

CHAPTER - 5

SOME OBSERVATION OF NUTRITIVE VALUE AND FRESHNESS
OF FOOD FISHES STORED AT LOW TEMPERATURE
FOR TWO WEEKS

INTRODUCTION

The marine fish landing centers in India are located in innumerable fishing hamlets scattered along the extensive coastline extending about 5000 km. (Venkataraman and Prabhu, 1964). Fish consuming centers are far away from landing places. Fish being highly perishable commodity, the problem of transporting it in a prime condition from the landing places to consuming centers is stupendous one. It requires proper care during handling, transportation, distribution and marketing.

Fishes are normally transported under low temperature. Changes in temperature at various stages result in deterioration of the quality at different rates. There is no report available on the effectiveness of the various storage temperature in reducing the spoilage rate of different varieties of marine and freshwater fishes. It was therefore, felt necessary to study the effect of different temperature on the rate of spoilage changes during storage.

The shelf-life of iced fish in general may not

exceed 10-12 days which is inadequate for long distance transportation. Therefore, further extension of shelf-life could be of great practical significance, particularly where fast moving refrigerated transport system is not available.

For evaluation of freshness and standardized quality control of fishery products an objective criterion is a necessity. Industrial objective tests, however, can determine a single or a few aspects of physical quality. Therefore, a combination of different aspects of physical quality tests has been used to obtain information on texture, flavour, freshness, odour, firmness, gill, eye, body surface, abdomen, flesh and overall acceptability.

Fish undergoes series of complicated changes due to own enzymes, bacterial and chemical actions from time of its catch until it is processed (Fish handling and processing, 1965; Dassow, 1963). Enzymes of fish muscle and intestine are involved in spoilage. Muscle enzymes are particularly active in the initial phase and bio-chemical changes takes place (Borgstrom, 1965). The catalase enzymes of gills also run parallel to degree of spoilage (Tomiyama *et al.*, 1950). How rapidly is the spoilage process during storage of the fish depends on various factors such as species, variation in chemical composition, fishing methods,

condition of post-harvest handling, preservation and transportation (Shewan, et al., 1960). Fatty fish shows lipid changes during storage at low temperature also (Bose, 1969). For assessing the rate of spoilage of fish during storage, total volatile nitrogen has been recommended as a suitable chemical index (Rubbi, et al., 1987). The amount of TVN increases as the fish deteriorate during storage.

The irreversible changes in odour, flavour and appearance continue to some degree even at low temperature. In evaluating the acceptability and edibility of fish, smell and sight, supplemented by touch and taste are used. The use of senses (organoleptic test) is a subjective procedure for evaluating fish quality. The condition of eyes, texture of fish, odour, and appearance of the abdominal wall are useful criteria for determination of freshness of raw fish. Score sheets and a point system for numerical scoring of the samples have been elaborated as a basis for the sensory judgements.

For assessment of overall acceptability of stored fish, the hedonic rating scales (Howgate, 1978) has been used. This has been used by Peryam and Girandot, 1952; Jones and Thoustrone, 1955; Jones, et al., 1955 and Stevens, 1961. Attempt

has been made to compare hedonic scale rating with the results of chemical test (TVN).

Present experiment also aims at to compare the rate and pattern of spoilage changes in the freshwater and marine fishes during storage at low temperature.

MATERIALS AND METHODS

Organoleptic fresh different fish species were purchased from local market and were kept immediately at 0°C throughout the period of study. The deterioration in the quality was assessed both chemically and physically (organoleptically by sensory evaluation). The experiments were carried out using fourteen different fish species. The TVN value at 1°C to 8°C temperature were calculated from the TVN values at 0°C temperature of storage at two weeks. Fish samples were taken in weekly intervals for the purpose of the present study.

The present work was carried out with fourteen different species, it was necessary to identify the species. The keys suggested by Patel and Chhaya (1980) and Day (1958) are used.

Cirrhina mrigala (Hamilton-Buchanan), Hilsa ilisha (Hamilton-Buchanan), Catla catla (Cuvier and Valen-

ciennes), Mystus aor (Hamilton-Buchanan), Harpodon neherus (Hamilton-Buchanan), Pampus argenteus (Euphrasen), Notopterus Chitala (Hamilton-Buchanan), Wallago attu (Bloch and Schneider), Lates calcarifer (Bloch), Lutianus Johni (Bloch), Serranus sp.(Cuvier), Arius nenga (Cuvier and Valenciennes), Arius sona (Cuvier and Valenciennes).

TOTAL VOLATILE NITROGEN (TVN)

The quality of fish during spoilage was determined by estimation of total volatile nitrogen (TVN) from TCA extract by Conway microdiffusion technique (Conway and Byrne, 1933 modified by Pearson, 1962). The TVN value expressed as mg.N/100 gm of fish flesh.

MOISTURE CONTENTS

Two gm of fish muscle were placed in a convention over maintained at 105°C and heated upto the constant weight was reached. The weight loss was presumed to be entirely due to evaporation of water (Poulter et al., 1978).

TOTAL PROTEIN CONTENTS

This was determined on 100 gm fish samples by using Lowry et al., (1951) method.

TOTAL LIPID

Weighed tissue was ground separately with thoroughly washed sand and used for determination of total lipids. Total lipids were estimated using 2:1 chloroform: methanol mixture for extraction as per the method of Folch et al., (1957). The lipid content was calculated in terms of gm percentage of fresh tissue.

