Fishery Technology
1997, Vol. 34(2) pp : 15 - 20

Evaluation of two Empirical Devices for Measurement of Fish Texture

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Two types of texturometers (weight-operated and spring operated) were fabricated for the evaluation of fish texture. These devices were used to measure the toughness of twenty species of commercially important fishes in raw and cooked conditions. Texture was also evaluated by organoleptic method. A significant positive correlation could be obtained between organoleptic scores and the texturometer readings in the case of fish fillets both in raw and cooked condition.

Key words : Texturometers, texture evaluation, organoleptic scoring, collagen, raw and cooked fish.

The texture of food is an important criteria of its palatibility and consumer acceptance. In the case of raw fish, texture is one of the most important factor for organoleptic quality assessment. Consequently measurement of texture and devices for texture evaluation has attracted the attention of many fishery scientists. The most widely used method of texture evaluation is still organoleptic scoring. Eventhough organoleptic scoring by a trained panel of judges is more dependable, it is highly variable, time consuming, costly and subjective.

In spite of all these drawbacks, organoleptic evaluation of texture is still the mainstay of many food processing industries because there is yet to be a satisfactory objective instrument to measure this parameter. Instrumental methods have been developed for texture measurement with a view to lower the cost of texture evalution (Diehl *et al.*, 1979). A torsion test that measures shear stress and strain has been used to evaluate protein gels (Kim *et al.*, 1986; Howe *et al.*, 1994). The properties measured relating to gel strength and gel deformability are closely related to sensory texture profile analysis (Montejano *et al.*, 1985). Studies of Hamann & MacDonald (1992) has given detailed coverage of several rheology and mechanical texture evaluation methods for surimi gels.

Fish texture is a delicate property requiring meticulous care and precision for its measurement. It is also a highly variable property among the numerous species of fish and among different age and size groups of the same species. The texturometers developed earlier (Messtorff, 1954; Friedman *et al.*, 1962; Sutton & Main, 1969 & Hatae *et al.*, 1984) did not perform well as these instruments were constructed without considering the multitude of variables as stated above. The present paper deals with development of two types of texturometers and their evaluation for texture measurements.

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Materials and Methods

Twenty commercially important species of fish were used for the study, which are listed in Table 1. The marine fishes were collected from fisheries harbour Cochin, the brackish water fishes form the "Matsyafed" farm at Narakkal and the fresh water fishes from the Pookot Fish Farm, Trichur. The fish upon collection, were immediately chilled in ice and brought to laboratory for analysis. In any case the duration of chilling never exceeded five hours.

In the lab, the fishes were filleted and the fillets were cut into approximatley 2xlxl cm^3 pieces. About one hundred pieces were prepared from each species of fish, without any preference for any specific portion of the fish body. Half the number of pieces randomly selected, were maintained in the chilled condition for raw texture evaluation and the other half was cooked in 3% boilding brine for ten min. for evaluation of cooked texture.

Organoleptic evaluation of texture was done according to Sato (1988), with the assistance of a taste panel of eight members. The raw meat was evaluated by feeling with the fingers whereas the cooked meat was evaluated by chewing. The results were recorded on scoresheets giving appropriate numerical scores.

A spring - operated and weight - operated penetration type texturometers were designed and fabricated for objective evaluation of texture (Fig. 1 and Fig. 2 respectively). The spring-operated texturometer consists of a spring, whose ends are supported with the help of two blocks. The spring made out of tension steel has outside diameter of 14 mm, length 40 mm, total number of windings of 7 turns and 1mm diameter. The upper block is fixed inside a hollow cylindrincal case. A stainless steel needle of diameter 0.8 mm, is mounted on the lower block and passess through the spring, upper block and out through the case at the top. The scale graduated in millimeters with zero at the bottom and with a maximum

