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Introduction

An interaction between mercury and selenium that reduces the toxicity of methylmercury in growing chicks and laying hens has been demonstrated in previous work from the South Dakota Agricultural Experiment Station (A.S. Series 78-6 and 79-25). An inorganic form of selenium, sodium selenite, was used in those studies. However, much of the selenium occurring in plants and animals is in an organic form, principally selenomethionine and/or selenocysteine bound to protein moeties. Studies described herein were to compare the effectiveness of selenium as found in seleniferous wheat with that of sodium selenite in counteracting methylmercury toxicity in growing chicks.

Methods

A total of 400 SCW Leghorn day-old pullet chicks were used in 10 treatment groups replicated four times with 10 birds per treatment replicate. They were housed in batteries with suspended wire floors and were fed ad libitum. The control diet contained 8% wheat and provided 0.058 ppm selenium by analysis (treatments 1 and 2). Sodium selenite was added to provide selenium levels of 0.5 ppm (treatments 3 and 4) and 2.0 ppm (treatments 5 and 6). Seleniferous wheat grown in a high selenium area of western South Dakota and containing 25 ppm selenium was substituted for a portion of the control wheat to provide diets having selenium levels of 0.5 ppm (treatments 7 and 8) and 2.0 ppm (treatments 9 and 10). Treatments 1, 3, 5, 7 and 9 constituted the low mercury series, while dietary methylmercuric chloride equivalent to 15 ppm mercury was incorporated into treatments 2, 4, 6, 8 and 10 for the high mercury series. Body weight and tissue accumulations of mercury and selenium at 4 weeks of age were used as criteria for comparing the two sources of selenium.

Results

There were no deaths attributed to the mercury or selenium treatments in this study. The feeding of 15 ppm of methylmercury resulted in lower ($P<0.05$) body weight in 2 weeks which continued through the fourth week. At the end of 4 weeks, the average weight of all mercury treated birds was 6.2% less ($P<0.05$) than for those on the corresponding nonmercury treatments. There were no effects of the selenium treatments on body weight and no interactions between selenium and mercury in that regard.

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Data pertaining to liver, kidney, brain, muscle and feathers (Table 1) were analyzed statistically by orthogonal comparisons. Methylmercury reduced ($P<0.05$) liver weight approximately proportionate to the decrease in body weights but had no apparent effect upon the weight of kidneys or brains. When compared with the 0.5 ppm level of selenite selenium, lower ($P<0.01$) liver and kidney weights were associated with the feeding of 2 ppm selenium from the same source in the high mercury series birds. Thus, neither source of selenium counteracted the growth or liver weight depression associated with the feeding of methylmercury. Average brain weight which was not affected by methylmercury was 4.4% heavier ($P<0.01$) in the selenium supplemented, low mercury-fed birds with no differences between the two sources.

Liver mercury concentrations averaged 22.5 ppm in the mercury-fed birds with kidney mercury concentrations being of the same order of magnitude at 23.9 ppm. Muscle tissue averaged 11.5 ppm, brain 8.3 ppm and feathers 58.3 ppm mercury, the higher concentration in feathers being a reflection of the lower moisture content of this tissue. Liver and kidney mercury were reduced ($P<0.01$) by selenium, 2 ppm selenium from selenite or wheat being more ($P<0.05$) effective in this regard when compared with the corresponding 0.5 ppm selenium treatments. A comparison between the two sources of selenium showed lower ($P<0.05$) liver and kidney mercury values to be associated with the feeding of seleniferous wheat.

The feeding of methylmercury resulted in higher selenium concentrations in all tissues analyzed with the exception of muscle. Overall, this amounted to increases of 43% for liver ($P<0.01$), 73% for kidney ($P<0.01$), 23% for brain ($P<0.05$), 11% for feathers ($P<0.05$) and only 1% for muscle (N.S.). This interrelationship between selenium and mercury evident in tissue appears to be an important mechanism for the function of selenium in reducing methylmercury toxicity. In all instances, tissue selenium concentrations were greatest in liver, kidney, muscle, feathers ($P<0.01$) and brain ($P<0.05$) for birds fed seleniferous wheat as opposed to selenite.

It can be concluded from these data that selenium from either selenite or seleniferous wheat is capable of entering into a biological interaction with methylmercury. While selenium contained in seleniferous wheat appeared to yield slightly higher tissue selenium levels, the differences are not of a magnitude that would be expected to have important biological implications.

Table 1. Body weight and tissue accumulation of mercury (Hg) and selenium (Se) in Leghorn pullets

	Treatment		4-wk body wt	Liver[1]		Kidney		Muscle		Brain		Feathers	
No.	Hg (ppm)	Se (ppm)	(g)	Hg (ppm)	Se (ppm)	Hg (ppm)	Se (ppm)	Hg (ppm)	Se (ppm)	Hg (ppm)	Se (ppm)	Hg (ppm)	Se (ppm)
1	0	0[2]	244	0.16	0.22	0.14	0.25	0.06	0.09	0.12	0.22	0.47	0.57
2	15	0	241	24.3	0.27	26.3	0.29	11.2	0.08	8.3	0.17	60.4	0.66
						Selenite Treatments							
3	0	0.5	251	0.08	0.64	0.06	0.70	0.06	0.14	0.10	0.23	0.37	0.87
4	15	0.5	236	23.7	1.09	15.7	1.60	12.8	0.16	8.4	0.26	55.8	1.04
5	0	2.0	261	0.10	1.31	0.19	1.20	0.11	0.18	0.10	0.27	0.54	1.76
6	15	2.0	218	21.8	1.76	21.7	1.74	11.3	0.18	9.5	0.45	57.4	2.20
						Seleniferous Wheat Treatments							
7	0	0.5	258	0.15	0.80	0.16	0.80	0.10	0.33	0.15	0.28	0.46	1.40
8	15	0.5	244	23.6	1.20	25.2	1.70	11.4	0.34	7.9	0.28	63.2	1.35
9	0	2.0	249	0.10	1.47	0.10	1.50	0.05	0.93	0.10	0.47	0.48	3.32
10	15	2.0	240	19.4	2.04	20.7	2.38	10.8	0.94	7.4	0.67	54.6	3.23

[1] All data are averages of four replicates of 10 birds each.
[2] Se added as sodium selenite or seleniferous wheat; basal diet contained 0.058 ppm Se.