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Effect of Inorganic and Nano Selenium Supplementation on Growth Performance and Nutrient Utilization in Growing Hariana Heifers

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ABSTRACT

The present study was conducted to see the effect of inorganic selenium (ISe) and nano selenium (NSe) supplementation on growth performance and nutrient utilization in Hariana heifers. A total of 18 Hariana heifers were selected and allocated into three groups having six heifers in each group and fed treatment diet for 90 days. In present study, control (Con) group was not supplemented with any extra amount of Se other than present in the basal diet, T1 group was supplemented with inorganic Se @ 0.3 mg/kg of dry matter(DM) offered, while T2 group was supplemented with nano Se @ 0.3 mg/kg of DM offered. Basal diet offered to experimental groups containing 50% concentrate, 35% green jowar fodder and 15% wheat straw. DM was offered to all experimental group at about 3.5% of the body weight of animals. All groups of animals were fed with basal diet having same levels of nutrients. Body weight (BW) and dry matter intake (DMI) were recorded fortnightly. DMI (kg/day), DMI (kg/100kg BW),total digestible nutrients(TDN) intake (g/kg $W^{0.75}$) and digestible crude protein (DCP) intake (g/kg $W^{0.75}$) remained similar in all experimental groups. Nutrient digestibility and digestible nutrient intake were not impacted by supplementation of different levels of Ise and NSe supplementation to all treatment groups. Average fortnight body weight gain, average daily gain (ADG), metabolic body weight gain was similar in all groups. Feed conversion ratio (FCR) and feed conversion efficiency (FCE) were not significantly different between treatment and control group. So, it can be finally concluded that supplementation of Se either from inorganic or by nano source did not exert any adverse effect on growth performance and nutrient utilization.

KEYWORDS: Growth Performance, Heifers, Nano Selenium, Nutrient Utilization

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INTRODUCTION

India has a large livestock resource, which plays an important role in improving the social and economic conditions of the rural population (Sultana et al., 2015). Nutrition has a strong influence on livestock productivity. Balanced and high-quality nutrition is critical for optimizing livestock production. Trace mineral research has previously received less attention, and recommendations on these mineral requirements are primarily based on previous research (NRC, 1985). These minerals have recently received attention due to the recognition that they have both a direct and indirect effect on ruminant performance. Deficiency of these minerals in the diet can reduce animal production by 20-30% (Mohanta and Garg, 2014). Se occurs naturally in both inorganic and organic forms. Se supplements could increase live weight gains, wool production, growth rate, and improve the efficiency of the antioxidant system, enhance the disease resistance, and nutritional quality in animal (Mahima et al., 2006). Less bioavailability and more excretion are the major environmental issue related to the inorganic mineral sources (Pandey et al., 2024).

Nowadays, nanoparticles (NPs) production by controlling size and morphology using physical, chemical, or biological methods is now considered an important research direction in biotechnology (Malyugina et al., 2021). According to Singh (2018), they possess important chemical and physical properties like colour, strength, infusibility, solubility, and a high surface-to-volume ratio.Among all the probable approaches, use of nanotechnology to produce nano minerals is a novel and potential alternate to other conventional used sources. (Singh et al., 2024).Inorganic or organic forms of Se are commonly used as supplement but nano form gains attention recently (Yaghmaie et al., 2017; Kachuee et al., 2019).Recently, elemental NSe has attracted a wide spread attention to its high bioavailability and low toxicity (Zhang et al., 2008). Both the dietary concentration and source of Se have been demonstrated to affect antioxidant system and Se status (Petrera et al., 2009).

MATERIALS AND METHODS

Eighteen growing Hariana heifers were selected from the cattle herd maintained at Livestock Farm Complex (LFC), DUVASU, Mathura. All heifers were housed in a well-ventilated shed having the proper arrangement for individual feeding and watering without having access to the other animal's diet. The animals shed was washed daily and thoroughly cleaned to remove faeces and dirt. All the animals were maintained under clean and hygienic conditions. Animals in Con group were fed with basal diet i.e., wheat straw, chaffed green jowar fodder and compounded concentrate mixture as per NRC (2005) requirements. The chemical composition of experimental diet and dietary components (on DM basis) are presented in Table 1.

