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Investigation on the Gel Forming Ability of Some Under-utilized Marine Fish and Shell Fish 6pecies of Bay of Bengal

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Abstract: Eighteen under-utilized marine fish and shell fish species were studied for their gel forming ability and surimi was prepared from all of the fish species. Difference in proximate composition and muscle pH of raw fish and the surimi products were also studied. Four species, namely, *T. thalassinus. S. sihama, L. savala* and *C. macrolepidotus* were found with extremely elastic gel forming ability (AA) and among others eight species were with moderately elastic gel (A). Two species, *C. guttatum* and *M. cordyla* were found with very poor gelling quality. Relation between muscle pH and water retention with the gelling quality of the fish has also studied.

Key words: Gel forming ability, marine fish, shell fish, Bay of Bengal

Introduction

In Bangladesh, from the Bay of Bengal, a considerable quantity of under-utilized marine fish were caught as non target species, which has been intensified with the introduction of deep sea fleets, particularly shrimp trawlers from mid 70's. Some quantity of these by-catch are landed for human consumption and the greater portion of these are discarded in the sea. Generally in most of the shrimp fisheries, by-catch comprises of 80-90 percent of total catch volume. Information of such by-catch specially on the discarded part is scanty. According to Bangladesh Fisheries Development Corporation (BFDC, 1986) the post harvest losses from discard by trawlers are estimated to be 3500-4000 MT per year in addition to discard from traditional artisanal fisheries. Utilization of these underutilized discarded fish as a rich source of low cost animal protein by various product development for human consumption might paves the way to solve the animal protein deficiency of the nation and to earn foreign exchange, in addition. Based on the considerations, an attempt was taken to find out the gelling capacity of some underutilized marine fish and shell fish which is an important factor for specific product development, such as kamaboko, surimi etc.

Materials and Methods

Less attractive fish and shell fish species those have only limited value in the fresh form and abundantly available round the year were used as raw material. Eighteen such by-catch marine fish and shell fish species of different families were included in this study (Table 1). Fish species were obtained from Cox's Bazar BFDC fish harvour in between March to July. Fish were obtained in iced/frozen condition and transported to laboratory in iced condition for preparation of kamaboko and other analytical purposes.

Analytical methods:

Measurement of muscle pH: pH value were measured by using pH meter for muscle homogenate- The muscle homogenate were prepared by blending 10 g of minced mear/surimi with 40 ml of chilled water.

Proximate composition: Proximate composition, such as, moisture, crude protein, crude lipid and ash content of the sample were analyzed according to standard procedure given in AOAC (1980). Moisture content was determined by drying 5 g sample at 105°C for 24 hours. The lipid content were determined by extracting given quantity of samples with petroleum ether in Soxhlet apparatus for 16 to 18 hours. For crude protein determination about 1.5 g communited sample were employed for Kjeldahl procedure. A factor of 6.25 was used for converting the total nitrogen to crude protein. Ash content were determined by igniting the samples in a muffle furnace at 550°C for 6 hours.

Preparation of surimi: After beheaded and gutted, fish were washed in clear cold water and then filleted by hand. Fillets were then minced with a mincer and washed according to Watabe and Hashimoto (1986). Three successive washing were employed with the solutions (0.5% $NaHCO_3$) to help to remove sarcoplasmic protein and in dewatering) for 10 minutes for about 40°C with a solution/fish mince ratio of 5:1 (V/W). Final dewatering was carried out by centrifuging. Sorbitol (4 g) and polyphosphate (0.3 g) was added to 100 g of the dewatered minced as cryoprotective agents. After mixing for 2 min. at temperature below 10°C the resulted surimi was frozen at -3°C (wrapped in polythene bags) and were kept at -20°C for storage.

