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Sources and Levels Effect of Sodium Selenite and Selenium Enriched Yeaston Carcass Characteristics in Broiler Chicken

Roshan Kumar Sahu*, M. K. Gendley, Meenu Dubey, G. K. Dutta, Ramchandra Ramteke, Raina Doneria, SonaliPrusty and Kiran Kumari

College of Veterinary Science & A.H, Anjora Durg, C.G.K.V., C.G, India

**Corresponding author*

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A B S T R A C T

A total of 180-day-old broiler chickens (Ross AP strain) were allocated to 4 dietary treatments to evaluate the effects of two sources and levels of selenium and their interaction on carcass characteristics and meat quality in broiler chicken reared under deep litter system in a well-ventilated house with standard management practices. The experiment consisted of 2×2 factorial arrangement with 2 sources of dietary Se [Sodium selenite (SS), and Selenium enriched yeast (SY)] and 2 levels of supplemental Se (low: 0.15 mg/kg, and high: 0.50 mg/kg). Each treatment had 3 replicates of 15 broiler chickens per replicate. Two birds from each replicate were sacrificed to study carcass characteristics (dressed, liver, heart, intestine, breast, thigh, wing, neck, back and giblet weight %) and meat quality (WHC, ERV and TBA value) at 35th day of age. Findings suggested that adding of 0.5 ppm of selenium enriched yeast supplementation showed significant ($p<0.01$) difference in WHC percentage, breast weight percentage and dressing percentage, however, TBA value supplemented with sodium selenite was significantly ($p<0.01$) higher than selenium enriched yeast supplementation.

Introduction

Broiler production has been the fastest growing sub sector of Indian agriculture with a quantum jump with respect to broiler population as well as productivity.Feed represents the major cost of poultry production, constituting up to 70 percent of the total feed cost, about 95 % is used to meet energy and protein requirements, about 3-4 % for major mineral, trace mineral and vitamin requirements, and 1-2% for various feed additives (DAHDF., 2017). The growth in the broiler segment is expected to remain strong due to consumer preference for poultry, increasing income levels, and changing food habits. With the increasing demand and need of poultry sector in India, poultry must be

provided with adequate nutrition and balanced diet. It is a well-established fact that tables of feeding standards as well as breed manuals state the nutrient requirements of the birds at different stages of production only under normal condition and do not pay attention to the extra nutrient required in disease and/or stress conditions (Alian *et al.,* 2020).

The birds that are being reared in open-sided poultry houses may lead to stress due to constant dynamic variations in temperature and humidity in the environment, which causes adverse effects on performance (Niu *et al.,* 2009), and meat quality (Thompson and Scott, 1969). High environmental temperature in the tropical countries causes heavy financial losses to poultry due to reduced feed intake and decreasing feed conversion efficiency. Meat quality and stability are affected mainly by the lipid peroxidation which is related to the production of free radicals and reactive oxygen species (ROS), which are produced as a part of the normal cell metabolism (Tappel and Tappel, 2004). Excessive reactive free radicals will reduce meat sensory traits and nutritional values (Mohamed *et al.,* 2020). Furthermore, in a several physiological and pathological states, excess amounts of ROS are generated (Fridovich, 1978), which damages the cell phospholipid membranes and other macromolecules (Wiseman and Halliwell, 1996).

Lipid oxidation is an important determinant of shelf life of meat and meat products. Post-slaughter biochemical changes involved in the conversion of muscle to meat are accompanied by a loss of cellular antioxidant defences and an increased propensity of meat lipids to undergo oxidation (Morrissey *et al.*, 1994). This contributes to undesirable changes in a number of quality parameters, including loss of water-holding capacity, texture and flavour. Microbial growth leads to the precipitation of public health hazards which, in turn, contribute to the deterioration in meat products during storage (Fernandez-Lopez *et al.,* 2005). Due to the above reasons, consumers are more interested in the beneficial health promoting effects of functional foods enriched with natural ingredients. This has led to the opportunities for marketing meat products with added nutritional value and quality (Grashorn, 2007). Utilization of appropriate antioxidants will help the biological system by scavenging reactive oxygen, which intern reduces lipid peroxidation (LP) and increase activity of antioxidant defense system (Nunes *et al.*, 2005). In living organisms, antioxidant processes protect the body cells from the harmful effects of free radicals (Rotruck *et al.,* 1973).

