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Effect of sunflower (*Helianthus annuus*) oil supplementation on nutrient digestibility, hematological profile and return over feed cost in lactating Mehsana buffaloes

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Abstract
To study the effect of sunflower (*Helianthus annuus* L.) oil supplementation on milk production, nutrient digestibility, hematological profiles, and return over feed cost, eighteen lactating Mehsana buffaloes were assigned randomly into three groups. The treatments were CON: control group (fed basal diet); SO125 and SO250 were fed control diet supplemented with 125 and 250 ml/h/d sunflower oil for a period of 90 days. There was no difference (p>0.05) in feed intake of lactating buffaloes among the dietary treatments. Dietary inclusion of sunflower oils improved milk yield by 17.9 and 20.7%, 6% FCM yield by 16.4 and 22.9% and ECM yield by 16.0 and 23.0% in SO125 and SO250 groups, respectively as compared to the control. There was no significant (p>0.05) effect on the digestibility of dry matter, crude protein, crude fiber, ether extract, and nitrogen-free extract among the treatment groups. The mean hematological parameters were comparable between the control and treatment groups. The net return over feed cost was 30.22 and 26.41% higher in SO125 and SO250 groups, respectively as compared to the control. Based on the results, it may be concluded that 125 ml sunflower oil supplementation in the diet of lactating Mehsana buffaloes improved milk production and net return over feed cost.

Keywords: Buffalo, Milk yield, Return over feed cost, Sunflower oil

Introduction
India posses 109.85 million buffalo which contribute around 51% of the country's total milk production (20th Livestock Census 2019) [9]. The Mehsana breed of Indian buffalo have originated through crossbreeding between the Murrah and the Surti. A dairy breed of buffalo known as Mehsana can be found in north Gujarat and the neighboring state of Maharashtra. Milk fat content of buffaloes is higher and with the sudden onset of parturition, there is energy mismatch due to lower feed intake at the beginning of lactation. It increases the mobilization of body reserves to maintain the milk yield (Saqib *et al*. 2022) [16]. Vegetable oils like sunflower (*Helianthus annuus* L.) oil can be supplemented to increase energy intake and lessen the harmful consequences of a negative energy balance in lactating buffaloes. Earlier studies have found benefits of sunflower oil supplementation in lactating animals include increased energy concentration in the diet, reduced supply of rapidly fermentable carbohydrates, and better productive performance (Bernard *et al*., 2009) [3].
However, most of the studies of feeding sunflower oil have been carried out in lactating cows and goats. We hypothesized that supplementation of sunflower oil in early lactating Mehsana buffaloes will to bring improvement nutrient digestibility, hematolgy as health parameter and and economics of milk yield. Thus, the study has been planned to asses the effect of sunflower oil supplementation nutrient digestibility, hematological profile and return over feed cost in lactating Mehsana buffaloes.

Materials and Methods
Animals and experimental design: The current study was carried out at Sardarkrushinagar Dantiwada Agricultural University's Livestock Research Station in Sardarkrushinagar, Gujarat. The experimental protocol followed in this study was approved by the Institutional Animal Ethics Committee (VETCOLL/IAEC/2020/16/PROTOCOL-7). Eighteen lactating Mehsana buffaloes (21 days in milk, 465 kg average body weight, 2073 kg standard lactation milk yield) were assigned randomly into three treatments: CON: control group (fed basal diet); SO125 and SO250 were fed control diet supplemented with 125 and 250 ml/h/d sunflower oil for a period of 90 days.

Sunflower oil was properly mixed into the concentrate mixture thoroughly and provided once daily during the experimental period. The experimental animals were fed as per ICAR (2013) feeding standards to meet the nutrient requirements. The chemical composition of feeds and fodders fed to the experimental animals is given in Table 1.

Table 1: Chemical composition (% DM basis) of feeds and fodder fed to experimental animals

Composition	Concentrate mixture	Green oat fodder	Jowar hay
Dry matter	94.76	17.44	11.83
Crude protein	20.56	8.92	6.39
Crude fibre	6.38	27.67	32.25
Ether extract	4.15	3.12	1.34
Total ash	12.21	7.34	9.07
NFE	56.70	23.81	21.79

Sampling and chemical analysis: The representative samples of feed and fodder were drawn at the time of feeding were weighed in pre-weighed dishes, and then dried overnight in the hot air oven at 100±5 ºC for dry matter estimation and use further analysis of ash (method 942.05), crude protein (method 976.05), crude fibre and ether extract (method 973.18) according to AOAC (2007) [1].

