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Effect on the growth performance of broiler chickens by selenium nanoparticles supplementation

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ABSTRACT

Selenium nanoparticles were prepared by chemical method. The x-ray diffraction studies indicated the formation of Se with hexagonal phase and no secondary phase was observed. The composition analysis results show that Se is present in the sample. TEM images reveal that Se nanoparticles size ranging from 30-50 nm. The present study was conducted to determine the effect of prepared selenium nanoparticles on the growth performance of broiler chickens. Thirty numbers of a day old Vencobb broiler chicks were wing banded, weighed and randomly allotted to three groups with ten chicks in each group. Their weight gain was taken for six consecutive weeks to observe the effect of dietary selenium nanoparticles over growth utilization of birds. Three different groups, T1 control standard diet, T2 Standard diet + Sodium selenium 0.3mg/Kg diet and T3 Standard diet + Selenium nanoparticles 0.3mg/Kg diet respectively. The percent weight gain was highest in T3 group as compare to T1 and T2 which was supplemented 0.3 mg Se/kg of feed. Therefore it was concluded that supplementation of selenium nanoparticles 0.3 mg/kg diet of poultry enhances the growth rate in the broiler birds.

Keywords: Selenium nanoparticles, Nutrient utilization, weight gain.

INTRODUCTION

Selenium is a trace mineral essential to maintain good health in animals and human beings. Selenium is incorporated into proteins to form selenoproteins, which are important

antioxidant enzymes. These antioxidant enzymes prevent oxidative damage to body tissues. Unfortunately, in many parts of the world, major food ingredients contain inadequate level of selenium resulting in selenium deficiency in human and animal nutrition

In commercial poultry production, selenium needs to be supplemented to overcome various stressors (Chun fan et al 2009). Selenium is involved in antioxidant defense system; thereby influencing the livability and production in broiler chickens. Selenium is added to poultry diet as sodium selenite or sodium selenate. These inorganic forms of selenium have low transfer efficiency from feed to tissues and can't be added at higher levels in feed due to toxic nature (Beck et al 2007). To overcome the toxicity of selenium, organic sources were also tried.

Selenium supply to animals may be increased using selenium nanoparticles with more bioavailability and least toxicity as reported in studies on mice (Huali Wang et al 2007). To enrich poultry products with selenium so as to provide the selenium requirement of human beings, selenium nanoparticles can be supplemented through diet because of its low toxicity and higher bioavailability. The toxicity of nano-selenium is 7 times lower than that of inorganic selenium and 3 times lower than that of organic selenium (Peng et al 2007).

Therefore, selenium nanoparticles can be used as feed additive to enrich selenium in poultry products. Hence, the present study was conducted to determine the effect of prepared selenium nanoparticles on the growth performance and activities of antioxidant enzymes of broiler chickens.

Experimental

Selenium nanoparticles have been prepared using the required precursors by chemical precipitation method. In brief, SeO_2 (20 mg) and the starch (20 mg) were first dissolved in water (10 ml) and stirred for about 40 min at room temperature. Ascorbic acid (15 ml, 0.028 M) was added drop wise to the above mentioned solution. The colour of the solution changed into brick-red, indicating the formation of Se nanoparticles in the solution and then stirred for 8 hours at room temperature. After8 hours, the suspension was centrifuged and washed with water and ethanol several times. The samples were then suspended in ethanol and allowed to age for 2 hours without stirring. After centrifugation, the samples were dried at room temperature.

X-ray diffraction studies have been carried out using PANalytical x-ray diffractometer, surface morphology of the samples has been studied using scanning electron microscope (JEOL JSMS 800-V). Transmission electron microscope (TEM) images of the prepared Se have been recorded using a Philips TECNAI F20 microscope. Compositional

analysis of the samples has been studied using energy dispersive analysis of X-rays (JEOL Model JED -2300).

RESULTS AND DISCUSSION

Figure 1 shows the X-ray diffraction patterns of Se as prepared. The diffraction peaks at 2θ (degrees) of 23.57°, 29.73°, 41.28°, 43.68°, 45.43°, 51.72°, 56.07°, 65.24° and 71.60° are respectively indexed as the (100), (101), (110), (102), (111), (201), (112), (210) and (113) planes of Se. All the diffraction peaks in the 2θ range measured can be indexed as the hexagonal structure of Se with lattice constants a = 4.354Å and c = 4.931Å, which are in good agreement with those on the standard card (JCPDS card No. 06–0362). The sharpness of the diffraction peaks suggests that the product is well crystallized.