Selenium (Se) is an essential trace mineral for poultry nutrition and great information has been collected during the previous 20 years indicating that dietary form of Se is a major determinant of its efficiency. It is the component of at least 25 selenoproteins that participate in redox balance maintenance and antioxidant defences (Surai and Fisinin, 2014). The importance of Se is principally associated with its role as an essential part of the glutathione peroxidases (GSH-Px) which provide a defense against oxidative stress by catalyzing the reduction of hydrogen peroxide and lipid peroxides to less harmful hydroxides (Baltic *et al.,* 2015).

Selenium deficiency results in a number of disorders and injuries in poultry, such as skeletal myodegeneration, exudative diathesis (ED), muscular haemorrhages, atrophy of pancreas, decreased production of eggs, liver injury, reduced hatchability, and inhibited growth of bursa and thymus (Gao *et al.*, 2012). Animal and poultry feed require Se supplementation to ensure sound health, efficient performance and good meat quality.

An insufficient Se supply has negative effects on the performance of chickens (Bakhshalinejad *et al.,* 2018). The supplementation of Se is necessary for maintaining the high performance of broiler chickens (Perić *et al*., 2009).

The bioavailability of selenium is linked to its physical form. Currently, sodium selenite is the most commonly used selenium source in animal feeds; however, it has some disadvantages of lower availability, as well as potential toxicity at higher concentration (Suchy *et al.,* 2014). On the other hand, organic forms like selenium-enriched yeast and selenomethionine are utilized in many countries as a safer and better source of Se in animal feed (Mohamed *et al.,* 2020). The main and foremost advantage is its bioavailability. Organic selenium can be utilised to synthesize selenoproteins and excess selenium can be stored in a protein pool for different applications. But in case of inorganic forms are utilised for synthesis of selenoproteins and the excess selenium is excreted. Secondly organic selenium improves the antioxidant properties by increasing the GSH-Px and tissue selenium concentration in comparison to inorganic sources (Payne and Southern., 2005). Thirdly organic selenium fails to undergo pro-oxidation unlike inorganic selenium as it already exists in an organic form (Mohanty *et al.,* 2018). The basic advantage in chelating of mineral is improved bioavailability due to firm binding of metallicions with organic molecule like amino acid e.g. Selenised Yeast. Organic selenium from yeast having improved bioavailability due to better solubilisation, greater stability in the lumen and provides antioxidant protection at greater level than inorganic selenium (Mahmoud and Edens., 2003).

There are various opinions of scientist about various level of inclusion of Se and different source of Se in the diet of poultry for better performance on growth and egg production. Food and Drug Administration, USA, (2000) has approved the use of selenium as sodium selenate or selenite in poultry feed at levels of 0.3 mg/kg of diet, while the NRC (1994) and ICAR (2013) have recommended a level of 0.15 mg of Se/kg feed in broilers. The inclusion level of 0.5 mg/kg of selenium appeared to have better overall performance when fed to broiler chicken (EC. 2014 and Okunlola *et al.,* 2015). Considering these facts, the aim of the present study was planned to evaluate the carcass characteristics and meat quality parameter in broiler chicken fed on two sources and levels of selenium.

Materials and Methods

Housing and management

The experiment was conducted in the Department of Animal Nutrition, College of Veterinary Science and Animal Husbandry, Anjora, Durg (C.G.). 5 weeks feeding trial was carried out on 180 day old Ross AP Strain broiler chicks housed under the deep litter system, in a well-ventilated room with standard management practices. The chicks were weighed individually and randomly allocated to 4 treatment groups with 3 replicates of 15 chicks each.

