FURTHER STUDIES ON CHANGES IN PROTEIN FRACTIONS OF FISH MUSCLE DURING STORAGE IN ICE

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The changes in the major protein nitrogen fractions of two commercially important fishes of Indian waters, *viz.*, mackerel (*Rastrelliger kanagurta*) and lactarius (*Lactarius lactarius*), during storage in ice are reported. The significance of the findings is discussed in comparison with the results of a similar study on two species of marine prawns and oil sardine, reported earlier.

INTRODUCTION

Compared to the volume of work reported on the changes of meat proteins during storage under different conditions, very little information is available on the changes in protein fractions of fish muscle during storage. This becomes all the more significant in view of Connell's (1961) observation that proteins of fish do not necessarily behave like avian or mammalian muscle proteins.

Japanese workers have made some significant contributions in this field. Post-mortem changes in proteins of ice stored horse mackerel have been followed by Maruyama and Suzuki (1968). Shiro Konogaya, Masamichi Bito and Keishi Amano (1970) fractionated the proteins of the jellified meat of tuna. Masayuki Kochi and Shitoku Era (1959) studied the chemical composition of meat proteins of the yellowfin tuna. The 'gel components' in fish muscle has been subjected to a detailed study by Shigeru Umemoto and Koichy Kanna (1971). Kumitsugu Kitabayashi and Sengi Ishikawa (1964) studied the composition of acid soluble proteins of squid muscle.

Apart from the Japanese workers, Awad, Powrie and Fennema (1969) have reported the deteriorative changes in fresh water white fish muscle during frozen storage.

In India, Moorjani, *et al.*, (1962) and

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Baliga, Moorjani and Lahiri (1962, 1962a, 1969), have attempted to follow the changes in muscle proteins of fresh water fishes during ice storage. Sawant and Magar (1961), Shenoy and Pillai (1971) and, Shenoy and James (1972) followed the course of protein denaturation in frozen fish. Govindan (1962) reported results of some investigations on the protein fractions in ice stored prawns. The present authors in an earlier paper (1970) reported results of a detailed study on the changes in the major protein fractions in prawns and oil sardine during ice storage. This communication presents the results of a similar study on two commercially important species of fish of Indian coast *viz.*, mackerel and lactarius.

Materials And Methods

Fresh mackerel (*Rastrelliger kanagurta*) and lactarius (*Lactarius lactarius*) were obtained from the catches of the Institute's boats. They were washed well and packed in thick polythene bags and stored in crushed ice.

The extraction procedure and buffers used for the franctionation of muscle proteins were the same as reported earlier (Devadasan and Nair, 1970).

Results And Discussion

The changes in the major protein nitrogen fractions of mackerel and lactarius during storage in ice are given in Table I. It is observed that mackerel contains a relatively higher percentage of sarcoplasmic proteins. In this respect it resembles prawn muscle. But unlike in the results reported earlier for prawns and oil sardine (Devadasan and Nair, 1970) the percentage of sacroplasmic proteins decreased steadily with progressive storage in ice, in both mackerel and lactarius. At the end of 13 days' storage, the sarcoplasmic proteins in mackerel came down to almost 50% of the original and in lactarius to 60% of the original in 12 days.

The higher amounts of sarcoplasmic proteins observed in mackerel may be due to a relatively higher contribution of ions from the muscle to the total ionic strength of the buffer. Usually, contribution of the ions from the muscle to the total ionic strength is not taken into account, though at times it can be significant (Dyer and Dingle, 1961a). This is a possibility to be considered since in the extraction procedure adopted (10 g. muscle repeatedly with 30 ml. portions of buffer in a steel centrifuge tube) the fish to buffer ratio is fairly high. This may then result in the extraction of some myofibrillar fractions also, along with the sacroplasmic proteins, as observed in squid. In squid, part of the actomyosin gets extracted in the water extract itself (Matsumoto, 1957). A similar phenomenon cannot be altogether ruled out in the case of mackerel. The presence of an easily denaturated myofibrillar protein fraction in the sarcoplasmic extract may also explain the unusual rapid fall in the percentage of extractable sarcoplasmic protein in mackerel. However, a detailed study characterising all the components appearing in the sarcoplasmic protein fraction only can confirm the presence of any myofibrillar protein fraction in this extract.

As in prawns and sardine, in these fishes also, the myofibrillar proteins get insolubilized to a greater extent during

TABLE I
*CHANGES IN THE PROTEIN NITROGEN FRACTIONS OF MACKEREL AND LACTARIUS DURING STORAGE IN ICE

Days	Sarcoplasmic protein nitrogen	Myofibrillar protein nitrogen	Denaturated protein nitrogen	Stroma protein nitrogen
		Mackerel		
0	30.55	7.62	57.16	5.23
2	27.26	5.23	62.36	5.81
5	15.24	4.82	73.61	6.22
10	15.52	3.92	74.72	6.08
13	15.40	2.92	75.26	6.23
		Lactarius		
0	25.68	7.64	59.38	7.13
4	23.32	5.37	64.10	7.26
6	17.50	4.28	70.50	7.62
12	15.76	3.08	74.19	7.82

* As percentage of total protein nitrogen.

storage in ice. In both cases, the soluble myofibrillar proteins decreased almost to 40% of its original after 13 days' storage in ice. In sardine within the same period it came down to about 62% of the original, whereas in prawns this decrease was maximum, solubility coming down to 35% of the original.