ASSESSMENT OF PHYSICAL QUALITY

The quality of fresh fish was determined by sensory judgement (organoleptic score). The score sheets used for the present experiment are accounting to Shewan et al., (1953). Scoring was out of 10 for the different quality aspects of fresh fish. Methods for measuring physical quality and overall acceptability of stored fish sample are described and compared according to the method of Howgata, (1978).

The relative rate of spoilage chart (1°C to 8°C) were build from the TVN values at 0°C temperature. The effect of temperature (Q) on the rate of spoilage (U) of fish samples stored at different temperature between 1°C to 8°C was found to be approximately linear and expressible in the form $u=v(1+C.Q.)$ Where v is the spoilage rate at Q and C is a constant upto 8°C (0.25) (Spencer and Baines, 1964).

STATISTICAL METHOD

The statistical analyses were carried out according to the standard method, (Mian and Miyan, 1984).

ORGANOLEPTIC (SENSORY TESTS)

(According to Shewan *et al.*, 1953)

1. Eye

Bright, clear & full	10
Slightly dull	9
Moderately dull	8
Dull	7
Slightly sunken	6
Moderately sunken	4
Sunken	2
Completely sunken	0

2. Gill

Bright red	10
Slightly dull/pale	9
Slightly pale/white	6
Pale/white	5
Brownish/Greyish	4
Dark colour	2
Blackish	0

3. Flesh

Translucent	10
Loss of translucent	9
Slightly dull	8
Moderately dull	7
Dull	6
Dull red	4
Reddish losses/ slightly waxy	2
Reddish and loose	0

4. Pupil

Brightly trans- parent	10
Slightly dull & misty	8
Dull/slightly milky white	7
Watery colour/white	6
Slightly misty/ milky white	4

Pale/white	2	More discolouration	6
Extremely pale/more white	0	Slightly digested	4
		Extremely digested	0
5. Body surface		7. Texture	
Shining bright	10	Firm elastic	10
Slightly loss of brightness	8	Rigor mortis	8
Loss of brightness	6	Just post rigor stage	6
Slightly dull	4	Slightly soft	4
Dull & slightly reddish of tail	2	Moderately soft	2
completely dull	0	Soft & loose	0
6. Abdominal wall			
Normal flesh	10		
Slightly discolouration	8		

PHYSICAL QUALITY

(According to Howgate, 1978)

1. Flavour		2. Dryness	
Absent	0	Sloppy watery	0
Very slight	1	Juicy, moist	1
Moderate	3	Slightly dry	2
Strong	4	Dry	3
Very strong	5	Extremely dry	4

3. Odour		Slight tough	4
		Tough	5
Absent	0	Extremely tough	6
Slight	2		
Moderate	4	5. Toughness	
Strong	6		
Very strong	8	Extremely tender	1
Extremely strong	10	Very tender	2
		Tender	3
4. Firmness		Slightly tough	6
		Tough	7
Very soft	0	Very tough	8
Softer than normal	1	Extremely tough	9
Firm	2		
Slightly firmer than normal	3		

HEDONIC RATING SCALE

(According to Howgate, 1978)

Overall acceptability	
Like extremely	9
Like very much	8
Like much	7
Like slightly	6
Neither like nor dislike	5
Dislike slightly	4
Dislike much	3
Dislike very much	2
Dislike extremely	1

RESULTS AND DISCUSSION

The composition of the muscles of the different fish species are shown in the Fig. 2. The moisture contents of the fishes ranged from 88.47 to 77.77% and lipid contents mg/100 mg fish muscle was 3.5 to 1.25. The lipid content was relatively low in wallago attu (1.25), Serranus areolatus (1.5) and Harpodon neherus (1.63). The lipid content was high in Hilsa ilisha (3.5) and catla catla (2.75). Mystus aor (2.0), Pampus argenteus (2.25), Lates calcarifer (1.75) and serranus species (2.25) have intermediate lipid contents. There is a inverse linear relationship between lipid and water contents in fatty fishes. The protein content was greatest for the fishes mainly i.e. Hilsa ilisha (15.92) Cirrhina mrigala (16.25), Pampus argenteus (28.57), Lates calcarifer (19.53) and Serranus species (30.20) and least in mainly, Catla catla (11.65), Mystus aor (12.5), Harpodon neherus (12.15) and Wallago attu (12.50). Thus protein content was between 30.20% in Serranus sp. to 11.65% in Catla catla. Highest moisture content was observed in Harpodon neherus (88.47%) and lowest moisture content was observed in Catla catla (77.77%). The overall protein content was greatest for fatty fish and least in the lean fish. The results of the composition shows a clear interrelationship of the main constituents of the fish muscle. There seems to

