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Effect of Dietary Supplementation of Different Sources of Selenium on Growth Performance and Nutrient Utilization of Barbari Bucks

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ABSTRACT

The present study was designed to evaluate the effect of dietary supplementation of different sources of Se on growth performance, intake and nutrient digestibility of Barbari bucks. For this study, 24 experimental bucks were selected and equally divided into four groups (n=6) on body weight basis. The animals in control group were fed on basal diet i.e., concentrate mixture, gram straw and corn silage as per ICAR (2013) feeding standard whereas, the groups T1(SS), T2(SY) and T3(NS) were fed basal diet along with supplementation of inorganic Se (Sodium selenite), organic Se (Se-Yeast) and Se nano particles at level of 0.3mg/kg DM offered respectively. The experimental feeding was done for 90 days. DMI was calculated by recording daily the feed offered and residue left. 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. ADG (g/d) and Feed conversion ratio (FCR) was calculated by the amount of DMI (kg) required for unit (per kg) weight gain by animals during the trial period. To compare the efficiency of nutrient utilization in experimental bucks, a digestion trial for a period of 7 days was conducted at the end of the study.The results revealed dietary supplementation of Se from either source have no significant ($P<0.05$) effect on BW, ADG, FCR, feed intake and digestibility of nutrients. Hence, it can be concluded that dietary supplementation of Se from either inorganic, organic and nano sources have no effect on growth, intake and nutrient digestibility of Barbari bucks.

HIGHLIGHTS

- Dietary supplementation of either inorganic, organic and nano sources of Selenium at 0.3 ppm levels has no effect on growth performance of bucks.
- No significant effect of Se supplementation on dry matter intake and nutrient digestibility of Barbari bucks.

Keywords: Bucks, growth, inorganic, nano, organic, selenium

Selenium (Se) is currently acknowledged to be an essential dietary trace element required for various body functions such as growth, reproduction, immune system and protection of tissue integrity (Pilarczyk *et al*., 2013). The most important action of selenium biological functions comes from several specific seleno-proteins, some of which are involved in thyroid hormone metabolism, while others play an important role in the maintenance of the body redox balance and antioxidant defense. Therefore, an adequate feed supplementation with Se plays a pivotal role in maintaining animal production and performances. In this context, in order to avoid Se deficiency and to fulfil the Se requirements of livestock animals, feeds are supplemented with different forms of Se. Conventionally, inorganic and organic Se sources are used as a supplement in animal feeds. Inorganic forms of trace minerals rapidly

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dissociate in the rumen and become free to interact with antagonists, resulting in the loss of the trace minerals prior to absorption by the animal (Ward *et al*., 1996). However, in organic forms, the bonds between the ligand and the mineral can prevent the minerals from interacting with antagonists and improve the bioavailability of the mineral (Keshri*et al*., 2019). Recently, elemental nano-Se has attracted a wide spread attention to its high bioavailability and low toxicity (Wang *et al*., 2007; Zhang *et al*., 2008). Nano minerals improve the bioavailability due to its novel characteristics such as high surface activity, a lot of surfaces active centers, strong adsorbing ability and high catalytic efficiency (Wang *et al*., 2013). Nano-Se has efficient functions on animal growth, reproduction and immunity systems (Shi *et al*., 2010). In sheep, Nano-Se had improved ruminal fermentation, nutrient digestibility (Shi *et al*., 2011). In addition, some reports on rats and mice demonstrated that Nano-Se had higher efficiency than sodium selenite and other Se sources in up-regulating selenoenzymes, exhibiting lower toxicity comparing with organic or inorganic Se sources (Zhang *et al*., 2001). Thus, the present investigation is aimed to compare the effect of dietary supplementation of inorganic, organic and nano Se on the growth performance and nutrient digestibility of barbari bucks.

MATERIAL AND METHODS

Location of Study and Experimental Animals

The experiment was conducted in the Barbari buck shed at Goat Farm Complex, DUVASU, Mathura (Uttar Pradesh). Animal care procedure and experiment protocol was approved under the established standard of the Institutional Animal Ethics Committee, constituted as per the article number 13 of the Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA) rules laid down by the Government of India.