The decrease in extractable sarcoplasmic and myofibrillar proteins was always accompanied by a corresponding increase in the amount of denatured proteins extracted by 0.1 N. sodium hydroxide. The stroma proteins did not register any appreciable change during storage.

An interesting point observed is that as in oil sardine, in the case of these fishes also, the extraction of myofibrillar proteins from the residue after extration of sarcoplasmic proteins was found to be inhibited to a considerable extent even in the fresh condition. This can be due to the presence of free fatty acids in the muscle which can inhibit the extraction of muscle proteins (Devadasan and Nair, 1971). Alternatively, it may be that the extraction of sarcoplasmic proteins is causing some modifications in the residual proteins as suggested by Dyer and Dingle (1961 b). Some of sarcoplasmic proteins getting insolubilized during extraction can possibly get deposited as a layer over the myofibrils, making it less extractable. But this effect is not very pronounced in the case of prawns, in which case better yield of soluble myofibrillar proteins is observed even when the residue after removal of albumins is used for the extraction. This

may be due to the very low content of free fatty acids (FFA) in prawn muscle as against appreciable amounts found in fish muscle. Thus it is reasonable to think that free fatty acids first react with sarcoplasmic proteins resulting in their insolublization due to the formation of a hydrophobic surface. This insolubilized sarcoplasmic proteins may then get deposited over the myofibrils reducing the extractability of myofibrillar proteins from the residue. Due to the higher FFA content in fish muscle this is more pronounced in these cases, whereas this is not apparent in prawns having a very low FFA level.

It is thus clear that there is a basic difference between prawn muscle proteins and muscle proteins of fish. A detailed study fully characterizing these proteins is necessary to understand the basic differences.

ACKNOWLEDGEMENTS

The authors are grateful to Shri. G. K. Kuriyan, Director, Central Institute of Fisheries Technology, Cochin, for his permission to publish this paper.

REFERENCES

Awad, A., W. D. Powrie and O. E. Fennema. 1969. *J. Food. Sci.*, **34**, 1 : 1.

Baliga B. R., M. N. Moorjani and N. L. Lahiri. 1969. *J. Food. Sci.*, **34** : 597.

Baliga, B. R., M. N. Moorjani and N. L. Lahiri. 1962 (a). *Food Technol.*, **16**, 2 : 84.

Baliga, B. R., M. N. Moorjani and N. L. Lahiri. 1962 (b). *Food Technol.*, **16**, 2 : 96.

Connel, J. J. 1961. *Biochem. J.*, **80** : 503.

Devadasan, K. and M. R. Nair. 1970. *Fish. Technol.*, **7**, 2 : 195.

Devadasan, K. and M. R. Nair. 1971. *Fish. Technol.*, **8**, 1 : 107.

Dyer, W. J. and J. R. Dingle. 1961(a). *Fish as Food.*, Ed. G. Borgstrom. Academic Press. p. 280.

Dyer, W. J. and J. R. Dingle. 1961 (b). *Fish as Food.*, Ed. G. Borgstrom. Academic Press. p. 287.

Govindan, T. K. 1962. *Indian J. Fish.*, **9B** : 7.

Kumitsugu Kitabayashi and Sengi Ishikawa. 1964. *Bull. Hokkaido Reg. Fish. Res. Lab.*, p. 28.

Maruyama Y. and Suzuki. 1968. *Bull. Jap. Soc. Scient. Fish.*, **23** : 92.

Masayuki Kochi and Shitoku Era. 1959. J. Shimonoseki Univ. Fish., **8** : 1.

Moorjani, M. N., B. R. Baliga, B. R. Vijaya Ranga and N. L. Lahiri. 1962. *Food Technol.*, **14** : 376.

Sawant, P. L. and N. G. Magar. 1961. *Fd. Sci*, **26**, 2 : 253.

Shenoy, A. V. and V. K. Pillai. 1971. *Fish. Technol.*, **8**, 1 : 37.

Shenoy, A. V. and M. A. James. 1972. *Fish. Technol.*, **9**, 1 : 34.

Shigeru Umemoto and Koichy Kanna. 1971. *Bull. Tokai Reg. Fish. Res. Lab.*, No. 65 : 161.

Shiro Konagaya, Masamichi Bito and Keishi Amano. 1970. *Bull. Jap. Soc. Scient. Fish.*, **36**, 6 : 599.