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Influence of vanadium supplementation on the antioxidant status of 'Barbari' goat kids

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Abstract
Different levels of Vanadium were used to assess the effect on antioxidant status of Barbari goat kids. A total number of 21 barbari goat kids with body weight (BW) of 16.27 ±0.89 kg were selected for 90 day experimental trial. Kids were randomly allocated into 3 treatments. The treatments were as follows: 1) Control comprised of total mixed ration (TMR) without any supplementation of vanadium; 2) T1 group was provided TMR basal diet with vanadium @ 1.5 mg/kg DM/kids/day); 3) T2 group were supplemented TMR basal diet with vanadium @3.0 mg/kg DM/kids/day. Total antioxidant status was recorded higher significant (p<0.05) in T2 than control and T1 groups. The levels of superoxide dismutase in the different groups changed significantly (p<0.05). Catalase was statistically higher in both the vanadium supplemented groups. Thiobarbituric acid reactive substance was lesser in T1 and T2 as compared control group. The study accomplished that the dietary fed of vanadium elevated the antioxidant status of Barbari kids.

Keywords: Antioxidant, vanadium, Barbari, goat kids, TMR

Introduction
Vanadium is a metallic element that appears as number 23 in the periodic table. For many years it has been suspected to be essential in animals and human physiology. There have been strong arguments that very small amounts of vanadium are necessary to maintain health. However, the microgram quantities of vanadium that are likely to be essential for human health are far smaller than the milligram doses of vanadium that can be used to improve glucose metabolism and insulin sensitivity. Thus, while vanadium may be an essential trace mineral, it may also be used at high doses as a drug. Minerals are uncommon chemicals present in all body fluids and their optimum dose is essential for sustaining a certain biological function. Vanadium (V) has not been reported as an essential mineral in ruminants, although its well-known role as an insulin-a mimic agent for catalysis enzymatic activities in lower organisms. Vanadium compounds have been linked to various effects in the development of human illnesses as well as the maintenance of healthy bodily functioning. Vanadium salts interrupt a wide range of enzyme systems, including ATPases, protein kinases, ribonucleases and phosphatases. Several genes are regulated by this element or its compounds, including genes for tumor necrosis factor-alpha (TNF), Interleukin-8 (IL-8), activator protein-1 (AP-1), c-raf-1, mitogen-activated protein kinase (MAPK), p53, nuclear factors-KB and others, while vanadium deficiency accounts for several physiological malfunctions such as thyroid, glucose and lipid metabolism etc. Vanadium is used for treating diabetes, low blood sugar, high cholesterol, heart disease, tuberculosis, syphilis, a form of "tired blood" (anemia), and water retention (edema); for improving athletic performance in weight training; and for preventing cancer. Vanadium-deprived goats were found to exhibit an increased abortion rate and depressed milk production. *In vitro* studies with cells and pharmacological studies with animals have shown that vanadium has insulin-mimetic properties; numerous stimulatory effects on cell proliferation and differentiation; effects on cell phosphorylation–dephosphorylation; effects on glucose and ion transport across the plasma membrane and effects on oxidation–reduction processes.

Materials and Methods

All the procedures followed in this study were sanctioned by the Institutional Animal Ethics committee, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut. Twenty-one Barbari kids were sorted out from LRC-2, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, India and arbitrarily distributed into three groups (n=7) after blocking by body weight (16.27 ±0.89 kg) and age (6.0±0.15 month). The diet was provided to the experimental kids in the form of a total mixed ration (TMR). Total mixed ration prepared as per feeding standard and offered daily in the morning (07.00 h), noon (13.00 h) and evening (17.30 h). Kids were fed a TMR without vanadium (control) or with vanadium supplementation at 1.5 mg/kg DM/kids/day (T1) and 3.0 mg/kg DM/kids/day (T2) for 90 days of experiment period. Clean and fresh tap water was offered ad-libitum. Experimental animals were kept under a conventional housing system. The shed were washed and cleaned daily to prevent the chances of any infections. During the entire period of study, various management practices *viz*., deworming, washing, grooming and treatment, etc. were followed as per the standard procedure of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut. Blood samples were collected from the jugular vein of kids at the fortnightly interval in the EDTA coated Vacutainer tube at 07.00 a.m. before feeding and watering. Fraction of blood was used in the estimation of hemoglobin, total leukocyte counts, lymphocyte and neutrophil. The rest of the blood samples were centrifuged at 3000 rpm for 30 min. The plasma was kept in Eppendorf tubes and stored at -20 °C till further analysis of antioxidant, immune status, energy and lipid metabolites. After centrifugation hematocrit was washed and centrifuged thrice with normal saline (0.9% NaCl) solution. Then distilled water was added to the erythrocyte pellet slowly and with constant stirring up to the marked level to prepare hemolysate and the rest of hemolysate was quickly stored at –20 °C till activities of superoxide dismutase and catalase were estimated.