Concentrate, green fodder and wheat straw were fed in the ratio of 50:35:15, respectively in Con, ISe(T1) and NSe (T2) groups. Ingredients and chemical composition of the basal diet fed during the experimental period is depicted in Table 2. In Con group, no supplementation of Se was there, T1 group was supplemented with inorganic sodium selenite (SS) @ 0.3mg/kg DMI, while T2 group were supplemented Se as nano selenium oxide @ 0.3 mg/kg DMI. Animals were fed with basal diet i.e.,concentrate mixture, green fodder (Jowar) and wheat straw as per NRC(2005) requirements.Supplementation of Iseand NSe to treatment group was done in the form of premix separately. ISe (Na_2SeO_3)and NSe (SeO_2) powder premix was made by mixing with fine grinded barley flour. Deworming of all the animals was done before the start of the experiment.

Table 1. Ingredient and chemical composition (% DM basis) of experimental diet fed to heifer

Item	Concentrate	Jowar fodder	Wheat straw
Dry matter %	91.50	17.50	91.10
Organic matter %	92.10	88.80	86.70
Ether extract %	4.50	4.10	1.20
Crude protein %	20.68	10.20	3.53
Total ash %	7.40	11.20	13.20
Nitrogen free extract %	59.22	47.36	43.47
Crude fibre%	11.7	26.9	40.23
Neutral detergent fibre%	44.80	51.06	80.50
Acid detergent fibre%	13.45	46.15	53.74
Acid detergent lignin %	0.50	4.56	3.60
Cellulose %	16.90	34.70	50.30
Ca %	1.28	1.37	1.07
P %	0.61	0.67	0.54
Cu mg/kg	6.61	9.98	8.5
Zn mg/kg	14.87	45.07	16.27
Se mg/kg	0.21	0.18	0.04

The experimental heifers were monitored daily for DMI and fortnightly for growth performance and feed efficiency measures. The feeds offered to the animals and residue left were recorded on daily basis to find out the total DMI of the experimental heifers. Intake of DM was calculated as the difference between the amount of DM offered and amount of DM ort. Body weight of experimental animals was recorded at start of experiment followed by fortnight intervals. The experimental heifers were weighed before feeding and watering.

Fortnightly weight gain was calculated by increase in body weight in one fortnight and ADG (kg/day) was calculated by dividing the fortnightly weight gain with number of days (15). 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. FCE was calculated as the ratio between ADG (kg) and DMI (kg) by animals during the trial period. The representative samples of feeds and fodders offered and orts left were dried in a hot air oven at 60°C till a constant weight was attained and then ground in a Wiley mill to pass a 1-mm sieve. The samples were analyzed for DM, CP, Ether Extract (EE), and Total ash (TA) following standard procedures (AOAC, 2005). Neutral detergent fiber (NDF) and acid detergent fibre (ADF) were determined according to the procedures described by Van Soest et al. 1991.

Table 2. Chemical composition (% DM basis) of total mixed ration (TMR) fed to heifer during feeding trial

Ingredients (%)	Groups		
	Con	ISe	NSe
Oats	18	18	18
Barley grain	15	15	15
Wheat bran	18	18	18
Gram chunni	15	15	15
Mustard oil cake	32	32	32
Mineral mixture*	2	2	2
Jowar fodder	35	35	35
Wheat straw	15	15	15
Nutrients	Chemical composition (%)		
DM	76.55	76.55	76.55
OM	85.9	85.9	85.9
EE	2.52	2.52	2.52
CP	12.36	12.36	12.36
ASH	8.59	8.59	8.59
CF	23.57	23.57	23.57
NFE	50.83	50.83	50.83
NDF	56.76	56.76	56.76
ADF	32.48	32.48	32.48
Ca	1.86	1.86	1.86
P	0.91	0.91	0.91
Cu mg/kg	15.45	15.45	15.45
Zn mg/kg	38.08	38.08	38.08
Se mg/kg	0.21	0.37^{a}	0.40^{b}

To compare the efficiency of nutrient utilisation in growing heifers, a digestion trial for a period of 7 days was conducted at the end of the study. Heifers were weighed before start and at the end of digestion trial. Weighed amount of feed 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 hours were collected and measured daily for 7 days.

Results were reported as means with SEM. Differences between the treatments mean were considered significant at P<0.05. Homogenous subsets were separated by Tukey's test.

