The Effect of Age on Water Metabolism in Hens[1] (37362)

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Prior to 1967, metabolic water studies in the domestic chicken were confined to direct measurements of water intake and loss (1, 2).

Chapman and Black, (3), using tritium, determined the turnover of body water in 14-month-old chickens and found the half-life of the body water pool of hens to be shorter than that of roosters. They also indicated that the size of the body water pool as a percent of the body weight did not differ between the sexes.

Considering that changes in body water metabolism are age-dependent in mammals (4), it seemed appropriate to investigate this aspect in two age groups of hens as determined by the disappearance from blood of tracer amounts of intravenously and orally administered tritiated water.

Materials and Methods. Seven-year-old single comb White Leghorn Kimber hens and five-month-old ArborAcre X Indian River pullets were used. Breed and body weight differences between the groups were considered to have no effect on this comparison as indicated by Chapman and Mihai in 1972 (5). Ten hens from the 7-year-old age group and six 5-month-old pullets were housed in wire bottom cages, three birds per cage, at 23 ± 2°. Humidity was not controlled. Feed and water were provided *ad libitum,* the pullets receiving grower and the hens layer rations. A three-day period for acclimatization was allowed before starting the experiment.

The pullets were injected intravenously with 88.09 μCi of tritiated water in 3-ml doses, using either the right or left brachial vein. The hens received 85.72 μCi of tritriated water (3-ml doses), by lavage into the crop. Serial blood samples (3 ml) were collected from the brachial veins of all birds 24 hr after treatment. This period of time was considered sufficient to attain equilibration of the tritiated water in all body water compartments, which, according to Novak (4) takes place within 6 hr in the mammal, regardless of the route of administration.

Blood was collected at 24-hr intervals for 6 days for the pullets and for 5 days for the hens. Immediately after collection blood proteins were precipitated with 200 mg of dry trichloroacetic acid (TCA). The samples were kept at room temperature throughout collection, and the protein-free supernatant was removed by centrifugation for 15 min at 17,500*g*. Duplicate 0.5-ml portions of the supernatant were transferred to vials containing 10 ml of "Aquasol" liquid scintillation fluid (New England Nuclear), and counted for 10 min in a Beckman 200 liquid scintillation counter (Beckman Instruments, Inc.). Base counting efficiency and quantification of the injected isotope were established with a primary tritiated toluene standard (New England Nuclear). A quench curve was prepared using known amounts of tritiated water added to varying ratios of blood and TCA. Counting efficiency ranged 30–36%. Radioactivity in the samples was converted to microcuries of tritium per unit volume. Regression curves were obtained by correlation–regression analyses and the various comparisons between mean values were established by unpaired Student's *t* tests.

Results and Discussion. It was apparent that the concentration of tritium in body water decreased exponentially with time, in-

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TABLE I. Body Water Kinetics in Two Age Groups of Hens.

Parameters measured	7-year-old hens[a] (10)[b]	5-month-old pullets[a] (6)[b]	Significance of comparsion
Body weight (kg)	2.15 ± 0.12	2.68 ± 0.07	$p < 0.01$
Body water (% body weight)	57.28 ± 2.66	75.62 ± 2.05	$p < 0.01$
^{3}H-water half-life (hr)	197.7 ± 19.9	145.2 ± 9.7	$p < 0.05$
Body water flux (ml/hr/kg)	2.18 ± 0.20	3.66 ± 0.17	$p < 0.01$
Body water flux (ml/hr/liter pool)	3.79 ± 0.31	4.87 ± 0.29	$p < 0.05$

[a] Values expressed as mean ± standard error.
[b] Number of birds per age group.

dividual values closely fitting the calculated regression lines (correlation coefficients > 0.90). The kinetic parameters, listed in Table I, were derived as described by Chapman and Black (3).

The half-life of tritiated body water was significantly longer ($p < 0.05$) in the hens than in the pullets. Our values for half-life were higher than those reported by Chapman and Black (3) in 14-month-old hens and comparable to the values they indicated for cocks of the same age. If one uses the relationship between water turnover and body weight established by Richmond *et al.* (6), then the half-life values we found are comparable to those reported for dogs and horses rather than for cattle and rats as Chapman and Black (3) had previously suggested.

The differences in the half-life of body water between the two age groups can not be explained in terms of egg production since the hens, still producing a small number of eggs, turned over water at a slower rate than the pullets which had not yet reached the egg-laying stage. It appears more reasonable to suggest that the differences in water turnover are due to a higher utilization of water for anabolic purposes by the younger birds. Since the pullets were significantly heavier ($p < 0.01$) than the hens, it was necessary to express turnover rates as ml/hr/kg of body weight. Under these conditions the younger birds showed a twofold significant increase ($p < 0.01$) in the rate of body water flux per unit weight. On the basis of ml/hr/liter of body water pool, the pullets also turned over water at a significantly higher rate ($p < 0.05$) than the hens.

The longer half-life of the body water in the older hens apparently reflects the extent of the decrease in the rate of metabolic functions with age as previously suggested by Novak (4), who found a steady decrease in basal oxygen consumption with age in human females.

Total body water, expressed as percent of body weight, was significantly higher ($p < 0.01$) for the pullets than the hens. These results are consistent with those found in chickens by other workers (2, 7) showing a gradual decline in body water content with aging. The lower water content of the hens may be due to their greater fat mass as compared to the pullets, since the percent water content in fat is lower than that in muscle (8). This fact was apparent in our study upon simple inspection of the birds after death, and is supported by the work of Novak (4) who reported a significant decrease in total body water with age in human females as a result of a replacement of functional, lean body tissue by fatty tissue. It appears then, that the progressive loss of the functional cellular mass as a result of the significant decrease in intra- and extracellular body water with age, is primarily responsible for the water kinetic changes observed in this study.

Summary. Kinetic parameters associated with the body water pool were studied in hens of two age brackets by Isotope Dilution Techniques using tritium-labeled water.

The half-life of body water was found to be significantly longer ($p < 0.05$) in hens than in pullets. It is probable that the difference is due to an increased utilization of body water by the younger birds for their greater anabolic demands.

Total body water, expressed as percent of body weight, was significantly higher ($p < 0.01$) in the pullets than in the hens. The lower water content of the hens appears to be due to a decrease in intra- and extracellular body water with age as previously suggested for mammals. Additionally, the greater fat mass of the older birds may be contributing to the results observed.

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