Total antioxidant activity

The overall antioxidant activity was measured according to Benzie and Strain (1999) [4] ferric reducing antioxidant power (FRAP).

Superoxide dismutase (SOD)

The enzyme activity was assayed by the method of Marklund (1974) with the help of reagents Pyrogallol (2 mM) and Tris buffer (50 mM).

Catalase (CAT)

The activity of the enzyme was estimated by spectrophotometer using the method described by Aebi (1984) with the help of reagents namely Phosphate buffer (50 mM) and H_2O_2 (30 mM).

Thiobarbituric acid reactive substances (TBARS)

The extent of lipid peroxidation, an index of oxidative stress was measured as Thiobarbituric acid reactive substances formed. Lipid peroxides were measured by the TBA test method of Asakawa and Matsushita (1979) [3].

Statistical analysis

Analysis of variance techniques was used to analyze the data using the GLM procedure of SPSS (V20: SPSS Inc., Chicago, IL, USA). Duncan's Multiple Range Test was conducted to compare the means.

Results and Discussion

Total antioxidant status

The influence of vanadium supplementation on the total antioxidant status on growing Barbari kids has been reported in Table 1 and Fig. 1. The total antioxidant status on initial day was 1.22, 1.24 and 1.27 µmol/ml, respectively. Vanadium supplementation did not affect the treatment groups and there was no significant (p>0.05) difference found in total antioxidant status across the groups. The mean total antioxidant status in the control, T1 and T2 groups was 1.28, 1.39 and 1.41 µmol/ml, respectively, indicating that the total antioxidant of the T2 group was statistically (p<0.05) higher than the concentration of total antioxidant status recorded in the T1 and control groups. Similar reports as comes from Vijay *et al.* (2019) [12] in rats and Gupta *et al.* (2020) [6] was reported that the plasma total antioxidant status increases linearly in vanadium supplemented groups in Hariana heifers.

Table 1: Effect of vanadium supplementation on total antioxidant status (µmol/ml) of Barbari kids

Fortnight	Treatment			SEM	P Value		
	Control	T1	T2		Contrast	Linear	Quadratic
0	1.22	1.24	1.27	0.03	0.383	0.175	0.858
1	1.26	1.28	1.32	0.08	0.854	0.587	0.916
2	1.27	1.34	1.36	0.09	0.799	0.530	0.837
3	1.28	1.39	1.42	0.06	0.291	0.137	0.639
4	1.29	1.55	1.45	0.07	0.082	0.162	0.073
5	1.31	1.44	1.57	0.08	0.148	0.054	1.000
6	1.32	1.52	1.51	0.06	0.059	0.041	0.199
Mean	1.28[a]	1.39[b]	1.41[b]	0.07	0.002	0.001	0.189

Control, group without vanadium supplementation; T1, vanadium supplemented group (1.5 mg/kg DM); T2, vanadium supplemented group (3.0 mg/kg DM); SEM, Standard error mean

Mean with different superscripts (a and b) in a row differs statistically at (p<0.05)

