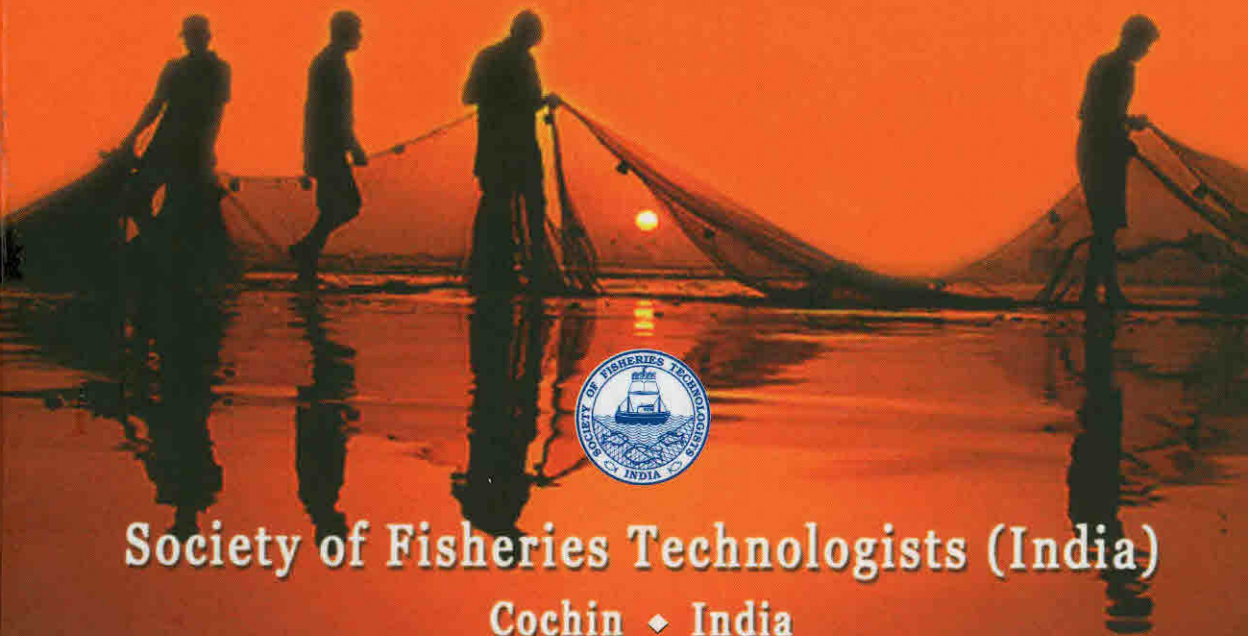
Coastal Fishery Resources of India

Conservation and Sustainable Utilisation



Society of Fisheries Technologists (India)

Cochin ◆ India

Coastal Fishery Resources of India: Conservation and Sustainable Utilisation

Proceedings of the National Seminar on Conservation and Sustainability of Coastal Living Resources of India, 1-3 December 2009, Cochin

Organised by

Society of Fisheries Technologists (India), Cochin
and
Centre for Ocean and Environmental Studies, New Delhi

In association with

Ministry of Earth Sciences (New Delhi)
Central Marine Fisheries Research Institute (Cochin)
National Institute of Oceanography (Goa) and
Central Institute of Fisheries Technology (Cochin)





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ISBN: 978-81-901038-7-9

Published by

Society of Fisheries Technologists (India)
P.O. Matsyapuri, CIFT Junction, Cochin - 682 029, India

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Citation:

Rao, G.S. (2010) Current status and prospects of fishery resources of the Indian continental shelf, In: Coastal Fishery Resources of India: Conservation and Sustainable Utilisation (Meenakumari, B., Boopendranath, M.R., Edwin, L., Sankar, T.V., Gopal, N. and Ninan, G., Eds.), p. 1-13, Society of Fisheries Technologists (India), Cochin

Cover design: Vineethkumar, P., CIFT, Cochin

Printed at PAICO, Cochin - 682 035, India

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Relation between Physicochemical Properties and Gel Strength of Myofibrillar Protein from Selected Marine Fishes

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Introduction

The functional properties of fish meat depend mainly on characteristics of myofibrillar proteins (Goll *et al.*, 1997) which in turn depends on their composition, structure and their interaction with other food components (Colmenero and Borderias, 1993). Study of functional property of myofibrillar proteins is important in determining the quality of the product (Roura and Crupkin, 1995). The native characteristics of proteins in fish muscles can be better understood when investigated when proteins are extracted from fish in prime condition. Further, protein being hydrophilic in nature, tissue proteins usually exists in native characteristics in tune with the aqueous environment as shown by low surface hydrophobicity, low SH groups etc. in order to exhibit maximum physiological function. The variation in native characteristic is related to both intrinsic and extrinsic factors affecting the characteristics of protein *in vivo* and its interaction with other tissue components.