Treatment and additives

Ingredient and nutrients composition of diets for chicks at 0 to 35 days old were based on the Indian Council of Agriculture Research (ICAR, 2013) recommendations. Four isonitrogenous and isocaloric diets were formulated. The different dietary treatments were includes: Diet 1 (T1) & 2 (T2) contained basal diet with inorganic source of Selenium (Na_2SeO_3) @ 0.15 ppm & 0.5 ppm, respectively. Similarly diet 3 (T3) & 4 (T4) contained basal diet with organic source of

Selenium (Selenium enriched yeast) @0.15ppm & 0.5ppm,respectively. The ingredient compositions of experimental diets for pre-starter, starter & finisher phase are presented in Table 1.

Carcass Characteristics

Two birds from each replicate were slaughtered on 35th days of experiment. Prior to slaughter, birds were offered no feed for 12 hours and then weighed individually (pre-slaughter weight).

The selected birds were slaughtered by halal method and then after head and feather were removed. Both the legs were knuckled from hock joint. Abdomen was opened for evisceration and carefully all the viscera including organs of alimentary tract, air sacs, giblets (gizzard, liver and heart) and spleen were separated from carcass. The organs like gizzard, liver, heart, spleen and different cuts of carcass like thigh, wing, back and neck and breast were weighed using sensitive balance. Lastly eviscerated carcass along with giblets and spleen were weighed for calculating dressing percentage.

Meat Quality Parameter

The meat samples were analysed for various meat quality parameters on 0^{th} day (fresh). The various meat quality parameters *viz* Extract release volume was determined by Pearson, 1968 and Water Holding Capacity (WHC) was estimated by Harris and Shorthose., 1988. The thio barbituric acid number was determined by Strange *et al.*, 1977with slight modification.

Statistical Analysis

For interpretation of the results, the data of two levels of doses and two sources of Selenium were subjected for analysis of variance following 2x2 factorial schemes as per the Snedecor and Cochran 1994. The significance of difference due to two levels of doses and two sources of selenium supplementation and interaction effect of levels and sources were analysed by Duncan's Test (1955).

Results and Discussion

The effect of two levels and sources of sodium selenite and selenium enriched yeast on carcass characteristics (dressed wt., liver, heart, intestine, breast, thigh, wing, back and neck and giblet) and meat quality (Water Holding Capacity (WHC), Extract Reserve Volume (ERV), Thiobarbituric Acid (TBA) value parameters is presented in Table 2 and 3.

Carcass Characteristics

Dressing wt. (%) did not vary significantly due to supplementation of two levels of sodium selenite, however, two level of selenium enriched yeast showed significant ($p<0.01$) difference. The dressed weight with 0.5 ppm Se group was highly significant ($p<0.01$) than 0.15group.

No significant ($p>0.05$) effect on liver, heart, intestine, thigh, wing, back and neck and giblet wt. percentage due to two levels of selenium supplementation was recorded, however, breast wt. percentage and dressing percentage differed significantly ($p<0.05$) due to 0.5 ppm of selenium enriched yeast supplementation.

The finding was corroborated with the finding of earlier researcher (Payne and southern., 2005; Deniz *et al.*, 2005., Savcikova *et al.*, 2006; Mikulski *et al.*, 2009 Da Silva *et al.*, 2010; Yang *et al.*, 2012; Rao *et al.*, 2013; Rajashree *et al.*, 2014; Oliveira *et al.*, 2014; Boostani *et al.*, 2015; Prasad, M. V., 2019)

reported no significant (p>0.05) affect due to supplementation of different level of selenium or different source of selenium, however, most of the researcher (Naylor *et al.,* 2000; Choct *et al.,* 2004; Heindl *et al.,* 2010; Baltic *et al.,* 2015; Markovik *et al.,* 2018) reported higher breast meat and dressing weight percentage due to supplementation of higher level of organic selenium in poultry, who advocated higher breast weight percentage might be due to higher amount of organic selenium deposition in the breast weight. Similarly higher dressing percentage might be due to higher growth performance in organic selenium supplemented group.

Meat Quality Parameter

The water holding capacity (WHC) and Thiobarbituric Acid (TBA) value due to supplementation of two levels of sodium selenite and selenium enriched yeast did not differ significantly. Similarly ERV (ml) due to two level of sodium selenite did not vary significantly (p>0.05), however, ERV (ml) supplemented with two level of selenium enriched yeast differed significantly (p<0.05) in 0.5 ppm Se supplemented group. The ERV (ml) due to overall level and source effect did not show significant (p>0.05) difference, however, interaction effect differed significantly (p<0.05).

