Haryana Vet. (December, 2020) **59(2)**, 206-209

Research Article

EFFECT OF β-CAROTENE SUPPLEMENTATION ON MILK YIELD AND ITS COMPOSITION IN MURRAH BUFFALOES

SAGAR KADYAN*, HARISH K. GULATI, OSHIN[1], SUSHIL KUMAR[2] and SAJJAN SIHAG[2]
Department of Livestock Production Management, [2]Department of Animal Nutrition, LUVAS, Hisar-125004,
[1]Department of Animal Genetics and Breeding, NDRI, Karnal, India

Received: 18.07.2019; Accepted: 11.06.2020

ABSTRACT

Fifteen pregnant buffaloes, one month prior to parturition were divided into three groups randomly on the basis of their age, parity, body weight and previous milk yield. Group G_1 (control) was fed with basal diet as per ICAR (2013). G_2 was supplemented with β-carotene at the level of 300 mg/animal/day orally and G_3 was supplemented with β-carotene at the level of 500 mg/animal/day orally, in addition to control diet. Average milk yield of animals was not affected due to β-carotene supplementation. Mean milk fat % among the different groups remained unaffected at each progressive week of sampling, but the overall mean milk fat% in the control group G_1 (5.57%) was significantly lower ($p<0.05$) than that of G_2 (6.22%) and G_3 (5.98%) . Milk SNF%, Protein%, and Lactose% showed non-statistical variations only. Overall milk SCC in control group (106.79 × 10^3 somatic cells/ml of milk) was significantly higher ($p<0.05$) as compared to that of group G_2 (94.13 × 10^3 somatic cells/ml) and G_3 (95.13 ×10^3 somatic cells/ ml of milk).

Keywords: β-carotene, Murrah, Production, Reproduction

During the early lactation, when the energy demand of the high-producing dairy animal becomes increasingly difficult to meet out, nutrition, production and reproduction of the animal are closely associated with each other (Bisinotto *et al*., 2012). Energy, protein and minerals have profound effect on milk production and fertility performance (Ibtisham *et al*., 2018). In addition, vitamins A, E and B_{12} also influence fertility performance (Mwendia, 1991). The main source of vitamin A for ruminants is β-carotene from green foliage. In the intestinal mucosa, β-carotene is converted to vitamin A. A serum β-carotene level of 3.0 µg/ mL has been suggested as the level for which dietary supplementation with β-carotene is beneficial (Frye *et al*., 1991). Studies have found dietary β-carotene supplementation to positively affect milk yield (Oldham *et al*., 1991; Arechiga *et al*., 1998). However, others have not seen production responses with supplemental β-carotene (Bindas *et al*., 1984; Rakes *et al*., 1985; Wang *et al*., 1988). β-carotene also functions separately from vitamin A as an antioxidant and can directly enhance immunity with possible reproductive and mammary benefits (Chew, 1993). Current study was designed to study the effect of β-carotene supplementation on milk yield and its composition in Murrah buffaloes.

MATERIALS AND METHODS

Location of study: The study was carried out at the Buffalo farm of Department of Livestock Production Management, College of Veterinary Sciences, LUVAS, Hisar which is situated in a semi-arid region with sub-tropical climate. Geographically, Hisar is situated at 29°10' N latitude, 75°40' E longitude and 215.2 meters altitude.

Experimental animals: A total of 15 pregnant buffaloes, one month prior to parturition were taken from farm of the Department of Livestock Production Management. On the basis of age, parity, body weight and previous milk yield, animals were divided in 3 groups (G_1, G_2 and G_3) each with 5 animals.

G_1: served as control and fed with basal diet as per ICAR (2013) feeding standard.

G_2: supplemented with β-carotene @ 300 mg/animal/day orally in addition to control diet.

G_3: supplemented with β- carotene @ 500 mg/animal/day orally in addition to control diet.

