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Effect of Niacin Supplementation on Nutrient Utilization and Blood Biochemical Parameters in Crossbred Cows during Heat Stress

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ABSTRACT

The present study was conducted in eighteen crossbred early lactating cows (2^{nd} to 4^{th} lactation; 11.56±1.74 days in milk) to investigate the effect of different levels of niacin supplementation on nutrient utilization and blood biochemical profile during heat stress period (April to August; 120 days). The animals were divided into three groups of six animals each on the basis of milk production and body weight. The basal ration was fed same to all cows, except the addition of niacin @ 600 and 800 mg/kg dry matter intake (DMI) in T_1 and T_2 groups, respectively. The temperature humidity index (THI) was calculated at 07:30 am and 02:30 pm daily. At the end of experimental feeding, a digestibility trial was conducted to estimate the digestibility of nutrients and their balance. Fortnightly body weights were recorded and blood was collected at day 0 and then at fortnightly intervals to study the blood biochemical profile. The results revealed that animals were in either moderate or severe stress at morning, whereas during afternoon the animals were in very severe stress during the entire trial. The mean dry matter intake (DMI; kg/d) was significantly ($P<0.05$) high in T_1 (12.03) than C (11.78), but T_2 has an intermediate value (11.89). But body weight, nutrient digestibility and nutrient balance (Ca and P) were similar in control and niacin supplemented groups. Likewise different blood parameters were found similar irrespective of different dietary treatments except total protein and albumin which was significantly higher ($P<0.05$) in T_2 than C. It can be concluded that supplementation of niacin at 600 and 800 mg/kg DMI in the diet of lactating crossbred cows had no significant beneficial effect on nutrient utilization.

Key words: *Crossbred cows, Niacin, Nutrient utilization, blood biochemical profile, Heat stress*

INTRODUCTION

Heat stress is a serious problem in dairy farming which results in lower milk yield, disturbances in reproduction, health problems and economic loss[27]. Dairy cows suffering from heat stress during the summer exhibit decreased feed intake and activity, as well as increased respiratory rates, peripheral blood flow and sweating[26]. It can decrease dry matter intake and milk yield of dairy cows by 6 to 30% and 15 to 20%, respectively[23].

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Certain vitamins (A, C, E, B_3) and minerals (Cr, Se, K) can play an important role in reducing heat stress. Out of this, nicotinic acid (NA), a B vitamin, is an important vitamin that elicits vasodilator reactions which is beneficial for cows under heat stress. Peripheral and internal vasodilatation, caused by therapeutic concentration of NA may enhance heat transfer from core to skin sites and generate the temperature gradient favoring heat loss from skin to environment[1]. Earlier researchers reported either decreased DMI[9,16], increased DMI[19] or no effect on DMI[27,28,30] while supplementing niacin.

Earlier it was assumed that niacin is synthesized in adequate amounts in the rumen to meet out the needs of the dairy cow[17]. However, due to improvement in the genetic potential of dairy cows in recent years, the requirements tend to exceed the capacity of rumen microorganisms to synthesize sufficient amount of this vitamin[25]. Considering above facts, the study was undertaken to evaluate the effect of niacin supplementation on nutrient utilization and blood biochemical parameters in lactating crossbred cows under heat stress conditions.

MATERIALS AND METHODS

The present study was conducted in the cattle yard of National Dairy Research Institute (NDRI), Karnal, Haryana. The city Karnal is situated at an altitude of 250 meters above mean sea level, latitude and longitude position being 29^o 42” N and 79^{o}54” E respectively. The maximum ambient temperature in summer goes up to 45^{0}C and minimum temperature in winter comes down to 0 ^{0}C with a diurnal variation in the order of 15-20 ^{0}C.

Experimental design, animals and management

Eighteen healthy lactating crossbred cows (Karan Fries) in their early lactation (2nd to 4th lactation; 11.56±1.74 days in milk) were selected and randomly divided into three groups of six animals each on the basis of milk production (17.30±1.80 kg) and body weight (414.33±8.35 kg). The experiment was conducted during 25th April to 22nd August. The design of the experiment was Randomized block design (RBD). There was separate manger for all cows. The cows were milked thrice daily. When cows returned to their respective pens after the morning milking, head-locks were set for breeding. The animals were provided with fresh and clean drinking water free choice thrice daily at 06:00 am, 11:30 am and 06:30 pm.

