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Original Research Article

Effect of β- Carotene Supplementation on Milk Performance in Cross Bred Cattle (Yield and Milk Composition)

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A B S T R A C T

Twelve lactating cross bred cows was selected from Dairy farm of Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh. These cows was randomly divided into two equal groups I & II and fed on green fodder *ad libitum* and measured amount of concentrate mixture. All the cows were free from physiological, anatomical and infectious disorders. Group I & II was supplemented with beta carotene 0 & 500 gm per day respectively for a period of 30 days. After completion of these trial milk yield and milk composition were determined and statistically analyzed. Milk yield and composition was also determined on 1, 8, 15, 22, and 29 day. Milk from cows receiving beta carotene contained higher milk yield, fat and Total solid. Milk SNF, protein, lactose & pH were differ non significantly in supplemented group.

Keywords

Milk production, antioxidant status and immune system

Introduction

Fat soluble antioxidant vitamins *i.e.* β-carotene and retinol are necessary for good health, immune system, physical growth and reproduction of cattle. Supplementation of these vitamins considered necessary for optimization of cattle health and cattle product quality due to their capability to impact the lipid oxidations in biological systems. Vitamin-A (β- carotene) is an essential feature in promoting immunity and reducing oxidative stress. The impact of nutritional β-carotene concentration on milk production, antioxidant status and immune system in cattle were assessed. Some findings of earlier workers showed that milk yield and milk composition remained unchanged upon supplementation with a high dose of β-carotene as compared to control, but providing a higher dose of β-carotene resulted in a considerable decrease in the SCC of the milk. More than 90 percent of mineral deficiencies exist at subclinical level in livestock (Underwood and Suttle, 1999). Garg and Bhandari (2005) reported low animal productivity and impaired reproductive behavior due to mineral deficiency and corrected these ailments through supplementation of various vitamins & minerals. Supplementation of area specific mineral mixture and vitamin are not practicing in most of the part of country (Garg *et al.,* 2004). The purpose of this study was to determine the effect of supplementation of beta-carotene on milk yield and composition in cross bred cows.

Materials and Methods

This investigation was undertaken to study the milk production in lactating cross bred cows on diet containing different feed supplements. The experiment was carried out for a period of 30 days. The trial was conducted on crossbred lactating cows maintained at dairy farm, Department of Animal Husbandry and Dairying, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. Twelve crossbred cows in lactation was selected herd. They were divided into two groups on the basis of their lactation number and lactation yield during the current lactation. Cows group was selected according to their milk production, lactation period and body weight to maintain the similarity in the trial.

Treatment details

Selected animals was divided into two groups. Cows of groups I and II were supplemented with 0 and 500 mg beta-carotene (β-C) respectively in the lactating period which was continued 30 days of lactation.

The nutrient requirements of all experimental animals were mostly met with *ad libitum* green fodder and measured amount of concentrate. Concentrate mixture had 20% CP and 70% TDN consisted of 33% maize, 21% ground nut cake (oiled), 12% mustered cake (oiled) 20% wheat bran, 11% de-oiled rice bran, 2% mineral mixture and1% common salt.

Observation recorded

Milking Schedule

Milking was done 2 times per day, at equal intervals. Morning at 5.00 to 6.00 AM and evening 5.00 to 6.00 PM. Hand milking was practiced in cattle and milk yield of each animal was recorded.

Collections of Milk Samples and Recording Milk Yield

The milk samples collected during milking and further analyzed in lab. The milk yield of individual animals was also recorded during the experiment. The milk samples were collected on 1, 8, 15, 22, and 29 day. The milk yield (morning & evening) of individual animals per day was also recorded during the experiment. Cow milk samples for chemical analysis were prepared as per the method described in BIS Handbook (SP 18: 1981).

Milk Composition Analysis

Determination of Fat

In the Gerber method, this is achieved by treating milk with sulphuric acid of known specific gravity, which dissolves milk proteins and carbohydrates and releases fat. The released fat is separated from the digested material by adding small amount of iso-amyl alcohol which acts as surfactant.

The mixture is then centrifuged at 1100 rpm for 4 min and the volume of separated fat is then read on the graduated stem of the butyrometer at 65°C. This is a quick, routine method in common use and gives results within accuracy of ± 0.10% when compared with gravimetric method.

Determination of SNF (solids-not-fat) and TSS (total solids)

Measurement of specific gravity or density by a lactometer is based on the Archimedes principle. A floating object sinks till it has displaced a weight of fluid equal to its own weight. The greater the volume of displaced fluid, smaller is the density of the fluid and lower is the lactometer reading. The total solids and the SNF content of milk are related to its fat percentage and specific gravity by the Richmond's formula. Milk drawn from the udder contains a large volume of air bubbles and the milk fat undergoes a gradual solidification. Due to these factors a gradual contraction in the volume of milk takes place with a slow increase in specific gravity to a maximum (Racknagal phenomenon). The specific gravity of milk will, therefore, vary with the duration and temperature of storage. This variation may be overcome by ensuring that the fat is completely in the liquid state before the specific gravity reading is taken. This is achieved by pre-warming the milk.