The unfolding of protein on exposure to extreme environments leads to loss or alteration in the native characteristics of protein with simultaneous alterations in functionality. In this study the functional property particularly gel strength of fish protein from selected marine fishes is evaluated in relation to their physiochemical characteristics.

Materials and Methods

The marine fishes *Nemipterus japonicus* (TL: 26±5 cm; weight: 300±21 g), *Rastrelliger kanagurta* (22±8 cm;135±12 g), *Epinephelus tauvina* (39±11 cm;1200±54 g), *Sphyraena jello* (74±15 cm;1600±27 g)

and *Megalaspis cordyla* (34±9 cm; 422±38 g), *Lutjanus argentimaculatus* (49±8 cm; 1960±74 g) were collected from fish landing centers in fresh condition. The fishes were transported to the laboratory in ice. The fishes were thoroughly washed with cold water to remove blood, slime, dirt etc. Three fishes from each species, in pre-rigor condition were eviscerated, de-skinned and filleted. The fillets were minced and boneless meat was used for experiments. Temperature was maintained at 2 - 4°C throughout the experiment.

The myofibrillar proteins from the fishes were extracted by the method of King and Poulter, (1985). Ca^{2+} ATPase activity of myofibrillar proteins was assayed according to the method of Jiang *et al.*, (1987). The surface hydrophobicity of the extracted myofibrillar proteins was determined (Kato and Nakai, 1980) using cis-parinaric acid (CPA) as fluorescence probe. Reactive sulphydryl groups of the myofibrillar fractions were estimated according to Sedlak and Lindsay (1968). Heat induced gels were prepared and the gel strength was evaluated as described earlier (Lan et al., 1995).

Results and Discussion

The solubility of myofibrillar protein ranged between 93 to 184mg.g^{-1} meat for the different fishes studied (Fig. 1). The highest solubility was noticed in the case of *R. kanagurta* and lowest for *M. cordyla*. Solubility characteristics of protein are affected by its amino acid composition contributing to functional groups at the protein surface and the thermodynamics of its interaction with solvent (Damodaran, 1997). The Ca^{2+} ATPase activity is associated with myosin head region and any alteration in the myosin head affects the functionality of protein. High Ca^{2+} ATPase activity (>0.70) is associated with high solubility of MFP (>180 mg.g^{-1} meat). With decrease in ATPase activity, the myosin solubility showed a decreasing trend indicating the close positive relation between them. In the same way in fishes which exhibited higher Ca^{2+} ATPase and higher MFP solubility demonstrated lower SH group and surface hydrphobicity. This shows the inverse relationship between protein denaturation and solubility. Many earlier studies (Sano *et al.*, 1994; Sankar and Ramachandran, 2005; Mohan *et al.*, 2006) have reported similar relation of surface hydrophobic groups with solubility. SH groups are exposed to the exterior during protein unfolding facilitating protein-protein interaction before the setting of gels. The lower the SH groups in protein is associated with low protein unfolding, indicating low alteration in native structure and is associated with lower gel strength. This shows that a minimum level of protein unfolding is a

prerequisite for gel strength. Protein with low SH (21, 27 and 35) are associated with low gel strength against the proteins with moderately higher SH groups as seen in other fishes. The SH group represent the reactivity of the proteins for a particular fish and the content of surface reactive SH groups increased with the unfolding of protein during exposure to extreme conditions (Sankar and Ramachandran, 2005). Further, high surface hydrophobicity (80) of myosin in *R. kanagurta* is associated with low gel strength (282) while a reverse trend is seen in the case of *N. japonicus*. This clearly indicates that high order of protein unfolding is associated with negative effect on the gel forming abilities of fish proteins.