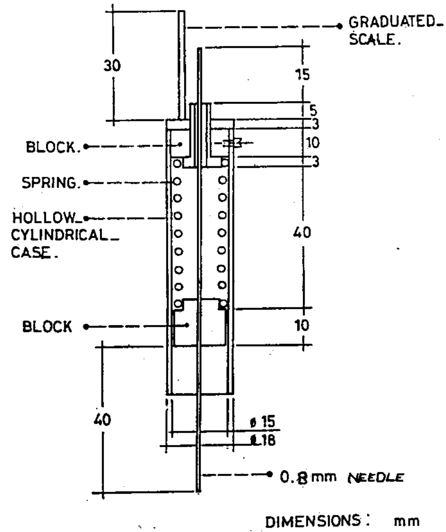

Fig. 1. Spring-operated texturometer

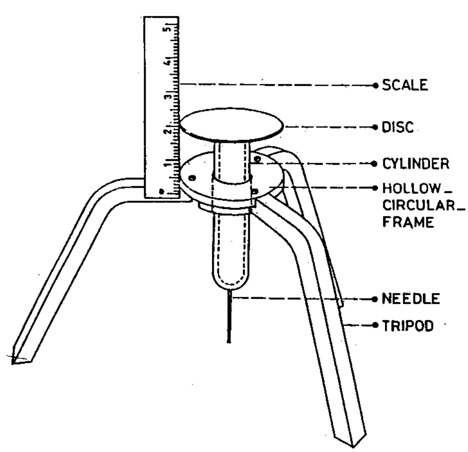

Fig. 2. Weight-operated texturometer

reading of 30, is fixed at the top of the case, parallel to the needle. A reference mark that coincides with the zero of the scale at zero position, is provided at the top of the needle so that the distance moved by the needle can be read from the scale. When pressed, the needle moves upwards along with the lower block compressing the spring.

For texturometer measurement, sufficient number of meat pieces, drawn at random, were placed one above the other to a height of four centimeters. The instrument was placed vertically on the sample with its end resting on the sample surface. The case of the instrument was pressed down vertically until the bottom of the case just touched the sample surface. The extent of penetration of the needle into the sample, exactly after five seconds, is read from the scale. An average of ten readings was taken for each sample. The texture of the sample was obtained by substracting the average reading from thirty.

The weight operated texturometer consists of a cylinder as shown in the figure (Fig. 2.). A disc is attached horizontally to its upper end on which a weight can be placed. To the lower end of the cylinder a 0.9 mm guage needle is attached. The cylinder can move freely through the hollow of a circular frame supported on a tripod stand. A scale, with graduations in millimeters, is fixed parallel to the axis of the needle. The texture of the sample were measured, by placing the sample below the needle of the texturometer and is allowed to just touch the fish surface. The initial reading on the scale in this position is noted. A weight of 50 gm is then placed on the disc. Immediatey the needle will start penetrating into the tissue and the extent of penetration depends upon the texture of the fish fillet and the period of weight application. After exactly thirty seconds, the final reading on the scale is noted. The result between the initial and final reading is substracted from thirty, to give the texture of the meat.

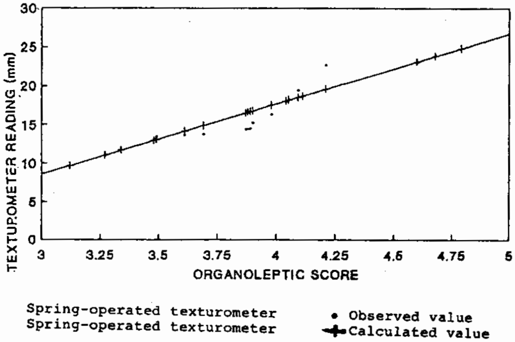

Fig. 3a. Texture of raw meat evaluated by organoleptic score and spring-operated texturometer

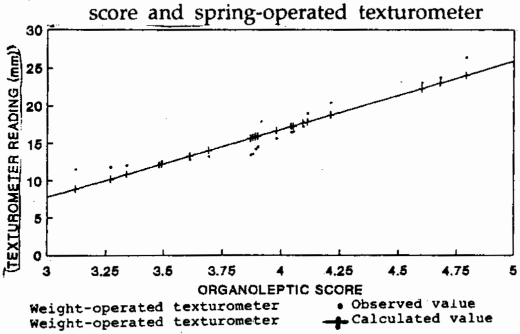

Fig. 3b. Texture of raw meat evaluated by organoleptic score and weight-operated texturometer

