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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; SP-12(6): 18-22

www.thepharmajournal.com
Received: 29-03-2023
Accepted: 31-04-2023

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Effect of rumen protected niacin supplementation on erythrogram and leukogram profile of transition Surti Goats

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Abstract
The present study was conducted to study effect of rumen protected niacin supplementation on erythrogram and leukogram profile of transition Surti goats. Based on parity, body condition score and body weight, 18 pregnant Surti goats were selected and divided equally into two groups as control (CON, n=9) and treatment (RPN, n=9). Treatment group (RPN) was supplemented with rumen protected niacin (RPN) @1.5 gram/animal/day from 2 weeks pre kidding (-2 w) to 6 weeks post kidding (+6 w). At -2 week, at kidding, +2, +4, +6, +8 and +10 week of kidding, collection of blood samples for analysis of hematological parameters were done. RPN supplemented group had significantly (P≤0.05) higher TEC and Hct at 0 as well as +6 week and higher Hb at +6 week. Supplementation of RPN led to significantly (P≤0.05) lowering of neutrophil % as well as neutrophil to lymphocyte ratio at 0 week and significant (P≤0.05) elevation of eosinophil % at +4 week as well as significantly (P≤0.05) lowering of it at +8 week. Due to RPN supplementation there was significantly (P≤0.05) higher lymphocyte% at 0 week. Non-significant differences were observed for MCV, MCH, MCHC, basophil, monocyte and TLC. It was thus concluded that RPN supplementation @1.5g/goat/day in transition Surti goats improved erythrogram parameters as indicated by increased TEC and Hct at kidding and +6 weeks as well as Hb at +6 weeks post-kidding and improved immune status as evident by increased neutrophils, decreased lymphocytes and increased neutrophil to lymphocyte ratio among leukogram parameters at kidding.

Keywords: Rumen protected niacin, erythrogram profile, leukogram profile, transition Surti goats

1. Introduction
Goats are key species of small ruminants contributing towards milk and meat production. As compared to well managed intensive rearing system, goats are commonly reared in extensive system without taking any extra care for dietary supplementation of additional nutrients. Higher prolificacy and ability of improved performance of production as well as reproduction despite scarcity of resources along with minimum financial investment render them a preferred species of choice among owners that are marginal and poor and belong to lower strata of socio-economic status. South Gujarat is the native home tract of Surti goats and hence they are popular amongst local inhabitants. Physiological stages of transition and early lactation are quite stressful and difficult to cope with. This is because of high metabolic demand either due to developing fetus during prepartum and for milk biosynthesis during postpartum. Despite high metabolic demand the fetus and mammary gland are privileged for diversion of energy metabolites especially glucose. This energy partitioning mediated by development of insulin resistance and complicated by lowered dry matter intake creates negative energy balance in goats. Hematological parameters comprising of erythrogram and leukogram profile are indicative of general health, immunity as well as nutritional status of animals. Due to stress of transition, decreased TEC (El-Ghoul *et al.* 2000) [1], lower TEC and Hct (Tharwat and Al-Sobayil, 2013) [2] and decreased TEC, Hb and Hct (Manat *et al*., 2016) [3] have been reported. Stress has also been associated with alteration of immune status that are reflected by decrease in lymphocyte concentration (Dayal, 2017) [4], decrease in lymphocytes and increase in neutrophils, increase in the neutrophil: lymphocyte ratio (Dhabhar *et al.*, 1996) [5]. Neutrophil: lymphocyte ratio acts as an inflammatory index and indicates stress as reported for thermal stress (Stanger *et al.*, 2005) [6]. In order to minimize metabolic stress and insulin resistance during transition some supplementation strategies can be adopted. One such option can be supplementation of niacin in diet.