Diet

All the cows were fed same basal ration consisted of wheat straw, chaffed green maize fodder and compounded concentrate mixture as per NRC[18]. But the ration of T_1 and T_2 groups were supplemented with niacin @ 600 and 800mg/kg DMI/animal/day, respectively. The quantity of niacin to be supplemented was mixed in a small quantity of concentrate mixture to ensure the full consumption. The total concentrate mixture offered to each animal was divided into three portions and fed at 04:30 am, 09:30 am and 04:30 pm, whereas green fodder was fed twice daily at 11:00 am and 06:00 pm. The dry fodder was given *ad lib*. The chemical composition of green fodder, straw and concentrate mixture used in the present study is presented in Table 1.

Recording of climatic variables and temperature humidity index

Microclimatic data viz., dry bulb temperature and wet bulb temperature and minimum and maximum temperature and relative humidity was recorded at 7:30 am and 2:30 pm using Zeal (UK) thermometer every day during experimental period. Temperature humidity index (THI) was calculated by using the formula of Johnson *et al*[12].

$$THI = 0.72 (T_{db} + T_{wb}) + 40.6$$

Where, T_{db} = dry bulb temperature (ºC)

T_{wb} = wet bulb temperature (ºC)

Body Weight and Dry matter Intake (DMI)

The animals were weighed before feeding and watering in the morning on two consecutive days at the start of experimental feeding and thereafter at fortnightly intervals during the experimental period of 120 days. DMI was recorded weekly by subtracting the residual DM from the quantity of DM offered.

Digestion trial

A digestion trial of seven days was conducted at the end of trial. Representative samples of feed, residue and faeces were taken from individual animal in the morning and pooled samples of seven days were analyzed for dry matter, proximate principles and fiber fractionation. Total amount of faeces voided by each animal during 24 hrs was recorded. An aliquot of faecal samples (1/250th) was dried daily at 100^{0}C in the oven and pooled for seven days for the estimation of chemical composition. The samples of feed offered, residue and faeces were analyzed for proximate principles as per the protocol described in AOAC[2]. Calcium in feed and faeces were estimated by using atomic absorption spectrophotometer (Model Z-5000, Polarized Zeeman Atomic absorption Spectrophotometer, Hitachi High-Technologies Corporation, Tokyo, Japan). Phosphorus content in sample was estimated by Photometric method[5].

Blood sampling and observation

Blood samples (10 ml) were taken from jugular vein at day 0 and fortnightly intervals and serum separation was done and stored at -20 ^{0}C in different aliquots for the analyzing various biochemical constituents. Different blood biochemical parameters viz. Total Protein, albumin, creatinine, cholestrol, ALP, SGOT and SGPT were analyzed by using standard diagnostic kits. Blood was analyzed within one hour after collection using BC-2800 Vet Autohaematology analyzer (Shenzhen Mindray Bio-medical Electronics Co. Ltd.) for analysis of WBC, HGB, RBC and PLT parameters respectively. The respective analyzer works on electrical impedance for counting cells and cyanide free method.

Statistical Analysis

The data obtained was analyzed as described by Snedecor and Cochran[21]. The test of significance among the different treatments was also analyzed[22].

RESULTS AND DISCUSSION

Environmental variables recorded during the experiment

The maximum and minimum temperature (^{0}C) at morning time ranged from 32.2-41.5 and 19.4 to 27.5 respectively throughout the experimental period (25th April, 2012 - 22th August, 2012) being higher on 45 (represents the mean temperature of 24th May - 9th June, 2012) and 60th day (represents the mean temperature of 10th June – 24th June, 2012; Table 2). However, at afternoon the corresponding maximum and minimum temperature ranged from 32.6-42.2 and 20.4-28.9 respectively. The relative humidity in morning and afternoon session ranged between 52-90 and 19-75 respectively. The high temperature and low humidity represented the hot dry condition up to 25th June whereas afterwards there was hot humid condition (low temperature and high humidity). Temperature humidity index (THI) varied from 69.7-80.6 and 81.4-87.3 in morning and afternoon, respectively. The THI was increased in a linear fashion up to 75th day of experimental period afterwards it showed a descending trend. The THI values of morning depicted that animals were in moderate (25th April - 9th May) and severe stress (10th May onwards) whereas in afternoon they were in very severe heat stress condition throughout the experimental period of 120 days.

