THE POTENCY OF INORGANIC SELENIUM SUPPLEMENTATION ON SERUM, ANTIOXIDANT AND MINERAL INDICES OF HEAT STRESSED BROILER CHICKS

D.I. Ndubuisi
Department of Animal Production and Health, Federal University Wukari, Taraba State, Nigeria.
Correspondence Email: d.ndubuisi@fuwukari.edu.ng Phone No: +2348138615363

ABSTRACT
A research was conducted to investigate the potency of inorganic selenium supplementation on serum, antioxidant and mineral indices of broiler chicks during heat stress. Two hundred and fifty six, 1-day old chicks were randomly allotted to four experimental treatments (0, 0.1 0.2 and 0.3 mg of Se/kg), with four replicates each in a Completely Randomized Design. Results indicated a similarity (P>0.05) among all treatment groups. In conclusion, during period of heat stress, selenium can be supplemented in the diet of broilers at levels ranging between 0.1-0.3mg/kg diet.
Keywords: chicks; mineral; antioxidant; stress; broiler

INTRODUCTION

Poultry is more sensitive to heat stress than other domestic animals, because they do not have sweat glands, their metabolism is rapid and they have high body temperatures (Lara and Rostagno, 2013). Increased environmental temperature caused increased lipid peroxidation (in addition induced the formation of malondialdehyde (MDA), which is an indicator for lipid peroxidation). Therefore, the antioxidant defence system is altered (Chauhan *et al*., 2014; Lara and Rostagno, 2013).

It is said that a large amount of ROS causes disruption of mitochondrial function, increases lipid peroxidation, decreases vitamin concentrations, induces stress gene expression, leads to dysfunction in antioxidant enzymes and also causes DNA damage. Selenium is an essential micronutrient and can be found in two forms as inorganic (selenate and selenite) and organic forms (selenomethionine and selenocysteine). Selenium functions as a co-factor for antioxidant enzymes including glutathione peroxidase, superoxide dismutase and thioredoxin reductase. Glutathione peroxidase removes reactive oxygen species, protects cells against oxidative stress damage (Tappel, 2014) and prevents lipid and protein oxidation (Nunes *et al.,* 2015). Studies in broilers indicates that dietary supplementation with selenium at doses ranging from 0.1 to 1 mg/kg significantly enhanced growth performance when chickens were exposed to heat stress (Ndubuisi *et al*., 2021). Therefore it is necessary to investigate the importance of supplementing inorganic selenium in the diets of broiler chicks during heat stress.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted at a facility within Ahmadu Bello University, Samaru, Zaria, Kaduna State, Nigeria. Zaria is located in the Northern Guinea Savannah zone of Nigeria on Latitude 110 09' 01.78" N and Longitude 70 39' 14.79" E, at an altitude of 671m above sea level (IARM, 2019). The area has three distinct seasons; namely the hot dry season from March to May, the warm rainy season from June to September, and a cool dry season from November to February with a mean annual rainfall of about 700-1400 mm. The area has an average relative humidity of 36.0% during the dry season and 78.5% for the wet season and an ambient temperature ranging from 26-320 C (IARM, 2019).

Experimental Design, Diets and Management of Birds

Two hundred and fifty six, day old broiler chicks were randomly allotted to four experimental treatments (0, 0.1, 0.2 and 0.3 mg Se/kg), with four replicates each in a Completely Randomized Design. A maize/soybean meal based broiler starter diet (table 1) was formulated according to NRC (1994) nutrient requirement. Feed and water were provided *ad libitum*. All standard routine management practices were strictly adhered to as the experiment lasted for 28 days.

