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Original article

Comparative effect of selenium source on the performance, meat quality and meat oxidative stability of broiler chickens

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A B S T R A C T

The present investigation was carried out to study the comparative effect of selenium source on the performance, meat quality and meat oxidative stability of broiler chickens for a period of 6 weeks. The total 375 day old straight run broiler chicks were procured and divided into five different dietary treatments viz. A, B, C, D and E, respectively, with three replicates in each treatment. Treatment group A was control (without selenium), B fed with organic selenium @ 0.3ppm , C fed with inorganic selenium @ 0.3ppm , group D fed with organic selenium @ 0.6ppm and group E fed with inorganic selenium @ 0.6ppm through feed. The sources of organic and inorganic selenium were selenomethionine and sodium selenite, respectively. The growth performances (body weight, feed consumption, FCR, mortality) were recorded on weekly basis. The carcass traits (edible carcass yield, thigh yield, drum stick, giblet, breast yield, abdominal fat, neck yield, wing yield) were measured after slaughtering the bird on 42nd day. The thigh and breast meat were collected in LDPL bags and kept -180C till the analysis is carried out for the PH, purge loss and TBA values at 0,7,14,21 and 28 day of slaughter. Whatever the origin of selenium supplementation, no significant effect on body weight gain, feed intake and FCR was observed in various weeks. The highest mortality was observed in organic selenium supplementary group. The carcass traits were also unaffected at the end of experiment. Dietary level of organic and inorganic selenium did not affect the PH of breast meat at 0, 7, 14, 21 and 28th day of storage of meat. However, slightly higher PH values were notice for treatment group without selenium supplementation. Purge loss was numerically higher in control group but did not differ significantly for organic and inorganic selenium supplemented groups at 7th and 14th day of storage. The decreased TBA values of breast meat at 0, 7, 14, 21 and 28th day of storage for dietary supplementation with organic and inorganic selenium were observed. In conclusion, the supplementation of broiler diets with organic and inorganic selenium reduced drip loss, TBA values during storage thereby improved quality of meat.

1. Introduction

Selenium is an essential micro nutrient required for normal growth and maintenance in poultry. The selenium requirement to broiler throughout the growth period is 0.15ppm (NRC, 1994) and this requirement often can be met by natural feedstuffs in the diet. However due to the considerable regional variation in selenium contain of natural feedstuffs, it is common practice to supply broiler diets with selenium. The selenium supplement that primarily has been used in poultry diet is the inorganic form, sodium selenite. However there has been interest in the use of organic form of selenium such as selenium enriched yeast, as supplemental source of selenium (Payne and Southern, 2005). Biological function of selenium, as a component of glutathione peroxidase was reported by Rotruck et al., (1973). The glutathione peroxidase catalyzes the reduction of hydrogen peroxide and a variety of organic hydroperoxidase using glutathione as a hydrogen donor to water and corresponding alcohol to protect cells and membrane from oxidative damage (Rayman, 2000). As the selenium is an integral part of glutathione peroxidase enzyme, involved in detoxification of hydrogen peroxide and lipid hydroperoxides, preventing oxidative damage to body tissues, resulting in more meat yield. Supplementation of organic selenium in the diets of poultry enhanced weight gain and feed conversion efficiency (Acamovic, 2001).Colnago et. al., (1984) observed that chicks reared on diets supplemented with selenium at levels exceeding 0.25 ppm had improved growth performance. Edens (1996) found a greater reduction in drip loss when selenium yeast was used compared to sodium selenite. Similarly, Naylor et. Al (2000) reported that organic selenium reduced 24 hrs. Drip loss in broiler carcasses by 23%. It was speculated that organic selenium reduced drip loss by maintaining integrity of the cell membrane thereby improving the meat quality and self life. However, scientific information available on performance and meat quality in broiler using organic and inorganic selenium is limited, often not conclusive and sometimes consistent. The objective of present research was to evaluate the comparative effect of different levels of dietary supplementation with organic and inorganic selenium on growth performance, carcass traits, meat oxidative stability and purge loss of broiler chicken.