Fortnightly body weight of lactating cows

Average body weight after eight fortnights were 393.22±3.80, 398.74±2.58 and 393.23±3.55 kg in control, T1 and T2 groups, respectively (Table 3). Statistical analysis of data did not show any significant effect of supplementation of niacin on body weight of cross bred cows during summer season ($P<0.05$). These results are in accordance with the findings of Yuan *et al*[28] who did not find any significant effect on body weight while supplementing 12 g/d rumen protected niacin (RPN). Kumar and Dass[13] also reported no effect on body weight gain during 120 days of experimental feeding in male buffalo calves after supplementing 100 and 200 ppm niacin. Similarly, Magliocca *et al*[14] supplemented 200 mg niacin per day in the diet of young bulls and reported that it did not improve the performance of bulls in terms of live weight gains. The failure of supplementary niacin to improve animal performance may be due to its breakdown in the rumen by rumen microbes with little subsequent increase in its intestinal absorption[32].

Dry matter intake

The results of fortnightly average DMI (kg/d, kg/100 kg BW and g/kg $W^{.75}$) are presented in Table 4. Dry matter intake (kg/d) averaged 12.35±0.21, 12.39±0.18 and 12.40±0.24 at start of trial which decreased to 11.64±0.27, 11.89±0.24 and 11.75±0.26 at 120 days of experimental diets in control, T1 and T2, respectively. The decrease in dry matter intake might be attributed to decreased body weight because of heat stress and lactation stress. The high environmental temperature stimulates peripheral and core receptors that results in the transmission of suppressive impulses to the appetite centre which causes decrease in feed intake[15]. On an average dry matter intake (kg/day) in control, T1 and T2 were 11.78±0.08, 12.03±0.06 and 11.89±0.09 respectively. The DMI was significantly higher in T1 than control; however there was no significant difference between T1 and T2. DMI in control and T2 were also comparable (P>0.05). The higher DMI in T1 was because of higher body weight (398.74±2.58 kg) as compared to control (393.22±3.80 kg) and T2 (393.23±3.55 kg). The dry matter intake (kg/100 kg BW, g/kg $W^{.75}$) was 3.00±0.01, 3.02±0.01 and 3.03±0.01 and 133.55±0.44, 134.89±0.51 and 134.72±0.47 in C, T1 and T2 groups, respectively which was statistically similar in all the three groups (P>0.05). Similar results were reported by other workers (Ghorbani *et al*[11]., Small[20], Yuan *et al* [28]., Wrinkle *et al*[27]., Zimbelman *et al* [30]). Zimbelman *et al*[29] found no treatment effect of supplementing RPN on DMI. Kumar and Dass[13] also reported no effect of supplementing 100 and 200 ppm niacin on dry matter intake in male buffalo calves during 120 day of experimental feeding. Trials that supplemented un-protected niacin are numerous, but these studies were not conducted during summer months and also the results are widely inconsistent. However, Zimbelman[31] reported an increase in DMI on supplementing RPN. The difference found might be explained in the light of fact that the present study was conducted under very severe heat stress condition.

Effect of niacin supplementation on nutrient intake and nutrient digestibility in cross bred cows during digestibility trial

Digestible intake of DM, OM, CP, EE, NDF and ADF was not influenced by supplementation of niacin (Table 5). Though digestible DM, OM, CP and ADF intake were numerically higher in T1 and T2 in comparison to control group but statistically the results were insignificant (P>0.05).The digestibility coefficient of DM, OM, CP, EE, NDF and ADF are presented in Table 6. The results revealed that digestibility of various nutrients were statistically similar exhibiting no effect of niacin supplementation (P>0.05). These results are in agreement with those obtained by Ghorbani *et al*[11] who reported that niacin supplementation (0, 6 and 12 g niacin per cow per day) did not significantly affect OM, NDF and ADF digestibility in 21 Holstein cows during summer. Similarly, Kumar and Dass[13] also reported that supplementation of 100 and 200 ppm niacin/day in male buffalo calves did not have any significant effect on nutrient intake and digestibility of DM, OM, CP and EE, NDF and ADF. Previous research workers also did not observe any significant difference on DM, CP and NDF digestibility between niacin and non-niacin supplemented dairy cattle in normal environment studies[5,8,10].