Preparation of kamaboko gels (standard process): Frozen surimi after thawing at 4°C were mixed 2 min. at 5-10°C with each 3 g

Table 1: Name of the under-utilized by-catch marine fish and shell fish species used in the experiment

S. No.	Scientific name	Local name
1.	*T. thalassinus*	Guijja
2.	*S. sihama*	Hundra
3.	*L. savala*	Churi
4.	*C. macrolepidotus*	Pate mach
5.	*J. belangari*	Poe
6.	*H. neherius*	Laitta
7.	*C. madrasensis*	Lal samuk
8.	*P. diacanthus*	Baura
9.	*A. hians*	Kaika
10.	*G. punctatus*	Bamosh
11.	*E. affinis*	Born maita
12.	*C. talabon*	Pike
13.	*P. haste*	Sada datina
14.	*D. zugei*	Pate hanger
15.	*S. kuhlli*	Chapa
16.	*P. maculatus*	Kale datina
17.	*C. guttatum*	Maitta
18.	*M. cordyla*	Kawah

Table 2: Showing degree of elasticity and folding quality of different grades of gels

Score	Grade	Results on folding	Degree of elasticity
5	AA	No cracks on folding in quarters	Extremely elastic
4	A	No cracks on folding in half; cracks on folding in quarters	Moderately elastic
3	B	Some cracking on folding in half	Slightly elastic
2	C	Breaks into pieces on folding in half	Not elastic
1	0	Breaks into fragments with finger pressure	Poor

Source : Kudo *et al.* (1973)

Table 3: Proximate composition of raw fish muscle and surimi products prepared from various under-utilized marine species

S. No.	Species	Form	Proximate composition			
			Moisture	Protein	Fat	Ash
1.	*T. thalassinus*	Raw	81.51	14.50	0.89	1.20
		Surimi	78.51	15.44	0.11	1.07
2.	*S. sihama*	Raw	79.50	15.20	0.21	1.27
		Surimi	77.55	15.22	0.05	1.16
3.	*L. savala*	Raw	77.15	15.78	2.75	1.79
		Surimi	73.94	14.31	0.08	1.86
4.	*C. macrolepidotus*	Raw	87.92	13.97	1.85	1.63
		Surimi	85.00	13.03	0.07	1.57
5.	*J. belangari*	Raw	81.64	14.12	1.94	1.24
		Surimi	77.07	14.48	0.09	1.41
6.	*H. neherius*	Raw	88.40	8.20	0.35	1.50
		Surimi	83.61	9.78	0.03	0.98
7.	*C. madrasensis*	Raw	74.02	18.18	4.73	1.27
		Surimi	70.27	17.40	0.05	0.32
8.	*P. diacanthus*	Raw	76.20	13.87	2.01	1.28
		Surimi	71.41	13.96	0.09	1.38
9.	*A. hians*	Raw	77.80	14.23	1.37	1.30
		Surimi	72.67	13.97	0.10	1.71
10.	*G. punctatus*	Raw	74.11	15.95	8.01	1.54
		Surimi	69.50	15.26	0.11	1.72
11.	*E. affinis*	Raw	79.44	13.93	2.62	1.89
		Surimi	74.88	14.06	0.10	1.47
12.	*C. talabon*	Raw	80.34	14.20	1.00	1.17
		Surimi	74.87	13.95	0.08	1.11
13.	*P. hasta*	Raw	78.15	14.14	4.38	1.99
		Surimi	70.34	14.19	0.10	1.73
14.	*D. zugei*	Raw	76.16	14.07	2.62	1.97
		Surimi	69.40	14.76	0.02	1.89
15.	*S. kuhlli*	Raw	76.99	14.67	1.97	1.25
		Surimi	70.60	14.23	0.09	1.76
16.	*P. maculatus*	Raw	78.72	15.63	3.89	1.24
		Surimi	71.43	14.98	0.09	1.69
17.	*C. guttatum*	Raw	77.27	15.01	2.23	1.81
		Surimi	69.30	14.01	0.07	1.72
18.	*M. cordyla*	Raw	76.65	13.71	1.93	1.40
		Surimi	68.96	13.43	0.04	1.06

NaCl and 5 percent potato starch while water content were adjusted to 76-80 percent on wet basis and the pH adjusted to 6.66.8 (usual natural pH of surimi). The resulted paste were introduced to vinylidene chloride tube (2.6 cm) using a manual staffer. Then the tube after preheating for 30 min at 40°C in water bath were cooked again for 50 min at 90°C in water bath. Then the tube were cooled for 30 min in the running water and finally kept in a refrigerator at 40°C for 15 hours before subsequent analysis.