The gel strength of the heat induced gels were in the order *E. tauvina* > *N. japonicus* > *S. jello* > *R. kanagurta* > *M. cordyla* > *L. argentimaculatus* (Fig. 2). The hydrophobic groups that are exposed during heating are involved in protein gel networks, and formation of gel networks obviously results from aggregation of protein soluble at high ionic strength presumably by myofibrillar protein, through hydrophobic interaction (Xiong, 1997). A balance of attractive and repulsive forces gives good gel strength. The formation of gel network could be correlated with the surface hydrophobicity and solubility of the MFP of fishes.

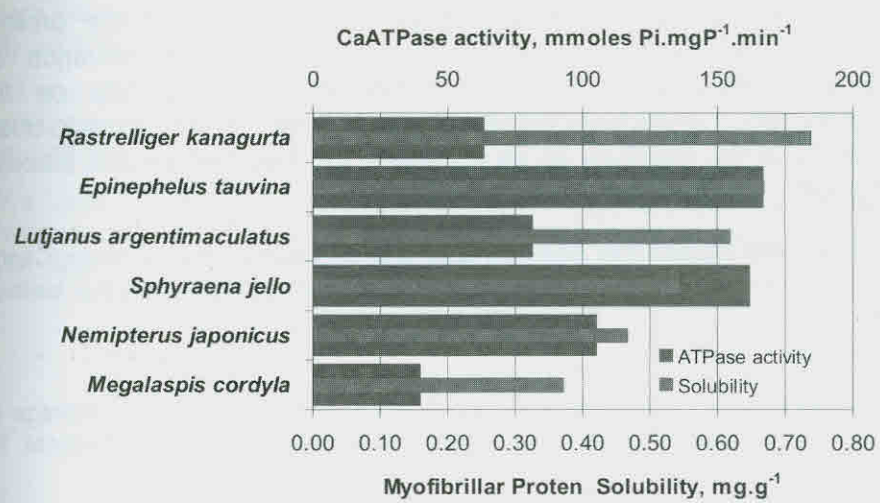

Fig. 1: Inter-relationship between Ca^{2+} ATPase activity and myofibrillar protein solubility in selected marine fishes

The Ca^{2+} ATPase activity, which is a measure of actomyosin integrity of the myofibrillar protein, shows comparable values among the fishes from different habitats. Alterations in conformational changes as indicated by

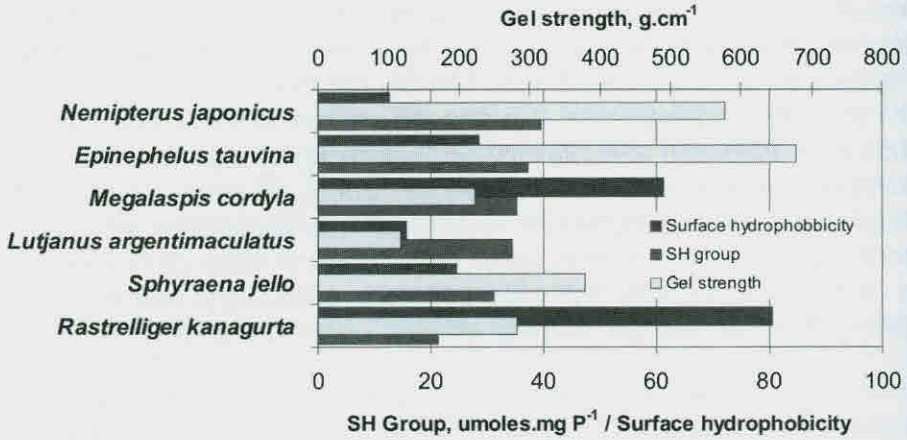

Fig. 2: Inter-relationship between SH groups, surface hydrophobicity and gel strength in selected marine fishes

increases in reactive sulphydryl groups and the surface hydrophobicity, is associated with decrease in myofibrillar protein solubility. Similarly the study demonstrated an inverse relation between surface hydrophobicity and gel strength. This clearly shows that unfolded flexible proteins are more active at the interface, increasing these functionalities of the protein. Surface hydrophobicity and solubility has a profound influence on functional properties of MFP, as these functionalities rely on the hydrophobic-hydrophilic balance of the protein, which enable them to orient themselves at the interface so as to reduce the free energy and stabilize the system.

The authors express their sincere thanks to Dr. B. Meenakumari, Director, Central Institute of Fisheries Technology, Cochin for the support and providing the facilities.

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