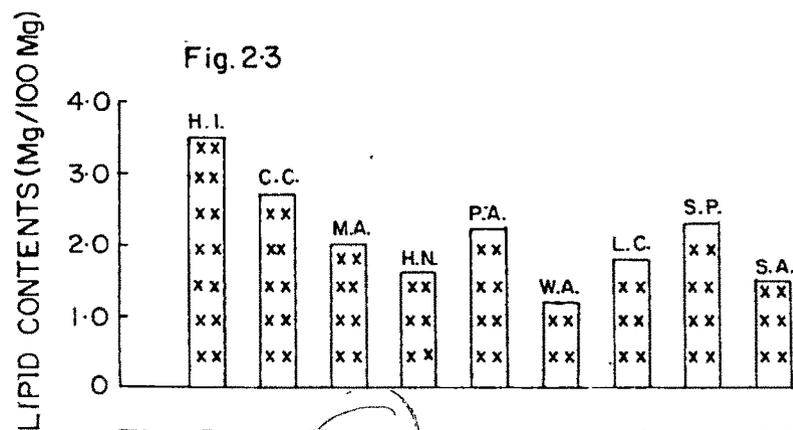
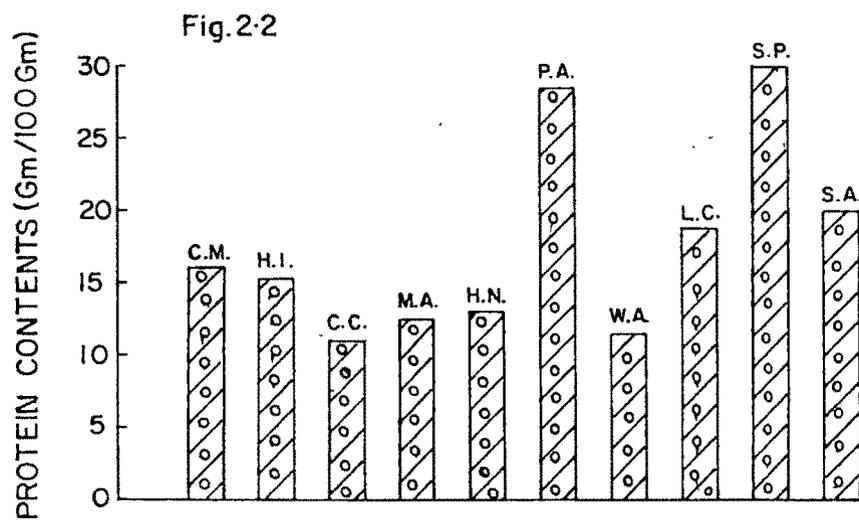
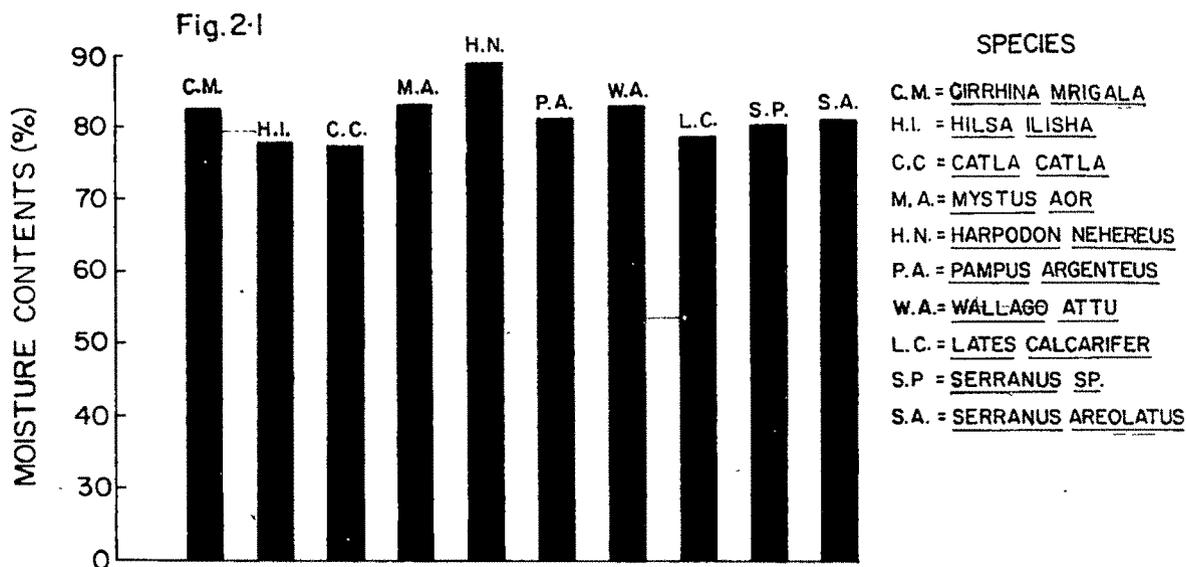


Fig.2. NUTRITIVE VALUE OF DIFFERENT FISH SPECIES BEFORE PRESERVATION.

be a considerable variation of the individual constituents. Among all the fresh water fish Wallago attu contained lower amount of fat (1.25). Present results showed that there was a variation in fat content in the fresh and marine fish species. The composition of the fish varies within the Genus (Serranus species), especially in fat contents. This seems to hold true not only for the whole fish but also portions of the body (Brandes, 1954). Excess fat is generally acquired at the loss of water of the tissue (Jacquot and Creach, 1950). There is a clear interrelationship between water contents and the amount of fat contents. The protein did not show a distinct result in non-fatty fishes (Kordyl, 1951). A good correlation was seen between protein and water contents (Jacquot, 1961). Various factors affect the degree and rate of changes of protein and other tissue constituents. The composition of the fish muscles is influenced by the age, sex, maturity and feeding habits of the fish (Love, 1970; Rao, 1971). Ahmed et al. (1981 and 1983); Gheysuddin et al. (1979) and Gheyasuddin and Saik (1980) have shown the composition of different species of fish and shell fish. Accumulated data on the composition of fish by Khuda et al. (1960 and 1962); Kamaluddin et al. (1977) and Gopalan (1978) on the proximate composition of fish were almost the same with some variation in fat. The differences in variation of composition of fish species

TABLE-2 : INCREASE OF TVN IN DIFFERENT STORAGE TEMPERATURE
(1°C to 8°C) AT TWO WEEKS.