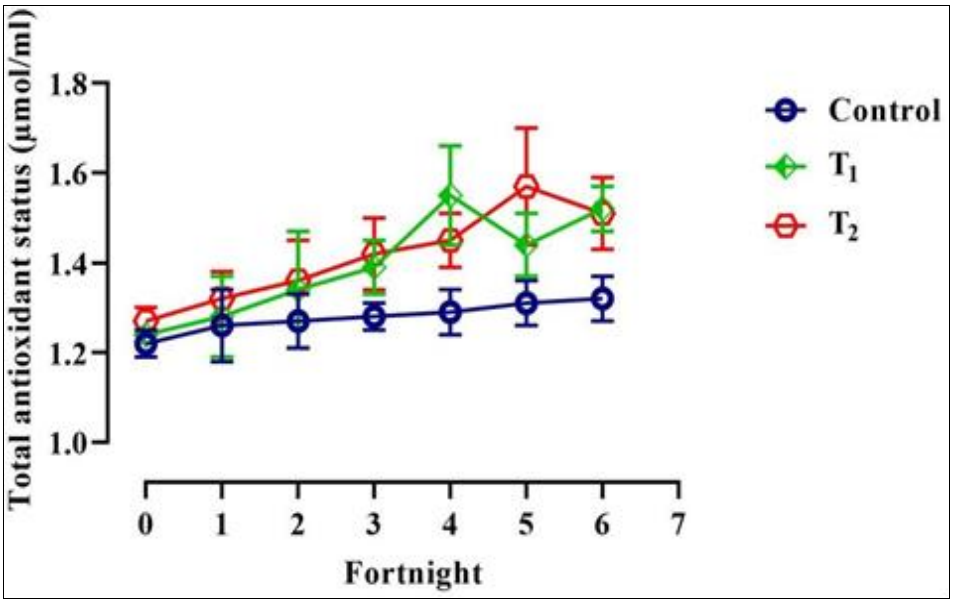

Fig 1: Fortnight changes of total antioxidant status supplemented with vanadium

Superoxide dismutase

Table 2 and Figure 2 show the superoxide dismutase results for each of the three groups. The superoxide dismutase activity in the control, T1 and T2 groups was 1.82, 1.85 and 1.88 U/mg Hb, respectively before beginning vanadium supplementation. During the 5th fortnight of the observation period, superoxide dismutase activity in the T2 group was statistically higher (p<0.05) than control and T1 groups. The total mean of superoxide dismutase activity in treatments given either 1.5 or 3.0 mg/kg DM vanadium was substantially greater (p<0.05) than in the control group. Such finding was obtained by Adler *et al.* (1995) [1] in rats and Matsubara *et al.* (1995) [8] who had reported that the SOD increase with the vanadium supplementation in Mahabadi goat kids, but Pal *et al.* (2018) [9] reported that the SOD concentration had contrast in vanadium supplemented with a dose of 9 mg/kg DM in crossbred calves.

Table 2: Effect of vanadium supplementation on superoxide dismutase (U/mg Hb) of Barbari kids

Fortnight	Treatment			SEM	P Value		
	Control	T1	T2		Contrast	Linear	Quadratic
0	1.82	1.85	1.88	0.12	0.942	0.734	0.989
1	1.88	2.07	2.13	0.16	0.545	0.295	0.761
2	1.95	2.34	2.21	0.12	0.118	0.167	0.115
3	2.02	3.13	2.37	0.26	0.068	0.446	0.029
4	2.08	2.69	2.62	0.19	0.076	0.063	0.170
5	2.11^{a}	3.04^{ab}	3.04^{b}	0.25	0.029	0.020	0.159
6	2.13	3.25	3.46	0.34	0.046	0.021	0.333
Mean	2.00^{a}	2.62^{b}	2.53^{b}	0.19	<0.001	<0.001	0.006

Control, group without vanadium supplementation; T1, vanadium supplemented group (1.5 mg/kg DM); T2, vanadium supplemented group (3.0 mg/kg DM); SEM, Standard error mean.

Mean with different superscripts (a and b) in a row differs statistically at (p<0.05).

