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Transfer of Methylmercury to Hens' Eggs after Oral Administration

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There has been considerable information about the presence of mercury in food (Hugunin and Bradley 1975; Kirkpatrick and Coffin 1975; Maggi et al. 1979) because the concentration of this element in food has been considered as the greatest toxicological danger to the average citizen. Concurrently, mercury residues in hen's eggs had been reported by many authors (Smart and Lloyd 1963; Kiwimae et al, 1969; Kambamanoli-Dimou et al, 1989). There has also been described mercury's distribution among tissues of birds following it's administration in various chemical forms (Gardiner et al, 1971; Wright et al, 1973) and it's transfer from diet to eggs, particularly when alkylmercury compounds had been fed (Tejning and Westerberg 1964; Kiwimae et al, 1969).

The present investigation was performed to elucidate the possibility of transport of methylmercury into eggs after it's oral administration. Also, to determine the quantity of mercury excreted via eggs after oral administration of a certain quantity of this element once or in doses.

MATERIALS AND METHODS

A total of 30 White Leghorn type Hisex hens, 14 months of age and approximately of 75% of eggs productivity had been used. The hens had been divided into two treatment groups (A and B) of 13 birds each and a control one of 4 birds. The hens of group A had been devided into A1 sub-group of 4 birds and A2, A3, A4 sub-groups of 3 birds each. The same had been done with group B. The birds of each sub - group and the control group M had been kept in individual cages. Group A birds had been fed once by dropping into their mouth 500 µg of methylmercury chloride per Kg of body weight and group B birds had been fed with 100 µg of methylmercury chloride per Kg of body weight daily for a period of five days, that is 500 µg/Kg of body weight in all (a 500mg/l aqueous solution of methylmercury chloride for birds of group A and a 100 mg/l solution for birds of group B had been used). The birds of proup M did not receive methylmercury chloride. The eggs of each sub-group had been collected every day and after removal of the shells, yolks and albumens had been macerated together to give a homogeneous sample. Portions of 50

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gwere analysed for methylmercury chloride. The same was done with samples of eggs of group M.

For the determination of methylmercury chloride in eggs the method of Kambamanoli -Dimou et al (1989), based on Westoo (1967, 1968) and Watts et al (1976) methods, was used. The recovery of the method ranged from 69% to 93% when egg samples spiked with 10, 50, 200 and 500 ppb of methylmercury chloride were analysed. Concentrations down to 0.1 ppb of methylmercury chloride in eggs could be readily determined. Determinations of methylmercury chloride in eggs of all sub-groups and group M were conducted just before the administration (day zero) and on the 1st, 2nd, 3rd, 4th, 5th, 6th, 7 th, 10th, 14th, 18th 22nd, 26th, 30th, 34th, 38th, 42nd and 46th day after the administration (the administration of the other doses of methylmercury chloride to group B birds were continued on the 1st, 2nd, 3rd and 4th day).

RESULTS AND DISCUSSION

All birds remained normal, bright and active throughout the experiment and there was no obvious difference in egg production between treated and untreated birds. The concentrations of methylmercury chloride in eggs of treated hens of each sub-group and in the eggs of control hens are shown in Table 1, as well as the mean concentrations of methylmercury in eggs of groups A and B. A significant residue of methylmercury in the eggs was first detected two days after the administration of methylmercury, which means that the transfer of methylmercury to eggs started to increase on the second day of the administration and it was found to be higher in group A. The highest concentration of methylmercury chlolide was observed on the third day after the administration for group A and on the sixth day of the first dose (or the second day after the administration of the total amound of methylmercury) for group B. Also, the highest concentration of methylmercury in the eggs of group A was higher (1685ppb) than in the eggs of group B (1041ppb). During the course of the experiment the transfer of methylmercury to eggs was decreased and that was faster in group A. No changes were observed in the methylmercury concentrations in the eggs of the control group throughout the experiment. The fluctuations of methylmercury mean concentrations in eggs of groups A and B are given in Figure 1.

