1973

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A.S. Series 73-18

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Introduction

Mercury in our environment has been implicated in egg shell thinning and poor hatchability among various species of wild birds. We have used domestic chickens to determine the effect of a range of sublethal levels of two dietary mercury compounds, i.e., inorganic mercuric chloride and organic methylmercuric chloride.

Methods

Day-old Shaver Starcross 288 pullet chicks were started in batteries and given free access to a 20% protein starter diet. Ten treatments incorporated into the diet consisted of a control, mercuric chloride providing levels of 1.25, 2.5, 5.0, 10.0 and 20.0 ppm mercury, and methylmercuric chloride providing 1.25, 2.5, 5.0 and 10.0 ppm mercury. Each treatment was replicated three times with 16 chicks per cage. At 8 weeks of age, eight chicks from each treatment were killed to obtain tissues for mercury analysis. At that time, the remaining 40 birds in each treatment were divided into four replicates of 10 birds each and placed in 24-inch cages in a layer house where they remained for the duration of the experiment. Additional birds were killed at 16 and 33 weeks of age, reducing numbers in each cage to six birds each (total of 24 birds per treatment). Except for subsequent mortality, these were continued through a complete egg-laying cycle.

Egg production was measured daily and egg-quality measurements were made biweekly on a one-day collection of eggs. At two intervals during the laying cycle, the hens were inseminated artificially using semen from normal nontreated males, and eggs were collected for hatching. A maximum of 30 eggs from each treatment replicate (120 eggs per treatment) was set. Eggs failing to hatch were opened and the embryos were examined visually for abnormalities. After hatching, chicks were weighed, placed in batteries and fed a 20% protein starter diet. Growth and survival were measured over a period of 4 weeks.

Results

Weight gains and tissue mercury concentrations for birds during the pre-laying growth period are shown in Table 1. There were no obvious effects of either form of mercury on growth of chicks to 33 weeks of age. Mercury concentrations

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in all tissues analyzed, i.e., kidney, liver, muscle and brain, reached approximate maximum concentrations within 8 weeks for birds fed the inorganic mercuric chloride. Concentrations of mercury in the kidneys of these birds were two to four times higher than mercury concentrations in the livers. However, mercury concentrations in the muscle and brain of inorganic-mercury fed birds were no higher than for controls.

Birds fed methylmercuric chloride had mercury concentrations in all tissues higher than for those fed the same level of inorganic mercury. Concentrations of mercury in kidney reached a high of approximately 21 ppm when 10 ppm methylmercury were fed. Mercury concentrations in kidney did not increase noticeably between the 8- and 33-week sampling periods. However, levels of mercury in liver, muscle and brain increased by one and one-half to two times between these periods.

Detrimental effects of mercury on egg production and quality were restricted to groups fed the highest levels of methylmercury (i.e., 5 and 10 ppm mercury). Birds fed 10 ppm methylmercury, in addition to producing fewer eggs, laid smaller and misshaped eggs with rough, poorly calcified and thinner shells. When broken, these eggs had lower Haugh unit ratings. Other eggs, which should have contained approximately 13 ppm mercury showed, in two hatches, a much lower rate of hatchability. The few chicks produced, while slightly smaller initially, made normal weight gains during the post-hatching 4-week growth period.

Effects of 5 ppm dietary methylmercury were less evident while 2.5 ppm had no obvious effect on egg quality. The presence of 8 ppm mercury in eggs from hens fed 5 ppm methylmercury had little, if any, effect on hatchability or subsequent growth of chicks during the 4-week post-hatching period.

Although mortality during the experiment was quite high in the control group (16% mortality), this was largely the result of cannibalism in one cage. On the other hand, mortality was higher (33% loss) for birds fed 10 ppm methylmercury.

It appears from these studies that inorganic mercury up to a level of 20 ppm in the diet of chickens does not influence growth, egg production, egg quality or hatchability. Methylmercury at levels of 2.5 ppm or less also appears to be well tolerated with no visible harmful effects. Effects of higher levels became increasingly severe with progression of the experiment.

