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Review Article

ROLE OF SOYBEAN OIL AND MUSTARD OIL IN THE PERFORMANCE OF LACTATING DAIRY ANIMALS

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Abstract: Energy is critical for milk production in high-yielding dairy animals, and the supplementation of lipids to ruminant feed is a strategy to increase the energy density of the diet without increasing the proportion of grains, thus, preventing ruminal acidosis and low milk fat yield. In this context, soybean oil and mustard oil are readily available sources of lipids to dairy producers in India that have shown marked improvement in the performance of dairy animals.

Keywords: *Energy, Grains, Soybean oil, Mustard oil*

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Introduction

As calving approaches, a progressive decrease in dry matter intake by 30% in the last three weeks of gestation and about 90% during the last five to seven days before calving is observed [1]. After calving, most of the energy gets diverted for colostrum and milk synthesis as a result of which animal goes into negative energy balance [2]. Therefore, to prevent negative energy balance, an alternate source of energy is required that also counters the demerits of higher levels of concentrate feeding and saturated fatty acids in milk fat. Also, the cost of feeding per litre milk production is a significant factor in governing the economic viability of the livestock sector which must be reduced by adopting new measures in the ration formulation. This leads to the search for sources that are also easily available and economically feasible. In this context, soybean oil and mustard oil have been used for a long in many developing countries for high-producing dairy animals.

The role of soybean oil and mustard oil in the performance of lactating dairy animals is given below:

Body condition scoring (BCS) of dairy animals:

Boken, *et al*., (2005) [3] studied the effect of grazing and soybean oil refined by-product (SORB) on BCS in early lactating Holstein cows for 14 weeks post-partum study and observed that loss of body condition was less in cows fed SORB than in the control group (3.25 vs. 2.98). Similarly, Parihar, *et al*., (2018) [4] studied the effect of dietary supplementation of mustard oil (MO) and molasses @ 200 g each on average BCS of lactating indigenous cattle for the period of 90 days and revealed that overall BCS was higher in the MO group (2.65) followed by molasses (2.55) and control group (2.47). Meanwhile, Renno, *et al*., (2014) [5] studied the effect of supplementation of soybean oil and calcium salts of unsaturated fatty acids each fed @ 30 g/kg dry matter basis on BCS of pregnant Holstein cows during 35 days pre-partum to 84 days post-partum and observed decrease in BCS.

Body weight of dairy animals:

Gandra, *et al*., (2014) [6] studied the effect of refined soybean oil and calcium salts of fatty acids (MEGALAC-E) supplementation fed @ 3% each on the body weight of Holstein Friesian cows during the transition period and observed that the body weight of soybean oil treated group and control group was higher during pre and post-partum period, respectively. In addition, Kale, *et al*., (2016) [7] reported an increase in the body weight of Murrah buffalo heifers in the soybean oil and rice bran oil group by 4.43 and 3.66% as compared to the mustard oil group following the inclusion of the above oils at 3.5% of concentrate mixture. Besides, Lerma-Reyes, *et al*., (2018) [8] studied the effect of supplementation of soybean or canola oil @ 20 ml/goat/day on body weight changes in the grazing lactating goats (crossed Alpine x Nubian goats) for a period of 40 days and revealed reduced weight losses in the treatment group over the control group (0.090 vs. 0.060 kg/day). However, Suharti, *et al*., (2017) [9] studied the effect of calcium soap-soybean oil supplementation @ 5% on body weight in Bali cattle for 60 days period and observed a significant increase in body weight gain (kg/hr) in the control group (9.60) compared to treatment group (6.40).

Birth weight of calf

Tyagi, *et al*., (2010) [10] studied the effect of bypass fat supplementation @ 2.5 per cent on weight gain in crossbred cows (2nd – 4th lactation) during 40 days pre-partum to 90 days post-partum and observed that the average birth weight (kg) of the calves were 24.94 and 27.95 in control and treatment group, respectively. Ramteke, *et al*., (2014) [11] studied the effect of bypass fat supplementation @ 100 g/d for 30 days pre-partum and @ 15 g/kg milk yield for 120 days post-partum in buffaloes in 2nd - 4th lactation and observed that the average birth weight of calf was statistically higher by 7.32% in the treatment group than the control group. Thul, *et al*., (2017) [12] studied the effect of mustard oil supplementation @ 200 g/head/day on the birth weight of calves of advanced pregnant Murrah buffaloes during the transition period and observed that the mean birth weight (kg) of the calf was statistically non-significant although higher in the treatment group (31) than the control group (28.25).

