0.59	17.90±0.20	18.25±0.26	17.85±0.37	18.19±0.54
12th	17.47±0.58	18.15±0.19	18.55±0.22	18.32±0.38	18.54±0.53
13th	17.58±0.59	18.3±0.20	18.73±0.21	18.55±0.38	18.66±0.52
14th	17.85±0.55	18.37±0.18	19.03±0.21	18.90±0.33	18.95±0.47
15th	18.25±0.57	18.41±0.18	19.35±0.22	19.28±0.30	19.15±0.48
16th	18.31±0.58	18.49±0.15	19.37±0.19	19.31±0.30	19.32±0.50
17th	18.42±0.55	18.44±0.18	19.46±0.16	19.38±0.29	19.38±0.49
18th	18.52±0.56	18.58±0.19	19.46±0.15	19.4±0.28	19.41±0.48
Average	16.98±0.40	17.19±0.18	17.71±0.30	17.38±0.32	17.60±0.45
Increase in comparison to T1	-	0.21	0.73	0.40	0.62
Increase in comparison to T1 (%)	-	1.24	4.30	2.36	3.65

Discussion

Similar findings of increase in milk yield by use of roasted soybean (T5 group) have also been reported by Faldet and Satter (1991) in Holstein cows supplemented with raw soybean, unheated SBM and roasted soybeans and found an increase in the milk yield of 28%, 36%, and 67%, respectively. Similarly, Socha (1991) in Holstein cows supplemented with roasted soybeans and Kumar *et al.* (2015) in high yielding dairy cows using heat treated whole soybean reported higher milk yield.

Regarding increase in milk yield of animals due to intake of additional energy through use of bypass fat as a supplement in buffaloes have been supported by Barley and Baghel (2009) in Murrah buffaloes supplemented with bypass fat @ 100 g/head/day and Sharma *et al*. (2016) in Murrah buffaloes supplemented with prilled fat @ 150 g/d found increase in the milk yield of buffaloes.

The increase in milk yield has been also reported in cows due to supplementation of additional energy through use of bypass fat. Soni and Patel (2015) in cross bred cows with bypass fat supplementation @ 100 g per animal per day; Suksombat and Chullanandana (2008) by soybean oil or rumen protected conjugated linoleic acid supplementation @ 150 g/animal/day in lactating Holstein Friesian crossbred cows and observed increase in their milk yield. Similarly Singh *et al*. (2016) in Karan Fries cows supplemented with prilled fat @ 150 g/animal/d observed significant increase in the milk production and fat percentage over the control group. The improvement in MY associated with supplemental fat can largely be attributed to an improvement in energy balance.

Statistically higher values of overall average daily MY in T3 group corroborate with the findings of AlZahal *et al*. (2008) in Holstein cows supplemented with monensin and soybean oil; Sultana *et al*. (2008) in Holstein cows supplemented with calcium salts of soybean oil and linseed oil fatty acids @ 1 per cent in diet and Ye *et al*. (2009) in Holstein cows supplemented with flaxseed oil, soybean oil and extruded soybean oil @ 2 per cent found increase in the daily milk yield of animals.

The increase in milk yield due to inclusion of fat in basal ration was attributed to increase in DMI and an improvement in the efficiency of energy utilization. The highest average per cent increase in daily MY was 17.5 in the present study than 7.27 and 7.30 reported by AlZahal *et al*. (2008) and Gowda *et al*. (2013), respectively which further indicates that pre and post-partum feeding was more effective in eliciting the higher milk production response than feeding alone in early lactation.

In the present study, gradual decrease in average daily MY from 5th month onwards was due to increase in the lactation length. It was in agreement with the findings of Altenhofer *et al*. (2014) and Rodrigues (2017) in Holstein cows supplemented with soybean oil, respectively.

Higher peak milk yield (lit.) in T3 group followed by T5, T4, T2 and T1 groups corroborate with the findings of Tyagi *et al*. (2010) in crossbred cows supplemented with bypass fat @ 2.5 per cent of the feed dry matter and Ranjan *et al*. (2012) in Murrah buffaloes supplemented with bypass fat @ 200 g/d. The findings may be attributed to the increased energy density of the ration due to fat supplementation resulting in to higher MY and lower milk fat per cent in comparison to T1 group.

The Persistency of lactation in lactating Murrah buffaloes of different treatment groups is presented in Table 05. The persistency of lactation (%) was found higher in T4 group of buffaloes (87.01±4.58) followed by T3 (86.68±4.33), T5 (86.30±4.48), T2 (86.04±4.67) and T1 (79.87±4.97) groups, respectively. No significant difference was observed among the groups. In comparison to control group T1, the percent increase in persistency of lactation in T2, T3, T4 and T5 groups were 7.73, 8.53, 8.94 and 8.05, respectively.

Persistency of lactation was numerically higher in group T4 as compared to T1, T2, T3 and T5 groups. The persistency of lactation was monitored for 305 days of lactation after cessation of fat supplementation to buffaloes and it was observed that bypass fat supplementation in T4 group of buffaloes not only increased the MY but the effects persisted even after the supplement was withdrawn which may be due to better dry matter intake and improved reproductive performances. The findings are in orthodox with findings of Yadav *et al*. (2018) in advance pregnant Murrah buffaloes with basal diet and soybean oil supplementation @ 200 ml/animal/day up to 90 days post-partum.