Texture evaluation: Kamaboko samples were equilibrated for 1 hour at 20°C before measurement. Folding tests were carried out carefully to examine the flexibility of gels of 3 mm thickness by a conventional method (Shimizu, 1978; Hashimoto *et al.*, 1983; Holmquist *et al.*, 1984) following the ranks as per Table 2.

Mater retention properties: Water retention properties of gels was determined by equilibrated 2 g sample at 200°C for 1 hour, fragmented into small pieces with a cutting spatula and centrifuged at 1500 X g for 5 minutes on top of a porous polyamide membrane. Water retained in the gel per 100 g water present in the gel before centrifugation measured was carried out in triplicate.

Results and Discussion

The gel forming ability of the fish were evaluated on the basis of grades described in Table 2. *T. thalassinus, S. sihama, L. sawala* and *C. macrolepidotus* were judged as grade AA in folding test. In the case of the species listed from sl. no. 5-12 in Table 3, the gels were evaluated as moderately elastic (A) and in case of SI. No. 13 and 14 of the same, gels were found slightly elastic nature (8) and

Table 4: pH value of raw fish muscle and surimi products and water retention and gel quality of the surimi products

Si. No.	Species	Form	Parameters		
			pH	Water retention (%)	Gelling capacity
1.	T. *thalassinus*	Raw	6.80		
		Surimi	6.80	96.00	AA
2.	*S. sihama*	Raw	6.60		
		Surimi	6.70	97.00	AA
3.	*L. savala*	Raw	6.70		
		Surimi	6.80	95.00	AA
4.	*C. macrolepidotus*	Raw	6.50		
		Surimi	6.80	95.00	AA
5.	*J. belangari*	Raw	6.72		
		Surimi	6.80	92.00	A
6.	*H. neherius*	Raw	6.90		
		Surimi	6.80	92.00	A
7.	*C. madrasensis*	Raw	6.60		
		Surimi	6.70	92.00	A
8.	*P. diacanthus*	Raw	6.20		
		Surimi	6.60	91.00	A
9.	*A. hians*	Raw	6.70		
		Surimi	6.80	93.00	A
10.	*G. punctatus*	Raw	6.40		
		Surimi	6.80	92.90	A
11.	*E. affinis*	Raw	6.70		
		Surimi	6.60	91.00	A
12.	*C. talabon*	Raw	6.70		
		Surimi	6.70	91.00	A
13.	*P. haste*	Raw	6.00		
		Surimi	6.00	86.00	B
14.	*D. zugei*	Raw	6.20		
		Surimi	6.00	85.00	B
15.	*S. kuhlli*	Raw	6.00		
		Surimi	5.70	82.00	C
16.	*P. maculatus*	Raw	8.20		
		Surimi	5.80	82.00	C
17.	*C. guttatum*	Raw	6.00		
		Surimi	5.70	79.00	D
18.	*M. cordyla*	Raw	6.00		
		Surimi	5.80	80.00	D

