phosphorus turnover more closely resembling neoplastic than normal tissue. Further studies concerning the biochemical changes mentioned are in progress.

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Effect of Bile Acids on Serum Cholesterol in the Chick.*† (26741)

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Recently Beher *et al.*(1) and Howe *et al.* (2) have reported that several bile acids (hyodeoxycholic acid, chenodeoxycholic acid and lithocholic acid) counteract the hypercholesterolemic effect of cholic acid in mice and prevent cholesterol accumulation in the liver and carcass. Portman and Bruno(3) have reported similar findings with rats. Experimental work on the effect of cholic acid or any other bile acids on serum cholesterol levels in chickens has not been carried out. Since the chicken is known to secrete quite different bile acids than the mouse and rat, it was desirable to investigate the effect of feeding various bile acids on serum cholesterol in chickens.

Experimental. The experiment was conducted with day-old cross-bred cockerel chicks (Cornish male X White Plymouth Rock female) obtained from a local hatchery. They were housed in electrically heated batteries with wire floors and were supplied feed and water *ad libitum*. They received the experimental diets for 3 weeks and were weighed at weekly intervals during this period. At termination of the growth phase of the experiment, blood samples were obtained by heart puncture and the serum separated for total cholesterol determination by the method of Schoenheimer and Sperry(4). The cholic acid, lithocholic acid and hyodeoxycholic acid used in the experiment were obtained from Nutritional Biochemicals Corp. These bile acids were added to the diet at the 0.2% level singularly and combinations of cholic and lithocholic acids, and cholic and hyodeoxycholic acids. The basal diet used was similar to that used in earlier work(4), modified to contain 4.0% corn oil. All substitutions in the diet were made at the expense of fiber.

Three groups of 8 chicks each were started on each of the dietary treatments. The results were analyzed for statistical differences by the Multiple Range Test(5).

Results. The effect of feeding the various bile acids on growth and serum cholesterol is shown in Table I. Addition of lithocholic acid to the basal diet caused a marked depression in growth rate. When cholic acid was added to the diet containing lithocholic acid this retardation in growth rate was reversed. Addition of cholic acid, hyodeoxycholic acid or a combination of these 2 bile acids to the basal diet had no statistically significant effect on growth rate of cockerels. However, it should be noted that rate of growth was faster when both hyodeoxycholic acid and the combination of hyodeoxycholic acid and cholic acid were added to the basal diet.

While lithocholic acid depressed growth, it caused an approximately 3-fold increase in serum cholesterol level of the cockerels. Addition of cholic acid to the diet containing

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TABLE I. Effect of Bile Acids on Growth and Serum Cholesterol of Chicks.

Supplements to basal diet	Avg wt 3 wk, g	Cholesterol/100 ml of serum, mg
None	307 ± 7	178 ± 7
.2% cholic acid	298 ± 7	181 ± 7
" lithocholic acid	176 ± 8	575 ± 26
" hyodeoxycholic acid	319 ± 9	189 ± 9
" cholic acid + 2% lithocholic acid	294 ± 11	298 ± 15
" cholic acid + 2% hyodeoxycholic acid	330 ± 9	169 ± 7

Grouping of treatment results*

Body wt	176	294	298	307	319	330
Serum chol.	169	178	181	189	298	575

* Two values not underscored by the same line are significantly different ($P < .05$).

lithocholic acid appears to have caused a reduction in this hypercholesteremic condition. However, the serum cholesterol level was still approximately twice the normal value. Addition of cholic acid, hyodeoxycholic acid or a combination of the two did not affect serum cholesterol significantly as measured by the statistics applied. A small, non-significant drop in serum cholesterol was observed in chicks receiving the combination of cholic acid and hyodeoxycholic acid.

Discussion. The results indicate in light of other studies that striking species differences may be expected with respect to the effect on serum cholesterol when various bile acids are added to the diet. Howe *et al.*(2) found that lithocholic acid was very effective in lowering serum cholesterol in mice, while the results reported here with chickens are the reverse. It seems possible that this may be caused by differences in the type of bile acids excreted by the 2 species. Haslewood and Wootton(6) reported finding only cholic acid in the mouse (*Mus musculus*), while Japanese workers (reviewed by Anderson, Haslewood and Wootton(7)) have found a large array of bile acids in the domestic chicken. They are chenodeoxycholic acid, isolithocholic acid, tetrahydroxynorsterocholanic acid, 3 α-hydroxy-7-oxocholanic acid and 3-oxochola-4:6-dienic acid. No investigations have been conducted with the chick on production of bile acid artifacts by circulation of the original "native" bile salts through the enterohepatic circulation, or by intestinal micro-organisms. Therefore, it cannot be known exactly which of the above bile acids are "natural" to the domestic chicken. If regulation of bile acid production in the domestic fowl is a homeostatic process as indicated for the rat(8), it may be that lithocholic acid interferes with absorption of chenodeoxycholic acid or some other bile acid that plays a part in the homeostatic control in chicks, or the lithocholic acid itself may be absorbed and play a role in the homeostatic control in the chicken.

Portman and Bruno(9) have reported on the effects of feeding a number of bile salts to rats. They found that all the bile acids tested that had serum cholesterol-elevating activity contained a 12α-hydroxy grouping. Their results are in close agreement with those of Howe *et al.*(2) with respect to activity of various derivatives of cholic acid to raise the serum cholesterol of mice. It is obvious from the results presented in this paper that the theory that bile salts must have a 12α-hydroxy grouping to have serum cholesterol-elevating activity will not apply with the domestic chicken.

Summary. Addition of cholic acid to the diet of chicks does not cause a rise in serum cholesterol as has been reported in mice and rats. Addition of lithocholic acid to the chicken diets caused a marked increase in serum cholesterol. This effect is opposite to that reported to occur in mice and rats.

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