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The Carotenoids in Tropical Marine Yellow Fish

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Abstract

The carotenoids were isolated from eleven species of tropical marine yellow fish. The main carotenoids isolated were tunaxanthin, lutein, cryptoxanthin, and zeaxanthin, and a high correlation was confirmed between the contents of lutein and tunaxanthin.

The carotenoids in tuna fish and mackerel were investigated and the main carotenoid was isolated as tunaxanthin by Hirao et al.[1]. Crozier[2] determined the structure of tunaxanthin to be 3, 3′-dihydroxy-ε-carotene by partition coefficient. Tunaxanthin was believed to be the main carotenoid in marine yellow fish. In the previous paper[3], a tunaxanthin-like carotenoid was isolated from Kiwada, *Neothunnus albacra*, and its structure was considered to be 3-hydroxy-ε-carotene (neothxanthin) by the absorption spectra and partition coefficient. It was proposed that 3-hydroxy-ε-carotene (neothxanthin) could be the intermediate in the bioconversion of ε-carotene to tunaxanthin.

The present investigation was undertaken to determine the main carotenoid in tropical marine yellow fish.

Materials and Methods

Fresh samples of eleven tropical yellow fish were obtained from Kagoshima Marine Park and Nagashima Marine Laboratory for Fisheries Sciences of our university. The yellow sections of the integuments were collected and extracted repeatedly with acetone until the residues became colorless. The combined extracts were transferred to petroleum ether by the addition of water, and then washed with water until free of acetone. The petroleum ether solution of the pigments was concentrated under vacuum to an oil. The pigments were dissolved in 20 ml of absolute ethanol, and 2 ml of 60% aqueous potassium hydroxide (W/V) solution was added[4]. The alkaline mixture was left overnight in the dark at room temperature. After saponification, the pigments were transferred to petroleum ether by the addition of water. The saponified pig-

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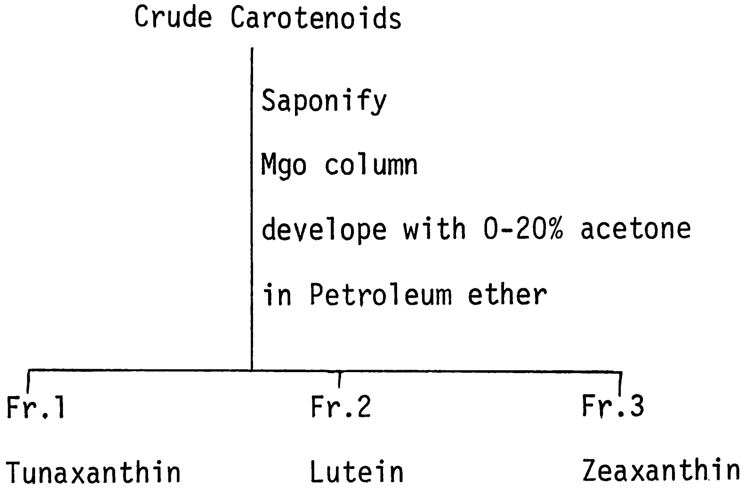


Fig. 1. Isolation of Zeaxanthin, Lutein and Tunaxanthin from *Forcipiger flavissimus*.

ments were concentrated under vacuum and dried over anhydrous sodium sulfate. The pigments were then dissolved in approximately 10 ml of petroleum ether for chromatography on magnesium oxide. The purification procedure is shown in Fig. 1. The carotenoids were characterized by their absorption spectra, behaviour on the column, and co-chromatography with authentic samples.

Results and Discussion

The relative abundances of the carotenoids obtained from eleven tropical marine yellow fish are shown in Table 1. Tunaxanthin, lutein, zeaxanthin, or cryptoxanthin was found to be the main carotenoid, depending on the species. Tunaxanthin was the main carotenoid in *Forcipiger flavissimus*, *Hemitaurichthys polylepis*, *Zanclus cornutus*, *Chaetodon auriga*, and *Paracanthurus hepatus*. Lutein was the main carotenoid in *Forcipiger flavissimus*, *Chaetodon auriga*, *Chaetodon kleini*, *Megaprotodon trifascialis*, and *Zebrasoma veliferum*. Cryptoxanthin was the predominant carotenoid in *Chaetodon trifasciatus* and *C. kleini*, and zeaxanthin was predominant in *Hemitaurichthys polylepis* and *Zebrasoma veliferum*. Amongst lutein, zeaxanthin, cryptoxanthin, and tunaxanthin, tunaxanthin is the only carotenoid not contained in terrestrial plants or animals, but is found in marine fish. The origin of tunaxanthin has not yet been elucidated. Amongst the eleven species of marine yellow fish, seven species contained tunaxanthin and in considerable amount. Lutein and zeaxanthin are also widely distributed, and there is a high correlation between the amounts of tunaxanthin and lutein. An increase in the proportion of lutein was always accompanied by a decrease in tunaxanthin.