The % of SNF and Total Solids in milk is the calculated using the following formula:

$$\text{SNF (in \%)} = \frac{\text{CLR}}{4} + 0.25\text{F} + 0.44$$

Total solids = CLR / 4 + 1.22 F + 0.57

Where,

F = Fat content of milk.

SNF = Solids-not-fat in milk;

CLR = Corrected lactometer reading at 27°C,

Determination of milk pH

The pH of milk samples was measured using pH meter.

Determination of milk Lactose

The lactose content of all the milk sample of milk were determined using Lane Eynon Method described in BIS Handbook (SP 18: part XI, 1981).

Lactose (% by Weight) = 5X / Y

Where,

X = ml of 0.5% standard lactose solution used for titration.

Y = ml of lactose milk filtrate used for titration.

Determination of milk Protein

The milk protein content of all the milk sample of milk were determined using micro-Kjeldahl method of nitrogen estimation as described in BIS Handbook (SP 18: part XI, 1981). The percent total protein was obtained multiplying the percent nitrogen by a factor of 6.38.

Calculation

Calculate the total nitrogen content of the test sample by the following equation:

Total N = $1.4007(V_s - V_b)\, M_r / W$

Where,

V_s = volume of standard acid used for titration of test sample (ml).

V_b = volume of standard acid used for titration of blank sample (ml).

M_r = exact concentration of standard acid used in titration (N).

W = weight of sample used (g).

Statistical Analysis

The data obtained during investigation were subjected to statistical analysis using t- test to compare difference among group's means for different parameters by using SPSS 16.0 software.

Results and Discussion

Milk yield

Effect of supplementation of β- carotene on milk yield is presented in Table 1.1. It is clearly indicated by the presented data that milk yield differed significantly by using supplementation of β- carotene. The average milk yield was recorded higher in group-2 (treatment) (5.23 kg/ d) as compared to group-1 (control) (5.04 kg/d). The average increase in milk yield was recorded 0.19 kg/d. This increase was recorded consistently throughout the whole experiment. Similar findings were obtained by Arechiga *et al.,* (1998) who indicated that milk yield was increased up to 6.11% when the dairy cattle was supplemented with 400 mg/d concentrated of β- carotene.

Milk Fat

Data pertaining to milk fat % are presented in Table 1.2. It is obvious from the data that higher milk fat (3.49 %) was recorded with group-2 (treatment), whereas, minimum milk fat (3.37 %) was observed in group 1 (control). The average increase in milk fat was recorded 0.12 %. The difference in milk fat % was found non-significant up to two weeks after supplementation, while during 3rd and 4th week, milk fat % was found significantly different between both the treatments. Ondarza *et al.,* (2009) found significantly ($P < 0.05$) higher fat concentration (+0.1%) especially for early lactation cows and cows in their third lactation are greater.

SNF (%)

The effect of supplementation of β- carotene on SNF content of milk is shown in Table1.3. It was seen from the findings of the experiment that higher SNF content was recorded with group-1 (control) (7.60 %) as compared to group 2 (treatment) (7.51 %). It is clearly indicated by the present findings that there is no effect of supplementation of β- carotene on SNF content of milk. Jin *et al.,* (2014) also found non-significant effect on milk SNF (%) when supplemented of VA (110 IU/kg BW or 220 IU/kg BW) did not affect the milk solids not-fat.

Protein (%)

Data presented in Table 1.4 showed the effect of supplementation of β- carotene on protein % of milk. It can be concluded from the data presented in the Table that group 1 contained higher protein content as compared to group-2 on 2nd and 3rd week. The difference in protein content of milk was found nearly similar in both groups, while during 4th week, milk protein content was found non-significant in group - 2.

Lactose (%)

Data concerning lactose content of milk as affected by supplementation of β- carotene are presented in Table 1.5. It is apparent from data that group-1 (control) contained higher lactose content (4.20 %) as compared to group 2 (treatment) (4.15 %). It is clearly indicated by the present findings that there is no effect of supplementation of β- carotene on lactose content of milk.

Table.1 Effect of beta carotene supplementation on milk yield (kg).

WEEK	MEAN ± SD		SEM	P VALUE
	GROUP 1 (Control)	GROUP 2 (Treatment)		
0	5.12±0.60	5.18±1.21	0.26	0.884
1	5.05±0.62	5.25±1.02	0.23	0.554
2	5.00±1.09	5.19±0.76	0.25	0.624
3	5.06±1.20	5.24±1.26	0.31	0.732
4	4.95±0.98	5.25±1.20	0.30	0.511

Mean bearing different superscript in a column differ significantly ($p < 0.05$).

