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Influence of dietary nano zinc and selenium supplementation on growth performance, nutrients digestibility and carcass characteristics of broiler chickens

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Target Audience:

Abstract

The study was conducted to investigate the effect of nano zinc and selenium supplementation on growth performance, nutrients digestibility and carcass characteristics of broiler chicks. Three hundred and twenty 28 day old broiler chicks of Arbor Acre strain were used in a completely randomized design with 4×4 factorial combinations. Birds were fed control diets containing 20% CP and 3000kcal/kg ME supplemented with varying levels of nano zinc (20, 30, 40.and 50mg/kg) and selenium (0.10, 0.15, 0.20 and 0.25mg/kg) respectively for 21 days. Data generated were subjected to Statistical Package for Social Science (SPSS version 16.0). The supplementation of nano zinc (30mg) and selenium (0.10mg) increased weight gain, reduced feed consumed and better FCR. Dry matter, crude fibre, crude protein, ether extract and ash digestibility were significantly enhanced. The carcass traits were improved irrespective of the levels. The use of nano zinc and selenium in broiler feeding can improve productive performance of broiler chickens without any detrimental effect to the animal.

Key words:

Description of Problem

The increase in human population and demand for safe animal products encouraged scientists to enrich poultry meat and egg with some essential bioactive minerals such as nano Zinc (Zn) and Selenium (Se) via ration intake. It is a leading strategy for the promotion of poultry health, better growth and optimum productive efficiency of commercial birds which have positive impact on the overall economy of production (15). It has been reported that minerals in nano form of dietary supplementation increases the surface area and highly absorbable than inorganic minerals which could possibly boost absorption and utilization of minerals leading to reduction in the quantity of supplements and ultimately lowering the cost of feeding (6). In recent years, nanotechnology is being used in poultry nutrition to enhance efficiency of livestock production. If well used, it can effectively and efficiently satisfy the mineral needs of the broiler chickens (14). Minerals such as Zinc, Copper, Manganese, and Selenium have been recommended as external antioxidants in the management of oxidative stress in broiler chickens (21). Furthermore, Zn and Se are nutritionally indispensable trace elements required for normal growth, appetite regulation and normal metabolic functioning of some biochemical enzymes, hormone production, promote fertility and cell division, protein and DNA synthesis, antioxidant activity, enzyme inhibitors, anti-tumor and anti-infective agents, cytokine inducers and immuno-modulators for all avian species (23).

Despite the importance of these minerals, there are among the most deficient minerals in chickens resulting in low productivity (4). Glutathione peroxidase is a Se-dependent enzyme involved in the antioxidant system; it is the main enzyme which helps to control free radical formation via reduction of hydrogen peroxide and lipid peroxide to water and the corresponding alcohol (12). Furthermore, selenoprotein plays antioxidant function in chicken myoblasts and its synthesis is affected by the nutritional level of the Se (23). Zinc element plays vital role in numerous biological processes as a component of many enzymes (7). It is essential for growth, skeletal development and immune competence (1). In poultry, Zn deficiency causes reduction in weight gain, skeletal malformations, poor bone mineralization and immunological dysfunctions (2) Therefore, Zn supplemented in poultry diets results in positive response in broiler chickens, thus, tissue uptake of Zn in chicks is linearly related to Zn levels in the diet (1). Zinc was found to be essential for normal functioning of the immune system by increasing the counts of thymocytes and peripheral T cells which served as natural killer cells (5). It also boosts the production of neutrophils, antibodies and improving the functions of macrophages (7). Similarly, Zn supplementation was found to be essential, thus, National Research Council (13) recommended 30 mg of Zn/kg and 0.15 mg of Se/kg for broiler chickens (2). However, higher Zn levels (60 to 80mg) produced better immune status in broiler chickens (1). Therefore, nano zinc and selenium have attracted a great attention because they show novel characteristics such as size, shape, large surface area, high surface activity, high catalytic efficiency, and strong adsorbing ability (20). When compared with ZnO. For instance, nano-ZnO has a stronger chemical activity and participates in oxidation reactions with a variety of organic compounds. The permeability of nano-ZnO can also help prevent adverse gastrointestinal reactions and improve the absorption of nutrients in the gastro intestinal tract of broilers chicken. (24).

The aim of this study was to evaluate the influence of dietary nano zinc and selenium supplementation on growth performance, nutrients digestibility and carcass characteristics of Arbor acre broiler chickens.

Materials and Methods

Location of experimental site

The protocols adopted in this study were approved by ethical committee of Federal University of Technology, Minna. The experiment was carried out at the Poultry Unit of the Teaching and Research Farm of the Department of Animal Production, School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Niger State, Nigeria. The town is situated between latitude $9^o28'$ and $9^o37'$ North, longitude 6^o 23' and $6^o33'$ East. It has an annual rainfall of 1000 – 1500 mm and average temperature of 32 ^oC. It is located in the Southern Guinea Savannah Vegetation Zone of Nigeria.

