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Role of Collagen in Gaping of Fish Fillets

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The extent of gaping in the skinless fillets of *Sardinella longiceps, Rastrelliger kanagurta, Oreochromis mossambicus, Cyprinus carpio, Euthinnus affinis* and *Scoliodon sorrkowah* during frozen storage and its relationship with the collagen content of the muscle were studied. Gaping was not significant in any of the fillets during the first three months of frozen storage, irrespective of the collagen content. Significant gaping occurred in fish stored for longer period. The degree of gaping was more in those fish which had low collagen content. Removal of skin appeared to be helpful in preventing gaping.

Key words : Gaping, fillets, collagen

Gaping is a phenomenon in which sheets of connective tissue in fish muscle (myocommata) fail to hold the myotomes together (Love & Robertson, 1968; Love *et al.*, 1969). This is seen particularly in frozen fillets, since the connective tissue gets weakened or damaged due to the formation of ice crystals. This has got serious economic consequences leading to unacceptability and wastage of otherwise valuable material. Badly gaped fillets cannot be skinned or sold from open display and have only a limited use in certain products like minced meat. Gaping is a factor which will adversely affect consumer appeal, and hence the extent of gaping can be used as an index of fillet quality. Love & Haq (1970) found that when the pH was low, the extent of gaping was more and the removal of skin reduced gaping. Yamaguchi *et al.* (1976), after conducting a comparative study on the connective tissues of hake, cod and cat fish, found that the musculature of hake separates readily into flakes because of intrinsic weakness in connective tissue.

The connective tissues of fish are chiefly composed of stroma proteins and these form only a small fraction of the total protein content of fish meat. Among the connective tissue proteins, collagen is the major one. The present paper is an attempt to investigate the role of collagen in the gaping of fish fillets.

Materials and Methods

Six commercially important species of fish were used for the study. They included four marine fish viz., oil sardine (*Sardinella longiceps*), mackerel (*Rastrelliger kanagurta*), tuna (*Euthinnus affinis*) and shark (*Scoliodon sorrakowah*), one fresh water fish, common carp (*Cyprinus carpio*) and one brackish water fish, tilapia (*Oreochromis mossambicus*). The marine fish were caught off the coast of Cochin, and collected from Cochin Fisheries Harbour and tilapia and common carp were obtained from culture ponds. The fish were immediately chilled in ice and brought to laboratory for the study.

The samples were properly washed with potable water, skinned and filleted. About 75 gm of the fillets were used for estimating collagen. The method of Sato (1988) was used for the estimation of collagen. Approximately one kilogram of fillets were dipped for one minute in 0.01 M phosphate buffer (pH 6.8) containing 1/15 M potassium dihydrogen phosphate

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and 1/15 M disodium hydrogen phosphate. The material was then divided into smaller lots of 200g each and was then packed in polyethylene bags with appropriate labeling. The packed samples were frozen in contact plate freezer at -40°C for 90 min. One sample was drawn immediately to serve as the control. The rest of the samples were stored at -18°C.

Samples were drawn every month and thawed in running water at room temperature. The thawed material was divided into two parts. The degree of gaping in the raw and cooked (in 0.5% boiling brine for 10 min) fillets was assessed by the method of Love & Haq (1970). A 5-point scale was used for rating where a score zero corresponds to the absence of gaping and the score four refers to dropping pieces or complete disintegration of muscle.

Results and Discussion

Soluble, insoluble and total collagen contents of the fish species studied are presented in Table 1. The soluble collagen content was found to vary between 0.36 to 2.13 g/100g wet meat and insoluble collagen, between 0.09 and 0.86 g/100g wet meat. The total collagen content varied between 0.45 and 2.99 g/100g wet meat.

In the present study pH of the fillets were kept constant by dipping in phosphate buffer. Since the samples were caught within a period of one month, the influence of season may be assumed to be eliminated. All the lots were in post rigor condition.

Table 2 gives the extent of gaping of raw and cooked fillets of various species during frozen storage for six months. The data showed that the length of frozen storage influenced the extent of gaping. Gaping scores after 3 months were comparatively low for all the species in raw as well as cooked samples. Gaping was severe after six months, especially in the species with low collagen content (sardine and mackerel). The fillets were totally disintegrated to pieces and were not in an acceptable condition. Extent of gaping was less in fish with medium collagen content (common carp and tilapia) when compared to sardine and mackerel. Tuna and shark, which had the highest collagen content were the least affected species. There was a direct correlation between the collagen content of the fish and the degree of gaping during frozen storage (Table 3). Both cooked and raw samples were affected during frozen storage and there does not appear to be any difference between the two as far as the extent of gaping was concerned. Love & Haq (1970) pointed out that gaping was not a problem when fish was filleted prior to freezing, where as when whole or dressed fish was frozen, there was an increase in gaping. Sato (1988) also observed that fish with lower collagen content was more prone to gaping.

Table 1. Content of soluble, insoluble and total collagen of various fish species (g/100g wet meat)*

	Soluble	Insoluble	Total
Sardinella longiceps	0.36	0.09	0.45
Rastrelliger kanagurta	0.38	0.09	0.47
Oreochromis mossambicus	0.47	0.22	0.69
Cyprinus carpio	0.49	0.21	0.70
Euthinnus affinis	1.06	0.39	1.45
Scoliodon sorrakowah	2.13	0.86	2.99

*Mean of three replicates

Table 2. Gaping score for raw and cooked meat of various fish species during frozen storage.*

		Storage period months						
		0	1	2	3	4	5	6
Sardinella longiceps	Raw	1.05	0.47	0.89	0.90	2.00	3.21	4.00
	Cooked	1.25	1.24	1.24	1.15	2.02	3.10	4.00
Rastrelliger kanagurta	Raw	1.17	1.59	1.59	1.68	1.98	2.82	3.80
	Cooked	1.44	1.58	2.22	1.70	1.79	2.59	4.00
Oreochromis mossambicus	Raw	0.38	0.42	0.43	0.50	1.13	2.41	3.21
	Cooked	1.07	1.84	1.29	1.64	1.91	2.31	3.12
Cyprinus carpio	Raw	0.86	0.84	0.38	0.94	1.64	2.52	3.11
	Cooked	1.46	1.14	1.24	1.04	1.46	2.53	2.91
Euthinnus affinis	Raw	1.14	1.20	1.57	1.06	1.32	1.56	2.00
	Cooked	1.76	1.53	1.96	1.22	1.52	1.68	2.01
Scoliodon sorrakowah	Raw	0.35	0.44	0.57	0.66	0.71	0.73	0.81
	Cooked	0.68	0.66	0.76	1.86	0.87	0.89	0.92

*Mean of three replicates with eight judges per replicate

Table 3. Correlation coefficients between different collagen fractions and gaping of raw and cooked meat of various Fish species during frozen storage.

Storage period (months)	Soluble Collagen	Insoluble Collagen	Total Collagen
Raw			
0	-0.51*	-0.59*	-0.54*
1	-0.27	-0.34	-0.29
2	-0.12	-0.23	-0.15
3	-0.34	-0.44*	-0.37
4	-0.82	-0.87*	-0.84*
5	-0.95	-0.96*	-0.96*
6	-0.96	-0.97*	0.97*
Cooked			
0	0.55	-0.59*	-0.56*
1	-0.70	-0.69	-0.72
2	-0.48	-0.55	-0.50
3	-0.63	-0.62	-0.63
4	-0.91	-0.92	-0.91
5	-0.95	-0.96	-0.95
6	-0.94	-0.96	-0.97

* Significant value ($p<0.05$)

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