Results and Discussion

The texture of raw and cooked specimens of the twenty species of fish measured with the texturometers and by organoleptic scoring are listed in Table 1. The fishes are arranged in the increasing order of raw texture as determined by organoleptic evaluation. It is evident from the table that the two texturometer readings show a corresponding increase with increase in texture of fish by organoleptic methods. The organoleptic scores and the two texturometer readings of raw fillets of the twenty species of fish were plotted on a graph and the results are shown in Fig. 3 (a&b). A well established linear relationship can be derived for texture of raw fish between organoleptic score and texturometer reading as follows.

y = 9.09 x - 18.64, r = 0.94,
for spring-operated texturometer

y = 9.06 x - 19.37, r = 0.94,
for weight - operated texturometer

Table 1 also indicates the organoleptic scores and the readings for the texture of cooked fillets measured by the two texturometers. It is seen that on cooking, the texture pattern is completely altered and the original gradation based on raw texture is lost. These changes brought about during the thermal processing reveals the significance of gelation events (Hamann, 1994).

Table 1. Evaluation of the Texture of raw and cooked meat by organoleptic score, spring and weight operated texturometers

Name of fish			Texture of raw fillets			Texture of cooked fillets		
			$ OS	= SOT	* WOT	$ OS	= SOT	* WOT
Pomfret white	*Pampus argentius*	(M)	3.12+/-0.26	11.8+/-0.58	11.5+/-0.19	3.01+/-0.49	10.8+/0.52	10.5+/-0.41
Sardine	*Sardinella longiceps*	(M)	3.27+/-0.33	12.2+/-0.47	11.8+/-0.21	3.03+/-0.38	11.2+/-0.14	10.8+/-0.28
Mackerel	*Rastrelliger Kanagurta*	(M)	3.34+/-0.29	12.8+/-0.60	12.0+/-0.33	2.94+/-0.41	12.2+/-0.22	11.2+/-0.32
Sole	*Cynoglossus semifaciatus*	(M)	3.48+/-0.58	13.1+/-0.53	12.2+/-0.19	3.08+/-0.28	12.4+/-0.18	11.6+/-0.41
Vatta	*Caranx* spp.	(M)	3.49+/-0.56	13.4+/-0.55	12.6+/-0.21	3.13+/-0.39	12.6+/-0.43	11.6+/-0.18
Ribbon fish	*Trichurus savala*	(M)	3.61+/-0.48	13.6+/-0.38	12.9+/-0.33	3.40+/-0.31	13.2+/-0.39	12.0+/-0.33
Anchovy	*Anchoviella* spp.	(M)	3.69+/-0.59	13.7+/-0.53	13.2+/-0.42	3.36+/-0.28	13.0+/-0.41	11.6+/-0.41
Tilapia	*Oreochromis mossambicus*	(B)	3.87+/-0.66	14.4+/-0.62	13.4+/-0.29	3.40+/-0.47	13.6+/-0.42	12.8+/-0.38
Common car	*Cyprinus carpio*	(F)	3.88+/-0.18	14.4+/-0.29	13.6+/-0.38	3.57+/-041	14.0+/-0.49	13.0+/-0.28
Rohu	*Labeo rohita*	(F)	3.89+/-0.21	14.5+/-0.37	14.2+/-0.41	3.60+/-0.29	14.4+/-0.41	13.2+/-0.26
Palankanni	*Megalops cordyla*	(B)	3.90+/-0.33	15.2+/-0.41	14.5+/-0.18	3.66+/-0.12	14.4+/-0.36	13.2+/-0.31
Paral	*Barbus* spp.	(B)	3.98+/-0.11	16.3+/-0.39	15.6+/-0.16	3.70+/-0.36	14.8+/-0.26	13.4+/-0.31
Veloori	*Kowala kowal*	(B)	4.04+/-0.28	18.0+/-0.52	16.4+/-0.23	3.68+/-0.43	14.8+/-0.21	13.6+/-0.42
Kilimeen	*Nemipterus japonicus*	(M)	4.05+/-0.58	18.2+/-0.61	16.5+/-0.32	2.48+/-0.42	8.8+/-0.31	8.0+/-0.29
Mullet	*Mugil cephalus*	(M)	4.09+/-0.37	19.4+/-0.28	17.2+/-0.53	2.08+/-0.51	8.6+/-0.33	8.2+/-0.33
Catla	*Catla catla*	(F)	4.11+/-0.43	20.5+/-0.53	18.9+/-0.29	2.42+/-0.29	8.6+/-0.28	8.2+/-0.11
Tuna	*Euthinus affinis*	(M)	4.21+/-0.36	22.7+/-0.62	20.3+/-0.39	4.04+/-0.32	23.0+/-0.36	23.7+/-0.11
Whiting	*Sillago sihama*	(M)	4.60+/-0.42	23.1+/-0.47	23.0+/-0.42	2.90+/-0.53	10.0+/-0.21	9.2+/-0.71
Ray	*Himantura*	(M)	4.68+/-0.53	23.9+/-0.39	23.7+/-0.38	4.07+/-0.39	23.2+/-0.11	20.4+/-0.68
Shark	*Scoliodon sorrakowah*	(M)	4.79+/-0.22	26.3+/-0.66	26.3+/-0.31	4.08+/-0.61	23.4+/-0.32	20.6+/-0.62