Housing and management of the animals: Experimental buffaloes were housed in loose houses. The dimension of each loose house was 135 feet (Length) × 65 feet (width), which can accommodate 50 adult buffaloes. The covered area of the loose house (shed) had a concrete manger, as well as in the open area along with a 1.25 m north side boundary wall. Asbestos sheet roofing with "*Typha-Typha"* (*Patera*) grass insulated the covered area. Concrete waterers under tree shade were provided in the open area. Three weeks before the expected calving date, the animals were moved to the down calver. After calving, buffaloes were transferred to the lactating herd. Milking of

Corresponding author: sagar.kadyan21@gmail.com

Table 1

Ingredient composition (%) of concentrate mixture offered to animal under different dietary treatment groups

Ingredients (kg/100 kg)	Concentrate Mixture		
	G_1	G_2	G_3
Wheat	20	20	20
Barley	27	27	27
Mustard cake	24	24	24
Groundnut cake	8	8	8
Soybean meal	8	8	8
Wheat bran	10	10	10
Min. mix.	2	2	2
Common salt	1	1	1
β-carotene (mg/day/animal)	-	300	500

the lactating buffaloes was being done twice a day in separate milking parlor as per the routine management practice.

Feeding and watering: Balanced concentrate mixture was prepared with cereals, cakes, byproduct, mineral mixture and salt according to the BIS (1992) standards as shown in Table 1.

Concentrate mixture was provided twice daily, in the morning and evening. Seasonal green was chaffed and offered twice during working hours. *Ad libitum* wheat straw was provided in the manger keeping in view that a small quantity remains for the next day and the manger may not get empty.

Duration of the feeding trial: Beta carotene supplementation in the lactating buffaloes was done for 2 months i.e. one month prior to parturition to one month after the parturition.

Analysis of milk parameters: Simultaneous analysis of the milk was also done from the day of parturition to end of the feeding trial. The animals were hand milked and yields were recorded at each milking. The yields were then added to estimate daily yield of individual animal starting from 3-4 days after calving. Composition of milk samples were recorded at 1st week after calving and at each weekly interval thereafter until the end of the experiment. These samples were collected during the morning milking from each experimental animal. A total of 60 samples were taken and processed at the same day.

The data pertaining to milk yield were obtained from the record of the farm. Milk sample were collected at weekly interval and analyzed for fat, protein, SNF, lactose (%) using automatic machine (mrc milk analyzer, Model: MIA-S-30, S/N: 9166). Somatic cell count in milk was analyzed using automatic somatic cell counter (Lactoscan, milkotronic ltd). β-carotene was estimated by the method proposed by AOAC (2000).

Table 2

Mean values of Milk yield (kg/week) of experimental animals under different treatment groups

Period (week)	Treatment Groups		
	G_1	G_2	G_3
I	31.62±2.55	33.78±3.22	32.03±0.70
II	47.42±9.38	50.90±5.52	54.72±5.74
III	67.12±5.34	68.67±6.64	68.07±4.31
IV	74.70±3.56	74.70±6.57	75.42±5.01
Overall mean	55.22±5.21	57.01±5.49	57.56±3.94

Statistical analysis: Statistical analysis was performed by using the IBM SPSS statistics 20 software package for windows using the one-way analysis of variance. Significant differences among the treatments were determined using Duncan's test as per Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

The overall mean of milk yield during the study varied from 55.22±5.21 kg/week in control group to 57.01 ± 5.49 and 57.56±3.94 kg/week in G_2 and G_3, respectively, being slightly ($P<0.05$) higher in β-carotene supplemented group (Table 2). Similarly, De-Ondarza *et al*. (2009), who in a study of supplementation of 425 mg β-carotene per day found no effect on the milk production. In contrary to the current findings, Arechiga *et al*. (1998) and Oldham *et al*. (1991) reported increase in milk production upon β-carotene supplementation in lactating animals.

Mean value (%) of the different milk parameters *viz*. milk fat, SNF, protein and lactose percent have been shown in Table 3.

The overall mean value of milk fat % in the control group, G_1 (5.57%) was significantly lower ($p<0.05$) than the animals which were supplemented with β carotene i.e. G_2 (6.22%) and G_3 (5.98%) groups. Milk fat percentages were significantly influenced by supplementation of β-carotene as reported by Rakes *et al*. (1985) and Lotthammer (1985). Supplemental beta-carotene has a positive effect on the rumen cellulolytic bacteria and alter rumen biohydrogenation and reduced formation of trans-10 isomers in the rumen resulting in less milk fat depression (Pottier *et al*., 2006). De-Ondarza *et al*. (2009) observed increases in 3.5% FCM and milk fat yield in early lactation and mature cows.