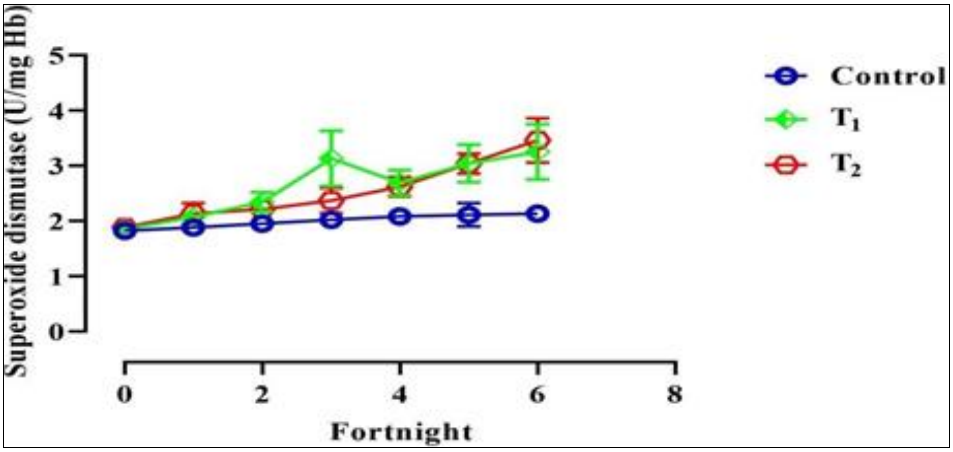

Fig 2: Fortnight changes of superoxide dismutase supplemented with vanadium.

Catalase

Table 3 shows the effect of vanadium supplementation on catalase in growing Barbari kids, which is represented in Figure 3. Before commencing the vanadium feeding, catalase levels in control, T1 and T2 were 0.32, 0.34 and 0.36 H2O2 consumed/min/gm Hb, respectively. In the control, T1 and T2 groups, the overall mean of catalase consumption was 0.38, 0.45 and 0.46 mol H2O2/min/gm Hb, respectively, indicating that there was a linear significant (p<0.05) difference in control and T2 groups, but no statistical difference between T1 and T2 groups during the experimental period. The results were confirmed by earlier findings of Soares *et al.* (2008) [11] in fish and Marouane *et al.* (2011) [7] who had also reported an increase in the catalase activity in rats.

Table 3: Effect of vanadium supplementation on catalase (µmol/min/gm Hb) of Barbari kids

Fortnight	Treatment			SEM	P Value		
	Control	T1	T2		Contrast	Linear	Quadratic
0	0.32	0.34	0.36	0.02	0.318	0.140	0.815
1	0.35	0.40	0.39	0.03	0.520	0.401	0.443
2	0.36	0.43	0.46	0.04	0.334	0.157	0.698
3	0.37	0.50	0.43	0.05	0.270	0.412	0.163
4	0.39	0.44	0.52	0.05	0.335	0.151	0.781
5	0.41	0.53	0.55	0.05	0.204	0.099	0.513
6	0.43	0.48	0.49	0.05	0.780	0.514	0.808
Mean	0.38a	0.45b	0.46b	0.04	0.007	0.003	0.238

Control, group without vanadium supplementation; T1, vanadium supplemented group (1.5 mg/kg DM); T2, vanadium supplemented group (3.0 mg/kg DM); SEM, Standard error mean

Mean with different superscripts (a and b) in a row differs statistically at (p<0.05)