The results show that egg production is a major route of elimination of mercury from the body of laying hens since the oral administered methylmercury was readily transferred into eggs. Data had been presented describing the distribution of mercury among componends of eggs following the administration of methylmercury chloride to chickens or to laying Japanese quail. It had been reported that mercury concentration of eggs produced by hens fed 10 ppm of CH_3HgCl for 10 days had increased sharply the first 12 days of the experiment and had declined slowly for the subsequent 58 days (Sell et al, 1974). On the 4th day of the trial, mercury was readily detected in the whites and yolks of the eggs and maximum concentration of more than 10 ppm and 5 ppm of Hg were attained in whites and yolks of eggs respectively. It has also

Table 1. Methylmercury chloride in eggs of treated and control hens (ppb wet weight).

Group	Time after the administration (days)																	
	0	1	2	3	4	5	6	7	10	14	18	22	26	30	34	38	42	46
A1	0.6	0.3	87.9	1448.1	1399.8	1084.6	981.3	789.3	568.9	331.0	236.4	167.2	134.5	83.7	64.1	42.0	40.5	19.0
A2	0.4	0.3	135.3	1806.7	1677.5	1331.0	1048.1	810.7	417.2	236.4	225.8	133.3	83.2	62.0	44.8	21.9	20.1	7.3
A3	0.8	0.8	143.1	1776.4	1649.8	1194.9	1101.5	909.5	522.4	312.9	210.7	137.6	80.9	71.3	51.6	34.4	24.6	12.2
A4	0.2	0.6	150.3	1710.2	1659.6	1287.4	995.6	798.4	429.6	324.9	210.2	154.0	94.5	78.5	60.6	27.6	25.4	10.4
Mean A	0.5	0.5	129.2	1685.4	1596.7	1224.5	1031.6	827.0	484.5	301.3	220.8	148.0	98.3	73.9	55.3	31.5	27.7	12.2
(S.D) ±	(0.2)	(0.2)	(28.0)	(163.2)	(131.8)	(108.9)	(54.5)	(55.5)	(73.2)	(44.1)	(12.5)	(15.7)	(24.6)	(9.1)	(8.6)	(8.6)	(8.7)	(5.0)
B1	0.3	0.2	10.7	213.8	365.5	590.2	924.0	842.7	568.9	332.4	234.7	139.6	103.4	67.9	54.1	20.9	28.9	14.9
B2	0.3	0.3	27.9	196.5	565.2	896.0	1034.3	930.9	554.7	336.0	215.1	126.7	77.6	44.4	28.4	22.7	27.9	9.6
B3	0.3	0.4	101.3	291.0	647.1	909.3	1139.1	1059.3	685.9	360.9	260.7	184.4	95.2	64.4	47.9	29.6	20.7	14.7
B4	0.2	0.5	30.9	244.1	563.3	763.4	1066.7	1048.0	639.1	332.1	220.4	146.8	83.5	52.1	39.0	25.4	23.2	12.6
Mean B	0.3	0.4	42.7	236.4	535.8	789.7	1041.0	970.2	612.2	340.4	232.7	149.4	89.9	57.2	42.4	24.7	25.2	13.0
(S.D) ±	(0.1)	(0.1)	(39.8)	(41.2)	(119.8)	(148.4)	(89.4)	(102.7)	(61.3)	(13.9)	(20.1)	(24.8)	(11.7)	(11.0)	(11.3)	(3.4)	(4.2)	(2.6)
M	0.2	0.3	0.3	0.2	0.4	0.3	0.1	0.,2	0.2	0.2	0.4	0.2	0.1	0.2	0.2	0.3	0.3	0.3

A1, A2, A3 A4 = 500µg/Kg body weight once

B1, B2, B3, B4 = 100 µg/Kg body weight daily for 5 days.

M == Control group.