Source of experimental materials

The feed ingredients used for experimental ration formulation includes (Maize, soybean cake, dicalcium phosphate, limestone powder, fish meal, wheat offal, palm oil, salt, vitamins/trace minerals premix, synthetic lysine and methionine) were procured from step by step Agro store, Western bypass, Minna.

Chemicals and Equipment

African scent leaf (Ocimum gratissimum), knife, distilled water, beaker, measuring cylinder, PH meter, magnetic bar, heater-stirrer,Whatman filter paper no.1, Zinc nitrate $Zn(NO_3)_2$, Sodium selenite (Na_2SeO_3),Sodium hydroxide (NaOH), UV-Visible spectroscopy, zetax, spatula, Centrifuged, Sensitive weighing balance and drier box (oven).

Preparation of the plant extract

Fresh leaves of Ocimum gratissimum known as African scent were collected from olericulture garden, opposite Gbeganu junction, Bida road, Minna, Niger state of Nigeria between June to August 2020. About 50g of scent leaf were thoroughly washed and rinsed with distilled water. It was chopped with knife into small size and mixed with 500ml distilled water in 1000ml beaker and heated at 100 ^{o}C for 30mins using a heater-stirrer (Jenway). It was allowed to cooled at room temperature and then filtered using Whatman paper no. 1. The filtrate was centrifuged at 4000 rpm for 10min at room temperature to remove the plant residues and impurities using Centrifuge 80-2 (Life assistance scientific Uk). The final plant extract was stored in the refrigerator until needed.

Green synthesis of metal nanoparticles

For the synthesis of zinc oxide nanoparticles, 100ml of scent leaf aqueous extract with initial pH of 1.6 and 2 g of sodium hydroxide (NaoH) was added into the plant extract to buffer the pH to 13.00 using (Hanna pH meter). Thereafter, flask containing 50ml of 0.2mM solution of zinc nitrate was slowly added at drop wise into 400ml of scent leaf extract in the beaker until the solution colour changes to yellowish white. The mixture was heated and stirred vigorously with magnetic bar for 30minutes at room temperature using heater-stirrer (Hot Plat, Jenway). Liquor of 2 ml was taken from zinc nanoparticle into a small plastic bottle to measure the wavelength from 200nm to 800nm using UV-visible Spectrophometer (UV.1800, Shimadzu Japan). It was centrifuged at 4000 rpm for 10 minutes at room temperature using Centrifuge 80-2 (Life assistance scientific UK). The obtained product was calcined at 100 ^{0}C in an oven for 8 hours.

Synthesis of selenium nano particle, 100ml of 0.4mM concentration of sodium selinite was gently added to 40ml of scent leaf aqueous extract and stirred slowly with spatula until the solution colour change from light grey to dark brown. The beaker containing solution mixture and magnetic bar was thoroughly heated and stirred for 30 minutes at room temperature with Hot Plat (Jenway). Liquor of 2 ml was drawn from selenium nanoparticle solution into a small plastic bottle to measure the wavelength from 200nm to 800nm using UV-visible Spectrophometer (UV.1800, Shimadzu Japan). The product obtained was calcined at 100 ^{0}C in an oven for 36 hours. Nano zinc and selenium obtained were subjected to zetasizer analysis to determined particles size. The synthesis of nano zinc and selenium were carried out in line with the protocols described by (25). The green synthesis was conducted in the Step 'B' Drug and Vaccine Discovery Laboratory, Bosso Campus, Federal University of Technology, Minna, Nigeria.

Experimental Diets and Design

The experimental diets were formulated to meet nutrient requirement of the broiler chickens in line with the nutrients recommendation of National Research Council (13). The ingredients composition of the experimental diets is presented in Table 1.

This experiment was carried out on three hundred and twenty (320) day old broiler chicks of Arbor acre strain. The chicks were procured from Yammfy Farm Hatchery at Ilemona, Kwara state. They were randomly assigned to four (levels of Zn) by four (levels of Se) in factorial arrangement (4 x 4) in a completely randomized design having 16 treatments, each group was replicated four times with five birds per replicate.

Table 1: Ingredients composition of the experimental diets (as fed)

Ingredients %	Finisher phase
Maize	55.00
Soybean cake	26.00
Fish meal	3.00
Wheat offal	11.00
Palm oil	1.00
Limestone powder	1.00
Bone meal	2.00
Salt	0.25
Lysine	0.25
Methionine	0.25
Premix	0.25
Total weight (kg)	100.00
Calculated analysis	
Crude protein (%)	20.00
Crude fibre (%)	5.53
Ether extract (%)	5.55
Ca (%)	1.11
Avail P (%)	0.58
ME (kcal/kg)	3000.00

Premix supplied per Kg of diet: Vit. A, 2.5iu;Vit D3, 0.5iu; Vit E, 0.0057mg; Vit. K, 0.0005mg; Vit, B1, 0.00045mg; Vit B2, 0,0013mg; pantothenic acid, 0.0018mg; Vit. B12, 0.000005mg; Folic acid, 0.00018mg; Biotin, 0.000015mg; Choline chloride, 0.075mg; Cobalt, 0.00005mg; Copper, 0.00075mg; Iodine, 0.00025mg; Iron, 0.0025mg; Manganese, 0.01mg; Selenium, 0.00005mg; Zinc, 0.0075mg; Antioxidant, 0.00031mg.