Experimental Design and Feeding

A total twenty-four experimental bucks of 1.5 to 2 year age were selected from the herd maintained at Goat farm, DUVASU, Mathura (U.P.). Experimental bucks were randomly assigned into four groups (six bucks in each) on body weight basis. All bucks were housed in a well-ventilated individual sheds having the proper arrangement for feeding and watering. Deworming of all the animals was done with Albendazole before the start of the experiment. The bucks were fed basal diet comprising of concentrate mixture, gram straw and corn silage. The animals of each experimental group were maintained and fed individually on roughage and concentrate based ration to meet out requirement as per ICAR (2013) feeding standard. Diets were prepared by taking concentrate and roughage in the ratio of 40:60 respectively. The roughage part composed of gram straw (40%) and corn silage (20%). Concentrate mixture was prepared by mixing barley grain, wheat grain, wheat bran, gram chunni, mustard oil cake, and mineral mixture (without Se) in 15, 15, 25, 10, 33 and 2 parts, respectively. The chemical composition (% DM basis) of dietary feed ingredient fed to experimental bucks is presented in the Table 1. The calculated amount of Se was premixed in barley flour that differed in Se source and corresponded to three treatments; T1 (SS)- Inorganic Se – 0.30 mg/kg Se as sodium selenite (LobaChemie Maharashtra, India); T2 (SY) -Organic Se – 0.30 mg/kg as Se-enriched yeast (Chaitanya Chemicals Maharashtra, India) and T3 (NS)- nano Se – 0.30 mg/kg as Se Nano particles (Nano shel Punjab, India). The premix was then mixed in concentrate mixture of each buck of respective group at the time of feeding to ensure the required intake. Clean and fresh drinking water was offered *ad libitum* twice to each animal daily. The duration of experiment was of 90 days. The animals were given an adaptation period of fifteen days, before the start of experiment. All the groups were kept on similar feeding regimen, except different sources of Se that was additionally supplemented to the treatment groups.

Observation Recorded and Analytical Procedures

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 interval during experimental period of 90 days. Fortnightly weight gain was calculated by increase in body weight in one fortnight and ADG (g/d) was calculated by dividing the fortnightly weight gain with number of days (15). The feeds offered to the animals and residue left were recorded daily to find out the total DMI of the experimental animals. Intake of DM was calculated as the difference between the amount of DM offered and amount of DM left in residue. Feed-to-gain ratio or FCR was calculated by the amount of DMI (kg) required for unit (per kg) weight gain by animals during the trial period. To compare the efficiency of nutrient utilization in experimental bucks, a digestion trial for a period of 7 days was conducted at the end of the study. Bucks were weighed before start and at the end of digestion trial to find out body weight gain. Weighed amount of feeds and fodders was offered during digestion trial. Representative samples of the feed offered and residue left were collected and analysed for chemical composition. Faeces voided during 24:00 hours were collected and measured daily for 6 days. Dried dung samples were oven dried to a constant weight at 60 °C and were then ground through Wiley mill to pass a 1-mm sieve and analyzed for DM, crude protein (CP), ether extract (EE), and total ash (AOAC, 2005). The methods proposed by Van Soest *et al*. (1991) were used for neutral detergent fiber (NDF), acid detergent fiber (ADF), and acid detergent lignin (ADL) determination. The digestibility coefficient of nutrients was calculated from the nutrient intake and nutrient outgo in faeces during digestion trial.

STATISTICAL ANALYSIS

The data was analyzed using the general linear model (GLM) procedure of Statistical Package for the Social Sciences (SPSS 2020 Inc., Chicago, IL, USA) as a randomized block design with animal as the experimental unit as per Snedecor and Cochran (1989). The pair-wise comparison of means was carried out using "Tukey's honest significant difference (HSD) test". Significance was determined at $P<0.05$.

RESULTS AND DISCUSSION

The effect of dietary supplementation of different sources of Se on DMI and growth performance is presented in (Table 2). The experimental results revealed no significant ($P>0.05$) effect on growth performance (average body weight, average daily gain (g) and FCR) among the groups supplemented with different (inorganic, organic and nano) forms of Se at 0.3 ppm levels in Barbari bucks. The present results are in agreement with a previous work involving Korean native goats (Chung *et al*., 2007) and in lambs (Domínguez-Vara *et al*., 2009; Vignola *et al*., 2009). Many researchers also indicated that either levels or source of Se did not influence growth in cows (Gunter *et al*., 2003), lambs (Juniper *et al*., 2009) and chicken (Payne and Southern, 2005). Juniper *et al*. (2006), did not reported any significant results on rates of growth, feed intake or feed to gain ratio using organic and inorganic Se supplements in the diets of growing lambs for a period of 112 days. In addition, Lawler *et al.* (2004) observed that neither Se source nor dietary Se concentration