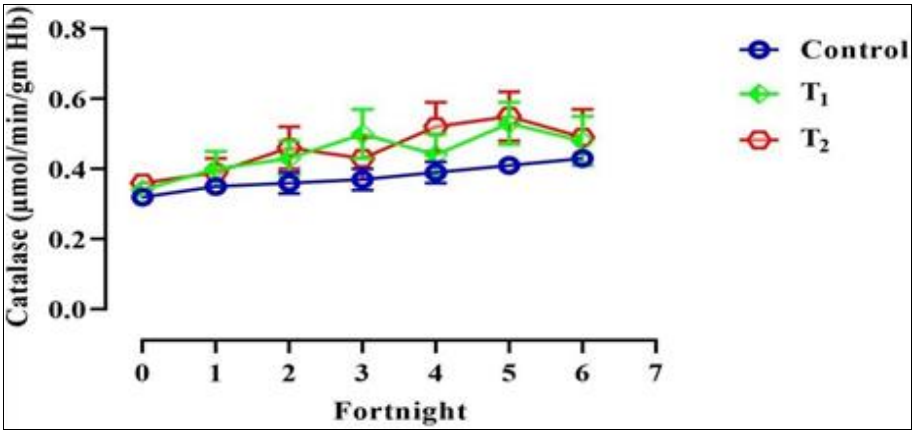

Fig 3: Fortnight changes of catalase supplemented with vanadium

Thiobarbituric acid reactive substance

Table 4. shows the thiobarbituric acid reactive substance of all three groups of Barbari kids, which is outlined in Figure 4. TBARS circulation concentrations were 1.37, 1.29 and 1.31 nmol/ml in the control, T1 and T2 groups, respectively, during the initial study period. On the 2nd fortnight, the respective values of TBARS were 1.47, 1.33 and 1.29 nmol/ml, revealing that there was a lower significant (p<0.05) in both treatment groups supplemented with vanadium at 1.5 or 3.0 mg/kg DM. Similarly, as compared to the control group, the average mean value of TBARS was statistically lower in the T2 and T1 groups. The results of the present study are in accordance with Elfant and Keen (1987) [5] in rats, Preet *et al.* (2005) [10] also reported in rats.

Table 4: Effect of vanadium supplementation on thiobarbituric acid reactive substances (nmol/ml) of Barbari kids

Fortnight	Treatment			SEM	P Value		
	Control	T1	T2		Contrast	Linear	Quadratic
0	1.37	1.29	1.31	0.04	0.404	0.378	0.310
1	1.39	1.31	1.26	0.04	0.157	0.058	0.898
2	1.47^{b}	1.33^{a}	1.29^{a}	0.04	0.010	0.004	0.316
3	1.40	1.30	1.33	0.05	0.387	0.340	0.322
4	1.43	1.31	1.24	0.05	0.062	0.021	0.740
5	1.39	1.29	1.27	0.06	0.375	0.203	0.574
6	1.31	1.24	1.30	0.08	0.802	0.901	0.520
Mean	1.39^{b}	1.30^{a}	1.29^{a}	0.05	<0.001	<0.001	0.076

Control, group without vanadium supplementation; T1, vanadium supplemented group (1.5 mg/kg DM); T2, vanadium supplemented group (3.0 mg/kg DM); SEM, Standard error mean

Mean with different superscripts (a and b) in a row differ statistically at (p<0.05).

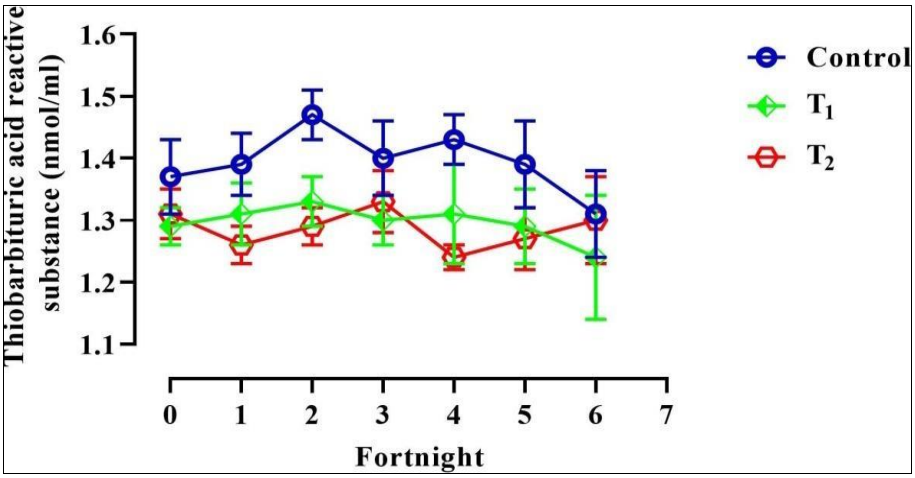

Fig 4: Fortnight changes of thiobarbituric acid reactive substance supplemented with vanadium

Conclusions

The dietary of vanadium supplementation increased total antioxidant activity, superoxide dismutase, catalase and decreased thiobarbituric acid reactive substance (TBARS). The results indicate that vanadium supplementation might improve the antioxidant status of Barbari kids.

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