2. Materials and methods

The experiment was carried out on commercial straight run broilers for a period of 42 days (6 weeks) from15 June, 2011 to 26th July 2011 in the Department of Poultry Science, College of Veterinary and Animal Sciences, MAFSU, Parbhani. 375 day old Vencobb400 broiler chicks were obtained from M/s Yogeshwary Hatcheries Pvt. Ltd. At. Post Warwati, Ambejogai-Parli road, Ambejogai, dist. Beed, (Maharashtra). On arrival, the chicks were weighed and distributed randomly into five treatment groups viz, A, B, C, D and E with three replicates of 25 chicks each. A basal diet was prepared with maize and soybean meal having uniform nutrient composition, except for supplementation of organic and inorganic selenium (Table.1). Treatment group A was control (without selenium), B fed with organic selenium @ 0.3ppm , C fed with inorganic selenium @ 0.3ppm , group D fed with organic selenium @ 0.6ppm and group E fed with inorganic selenium @ 0.6ppm through feed. The sources of organic and inorganic selenium were selenomethionine and sodium selenite, respectively. The brooding was carried out with electric hover brooders as source of heat, light and continued until 2 weeks of age in the respective pen of each replication and treatment group. The live body weights of all birds were recorded replicate wise at weekly

interval. The pre-starter ration was offered for first eight days of age, starter ration was offered from 9th day up to end of 21st day of age and finisher ration was offered up to 42nd day of age(Table1). The daily mortality was recorded and the weights of all the dead birds were taken in order to minimize the error in feed conversion ratio. It was expressed as percentage mortality at the end of the experiment for corresponding treatment group. At the end of the experiment, three birds from each treatment group one bird from each replicate were randomly selected for carcass evaluation studies. The birds were fasted for a period of ten hours prior to slaughter. An edible carcass yield was weighed after removal of feathers, viscera, head and legs by keeping the skin intact with the carcass. The percent weights of edible carcass weight were calculated over live weight. Edible carcass yield was calculated by adding the weight of carcass, neck, giblet and expressed as percentage of edible carcass yield of live weight. The weight of weight of thigh, drum stick, giblet, breast yield, abdominal fat, neck and wing were recorded by separating it from carcass and expressed as percent of the total carcass yield. In the present study breast and thigh meat samples of one bird per replicate of each treatment were stored at 4oC in LDPE (low density poly ethylene) bags and their oxidative stability i.e. thiobarbituric acid values was determined by modified method as described by Strange et al.(1977) with little modification in the technique. Five ml of aliquot of TCA extract was mixed with 5ml of TBA reagent in a test tube .TBA reagent was prepared according to the method of Pearson (1968), by dissolving 0.2883 g of Thiobarbituric acid in sufficient quantity of 90% acetic acid with slight warming, and the volume was made upto 100ml with 90% acetic acid. The test tubes containing samples were kept in a water bath at 100oC for 30 min along with control test tube containing a blank of 5ml of 10% TCA and 5ml TBA reagent. After cooling the tubes in running water for about 10 min the optical density was measured at 530 nm in a spectro- photometer. The 10gm of meat was made into paste with 50ml of distilled water in laboratory blender. The pH was measured by the pH meter equipped with a combined glass electrode. The Purge loss was determined by the following formula. The weight of breast meat was recorded before chilling and after chilling which was stored at 4oC in deep freeze upto 28 days. The purge loss was recorded at 0,7,14,21,28 days of storage period.
Purge loss= (weight of sample before chilling- weight of sample after separation of liquid)/ (weight of sample before chilling) x100 Data, thus collected were subjected to statistical analysis by using Complete Randomized Design by Snedecor and Cochran (1968). The treatment means were compared by critical differences (CD) and Analysis of Variance.

3. Results and discussion

Table 2 shows the comparative effect of dietary supplementation of organic and inorganic selenium at different dose level on performance traits and mortality. The incorporation of organic and inorganic selenium did not significantly improve the average body weight gain. Moreover, the nature of selenium source (organic vs. inorganic) did not significantly modify broiler growth. However higher cumulative body weight gain at 6th week was observed for organic selenium with 0.60 ppm. The feed consumption did not differ significantly for various treatment groups. Marginally superior feed conversion was recorded in treatment group with 0.30 ppm organic selenium inclusion at 4th week. Beyond 0.30 ppm organic and inorganic selenium level there was no further improvement in feed conversion. The mortality was higher in organic selenium group with 0.3ppm. The results are in agreement with the finding of other authors (Edens et.al. 2001; Spears et.al., 2003; Payne and Southern,2005; Ryu et.al.,2005). Edens et.al.,(2001) reported no differences in body weight or feed efficiency when broilers were fed diets containing 0.20 ppm selenium. Similarly, Spears et.al.,(2003) reported no difference in body weight gain or feed efficiency of broiler chickens fed diets containing 0,0.05 or 0.15 ppm selenium from sodium selenite or selenomethionine. In contrast, Cantor et.al.,(1982) recorded higher live weight and increased feed intake in poults at the age of 28 days after dietary selenium supplementation in form of sodium selenite or selenomethionine (0.04 to 0.12 ppm selenium).

The carcass traits were not affected by selenium source or level of supplementation (Table3) except wing yield. The wing yield was significantly higher in treatment group with 0.60 ppm organic and inorganic selenium supplemented group. The results are in agreement with Downs et.al.,(2000) and Payne and Southern(2005). Choct and Naylor(2004) also reported that vitamin E and selenium source at 0.1ppm did not have a significant influence on eviscerated weight, dressed weight, breast fillet yield at processing. In contrast, the previous trails Choct et, al.,(2004) found that birds receiving organic selenium in their diets had improved eviscerated weight, dressed weight, breast fillet yield at processing.

