RESEARCH NOW

New Generation Organic Selenium (zinc-L-selenomethionine) Increases Muscle Selenium Levels in Chicks

Introduction:

Organic selenium in the form of selenomethionine is uniquely incorporated into muscle and tissue, via the methionine incorporation pathway. Inorganic selenium, such as sodium selenite (NaSe) is not able to produce this same effect. The following experiments evaluated the efficacy of a new organic selenium compound, zinc-L-selenomethionine complex (Availa®Se), as compared to sodium selenite, in broiler chicks.

Results:

- Weight gain and feed conversion were not affected by dietary Se level or source.
- Clinical signs of Se deficiency were not observed
- Generally, GSH-Px activity was similar or higher for NaSe supplemented chicks versus Availa-Se
- Availa-Se increased muscle selenium levels vs. NaSe in both experiments ($P<0.01$)
- Based on muscle selenium levels, Se from Availa-Se is 238 to 338% more available than from NaSe

Trial Design & Duration:

- 2 experiments
- Day old male chicks fed Se deficient diets for 7 days
- After 7 day depletion, chicks randomly assigned to pens
- Pens assigned to Treatments

Conclusion:

Data from these experiments indicate that NaSe or zinc-L-selenomethionine complex can adequately meet the GSH-Px requirements of chicks, but zinc-L-selenomethionine complex uniquely builds muscle selenium levels.

Treatments:

Exp. 1

Low Se, Basal (B)
B + 0.05 ppm Se from NaSe
B + 0.15 ppm Se from NaSe
B + 0.05 ppm Se from Availa-Se
B + 0.15 ppm Se from Availa-Se

Exp. 2

Low Se, Basal (B)
B + 0.05 ppm Se from NaSe
B + 0.10 ppm Se from NaSe
B + 0.15 ppm Se from NaSe
B + 0.05 ppm Se from Availa-Se
B + 0.15 ppm Se from Availa-Se

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ABSTRACT

Efficacy of a Novel Organic Selenium Compound (zinc-L-selenomethionine, Availa®Se) in Broiler Chicks. J. W. Spears[1], J. Grimes[1], K. Lloyd[1], T. L. Ward*[2]. [1] *North Carolina State University, Raleigh,* [2] *Zinpro Corp., Eden Prairie, MN.*

Introduction. Selenium (Se) exists in nature in two forms, inorganic and organic. The most common form of Se used in animal nutrition is sodium selenite (NaSe). However, there is renewed interest in Se supplementation of commercial livestock largely due to human and animal research demonstrating some forms of organic Se are more bioavailable than NaSe, and may uniquely provide animal performance benefits in commercial livestock. Reported improvements include increased rate of gain and improved feathering in broilers, increased maternal transfer of Se to progeny, improved immune function, and reduced drip loss of meat. Other potential economic benefits uniquely provided by organic Se relate to Se enrichment of eggs, meat and milk, and the subsequent health benefits this may bestow on consumers, especially in terms of reduced cancer and heart disease. Organic Se, in the form of selenomethionine, is the predominant form of Se found in feedstuffs. In this regard, NaSe is not found naturally, and as a result is less effective in terms of assimilation from the feed and building reserves of Se within muscle tissue as compared to selenomethionine. The objective of the current research was to evaluate the efficacy of a unique organic Se compound (zinc-L-selenomethionine; Availa®Se, Zinpro Corporation) in broiler chicks.

