

The effect of water-borne fluoride on the egg production of laying hens

Christél B Coetzee*, NH Casey and JA Meyer

Department of Animal and Wildlife Sciences, Faculty of Biological and Agricultural Sciences, University of Pretoria, South Africa

Abstract

One thousand Silver Grey Hyline hens were given drinking water containing 6, 10, 14 and 20 mg/l sodium fluoride during their laying period. The control group received municipal water (containing 0.29 mg/l fluoride) with no added sodium fluoride (0 mg/l).

Fluoride addition to the water had a significant effect ($P = 0.0001$) on egg production, but eggshell breaking strength was not significantly influenced.

At the termination of the study (74 weeks of age) the carcass mass and the fluoride content of the *os femur* showed a significant increase ($P = 0.0001$) which correlated with the increase in fluoride concentration in the water.

No important microscopic changes in the livers and kidneys were noticed, and liver mass and breaking strength of the *os femur* were unaffected by the amount of fluoride consumed.

The data showed a significant drop in egg production at 6 and 20 mg/l sodium fluoride.

Introduction

A literature and water-source survey in South Africa by Casey et al. (1994), indicated that exposure time, production system, ingestion rates and species tolerance are important factors which need to be taken into account when formulating water quality guidelines for livestock. Fluoride was found to be the constituent with the highest potential to produce toxic effects in animals in South Africa. The highest fluoride concentration in the water-sources surveyed was approximately 20 mg/l (Meyer et al., 1997), a concentration 10 times higher than that considered acceptable (Kempster et al., 1985). The toxicities of different forms of fluoride have been shown to be in the following descending order of severity: fluorosilicates, sodium fluoride, rock phosphate and calcium fluoride (Haman et al., 1936).

It is known that various physiological aberrations occur in poultry following the ingestion of fluorides over an extended period of time. As reported by Halpin and Lamb (1932), egg production was not affected by dietary concentrations of rock phosphate containing fluoride at 10 or 20 g/kg. However, at concentrations of 30 g/kg egg production decreased. At these concentrations the rock phosphate supplied the diets with approximately 0.35, 0.70 and 1.05 g/kg of fluoride respectively.

The occurrence of bone fragility in caged layers is a major problem in the modern poultry industry. Merkley (1981) found that fluoride treatment increased the breaking strength of humeri from 6.86 to 13.35 kg and that of tibiae from 6.61 to 13.10 kg and recommended fluoride supplementation of the water of up to 100 mg/l. Egg quality and rate of production were not reduced by fluoride treatment. Huyghebaert and De Groot (1988), however, disputed Merkley's findings and recommended the discontinuation of dietary fluoride supplementation to improve bone strength. These contradictions together with the need for water-quality guidelines for livestock in Southern Africa, were the main reasons

for establishing the fluoride tolerance of laying hens over their production cycle.

Previous studies on the effect of sodium fluoride on egg production and bone strength of caged laying hens (Van Toledo and Combs, 1984), were done by dietary means and used much higher concentrations of dietary sodium fluoride (0; 0.3; 0.6; 0.9 and 1.2 g/kg). In this experiment fluoride additions much closer to the natural fluoride content of South Africa's groundwater sources were used. The objective of this study was to determine the long-term effects of 5 different concentrations of sodium fluoride, in the drinking water, on the egg production of caged laying hens.

Materials and methods

Treatments

Sodium fluoride was provided in the drinking water to 1 000 day-old Silver Grey Hyline laying hens over their production period. The trial comprised 5 inclusion rates of sodium fluoride (0, 6, 10, 14 and 20 mg/l) with 4 replicates of 50 birds per group. The water was obtained from Pretoria's municipal source and the negative control (0 mg/l added sodium fluoride) contained 0.29 mg/l fluoride. Sodium fluoride was dissolved in the water to attain the treatment concentrations.

Laying phase (18 - 74 weeks of age)

The flock was kept in a convection battery with laying cages where they were caged individually. A system measuring the precise water intakes of the birds was designed and installed. The system comprised calibrated perspex cylinders attached to the main water line, drainage taps at the bottom of each cylinder and removable lids for easy administration of chemicals. Water intake (water intake/replicate-d) and egg production (eggs/hen-d) was determined daily; production figures were later recalculated in terms of eggs/group-week. From peak production, the shell breaking strengths of a randomly selected sample of eggs ($n = 20$) were determined over a 20-week period (from Week 50 to Week 70).

* To whom all correspondence should be addressed.

☎ (012) 669-0219; fax(012) 669-0219; e-mail christel@intekom.co.za
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