Dry matter intake (DMI) of dairy animals

Veira, *et al*., (2001) [13] studied the effect of feeding soybean oil @ 3% on feed intake in mid-lactating Holstein cows for 18 weeks period and observed that there was a slight reduction *i.e*., 5 per cent in DMI in the treatment group than the control group. Further, Gandra, *et al*., (2014) [6] reported less DMI during the transition period in Holstein Friesian cows supplemented with refined soybean oil and calcium salts of fatty acids @ 3% each as compared to the control group. In addition, Sultana, *et al*., (2008) [14] observed no difference in the DMI following supplementation of 1% calcium salts of soybean oil and linseed oil fatty acids in the diet of Holstein cows. Similarly, Kathirvelan and Tyagi (2009) [15] reported no changes in DMI among the groups following dietary supplementation of mustard oil in Murrah buffaloes over 90 days period. Also, Yadav, *et al*., (2018a, 2022) [16, 17] reported no changes in the DMI of lactating Murrah buffaloes supplemented with soybean oil and mustard oil @ 200 ml/h/d during 21 days pre-partum to 90 days post-partum. Suharti, *et al*., (2017) [9] studied the effect of calcium soap-soybean oil supplementation @ 5% on feed intake in Bali cattle for 60 days period and observed a significant increase in feed consumption (kg/hour/day) of forage and concentrate in treatment (5.43) over control (5.19) group. Likewise, Parihar, *et al*., (2018) [4] observed higher overall DMI in treatment group than control group.

Milk production in dairy animals

Rego, *et al*., (2005) [18] studied the effect of supplementation of sunflower and soybean oils @ 0.5 kg each per cow per day on milk production in mid-lactating Holstein cows for 28 days and reported that the treatments had no effect on milk yield averaging around 26.3 kg/d. Also, Suksombat and Chullanandana (2008) [19] studied the effect of soybean oil or rumen-protected conjugated linoleic acid supplementation @ 150 g/animal/d each on milk yield of lactating Holstein Friesian crossbred cows and observed that milk yield was not significantly different among the groups.

AlZahal, *et al*., (2008) [20] studied the effect of monensin (22 g/kg of DM) and dietary soybean oil (1.7 and 3.4%) on the milk yield of lactating Holstein Friesian cows and observed that soybean oil linearly increased milk yield. In addition, Mele, *et al*., (2008) [21] studied the impact of soybean oil supplementation @ 100 g/day on the milk yield of lactating Saanen goats for a period of 12 weeks and observed a significant increase in the milk yield of treatment groups over control groups. Similarly, Sultana, *et al*., (2008) [14] reported an increase in milk production by 8.5 and 11.3% in Holstein cows supplemented with calcium salts of soybean oil and linseed oil fatty acids, respectively. Also, Kathirvelan and Tyagi (2009) [15] observed higher milk yield (8.90 kg/day) in mustard oil-fed buffaloes than the other groups over 90 days study period. On the other hand, Ye, *et al*., (2009) [22] studied the effects of flaxseed oil, soybean oil, and extruded soybean oil supplementation @ 2% each on the milk yield of Holstein cows during nine weeks study period and observed that the daily milk yield of treatment groups was higher than that of the control group without any change in fat corrected milk yield. Shelke, *et al*., (2012) [23] observed 19% higher milk yield in Murrah buffaloes fed with protected nutrients during 60 days pre-partum to 90 days post-partum period. Further, Yadav, *et al*., (2018a, 2022) [16, 17] observed a significant increase in daily milk yield in Murrah buffaloes by 13.54 and 8.10% in soybean oil and mustard oil supplemented groups, respectively.