Calcium and Phosphorous balance

The intake, excretion and balance of Ca and P were statistically similar in all the three experimental groups (Table 7). All the animals were found to be positive in calcium and phosphorous balance. The Ca and P balance in C, T1 and T2 were 32.42±1.95, 34.92±6.04, 38.63±6.51 and 48.56±3.91, 51.88±5.59, 52.29±6.76 respectively. The calcium and phosphorous retention also did not differ significantly among the experimental groups. The above results corroborate well with the findings of Kumar and Dass[13] who found that niacin supplementation (100 and 200 ppm) had no effect on intake, outgo and balances of Ca and P in male buffalo calves. The information regarding the effect of niacin on Ca and P balances in lactating cows is not available, so the results cannot be discussed in the light of previous literature.

Blood Biochemical parameters

Different blood biochemical parameters viz. Globulin (g/dl), A:G ratio, creatinine (mg/dl), cholestrol (mg/dl), ALP (IU/l), SGOT (IU/l) and SGPT (IU/l) revealed no statistical difference of niacin supplementation among different dietary treatments (Table 8). These findings corroborate with the results of earlier researchers[13,7]. However, total protein (g/dl) was found significantly higher ($P<0.05$) in T_2 (6.93) than C (6.63), but T1 has intermediate value (6.80). But albumin concentration (g/dl) was found higher ($P<0.05$) in T2 (3.20) than C (2.85) and T1 (2.94). The results indicate the nitrogen adequacy in 800 ppm niacin supplemented group. Daghash *et al*[6] also found increased serum total protein on niacin supplementation in suckling calves. But Kumar and Dass[13] and Belibasakis and Tsirgogianni[4] found no effect of niacin supplementation in male buffalo calves and dairy cows respectively. The difference found might be because these studies are not conducted in heat stress period.

Blood Hematology

There was no difference found in blood hematology on niacin supplementation (Table 9). Similarly Waltz *et al*[24] also found no significant effect of heat stress on blood haematological parameters in growing pigs. The literature pertaining to effect of niacin supplementation on haematological parameters is not available to best of our knowledge so the results can't be discussed.

Table 1: Chemical composition of maize fodder, wheat straw and concentrate mixture (on % dry matter basis)

Feed ingredients	DM	CP	OM	EE	ASH	NDF	ADF	Niacin content (ppm)
Maize fodder	15.42	8.45	90.33	1.95	9.67	51.20	28.44	273.92
Wheat straw	89.33	3.23	86.02	0.95	13.98	66.30	37.30	355.38
Concentrate mixture	90.56	21.22	92.82	4.10	7.18	32.19	16.33	538.16

Table 2: Environmental parameters recorded during the experimental period (25th April-22nd August)

Days	Maximum temp' (^{0}C)		Minimum temp' (^{0}C)		Relative Humidity' (%)		THI'^	
	M*	A⁺	M*	A⁺	M*	A⁺	M*	A⁺
0#	35.4	37.8	19.6	20.4	69	26	69.7	81.4
15	36.5	38.7	19.4	20.8	57	20	70.2	81.8
30	39.7	39.9	23.2	25.2	52	19	74.1	84.7
45	41.5	42.2	25.1	27.4	56	25	76.7	86.5
60	41.2	41.9	27.0	28.8	63	35	79.8	87.3
75	37.4	37.7	27.5	28.9	74	55	80.6	87.0
90	34.6	34.8	26.8	28.6	84	60	80.4	85.6
105	32.3	32.8	26.2	28.5	90	75	79.3	83.0
120	32.3	32.6	25.9	28.8	90	73	78.8	83.4

*M= observation recorded at 7:30 am, ⁺A= observation recorded at 2:30 pm

^THI= Temperature humidity index, 'represents the mean of 15 days observation

0#represents the mean of the adaptation period

Table 3: Fortnight body weight (kg) of cross bred cows (KF) fed ration supplemented with niacin