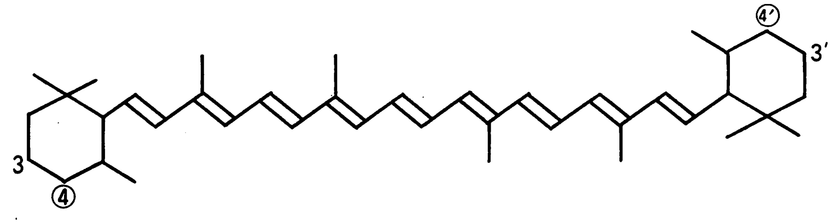
In the previous papers5)~9), the authors indicated that aquatic animals could be

Table 1. Relative abundances of carotenoid in the eleven species of marine fish.

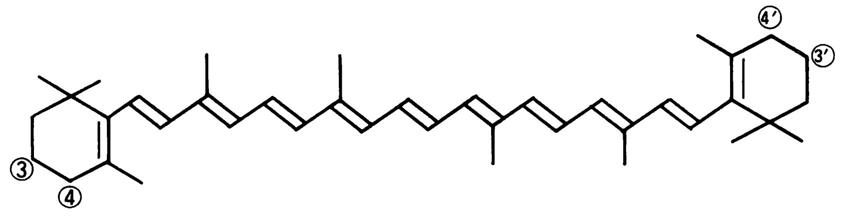
Carotenoids	Relative abundances (%)										
	Forcipiger flavissimus	*Hemitaurichthys polylepis*	*Zanclus cornutus*	*Chaetobon auriga*	*C. trifasciatus*	*C. unimaculatus*	*C. kleini*	*Megaprotodon trifsacialis*	*Holacanthus trifascialis*	*Zebrasoma veliferum*	*Paracanthurus hepatus*
Tunaxanthin	76	33	92	—	—	55	—	93	—	21	100
Neothxanthin	—	—	—	—	—	45	—	—	—	3	—
Zeaxanthin	4	40	8	16	19	—	22	—	—	29	—
Lutein	20	10	—	63	—	—	32	37	44	2	—
α-Cryptoxanthin	—	11	—	21	9	—	10	—	26	4	—
Cryptoxanthin	—	—	—	—	49	—	36	—	—	—	—
Unknown	—	6	—	—	23	—	—	4	—	1	—

divided into three groups on the basis of astaxanthin biosynthesis, as given below.

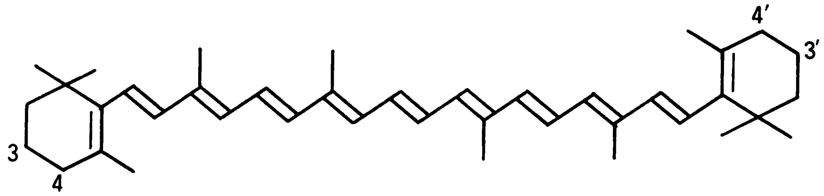
Group I. Can oxidize the 4 and 4′ positions of the β-ionone rings of the carotenoids. Goldfish, red carp, and fancy red carp belong to this group.



Group II. Can oxdize the 4 and 4′ positions and 3 and 3′ positions of the β-ionone rings of the carotenoids. Prawn, and crab belong to this group.



Goup III. Cannot oxidize the 3 and 3′ or the 4 and 4′ positions of the β-ionone rings of the carotenoids, but they can selectively deposit the carotenoids in the diet without modification. Madai, chidai, rainbow trout, and salmon belong to this group.



As the tropical marine yellow fish of this study did not contain astaxanthin, these yellow fish must have a different metabolic pathway from those mentioned above.

The existence of tunaxanthin was confirmed in prawn, *Penaeus japonicus*(10) and koraiebi, *Penaeus orientalis*(10), besides marine fish, and as marine yellow fish may consume these, the origin of tunaxanthin might be dietary. In this study, the probable intermediate from ε-carotene to tunaxanthin, neothxanthin, was found in some yellow marine fish, and they may be able to biosynthesize tunaxanthin from neothxanthin. Also, there was high correlation between the amounts of tunaxanthin and lutein, and a third possibility of conversion of lutein to tunaxanthin arises. This problem of the metabolic pathway should be resolved in the future.

Acknowledments

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