Housing and Management

Prior to the arrival of the broiler chickens, the experimental pens, drinkers and feeders were thoroughly cleaned, washed and disinfected with izal solution and fumigated using formaldehyde and potassium permanganate. The birds were reared on deep litter. The building was demarcated into 68 compartments with woods, net and ceiling board. Fresh wood shavings were spread to a depth of 5 cm and other appliances such as pilot light, drinkers, feeders and heating devices (Abacha charcoal stove) were provided.

All the groups were provided with similar environmental and management conditions throughout the experimental period. On arrival, the broiler chickens were weighed individually, sorted and randomly allocated to 16 treatment groups with four replicates of five birds in each group for 21 days.

Adequate feeding and watering space was provided to all the birds throughout the experimental period. The birds were given free access to fresh, clean drinking water throughout the experimental period. Weighed amount of experimental feeds were offered to each treatment groups and the left over feeds were collected and weighed separately at daily interval. From this data, the average daily feed consumption per bird in each replicate was calculated. Immediately after arrival, birds were provided with anti-stressor (Vitalyte®) via drinking water for a period of three weeks.

Data Collection

Growth performance

The parameters that were determined under growth performance include: initial body weight, feed intake, body weight gain and feed conversion ratio. The body weight was recorded at weekly intervals and feed intake was measured on daily basis while feed conversion ratio was calculated.

Apparent nutrients digestibility

The nutrient digestibility was conducted on the third week of this experiment. Total collection method was adopted and digestibility trial was performed in single bird battery cages for seven day. Three broiler chickens were randomly selected from each replicate and acclimatized for three day. The birds were off-feed overnight between 7:00pm to 7:00am for 12 hours prior to faecal collection but allowed free access to water and thereafter, assigned to respective diets supplemented with nano zinc and selenium for four days. Each cage was fastened with a plastic sheet for the collection of total excreta. The droppings of the birds in each replicate were collected, preserved with boric acid in aluminum foil paper, oven dried at 90 ^{o}C and recorded daily on (dry matter basis). The proximate composition of the feeds and faeces were determined and nutrients' digestibility of the birds was evaluated using the formula:

$$\text{Apparent nutrient digestibility (\%)} = \frac{\text{Nutrient in feed intake} - \text{Nutrient voided in faeces}}{\text{Nutrient in feed intake}} \text{x } 100$$

Carcass characteristics

At the end of feeding trial; two broiler chickens were randomly chosen from each replicate and deprived of feed overnight for 12 hour but allowed free access to water. The birds were weighed individually before slaughtering. The bled weight, plucked weight, eviscerated weight, carcass weight and dressing percentage were determined as well as cut-up parts (head, neck, breast, wings, back, thighs and drumsticks) measurements and dressing weight was expressed as percentages of live weight respectively.

$$\text{Dressing (\%)} = \frac{\text{dressed carcass weight}}{\text{live weight}} \times 100$$

Data analysis

All data generated from this experiment were subjected to 4×4 factorial design using General Linear Model (GLM) procedure of the Statistical Package for Social Science (SPSS version 16.0) to determine treatment effect and interaction. Significant means variations were separated using Duncan multiple range test of the same package.

Results and Discussion

The results of main effect of nano zinc and selenium supplementation on growth performance of finisher broiler chickens are presented in Table 2. The results of main effect of nano zinc revealed that only total feed consumed was significantly ($p<0.05$) influenced by nano zinc supplementation across all parameter measured. However, nano selenium main effect indicated that all growth indices evaluated were significantly ($p<0.05$) affected by dietary treatment except initial body weight. It was observed that birds on 20 mg of NZn had higher total feed consumed value than other treatment groups. Final body weight and body weight gain main effect of NSe showed that birds fed 0.10 and 0.15 mg NSe had greater body weight gain and better feed conversion ratio among the treatment groups respectively. The main effect of nano zinc and selenium on feed intake for zinc and final body weight, body weight gain, feed consumed and feed conversion ratio for selenium could be due to their physical and chemical properties. Since nanoparticles have a surface area much larger than micro-particles. It is assumed that as the particle size of nano minerals decreases, the surface area for chemical reactions increases, leading to better digestion, bioavailability and utilization of minerals in the gastro intestinal tract. This is in agreement with the reports of (8, 9, 14, 22) that indicated significant increases in body weight gain, feed efficiency and overall performance of broiler chickens and (16) layer chickens. Similarly, the same result pattern was observed in other animal model particularly in piglets, the authors found that Nano ZnO supplementation enhance growth performance and improved feed efficiency in piglets at different dietary levels (23).