Niacin is a vitamin of B-complex group having antilipolytic effect (Cincović *et al*., 2018) [7], is a precursor of coenzyme - nicotinamide adenine dinucleotide (NAD) catalyzing oxidation-reduction reactions (Bender, 2003) [8]. To prevent ruminal degradation rumen protected niacin is more suitable for increasing the bioavailability of niacin to ruminants. RPN supplementation is postulated to ameliorate metabolic stress by decreasing insulin resistance, reduce oxidative stress and reduce the chances of infection at kidding by improving immunity. Thus the present study was conducted with the objective 'to observe the effect of rumen protected niacin supplementation on erythrogram and leukogram profile of transition Surti goats'.

2. Materials and Methods

The present study was done at Department of Veterinary Physiology and Biochemistry, College of Veterinary Science and Animal Husbandry, Navsari (Kamdhenu University), Gujarat, India. The study was approved by Institutional Animal Ethics Committee (IAEC). Eighteen apparently healthy Surti goats in advanced gestational stage were selected from Livestock Research Station, Navsari Agricultural University, Navsari for the study. Based on parity, body condition score and body weight the selected goats were divided into two groups i.e. control (n=9) and treatment (n=9) having 9 goats in each group. Goats in treatment group were individually supplemented with rumen protected niacin @ 1.5 gram/animal/day. Supplementation of diet for treatment group was done from 15 days pre kidding to +8 week post kidding. The selected goats were maintained under standard housing, feeding and management practices followed at Livestock Research Station, Navsari.

Whole blood was collected in vacutainer containing anticoagulant (K_3EDTA) at -2 (prekidding), 0 (at kidding), +2, +4, +6, +8 and +10 weeks of kidding. Blood was analyzed for parameters of erythrogram profile such as total erythrocyte count (TEC), hemoglobin (Hb), packed cell volume (PCV) or hematocrit (Hct), Mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) and leukogram profile such as total leukocyte count (TLC), differential leukocyte count (DLC)-neutrophils, eosinophils, basophils, lymphocyte, monocyte and neutrophil: lymphocyte ratio. The results obtained was tabulated and analysed with the help of descriptive statistics for obtaining Mean ±SE for both the groups of each parameter. Comparisons of means between groups were done using student t-test for differences at 5% level of significance ($P \leq 0.05$).

3. Results and Discussion

The results for erythrogram profile and leukogram profile (Mean ±SE) in control (CON) and treatment (RPN) groups of Surti goats during pre-kidding, kidding and post-kidding stages are presented in table 1 and 2 respectively.

Table 1: Erythrogram profile (Mean ±SE) in control (CON) and treatment (RPN) groups of Surti goats during pre-kidding, at kidding and post-kidding stages

Parameters			CON	RPN
TEC ($x10^6/\mu l$)	Pre-kidding	-2 Week	14.01±0.46	13.87±0.56
	Kidding	0 Week	10.91^b±0.30	12.32^a±0.45
	Post-kidding	+2 Week	12.56±0.28	13.22±0.20
		+4 Week	12.70±0.22	13.06±0.19
		+6 Week	12.57^b±0.33	13.84^a±0.29
		+8 Week	13.43±0.49	13.72±0.23
		+10 Week	13.77±0.48	14.34±0.58
Hb (g/dl)	Pre-kidding	-2 Week	9.29±0.19	8.98±0.18
	Kidding	0 Week	6.93±0.22	7.63±0.29
	Post-kidding	+2 Week	7.93±0.12	8.27±0.13
		+4 Week	7.91±0.16	8.07±0.14
		+6 Week	8.24^b±0.16	8.69^a±0.10
		+8 Week	8.61±0.18	8.58±0.15
		+10 Week	9.10±0.19	9.39±0.15
Hct (%)	Pre-kidding	-2 Week	27.46±0.59	26.49±0.57
	Kidding	0 Week	20.32^b±0.71	22.72^a±0.78
	Post-kidding	+2 Week	23.40±0.43	24.31±0.44
		+4 Week	23.29±0.56	23.66±0.39
		+6 Week	24.27^b±0.50	25.60^a±0.32
		+8 Week	25.22±0.52	25.31±0.41
		+10 Week	26.81±0.61	27.56±0.50
MCV (fl)	Pre-kidding	-2 Week	19.79±0.90	19.26±0.54
	Kidding	0 Week	18.61±0.28	18.47±0.30
	Post-kidding	+2 Week	18.66±0.23	18.38±0.09
		+4 Week	18.33±0.19	18.12±0.16
		+6 Week	19.43±0.72	18.53±0.29
		+8 Week	18.97±0.80	18.45±0.05
		+10 Week	19.62±0.64	19.42±0.74
MCH (pg)	Pre-kidding	-2 Week	6.70±0.30	6.53±0.20
	Kidding	0 Week	6.35±0.10	6.19±0.05
	Post-kidding	+2 Week	6.33±0.08	6.25±0.00
		+4 Week	6.23±0.04	6.18±0.06
		+6 Week	6.60±0.23	6.29±0.11
		+8 Week	6.48±0.29	6.25±0.00
		+10 Week	6.66±0.22	6.62±0.25