Fortnights	Control	Treatment 1	Treatment 2
0*	414.67±9.71	414.33±8.35	413.83±9.89
1	409.00±10.18	411.83±7.17	407.83±10.45
2	401.67±10.26	406.50±7.02	401.17±9.58
3	396.67±10.70	401.83±7.05	396.00±9.68
4	390.17±11.53	396.17±8.31	387.83±9.53
5	384.50±12.09	393.17±7.02	385.83±10.09
6	380.00±12.26	388.83±7.08	381.08±10.45
7	380.00±11.19	386.67±6.84	380.83±11.65
8	382.33±11.70	389.33±5.43	384.67±11.65
Overall mean±SEM	**393.22± 3.80**	**398.74±2.58**	**393.23±3.55**

Table 4: Fortnight DMI (kg/d, kg/100kg B.W. and g/kg $W^{0.75}$) of cross bred cows fed ration supplemented with niacin

Fortnights	DMI (kg/day)			DMI (kg/100 kg B.W.)			DMI g/kg $W^{0.75}$		
	C	T_1	T_2	C	T_1	T_2	C	T_1	T_2
0*	12.35±0.21	12.39±0.18	12.40±0.24	2.98±0.04	2.99±0.03	3.00±0.04	134.43±1.26	134.99±1.11	135.20±1.30
1	12.29±0.14	12.47±0.13	12.18±0.17	3.01±0.05	3.03±0.04	3.00±0.06	135.29±1.66	136.52±1.52	134.48±1.86
2	12.03±0.10	12.24±0.19	12.11±0.24	3.00±0.05	3.02±0.04	3.02±0.02	134.33±1.64	135.29±1.74	135.10±0.80
3	11.81±0.16	12.07±0.14	11.93±0.18	2.98±0.04	3.01±0.04	3.02±0.04	133.02±1.13	134.49±1.24	134.44±1.27
4	11.70±0.27	11.92±0.12	11.79±0.27	3.01±0.05	3.02±0.04	3.04±0.03	133.45±1.85	134.38±1.28	134.93±1.14
5	11.49±0.26	11.77±0.17	11.76±0.27	2.99±0.04	3.00±0.02	3.05±0.02	132.40±1.00	133.37±0.87	135.04±0.94
6	11.38±0.28	11.78±0.20	11.54±0.30	3.00±0.03	3.03±0.04	3.03±0.04	132.30±0.75	134.52±1.50	133.82±1.79
7	11.36±0.27	11.75±0.15	11.55±0.28	3.00±0.05	3.04±0.05	3.04±0.06	132.07±1.63	134.80±1.96	134.09±2.13
8	11.64±0.27	11.89±0.24	11.75±0.26	3.05±0.03	3.05±0.06	3.06±0.05	134.67±0.78	135.64±2.65	135.35±1.79
Overall mean ± SEM	11.78^{a}±0.08	12.03^{b}±0.06	11.89^{ab}±0.09	3.00±0.01	3.02±0.01	3.03±0.01	133.55±0.44	134.89±0.51	134.72±0.47

0* represents mean values of the adaptation period

^{a,b}Values with different superscripts in a row differs significantly (P<0.05)

Table 5: Effect of niacin supplementation on nutrient intake (kg/d) in cross bred cows

Parameter	C	T_1	T_2	SEM
Digestible nutrient intake (kg/d)				
Digestible Dry matter	7.54±0.37	7.72±0.20	7.59±0.21	0.15
Digestible Organic matter	6.88±0.24	7.14±0.19	7.03±0.18	0.11
Digestible Crude Protein	1.12±0.07	1.15±0.05	1.16±0.05	0.03
Digestible Ether Extract	0.30±0.01	0.31±0.02	0.31±0.01	0.01
Digestible NDF	3.51±0.22	3.56±0.09	3.50±0.12	0.09
Digestible ADF	1.24±0.12	1.36±0.07	1.26±0.10	0.05
Digestible TDN	7.69±0.33	7.91±0.19	7.75±0.20	0.14
Nutrient density (%)				
TDN%	66.73±1.40	66.91±0.93	66.52±0.54	0.55
DCP%	9.68±0.38	9.78±0.38	9.80±0.39	0.21