Figure 2 (a & b) shows the scanning electron microscope (SEM) image of the as prepared Se is uniform nanoparticle. The SEM image reveals that the Se nanoparticle are of uniform size. It can be seen that nanoparticles were uniform with ranging from 30 to 50 nm and verifying the results of the TEM images. Figure 3 shows the energy dispersive x-ray analysis (EDS) result for the Se sample. In the EDS, Se is the only element detected, indicating that the sample is highly pure.

Figure 4a shows the transmission electron microscope (TEM) image of as-prepared Se nanoparticles, indicating the nanoparticle are uniform with an average size of about 30 nm. Figure 4b shows the selected area electron diffraction (SAED) pattern of as-prepared Se nanoparticles image (Figure 4b) also exhibit diffraction rings corresponding to the (100), (101), (110), (102), (111) and (201) directions of the hexagonal phase of Se. The d spacing values obtained for all the diffraction rings from the SAED pattern match very well with that of hexagonal Se. Ring patterns are observed in the selected area electron diffraction pattern of Se nanoparticles Figure 4b clearly indicated the formation of polycrystalline nature of Se nanoparticle.

MATERIALS AND METHODS

The biological experiment was carried out at Department of Veterinary Physiology, Veterinary College and Research Institute, Namakkal, Tamil Nadu. India.

Experimental birds

One-day-old straight run broiler chicks obtained from commercial hatchery at Namakkal were utilized in the biological trial.

Experimental design

Thirty numbers of a day old Vencobb broiler chicks were wing banded, weighed and randomly allotted to three groups with ten chicks in each group. The birds were reared in cages under standard managemental practices from 1 day old to six weeks of age. The experimental broiler birds were vaccinated against Ranikhet disease on day 7 and 21, and Infectious Bursal Disease at the age of day 14.

Experimental Diet

The experiment was designed to find out the impact of adding nanocrystalline selenium supplement over the recommended level on growth performance and antioxidant enzymes of broilers. Selenium nanoparticles and feed grade sodium selenite were used for this study.

The experimental diet was formulated according to the standards prescribed in B.I.S (1992).

Treatment	Experimental diets
T1 (Control)	Standard diet
T2	Standard diet + Sodium selenium 0.3mg/Kg diet
T3	Standard diet + Selenium nanoparticles 0.3mg/Kg diet

The broiler starter and finisher diets were fed ad libitum to the birds from 1 to 21 and 22 to 42 days of age respectively. At the end of every week, body weight of the individual birds was recorded. The inclusion levels of the feed ingredients in broiler starter and finisher diet are given in Table 1.1.

Body Weight

At the end of every week, body weight of individual birds was recorded.

Body weight analysis

The effects of selenium supplementation on mean body weight of broiler chicken from 1 to 6 weeks of age are presented in Table 1.2. Body weight was observed to be significantly different in treated groups compared to the control group with increase in growth performance of broiler ($P < 0.05$).

The mean body weight (g) recorded at the age of 6th week was 1893 and 1903 for the group T2 and T3 respectively compared to 1869 in control (T1). The mean body weight increased slightly among the treatment groups.

The observation of this study concurs with the findings of (Colnago et al 1984) observed an increase in weight with increasing selenium levels (Xia et al 2005) observed that

the chicken had higher (P<0.05) growth performance at concentration range of 0.4-1.0 mg/kg with selenium nanowire than sodium selenite. Similarly, (Chunxiang et al 2007) observed selenium nanowires diet significantly increased the growth performance of goats (P <0.05).