Milk production: Buffaloes were milked twice a day at twelve hours intervals and individual milk yield (kg/d) was recorded in kg at each milking by using electronic weighing balance. The 6% fat corrected milk (FCM) was Calculated by using Rice formula (1970): milk yield (kg) x 0.4 + fat yield (kg) x 15/1.3. Energy corrected milk (ECM) was determined according to Davidson *et al.* (2008) [5]: 0.327 × milk yield (kg/d) + 12.86 × fat yield (kg/d) + 7.65 × protein yield (kg/d).

Nutrient digestibility: A digestion trial of 7 days duration was conducted at the end of experimental feeding. It involved quantification of feed intake and faeces excreted for assessing the digestibility of nutrients. Any feed not consumed within 24 hrs. of offering was removed from the enclosure and recorded as refusal. Representative samples of feed offered and residues left were collected from each meal, pooled animal-wise over the period of 7 days and brought to the laboratory for further laboratory analysis.

Hematological profiles: At the end (90th day) of experimental feeding, blood samples from external jugular vein were collected from each experimental animal in sterilized anti-coagulant vial for hematological parameter measurement The data obtained was analyzed by adopting standard statistical procedures.

Results and Discussion

Milk production: The supplementation of 125 and 250 ml of sunflower oil in Mehsana buffaloes improved overall milk yield by about 18% and 21% in SO125 and SO250 groups as compared to the CON, respectively. Also 6% FCM yield improved around 16.4 and 22.9% and ECM yield improved 16.0 and 23.0% (P=166) in SO125 and SO250 groups, respectively as compared to the CON group (Table 2). Numerical improvement in milk yield observed due to supplementation of sunflower oil might be dure to the change in ruminal fermentation pattern leading to increased propionate production caused by antimicrobial properties of the supplement. Propionate is the most important substrate for hepatic gluconeogenesis (accounting for 60–74% total substrate), which is highly associated with milk yield in cows (Aschenbach *et al*., 2010) [2]. Besides, glucose is a precursor of lactose, an osmotic constituent of milk, which increases water secretion and consequently milk volume (Miglior *et al*., 2006) [13]. Dai *et al.* (2011) [4] found significant (p<0.05) increase in milk yield (26.4 *vs.* 25.5 kg/d) in dairy cows supplemented with 2% sunflower oil. In contrast, no effects on milk production performance due to feeding of sunflower oil in dairy cows were reported in the earlier studies (Silva *et al*. 2018; De Souza *et al.* 2019; Ferlay and Chilliard 2020) [18, 6, 9].

Table 2: Effect of sunflower oil supplementation on milk yield of lactating Mehsana buffaloes

Yield (kg/d)	Dietary groups			
	CON	SO125	SO250	P value
Milk	7.44±0.71	8.77±0.54	8.98±0.30	NS
6% FCM	7.64±0.78	8.89±0.71	9.39±0.37	NS
ECM	10.70±1.07	12.41±0.97	13.16±0.51	NS

NS, non-significant
FCM: fat corrected milk; ECM: energy corrected milk
†CON: fed on basal diet (Control), SO125: CON + 125 ml/animal/day of sunflower oil; SO250: CON + 250 ml/animal/day of sunflower oil

Nutrient digestibility: Digestibility of all the nutrients was non-significant (p>0.05) in SO125 and SO250 group as compared to CON group. Higher amount of fat (5-7%) may affect the fiber digestibility in ruminants. However, as the level of sunflower oil supplementation was lower in present study, no deleterious effect was observed on nutrient digestibility. Similar to the present findings, Do Prado *et al.* (2015) [8] reported non - significant effect of sunflower oil supplementation on digestibility of DM, CP, NDF and ADF in treatments as compared to the control group. Moreover, Sarrazin *et al.* (2004) [15] found that supplementation of 78 g/kg of dry matter sunflower seed in lactating Holstein cows also showed non - significant effect on dry matter, neutral detergent fibre, acid detergent fibre and crude protein digestibility, However, significant improvement in ether extract digestibility was reported. Hartanto *et al.* (2019) [10] found significantly decrease (p>0.05) in digestibility (%) of dry matter, crude protein, acid detergent fibre with increase in ether extract in female goat on supplementation of sunflower oil at the rate of 33 and 66 g/ kg of dry matter.