The findings of interaction effect between nano zinc and selenium supplementation on growth performance of finisher broiler chickens are shown in Table 3. The results demonstrated that all parameter evaluated were significantly different except for initial body weight. Birds supplied 40 NZn and 0.25 NSe mg/kg diet had higher final body weight and body weight gain as compared to their counterparts but did not differ ($p>0.05$) significantly from those on 20 NZn and 0.10 NSe mg/kg throughout the experimental groups. However, reduced values of final and body weight gain were recorded on the birds fed 20 NZn and 0.20 NSe mg/kg; and 40 NZn and 0.20 NSe mg/kg. Conversely, birds on 40 NZn and 0.25 NSe mglkg and 40 NZn and 0.20 NSe mg/kg had higher total feed consumed values among the experimental groups. The results of feed conversion ratio revealed that birds fed 30 NZn combine with 0.10 and 0.15 mg/kg recorded best FCR values across the groups respectively. The comparable values of interaction effect of this study may be attributed to the particle size of nano zinc and selenium as feed additives is claimed to be smaller than 100 nanometre, which can pass through the gastrointestinal epithelium, body cells and are absorbed more quickly than ordinary minerals with larger particle size (10). This is in line with the reports of (11) observed that body weight of broiler chickens was improved ($p<0.05$) by dietary supplementation of nano-Se. Stenclova et al (16) revealed that different levels of Zinc had no significant effect on body weight gain and feed conversion ratio from 120 to 200 mg Zn/kg in broiler chickens.

Table 2: Main effect of dietary nano zinc and selenium supplementation on growth performance of finished broiler chickens

(28-49d)

Nano zinc (mg/kg)	Nano selenium (mg/kg)	Initial body weight (g/b)	Final body weight (g/b)	Total feed consumed (g/b)	Body weight gain (g/b)	FCR
20	0.10	970.31	2320.34^{ab}	2624.42^{d}	1339.31^{b}	1.97^{bc}
	0.15	969.25	2185.21^{e}	2647.38^{c}	1206.17^{f}	2.09^{fg}
	0.20	962.24	2044.42^{i}	3555.32^{a}	1081.32^{k}	2.10^{gh}
	0.25	960.90	2249.15^{d}	2662.37^{b}	1289.26^{d}	2.10^{gh}
30	0.10	967.78	2244.87^{d}	2417.23^{l}	1265.38^{e}	1.90^{a}
	0.15	964.82	2304.17^{c}	2433.37^{k}	1339.04^{b}	1.89^{a}
	0.20	962.78	2154.25^{g}	2415.86^{l}	1191.27^{g}	2.03^{de}
	0.25	968.07	2130.13^{h}	2578.21^{g}	1162.32^{i}	2.13^{i}
40	0.10	969.36	2245.26^{d}	2490.54^{j}	1265.09^{e}	1.94^{ab}
	0.15	969.52	2177.32^{e}	2535.32^{i}	1208.18^{f}	2.06^{ef}
	0.20	964.89	1944.93^{j}	2416.87^{l}	978.60^{l}	2.18^{j}
	0.25	964.45	2325.12^{a}	2588.19^{f}	1361.16^{a}	1.98^{bc}
50	0.10	967.33	2313.11^{c}	2600.41^{e}	1331.03^{c}	2.01^{cd}
	0.15	965.83	2127.73^{h}	$2495..63^{j}$	1146.38^{j}	2.04^{de}
	0.20	970.68	2150.32^{g}	2551.21^{h}	1168.01^{i}	2.10^{h}
	0.25	969.19	2165.54^{f}	2427.39^{k}	1187.27^{h}	2.00^{ce}
SEM		16.25	76.97	7.37	78.24	0.08
P-value		0.06	0.00	0.00	0.00	0.00

abc = means in the same column carrying different superscript differs significantly (P<0.05)
FCR = feed conversion ratio
SEM = standard error of mean
P –value = probability levels
mg = milligram and g/b = gram per bird

Table 4 revealed the main effect of dietary nano zinc and selenium supplementation on nutrients digestibility of finisher broiler chickens. The results showed that crude fibre, crude protein, ether extract and ash digestibility were significantly (p<0.05) affected by dietary treatments except dry matter and nitrogen free extract digestibility for NZn and only ash digestibility was significantly ($p<0.05$) influenced for NSe among the treatment groups. This might be due to enzyme cofactor role of zinc in body metabolism that could result in better nutrients digestibility, absorption and utilization by the birds. The observation of this study is supported by the work (25) who documented that dietary addition of nano-ZnO can help prevent adverse gastrointestinal reactions and improve the absorption of nutrients in the gastro intestinal tract of broiler chickens and (27) reported that increasing inclusion of Zn (0, 30 and 60 mg/kg) linearly enhanced digestibility of dry matter, organic matter, crude protein and ether extract. However, these results are contrary to the findings of (19) who indicated that the supplementation of nano selenium had led to significant ($p<0.05$) reduction in ash digestibility in broiler birds.