Table 3

Mean values of Milk parameters (%) of experimental animals under different treatment groups

Period (week)	Treatment Groups		
	G_1	G_2	G_3
Milk Fat%			
I	5.78±0.32	6.48±0.34	6.18±0.27
II	5.62±0.33	6.23±0.32	6.04±0.28
III	5.46±0.30	6.13±0.35	5.88±0.26
IV	5.39±0.31	6.05±0.33	5.81±0.28
Overall mean	5.57^{a}±0.15	6.22^{b}±0.16	5.98^{b}±0.13
Milk SNF %			
I	8.83±0.06	8.92±0.08	8.76±0.09
II	8.87±0.03	8.95±0.07	8.87±0.05
III	8.85±0.04	8.92±0.07	8.95±0.04
IV	8.89±0.03	8.97±0.06	9.00±0.03
Overall mean	8.86±0.02	8.94±0.03	8.89±0.03
Milk Protein %			
I	3.52±0.13	3.55±0.12	3.66±0.07
II	3.58±0.10	3.57±0.03	3.66±0.05
III	3.61±0.06	3.58±0.10	3.63±0.09
Period (week)	Treatment Groups		
	G_1	G_2	G_3
IV	3.77±0.02	3.68±0.07	3.81±0.02
Overall mean	3.62±0.05	3.60±0.04	3.69±0.03
Milk Lactose %			
I	4.63±0.09	4.62±0.04	4.55±0.06
II	4.58±0.07	4.53±0.12	4.55±0.02
III	4.71±0.05	4.64±0.02	4.69±0.05
IV	4.70±0.02	4.50±0.07	4.57±0.11
Overall mean	4.65±0.03	4.58±0.03	4.60±0.03

Mean values with different superscripts in a row differ significantly ($p<0.05$).

Milk SNF % (Table 3) was almost equal in all the treatment groups with non-statistical variations. The overall Milk SNF % among the different groups G_1, G_2 and G_3 were 8.86, 8.94 and 8.89%, respectively. These results indicated that β-carotene supplementation didn't make any significant effect on milk SNF%.

Similar to milk SNF %, milk protein % was also observed to be not affected by the β-carotene supplementation (Table 3). The overall milk protein percentage among the different groups varied from 3.62 in G_1 to 3.60 and 3.69%, G_2 and G_3, respectively. Overall mean milk lactose varied from a minimum of 4.58% in G_2 to a maximum of 4.65 in G_1 but there was no influence of β-carotene supplementation at any level on milk Lactose % at any week of lactation.

Table 4

Mean values of Somatic Cell Count (×10^3/ml) in milk of experimental animals under different treatment groups

Period (week)	Treatment Groups		
	G_1	G_2	G_3
I	123.50^{a} ±2.74	93.16^{b} ±4.12	92.16^{b} ±4.11
II	105.00±2.97	95.66±4.62	97.00±3.16
III	99.50±2.50	95.33±5.89	93.83±5.12
IV	99.16±2.12	92.33±2.47	97.50±3.26
Overall mean	106.79^{a}±2.40	94.13^{b}±2.10	95.13^{b}±1.92

Mean values with different superscripts in a row differ significantly ($p<0.05$)

Milk carotene: β-carotene was not detected in any of the milk samples from the β-carotene supplemented groups i.e. G_2 and G_3.

Somatic Cell Count (SCC) of Milk: SCC (×10^3/ml) in the milk of the animals (Table 4) in G_1 (control group) was significantly higher ($p<0.05$) as compared to the β-carotene fed groups during the first week of lactation. The overall mean value of SCC (×10^3/ml) was lesser in β-carotene supplemented groups (94.13 in G_2 and 95.13 in G_3) in contrast to that of control group (106.79).

Rakes *et al*. (1985) stated that milk somatic cell concentrations were lower in cows supplemented with β-carotene. Similarly, Chew (1993) have observed the results which supported their initial hypothesis that deficiencies or insufficiencies in vitamin A and carotene may be associated with udder infections in cows. Vitamin A is important for mammary gland epithelial cell proliferation and apoptosis during the dry period making the udder healthier, leading to increased milk yield (Puvogel *et al*., 2005).

