THYROIDAL CONTROL OF SERUM ALKALINE PHOSPHATASE LEVEL IN THE CHICKEN

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It has been reported that serum alkaline phosphatase level is extremely high in the young chicken but reaches a low level in the adult (Common, 1936; Tanabe and Wilcox, 1960a). Thyroid hormone secretion rate on the basis of unit body weight has been noted to be higher in the young chicken than in the adult (Schultz and Turner, 1945; Himeno et al., 1960). Recently, Tanabe and Wilcox (1960b) reported that the administration of thyroxine at high levels significantly increased serum alkaline phosphatase in the chicken. The present investigation was conducted to determine whether physiological modifications of thyroidal function would change serum alkaline phosphatase level in the chicken.

MATERIALS AND METHODS

Six- and 7-week-old White Leghorn cockerels were used. L-Thyroxine (Nutritional Biochemicals Corp., Cleveland) dissolved in alkaline solution was injected subcutaneously to 6-week-old cockerels weighing 400 g at daily doses of 24 μg and 48 μg for 4 days. Control birds were injected with the same amount of isotonic saline, pH of which was adjusted to that of thyroxine solution by adding a small amount of NaOH. Blood samples were taken by heart puncture immediately before the 1st treatment, 24 hrs. after and 8 days after the last treatment.

Thiouracil (Nutritional Biochemicals Corp., Cleveland), added to the standard ration at 0.2%, was fed for 14 days to 7-week-old cockerels weighing 600 g at this institute. Control birds were maintained on the standard ration. Blood was taken by heart puncture just before the start of thiouracil feeding, on the last day, and 6 days and 11 days after the cessation of the feeding.

Some birds fed with thiouracil and some with only standard ration were injected subcutaneously with L-thyroxine at a daily dose of 250 μg for 1st 5 days, and of 1,000 μg for the following 5 days, beginning from the 15th day of the experiment. Blood was taken on the 20th and 25th day of the experiment.

Alkaline phosphatase of the serum was determined by the method of Bessey et al. (1946). Serum was incubated with p-nitrophenyl phosphate, pH of which was adjusted to 10.3, for 30 mins. at 37°C. The unit of alkaline phosphatase activity was expressed as mM of nitrophenol liberated per liter of serum per hr. Duplicate analyses were made on each blood sample.

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RESULTS

Results with L-thyroxine are illustrated in Figure 1. The injection of a daily dose of 48 μg of L-thyroxine for 4 days caused a three fold increase in serum alkaline phosphatase, as compared with the value before the treatent. The injection of daily dose of 24 μg of L-thyroxine for 4 days increased the value twice compared with that before the treatment, while the injection of isotonic saline caused very little change in the value. In either case of treatment with thyroxine, the value decreased and returned to the pre-treatment level 6 days after the last treatment. The average units of alkaline phosphatase before the treatment, 24 hrs. after the end of 24 μg thyroxine-treatment and 24 hrs. after the end of 48 μg thyroxine-treatment were 20, 42 and 58, respectively. The increase in the value in the birds treated with 48 μg of L-thyroxine is statistically significant at 1% level, as compared with either the value before the treatment or that of control birds. The value in the birds treated with 24 μg of L-thyroxine is significantly different at 1% level from the pre-treatment value and different at 5% level from the value of control birds.

Results with thiouracil and thyroxine are shown in Figure 2. Thiouracil feeding for 14 days caused 50% decrease in serum alkaline phosphatase level, as compared with the value either before the treatment or of untreated control birds. Six days after the cessation of thiouracil feeding, the value of these birds in-
Fig. 2. Effects of thiouracil feeding and L-thyroxine injection on serum alkaline phosphatase of 7-week-old cockerels.
- Showing the average value of 5 birds fed thiouracil.
+++ Showing the average value of 5 birds treated with L-thyroxine.
--- Showing the average value of 5 untreated control birds

creased twice and returned to the pre-treatment level or that of the control. Thyroxine injection following the cessation of thiouracil feeding caused a tremendous increase in serum alkaline phosphatase, while thyroxine injection into untreated control birds also caused a statistically significant increase. The value in untreated control birds did not show any remarkable change during the experimental period.

DISCUSSION

Thyroid hormone secretion rate on the basis of 100 g of body weight is much higher in the young chicken than in the adult. L-Thyroxine secretion rate per day is estimated as 4 µg per 100 g of body weight in 6-week-old cockerels and as 0.8 µg per 100 g of body weight in the adult (Himeno et al. 1960). The present study demonstrated that the administration of daily dose of either 24 or 48 µg of L-thyroxine significantly increased serum alkaline phosphatase in 6-week-old cockerels weighing 400 g. This smaller dose is estimated as 150% of
the amount of endogenous thyroxine normally secreted from the bird's own thyroid. The previous works (Tanabe and Wilcox, 1960b; Takeuchi and Kono, 1958) as well as the present work showed that thiouracil feeding significantly decreased serum alkaline phosphatase in the chicken. These results indicate that serum alkaline phosphatase level is under the control of thyroid in the chicken, and the level can be modified by physiological changes in thyroid hormone secretion. The high level in serum alkaline phosphatase in the young chicken noted by Common (1936) and Tanabe and Wilcox (1960a) may be partly attributed to a high thyroidal activity, although another mechanism, e.g. an active bone formation, may also be involved. On the other hand, Tanabe and Wilcox (1960b) showed that mammalian growth hormone had no effect either on the growth or on the serum alkaline phosphatase level in the chicken, contrary to the observation by Li et al. (1947) in the rat.

SUMMARY

Effects of physiological modifications of thyroid function on serum alkaline phosphatase level in the chicken were studied. The administration of daily doses of 24 µg and 48 µg of L-thyroxine for 4 days into 6-week-old cockerels caused a significant (100–200%) increase in serum alkaline phosphatase level. Feeding of 0.2% thiouracil in diet for 14 days to 7-week-old cockerels significantly decreased (50%) serum alkaline phosphatase level. Serum alkaline phosphatase level seems to be controlled by thyroid function in the chicken.

REFERENCES