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Comparative Evaluation of nano elemental Selenium and Sodium Selenite on Selenium, calcium and Phosphorus retention in Growing male goats

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ABSTRACT
Present study was conducted on eighteen 5-6 months goat kids to evaluate the effect of sodium selente and selenium nano-particles on calcium, phosphorus and selenium metabolism. All the groups fed equal amount of common basal diet. Group T1 fed 0.3 ppm Se normal size particles as sodium selenite, group T2 and T3 were fed basal diet supplemented with 0.15 ppm and 0.3 ppm Se as its nano particles, respectively. A 6 days metabolism trial was conducted on experimental kids after 120 days of feeding to assess the efficiency of nutrient utilization. The intake, outgo through faeces, urine and balance of calcium (Ca) and phosphorus (P) in the three groups did not differ significantly (P>0.05). The intake of Se was significantly (P<0.01) higher in group T1 and T3 as compared to T2 group. The Se excretion through faeces and urine was significantly (P<0.01) lower in both the nano-Se groups (T2 and T3) as compared to control group. Se retention as % of intake and % of absorbed was significantly (P=0.01) higher in both the nano-Se groups (T2 and T3) as compared to control group.
Key words: *Goats, selenium, nano particles, calcium, phosphorus, nitrogen, metabolism*

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INTRODUCTION

Goats play important role to support economy of the small and marginal farmers and landless laborers in tropical countries. To maximize the profit, the major goal of goat farmers is to minimize the losses from diseases and attain good flock viability. The immune system mainly depends on the nutrients availability that mediates cellular functions pertinent to host defense. Nutrition is the major decisive factor in determining the expression of the genetic potential of goats in terms of growth and immunity.

Selenium (Se) is a naturally occurring metalloid element. It is essential to human and livestock in trace amounts. Selenium as a component of seleno-proteins displays metabolic function in preventing oxidative damage to body tissues. Selenium also plays important role in the antioxidant, reproduction, endocrine, and immune systems. In animals, Se deficiency has been linked to muscular weakness and muscular dystrophy. It also causes reduced appetite, poor growth, reproductive problems, and embryonic deformities. It has been reported that dietary selenium supplementation could increase growth rate in rats [1]. In diet of the animals Se is primarily supplemented as its inorganic salts like sodium selenite or sodium selenate, which has a very narrow margin between their nutritional dosage and toxicity. Recently nano elemental selenium has attracted wide spread importance due to its high bioavailability and lower toxicity. It has been reported that Nano-Se has a higher efficiency in upregulating selenoenzymes and exhibit less toxicity than selenite. It was found that Nano-Se had similar or higher bioavailability and much less toxicity in broiler and goat compared with selenite [2]. Supplementation of 150 ppb nano selenium particles gave the best performance in terms of increased serum globulin level, reduced A:G ratio and total cholesterol in male Wistar rats [3]. Bunglavan [3] also reported that T3 level was

significantly increased and T4 level and ratio of T4:T3 were significantly lowered in nano Se supplemented group as compared to organic and inorganic Se supplemented groups in rats and guinea pigs. Supplementation of selenium nanoparticles 0.3 mg/kg diet of poultry enhanced the growth rate in the broiler birds. Supplementation of nano Se improved growth performance, serum oxidant status and Se concentration in blood and tissues in growing male goats. Similarly, supplementation of nano zinc in broilers @ 20 ppm significantly improved weight gain, feed efficiency, total antioxidant capability and SOD and catalase activity as compared to control fed 60 ppm of zinc oxide [4].

METHODOLOGY

The study was conducted at Animal Nutrition Division, Indian Veterinary Research Institute (IVRI), Izatnagar, India. Eighteen growing male goat kids of 5-6 months of age were divided in to three equal groups in a completely randomized block design based on their body weights (BW). All the groups fed equal amount of common basal diet. Group T1 fed 0.3 ppm Se normal size particles as sodium selenite, group T2 and T3 were fed basal diet supplemented with 0.15 ppm and 0.3 ppm Se as its nano particles, respectively. A 6 days metabolism trial was conducted on experimental kids after 120 days of feeding to assess the efficiency of nutrient utilization. The animals were shifted to the metabolic cages having facilities for individual feeding and watering, and separate urine and faeces collection. After ensuring proper adaption of the animals in metabolic cages for 4d, the actual collection of faeces and urine was started. The total quantity of faeces and urine voided during 24 hours duration was weighed and representative sample was taken.