Table 3: Interaction effect of dietary nano zinc and selenium supplementation on growth performance of finisher broiler chickens

(28-49 d)

Main effect of nano zinc (mg/kg)	Initial body weight (g/b)	Final body weight (g/b)	Body weight gain (g/b)	Total feed consumed (g/b)	FCR
20	970.93	2199.62	1228.72	2621.84^{a}	2.07
30	968.86	2208.18	1239.21	2460.91^{d}	1.99
40	969.56	2172.65	1203.19	2507.32^{c}	2.04
50	980.76	2188.60	1207.83	2518.46^{b}	2.04
SEM	11.49	54.42	55.32	5.21	0.05
P-value	0.70	0.92	0.90	0.00	0.59
Main effect of nano selenium (mg/kg)					
0.10	980.70	2280.51^{a}	1299.83^{a}	2532.77^{b}	1.96^{a}
0.15	973.61	2198.33^{a}	1224.74^{a}	2527.82^{b}	2.02^{ab}
0.20	967.90	2072.73^{b}	1104.82^{b}	2484.35^{c}	2.10^{b}
0.25	967.89	2217.38^{a}	1249.44^{a}	2563.72^{a}	2.05^{ab}
SEM	11.49	54.42	55.32	5.21	0.05
P-value	0.64	0.00	0.00	0.00	0.04

abcdefghijl = means in the same column carrying different superscript differs significantly ($P<0.05$)
FCR = feed conversion ratio
SEM = standard error of mean
P –value = probability levels
mg = milligram and g/b = gram per bird.

The results of interaction effect of NZn and NSe supplementation on nutrients digestibility of finisher broiler chickens is in Table 5. Dry matter, crude fibre, crude protein, ether extract and ash digestibility were significantly elevated by dietary treatment except nitrogen free extract. Higher dry matter digestibility value was observed on birds fed 50 NZn and 0.10 NSe mg/kg and those on 20 NZn and 0.20mg/kg had lower dry matter value compared to their counterparts. A reduced crude fibre digestibility was evidenced on birds fed 20 NZn and 0.10 NSe mg/kg and 20 NZn and 0.20 NSe mg/kg. However, birds on 30 NZn and 0.25 NSe mg/kg had significantly higher crude fibre digestibility value than other treatment groups. Greater crude protein digestibility and ether extract values were recorded on birds received 40 NZn and 0.25 NSe mg/kg across the treatment groups. Comparable values were observed on ash digestibility, birds on 50 NZn and 0.20 NSe had higher ash digestibility value as compared with other treated. These agreed with (27) reported that increasing inclusion of Zn (0, 30 and 60 mg/kg) linearly enhanced digestibility of dry matter, organic matter, crude protein and ether extract.

Table 4: Main effect dietary nano zinc and selenium supplementation on nutrients digestibility of finisher broiler chickens (28-49 d)

Main effect of nano zinc (mg/kg)	DM (%)	CF (%)	CP (%)	EE (%)	ASH (%)	NFE (%)
20	86.84	76.98^{b}	80.06^{b}	81.66	78.92^{ab}	79.68
30	85.50	83.79^{a}	86.23^{a}	83.06	81.20^{ab}	84.94
40	89.70	80.68^{ab}	83.87^{ab}	84.41	77.14^{b}	82.99
50	88.77	81.34^{ab}	84.81^{ab}	83.09	81.84^{a}	85.11
SEM	1.70	1.62	1.56	1.95	1.38	1.86
P-value	0.31	0.04	0.03	0.80	0.04	0.16
Main effect of nano selenium (mg/kg)						
0.10	89.86	80.37	85.80	82.28	79.09^{ab}	84.77
0.15	90.26	80.13	81.02	86.30	77.48^{b}	81.89
0.20	84.96	80.87	82.39	80.22	82.89^{a}	82.09
0.25	85.74	81.41	85.77	83.41	79.63^{ab}	83.97
SEM	1.70	1.62	1.56	1.95	1.38	1.86
P-value	0.07	0.94	0.08	0.19	0.04	0.63

ab = means in the same column with vary superscript differs significantly ($p<0.05$).
DM = drymatter, CF = crude fibre, CP = crude protein, EE = ether extract and NFE = Nitrogen Free Extract.
SEM = standard error of mean
P –value = probability levels
mg = milligram and g/b = gram per bird
wt = weight
% = percentage

The result of main effect of nano zinc and nano selenium supplementation on carcass characteristics of finisher broiler chickens is presented in Table 3. The findings showed that carcass traits measured were significantly ($p<0.05$) affected by nano minerals' supplementation across the groups. However, main effect of head and breast weight at NZn levels and dressing percentage at NSe levels were not significantly ($p>0.05$) influenced. The results of live weight and slaughter weight revealed that birds' live weight and slaughter weight were not ($p>0.05$) significantly different as compared across the treatment group. Similarly, the same trend was observed on pluck, eviscerated and carcass weight.