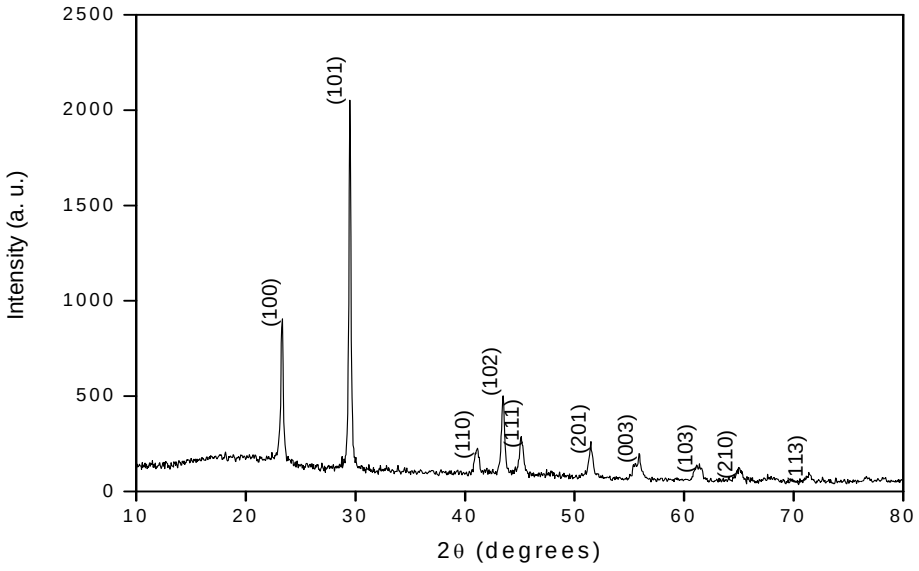

Figure 1 X-ray diffraction pattern of Se nanoparticles.

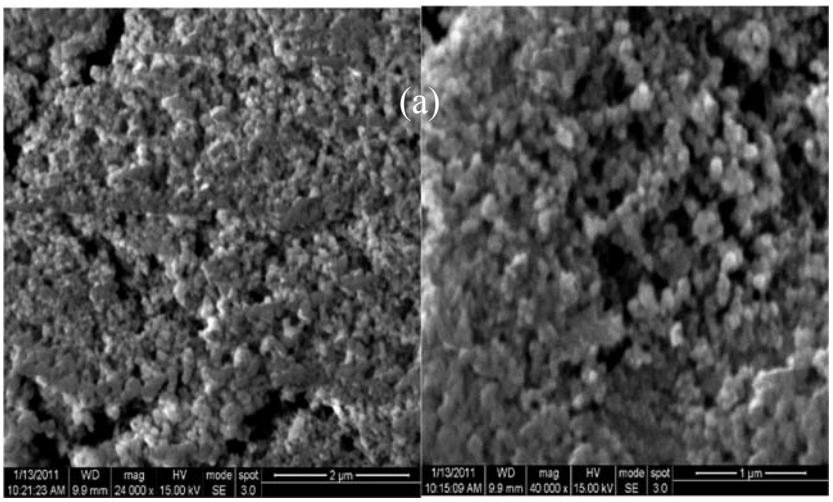

Figure 2 SEM image of Se (a & b) as prepared Se nanoparticles.