MCHC (g/dl)	Pre-kidding	-2 Week	33.84±0.09	33.91±0.12
	Kidding	0 Week	34.15±0.17	33.59±0.43
	Post-kidding	+2 Week	33.92±0.15	34.02±0.14
		+4 Week	33.99±0.15	34.10±0.07
		+6 Week	33.98±0.14	33.94±0.10
		+8 Week	34.14±0.13	33.88±0.09
		+10 Week	33.96±0.14	34.08±0.10
Means with alphabetical superscripts in lower case (a, b) differ significantly (p≤0.05) between groups CON-Control group and RPN- Treatment group (supplemented with rumen protected niacin)				

Comparison between groups revealed significantly (p≤0.05) higher TEC as well as Hct at 0 week and +6 week in RPN supplemented group as compared to control. RPN supplemented group also had significantly (p≤0.05) higher hemoglobin concentration at +6 week as compared to control. These parameters did not have significant difference between groups at other weeks but they were numerically higher in RPN supplemented group except Hb that was lower in RPN supplemented group at +8 week. Among other parameters of hematological indices, there were non-significant differences between groups for MCV, MCH and MCHC of control and treatment group.

Hematological parameters related to hemogram profile like TEC, Hb and Hct are important indicators that indicate optimal nutritional status and well-being of goats. Hence, these parameters represent health status. Physiological stages like transition period especially at parturition and early lactation especially at peak milk yield are stressful owing to negative energy balance and lowered feed intake and thus negatively impacts these parameters. Several studies have validated the findings that were observed in present study. In goats El-Ghoul *et al*. (2000) [1] have reported decreased TEC during periparturient period. TEC and Hct have also been reported to be lower during transition period in goats by Tharwat and Al-Sobayil (2013) [2]. Even though as compared to healthy counterparts, decrease in hematological parameters of TEC, Hb and Hct have been found during transition period in goats, reduction was more at parturition and less at time of peak milk yield during early lactation (Manat *et al*., 2016) [3].

In the present study, RPN supplemented group has showed increased TEC, Hb and Hct. As Hct and Hb indirectly depend on TEC any factor that affects TEC will also impact Hct and Hb in a similar manner. Niacin supplementation has been implicated to ameliorate metabolic stress in many studies. Amelioration of stress during transition and early lactation can indirectly elevate TEC, Hb and Hct values. Alternately, mechanisms through which niacin improves RBC counts could be related to the stability conferred by dietary niacin on the bone marrow cells as reported by Boyonoski *et al*. (2002) [9] and Kirkland (2012) [10]. Beneficial effects of niacin supplementation could also be viewed in the perspective of reduction of oxidative stress as has been discussed later for oxidative stress parameters. The present findings also agree with reports of Chaudhary *et al*. (2022) [11] who found higher TEC, Hb and Hct in buffaloes supplemented with RPN.