CONCLUSION

It was inferred from the study that the yield and chemical composition of milk e.g. protein, SNF and lactose were not affected by β-carotene supplementation in the diet of lactating buffaloes but milk fat % and somatic cell counts were significantly ($p<0.05$) improved in the supplemented animals.

REFERENCES

AOAC. (2000). Official Methods of Analysis (17th Edn.). The Association of Official Analytical Chemist, Gaitherburg, Madison.

Arechiga, C.F., Staples, C.R., McDowell, L.R. and Hansen, P.J. (1998). Effects of timed insemination and supplemental ß-carotene on reproduction and milk yield of dairy cows under heat stress. J.

Dairy. Sci. **81**: 390-402.

Bindas, E.M., Gwazdauskas, F.C., Aiello, R.J., Herbein, J.H., McGilliard, M.L., and Polan, C.E. (1984). Reproductive and metabolic characteristics of dairy cattle supplemented with ß-carotene. *J. Dairy. Sci.* **67**: 1249-1255.

BIS. (1992). Bureau of Indian Standards, Cattle Feed Specification (4th Review). Manak Bhawan, 9-Bhadur Shah Zafar Marg, New Delhi, India.

Bisinotto, R.S., Greco, L.F., Ribeiro E.S., Martinez, N., Lima, F.S., Staples C.R., Thatcher, W.W. and Santos, J.E.P. (2012). Influences of nutrition and metabolism on fertility of dairy cows. *Anim. Reprod.* **9(3)**: 260-272.

Chew, B.P. (1993). Role of carotenoids in the immune response. *J. Dairy Sci.* **76**: 2804-2811.

De Ondarza, M.B., Wilson, J.W., and Engstrom, M. (2009). Case study: Effect of supplemental ß-carotene on yield of milk and milk components and on reproduction of dairy cows. *Prof. Anim. Sci.* **25**: 510-516.

Frye, T.M., Williams, S.N. and Graham, T.W. (1991). Vitamin deficiencies in cattle. *Vet. Clin. N. Anim. Food Anim. Prac.* **7**: 217-275.

Ibtisham, F., Nawab, A., Li, G., Xiao, M., An, L. and Seer, G.N. (2018). Effect of nutrition on reproductive efficiency of dairy animals. *Med. Weter.* **74(1)**: 6025-2018.

ICAR (2013). Nutrient requirement of cattle and buffalo. Indian Council of Agricultural Research, New Delhi.

Lotthammer, K.H. (1985). Carotin-Einsatz in der winterfutterung von michkuhen. *Kraftfutter.* **68**: 40-42.

Mwendia, C.M.T. (1991). Effect of beta-carotene supplementation on fertility of dairy cattle in Kenya. M.Sc. thesis submitted to University of Nairobi, Kenya.

Oldham, E.R., Eberhart, R.J. and Muller, L.D., (1991). Effects of supplemental vitamin A or ß- ovarian activity and serum insulin concentrations in a goat model. *J. Endocrinol. Invest.* **36**: 23-45.

Pottier, J., M.Focant, M., Debier, C., De Buysser, G., Goffe, C., Mignolet, E., Froidmont, E., and Larondelle, Y. (2006). Effect of dietary vitamin E on rumen biohydrogenation pathways and milk fat depression in dairy cows fed high-fat diets. *J. Dairy. Sci.* **2**: 685-686.

Puvogel, G., Baumrucker, C.R., Sauerwein, H., Ruhl, R., Ontsouka, E., Hammon, H.M. and Blum, J.W. (2005). Effects of an enhanced vitamin A intake during the dry period on the retinoids, lactoferrin, IGF system, mammary gland epithelial cell apoptosis and subsequent lactation in dairy cows. *J. Dairy Sci.* **88**: 1785-1800.

Rakes, A.H., Owens, M.P., Britt, J.H. and Whitlow, L.W. (1985). Effects of adding beta-carotene to rations of lactating cows consuming different forages. *J. Dairy Sci.* **68**: 1732-1737.

Snedecor, G.W. and Cochran, W.G. (1994). Statistical Methods (8th Edn.) Iowa State University Press, Ames, USA.

Wang, J.Y., Owen, F.G. and Larson, L.L. (1988). Effect of beta carotene supplementation on reproductive performance of lactating Holstein cows. *J. Dairy Sci.* **71**: 181-186.