Dressing percentage indicated that birds received 20 and 30 NZn mg/kg diets had greater value than other groups. The outcome of neck and wings weight demonstrated that all birds across the treatment had similar values when compared. Likewise, similar trend was evidenced in back and thigh weight. The result of drumsticks weight showed that birds on 30

NZn mg/kg diet had least value among the treated groups. The findings of head and breast weight at NSe main effect revealed that birds' fed 0.15 mg/kg diet had significantly higher values than their counterparts. The improvement in live weight, carcass weight, dressing percentage and cut up part may be attributed to antioxidant and other functional property of nano selenium and metabolic enzyme co-factor of nano zinc. These results concord with (10) that reported increased carcass characteristics on addition of zinc nanoparticles in broilers diets while (19) found high dressing percentage, breast and thigh weights in birds supplemented with nano selenium.

Table 5: Interaction effect of dietary nano zinc and selenium supplementation on nutrients digestibility of finisher broiler chickens (28-49 d)

	Main effect of nano zinc (mg/kg)						Main effect of nano selenium (mg/kg)					
Parameters	20	30	40	50	SEM	P-value	0.10	0.15	0.20	0.25	SEM	P-value
Live wt (g)	2169.04^{a}	2088.75^{b}	2136.67^{ab}	2084.61^{b}	26.45	0.00	2212.01^{a}	2124.63^{b}	1973.95^{c}	2168.51^{b}	26.45	0.00
Slaughter wt (g)	2040.82^{a}	1954.73^{ab}	2018.93^{a}	1931.32^{b}	29.15	0.00	2060.23^{a}	2004.91^{a}	1851.24^{b}	2029.45^{b}	29.15	0.00
Pluck wt (g)	1952.73^{a}	1844.13^{b}	1879.20^{ab}	1761.15^{c}	28.29	0.00	1944.67^{a}	1877.56^{a}	1717.33^{b}	1898.10^{a}	28.29	0.00
Evis. wt (g)	1753.63^{a}	1641.32^{b}	1661.31^{b}	1548.43^{c}	28.18	0.01	1737.51^{a}	1673.72^{a}	1511.43^{b}	1681.92^{a}	28.18	0.00
Carcass wt (g)	1622.70^{a}	1509.11^{b}	1532.23^{b}	1415.12^{c}	28.86	0.00	1605.42^{a}	1532.73^{a}	1383.10^{b}	1557.82^{a}	28.86	0.02
Dressing (%)	74.98^{a}	72.28^{ab}	71.48^{b}	68.04^{c}	1.12	0.04	72.57	72.16	72.00	70.05	1.12	0.49
Head wt (%)	2.82	2.97	2.75	3.20	0.89	0.08	2.76^{b}	3.10^{a}	3.17^{b}	2.87^{b}	0.89	0.00
Neck wt (%)	6.07^{ab}	6.58^{ab}	6.18^{a}	6.76^{b}	1.42	0.00	5.83^{c}	6.96^{a}	6.57^{C}	6.59^{b}	1.42	0.01
Wing wt (%)	19.64^{ab}	19.34^{b}	20.89^{a}	24.89^{a}	11.49	0.02	21.93^{a}	21.19^{a}	20.47^{b}	21.92^{a}	11.49	0.00
Back wt (%)	11.31^{a}	9.95^{c}	11.71^{a}	11.97^{b}	4.19	0.00	11.14^{b}	12.37^{a}	11.18^{b}	12.18^{a}	4.19	0.00
Breast wt (%)	26.15	27.56	25.20	29.91	8.30	0.00	28.06^{a}	27.66^{b}	27.00^{c}	27.26^{b}	8.30	0.00
Thigh wt (%)	14.87^{b}	15.99^{b}	15.54^{b}	19.18^{a}	5.53	0.00	17.02^{a}	17.21^{a}	16.59^{b}	15.39^{b}	5.53	0.00
Drumstick wt	12.42^{a}	11.59^{b}	12.17^{a}	13.99^{a}	6.09	0.00	12.11^{a}	13.38^{a}	12.46^{b}	12.84^{a}	6.09	0.00

abcdefghi = means in the same column with vary superscript differs significantly ($p<0.05$).
DM = drymatter, CF = crude fibre, CP = crude protein, EE = ether extract and NFE = Nitrogen Free Extract.
SEM = standard error of mean
P –value = probability levels
mg = milligram and g/b = gram per bird
wt = weight, kg = kilogram
% = percentage