On the contrary, Altenhofer, *et al*., (2014) [24] observed that the dietary supplementation of rapeseed oil and soybean oil in Holstein cows had no significant effect on energy-corrected milk yield, however, a significant reduction in milk yield was observed in late lactating cows fed soybean oil than control group. Similarly, Gandra, *et al*., (2014) [6] observed that the milk yield and 3.5% fat-corrected milk yield were significantly higher in Holstein Friesian cows of the control group than the treatment group.

Milk composition of dairy animals

Veira, *et al*., (2001) [13] studied the effect of feeding soybean oil @ 3% on milk composition in mid-lactating Holstein cows for 18 weeks period and observed that there was a slight reduction in protein (4%) and a heavy reduction in fat (23%) in the treatment group. Similarly, Rego, *et al*., (2005) [18] studied the effect of supplementation of sunflower (SFO) and soybean oils (SBO) @ 0.5 kg each per cow per day on milk composition in mid-lactating Holstein cows for 28 days and reported that the treatments had no effect on protein yield and content, but there was decrease in milk fat yield (g/d) (SFO; 893 vs. SBO; 918 vs. C; 1015) and concentration (g/kg) (SFO; 34.1 vs. SBO; 34.9 vs. C; 39.2) in supplemented diet. Besides, AlZahal, *et al*., (2008) [20] studied the effect of monensin (22 g/kg of DM) and dietary soybean oil on milk composition in lactating Holstein Friesian cows and observed that monensin, soybean oil, and their interaction linearly reduced milk fat percentage. It was also noted that soybean oil linearly reduced milk fat yield and protein percent and increased milk protein yield. In addition, Huang, *et al*., (2008) [25] studied the effect of dietary supplementation of soy oil (4-5%), conjugated linoleic acid (1% CLA), or both on milk composition in mid-lactating Holstein cows for a period of four weeks and observed 30% decline in milk fat concentration, and 22.9 and 40% decline in milk fat yield when fed alone and together, respectively in treatment over the control group. A similar result was reported by Ye, *et al*., (2009) [22] where the milk fat percentage of the treatment group was less than the control group.

On the other hand, Mele, *et al*., (2008) [21] reported that the inclusion of soybean oil (100 g/h/d) in the diet of lactating Saanen goats resulted in a significant increase in milk fat yield and concentration. Shelke, *et al*., (2012) [23] observed no effect on milk total solid, protein, solid not fat, and lactose contents among the groups, however per cent milk fat was higher by 5.43 in the treatment group than in the control group. Also, Moncada-Lainez and Liang-Chou (2016) [26] studied the effect of 500 g dried green tea leaves (TL) and 500 ml soybean oil (SBO) supplementation on the milk composition of Holstein cows. Results revealed that SBO supplementation increased fat per cent in milk (3.19) as compared to TL (2.87) and control (2.81), whereas milk protein, lactose, and solid not fat did not show significant differences among groups. Likewise, Thul, *et al*., (2017) [12] observed a significant improvement in milk fat (%) of Murrah buffaloes in the treatment group (7.38) over the control group (6.76). Besides, no difference was recorded in milk protein, solid not fat, and lactose percentage among the groups. In addition, Yadav, *et al*., (2018a, 2022) [16, 17] recorded a significant increase in milk fat percentage by 7.25 and 9.14% in soybean oil and mustard oil supplemented groups, respectively.

First post-partum estrus in dairy animals

Tyagi, *et al*., (2010) [10] studied the effect of bypass fat supplementation @ 2.5% on post-partum estrus in crossbred cows (2nd – 4th lactation) during 40 days pre-partum to 90 days post-partum study and reported that the time required for the onset of cyclicity was reduced ($p<0.05$) by 6.5 days in the treatment group as compared to the control group. Similarly, Parihar, *et al*., (2018) [4] observed a significantly short post-partum estrus period (39.46 days) in lactating indigenous cattle in the mustard oil supplemented group followed by molasses (52.8 days) and control group (63.64 days).