Dietary level of organic and inorganic selenium did not affect the PH of breast meat (Table3) at 0,7,14,21 and 28th day of storage of meat. However, slightly higher PH was notice for treatment group without selenium supplementation. These PH value shown among the treatment group did not fall within PH range typically associated with unacceptable colour that may results from lower or higher PH range than the ultimate PH of chicken meat.

Purge loss was numerically higher (Table3) in control group but did not differ significantly for organic and inorganic selenium supplemented groups at 7th and 14th day of storage. The numerical drip loss of breast meat for organic and inorganic supplemented groups inferred that organic and inorganic selenium reduced drip loss by maintaining integrity of cell membrane. These findings are in closed agreement with Edens(1996) who found that a greater reduction in drip loss could be obtained when selenium yeast was used compared to sodium salenite.Naylor et. al., (2000) also supported these results and reported that organic selenium reduced drip loss by maintaining integrity of cell membrane. Downs et. al.,(2000) also showed low drip loss in broiler breast meat when birds were fed selenium yeast. Simek et. al.,(2002) found that animals fed the longest period with organic selenium prior to slaughter, had the lowest drip loss when compared to control.

The decreased TBA values (Table 3) of breast meat at 0, 7,14,21 and 28th day of storage for dietary supplementation with organic and inorganic selenium concludes that selenium exhibited antioxidative effect in broiler meat. The oxidative stability increased with the increase of concentration of selenium. OGrady et.al.,(2001) reported similar results. Ryu et.al.,(2005) observed that dietary supplementation with 8 ppm selenium in combination with 100 IU of α-tocopherol per Kg of feed was more effective in reducing TBA value at 12 day of storage. Rhee et.al.,(2006) found that diets supplemented with 4 and 8 ppm selenium reduced lipid oxidation. However, Ahn et.al.,(1995)reported that no effect on lipid oxidation in packed cooked chicken meat stored for 7 day at 40C.

Table-1

Percent Ingredient Composition of Prestarter, starter and finisher mashes.

Feed ingredients	Pre-starter	Starter	Finisher
Maize	53.2	54.0	58.5
Vegetable oil	3.0	4.2	4.9
Soybean meal	41.0	39.0	33.8
Dicalcium phosphate	1.5	1.5	1.5
Limestone powder	1.0	1.0	1.0
Salt	0.3	0.3	0.3
Total	100	100	100
Protein	23.05	22.02	20.05
M.E. Kcal/Kg	3011.16	3100	3202.22
E:P ratio	130.63:1	140.78:1	159.71:1
Supplements/additives (g/100 kg)			
*Trace Mineral mixture	300	300	300
**Vitamin mixture	150	150	150
Methionine	180	190	160
Lysine	170	130	100
Choline chloride	60	60	60
Coccidiostat(Madhuramycin)	50	50	50
Organic Selenium	*	*	*
Inorganic Selenium	*	*	*

*The organic and inorganic selenium were incorporated in the treatment groups as described in treatment detail.

*Trace Mineral Mixture: - Manganese Sulphate, Zinc Sulphate, Iron, Potassium Iodide, Copper Sulphate, and Cobalt Chloride.