Table 1: Ingredient Composition of Selenium Supplemented Diets Fed to Broiler Starter Chickens (day 1-28)

	Dietary levels of Selenium (mg/kg diet)			
Ingredients (%)	**0**	**0.1**	**0.2**	**0.3**
Calculated Analysis				
ME (KCal/kg)	2953.00	2953.00	2953.00	2953.00
Crude protein (%)	23.04	23.04	23.04	23.04
Ether extract (%)	4.77	4.77	4.77	4.77
Crude fibre (%)	3.76	3.76	3.76	3.76
Calcium (%)	1.34	1.34	1.34	1.34
Available phosphorus (%)	0.58	0.58	0.58	0.58
Lysine (%)	1.26	1.26	1.26	1.26
Methionine (%)	0.54	0.54	0.54	0.54
Selenium (%)	0.72	0.82	0.92	1.02

Vitamin-mineral premix provide per kg of diet: Vit. A, 10,000,000 IU; Vit. D_3, 2,000,000 IU; Vit. E, 20,000 UI; Vit. K, 2,250mg; Vit. B_1, 1,750mg; Vit. B_2, 5,000mg; Vit. B_6, 2,750mg; Vit. B_{12}, 15mg; Niacin, 27,500mg; Panth. Acid, 7,500mg; Folic acid, 7,500mg; Biotin, 50mg; Choline Chloride, 400g; Antioxidant, 125g; Manganese, 80g, Iron, 20g; Zinc, 50g; Copper, 5g; Iodine, 1.2g; Cobalt, 200mg; Selenium, 200mg.

Serum and Bio-markers Assay

Blood samples from the wing vein (2 mL) was collected from two birds per replicate on day 28 and was emptied into tubes containing no EDTA for bio-markers and serum assay. Concentrations of calcium and phosphorus in the blood was also analyzed.

Statistical Analysis

All data obtained from this experiment were statistically analyzed using General Linear Model Procedure of Statistical Analysis System software package while significant difference among means were compared using the Tukey Procedure (SAS, 2002).

RESULTS AND DISCUSSION

Selenium Supplementation on Serum and Antioxidant Indices of Broiler Chicks

Table 2 shows the result of serum and antioxidant indices of broiler chickens fed varying levels of selenium supplemented diet at starter phase. All parameters were similar ($p>0.05$). Broilers fed the control diet had more ($p>0.05$) glucose (238.05), Alanine-amino Transferase (ALT) (31.50), Alkaline Phosphatase (ALP) (32.00), albumin (2.73), cholesterol (131.75), low density lipoprotein (LDL) (162.75) and Calcium (8.55). Aspartate-amino Transferase (AST) (36.25), superoxide dismutase (SOD) (5.10) and Phosphorus (7.18) were higher for chickens fed 0.2 mg selenium supplemented diet. Broilers fed 0.1 mg selenium supplemented diet had higher values of total protein (4.03), globulin (1.45), malondialdehyde (MDA) (46385), glutathione peroxidase (GSHPx) (1.85) and triglyceride (100.25) while catalase (CAT) was higher ($p>0.05$) in broilers fed 0.3 mg selenium supplemented diet and ranged from 3.17 – 4.03.

Broilers fed the control diet had higher numeric values of glucose, ALT, cholesterol and Calcium and this agrees with the work of El-Samra *et al.* (2014) who fed laying hens with 0, 0.3 and 0.5 mg of organic selenium supplemented diet, he also reported a higher ($p<0.05$) value of albumin in layers fed the control diets.

Metabolic alterations in poultry during stress seems to cause mobilization or synthesis of glucose for energy required to maintain homeostasis during stress (Ademu, 2018). The glucose value recorded in the selenium treated groups was within normal physiological range and is an evidence that selenium exhibited its antioxidant property in ameliorating heat stress in broilers fed the selenium supplemented diets. Under conditions of chronic stress, there is synthesis of higher blood glucose level (Lin *et al.,* 2007). Also, the similarity in glucose observed in the selenium treated groups showed that selenium mitigated the effect of heat stress, hence glucose remained unchanged. According to the current result, supplemented dietary selenium alleviated the adverse effect of heat stress by lowering the activity of ALT in the blood plasma thereby promoting protein synthesis than cellular energy production. El-