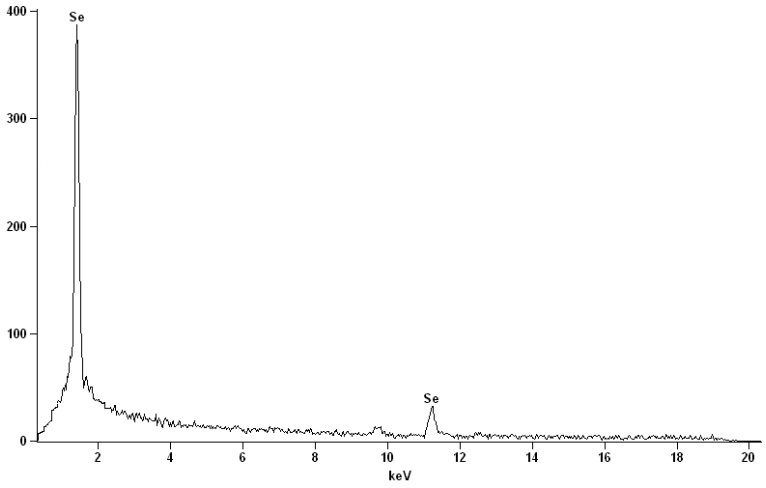

Figure 3 EDS spectra of as prepared Se nanoparticles

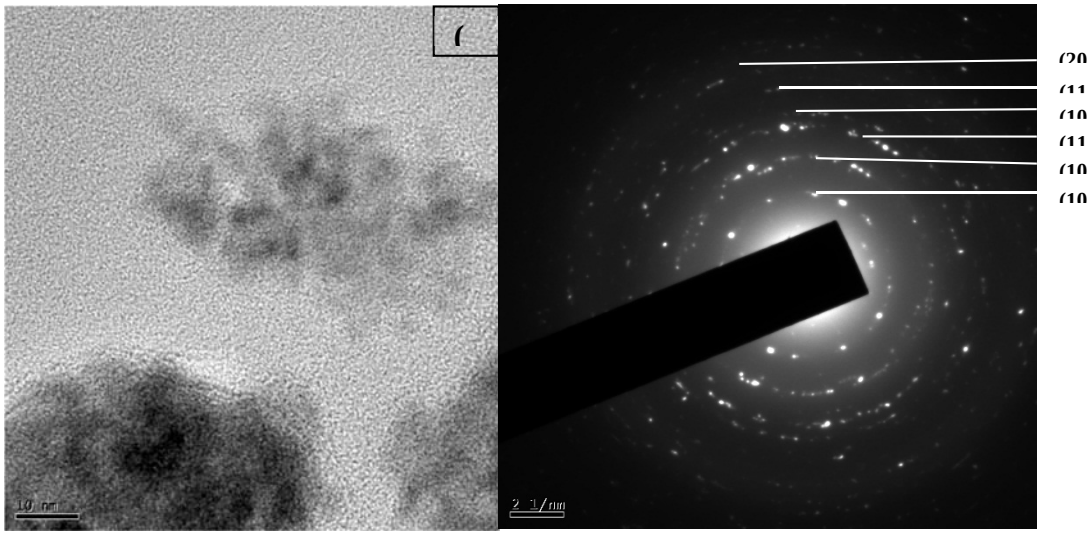

Figure 4 (a) Transmission electron microscope and (b) selected area electron diffraction images of as prepared Se nanoparticles

Table 1.1 Ingredients and nutrient composition (% DM) of broiler starter and finisher diet

Ingredients	Broiler starter	Broiler finisher
Maize (%)	55.8	41.5
Soyabean meal (%)	41.5	33.0
Di calcium phosphate (%)	1.5	1.5
Calcite (%)	2.1	1.5
Salt (g/100kg)	400	400
Methionine (g/100kg)	360	320
Supplements (g/100kg)		
Mineral mixture 1	100	100
Vitamin AB2D3K 2	20	20
Vitamin B complex 3	25	25
Antibiotic4	100	100
Coccidiostat5	50	50
Nutrient composition		
Dry matter	90.25	90.35
Crude protein	22.23	19.21
Crude fibre	3.04	882.78
Ether extract	2.27	2.60
Total ash	6.57	5.09
Nitrogen free extract	65.8	70.32
Acid insoluble ash	0.64	1.30
Calcium	1.49	0.80
Total phosphorus	0.62	0.53
Methionine* (g/100kg)	140	30
ME (kCal/kg) *	2795	2897

* calculated value

Table 1.2 Mean (± SE) body weight (g) of broilers fed supplemental selenium

Treatment	Day-old	I	II	III	IV	V	VI
T1 - Control	44.91± 0.84	130.18± 4.08	290.97± 11.23	577.62± 16.23	939.94± 27.78	1345.98± 26.87	1869.49± 41.27
T2 - Sodium Selenite	45.63± 0.63	131.03± 3.19	302.67± 8.94	569.30± 18.42	941.00± 26.32	1366.65± 34.89	1893.43± 56.33
T3 - Selenium nanow\particles	45.38± 0.68	132.65± 3.72	306.97± 12.73	596.75± 22.66	976.80± 34.04	1383.62± 53.64	1903.27± 61.15

Mean values are based on body weight of 10 birds per treatment

CONCLUSION

High purity and uniform Se nanoparticle with the size ranging from 30 to 50 nm have been successfully prepared under the chemical method. From the results of this study, it can be concluded that the selenium nanoparticles supplementation in the diets especially 0.3 mg/ kg diet of local chicks from one day of hatch to 6 weeks of age improved productivity, physiological and immunological traits including parameter such as live body weight. Therefore, selenium nanoparticles could be an essential form of selenium supplementation in dietary chicks.

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