

Effect of dietary organic selenium on egg and tissue selenium and glutathione peroxidase in broiler breeders

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An experiment was conducted to compare the effect of selenium sources on performance, Se incorporation into certain poultry tissues (blood, liver and breast muscle) and eggs, hatchability, glutathione peroxidase activities in tissues and eggs in broiler breeder. Broiler breeder hens were allocated to six diet treatments factorially arranged with three selenium sources (Sodium selenite, Selenium-yeast, and B-TRAXIM[®]Se) and two levels of each source (0.1 and 0.3 ppm). Egg production was higher ($P < 0.01$) in hens fed 0.3 ppm Se. Selenium contents in egg, liver, and breast meat were higher ($P < 0.01$ or 0.05) in hens fed the higher level of selenium. Selenium content in yolk was highest in hens fed B-TRAXIM[®]Se, whereas selenium content in albumen was highest in hens fed selenium yeast. However, there was no difference in combined selenium contents of yolk plus albumen. Selenium contents in liver and breast meat were higher in hens fed Se-yeast compared to hens fed other sources of selenium. Glutathione peroxidase activity (GPX) in liver and plasma was affected by selenium source but not by level. GPX in liver was higher in hens fed selenite or selenium yeast, and in plasma was higher in hens fed selenite compared to B-TRAXIM[®]Se or selenium yeast.

Keywords : selenium; broiler breeder; production; egg; GPX

Introduction

The inorganic salt of selenium (sodium selenite) is generally added to the diet of broiler chickens at the level of 0.3 ppm. Selenium is an integral part of the glutathione peroxidase enzyme, which is an antioxidant enzyme that destroys hydrogen peroxide and lipid peroxides produced during normal metabolic activity (Rotruck et al. 1973). Over the last few years, there has been interest in replacing either a portion or all of inorganic source with organic selenium. Presently the most common source of organic selenium is a selenium-yeast product. B-TRAXIM[®]Se is a newly developed organic selenium product manufactured by Pancosma. The aim of this study was to investigate the effect of selenium sources on performance, Se incorporation into certain poultry tissues (blood, liver breast muscle, and liver) and eggs, hatchability, glutathione peroxidase activities in tissues and eggs in broiler breeder.

Materials and methods

Forty eight, 50 week old broiler breeder hens were allocated at random to 1 of 6 diet treatment groups. Treatment consisted of 3 selenium sources (Selenite, Selenium yeast or B-TRAXIM[®]Se) and 2 levels of each source (0.1 ppm or 0.3 ppm). Each diet treatment combination was fed to 8 replicate individually caged broiler breeder hens. All diets were manufactured at the Arkell Research Station Feed Mill and details are appended. Diets were fed for 45 days at the level of 150grams of feed/bird/day after which time eggs and various tissues were assayed for selenium and other parameters.

Eggs were collected from day 30-35 for assay of egg weight and for eggshell deformation as a measure of shell strength. Egg production was monitored throughout the trial. All eggs produced between days 36 to 45 were collected to determine hatchability.

At 45 days, all birds were blood sampled for assay of glutathione peroxidase in plasma, then birds were humanely euthanized for breast muscle and liver sampling. Selenium assays were conducted on egg yolk and albumen, blood plasma, breast muscle and liver.

Selenium concentration of whole blood, tissue samples and extracts was determined by a semi-automated fluorometric assay (Brown and Watkinson 1977). For GPX assay, blood and tissue samples were collected. Blood samples were centrifuged for 15 min at 3,000 x g and 4°C. The plasma was collected and stored in -80°C until analysis. Livers were perfused in situ with ice-cold 0.15 mol/L KCl. Tissues were homogenized with 50 mM Tris-HCl buffer (pH 7.0). Homogenates were centrifuges at 13,000 x g for 15 min at 4°C. Supernatants were collected and stored in -80°C until analysis. Glutathione peroxidase activity in the supernatants and plasma was determined using a diagnostic kit (Sigma, USA). The protein in supernatants was determined spectrophotometrically using Bicinchoninic acid protein assay kit (Sigma, USA). GPX enzyme unit is one micromole GSH oxidized per minute and per milligram of protein.

In the trial, the 48 birds were arranged in a randomized design and individual bird was the experimental unit. The data were consider by a two factor factorial analysis (2 x 3) where the main effects were level of selenium (0.1 or 0.3% of diet) and source of selenium (selenite, selenium yeast or B-TRAXIM®Se). Data were subjected to an analysis of variance procedure (General Linear Models, SAS, Inc.) considering main effect and their interaction. Those response variables resulting in a significant F test were further analysed using Tukey's test. Interaction means are presented for interest and are not considered statistically. Significance was accepted at P <0.05.

Results and discussion

Egg production, egg weight and eggshell deformation are presented in Table 1.

Table 1. Egg production, egg weight and eggshell deformation of broiler breeder hens fed different levels and sources of selenium

Selenium Source	Egg production (%) [*]	Egg weight (g)	Eggshell deformation (μm)	Hatchability (% fertile eggs) [*]
Selenium source				
Sodium selenite	68.9	69.2	26.9	89.4
Selenium yeast	68.8	67.0	27.7	80.9
B-TRAXIM®Se	68.3	69.2	25.8	87.5
Selenium level, ppm				
0.1	64.9 ^B	68.9	26.2	88.6
0.3	72.3 ^A	67.9	27.4	83.4
Pooled SEM	9.2	3.6	2.7	17.0

^{A,B}P<0.01, ^{*}Interaction;P<0.01

Egg production was affected positively by level of selenium in the diet (P <0.01) but not by source of selenium and there was no interaction between level and source of selenium in the diet. Egg weight and eggshell deformation were unaffected by either level or source of selenium in the diet (P>0.05). Hatchability was not affected by either dietary selenium level or source. However, hatchability was affected by interaction between dietary selenium level and source (P<0.05); hatchability of eggs from hens fed selenium yeast was lower in hens fed 0.1 ppm selenium, whereas hatchability of eggs from hens fed 0.3 ppm selenium was comparable (but lower) across all treatments.