Species (Scientific name)	Storage Temperature/Storage Days/TVN Values (mgN/100gm fish flesh)											
	1°C		2°C		3°C		4°C		0-7		7-14	
	0-7	7-14	0-7	7-14	0-7	7-14	0-7	7-14	0-7	7-14	0-7	7-14
<u>Cirrhina mrigala</u>	10.60	24.32	12.80	29.19	14.93	34.05	17.06	38.92	17.06	34.05	17.06	38.92
<u>Hilsa ilisha</u>	20.63	38.40	24.75	46.08	28.88	53.76	33.00	61.44	33.00	53.76	33.00	61.44
<u>Catla catla</u>	12.87	33.50	15.44	39.75	18.00	46.38	20.58	53.00	20.58	46.38	20.58	53.00
<u>Mystus aor</u>	21.13	30.75	25.35	36.90	29.58	43.05	33.8	49.2	33.8	43.05	33.8	49.2
<u>Herpodon neherus</u>	15.31	33.28	18.38	39.95	21.43	46.60	24.50	53.26	24.50	46.60	24.50	53.26
<u>Pampus argenteus</u>	26.65	49.79	31.98	59.75	37.31	69.70	42.64	79.66	42.64	69.70	42.64	79.66
<u>Notopterus chitala</u>	17.71	33.51	21.26	40.22	24.80	46.92	28.34	53.62	28.34	46.92	28.34	53.62
<u>Wallago attu</u>	17.3	23.58	20.76	43.29	24.22	50.51	27.68	57.72	27.68	50.51	27.68	57.72
<u>Lates calcarifer</u>	21.57	47.01	25.88	56.42	30.19	65.82	34.50	75.22	34.50	65.82	34.50	75.22
<u>Lutianus Johni</u>	15.16	44.95	18.20	53.94	21.23	62.93	24.26	71.92	24.26	62.93	24.26	71.92
<u>Serranus sp.</u>	24.89	55.43	29.87	66.51	34.85	77.60	39.82	88.68	39.82	77.60	39.82	88.68
<u>Serranus aroolatus</u>	20.90	45.71	25.68	54.86	29.26	63.99	33.44	73.14	33.44	63.99	33.44	73.14
<u>Arius nenga</u>	19.43	42.11	23.33	50.54	27.21	58.96	31.10	67.38	31.10	58.96	31.10	67.38
<u>Arius sona</u>	13.51	43.60	16.22	52.32	18.91	61.04	21.62	69.96	21.62	61.04	21.62	69.96

TABLE-2 (Contd.)

Species (Scientific name)	Storage Temperature/Storage Days/TVN Values (mgN/100gm fish flesh)											
	5°C		6°C		7°C		8°C		7°C		8°C	
	0-7	7-14	0-7	7-14	0-7	7-14	0-7	7-14	0-7	7-14	0-7	7-14
<u>Cirrhina mrigala</u>	19.19	43.79	21.33	48.65	23.46	53.52	25.59	58.38	27.57	60.32	29.73	65.26
<u>Hilsa ilisha</u>	37.13	69.12	41.25	76.80	43.38	84.48	45.51	92.16	47.64	90.32	49.77	97.45
<u>Catla catla</u>	23.15	59.63	25.73	66.25	26.30	72.88	28.87	79.50	30.94	78.03	33.07	84.66
<u>Mystus aor</u>	38.03	55.35	42.25	49.24	46.48	67.65	51.70	73.08	53.83	81.89	55.96	88.00
<u>Harpodon nahanus</u>	27.57	59.92	30.63	66.58	33.69	73.23	36.75	79.89	38.88	86.43	41.94	93.98
<u>Pampus argenteus</u>	47.97	89.62	53.30	99.58	58.63	109.53	63.96	119.49	69.29	129.44	74.62	139.39
<u>Notopterus chitala</u>	31.88	60.32	35.43	67.03	38.97	73.73	42.51	80.43	46.04	81.83	49.57	88.34
<u>Wallago attu</u>	31.14	64.94	34.6	72.15	38.06	79.36	41.52	86.58	44.61	93.79	47.70	101.00
<u>Lates calcarifer</u>	38.81	84.62	43.15	94.03	47.44	103.43	51.75	112.83	56.06	122.23	60.37	131.63
<u>Lutianus johni</u>	27.29	80.91	30.33	89.9	33.36	98.89	36.39	107.89	39.42	116.88	42.45	125.88
<u>Serranus sp.</u>	44.79	99.71	49.78	110.85	54.76	121.94	59.73	133.02	64.71	144.11	69.68	155.20
<u>Serranus areolatus</u>	37.62	82.28	41.80	91.43	45.96	100.57	50.16	109.71	54.37	118.86	58.68	128.01
<u>Arius nenga</u>	34.98	75.80	38.88	84.22	42.71	92.65	46.65	101.07	50.54	109.52	54.47	117.97
<u>Arius sona</u>	24.32	78.48	27.03	87.20	29.73	95.92	32.43	104.64	35.14	113.37	37.85	122.12

TABLE-5.2 : COMPUTATION OF SIMPLE COEFFICIENT OF
CORRELATION BETWEEN TVN AND OVERALL
ACCEPTABILITY DURING STORAGE AT 0°C
TEMPERATURE

Species (Scientific name)	Coefficient of correlation between TVN and overall acceptability (r)
<u>Cirrhina mrigala</u>	- 0.95
<u>Hilsa ilisha</u>	- 0.99
<u>Catla catla</u>	- 1.0
<u>Mystus aor</u>	- 1.0
<u>Harpodon neherus</u>	- 0.81
<u>Pampus argenteus</u>	- 0.99
<u>Notopterus chitala</u>	- 1.0
<u>Wallago attu</u>	- 0.99
<u>Lates calcarifer</u>	- 0.99
<u>Lutianus Johni</u>	- 1.0
<u>Serranus sp.</u>	- 1.0
<u>Serranus areolatus</u>	- 0.82
<u>Arius nenga</u>	- 1.0
<u>Arius sona</u>	- 1.0

* Storage period : Two weeks (0°C)

* TVN = Total volatile nitrogen
(mg.N/100 gm of fish muscle)

may be due to numerous factors such as season, age size and geographical area. However, the overall ranges of the different components compare reasonably well with those of Stansly and Otcott (1963) which include mainly marine fish.