Table 6: Effect of niacin supplementation on nutrient digestibility in cross bred cows

Parameter	Digestibility coefficient (%)			SEM
	C	T_1	T_2	
DM	65.39±1.66	65.33±1.09	65.16±0.63	0.65
OM	66.65±1.54	66.80±1.17	66.79±0.54	0.63
CP	61.83±2.82	62.92±2.39	63.79±2.56	1.42
EE	75.42±1.10	75.47±0.50	75.89±0.91	0.48
NDF	60.27±2.26	59.56±1.26	59.50±0.88	0.86
ADF	44.75±2.85	47.74±1.78	44.91±2.32	1.32

Table 7: Effect of niacin supplementation on calcium (Ca) and Phosphorous (P) balance in cross bred cows

Parameter	C	T1	T2	SEM
Calcium balance				
Ca Intake (g/d)	109.97±2.40	113.04±0.71	111.21±2.32	1.10
Faecal Ca outgo (g/d)	62.96±3.28	63.86±4.86	58.21±5.91	2.67
Milk Ca outgo (g/d)	14.59±2.21	14.26±1.23	14.37±1.86	0.97
Total Ca outgo (g/d)	77.56±2.13	78.11±6.16	72.58±6.26	2.87
Ca Balance (g/d)	32.42±1.95	34.92±6.04	38.63±6.51	2.89
Ca Retention				
Absorbed Ca (g/d)	47.01±3.28	49.18±4.82	53.00±5.64	2.59
Absorbed Ca (% of Intake)	42.73±2.84	43.53±4.30	47.71±4.99	2.29
Phosphorous balance				
P Intake (g/d)	101.02±1.90	103.44±0.56	102.00±1.83	0.87
Faecal P outgo (g/d)	37.40±2.92	34.15±5.01	34.18±4.73	2.36
Milk P outgo (g/d)	15.06±1.14	17.42±0.91	15.53±0.70	0.42
Total P outgo (g/d)	52.46±2.86	51.57±5.36	49.71±5.41	2.53
P Balance (g/d)	48.56±3.91	51.88±5.59	52.29±6.76	3.00
P Retention				
Absorbed P (g/d)	63.62±4.04	69.30±5.33	67.82±6.06	2.86
Absorbed P (% of Intake)	62.85±3.21	66.94±5.02	66.22±5.19	2.48

Table 8: Effect of niacin supplementation on levels of blood biochemical and serum enzymes in lactating crossbred cows