Materials and Methods. Two experiments were conducted using day-old male chicks. Chicks were fed a semi-purified torula yeast-based diet deficient in Se for 7 days. Feed and deionized water were offered ad libitum. At the end of the 7-day depletion period, chicks were randomly assigned to pens [6 (Exp. 1) or 5 (Exp 2.) chicks per pen]. Pens were then randomly assigned to one of three dietary treatments. In Exp. 1 treatments consisted of: 1) control (low Se basal diet, 0.034 ppm Se; B), 2) B + 0.05 ppm Se from NaSe, 3) B + 0.15 ppm Se from NaSe, 4) B + 0.05 ppm Se from zinc-L-selenomethionine, and 5) B + 0.15 ppm Se from zinc-L-selenomethionine. In Exp. 2 treatments consisted of: 1) control (low Se basal diet, 0.038 ppm Se; B), 2) B + 0.05 ppm Se from NaSe, 3) B + 0.10 ppm Se from NaSe, 4) B + 0.15 ppm Se from NaSe, 5) B + 0.05 ppm Se from zinc-L-selenomethionine, and 6) B + 0.15 ppm Se from zinc-L-selenomethionine.

Experimental diets were fed for 14 days. Body weights and pen feed intakes were measured at 7-day intervals. Blood samples were obtained from two chicks per pen at the end of the 14-day repletion period for determination of plasma and whole-blood glutathione peroxidase activity (GSH-Px) and plasma thyroid hormone concentrations. Samples of liver and pectoralis muscle were collected at the end of the study from two chicks per pen for determination of GSH-Px and Se concentrations.

Procedures. Glutathione peroxidase activity was measured by a coupled-enzyme procedure. Plasma samples were assayed the day of collection and results were expressed as units/mg protein. Whole-blood samples were stored at 4°C and assayed the day following blood collection. Tissue samples were placed on ice at the time of collection and were later stored at -80°C until assayed for GSH-Px. Protein in tissue homogenates was determined by the Lowry procedure. Plasma thyroid hormone concentrations were determined using radioimmunoassays specific for T3 and T4. Feed and tissue Se concentrations were measured using a semi-automated fluorometric method following wet digestion with nitric and perchloric acid. Data were analyzed as completely randomized designs. Differences between treatment means were determined by single-degree-of-freedom contrasts. Selenium bioavailability was also estimated using multiple linear regression and slope-ratio methodology with NaSe as the standard (100%).

Results and Discussion. Weight gain and feed/gain of chicks were not affected by dietary Se level or source. Clinical signs of Se deficiency were not observed. Plasma, whole-blood, liver and muscle GSH-Px activities were lower ($P<0.01$) in chicks fed unsupplemented vs Se-supplemented diets. When 0.15 ppm Se was supplemented in Exp. 1, chicks fed zinc-L-selenomethionine had lower ($P<0.01$) whole-blood GSH-Px than chicks fed NaSe. Tissue GSH-Px activity in chicks fed zinc-L-selenomethionine did not differ from those supplemented with NaSe. Bioavailability estimates for zinc-L-selenomethionine relative to NaSe ranged from 73 to 100%, based on GSH-Px activity, with whole-blood ($P<0.01$) and liver ($P<0.05$) GSH-Px being lower in chicks fed zinc-L-selenomethionine. A number of studies with chicks have indicated that selenomethionine is less available than NaSe, based on GSH-Px, when fed at low concentrations of Se. Plasma T3 concentrations were not affected by treatment. Control chicks had lower ($P<0.01$) plasma T4 concentrations than those supplemented with Se. It is unclear why T4 concentrations were lower in controls. Selenium deficiency was probably not of sufficient severity and/or duration to alter the activity of iodothyronine 5'-deiodinase in the present study since T3 concentrations were not affected by treatment. The Se requirement for maximal enzyme activity is much higher for GSH-Px than for iodothyronine 5'-deiodinase in the rat. Selenium concentrations in liver and muscle increased ($P<0.01$) with increasing dietary Se. Muscle Se concentrations were higher ($P<0.01$) in chicks fed 0.15 ppm Se as zinc-L-selenomethionine than in chicks fed NaSe. Bioavailability estimates, based on liver Se concentrations, were lower ($P<0.05$) for zinc-L-selenomethionine than for NaSe. However, based on muscle Se concentrations, zinc-L-selenomethionine was 238 to 338% as bioavailable as NaSe. Higher Se concentration in muscle of chicks fed zinc-L-selenomethionine is consistent with selenomethionine being incorporated into non-specific proteins in place of methionine.