There was a slight difference in the initial quality among different fish samples based on organoleptic evaluation and chemical values. A good negative correlation was observed between the organoleptic assessment and chemical values (Table 5.2). The TVN value always increases and the organoleptic score decreases during the storage period (Tables 2 and 4). The fish stored in 0°C were found to be organoleptically acceptable upto one week of storage and were gradually spoiled on the remaining days of storage. The TVN values showed a gradual increase throughout the storage period.

It is apparent from the Table-2 and 4 that the fish preserved at different temperature became unacceptable when TVN values exceeded 33 mg.N/100 gm of fish flesh and overall acceptability (Physical quality) values becomes below 5.0. The acceptability of the fish muscles both chemically and physically during preservation depend on its initial quality. The pattern of spoilage rates increases linearly with storage

temperature. 0°C was chosen as reference temperature for estimation (by calculation) of the TVN values at 1°C to 8°C temperatures.

The spoilage rates of marine fish, tend to be lower than that of freshwater fish when measured by sensory tests. The physical appearance score probably decrease due to the effect of relatively rough handling of the fish and the method of storage (Table-4). The organoleptic score values markedly decrease and become less precise and less consistent at the end of freshness (Table-4). Fauber, (1965) reported that there is a steady decrease in the breaking point of muscle strips after rigor, the rate of spoilage varying with the storage temperature. The acceptability scores of 14 different species storage at 0°C temperature showed that Serranus species (4.0), and Pampus argenteus (3.33) were completely organoleptically unacceptable at the end of storage period. The differences between acceptability and unacceptability of storage fish samples were detected by the trained-panelists during the storage at 0°C temperature.

The highest and lowest total volatile nitrogen value was found in Serranus species (44.34) and Cirrhina mrigala (19.46 mg.N/100 gm of fish flesh) at two weeks of storage in 0°C. The increase of TVN value after storage of fish samples depends on its initial

TABLE -4 : PHYSICAL QUALITY CHANGES OF FISHES DURING STORAGE
AT 0°C TEMPERATURE

Species (Scientific name)	STORAGE(0°C) TEMPERATURE/STORAGE DAYS/SCORE													
	Eye		Pupil		Gill		Body surf.		Flesh		Belly wall		Texture	
	0-7	7-14	0-7	7-14	0-7	7-14	0-7	7-14	0-7	7-14	0-7	7-14	0-7	7-14
<u>Cirrhitina mriguela</u>	7.66	6.0	7.66	6.0	7.0	5.0	9.33	6.66	9.0	6.33	8.66	4.0	5.33	3.66
<u>Hilsa ilisha</u>	8.66	5.66	7.66	4.66	8.33	5.0	9.33	4.66	8.33	6.66	9.33	8.0	5.33	3.33
<u>Catla catla</u>	8.66	7.0	9.60	7.33	9.66	6.33	9.33	5.33	8.66	6.66	8.66	4.66	6.66	2.66
<u>Mystus aor</u>	9.66	7.66	9.33	7.0	9.66	5.66	9.33	6.0	9.66	7.33	9.33	6.66	0.00	2.66
<u>Harpodon nenerus</u>	9.66	8.00	8.66	5.66	9.66	5.33	9.33	5.33	9.00	6.33	8.00	4.66	8.66	3.33
<u>Rampus argenteus</u>	8.33	4.00	7.33	3.33	3.66	4.00	6.66	4.00	8.33	4.66	6.66	4.00	3.33	2.00
<u>Notopterus chitala</u>	8.66	4.66	8.66	6.66	9.66	5.33	8.66	6.00	9.33	7.66	9.33	6.66	4.00	2.66
<u>Wallega atbh</u>	9.66	8.00	9.33	7.00	9.66	7.00	9.33	6.00	9.00	7.00	8.00	4.66	7.33	4.66
<u>Lates calcarifer</u>	2.00	0.00	-	-	5.00	4.00	6.00	4.00	6.00	6.00	4.00	2.00	4.00	2.00
<u>Lutianus Johni</u>	2.00	0.00	7.00	-	6.00	5.00	6.00	4.00	6.00	4.00	4.00	4.00	4.00	2.00
<u>Serranus sp.</u>	4.00	0.00	6.00	2.00	5.00	5.00	4.00	2.00	6.00	6.00	6.00	4.00	4.00	2.00
<u>Serranus areolatus</u>	2.00	0.00	6.00	2.00	5.00	5.00	4.00	4.00	6.00	6.00	4.00	4.00	4.00	2.00
<u>Arius nenga</u>	6.00	4.00	6.00	2.00	5.00	2.00	6.00	4.00	7.00	6.00	4.00	2.00	4.00	2.00
<u>Arius sona</u>	7.00	2.00	4.00	2.00	6.00	-	4.00	2.00	7.00	4.00	4.00	2.00	4.00	2.00

TABLE-4 (Contd.)