The results of interaction effect between nano zinc and nano selenium supplementation on carcass characteristics of finisher broiler chickens is shown in Table 4. The exhibited that all carcass parameters evaluated were significantly enhanced by dietary minerals nano particle across the treatments. Birds fed 40 NZn and 0.25 NSe mg/kg diets had significantly ($p<0.05$) higher live weight, slaughter weight and pluck weight values than those in the other treatments. Eviscerated and carcass weight interaction findings demonstrated that broiler chickens fed 20 NZn and 0.10 NSe mg/kg had greater values when compared with other treatments. Conversely, least carcass weight was observed on birds fed 50 NZn and NSe 0.20 mg/kg diets. Results of dressing percentage and head weight indicated that broiler chickens fed 20 NZn and 0.10 NSe mg/kg diet recorded significantly ($p<0.05$) higher dressing percentage and head weight values throughout the experimental group. Similarly, the same trends were observed on wings and back weight respectively. However, the interaction effect of nano minerals on breast weight revealed that elevated value was observed in broiler chickens fed 20 NZn and 0.25 NSe mg/kg diet among the treatment groups. Reduced breast weight value was evidenced in birds that received 30 NZn and 0.25 NSE diet as compared. The result of thigh and drumstick weight interaction indicated that birds on 50 NZn and 0.15 mg/kg diet had ($p<0.05$) higher value than other treatments group respectively. These results confirmed the works of (3, 17, 18) and documented that different selenium significantly improve animal serum glutathione peroxidase (GSH-Px) activity, enhance oxidation resistance, effectively prevent the myoglobin or oxymyoglobin been oxidized to metmyoglobin, deepen the muscle chroma, increase flesh colour score, improved meat quality and the water retention properties of the muscle.

Table 6: Main effect of dietary nano zinc and selenium supplementation on carcass characteristics of finisher broiler chickens
(28-49 d)

Nano zinc (mg/kg)	Nano selenium (mg/kg)	DM (%)	CF (%)	CP (%)	EE (%)	ASH (%)	NFE (%)
20	0.10	90.39^{bc}	74.61^{i}	84.63^{d}	81.48^{d}	81.72^{c}	80.61
	0.15	90.53^{bc}	81.28^{de}	80.73^{f}	85.76^{b}	79.55^{de}	82.23
	0.20	78.20^{g}	73.66^{i}	74.19^{h}	75.83^{e}	76.48^{fg}	75.92
	0.25	88.25^{d}	78.36^{gh}	80.70^{f}	83.56^{c}	77.94^{ef}	79.97
30	0.10	83.79^{e}	83.09^{cd}	83.07^{e}	81.14d	79.54^{de}	81.23
	0.15	89.45^{cd}	78.78^{gh}	85.32^{d}	88.38^{a}	77.97^{ef}	87.25
	0.20	83.95^{e}	83.76^{bc}	88.20^{c}	81.21^{d}	85.44^{b}	86.73
	0.25	84.82^{e}	89.54^{a}	88.32^{c}	81.51^{d}	81.85^{c}	84.54
40	0.10	89.65^{cd}	84.26^{bc}	84.87^{d}	81.24^{d}	74.76^{g}	86.52
	0.15	91.32^{b}	80.23^{fg}	77.38^{g}	84.71^{bc}	74.89^{g}	76.87
	0.20	89.46^{cd}	80.86^{e}	81.06^{f}	83.92^{bc}	78.33^{ef}	81.75
	0.25	88.39^{d}	77.36^{h}	92.19^{a}	87.76^{a}	80.58^{cd}	86.81
50	0.10	95.62^{a}	79.54^{fg}	90.62^{b}	85.24^{bc}	80.36^{cd}	90.71
	0.15	89.73^{cd}	80.22^{fg}	80.66^{f}	86.38^{bc}	77.52^{f}	81.20
	0.20	88.22^{d}	85.21^{b}	86.10^{d}	79.92^{d}	91.31^{a}	83.99
	0.25	81.50^{f}	80.39^{ef}	81.87^{ef}	80.82^{d}	78.17^{ef}	84.56
SEM		3.40	3.25	3.13	2.77	3.91	3.72
P-value		0.00	0.00	0.02	0.00	0.00	0.47

abc = means in the same row carrying different superscript differs significantly ($P<0.05$)
SEM = standard error of mean
P –value = probability levels
mg = milligram and g/b = gram per bird

Table 7: Interaction details of dietary nano zinc and selenium supplementation on carcass characteristics of finisher broiler chickens (28-49 d)

