# Mercury Distribution in Laying Hens fed Whalemeal Supplement

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Whalemeal with a protein content of 75% is a valuable feed supplement. However, this current investigation has shown that this product contains a considerable amount of mercury.

Intake of methyl mercury has been reported (BERGLUND et al 1971) to have irreversible physiological effects and this has focussed attention upon the distribution of mercury in agriculture. Mercury is present in fungicides used as seed dressings and steps have been taken to find suitable alternatives with less hazard. Other sources also need consideration.

In preliminary studies, four samples of fish meal, local and imported, were found to contain less than 0.1 p.p.m. of mercury. Three samples of whale solubles and three samples of whalemeal, from Western Australia, contained from 1.7 to 3 and from 7.9 to 10 p.p.m. of mercury respectively. It is apparent that use of whalemeal could have a significant influence in providing excessive mercury levels and therefore warrants careful consideration.

This paper reports an experiment in which whalemeal was fed as the protein supplement in the diet of laying hens and the concentration of mercury in the eggs, faeces and separate fractions of the carcasses determined.

## MATERIALS AND METHODS

Twelve mature hens, approximately 103 weeks of age, were divided at random into two groups of six birds. Each bird was housed in a single laying cage. Two diets were fed in mash form on an ad-libitum basis and intake was recorded.

The control diet fed to the first group contained ground wheat, ground barley, ground oats, meat and bone meal, lucerne meal, inorganic nutrients and vitamins.

The experimental diet fed to the second group was similar except that the meat and bone meal was replaced by whalemeal, this corresponding to 8.8% of the mixture.



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Egg production was recorded daily and eggs identified with the group code, day number and individual weight of the eggs. Egg samples were analysed at weekly intervals.

The trial was conducted for 47 days, after which all the birds were slaughtered. Samples of flesh, bones, offal and feathers were taken from two birds selected at random from each group together with samples of breast flesh from three of the remaining birds.

## METHOD OF ANALYSIS

The weights of all samples were recorded.

Using an "egg separator", the egg whites were separated from the yolks.

The flesh samples and offal samples (head, feet and gut) were minced in a Hobart food chopper. The leg bones were ground in a hand mincer. The feathers were not ground but samples were obtained by cutting pieces from various feathers. The faeces were dried in an oven at 40°C and ground in a Christy and Norris hammer mill.

All samples were digested by the method of BRAUN and HUSBANDS (1971). Sample weights of 0.2 g were taken for diets, faeces and feathers, 0.3 to 0.4 g for egg yolks and shells and 0.4 to 0.5 g for flesh, egg white and offal.

The excess potassium permanganate was reduced with 8 ml of 20% hydroxylammonium sulphate solution instead of 15 ml of 20% hydroxylammonium chloride solution in order to reduce the blank. The final volume of solution was 60 ml. A 40 ml aliquot was taken for the mercury determinations.

A model AA5 Varian-Techtron Atomic Absorption Spectrophotometer, a Varian A25 recorder and a Varian open ended system mercury kit was used for the mercury determinations by cold vapour atomic absorption (STUX and ROTHERY 1971) (PARKER 1972).

The necessary vigorous stirring of the 40 ml aliquot of digest solution was obtained by using a 25 x 6 mm teflon coated magnetic stirring bar (KARTELL PLASTICS No. TS 757) for 90 secs. Air was blown into the vortex rather than bubbled through the solution.

## RESULTS AND DISCUSSION

The total mercury concentrations in the diets and faeces are given in Table 1.

TABLE 1.

Total mercury concentration in diets and faeces

| | Total Mercury (p.p.m.) | % Dry Matter |
|---|---|---|
| Control Diet | 0.01 | 90.9 |
| 8.8% whalemeal diet | 0.95 | 91.6 |
| Faeces (control diet) | 0.03 | 92.5 |
| Faeces (8.8% whalemeal diet) | 2.62 | 92.8 |

Table 2 shows the total mercury concentration of egg shells whites and yolks. The mercury concentration of the whites increased sharply for the first four weeks and then levelled off, except for the final seventh week sample, which was a sample of 3 eggs. The other weekly samples were a sample of at least 8 eggs. The mercury concentration of the whites was approximately four times the mercury concentration of the yolks and approximately three times the mercury concentration of the shells. The membrane had not been removed from the shells.

TABLE 2.

Total mercury concentration in egg shells, whites and yolks (on fresh basis).

| Diet | Weeks | Number of eggs | Total mercury (p.p.m.) Whites | Yolks | Shells |
|---|---|---|---|---|---|
| Control | 5 | 8 | <0.01 | <0.01 | <0.01 |
| 8.8% Whalemeal | 1 | 17 | 0.05 | 0.03 | 0.02 |
| " | 2 | 13 | 0.16 | 0.09 | 0.03 |
| " | 3 | 17 | 0.24 | 0.07 | 0.06 |
| " | 4 | 9 | 0.30 | 0.05 | 0.12 |
| " | 5 | 10 | 0.26 | 0.04 | 0.08 |
| " | 6 | 12 | 0.24 | 0.06 | 0.11 |
| " | 7 | 3 | 0.35 | 0.08 | 0.11 |

TABLE 3.