To estimate the calcium, phosphorus and selenium, mineral extract of feed, faeces and urine samples was prepared as per Garg and Dass [5]. Calcium estimation was done as per Talapatra et al. [6] in feed, faeces and urine samples. The phosphorus content of feed, faeces and urine samples was estimated from their mineral extract as per AOAC [7] using UV- visible spectrophotometer (Model Spekol-1200, Germany). Selenium in feed, feaces urine, samples was estimated by Atomic Absorption Spectrophotometer [Electronics Corporation of India Ltd. (ECIL) Hyderabad, India, Model No. 4141] with hydride generator.

RESULTS AND DISCUSSION

Chemical composition of feeds

Chemical composition of the concentrate mixture and wheat straw offered to the growing goat kids is given in Table 4.1. In concentrate mixture organic matter (OM), crude protein (CP) and ether extract (EE) were 91.67, 24.74, and 2.11%, respectively. The content of neutral detergent fibre (NDF) and acid detergent fibre (ADF) were 61.97 and 9.35%, respectively. The calcium (Ca), phosphorus (P), zinc (Zn) and selenium (Se) content in concentrate mixture were 1.23 % 0.68%, 36.60 ppm and 0.069 ppm, respectively. The levels of OM, CP, EE, TA, NDF and ADF in wheat straw were 92.13, 3.21, 0.76, 7.87, 58.71 and 52.02 % respectively. The Ca, P, Zn and Se content in wheat straw were 0.50 %, 0.17 %, 27.02 ppm and 0.014 ppm, respectively.

Table 1. Chemical composition of feeds (% DM basis) offered to goat kids

Attributes	Concentrate mixture	Wheat straw
Organic matter	91.67	92.13
Crude protein	24.74	3.21
Ether extract	2.11	0.76
Total ash	8.33	7.87
Neutral detergent fibre	61.97	58.71
Acid detergent fibre	9.35	52.02
Calcium	1.23	0.50
Phosphorus	0.68	0.17
Zinc (ppm)	36.60	27.02
Selenium (ppm)	0.069	0.014

Intake and balance of Calcium and Phosphorus

Calcium (Ca) and Phosphorus balance of goats under various dietary treatments has been presented in Table 2, 3. The intake, outgo through faeces, urine and balance of calcium (Ca) and phosphorus (P) in the three groups did not differ significantly (P>0.05). The results indicated that Se supplementation in the form of nano particles at the level of 0.15ppm and 0.3 ppm in the basal diet had no effect on Ca and P metabolism. Bunglavan [3] has also reported no effect on intake and balance of Ca & P on supplementation of different levels of nano-Se in wistar rats. Similar observations were made in guinea

pigs supplemented with 0.1, 0.2 and 0.3 ppm of organic Se [1], in growing lambs supplemented with 0.15 and 0.3 ppm Se as sodium selenite [8] and in male buffalo calves supplemented with 0.15 and 0.3 ppm Se as sodium selenite [9].

Table 2: Effect of dietary nano Selenium on Calcium retention by goats

Attributes	Treatments			SEM	P value
	T1	T2	T3		
Ca intake (gd $^{-1}$)	4.39±0.18	4.41±0.14	4.36±0.13	0.08	0.974
Ca excretion (gd $^{-1}$)					
Faeces	2.53±0.30	2.44±0.24	2.38±0.33	0.16	0.945
Urine	0.53±0.13	0.51±0.07	0.39±0.06	0.05	0.477
Total	3.06±0.35	2.95±0.24	2.77±0.33	0.17	0.813
Ca - excretion (% intake)					
Faecal	57.0±4.71	55.3±4.79	54.4±6.53	2.96	0.947
Urinary	12.0±2.91	11.5±1.24	8.93±1.52	1.06	0.480
Ca retention					
gd $^{-1}$	1.34±0.21	1.45±0.18	1.59±0.27	0.12	0.751
% of intake	31.0±5.96	33.2±4.20	36.7±6.38	3.03	0.775