Species (Scientific name)	STORAGE (0°C) TEMPERATURE/STORAGE DAYS/SCORE											
	Odour		Flavour		Firmness		Dryness		Toughness		Overall acceptability	
	0-7	7-14	0-7	7-14	0-7	7-14	0-7	7-14	0-7	7-14	0-7	7-14
<u>Cirrhina mrigela</u>	2.0	2.0	1.0	3.0	3.33	2.0	1.33	0.00	6.0	5.0	7.33	7.0
<u>Hilsa ilisha</u>	2.0	2.66	1.00	3.0	1.33	4.33	1.0	2.0	5.0	6.66	7.33	6.0
<u>Catla catla</u>	2.0	4.0	0.00	3.0	1.33	4.33	1.66	2.33	2.66	6.66	7.0	6.0
<u>Mystus aor</u>	1.0	2.33	1.0	2.33	1.0	2.0	1.66	2.66	1.33	3.66	8.33	6.33
<u>Harpodon neherus</u>	0.00	4.0	1.0	1.66	1.0	1.66	1.0	2.0	2.66	6.33	8.33	6.66
<u>Pampus argentatus</u>	3.33	7.33	1.66	4.0	2.66	3.0	1.0	1.0	3.66	6.66	7.0	3.33
<u>Notopterus chitala</u>	0.00	2.66	0.00	2.0	1.33	4.66	1.0	2.0	5.33	7.33	8.0	7.0
<u>Wallega attu</u>	0.00	2.0	0.00	1.0	0.00	1.33	1.0	1.66	1.0	3.33	7.33	6.66
<u>Lates calcarifer</u>	2.0	4.0	1.0	3.0	1.0	4.0	0.00	2.0	2.0	6.0	7.0	6.0
<u>Lutianus johni</u>	0.00	2.0	1.0	3.0	2.0	4.0	1.0	2.0	2.0	6.0	7.0	5.0
<u>Serranus sp.</u>	2.0	2.0	0.00	1.0	0.00	1.0	2.0	2.0	3.0	6.0	7.0	4.0
<u>Serranus argolatus</u>	4.0	4.0	1.0	3.0	1.0	3.0	3.0	-	6.0	7.0	6.0	5.0
<u>Arius nenga</u>	0.00	2.0	1.0	3.0	1.0	3.0	0.00	2.0	2.0	6.0	7.0	6.0
<u>Arius sona</u>	0.00	4.0	1.0	3.0	1.0	3.0	1.0	2.0	2.0	6.0	7.0	6.0