Mallah *et al.* (2011) observed a beneficial effect of selenium yeast on ALT by lowering its level. Abdelhady *et al.* (2017) observed that plasma cholesterol and triglyceride concentration was significantly increased in heat stressed quails. Cholesterol and triglyceride were within the normal range, cholesterol was lower in the selenium supplemented groups and can be attributed to its role in down-regulating fat metabolism. Changes in enzymes responsible for regulating cholesterol synthesis, oxidation or elimination may be responsible for lowering the cholesterol synthesis in mature as well as immature chickens (El-Samra, 2014). The similar results obtained for total protein and globulin agrees with the report of Salem *et al.* (2018) who supplemented selenium and zinc in the drinking water of broilers.

Antioxidant enzymes and MDA are involved in the regulation of the activities of free radicals (Dalia *et al*., 2017). The values of biomarkers (GSHPx, SOD, MDA and CAT) observed agrees with the report of Guoshun *et al.* (2013). The antioxidant potential of selenium was generally influenced by GSHPx because selenium is an active component of this enzyme, GSHPx activity depends on the selenium content of a feed. About 30-40% of selenium exists in the form of GSHPx in animal body tissue, and many animal diseases and dysfunction are caused by GSHPx deficiency (Pilarczyk *et al.*, 2012). The higher values of GSHPx recorded with selenium treated groups revealed that selenium is an important component in GSHPx formation and that the birds were stressed.

The values of AST and LDH that were below the normal range might be due to free radical production, which induced oxidative damage to cellular membranes and lipid peroxidation which caused hepatocellular injury and release of intracellular enzymes (Tan *et al*., 2010)**.**

Table 2: Selenium Supplementation on Serum and Antioxidant Indices of Broiler Chicks

	Dietary levels of Selenium (mg/kg diet)						
Parameters	**0**	**0.1**	**0.2**	**0.3**	**SEM**	**P value**	**Ref**
Glucose (mg/dL)	238.05	229.05	193.95	207.90	23.65	0.5611	137-363[w]
Total Protein (g/dL)	3.85	4.03	3.98	3.78	0.24	0.8807	3.60-5.50[x]
Albumin (g/dL)	2.73	2.58	2.55	2.40	0.40	0.9510	1.10-2.20[x]
Globulin (g/dL)	1.13	1.45	1.43	1.38	0.49	0.9624	-
Cholesterol (nmol/L)	131.75	121.25	93.25	122.00	15.66	0.3794	120-237
Low Density Lipoprotein (mg/dL)	162.75	124.75	103.25	149.00	20.25	0.2219	<130.00
Triglyceride (mg/dL)	58.25	100.25	66.50	75.50	15.22	0.2838	<135.00
Alanine-Amino Transferase (µ/L)	31.50	25.25	24.50	19.00	4.40	0.3046	-
Aspartate-Amino Transferase (µ/L)	19.00	35.50	36.25	23.75	6.96	0.2587	10-40[y]
Alkaline Phosphatase (µ/L)	32.00	25.50	19.00	27.25	5.33	0.4187	10-106[z]
Glutathione Peroxidase (µmol/mL)	1.55	1.85	1.77	1.68	0.30	0.9071	
Superoxide Dismutase (µmol/mL)	4.65	4.35	5.10	3.90	0.96	0.8421	
Malondialdehyde (nmol/mL)	18201.00	46385.00	16523.00	22092.00	13249.56	0.3856	
Catalase (U/ml)	3.29	3.17	3.41	4.03	1.18	0.9569	
Calcium (mg/dL)	8.55	6.95	7.18	8.05	0.72	0.3909	
Phosphorus (mg/dL)	6.13	4.65	7.18	4.88	0.74	0.1076	

Reference values: [w]Goodwin *et al*. (1994), [x]Ross *et al*. (1976), [y]LAVC (2009), [z]Bounous and Stedman (2000), Clinical Diagnostic Division (1990), Collins (2018).

CONCLUSION

Selenium in the diet of broiler chicks at 0.1-0.3mg/kg inclusion level is efficient in assisting birds combat the negative impact of heat stress during production.

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