Table 3: Effect of dietary nano Selenium on phosphorus retention by goats

Attributes	Treatments			SEM	P Value
	T1	T2	T3		
P intake (gd $^{-1}$)	2.22±0.08	2.23±0.07	2.21±0.06	0.04	0.992
P - excretion (gd $^{-1}$)					
Faeces	1.35±0.17	1.26±0.20	1.36±0.05	0.08	0.875
Urine	0.10±0.01	0.11±0.01	0.08±0.01	0.01	0.230
Total	1.44±0.17	1.36±0.19	1.44±0.04	0.08	0.904
P excretion (% intake)					
Faecal	60.0±5.76	56.2±7.94	61.9±3.40	3.29	0.789
Urinary	4.46±0.43	4.75±0.58	3.57±0.52	0.31	0.279
Total	64.5±5.64	61.0±7.45	65.5±3.14	3.10	0.838
P retention					
gd $^{-1}$	0.78±0.10	0.86±0.16	0.77±0.09	0.07	0.841
% of intake	35.5±5.64	39.0±7.45	34.5±3.14	3.10	0.838

Intake and balance of Selenium

The intake, excretion through faeces, urine and balance of selenium (Se) of goats under various dietary treatments has been presented in Table 4.

Table 4: Effect of dietary nano Selenium on selenium (Se) retention by goats

Attributes	Treatments			SEM	P value
	T1	T2	T3		
Se intake (mgd $^{-1}$)	0.19 ^{a}±0.01	0.12^{b}±0.01	0.19^{a}±0.01	0.01	<0.001
Se excretion (mgd $^{-1}$)					
Faeces	0.09^{a}±0.01	0.04^{b}±0.00	0.05^{b}±0.00	0.01	0.002
Urine	0.04^{a}±0.01	0.02^{b}±0.00	0.02^{b}±0.00	0.00	0.010
Total	0.13^{a}±0.02	0.06^{b}±0.01	0.07^{b}±0.01	0.01	0.001
Se retention					
mgd $^{-1}$	0.06^{b}±0.01	0.06^{b}±0.00	0.12^{a}±0.01	0.01	<0.001
% of intake	30.8^{b}±7.03	54.2^{a}±2.95	62.1^{a}±2.57	4.19	0.001
% absorbed	52.3^{c}±5.25	67.3^{b}±2.16	74.6^{a}±0.98	2.94	0.001

^{ab} Means with different superscripts within a row differ significantly

The mean intake of Se was significantly (P<0.01) higher in group T1 and T3 as compared to T2 group. The Se excretion through faeces and urine was significantly (P<0.01) lower in both the nano-Se groups (T2 and T3) as compared to control group. Though absolute retention of Se was significantly (P<0.01) higher in group T3 as compared to T1 and T2, but Se retention as % of intake and % of absorbed was significantly (P=0.01) higher in both the nano-Se groups (T2 and T3) as compared to control group. Significantly (P<0.01) higher intake of Se in T1 and T3 groups was obviously due to supplementation of higher (0.3 ppm) level of Se in these groups as compared to 0.15 ppm in T2 group (Table 4.7). But a

reduced (P<0.01) Se excretion through feces and urine in T2 and T3 groups as compared to T1 group, with significantly (P=0.01) higher retention in group T2 and T3 as compared to T1 group, indicated that bioavailability of Se increased with the supplementation as its nano form and excretion significantly decreased. Similar to our observation the amount of Se absorbed and absorption coefficient were found to be significantly increased in 150 ppb of nano Se group [3]. Similarly, Se absorption coefficient was significantly improved in guinea pigs [1] supplemented with 0.1 and 0.2 ppm organic Se. The higher retention of Nano-Se than sodium selenite was probably related to the different absorption process and metabolic pathways. It has been reported that nanoparticle show novel characteristics of transport and uptake and exhibit higher absorption efficiencies [10-15]. They suggested that the superior performance of nanoparticles may be attributed to their smaller particle size and larger surface area, increased mucosal permeability, and improved intestinal absorption due to the formation of nanoemulsion droplets.

CONCLUSION

It may be concluded that supplementation of selenium as nano particles (0.15 and 0.3 ppm) had no effect on calcium and phosphorus retention. However, significantly improved the selenium retention, which suggests that the superior performance of nano particle may be attributed to their smaller particle size, larger surface area, increased mucosal permeability and improved intestinal absorption.

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