RESULTS AND DISCUSSION

The objective of this study was to evaluate the effect of ISe and NSe supplementation on performance of growing heifers. In this experiment, eighteen Hariana heifers were selected and divided into three groups, each group contain six animals. In Con group, no supplementation of Se, T1 group was supplemented with ISe (Na_2SeO_3@ 0.3 mg/kg DMI), while T2 group was supplemented with NSe(SeO_2 @ 0.3 mg/kg DMI). The observations on effect of nano Se supplementation nutrient intake, growth performance and digestibility of nutrients were recorded.

Effect on Growth Performance

Effect of ISe and NSe supplementation on growth performance are depicted in Table 3. As the age of heifers advanced fortnightly BW change also increased. BW gain of heifers in 3 different groups measured at fortnightly intervals and found no effects of treatment on the fortnightly BW change. There was also no significant (P>0.05) effect of treatment on the fortnightly BW gain during the experimental period. There was no significant difference in BW observed on supplementation of different levels of ISe and NSe in diet of heifers though overall body weight increases over time but better body weight gain was observed in ISe and NSe supplemented group. The total Se content of the diet should not exceed 0.3 mg/kg, and the total desired supplement should not exceed 3 mg/head/day (Saha et al., 2016).

Table 3. Effect of inorganic and nano Se supplementation on DMI and growth performance

Attributes	Groups			SEM
	Con	ISe	NSe	
DMI (kg/day)	3.62	3.63	3.73	0.15
DMI	2.40	2.43	2.49	0.02
ADG (g/day)	332.28	346.31	353.87	5.91
FCR	11.08	9.89	9.28	0.44
FCE	0.11	0.12	0.13	0.01

Daily DMI (kg/d) in Con, ISe and NSe group during the experimental feeding was recorded and statistical analysis of data revealed that variation between the groups for DMI was not significantly different (P>0.05) between the groups and the mean daily DMI in the Con, Ise and NSe groups were 3.62, 3.63 and 3.73 kg/day. The percentage DMI (kg/100 kg BW) in experimental animals in Con, ISe and NSe groups during different fortnights of experimental feeding was also found in a similar pattern in all the experimental groups and the mean daily DMI in the Con, ISe and NSe groups were 2.40, 2.43 and 2.49 kg/100 BW.

The ADG (g/day) was calculated by dividing the fortnightly weight gain by the number of days in a fortnight i.e. 15. Statistical analysis of ADG in treatment groups shows no significant effect of treatment. The mean ADG of the experimental heifers during 90 days study in Con, ISe and NSe groups were 332.28, 346.31 and 353.87g/day, respectively. Similarly, it was found that Se NPs supplementation appears to have no impact on growth performance in Holstein suckling calves (Jamali et al., 2022).On the contrary findings reported by conducted an experiment by Kojouri et al. (2020) in small ruminants showed that Se NPs had positive effects on newborn lambs' weight gain patterns. The weight gain pattern of newborn lambs was observed throughout all sampling periods. The treated group showed a noticeable increase in weight gain, while the Con group showed a slight increase in weight gain. Also, in a study by Zommara et al. (2020), the ADG of the organic Se (OSe) and NSe supplemented groups increased by 27.13 and 25.83% when compared to the Con group when fed 0.3 mg Se/kg DM as OSe and NSe in the second and third groups, respectively. As similar to the attributes of BW, there was no effect of ISe and NSeon the metabolic BW change. The fortnightly metabolic BW change of the experimental heifers was recorded during 90 days of study and found no significant ($P<0.05$) effect of treatment on fortnightly metabolic BW gain in different treatment groups.

The FCR during the experimental period was recorded and over-all mean value found 11.08, 9.89 and 9.28 in Con, ISe and NSe groups, respectively. FCR were not significantly different ($P>0.05$) between groups. The FCE was recorded and found0.11, 0.13 and 0.12 in control, ISe and NSe groups, respectively. FCE were not significantly different ($P>0.05$) between groups. Just like the current study Alimohamady et al. (2013) randomly assigned 30, 4-5 month-old lambs to treatments including basal diet, SS and Se yeast. There were no significant differences in ADG, average daily feed intake, or feed/gain ratio. Shi et al. (2018) in a study on taihang goats reported that the final BW was increased in bucks supplemented with Se compared to the Con, and ADG in NSe and Se yeast was greater than in SS or Con bucks.

Effect on Nutrient Utilization

Effect of ISe and NSe supplementation on nutrients utilization are depicted in Table 4. DM digestibility was 59.39, 60.58 and 60.69% in Con, ISe and NSe group respectively whereas, the organic matter (OM) digestibility was 62.33, 63.59 and 64.99%, respectively. The statistical analysis of data on DM and OM digestibility percent revealed that difference between the groups were not significantly different ($P>0.05$). CP digestibility percent of Con, ISe and NSe diets were 68.37, 69.78 and 70.37, respectively.