Table.1 Ingredients composition of experimental diets for pre-starter, starter & finisher feed

Ingredient (%)	Pre-starter feed	Starter feed	Finisher feed
Maize	55.72	52.72	61.66
Soy DOC	37.95	37.92	30.80
Soy. Oil	2.86	5.24	3.70
DCP	1.28	2.17	2.00
LSP	1.08	0.78	0.70
Lysine	0.42	0.01	0.04
Methionine	0.14	0.23	0.14
Choline -60%	0.08	0.10	0.12
Salt	0.35	0.39	0.29
Premix[1]	0.42	0.42	0.50
Soda- bi-carb	0.09	0.32	0.42
Calculated value			
ME(kcal/kg)	3000	3100	3100
Protein (%)	23	22.00	19.50
Calcium (%)	0.94	0.94	0.94
Available P (%)	0.48	0.48	0.48
Lysine (%)	1.25	1.14	1.00
Methionine (%)	0.58	0.53	0.45
ME:CP	130.43	140.90	158.97
Ca:P	1.95	1.95	1.95

Vitamin-mineral premix contained the following per kg of premix: all-*trans* retinol, 548.4 mg; cholecalciferol, 22.025 mg; DL-tocopherol, 3397 mg; menadione sodium bisulphite, 1460 mg; vitamin B_{12}, 4.4 mg; biotin, 18.4 mg; choline chloride, 257 000 mg; folic acid, 330 mg; niacin, 14 690 mg; D-pantothenic acid, 3670 mg; pyridoxine hydrochloride, 1100 mg; riboflavin, 1830 mg; thiamine mononitrate, 735 mg; Cu (as copper sulphate), 1480 mg; I (as calcium iodate), 370 mg; Fe (as ferrous sulphate), 14 690 mg; Mn (as manganese oxide),22 020 mg.

Table.2 Effect of two sources and levels of sodium selenite and selenium enriched yeast supplementation on various carcass cuts of broiler chicken (as Percentage of Live Weight) at 0-35 d (gm/bird)

Particular	Individual effect					Significant
	Group I (SS)		Sig.	Group II (SY)		
	0.15 ppm	0.5 ppm		0.15 ppm	0.5 ppm	
Dressed wt. (%)	69.74 ± 0.58	68.05 ± 1.27	NS	70.65 ± 0.52^{b}	73.23 ± 0.59^{a}	**
Liver wt. (%)	1.77 ± 0.10	1.76 ± 0.28	NS	1.86 ± 0.13	2.09 ± 0.19	NS
Heart wt. (%)	0.45 ± 0.02	0.44 ± 0.00	NS	0.46 ± 0.04	0.48 ± 0.01	NS
Intestine wt. (%)	3.33 ± 0.07	3.88 ± 0.23	NS	3.44 ± 0.24	3.07 ± 0.32	NS
Breast wt. (%)	12.62 ± 0.91	11.48 ± 0.40	NS	13.50 ± 0.30	13.50 ± 0.30	NS
Thigh wt. (%)	19.89 ± 1.00	19.74 ± 0.19	NS	20.41 ± 0.62	19.89 ± 1.00	NS
Wing wt. (%)	18.86 ± 1.09	18.60 ± 1.95	NS	19.62 ± 0.89	18.94 ± 0.52	NS
Back & Neck wt. (%)	11.81 ± 0.37	11.59 ± 0.35	NS	11.95 ± 0.31	14.11 ± 1.01	NS
Giblet wt. (%)	4.39 ± 0.27	4.38 ± 0.17	NS	4.27 ± 0.17	4.73 ± 0.12	NS