(M) Marine; (B) Brackishwater; (F) Fresh water; $ Average of 8 x 3 readings; = Average of 10 x 3 readins;
* Mean of three replicates; OS Organoleptic score; SOT Spring operated texturometer;
WOT Weight operated texturometer

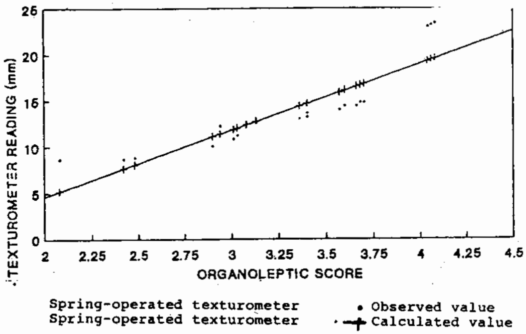

Fig. 4a. Texture of cooked meat evaluated by organoleptic score and spring-operated texturometer

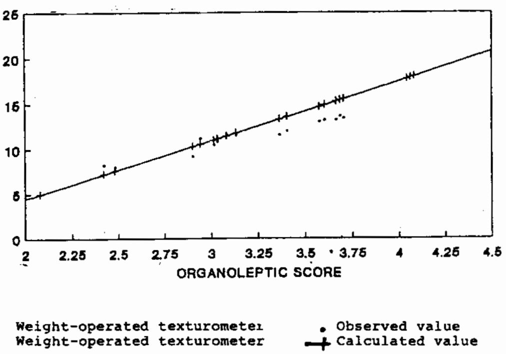

Fig. 4b. Texture of cooked meat evaluated by organoleptic score and weight-operated texturometer

According to Dunajeski (1979), during cooking, the binding property of collagen gets reduced by its conversion to gelatin, while myofibrillar proteins become more firm and fibrous. In other words, one factor responsible for texture is rendered ineffective and the contribution of the second factor namely structural proteins is made more prominent. These thermal changes could probably bring about a complete re-orientation in the structure and hence, the altered pattern of texture. The organoleptic scores and the texturometer readings of the cooked fillets are plotted on a graph and the patterns obtained are shown in Fig. 4 (a&b). There is a linear relationship between the organoleptic score of texture of cooked fish and the texturometer readings, indicating the effectiveness of the two texturometers to measure the texture of cooked meat. The linear equations, are

$Y = 7.18x - 9.75$, $r = 0.88$,
for spring - operated texturometer

$Y = 6.53x - 8.6$, $r = 0.86$,
for weight - operated texturometer

The two instruments are simple in construction, easy to use and effective for measuring texture of both raw and cooked fish fillets. The two texturometer readings are compatible with organoleptic scores both in raw and cooked condition of fish fillets.

Thanks are due to prof. (Dr.) M. Shahul Hameed, Director School of Industrial Fisheries, Cochin University of Science and Technology, Cohin - 16, for according permission to publish this paper. Technical advice and encouragement given by Dr. T.K. Sivadas, Principal Scientist and Head Engineering and Instrumentation Division, CIFT, Cochin for design and fabrication of the texturometers is gratefully acknowledged.

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