Table.2 Effect of beta carotene supplementation on milk fat (%)

WEEK	MEAN ± SD		SEM	P VALUE
	GROUP 1 (Control)	GROUP 2 (Treatment)		
0	3.49±0.35	3.47±0.39	0.10	0.923
1	3.36±0.20	3.45±0.29	0.07	0.387
2	3.37±0.16	3.46±0.26	0.06	0.333
3	3.29±0.18	3.48±0.24[a]	0.06	0.043
4	3.30±0.23	3.55±0.29[b]	0.06	0.035

Mean bearing different superscript in a column differ significantly ($p < 0.05$).

Table.3 Effect of beta carotene supplementation on SNF (%) in milk

WEEK	MEAN ± SD		SEM	P VALUE
	GROUP 1 (Control)	GROUP 2 (Treatment)		
0	7.50±0.15	7.46±0.11	0.03	0.465
1	7.64±0.15	7.61±0.12	0.04	0.622
2	7.56±0.10	7.56±0.15	0.03	0.964
3	7.66±0.12	7.55±0.15	0.03	0.232
4	7.62±0.10	7.53±0.16	0.02	0.142

Mean bearing different superscript in a column differ non-significantly ($p < 0.05$).

Table.4 Effect of beta carotene supplementation on milk Protein (%)

WEEK	MEAN ± SD		SEM	P VALUE
	GROUP 1 (Control)	GROUP 2 (Treatment)		
0	3.22±0.16	3.27±0.08	0.02	0.393
1	3.27±0.11	3.26±0.10	0.03	0.973
2	3.24±0.08	3.23±0.11	0.03	0.837
3	3.26±0.09	3.20±0.08	0.02	0.127
4	3.26±0.08	3.17±0.08[a]	0.02	0.006

Mean bearing different superscript in a column differ non-significantly ($p < 0.05$).

Table.5 Effect of beta carotene supplementation on Lactose (%) in milk.

WEEK	MEAN ± SD		SEM	P VALUE
	GROUP 1 (Control)	GROUP 2 (Treatment)		
0	4.20±0.07	4.22±0.07	0.02	0.564
1	4.19±0.07	4.20±0.08	0.03	0.822
2	4.18±0.07	4.17±0.09	0.03	0.871
3	4.20±0.07	4.16±0.11	0.02	0.239
4	4.20±0.06	4.15±0.13	0.02	0.102

Mean bearing different superscript in a column differ non-significantly ($p < 0.05$).

Table.6 Effect of beta carotene supplementation on pH in milk.

WEEK	MEAN ± SD		SEM	P VALUE
	GROUP 1 (Control)	GROUP 2 (Treatment)		
0	6.60±0.06	6.58±0.03	0.01	0.275
1	6.60±0.04	6.57±0.04	0.01	0.177
2	6.62±0.04	6.56±0.04	0.01	0.216
3	6.62±0.04	6.56±0.04	0.01	0.213
4	6.55±0.05	6.56±0.04	0.01	0.430

Mean bearing different superscript in a column differ non-significantly ($p < 0.05$).

Table.7 Effect of beta carotene supplementation on TSS (%) in milk.

WEEK	MEAN ± SD		SEM	P VALUE
	GROUP 1 (Control)	GROUP 2 (Treatment)		
0	10.99±0.39	10.96±0.34	0.10	0.846
1	11.09±0.25	11.06±0.30	0.08	0.830
2	10.94±0.20	11.03±0.29	0.07	0.379
3	11.02±0.25	10.97±0.43	0.09	0.776
4	10.93±0.24	10.98±0.32	0.08	0.698

Mean bearing different superscript in a column differ significantly ($p < 0.05$).

pH

The effect of supplementation of β- carotene on pH of milk is shown in Table 1.6. It was seen from the findings of the experiment that higher pH was recorded with group-1 (control) (6.6) as compared to group 2 (treatment) (6.57). It is clearly indicated by the present findings that there is no effect of supplementation of β- carotene on pH of milk.

TSS (%)

A perusal of data shown in Table 1.7 clearly indicated the effect of supplementation of β-carotene on TSS content of milk. It is apparent from data that higher TSS content was recorded with group 2 (treatment) (11.01 %) as compared to group-1(control) (11.00 %). It is clearly indicated by the present findings that there is significant effect of supplementation of β- carotene on TSS content of milk. Keeping in view the research outcomes summarized above, it can be concluded that the supplementation of β-carotene in the ration of cattle herd resulted in improvement of milk quality in term of increased milk yield, milk fat, milk acidity & total soluble solids (TSS) in milk. Whereas, there was no effect on solid-not-fat (SNF), protein, lactose, pH content of milk.

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