Total mercury concentration in separate fractions of slaughtered individual birds. (on fresh basis).

| Diet | Total Mercury (p.p.m.) Flesh | Bones | Offal | Feathers |
|---|---|---|---|---|
| Controls (2 birds) | <0.01 | <0.01 | <0.01 | <0.01 |
| 8.8% Whalemeal | 0.10 | 0.05 | 0.13 | 0.70 |
| " | 0.12 | 0.14 | 0.14 | 0.68 |
| " | 0.15) | Breast flesh samples only taken | | |
| " | 0.10) | | | |
| " | 0.18) | | | |

The mercury concentration of separate fractions of slaughtered individual birds is given in Table 3, which shows that mercury had accumulated in the flesh, bones, offal and feathers of birds fed the diet containing whalemeal. The feathers had the highest mercury concentration. The mercury concentration of the flesh samples was in the range 0.10 to 0.18 p.p.m. The results of duplicate determinations of mercury concentration of flesh sampled agreed within 10%. The mercury concentration of each bone sample was the average of the result of three determinations.

TABLE 4.

Results of production traits during the trial

| | Control diet | Whalemeal diet |
|---|---|---|
| Hen day production (eggs per bird) | 15.3 | 15.7 |
| Feed intake (kg per bird) | 4.48 | 4.76 |
| Average egg weight (g per bird) | 64.92 | 63.24 |

Egg production, feed intake and egg weights were essentially similar for birds on either diet (TABLE 4).

MINCHINTON et al (1973) reported an apparent digestibility of dry matter of 66.6 per cent for a diet similar to those used in this experiment. Based on this digestibility, we calculate a retention of 10 per cent of the mercury ingested and 90 per cent excretion in the faeces.

Neither metallic mercury nor inorganic mercury were detected in the control diet, whalemeal diet, faeces (control diet) or faeces (whalemeal diet). All the mercury was assumed to be present as organic mercury. WESTOO (1967) showed that most, if not all, mercury found in Swedish fish was present as methyl mercury.

Swedish workers, BERGLUND et al (1971), estimated that the effects of poisoning were detectable when 30 mg of mercury was contained in human tissue, assuming a body weight of 70 kg.

BAKIR et al (1973) in a comprehensive study of the incidence of poisoning of humans by methyl mercury compounds, found, in agreement with previous work, that the effects of poisoning were detectable when mercury had accumulated in the bodies of individuals, with an assumed body weight of 51 kg, to levels between 25 and 40 mg.

The percentage of bone in a dressed bird was found to be 11.5 and the percentage of shell in 17 eggs was found to be 11.2.

Assuming a person consumed weekly, one dressed bird (1 kg) containing 0.18 p.p.m. mercury and 14 eggs containing 0.2 p.p.m. mercury, the total mercury intake over an 18 month period could be 25 mg.

Assuming that mercury exists principally as the methyl derivative in these products, and using the relationship between exposure and organ concentration from BERGLUND et al (1971), a daily intake of 0.05 mg per day, based on these figures, could contribute a body burden of 5 mg of mercury. This represents a significant fraction of the threshold body burden and it is obviously not desirable to take in this amount of mercury from poultry products. Also, a person may eat fish regularly, which could add to the mercury intake.

However, eggs and egg pulp from the market in Victoria have been analysed and found to have a total mercury concentration of less than 0.01 p.p.m. This indicates that the current use of whalemeal in the poultry foods does not significantly add to the mercury intake of the population.

This work demonstrates the inadvisability of using whalemeal containing significant mercury content as a principle protein component of poultry feeds. Unpublished data on pig feeding trials indicates that low level incorporation of whalemeal leads to correspondingly low levels of mercury in flesh. The effect of low incorporation of whalemeal in poultry diets, on mercury levels in poultry flesh and eggs, has not been studied but it is reasonable to assume a similar situation.

From calculation, a 2% addition of whalemeal to broiler diets or 1% addition to layer diets would be the maximum rate which would provide that level of mercury in flesh and eggs which would not exceed a maximum residue level of 0.03 p.p.m. However, this may involve uneconomic additions of a particular protein supplement and control would be very difficult.

It has been demonstrated by Fox (1) that treatment of macerated shark tissue with acidified isopropanol substantially reduced the mercury level. This work was on a laboratory scale and was subsequently confirmed by REGIER (1972) with swordfish. It is possible that this technique could have application to whalemeal but the economics of the process have not been investigated.

For the time being, whalemeal or other fish meal concentrates which contain mercury and are incorporated in animal foods, should be used with caution.


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