Table 2: Leukogram profile (Mean±SE) in control (CON) and treatment (RPN) groups of Surti goats during pre-kidding, at kidding and post-kidding stages

Parameters			CON	RPN
TLC ($x10^3$/ µl)	Pre-kidding	-2 Week	10.37±0.36	11.05±0.38
	Kidding	0 Week	11.66±0.33	11.38±0.45
	Post-kidding	+2 Week	11.32±0.38	11.23±0.32
		+4 Week	10.88±0.35	11.10±0.38
		+6 Week	10.04±0.33	10.08±0.33
		+8 Week	10.08±0.27	10.06±0.22
		+10 Week	9.84±0.45	9.96±0.39
Neutrophils (%)	Pre-kidding	-2 Week	35.56±1.17	38.22±1.13
	Kidding	0 Week	42.67^{a}±1.18	34.11^{b}±1.80
	Post-kidding	+2 Week	39.89±2.20	38.11±1.81
		+4 Week	40.11±1.49	37.33±1.86
		+6 Week	38.44±1.72	35.78±1.56
		+8 Week	38.56±1.36	38.11±1.84
		+10 Week	39.00±1.56	37.44±1.68
Eosinophils (%)	Pre-kidding	-2 Week	3.78±0.36	4.00±0.50
	Kidding	0 Week	3.00±0.29	3.89±0.51
	Post-kidding	+2 Week	3.78±0.49	4.00±0.53
		+4 Week	3.33^{b}±0.33	4.56^{a}±0.38
		+6 Week	4.44±0.47	4.11±0.54
		+8 Week	4.78^{a}±0.36	3.00^{b}±0.37
		+10 Week	4.33±0.50	3.44±0.38
Basophils (%)	Pre-kidding	-2 Week	0.67±0.17	0.78±0.15
	Kidding	0 Week	0.22±0.15	0.56±0.18
	Post-kidding	+2 Week	0.67±0.17	0.44±0.18
		+4 Week	0.56±0.18	0.22±0.15
		+6 Week	0.67±0.17	0.56±0.18
		+8 Week	0.67±0.17	0.56±0.18
		+10 Week	0.56±0.18	0.22±0.15
Lymphocyte	Pre-kidding	-2 Week	58.56±1.16	55.22±1.37

(%)	Kidding	0 Week	52.67^{b}±1.27	59.89^{a}±2.25
	Post-kidding	+2 Week	53.78±1.98	55.78±1.88
		+4 Week	53.78±1.45	56.44±1.83
		+6 Week	55.00±1.98	58.67±2.07
		+8 Week	54.22±1.27	57.44±1.83
		+10 Week	54.11±1.59	57.00±1.84
Monocyte (%)	Pre-kidding	-2 Week	1.44±0.29	1.78±0.28
	Kidding	0 Week	1.44±0.34	1.56±0.44
	Post-kidding	+2 Week	1.89±0.35	1.67±0.33
		+4 Week	2.22±0.28	1.44±0.50
		+6 Week	1.44±0.41	0.89±0.31
		+8 Week	1.78±0.40	0.89±0.35
		+10 Week	2.00±0.29	1.89±0.39
Neutrophil: Lymphocyte (NL ratio)	Pre-kidding	-2 Week	0.61±0.03	0.70±0.04
	Kidding	0 Week	0.82^{a}±0.04	0.58^{b}±0.05
	Post-kidding	+2 Week	0.76±0.07	0.70±0.05
		+4 Week	0.76±0.05	0.68±0.06
		+6 Week	0.71±0.06	0.62±0.05
		+8 Week	0.72±0.04	0.68±0.05
		+10 Week	0.73±0.05	0.67±0.05

Means with alphabetical superscripts in lower case (a, b) differ significantly (p≤0.05) between groups CON-Control group and RPN- Treatment group (supplemented with rumen protected niacin)

There was no significant difference in TLC between control and treatment group. Levels of neutrophil were significantly (p≤0.05) lower in RPN supplemented group (treatment) as compared to control at 0 week (at kidding) of study. At +2 week, +4 week, +6 week and +8 week +10 week, neutrophil level was lower in RPN supplemented group but the difference was non-significant. Neutrophil % was 42.67±1.18 and 34.11±1.80 in control and treatment group respectively at 0 week. These values were found to have significant (p≤0.05) difference between the groups. This indicates that RPN supplementation helps in reducing the changes of infection at kidding as neutrophils are involved in phagocytic activity.