two other were not found elastic (C). Percent proximate composition of raw muscle and surimi products are presented in Table 3. Highest percent of moisture (88.40) found for the raw muscle of *H. neherius* and lowest percent was found (approximately 74%) for raw muscle of *C. madrasensis.* For surimi product of each sample moisture content was found close to approximately 3-12 percent less of the raw muscle which is within the acceptable limit for surimi preparation (Holmquist *et al*., 1984; Scott *et al*., 1988). The variation in gel quality due to variation in moisture content level (above or below the said range) was also reported by these authors. No remarkable variation was observed between the crude protein content of raw muscle and the product. Highest percent of protein (18.81%) was found for the raw muscle of *C. madransensis* while the lowest (8.20%) was found for *H. neherius* raw muscle. In this study, comparatively low gelling ability, poor water retention and low solubility of kamaboko prepared from different fish species are probably related to denaturation of muscle protein caused by low muscle pH (less than 6.0). It is likely that muscle pH which would decline rapidly in post mortem muscle even in ice storage, varies from species to species and condition of storage, declining of muscle pH of fish and its impact of gel forming was also reported by Ishikawa *et al.* (1977, 1979). Shimizu and Kaguri (1986) reported that probable reason for lowering gelling potential is the denaturation of myofibrillar proteins occuring more rapidly in acidic condition of pH 6.0 or less. Many workers agree that pH is the most important factor associated with changes in meat texture (Kramer and Peters, 1981), water holding capacity (Penny, 1967, 1969; Konagaya and Konagaya, 1979) and myofibrillar solubility (Konagaya and Konagaya, 1978). The findings of the present study also reveals that low pH of the raw fish muscle has direct impact on the quality of gel which is in full agrement with the observation as reported by the aforesaid authors. For most of the species of muscle pH near to 6 has showed poor or not elastic gel. The elastic quality of the gel found from different fish species showed a direct relation with the percent water retention. This extremely and moderately elastic gel has a good water retention i.e. more than 91 percent.

Fat content of the raw fish muscle were found very poor around 2 percent or lower for majority of the species. Higher percentage of fat was found only in *G. punctatus* (8.01%) and *D. zugei* (6.19%) and medium fat content was found in *P. haste* (4.38%). *P. maculatus* (3.89%), *L. savala* (2.75%) and *C. madrasensis* (4.73%). However, in the surimi products, fat content of all the raw muscle were reduced to below 0.1 percent (because of treatment with Kcl and centrifuging). Among the other factors those influences the kamaboko gel forming ability, high fat content, instability of muscle proteins, large amount of sarcoplasmic proteins and high proportion of dark to ordinary muscle are important. High fat content in the muscle weakens the gel forming ability and it is also impossible to make surimi from the fish those are not fresh even if the effective processing technology is applied (Suzuki and Watabe, 1986).

No remarkable variation in ash content of the raw muscle and the products were observed. Highest content (1.99%) was found for the raw muscle of *P. haste* and the lowest (1.170%) was found in *C. talabon.*

The pH and water retention values of raw muscle are presented in Table 4. pH value of raw muscle and product were found to vary between 6.20-6.90 without any significant difference. In the fresh muscle, lowest pH value (6.0) was found for *S. kuhlii, P. haste, C. guttatum* and *M. cordyla* and highest value (6.90) was found for *H. neherius.* Water retention of the products were found very high (95% and above) for *T. thalassinus, S. sihama, L. savala* and *C. macrolepidotus.* These four species were also found with highly elastic gel (AA). Water retention of the product of moderately elastic gel (A) species were found to vary between 91.00 to 93.00 percent and water retention of the product of slightly elastic and poor elastic gel were found below 86.00 percent. The water retention property of kamaboko prepared from fish were recorded between 79 to 97 percent and the lowest water retention was observed in case of *C. guttaturn* (79%). The gel forming ability of fish differs greatly depending on the type of fish and it is influenced by various factors, such as, fishing season, location and its condition, degree of freshness of fish, its muscle pH, freezing, amount of salt added to raw ground fish, amount of starch added, other additives like sugar, oil, polyphosphate. soaking raw materials and heating condition etc (Tanikawa, 1985). Also according to the type and body composition of fish species "Suwari" occurs rapidly or slowly or sometimes does not occur at all (Okada, 1959). Suwari (setting) a phenomenon in which myosin after dissolving in NaCl become jelly like structure having elasticity. This elasticity of gel forming ability of kamaboko is an important criteria of quality product. Myosin is a major component of protein mainly concern with the elasticity of kamaboko (Kitabayashi, 1954; Miyake and Hayashi, 1957).

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