The CF digestibility in Con, ISe and NSe was 51.38, 53.55 and 55.29%, respectively. The EE digestibility percent in Con, ISe and NSe were 81.54, 81.56 and 82.46%, respectively.

Table 4. Effect of inorganic and nano Se supplementation on nutrients digestibility percentage coefficient

Attributes	Groups			SEM
	Con	ISe	NSe	
DM	59.39	60.58	60.69	1.42
OM	62.33	63.59	64.99	2.06
CP	68.37	69.78	70.37	1.61
CF	51.38	53.55	55.29	1.24
EE	85.54	81.76	82.46	1.56
NFE	70.41	71.06	72.31	3.08
NDF	56.53	56.33	56.73	1.88
ADF	49.07	50.70	52.53	1.75

P>0.05: Non significant

Digestibility percent of NFE in Con, ISe and NSe were 70.41, 71.06 and 72.31% respectively. The NDF digestibility of control, ISe and NSe were reported as 56.53, 56.33 and 56.73% respectively. ADF digestibility percent were found 49.07, 50.7 and 52.53% in Con, ISe and NSe respectively. All nutrients digestibility coefficient were found similar in Con and treatments groups. similarly in a study conducted by Liu et al. (2024) on forty-eight Holstein dairy cows averaging 720 ± 16.8 kg of body weight, the addition of NSe increased the digestibility of dietary DM, OM, CP, NDF, and ADF while ether extract digestibility remained unchanged. Also, Ibrahim et al. (2018) studied the effects of ISe, OSe, and NSe particles on the nutritive digestibility, productivity and serum biochemical indices of 32 Ossimi lambs aged 4 months. Results showed higher digestibility of DM, increased digestibility of OM, CP, CF, EE, NFE, DCP, and TDN in lambs fed with the said diets. Digestible DM, OM, EE, NFE, CF, NDF and ADF intake were found similar in Con and treatment groups and shown in Table 5.

Total DMI (kg/d), DCP intake, TDN intake were not significantly different (P>0.05) in all four groups as mentioned in Table 5. The digestibility coefficients of DM, OM, CP, EE, CF, NFE, NDF, and ADF were unaffected by different levels of ISe and NSe supplementation in the diet of Hariana heifers. Digestible nutrient intake i.e.DMI (kg/100 kg BW),DCP(g/kg $W^{0.75}$)andTDN intake (g/kg $W^{0.75}$) intake were similar across treatment groups. In the current study, supplementation with ISe and NSe had no effect on nutrient intake, nutrient digestibility, or BW changes. In contrast to the current study, Liu et al. (2019) investigated the effects of SS on cannulated bulls using a replicated 4 x 4 latin square design with eight ruminally cannulated dairy bulls. The treatments were Con, low SS (LSS), medium SS (MSS), and high SS (HSS), with SS levels of 0, 0.1, 0.3, and 0.5 mg/kg of Se in dietary DM. The digestibility of DM, OM, CP, EE, NDF, and ADF has increased linearly.

Table 5. Effect of inorganic and nano Se supplementation on nutrient intake during digestion trial

Attribute	Groups			SEM
	Con	ISe	NSe	
Initial BW (kg)	154.77	156.41	158.23	11.84
Final BW (kg)	158.81	161.83	163.80	11.81
BW change (kg)	5.03	5.42	5.48	0.24
DM intake (Kg/day)	3.74	3.75	3.73	0.34
DM intake (%BW)	2.25	2.28	2.29	0.05
DCP (g/day)	528.30	491.42	587.81	0.509
DCP (g/kg $W^{0.75}$)	11.30	12.02	12.73	0.726
TDN intake (kg/d)	2.43	2.50	2.54	0.25
TDN (g/kg $W^{0.75}$)	57.4	61.63	62.97	47.15

P>0.05: Non significant

CONCLUSION

From the above study it may be concluded that supplementation of inorganic and nano Se did not have any effect on daily dry matter intake and body weight gain as compared to control group and also, the supplementation of inorganic and nano Se did not have any effect on nutrients digestibility. So, it can be finally concluded that supplementation of Se either inorganic or by nano source did not exert any adverse effect on growth performance and nutrient utilization in Hariana heifers.

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