

STUDIES ON TRIMETHYLAMINE OXIDE

II. THE ORIGIN OF TRIMETHYLAMINE OXIDE IN YOUNG SALMON*

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Trimethylamine oxide has been found widely distributed in marine fish; however, its origin or its function in metabolism is not known. Hoppe-Seyler (1) found it in the muscle, blood, and urine of elasmobranchs along with high concentrations of urea and suggested that it played a rôle similar to that of urea. He considered it to be a weakly basic, non-toxic end-product of nitrogen metabolism which assisted in maintaining osmotic pressure and water balance. The fact that trimethylamine oxide is not found in the blood of marine teleost fish (2), in contrast to the relatively high concentration in the blood of elasmobranchs, may suggest a different function in metabolism.

Beatty (3) analyzed muscle extracts of eel (*Anguilla rostrata*) from individuals living in fresh water and also from those found in brackish water, and found appreciable quantities of trimethylamine oxide only in the latter.

The trimethylamine oxide content of the muscle tissue of fresh water fish has been found to be negative or very low. This is true also of the muscles of young salmon while they are still in fresh water. Adult salmon taken from salt water contain about 8 micromoles of trimethylamine oxide per gm. of tissue.

The greater amount of trimethylamine oxide in the muscle tissues of salmon in salt water might be of endogenous origin and associated with the change of osmotic requirements with environment, or might be derived from exogenous sources.

If the trimethylamine oxide is of endogenous origin, the transference of young salmon from fresh to salt water while they are maintained on a trimethylamine oxide-free diet should give rise to an increase of the base in the muscle tissue. In the following experiment such a test was carried out.

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EXPERIMENTAL

Twenty-five 1 year-old Chinook salmon (*Oncorhynchus tshawytscha*) were placed in two connected tanks, each of 40 liters capacity. The water was circulated by a small centrifugal pump which forced it through a sand filter, and was aerated constantly.

The temperature of the water was maintained at about 10° by means of cooling coils.

The water was changed from fresh water to the salinity of sea water in a stepwise manner, the volume fraction of salt water being increased by one-eighth about every 5 days. At each change of salinity the tanks were

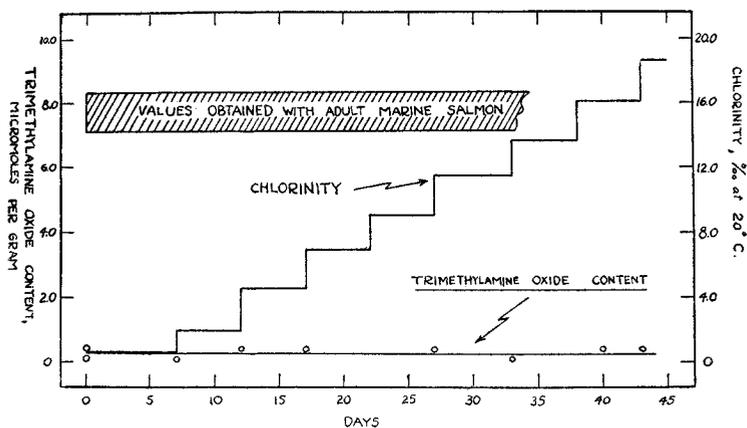


FIG. 1. Trimethylamine oxide concentration in young salmon and the chlorinity of the environmental water during the transition from fresh to sea water. The shaded bar represents values of trimethylamine oxide concentration in muscle tissue of adult Chinook salmon caught in salt water.

thoroughly cleaned. When the salinity was equal to that of sea water, the fish were transferred to an aquarium with circulating salt water maintained at approximately 10°. The salinity of the water was determined at each step by the Mohr method for total halide. During this period, the diet of the fish consisted of ground fresh beef liver.

Specimens taken periodically for analysis were killed and the heads, viscera, and tails removed. The carcasses were ground and analyzed in the manner described previously (2).

Results

The variation of the trimethylamine oxide content of the fish carcasses plotted against time, and the change in the concurrent chlorinity of the environmental water plotted against time, are given in Fig. 1.

After the fish had been in sea water for 8 days, they were divided into two groups and placed in separate tanks. One group was continued on the liver diet, and the other was fed a diet which consisted of 50 per cent liver and 50 per cent of some trimethylamine oxide-containing material (salmon meal for 1 week, then ground *Pecten hericius* muscle tissue). At weekly intervals a fish was removed from each tank and analyzed for trimethylamine oxide content. Results are given in Fig. 2.

Throughout the experimental period the fish appeared to be in excellent condition.

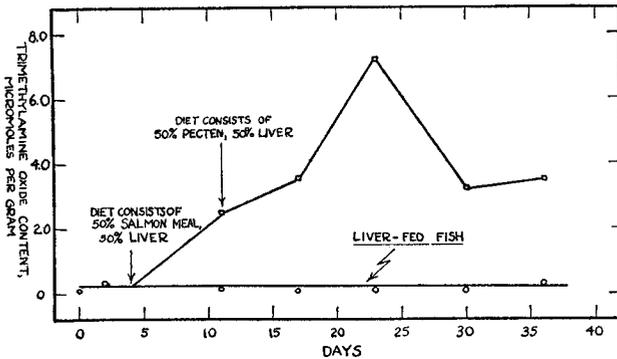


Fig. 2. Trimethylamine oxide concentration in young salmon on different diets

DISCUSSION

During the period of increasing salinity there was no significant variation in trimethylamine oxide content of the young salmon on the liver diet; even after they had been in sea water for 5 weeks they showed no increase. It is assumed that there would not have been an increase over a longer experimental period, but the results show that an increase in the trimethylamine oxide of the tissues over that present while the fish are in fresh water is not necessary for normal activity of young Chinook salmon either encountering or in salt water.

On the other hand, when the young salmon were fed trimethylamine oxide-containing material, there was a rapid accumulation of the compound in the muscle tissue. The concentration in the tissues attained that present in the normal marine adults after 3 weeks on the diet.

These results strongly suggest that, at least in the case of salmon, the occurrence of trimethylamine oxide in large amounts in the muscle tissue is due to the accumulation of ingested trimethylamine oxide, rather than to an endogenous metabolic function.

The reason for the decline in trimethylamine oxide content after the 3rd week on the trimethylamine oxide-supplemented diet (Fig. 2) probably lies

in the feeding habits of salmon. Isolated salmon will eat but little if at all. The last two fish on the trimethylamine oxide-containing diet did not feed well.

SUMMARY

When the environment of young Chinook salmon was changed from fresh to sea water while the fish were on a trimethylamine oxide-free diet, there was no significant change in the trimethylamine oxide concentration in their muscle tissues.

When young Chinook salmon in salt water were fed a diet which contained trimethylamine oxide, some of the compound was retained in their tissues.

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