20	0.10	2168.31^{c}	2102.23^{d}	2053.19^{b}	1855.21^{a}	1731.07^{a}	80.17^{a}	2.63^{a}	5.07^{d}	20.08^{d}	10.68^{cd}	24.33^{g}	14.59^{f}	10.25^{f}
	0.15	2142.09^{c}	2066.13^{e}	1983.76^{e}	1789.03^{e}	1646.39^{e}	76.86^{b}	3.05^{b}	6.79^{a}	21.40^{f}	12.94^{ab}	25.17^{f}	15.97^{de}	13.27^{c}
	0.20	2024.32^{ef}	1881.67^{m}	1775.34^{k}	1577.43^{j}	1454.23^{j}	71.88^{cd}	2.63^{j}	6.34^{b}	18.81^{fg}	10.21^{d}	25.05^{f}	15.62^{de}	12.94^{c}
	0.25	2342.12^{a}	2109.21^{c}	2001.72^{d}	1794.51^{d}	1659.06^{d}	71.05^{d}	2.91^{b}	6.16^{bc}	18.15^{g}	11.32^{c}	29.97^{b}	13.41^{g}	13.39^{c}
30	0.10	2237.16^{b}	2064.24^{f}	1947.41^{f}	1753.26^{f}	1607.15^{f}	71.82^{cd}	2.90^{b}	6.10^{bc}	20.76^{f}	10.30^{d}	27.63^{c}	18.01^{c}	13.19^{c}
	0.15	2078.63^{e}	1941.35^{j}	1838.44^{h}	1639.37^{h}	1503.28^{h}	72.31^{cd}	2.93^{b}	7.16^{a}	21.19^{c}	9.76^{de}	27.95^{c}	14.86^{f}	11.02^{e}
	0.20	2063.41^{de}	1938.62^{k}	1813.83^{j}	1609.18^{j}	1481.11^{i}	71.75^{cd}	3.18^{ab}	6.32^{ab}	17.80^{gh}	10.38^{d}	27.67^{c}	15.53^{e}	10.74^{ef}
	0.25	1977.97^{g}	1876.12^{o}	1778.73^{j}	1565.97^{k}	1446.41^{k}	73.24^{c}	2.89^{bc}	6.76^{e}	17.14^{i}	9.30^{e}	26.94^{cd}	15.39^{e}	11.26^{e}
40	0.10	2266.19^{b}	2126.51^{b}	2017.33^{c}	1805.65^{c}	1667.05^{c}	73.16^{c}	2.84^{bc}	6.10^{d}	21.83e	11.45^{c}	27.38^{c}	16.62^{de}	12.18^{d}
	0.15	2142.26^{c}	1996.74^{h}	1876.27^{g}	1658.34^{g}	1539.37^{g}	71.75^{cd}	2.76^{b}	7.09^{a}	19.00^{de}	11.94^{bc}	29.16^{b}	17.25^{d}	13.03^{c}
	0.20	1795.87^{h}	1710.43^{p}	1564.92^{p}	1350.07^{n}	1228.46^{o}	68.55^{d}	3.53^{a}	6.94^{a}	23.33^{d}	13.30^{a}	26.28^{e}	19.87^{ab}	14.46^{b}
	0.25	2343.11^{a}	2243.03^{a}	2060.17^{a}	1833.14^{b}	1695.00^{b}	72.46^{cd}	2.69^{c}	6.21^{bc}	24.40^{c}	13.11^{a}	24.05^{j}	14.96^{f}	12.31^{d}
50	0.10	2176.94^{c}	1945.31^{i}	1762.28^{l}	1538.37^{l}	1416.73^{m}	65.14^{f}	2.73^{c}	6.12^{bc}	25.76^{b}	12.26^{b}	33.88^{a}	19.33^{b}	13.07^{c}
	0.15	2136.17^{c}	2016.21^{g}	1813.63^{j}	1609.82^{h}	1443.52^{k}	67.74^{e}	3.72^{a}	6.82^{a}	23.25^{d}	12.65^{ab}	28.54^{bc}	21.01^{a}	16.33^{a}
	0.20	2014.44^{g}	1876.42^{o}	1717.16^{o}	1510.46^{m}	1370.37^{n}	68.04^{e}	3.43^{a}	6.73^{a}	22.54^{cd}	11.18^{c}	28.94^{bc}	18.10^{c}	12.01^{d}
	0.25	2012.33^{fg}	1889.87^{l}	1754.51^{m}	1537.52^{l}	1431.26^{l}	71.25^{d}	2.91^{b}	7.34^{ab}	27.91^{a}	11.74^{bc}	28.25^{b}	18.18^{c}	14.44^{b}
SEM		52.91	58.31	56.59	56.36	57.72	2.25	1.78	2.84	22.99	8.38	16.61	11.07	12.18
P-value		0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00

abcdefghijklmnop = means in the same column carrying different superscript differs significantly ($P<0.05$). LW = live weight, SLW = Slaughter weight, PLW = Pluck weight, EVW = Eviscerated weight, CW = Carcass weight, DR = Dressing percentage, HDW = Head weight, NKW = Neck weight, WGW = wings weight, BKW = Back weight, BRW = Breast weight, THR = Thigh weight and DMW = Drumsticks weight.
SEM = standard error of mean, P –value = probability levels, mg = milligram and g/b = gram per bird,
% = percentage.

Conclusion and Applications

The results showed that:

1. There were significant differences in the growth performance of finisher broiler chickens fed diets supplemented with varying levels of nano zinc and selenium.
2. Dry matter, crude fibre, crude protein, ether extract and ash digestibility were significantly elevated by nano zinc and selenium supplementation.
3. Carcass characteristics were improved with nano zinc and selenium supplementation without deleterious effect on the broiler chickens

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