Table 1: Chemical composition (%DM basis) of dietary feed ingredient fed to experimental bucks

Item	Concentrate	Gram straw	Corn silage	TMR
Dry Matter (%)	91.32	92.82	34.33	78.64
Organic Matter (%)	76.49	82.75	28.88	68.23
Ether Extract (%)	3.34	2.14	3.8	2.87
Crude Protein (%)	19.34	8.21	10.23	11.99
Total Ash (%)	14.83	10.06	5.45	10.4
Crude Fibre (%)	12.80	31.42	28.68	25.1
Nitrogen Free Extract (%)	49.69	48.16	51.84	49.32
Neutral Detergent Fibre (%)	31.58	61.93	57.4	54.6
Acid Detergent Fibre (%)	13.42	41.36	38.64	32.23
Acid Detergent Lignin (%)	1.60	3.60	2.80	2.80
Cellulose (%)	11.82	37.76	35.84	29.42
Hemicellulose (%)	28.16	20.57	18.76	22.37
Selenium (ppm)	0.086	0.36	0.25	0.23
Calcium (%)	1.85	0.31	0.74	1.01
Phosphorus (%)	0.43	0.11	0.36	0.27

Table 2: Effect of different sources of Selenium supplementation on dry matter intake and growth performance

Parameter	Control	Treatment			SEM	P value
		T1 (SS)	T2 (SY)	T3 (NS)		
Initial B Wt.	36.93	36.92	36.75	36.28	2.38	0.997
Final B Wt.	39.84	40.14	39.77	39.40	0.85	0.941
DMI (kg/day)	1.34	1.36	1.32	1.35	0.028	0.777
ADG (g/day)	65.55	71.48	69.63	68.33	3.03	0.57
FCR	22.38	20.40	22.87	21.43	1.76	0.76

Table 3: Effect of different sources of Selenium supplementation on Nutrient intake and digestibility

Attributes	Treatment				SEM	p Value
	Control	T1 (SS)	T2 (SY)	T3 (NS)		
Initial wt(kg)	41.20	41.69	41.30	40.67	2.230	0.991
Final wt (kg)	41.78	42.27	41.85	41.32	2.200	0.992
Wt gain(kg)	0.58	0.58	0.55	0.64	0.067	0.803
DM intake kg/day	1.55	1.52	1.47	1.48	0.048	0.586
CP intake kg/day	0.17	0.16	0.15	0.15	0.008	0.532
DCP intake kg/day	0.11	0.11	0.11	0.10	0.007	0.788
DCP intake g/kg $W^{0.75}$	6.94	6.501	6.55	6.45	0.395	0.813
TDN intake kg/day	0.70	0.633	0.62	0.69	0.049	0.601
TDN intake g/kg $W^{0.75}$	43.02	38.91	38.44	42.77	2.720	0.502
Nutrient digestibility (%)						
DM digestibility	60.83	58.66	61.42	62.02	1.87	0.61
OM digestibility	69.29	68.18	66.92	69.96	1.84	0.67
CP digestibility	66.11	65.712	68.033	66.637	2.008	0.857
CF digestibility	49.17	46.05	47.24	47.07	2.12	0.77
EE digestibility	81.30	82.13	81.42	83.08	1.97	0.91
NFE digestibility	58.26	56.54	58.13	56.20	2.88	0.93
NDF digestibility	56.38	57.12	57.68	58.06	3.01	0.98
ADF digestibility	51.19	48.37	47.49	46.16	2.20	0.44