** Vitamin Mixture: - Vit. A, D3, B1, B2, B6, B12, Niacin, Calcium D Pantotenate, Vit K, E, Folic acid etc.

Table 2

Comparative effect of organic and inorganic selenium on performance of broilers

Parameter	A	B	C	D	E	SE +	CD	CV %
Cumulative body weight gain 1st wk	105.307	104.70	105.04	91.427	87.68	5.35	16.85	9.475
Cumulative body weight gain 2nd wk	356.101	354.800	361.946	348.173	337.373	8.65	27.21	4.26
Cumulative body weight gain 3rd wk	714.02	719.08	731.00	720.27	710.54	13.80	43.44	3.32
Cumulative body weight gain 4th wk	1261.51	1285.91	1250.10	1238.32	1228.69	23.83	74.99	3.29
Cumulative body weight gain 5th wk	1883.27	1861.14	1856.03	1872.57	1822.78	20.36	64.08	1.89
Cumulative body weight gain 6th wk	2376.59	2397.30	2400.78	2406.72	2350.29	37.80	118.94	2.74
Weekly feed consumption 1st wk	117.48	125.13	113.81	106.49	99.89	3.23	10.18	4.98
Weekly feed consumption 2nd wk	461.17	459.39	458.26	446.16	466.93	7.39	23.26	2.79
Weekly feed consumption 3rd wk	992.86	998.03	995.67	987.49	1005.05	15.82	49.79	2.75
Weekly feed consumption 4th wk	1791.44	1808.68	1807.10	1784.74	1783.59	27.03	85.05	2.6
Weekly feed consumption 5th wk	2865.28	2872.03	2891.74	2861.25	2848.76	41.48	130.50	2.5
Weekly feed consumption 6th wk	3985.33	4010.03	4030.66	4003.09	3963.17	56.22	176.89	2.43
Cumulative FCR 1st wk	0.76	0.83	0.76	0.76	0.76	0.0282	0.088	6.34
Cumulative FCR 2nd wk	1.29	1.29	1.26	1.28	1.38	0.025	0.081	3.4
Cumulative FCR 3rd wk	1.39a	1.39a	1.36a	1.37	1.41b	0.013	0.042	1.67
Cumulative FCR 4th wk	1.42ab	1.40a	1.44b	1.44b	1.45b	0.0088	0.027	1.066
Cumulative FCR 5th wk	1.52	1.54	1.55	1.52	1.56	0.018	0.0578	2.06
Cumulative FCR 6th wk	1.67	1.67	1.67	1.66	1.68	0.020	0.065	2.16
Mortality %	1.33	4	2.66	2.66	1.33	-	-	-

Note: - means in columns not sharing a common superscript differ significantly.

Table 3
Comparative effect of organic and inorganic selenium on carcass traits, pH of mid-gut, purge losses and TBA values.

Parameter	A	B	C	D	E	SE +	CD	CV %
Body weight (gms)	2573.33	2633.33	2220.00	2433.33	2315.00	175.3	551.48	12.46
Edible carcass yield (%)	65.43	66.60	60.75	63.31	67.99	3.38	10.65	9.04
Thigh yield (%)	15.00	14.00	15.71	15.25	15.30	0.80	2.54	9.01
Drum stick (%) (pair)	15.52	16.64	15.95	15.95	14.65	0.70	2.22	7.78
Giblet (%)	7.39	6.92	7.68	7.01	7.45	0.38	1.21	9.16
Breast yield (%)	40.77	39.34	39.08	42.24	43.37	1.57	4.96	6.67
Abdominal fat %	2.47	2.47	3.39	2.55	3.38	0.37	1.18	22.80
Neck yield (%)	7.01	8.06	8.40	7.20	7.63	0.54	1.71	12.33
Wing yield (gm)	246.666[a]	252.33[a]	141.666[b]	159.000[b]	162.666[b]	19.51	61.38	17.55
pH of breast meat at 0th day	6.28[a]	5.93[b]	6.00[b]	5.81[b]	5.84[b]	0.076	0.23	2.21
pH of breast meat at 7th day	5.99[a]	5.81[b]	5.90[a]	5.74[b]	5.82[b]	0.047	0.14	1.41
pH of breast meat at 14th day	5.95[a]	5.77[a]	5.88[a]	5.70[a]	5.56[b]	0.088	0.27	2.63
pH of breast meat at 21st day	5.90[a]	5.71[a]	5.83[a]	5.67[a]	5.55[b]	0.10	0.34	3.28
pH of breast meat at 28th day	5.78[a]	5.64[a]	5.77[a]	5.59[a]	5.43[b]	0.103	0.32	3.17
Purge loss at 7th day (%)	9.96	9.65	8.83	7.07	7.44	1.66	5.24	33.59
Purge loss at 14th day (%)	13.11	12.62	11.01	9.54	12.49	1.47	4.64	21.73
TBA (Mg/Kg) 0th day fresh meat	0.0541[a]	0.0383[b]	0.0131[c]	0.0136[c]	0.0150[d]	0.045	0.014	154.60
TBA (Mg/Kg) 7th day of storage	0.137	0.136	0.130	0.138	0.132	0.0076	0.023	9.79
TBA (Mg/Kg) 14th day of storage	0.984[a]	0.906[a]	0.810[a]	0.749[b]	0.779[b]	0.056	0.179	11.66
TBA (Mg/Kg) 21st day of storage	1.22[a]	0.822[b]	0.963[a]	0.786[b]	0.940[a]	0.0487	0.153	8.92
TBA (Mg/Kg) 28th day of storage	1.39[a]	0.853[b]	1.30[a]	0.816[b]	1.06[b]	0.0878	0.276	14.03

4. Conclusion

In conclusion, the supplementation of broiler diets with organic and inorganic selenium reduced drip loss, TBA values during storage thereby improved quality of meat. However body weight gain, feed consumption, FCR, carcass traits were unaffected by selenium sources. It is possible that the used of organic selenium instead of inorganic selenium in broiler diet may increased both meat quality and economic gain by reducing drip loss and TBA values.

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