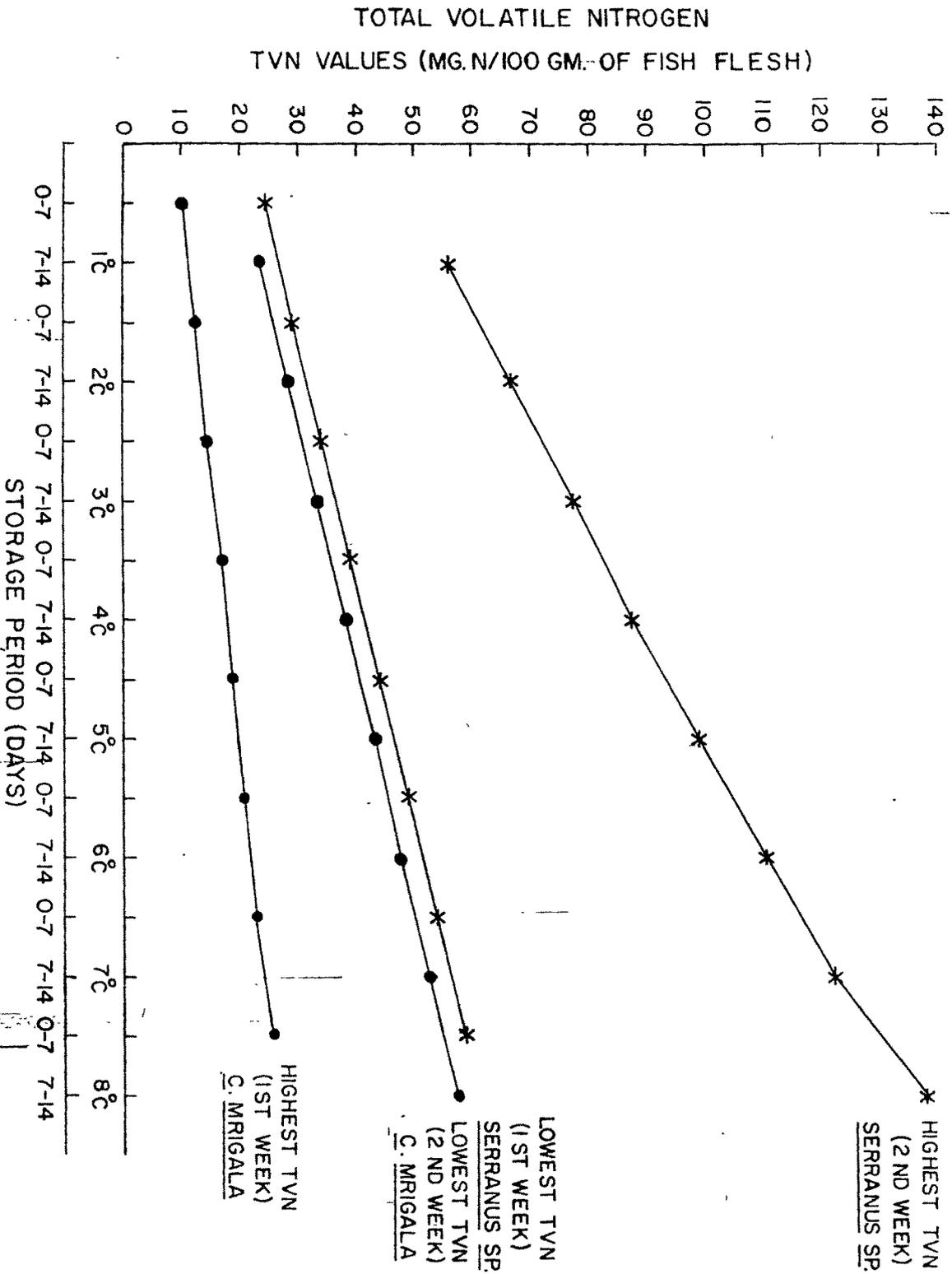


Fig. 1 HIGHEST AND LOWEST TVN VALUES AMONG 14 DIFFERENT SPECIES, STORED AT 1°C TO 8°C TEMPERATURES

TABLE-5.1 : THE TEST STATISTICS 't' BETWEEN TWO VARIABLES
(TVN VALUE IN FIRST AND SECOND WEEKS OF STORAGE
AT 0°C TEMPERATURE)

X_{1i} (TVN values at 0-7 days of storage)	X_{2i} (TVN values at 7-14 days of storage)	$d_i = (X_{1i} - X_{2i})$	n =
8.53	19.46	- 10.33	
16.50	30.72	- 14.22	
10.29	26.50	- 16.21	
16.90	24.60	- 7.7	n=14
12.25	26.63	- 14.38	
21.32	39.83	- 18.51	
14.17	26.81	- 12.64	
13.84	28.86	- 15.02	
17.25	37.61	- 0.61	
12.13	35.96	- 23.83	
19.91	44.34	- 24.43	
16.72	36.57	- 19.85	
15.55	33.69	- 18.14	
10.81	34.88	- 23.97	
		$\bar{d} = -15.76$	

The test statistics 't' = - 8.90

$$S^2_d = 43$$

$$S_d = 6.62$$

Hypothesis = Storage temperature (0°C) has no effect on
chemical quality changes.

Conclusion: The test Statistics 't' with 13 degree of freedom
at 5% level of significance is - 8.90. The
tabulated value 2.160 is less than the calculated
values. Hence, it appears from the data that
storage temperature has a significant effect on
chemical quality changes.

quality at the time of purchase. After the first week of storage at 0°C all the samples were highly acceptable. Serranus species (44.34); Lates calcarifer (37.51); P. argenteus (39.83); Lutianus johni (35.96) and A. sona (34.88) mg.N/100 gm fish flesh were unacceptable in the second week of storage and these species exceeded the limit of acceptability value 33 mg.N/100 gm of fish flesh during storage (Fig. 1; Table-5.1, shows the TVN values at 0°C).

It is observed from table-4 that Cirrhina mrigala (7.0), Mystus aor (6.33), Harpodon neherus (6.66), Catla catla (6.0), Notopterus chitala (7.0) and Wallago attu (6.66) were quite acceptable by the taste panel assessment at the end period of storage, although by the external appearance had suffered some loss of quality the texture had become tough and the flesh had less flavour. A consistent difference in quality between marine and fresh water fish was noticed during the storage. The fresh water fishes. Cirrhina mrigala, Catla catla, Wallago attu, Mystus aor and Notopterus chitla species were acceptable in quality upto end of storage at 0°C.

The effects of different storage temperature 1°C to 8°C on freshness of fish muscle were calculated by using the TVN values at 0°C. The rate of increase in

TVN value was higher in higher temperature and lower in lower temperature of storage. Deterioration in quality was most pronounced when the fish had been at high temperature. There was a linear increase in TVN value over the storage period for all the samples of the present investigations.

In spoilage of both sensory and chemical variables were linear. The odour scores of the raw fish decreases during the storage period and their initial levels also vary (Table-4). The flavour scores shows similarity in variation as the odour scores. The loss of quality is indicated by changes in TVN values of fishes during storage from 0°C (Table-5.1), 1°C to 8°C (Table-2).

The taste panel evaluations of odour, texture and flavour shows that the actual spoilage was faster at higher temperature. The textural quality had been completely lost at the end of storage period. Significant variations were observed in the organoleptic scores obtained from various storage fish samples. The deterioration of the flavour of the fish muscle during storage involves a series of complex changes and reactions such as the development of rancidity in fat and degradation of the nucleotides (Poulter *et al.* 1978). In the fatty fish like Hilsa ilisha rancidity is probably the most important factor as far as flavour acceptability is concerned. However, the results of the

present study together with most of the other available information suggested that lean fish have a longer storage life than fatty fish species during preservation at similar storage temperature.

Low temperature is the principal factor governing the quality of the fish product. However, the quality of the product under low temperature storage is different for different fish species. Texture score gradually decreases, the toughness score increases with longer storage (Table-4). The lean species shows lower sensory score for flavour and odour. Softening texture of the muscle is influenced by fat content of fishes (Poulter et al. 1978). During storage at low temperature marked difference in rate of changes in texture and flavour were observed. Overall, on the basis of the organoleptic score the species C. mrigala, Notopterus and Wallago attu were considered highly acceptable throughout the storage period and Serranus species and Pampus argenteus samples were considered unacceptable at the end of storage period (Table-4).