Attributes/ Treatments	Months					Treatment Mean ± SEM
	0	I	II	III	IV	
Total Protein (g dl⁻¹)						
Control	6.78±0.20	6.64±0.16	6.32±0.12	7.29±0.38	6.12±0.27	6.63^{a}±0.13
T1	6.56±0.15	6.82±0.26	6.64±0.19	7.09±0.29	6.91±0.32	6.80^{ab}±0.11
T2	6.71±0.09	6.97±0.18	6.92±0.20	7.32±0.25	6.75±0.15	6.93^{b}±0.09
Albumin (g dl⁻¹)						
Control	3.00±0.12	2.77±0.11	2.80±0.13	3.03±0.16	2.65±0.10	2.85^{a}±0.06
T1	2.88±0.11	3.00±0.10	2.85±0.08	3.07±0.10	2.88±0.08	2.94^{a}±0.04
T2	3.27±0.14	3.15±0.15	3.32±0.16	3.23±0.18	3.02±0.19	3.20^{b}±0.07
Globulin (g dl⁻¹)						
Control	3.44±0.16	3.82±0.26	3.60±0.29	4.08±0.17	3.73±0.24	3.73±0.10
T_1	3.78±0.15	3.87±0.12	3.52±0.14	4.26±0.29	3.47±0.27	3.78±0.10
T_2	3.67±0.17	3.82±0.27	3.79±0.24	4.03±0.28	4.03±0.27	3.87±0.11
A:G Ratio						
Control	0.97±0.08	0.85±0.09	0.96±0.10	0.80±0.04	0.84±0.10	0.88^{b}±0.04
T_1	0.80±0.05	0.72±0.04	0.81±0.07	0.73±0.06	0.79±0.07	0.77^{a}±0.03
T_2	0.80±0.07	0.81±0.07	0.78±0.08	0.78±0.05	0.73±0.05	0.78^{a}±0.03
Creatinine (mgdl⁻¹)						
Control	1.50±0.16	1.56±0.13	1.47±0.15	1.30±0.07	1.33±0.14	1.43±0.06
T_1	1.63±0.21	1.30±0.08	1.41±0.11	1.22±0.15	1.30±0.15	1.37±0.07
T_2	1.74±0.07	1.45±0.18	1.34±0.18	1.37±0.12	1.37±0.11	1.45±0.06
Cholestrol (mgdl⁻¹)						
Control	123.92±3.78	138.00±5.54	152.83±7.59	142.18±7.45	135.46±10.07	138.48±3.46
T_1	129.16±7.43	140.62±9.40	145.46±6.62	136.04±6.86	124.82±5.26	135.22±3.31
T_2	125.14±7.13	135.79±5.90	140.79±10.48	136.77±6.46	127.77±8.54	133.25±3.45
ALP (IU L⁻¹)						
Control	22.55±0.41	23.04±0.32	24.32±0.61	23.81±0.72	22.29±0.49	23.20±0.26
T_1	22.46±0.34	23.13±0.49	23.87±0.57	23.38±0.49	22.31±0.42	23.03±0.22
T_2	22.41±0.42	23.52±0.46	24.70±0.34	23.10±0.27	21.99±0.49	23.15±0.24
SGOT (IU L⁻¹)						
Control	21.13±0.65	23.13±0.66	25.11±0.71	24.23±0.69	22.70±0.83	23.26±0.39
T_1	22.39±0.88	23.69±0.74	26.08±0.88	24.50±0.86	22.68±0.85	23.87±0.43
T_2	22.26±0.74	24.14±0.75	26.38±0.64	24.79±0.67	23.13±0.66	24.14±0.39
SGPT (IU L⁻¹)						
Control	89.28±1.48	94.06±2.56	98.42±1.42	92.53±1.75	85.46±3.47	91.95^{b}±1.25
T_1	90.56±2.11	91.94±1.44	95.77±2.01	90.76±1.92	86.34±2.79	91.07^{b}±1.04
T_2	85.93±2.69	89.88±2.39	93.70±1.58	87.22±2.02	81.62±1.85	87.67^{a}±1.16

Table 9: Effect of niacin supplementation on levels of blood profile in lactating crossbred cows

Attributes/ Treatments	Fortnight					Treatment Mean ± SEM
	I	II	III	IV	V	
WBC (X 10³/µl)						
Control	9.47±0.72	9.10±0.62	10.87±0.87	10.42±1.06	11.37±1.07	10.24±0.40
T_1	10.40±0.77	9.72±0.76	11.05±1.25	9.68±0.92	9.53±1.36	10.08±0.45
T_2	9.80±0.65	10.02±1.39	10.82±1.35	9.03±1.62	9.32±1.12	9.80±0.54
Haemoglobin concentration (gm/dl)						
Control	8.75±0.70	9.58±0.76	8.15±0.43	7.38±0.36	8.17±0.52	8.41±0.28
T_1	8.97±0.39	9.13±0.29	7.62±0.26	7.92±0.29	8.60±0.62	8.45±0.20
T_2	8.72±0.28	9.83±0.90	7.90±0.37	7.65±0.50	8.28±0.19	8.48±0.26
RBC (X 10⁶/µl)						
Control	6.24±0.53	6.95±0.65	5.83±0.42	5.44±0.31	6.40±0.44	6.17±0.22
T_1	6.73±0.24	6.81±0.15	6.23±0.28	5.70±0.26	6.76±0.24	6.45±0.13
T_2	6.34±0.31	6.99±0.82	6.00±0.20	5.75±0.29	6.14±0.23	6.24±0.20
Hematocrit (%)						
Control	29.57±2.44	32.37±2.77	29.75±2.22	24.43±1.25	29.55±2.31	29.13±1.05
T_1	31.30±1.38	30.52±1.20	30.85±1.09	26.20±0.96	32.13±1.78	30.20±0.67
T_2	30.22±1.13	32.70±3.51	30.77±1.12	24.65±1.76	30.50±1.84	29.77±0.99

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