affected the physical performance of finishing beef steers fed with supra-nutritional levels of organically bound Se. Skrivanova *et al*. (2007) did not report any influence of different Se levels or sources on the performance of growing calves. Sushma *et al.* (2015) reported that the gradual increase in Se supplementation from 0.0 to 1.8 ppm as sodium selenite had no significant (P >0.05) effect on total weight gain, ADG, feed intake and FCR (kg DMI/kg gain) of lambs. No difference in performance of Han woo steers was observed with increasing levels of Se from 0 to 0.9 mg Se/kg (Lee *et al*., 2006). Dominguez-Vara *et al.* (2009) noticed no effect of Se addition as Se enriched yeast at 0.3 ppm to basal diet on growth performance (final BWs and weight gains) of Rambouillet lambs. This might be due to availability of Se through basal diet, which may be sufficient enough to meet the nutrient requirement of sheep. However, contrary to present findings, some studies showed that feeding efficiency and ADG (Yue *et al*., 2009), and the final BW and ADG (Shi *et al*., 2011) of growing male goats supplemented with dietary Se were significantly higher compared with the control animals. Castellan *et al.* (1999) reported greater ADG and higher growth of calves receiving parenteral administration of Se having a low Se status. The inconsistency in responses may possibly be due to variable Se levels in the basal diets. In the present study, Se content present in the basal diet (0.23 mg/kg DM) was sufficient to meet the requirements that, if inadequate, could have adversely affected the growth performance. Se supplementation is not likely to influence growth rate unless there is an evident lack of the mineral (Johansson *et al*., 1990). Se is involved in the metabolism of thyroid hormones. A Se-deficient diet causes a reduction of tri iodothyronine (T3) and an increase of the tetra iodothyronine (T4) and a decrease in the ratio T3/T4 levels in blood (Thompson *et al*., 1995). These effects can influence growth rates since T3 is an active form of T4, which is known to be involved in the growth mechanisms. Se is a component of enzyme 5-iodothyronine deiodinase that convert T4 to T3 and this Se-dependent selenoprotein is affected in the event of Se deficiency. This delay could explain the fact that several studies that have explored various ways of Se supplementation do not show any significant effect of Se supplementation on growth, weight gain of calves, lambs, kids, cows etc. Apart from Se status other factors contributing to variation in results might be differences in age, breed, assays used to determine Se status, ration composition and availability or concentration of other trace elements.

The result ofinfluence of Se supplementation on DM intake and apparent digestible parameters are presented in Table 3. It showed no significant difference on DMI, nutrient digestibility and as well as total digestible nutrients ($P > 0.05$). The mean daily DM, OM and CP intake was found to be similar among the control and Se supplemented groups, which indicated that supplementation of different sources of Se at 0.3 ppm level had no effect on palatability and feed intake pattern of the bucks. The results of most researchers are consistent with the present study results, where DMI remained unaffected due to supplementation of inorganic Se at the 0.3 ppm level in Holstein cows (Ivancicand Weiss, 2001), at the 0.38 ppm level in crossbred beef steers (Lawler *et al*., 2004). Similarly, supplementation of Se at 0.3 ppm level in buffalo calves (Mudgal *et al*., 2008) did not showed any effect on DMI. The digestibility of organic nutrients and TDN was also found to be similar ($P > 0.05$) among the treatment groups suggesting that supplementation of Se through different forms (inorganic, organic and nano) had no effect on the digestibility of these nutrients. In agreement with these observations, supplementation of 1 ppm of Se had no effect on the digestibility of OM, CP and NDF in cattle calves (Nicholson *et al*., 1991). Similarly, there were no effect of 0.3ppm Se supplementation on intake and digestibility of organic nutrients in male buffalo calves (Mudgal *et al*., 2008) and lambs (Kumar, 2006). However, when selenium is added at graded level to the basal diet in any form (inorganic, organic and nano) resulted in significant increase in *in vitro* dry matter digestibility and microbial biomass production at all levels of addition compared to when no selenium was added (Vajpeyee *et al*., 2021). Taheri *et al.* (2018) proved that adding Se yeast significantly improved digestibility of nutrients and dry matter intake in forage in Iranian native goats. Wang *et al.* (2019) showed that the addition of Se yeast could improve digestibility of herbage and some nutrients. Chadio *et al.* (2006) studied the effects of Se supplementation on the level of thyroid hormone and Se enzyme activity in growth lambs, and found that Se affected thyroid hormone metabolism. The digestion and utilization of nutrients directly affect the growth of livestock. This suggested that Se regulates the nutrient digestibility of the body by regulating thyroid hormone. In the current study, it was found that supplementation of different forms of Se at 0.3 ppm level in the diet of bucks had no effect on the intake and digestibility of organic nutrients.

It can be concluded that the dietary supplementation of Se from either inorganic, organic and nano sources have no significant effect on growth, intake and digestibility of nutrients. Hence, indicating no impact of Se supplementation on growth performance and nutrient digestibility of Barbari bucks.

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