The colour, appearance and textures of the fish play an important role in organoleptic judgement. The TVN values showed a gradual increase during the storage period in all the fish species and exceeded the limit of acceptability 33 mg.N/100 gm of fish flesh, ultimately

the fish samples became unacceptable. During the storage period the range of TVN values of different fish species at 1°C to 8°C are C. mrigala (10.60 to 58.38); H. ilisha (20.63 to 92.16); C. catla (12.87 to 79.50); M. aor (21.13 to 73.08); H. neherus (15.31 to 79.89); P. argenteus (26.65 to 119.49); Notopterus (17.71 to 80.43); Wallago attu (17.30 to 86.58); Lates calcarifer (21.57 to 112.83); Lutianus johni (15.16 to 107.88); Serranus species (24.89 to 133.02); S. areolatus (20.90 to 109.71); A. nenga (19.43 to 101.07) and A. sona (13.51 to 104.64) mg.N/100 gm of fish flesh respectively (Table-2).

Storage temperature has the profound effect on the rate of spoilage. All varieties of fish at 0°C showed the longer shelf-life than other storage temperature. At lower temperature particularly below 9°C the enzymatic and other spoilage action was retarded to a great extent (Burgess et al., 1965). It is quite evident that there were a great difference in spoilage rate and pattern of spoilage for fish stored at 1°C to 8°C when other conditions for storage, being essentially the same (Table-2).

It may be concluded that the differences in spoilage rate were solely due the effect of storage temperature. TVN has been suggested to be 33 mg.N/100 gm

of fish flesh as the limit of acceptability by several workers (Tillmans and Otto, 1924; Yamura, 1933; Tanikawa, 1935; Kimura and Kiamukura, 1934) recommended TVN levels of 10 mg.N or less for fresh fish and 20-30 mg.N for spoiled fish. However, Glassman and Rockwager (1929) recommended 20 mg.N as the critical value for edibility Lucke and Geidel (1935) reported that 30 mg.N/100 gm fish muscles was considered as the upper limit for acceptability and 20-30 mg.N/100 gm fish muscle for beginning of spoilage. Wierzhchowski (1956) suggested 30-40 mg N/100 gm fish muscle as the upper limit for estimating the freshness of lean fresh water fish. De & Mea, (1966) studied the total volatile base nitrogen in the muscle of fresh fish ranging from 19-33 mg N/100 gm of fish muscle. In the present study the TVN value in most cases were in the range of unacceptable at the end of storage period and this agrees with the recommendation of Glassman and Rockwager (1929). There is also wide variation in TVN values for individual species at different storage temperature. In the present study, the limit of acceptability are drawn in 33 mg N/100 gm of fish flesh. Findings of the present investigations have some similarities with the findings of above researchers.

The pattern of spoilage of different species are different due to its size, sex, maturity and ecological

TABLE-5 : THE TEST STATISTICS 't' BETWEEN TWO VARIABLES
(ACCEPTABILITY VALUES IN FIRST AND SECOND
WEEKS OF STORAGE AT 0°C TEMPERATURE

X_{1i} (over all acceptability at 0-7 days of storage)	X_{2i} (over all acceptability at 7-14 days of storage)	$d_i =$ $(X_{1i} - X_{2i})$	$n =$
7.33	7.0	- 0.33	
7.33	6.0	- 1.33	
7.0	6.0	- 1.0	
8.33	6.33	- 2.0	n=14
8.33	6.66	- 1.67	
7.0	3.33	- 3.67	
8.0	7.0	- 1.0	
7.33	6.66	- 0.67	
7.0	6.0	- 1.0	
7.0	5.0	- 2.0	
7.0	4.0	- 3.0	
6.0	5.0	- 1.0	
7.0	6.0	- 1.0	
7.0	6.0	- 1.0	
$\bar{d} = -1.21$			

$$'t' = \frac{\bar{d}}{S_d / n} = - 4.65$$

$$S_d^2 = \frac{\sum (d_i - \bar{d})^2}{n-1}$$

$$S_d = 0.96$$

Hypothesis = Storage temperature (0°C) has no effect on physical quality changes.

Conclusion: The test statistics 't' with 13 degree of freedom at 5% level of significance is - 4.65. The tabulated value (2.160) is less than the calculated values. Hence it appears from the data that storage temperature has a significant effect on physical quality changes.

factors (Borgstrom, 1965). The storage temperature has profound effect on particular fish species. In the present experiment organoleptically acceptable fishes were procured from market for the determination of shelf-life. It is observed from the findings that higher the temperature, higher the rate of spoilage. The rate of increase of TVN value depends on its initial TVN values. The organoleptic values (Sensory evaluation) are reliable quality index for determination of initial quality in consumer like category. The actual spoilage start after certain period of fish catch. For the extension of shelf-life of different species, it may be suggested that care should be taken from fishing ground to storage depot. Because, by the action of autolysis and micro-organism the physical and chemical quality markedly decreases at the time of rigor mortis. The initial quality of fishes is of utmost importance for preservation. The total quality depends on the initial quality of the fish products. The relative rate of spoilage chart (Table-2) would be more useful for determination in limit of acceptability of particular fish species during the time of storage and transportation at different temperatures.

From the statistical analyses it may be said that the storage temperature has a significant effect on chemical and physical quality changes of different fish

species during short term preservation and storage
(Tables 5 and 5.1).