ABSTRACT

Table 1. Effect of Se source and level on growth and metabolic parameters in chicks (Exp. 1)

Supplemental Se source	None	Sodium Selenite		Zinc-L-selenomethionine	
Added dietary Se, ppm	0	0.05	0.15	0.05	0.15
Gain, g/chick	364	382	350	371	325
Feed/gain	1.61	1.84	1.82	1.51	1.69
Plasma GSH-Px, U/mg protein[ab]	4.1	23.9	61.7	17.0	63.9
Whole-blood GSH-Px, U/mg Hb[ab]	128.3	145.3	214.8	145.6	203.1
Liver GSH-Px, U/mg protein[ab]	23.4	57.9	145.0	39.0	152.9
Muscle GSH-Px, U/mg protein[ab]	16.5	29.8	45.5	25.1	44.8
Plasma thyroxine, μg/dL[c]	2.55	2.41	2.56	2.37	2.60
Plasma triiodothyronine, ng/dL	141.7	143.7	149.2	161.4	135.6
Liver Se, μg/g dry tissue[abd]	0.36	0.75	1.60	0.67	1.42
Muscle Se, μg/g dry tissue[abe]	0.21	0.31	0.36	0.32	0.58

[a] None vs added Se, P<0.01.
[b] 0.05 vs 0.15 ppm added Se, P<0.01.
[c] 0.05 vs 0.15 ppm added Se, P<0.01.
[d] 0.15 ppm Se as sodium selenite vs 0.15 ppm Se as zinc-L-selenomethionine, P<0.05.
[e] 0.15 ppm Se as sodium selenite vs 0.15 ppm Se as zinc-L-selenomethionine, P<0.01.

Table 2. Effect of Se source and level on growth and metabolic parameters in chicks (Exp. 2)

Supplemental Se source	None	Sodium Selenite			Zinc-L-selenomethionine	
Added dietary Se, ppm	0	0.05	0.10	0.15	0.05	0.15
Gain, g/chick	297	288	278	311	289	307
Feed/gain	2.05	2.12	2.25	2.25	2.30	1.96
Plasma GSH-Px, U/mg protein[abcde]	3.3	24.0	63.1	81.6	13.2	81.9
Whole-blood GSH-Px, U/mg Hb[abcdf]	39.7	51.3	87.1	107.3	52.1	87.8
Liver GSH-Px, U/mg protein[abd]	24.3	69.3	142.6	193.2	52.7	173.0
Muscle GSH-Px, U/mg protein[ab]	9.5	12.8	25.0	25.3	12.8	21.1
Plasma thyroxine, μg/dL[acd]	2.26	2.33	2.40	2.63	2.30	2.61
Plasma triiodothyronine, ng/dL	139.1	151.6	144.3	149.8	147.3	150.0
Liver Se, μg/g dry tissue[abcd]	0.40	0.71	1.30	1.72	0.55	1.40
Muscle Se, μg/g dry tissue[acdef]	0.07	0.13	0.15	0.24	0.28	0.55

[a] None vs added Se, P<0.01.
[b] 0.05 vs 0.10 ppm added Se, P<0.01.
[c] 0.05 vs 0.15 ppm added Se, P<0.01.
[d] 0.10 vs 0.15 ppm added Se, P<0.01.
[e] 0.05 ppm Se as sodium selenite vs 0.05 ppm Se as zinc-L-selenomethionine, P<0.05.
[f] 0.15 ppm Se as sodium selenite vs 0.15 ppm Se as zinc-L-selenomethionine, P<0.01.

Conclusions. Based on providing adequate GSH-Px activity and similar growth performance, zinc-L-selenomethionine is an efficacious source of Se for poultry. Increased muscle stores of Se when feeding zinc-L-selenomethionine, are indicative of a more bioavailable Se source relative to NaSe.

Implication. Zinc-L-selenomethionine (Availa®Se) should be considered for use in the livestock and poultry industries as a unique means of providing supplemental Se.

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