The results reported here are not necessarily applicable to wild birds that may be exposed to various stresses not experienced by the confined chickens used in these studies. These studies are being continued through a second egg-laying cycle for longer term observations.

Table 1. Growth and Tissue Mercury Levels of Mercury-fed Chicks During a Pre-laying Growth Period

Treatment	Weight[1]			Tissue mercury levels - ppm							
				8 weeks				33 weeks			
	4 weeks	8 weeks	32 weeks	Kidney	Liver	Muscle	Brain	Kidney	Liver	Muscle	Brain
	gm	gm	gm								
Control	288	624	1640	0.26	0.18	0.08	0.11	0.39	0.16	0.06	0.14
Inorganic mercury, ppm											
1.25	299	672	1650	1.54	0.38	0.14	0.12	1.62	0.21	0.02	0.09
2.5	293	650	1620	2.74	0.90	0.06	0.08	1.98	0.50	0.03	0.06
5.0	300	673	1670	5.18	1.80	0.06	0.08	5.62	1.62	0.25	0.06
10.0	294	649	1710	6.42	2.52	0.12	0.10	9.58	2.68	0.02	0.08
20.0	309	644	1670	12.62	4.90	0.06	0.06	10.28	10.04	0.05	0.11
Methylmercury, ppm											
1.25	267	648	1680	3.96	3.46	0.94	0.62	3.64	6.92	1.58	1.18
2.5	289	661	1680	6.78	6.80	1.70	1.36	5.34	10.03	2.98	1.89
5.0	279	631	1640	12.42	15.02	3.33	2.81	11.98	20.04	6.66	4.00
10.0	288	668	1670	21.76	23.30	6.62	4.96	20.39	41.08	13.32	8.21

[1]Initial weight at 1 day of age = 35 grams.

Table 2. Production Data for Mercury-fed Hens During A 26 Week Egg-laying Period

Treatment	Hen-day production	Feed consumed	Egg weight	Egg shell thickness	Haugh units	Mercury content of eggs	Mortality
	%	gm/day	gm	mm x 10^2		ppm	%
Control	79.5	111.1	59.5	40.5	82.9	0.03	16.7
Inorganic mercury, ppm							
1.25	74.7	108.0	59.8	39.6	82.4	0.09	8.3
2.5	81.9	110.3	59.8	38.8	82.5	0.18	4.2
5.0	78.7	111.1	60.3	40.2	82.1	0.41	0.0
10.0	78.4	110.1	60.3	40.0	82.9	0.94	0.0
20.0	80.5	114.2	59.8	39.0	82.2	1.86	8.3
Methylmercury, ppm							
1.25	82.0	110.7	59.8	39.3	80.9	1.71	4.2
2.5	78.2	112.2	59.5	40.0	80.2	3.74	4.2
5.0	72.8	111.3	55.7	41.0	73.1	8.06	12.5
10.0	55.4	110.8	51.1	37.5	67.9	13.35	33.3

Table 3. Hatchability of Eggs from Mercury-fed Hens

Treatment	Hatch No. 1			Hatch No. 2		
	Hatch of all eggs	Av. wt. progeny		Hatch of all eggs	Av. wt. progeny	
		Initial	28 days		Initial	28 days
	%	gm	gm	%	gm	gm
Control	55.3	37.0	263	79.2	40.3	296
Inorganic mercury, ppm						
1.25	62.7	37.4	271	70.0	41.1	302
2.5	73.1	36.1	258	77.5	40.7	290
5.0	51.7	36.7	264	70.8	42.8	297
10.0	64.2	37.1	261	81.7	40.9	292
20.0	58.3	36.1	252	77.5	40.8	287
Methylmercury, ppm						
1.25	60.2	36.9	254	80.0	40.0	299
2.5	57.5	35.4	264	78.3	39.5	307
5.0	69.7	34.1	259	68.1	35.9	290
10.0	34.0	32.7	254	25.0	34.2	304