Service period in dairy animals

Tyagi, *et al*., (2010) [10] observed that the service period was reduced ($p<0.05$) by 31.7 days in crossbred cows in the treatment group following dietary supplementation of bypass fat @ 2.5% over the control group. Similarly, Ramteke, *et al*., (2014) [11] revealed that bypass fat supplementation @ 100 g/d for 30 days pre-partum and @ 15 g/kg milk yield for 120 days post-partum caused a reduction in the service period of buffaloes by 32.56 days. Nevertheless, Thul (2014) [27] also observed that days open in Murrah buffaloes supplemented with mustard oil @ 200 g/head/day were reduced by 7.5 days.

First service conception rate in dairy animal:

Khalil, *et al*., (2012) [28] studied the consequence of dietary protected fat (PF) @ 3-5% on the number of services per conception in lactating Holstein cows and observed that number of services per conception reduced to 1.6 and 1.2 services in 3% and 5% PF groups, respectively as compared to 3 services in the control group. In addition, Thul (2014) [27] observed that the average conception rate in advanced pregnant Murrah buffaloes during the transition period was high in the treatment group over the control group (50 vs. 25%). Suharti, *et al*., (2017) [9] studied the effect of calcium soap-soybean oil supplementation @ 5% on the conception rate in Bali cattle for 60 days period and observed a significant increase in the proportion of cattle with service per conception (S/C=1).

Time required for expulsion of foetal membranes in dairy animals

Tyagi, *et al*., (2010) [10] revealed that the time taken for the expulsion of foetal membranes in crossbred cows was decreased ($p<0.05$) by 5.4 hours in the treatment group as compared to the control group. Likewise, Thul (2014) [27] observed a reduction in the time of the expulsion of foetal membranes in Murrah buffaloes by 4 hours in the treatment group over the control group.

Retention of foetal membranes in dairy animals

Thul (2014) [27] observed that there were 25% fewer incidences of retention of foetal membranes in Murrah buffaloes of the treatment group following mustard oil supplementation than in the control group. Besides, Singh, *et al*., (2016) [29] studied the effect of prilled fat supplementation @ 75 g/animal/d during 45 days pre-partum and @ 150 g/animal/d during 70 days post-partum on retention of foetal membranes in advance pregnant crossbred Karan Fries cows and observed that there were fewer cases of retention of foetal membranes in the treatment group than the control group.

Cost economics of milk production

Gowda, *et al*., (2013) [30] studied the effect of dietary supplementation of protected fat @ 10 g/lit milk on net profit in Holstein Friesian cows for 195 days soon after calving and reported a net profit of Rs. 11.60 per cow per day in the treatment group due to higher milk production. Similarly, Naik (2013) [31] studied the effect of feeding indigenously prepared bypass fat in rations of the high-producing dairy animals on the economics of milk production and observed an additional benefit of Rs. 12-40 per animal per day. Vahora, *et al*., (2013) [32] as well studied the effect of dietary supplementation of bypass fat @ 20 g/kg milk yield on the economics of production in 2nd - 3rd lactation buffaloes for a period of 3 months and reported significant improvement in net returns on the sale of milk (Rs./day) in supplemented group (66.46) over the control group (50.93). In addition, Parihar, *et al*., (2018) [4] studied the effect of dietary supplementation of mustard oil and molasses @ 200 g each on the economics of milk production in lactating indigenous cattle for the period of 90 days and revealed a net profit of Rs. 127.49 per animal per day in mustard oil treated group than the control group. Likewise, Yadav, *et al*., (2018b, 2018c) [33, 34] reported an increase in net returns per animal per day by 27.94 and 20.43% in soybean oil and mustard oil supplemented groups.

Conclusion

It is evident from the above works of literature that the dietary inclusion of soybean and mustard oil as lipid sources have a phenomenal effect in improving the overall performance of dairy animals, and thus, can be recommended in the dairy animals' diet as a safe, eco-friendly and cost-effective technology to generate higher revenues.

Application of research: Dietary inclusion of soybean oil and mustard oil maintains a positive energy balance in lactating dairy animals, and is a cost-effective strategy to generate higher profit.

Research Category: Livestock Production Management
Abbreviations: DMI- Dry matter intake, BCS- Body condition score

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