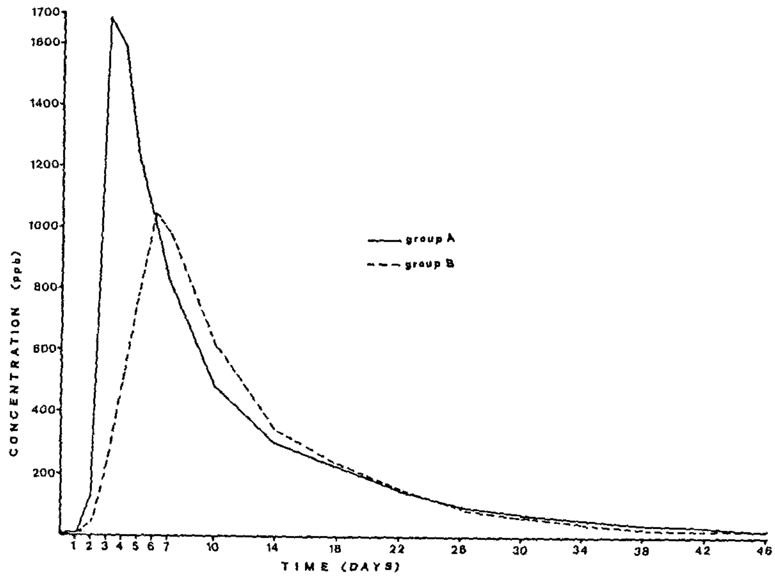

Figure 1. Fluctuations of methylmercury chloride concentrations in eggs of groups A and B.

been calculated that about 55% of Hg consumed by hens had been deposited in eggs produced during the 70 days experiment. During the same experiment a similar pattern of response had been observed with regard to radioactivity in eggs after a single intraperitoneal injection of $CH_3{}^{203}HgCl$ in the hens. About 65% of the total administered radioactivity had been deposited in eggs produced in 70 days. A transport mechenism of methylmercury into egg albumen had been investigated in laying Japanese quail which had received a single intravenous of ^{203}Hg methylmercuric chloride by Nishimura and Urakawa (1976). The uptake of ^{203}Hg had been higher in the oviduct than in any other tissue checked. Furthermore the ^{203}Hg had been detected in egg albumen which had been synthesized and secreted in the magnum portion of the oviduct. There had also been calculated that in 7 eggs laid over a period of 8 days after the injection, the total RHg content had been approximately 44% of the dose of the radiocompound administered. The largest amount of RHg had been found in the albumen of third egg in the order of oviposition after the injection.

In this experiment, mercury was readily detected in eggs two days after hens were fed with methylmercury chloride. The increase of methylmercury in eggs was found to be higher in group A, with the highest concentration observed on the third day and on the sixth day for the group B. Then the mercury concentration declined slowly in the subsequent days more slowly for group B. After the analyses and weight of eggs produced, it was calculated that 46%-54% (mean 50%) of administered methylmercury had been deposited in eggs for group A during the 46 days experiment and 32% - 54% (mean 46%) in eggs of group B. Methylmercury content in egg shells was not determined since eggshell is not an edible portion of egg and as Nishimura and Urakawa (1976) refer the Hg content in the shell is negligible.

From the statistical analysis of the results, the following equations describe the structural relationships of our experiments:
For the group A,
$y = 0.07498 \cdot e^{3.41702 \, . \, t} \cdot 22437.74804^{Dt} \cdot e^{-3.52125 \, . \, DTt}$
and for the group B,
$y = 0.46936 \cdot e^{1.52659 \cdot t} \cdot 3540.20530^{Dt} \cdot e^{-1.63359 \cdot DTt}$
where y = mean concentration

t = days after treatment

Dt = dummy variable (indicates zero values for the first time period, in which the concentration increasing, and one for the second).

DTt = dummy variable ($DTt = t \cdot Dt$)

The estimation of the parameters of these equations were done using the regression analysis procedure and especially the ordinary least square (O.L.S.) as well as the first autoregressive least square method.

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