Plasma selenium content was not affected by dietary selenium level or source (Table 2).

Table 2. Selenium content in plasma, egg, and tissue of broiler breeder hens fed different levels and sources of selenium

	Selenium source			Se level, ppm		SEM
	Sodium selenite	Selenium yeast	B-TRAXIM®Se	0.1	0.3	
Plasma(ug/mL)	0.173	0.169	0.152	0.156	0.173	0.033
Yolk (ug/egg)	7.40 ^B	7.49 ^B	8.70 ^A	7.65 ^b	8.13 ^a	0.080
Albumen (ug/egg) **	2.60 ^B	4.02 ^A	2.66 ^B	2.69 ^B	3.54 ^A	0.311
Yolk + albumen (ug/whole egg) *	10.01 ^B	11.73 ^A	11.31 ^A	10.31 ^B	11.80 ^A	0.887
Liver (ug/g) *	0.43 ^b	0.48 ^a	0.47 ^{ab}	0.44 ^b	0.48 ^a	0.055
Breast meat (ug/g) **	0.164 ^B	0.185 ^A	0.155 ^B	0.162 ^B	0.174 ^A	0.014

^{AB}P<0.01, ^{ab}P<0.01, Interaction; *P<0.05 and **P<0.01

Selenium content in egg, liver, and breast meat was affected by interaction between dietary selenium level and source (P<0.01 or 0.05). Selenium content of egg, liver, and breast meat were higher (P<0.01 or 0.05) in hens fed the higher level of selenium. Selenium content in yolk was highest in hens fed B-TRAXIM®Se, whereas selenium content in albumen was highest in hens fed selenium yeast. However, there was no difference in combined selenium contents of yolk plus albumen for hens fed selenium yeast or B-TRAXIM®Se. Selenium contents in liver and breast meat were higher in hens fed selenium yeast compared to hens fed other sources of selenium.

Glutathione peroxidase activity (GPX) in liver and plasma was affected by selenium source but not by level (Table 3).

Table 3. Glutathione peroxidase activity in liver, plasma, and breast meat of broiler breeder hens fed different levels and sources of selenium

	liver (mU/mg protein)	Plasma (mU/mg protein)	Breast meat (mU/mg protein)
Selenium Source			
Sodium Selenite	75.38 ^A	169.50 ^A	40.71
Selenium yeast	78.50 ^A	111.43 ^B	40.03
B-TRAXIM®Se	59.25 ^B	109.87 ^B	38.55
Selenium level, ppm			
0.1	71.75	128.26	39.76
0.3	70.33	123.30	39.96
Pooled SEM	12.265	35.253	8.240

^{AB}P<0.01.

GPX activity in liver was higher in hens fed selenite or selenium yeast and in plasma was higher in hens fed selenite compared to B-TRAXIM®Se or selenium yeast. GPX in breast was not different among treatments.

These data support the concept that broiler breeders require at least 0.3 ppm dietary selenium, and for many parameters there are benefits for an organic source of such selenium. The selenium in the selenium enriched yeast appears to deposit in proteins as evidenced by higher levels in both albumen and breast meat. However where there is more fat association, as in yolk, then the B-TRAXIM®Se is preferentially deposited. The effects of Se on glutathione peroxidase were somewhat surprising. There is anecdotal evidence suggesting higher GPX levels with higher levels of selenium. However enzymes are produced in response to levels of substrate. Higher levels of GPX are therefore expected with high levels of oxidation stress. Conversely there is no need for birds to sustain high levels GPX when oxidation stress is minimal. For example Cheng et al (1997) clearly demonstrated lower levels of GPX in mice fed adequate vs deficient levels of selenium. Likewise, Maraschiello et al (1999) show a negative correlation between GPX and vitamin E levels and positive correlation between GPX and markers for oxidation stress. Low levels of GPX as found in plasma with both organic Se products and in liver with B-TRAXIM®Se can be construed as indication of less oxidative stress in birds fed these products.

References

- BROWN M.W., and WATKINSON J.H.** 1977. An automated fluorimetric method for the determination of nanogram quantities of selenium. *Anal. Chim. Acta.* 89:29-35.
- CHEN W.H., HO Y.S., ROSS D.A., HAN Y., COMBS G.F., and LEI X.G.** 1997. Overexpression of cellular glutathione peroxidase does not affect expression of plasma glutathione peroxidase or phospholipid hydroperoxidase glutathione peroxidase in mice offered diets adequate of deficient in selenium. *J. Nutr.* 127:675-680.
- MARASCHIELLO C., SARRAGA C., and GARCIA REGUEIRO J.A.** 1999. Glutathione peroxidase activity, TBARS, and α -tocopherol in meat from chickens fed different diets. *J. Agric. Food Chem.* 47:867-872.
- ROTRUCK, J. T., POPE A.L., GANTHER H.E., SWANSON A.B., HAFEMAN D.G., and HOEKSTRA W.G.** 1973. Selenium. Biochemical role as a component of glutathione peroxidase. *Science* 179:588-590.