Overall effect							
Particular	**Level effect**		**Sig.**	**Source effect**		**Sig**	**Interaction (L x S)**
	0.15 ppm	**0.5 ppm**		**SS**	**SY**		
Dressed wt. (%)	69.19±0.42	70.64±1.31	NS	68.89 ± 0.73	70.94 ± 1.08	NS	*
Liver wt. (%)	1.80 ± 0.07	1.93 ± 0.17	NS	1.80 ± 0.14	1.93 ± 0.12	NS	NS
Heart wt. (%)	0.47 ± 0.02	0.45 ± 0.00	NS	0.46 ± 0.01	0.45 ± 0.02	NS	NS
Intestine wt.(%)	3.38 ± 0.11	3.48 ± 0.25	NS	3.26 ± 0.20	3.61 ± 0.16	NS	NS
Breast wt. (%)	13.36 ±0.69	12.49 ± 0.50	NS	12.05± 0.51^{b}	13.80 ± 0.49^{a}	*	NS
Thigh wt. (%)	20.09±0.27	20.15 ± 0.54	NS	20.42 ± 0.34	19.82 ± 0.45	NS	NS
Wing wt. (%)	19.24 ±0.65	18.77 ± 0.90	NS	19.28 ± 0.48	18.73 ± 1.00	NS	NS
Back & Neck wt. (%)	11.88 ± 0.22	11.87 ± 0.28	NS	11.99 ± 0.26	11.77 ± 0.22	NS	NS
Giblet wt. (%)	4.33 ± 0.11	4.56 ± 0.15	NS	4.56 ± 0.12	4.33 ± 0.14	NS	NS

Superscripts are read row wise for comparison of means. Means ± SE, in the same row with different superscripts a and b are significantly different * (P<0.05), ** (P<0.01), Sig.= Significant, NS= Non-Significant., SS: Sodium selenite, SY: Selenium enriched yeast, L: level, S: Source

Table.3 Effect of two sources and levels of sodium selenite and selenium enriched yeast supplementation on meat quality in broiler chicken (35 d) of age

Particular	Individual effect					Significant
	Group ISS			Group IISY		
	T1 (0.15 ppm)	T2 (0.5 ppm)	Sig.	T3 (0.15 ppm)	T4 (0.5 ppm)	
WHC %	68.04±0.79	70.75±1.37	NS	73.08±1.11	74.18±0.57	NS
ERV (ml)	24.26±0.58	22.93±1.19	NS	24.26±0.48^{b}	27.04±0.88^{a}	*
TBA value	0.27±0.00	0.30±0.00	NS	0.24±0.01	0.22±0.02	NS
Overall effect						
Particular	Level effect		Sig.	Source effect		Sig.	Interaction(LxS)
	0.15 PPM	0.5 PPM		SS	SY		
WHC %	70.56±1.28	72.46±1.01	NS	69.39±0.93^{b}	73.63±0.61^{a}	**	NS
ERV (ml)	24.26±0.33	24.99±1.13	NS	23.60±0.66	25.65±0.76	NS	*
TBA value	0.26±0.01	0.26±0.02	NS	0.28±0.01^{a}	0.23±0.00^{b}	**	NS

Superscripts are read row wise for comparison of means. Means ± SE, in the same row with different superscripts a and b are significantly different * (P<0.05), **(P<0.01), Sig.= Significant, NS= Non-Significant.,SS: Sodium selenite, SY: Selenium enriched yeast, L: level, S: Source

The WHC percent and TBA value due to level effect were non-significant, however source effect showed highly significant (p<0.01) difference for WHC percent and TBA value. The WHC % supplemented with selenium enriched yeast was significantly (p<0.01) higher than sodium selenite supplementation, however, TBA value supplemented with sodium selenite was significantly higher than selenium enriched supplementation. The interaction effect in WHC percent and TBA value were non-significant.

Significantly higher ERV ml was recorded in 0.5 ppm supplementation of selenium enriched yeast, however, level and sources effect did not affect ERV (ml) in poultry, while two sources of selenium affected the water holding capacity and TBA value in selenium enriched yeast supplemented group. The finding was in corroborated with result of Wang *et al.,* (2009); Boiago *et al.,* (2014) and Rajashree *et al.,* (2014), who reported improved meat quality through decreased lipid peroxidation.

In conclusion overall selenium enriched yeast source improved carcass characteristics and meat quality of broiler chicken. Significantly higher WHC % and lower TBA value were recorded with 0.5 ppm of selenium enriched yeast.

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Ethical standards

The research work has been approved by the ethical committee before undertaking work.

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