Levels of eosinophil were significantly (p≤0.05) higher in RPN supplemented group (treatment) as compared to control at +4 week of study and significantly (p≤0.05) lower at 8 week. At 6 week and 10 week (at kidding) eosinophil level was higher in RPN supplemented group but the difference was non-significant. At 6, 8 and 10 weeks of kidding, eosinophil % was higher in control as compared to treatment group but significant (p≤0.05) difference was observed at 8th week only. At -2, 0, 2 and 4 weeks of kidding eosinophil level was higher in RPN group than control but the significant (p≤0.05) difference was observed at 4th week of kidding only.

Levels of lymphocyte were significantly (p≤0.05) higher in RPN supplemented group (treatment) as compared to control at 0 week (at kidding) of study. At +2, +4, +6, +8 and +10 week, lymphocyte level was higher in RPN supplemented group but the difference was non-significant. There was also no significant difference in monocyte % and basophil % between control and treatment group.

Neutrophil and Lymphocyte (NL) ratio was significantly (p≤0.05) lower in RPN supplemented group (treatment) as compared to control at 0 week (at kidding) of study. At +2 week, +4 week, +6 week and +8 week +10 week, NL ratio level was lower in RPN supplemented group but the difference was non-significant.

Similar to finding for TLC in present study Chaudhary *et al.* (2022) [11] have found no significant difference for TLC due to RPN supplementation.

Increased glucocorticoid secretion during stress, may rally confiscated neutrophils from bone marrow to circulation. (Jain, 1993) [12]. Lymphocytes decrease due to stress (Devaraj and Upadhyay, 2007) [13]. Under thermal stress, lymphocytes have shown lesser *in vitro* proliferation (Lacetera *et al.*, 2005 [14]; Lacetera *et al.*, 2006 [15]; Kamanga-Sollo *et al.*, 2011 [16]). An increase in neutrophil concentration has also been attributed to heat stress or summer season (Naik *et al.*, 2013 [17]; Koubková *et al.*, 2002 [18]; Mayengbam, 2009 [19]). Neutrophil: lymphocyte ratio acts as an inflammatory index and indicates stress as reported for thermal stress (Stanger *et al.*, 2005) [6]. In the present study stress without RPN supplementation was more in control group which led to rise in NL ratio. Higher cortisol level in control group may also responsible for increasing more neutrophil in circulation. Stress during summer season has shown such variations (Naik *et al.*, 2013) [18]. Increased cortisol may also reduce lymphocytes. Simultaneous decrease in lymphocytes and increase in neutrophils, leading to an increase in the neutrophil: lymphocyte ratio occurs under stressful conditions (Dhabhar *et al.*, 1996) [5]. Chaudhary *et al.* (2022) [11] after RPN supplementation in buffaloes have also reported similar results to present study for neutrophils, lymphocytes and NL ratio.

4. Conclusion

It was thus concluded from the present study that RPN supplementation @1.5 g/goat/day in transition Surti goats improved erythrogram parameters as indicated by increased TEC and Hct at kidding and +6 weeks as well as Hb at +6 weeks post-kidding and improved immune status as evident by increased neutrophils, decreased lymphocytes and increased neutrophil to lymphocyte ratio among leukogram parameters at kidding. However further studies with higher dose and more number of goats can be done to increase the beneficial effects.

5. Acknowledgement

The authors of this manuscript acknowledge the help, support and facilities provided by Principal, College of Veterinary Science and Animal Husbandry, Navsari, KU and Research Scientist, Livestock Research Station, Navsari.

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