The average fat percent in milk has increased throughout the study period in all the groups. The present findings represents higher fat per cent in milk of supplemented groups and is comparable with the findings of Shelke *et al*. (2012) in Murrah buffaloes supplemented with protected nutrients @ 2.5 percent; Moncada-Lainez and Liang-Chou (2016) in Holstein cows supplemented with 500 g dried green tea leaves and 500 ml soybean oil and Thul *et al*. (2017) in Murrah buffaloes supplemented with mustard oil @ 200 g/head/day and Renno *et al*. (2014) in Holstein cows supplemented with soybean oil and unsaturated fatty acids each @ 30 g/kg observed in increase in milk fat content of the cows.

The physiological process indicates that the diets containing additional fatty acid sources suffered incomplete rumen biohydrogenation, which could have caused reduction in the Δ^9-desaturase enzyme activity, decreasing the milk fat concentration in buffaloes fed soybean oil. Among mechanisms involved in depressed milk fat per cent are the negative effects of fat supplementation on fibre digestion in the rumen leading to a reduction in the proportions of acetate to butyrate ratio, the main precursors of milk fat production, which is similar with the findings of Schroeder *et al*. (2004). Fat per cent is influenced more by lipolytic processes that tend to change the fat to protein ratio in the milk depending on the energy intake and rate of microbial protein synthesis and is similar with the findings of Negussie *et al*. (2013). In this study, increase in fat per cent in milk in all the groups may be attributed to the availability of more fatty acids for absorption in intestine and these fatty acids might have been directly incorporated in to milk fat after absorption from intestine, leading to increase in milk fat, which is in confirmation with the findings of Shelke *et al*. (2012).

The non-significant increase in protein percent in milk is in confirmation with the findings of Suksombat and Chullanandana (2008) in Holstein Friesian cows supplemented with soybean oil and rumen protected conjugated linoleic acid @ 150 g/animal/d; Altenhofer *et al*. (2014) in Holstein cows supplemented with rapeseed and soybean oil; Moncada-Lainez and Liang-Chou (2016) in Holstein cows

supplemented with 500 g dried green tea leaves and 500 ml
soybean oil and Sharma *et al*. (2016) in Murrah buffaloes supplemented with prilled fat @ 100 g/day during pre-partum and @ 150 g/day during post- partum.

Similarly, reduction in milk protein percent is related to the dilution of milk protein as higher milk volume synthesized is not synchronous with the uptake of amino acids by the mammary gland (DePeters and Cantt, 1992). Further, dietary fat decreases milk protein synthesis due to adverse effect on microbial fermentation and subsequent decline in microbial protein reaching the small intestine (Jenkins, 1993).

The non-significant findings in lactose percent in milk is in confirmation with the findings of Suksombat and Chullanandana (2008) in Holstein Friesian cows supplemented with soybean oil and rumen protected conjugated linoleic acid @ 150 g/animal/d; Sultana *et al*. (2008) in Holstein dairy cows supplemented with calcium salts of soybean oil and linseed oil fatty acids @ 1 per cent on DMB; Altenhofer *et al*. (2014) in Holstein cows supplemented with rapeseed and soybean oil; Moncada-Lainez and Liang-Chou (2016) in Holstein cows supplemented with 500 g dried green tea leaves and 500 ml soybean oil and Sharma *et al*. (2016) in Murrah buffaloes supplemented with prilled fat @ 100 g/day during pre-partum and @ 150 g/day during post- partum.

The non-significant findings about SNF percent in milk is in accordance with the findings of Suksombat and Chullanandana (2008) in Holstein Friesian cows supplemented with soybean oil and rumen protected conjugated linoleic acid @ 150 g/animal/d; Sultana *et al*. (2008) in Holstein dairy cows supplemented with calcium salts of soybean oil and linseed oil fatty acids @ 1 per cent on DMB; Altenhofer *et al*. (2014) in Holstein cows supplemented with rapeseed and soybean oil; Moncada-Lainez and Liang-Chou (2016) in Holstein cows supplemented with 500 g dried green tea leaves and 500 ml soybean oil and Sharma *et al*. (2016) in Murrah buffaloes supplemented with prilled fat @ 100 g/day during pre-partum and @ 150 g/day during post- partum.

The non-significant increase in SNF percent in milk is correlated with the findings of Suksombat and Chullanandana (2008) in Holstein Friesian cows supplemented with soybean oil and rumen protected conjugated linoleic acid @ 150 g/animal/d; Sultana *et al*. (2008) in Holstein dairy cows supplemented with calcium salts of soybean oil and linseed oil fatty acids @ 1 per cent on DMB; Altenhofer *et al*. (2014) in Holstein cows supplemented with rapeseed and soybean oil; Moncada-Lainez and Liang-Chou (2016) in Holstein cows supplemented with 500 g dried green tea leaves and 500 ml
soybean oil and Sharma *et al*. (2016) in Murrah buffaloes supplemented with prilled fat @ 100 g/day during pre-partum and @ 150 g/day during post- partum.

Conclusion

Supplementation of energy over and above the ICAR recommendation in buffaloes either through 5 per cent additional concentrate feeding or use of 100 ml of soybean oil or 100 g each of bypass fat or roasted soybean daily increased the milk yield and non-significant results of SNF, protein, lactose and

total solids percent in milk was found which might be due to less dose of supplementation of oils in the ration.

Declarations

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Danveer Singh Yadav : conducted experiment

G.P. Lakhani : As an advisor he timely checked the records of experimental findings

R.P.S. Baghel : Conceived and designed research

B. Roy : Analyzed data statistically

A. Mishra and S. Nanavati : Wrote the manuscript

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