Table 3: Effect of supplementation of sunflower oil on dry matter intake, nutrient intake and apparent digestibility of lactating Mehsana buffaloes

Attributes	Dietary groups			
	CON	SO125	SO250	P value
Dry matter intake (kg/day/animal)				
Dry matter	14.15±0.32	13.15±0.42	14.04±0.21	NS
Concentrate	6.06±0.27	5.29±0.40	6.06±0.29	NS
Green maize	3.93±0.04	3.99±0.02	3.90±0.03	NS
Dry Jowar	3.78±0.10	3.51±0.04	3.69±0.10	NS
Nutrient intake (kg/day/animal)				
Crude protein	1.73±0.05	1.57±0.08	1.73±0.04	NS
Ether extract	0.578±0.02	0.514±0.03	0.577±0.02	NS
Crude fiber	3.14±0.05	2.99±0.03	3.09±0.03	NS
Nitrogen free extract	7.35±0.17	6.81±0.23	4.29±0.12	NS
Nutritive value (% on DM intake)				
TDN	83.6±0.69	77.8±0.11	84.4±0.32	NS
DCP	13.3±0.09	12.1±0.05	13.4±0.05	NS
Apparent Digestibility (%)				
Dry matter	63.98±4.95	64.80±1.88	65.37±2.11	NS
Crude protein	76.89±3.58	77.76±0.83	77.72±1.32	NS
Crude fiber	61.57±8.77	62.75±3.29	62.16±2.96	NS
Ether extract	59.45±5.44	58.98±2.77	63.28±2.17	NS
Nitrogen free extract	65.77±3.02	65.69±2.39	67.28±3.09	NS

NS, non-significant

[†]CON: fed on basal diet (Control), SO125: CON + 125 ml/animal/day of sunflower oil; SO250: CON + 250 ml/animal/day of sunflower oil

Haematologicals parameters: The mean haemoglobin (Hb) and haematocrit values were comparable (p>0.05) between the control and treatment groups. There was no significant (p>0.05) effect on red blood cells count (erythrocytes) caused by the dietary addition of sunflower oil in lactating Mehsana buffaloes. The white blood cell count (leucocytes) was also not influenced on addition of sunflower oil which indicated that no inflammatory process was reported in the lactating cows during the experimental period. In agreement with present findings, Diapari *et al*. (2017) [7] also reported no alterations (p>0.05) in the values of Haematologicals parameters after feeding of 4 and 6% of sunflower oil of the DM of the diet /animal/day.

Table 4: Effect of supplementation of sunflower (*Helianthus annuus*) oil on haematological parameters of lactating Mehsana buffaloes

Parameters	Dietary groups			
	CON	SO125	SO250	P value
Haemoglobin (g/dL)	11.97±0.17	11.82±0.39	11.59±0.13	NS
Hematocrit (%)	33.55±0.68	32.83±0.48	33.88±1.04	NS
Erythrocytes(10^6/µL)	6.95±0.28	6.75±0.07	6.68±0.32	NS
Leukocytes(10^3/µL)	7.93±0.27	8.18±0.27	8.22±0.45	NS

NS, non-significant

[†]CON: fed on basal diet (Control), SO125: CON + 125 ml/animal/day of sunflower oil; SO250: CON + 250 ml/animal/day of sunflower oil

Economics of feeding: Net return over feed cost was significantly (p<0.05) improved in T_1 and T_2 groups as compared to the control but not significant different between T_1 and T_2 group. The net return over feed cost was 30.22 and 26.41% higher in T_2 and T_3 groups, respectively as compared to the control.

Table 5: Economics of feeding sunflower oil to experimental animals

Parameters	Dietary groups			
	CON	SO125	SO250	P-value
Feed cost /animal/day	206.489	198.32	205.32	-
Cost of sunflower oil /animal/day	-	15	30	-
Total feeding cost/animal/day	206.488[a]	213.318[b]	235.32[b]	p<0.05
Average milk yield/animal/day (g)	7.44	8.77	8.98	NS
Market value of milk yield/animal/day (Milk kg price- Rs.60/kg)	446.829[a]	526.286[b]	539.143[b]	p<0.05
Net Return over feed cost/animal/day	240.341[a]	312.967[b]	303.82[b]	p<0.05
Net Return over control	-	72.62	63.47	-
Net Return over control in percentage	-	30.21	26.4	-

NS, non-significant

[ab]Means with different superscripts in a row differed significantly

FCM: fat corrected milk; ECM: energy corrected milk

[†]CON: fed on basal diet (Control), SO125: CON + 125 ml/animal/day of sunflower oil; SO250: CON + 250 ml/animal/day of sunflower oil

Conclusion

Based on results, it may be concluded that sunflower oil may be supplemented in the diet of lactating Mehsana buffaloes at the rate of 125 ml/head/day for improved milk production performance and better for economics.

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