SECTION III—Nutrition

Experimental Gout in Turkeys*

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The major portion of the uric acid excreted by birds is derived from the conversion of urea in ordinary protein metabolism. Administration of urea increases the excretion of uric acid by normal birds. Minkowski demonstrated that the synthesis of uric acid from urea occurred in the livers of birds since such synthesis did not occur if birds were hepatectomized. Von Mach (2), after repeating these experiments, pointed out that uric acid did not entirely disappear from the urine of hepatectomized birds owing to the two sources of uric acid in these animals, one by synthesis from urea, which process occurs only in the liver, and the other from the purine bases liberated by nuclear metabolism throughout the body; the latter is independent of the action of the liver.

Urea is not converted to uric acid by animals other than birds and reptiles. Other animals, including man, possess a mechanism for the destruction of uric acid which varies in efficiency in the various species. The liver is also responsible for the destruction of uric acid (3). The normal dog excretes only traces of uric acid, but after removal of the liver large amounts of uric acid are found in the urine and no evidence of destruction of uric acid can be demonstrated. Because of the ability of animals to destroy uric acid this substance does not increase beyond a certain level in the blood of animals with complete urinary retention.

Urinary retention by birds produces a rapid, marked increase in the uric acid content of the blood and little elevation of the concentration of blood urea. Uremia is indicated by high levels of uric acid in the blood; values from 150 to 400 mg. per cent have been obtained (4). Under these circumstances there occurs a deposition of white, crystalline urates on all of the visceral surfaces and on the fascia of the muscles; deposits are also found on the articular surfaces of the joints (5, 6). The term “visceral gout” often has been applied to this condition and probably has led to some confusion in the literature. Until there is proof that uremia and tophaceous gout of birds are similar conditions we feel that the term “gout” should be reserved for the condition characterized by definite tophi.

Spontaneous avian gout is not infrequent among captive birds of zoological gardens. According to Fox (7), it occurs most often among parrots, gallinaceous and accipitrine birds, and herons. It has also been reported to have occurred among domestic birds such as the chicken, duck, goose and turkey. Kaupp (8) observed gout in a flock of capons. Kionka (9) experimentally produced gout in hens which he maintained exclusively on a diet of fat-free horse flesh. Gout became apparent in periods of from three to fifteen months. The symptoms and physical characteristics of this disease were similar to those of spontaneously occurring gout.

METHODS

One set of experiments was begun January 10, 1934, with eighteen turkeys which were at that time seven months old. They were placed, two each, in nine pens. Four pens were small cages measuring 26 by 26 inches, within an unheated building, and the remaining five pens were outside runs affording ample opportunity for exercise and a slightly greater range of temperature. Five combinations of diet were fed to these turkeys. The birds in outside pens and inside cages, which received identical paired diets, had free access to their food at all times. All turkeys received a basic diet of a commercial turkey mash containing wheat bran, middlings, yellow corn meal, meat and bone scraps, ground barley, soybean meal, dried buttermilk and cod liver oil. This diet contained 20 per cent protein, 4 per cent fat and 45 per cent carbohydrate. The five diets used were as follows: (1) the turkey mash without any additions, (2) turkey mash mixed with equal quantities of ground raw horse flesh, (3) turkey mash mixed with 5 per cent of crystalline urea, (4) turkey mash with a few leaves of fresh green spinach, and (5) turkey mash and cracker meal in equal quantities. Two birds were changed to diet 2 after having had diet 1 for eighteen weeks, and one bird was changed to diet 1 after having had diet 3 for twenty-six weeks.

All turkeys were weighed at approximately the same hour each week. At this time we also procured 1 c.c. of blood from the wing vein of each turkey. Determinations of the blood uric acid were made after proper dilutions, by the method of Folin (10).

On October 2, 1934, twenty other turkeys were placed in outside runs and given a diet composed of equal parts of turkey mash and ground raw horse meat. Four birds of the twenty were given intramuscular injections, three times each week, of 1 c.c. of a solution of uranium acetate containing 25 mg. of uranium. Four other birds of the twenty similarly received injections of solution of lead acetate containing 10 mg. of lead. Still four other birds of the twenty were fed cinchophen mixed with the food so...
that each turkey of the four received approximately 1 gm.
of cinchophen each day.

Necropsy was performed on each of the thirty-eight
birds; some died during the course of the experiments,
but most survived the entire period. No pathologic changes
were found in the visceral organs of any birds except those
found associated with enterohepatitis. The lesions that
were considered as gout consisted of tophaceous nodules
about the feet, knees, or wings, and the depositions of
chalky white material in the articular surfaces of the
joints of the extremities. In examination of most of the
gouty birds all of these changes were found, but in ex-
amination of a few the joints of the feet only were in-
volved. Microscopic examination of the material from the
gouty tophi revealed numerous needle-like crystals.

| Table I |

Effect of diet on blood uric acid

<table>
<thead>
<tr>
<th>Additions to turkey mash diet</th>
<th>Bird</th>
<th>Location</th>
<th>Blood uric acid, milligrams per cent</th>
<th>Duration, weeks</th>
<th>Tophaceous gout</th>
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<tr>
<td></td>
<td></td>
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<td>Average</td>
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<td>Low</td>
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<td>8.9</td>
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</tr>
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<td>3.3</td>
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<td>6.9</td>
<td>14.2</td>
<td>4.1</td>
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</tr>
<tr>
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<tr>
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The results of these experiments were summarized
in Tables I and II from which most of the pertinent
data can be ascertained. Comparisons of the values
for the blood uric acid of the birds as determined in
the different weeks disclosed variations such as are indi-
cated in Tables I and II. However, many of the low
values for uric acid, determined on the blood of birds
in which the concentration of uric acid usually was
found to be high, were obtained at times when the
animals were sick. Some turkeys had enterohepatitis
and others were not disposed to eat well at times when
gouty tophi were actively developing.

The effect of feeding and of fasting on the blood
uric acid of birds which did not have gout (Table III)
indicates that the blood uric acid rises after a meal
and that the amount of the rise is dependent on the
nature of the diet. Much greater rises were obtained
when diets contained an increased amount of protein
or of urea. If the animal was then fasted, the blood
uric acid decreased rapidly so that low values were ob-
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twenty-four hours there appeared to be a slight rise in
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were observed in animals with gouty tophi both in the
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