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K–Value, an Index for Estimating Fish Quality During Iced Storage

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Abstract : The quality of four species of marine finfish, viz., white pomfret *(Pampus argenteus)*, jew fish *(Pseudosciaena sp.)*, rainbow sardine *(Dussumieria hasseltii)* and ribbon fish *(Lepturacanthus savala)* and two species of prawns, poovalen *(Metapenaeus dobsoni)* and karikkadi *(Parapenaeopsis stylifera)* and the squid *(Loligo duvaceli)* stored in ice was evaluated by measuring the levels of breakdown products of adenosine triphosphate (IMP and hypoxanthine), K-value, volatile bases and sensory methods. In general, the initial K-value in these species were in the range of >1 to 7% and it increased with storage time. The rate of nucleotide degradation differed between species. The K-value of prawns, squid, pomfret and rainbow sardine exceeded 50% after 8-10 days storage in ice whereas the K-values of other two fin fish species increased quite rapidly. Relatively, higher levels of AMP had been recognised in postmortem prawn muscle. K-value appeared to be a good index of fish freshness. Sensory characteristic were well correlated with K- value.

Introduction

Objective chemical indices such as volatile base nitrogen (VB-N), trimethylamine nitrogen (TMA-N), ammonia (NH3) or diamethylamine nigrogen (DMA-N), in the case of gadoides etc. have been proposed to estimate the quality of fish which are produced mainly by bacterial action. However, autolytic changes are taking place rapidly in fish muscle before the microbial spoilage begins (Ehira & Uchiyama, 1986; Kennish & Kramer, 1986). Assessment of the freshness of fish based on nucleotide degradation products received substantial attention in recent years (Amu & Disney, 1973; Martin *et al.*, 1978; Jacober & Rand, 1982). Individual nucleotide and nucleotide ratios have been used to indicate quality in many species of fish (Gill *et al.*, 1987; Bremner *et al.*, 1988; Greene *et al.*, 1990; Price *et al.*, 1991; Hattula & Kiesvaara, 1992; Lakshmanan *et al.*, 1993, Ryder *et al.*, 1993). The limitation of Hx as an index of quality was realised since the rate of formation of inosine and hypoxanthine differs among species (Dyer *et al.*, 1966; Ehira & Uchiyama, 1973). Ehira (1976) remarked that K-value as proposed by Satio *et al.* (1959) was one of the most appropriate indicators of freshness. It has been defined as

$$\text{K-value (\%)} = \frac{(HxR + Hx) \times 100}{ATP+ADP+AMP+IMP+HxR+Hx}$$

Where

ATP - Adenosine 5[1] -triphosphate
ADP - Adenosine 5[1] diphosphate
AMP - Adenosine monophosphate
IMP - Inosine monophosphate
HXR - Inosine and Hx- Hypoxanthine

Ehira & Uchiyama (1986) determined K-value in a number of fish species from Japan and found that K-value is a suitable objective index for estimating the freshness of fish.

No previous reports are available on the suitability of Kvalue as an index of freshness for Indian fish. The objective of the present study was to determine the nucleotide degradation pattern in several species of marine finfish and shellfish during iced storage using High performance Liquid Chromatography (HPLC) and to calculate the K-value to assess the quality changes in stored fish. The results are compared with other chemical indices and sensory scores.

Material and methods

White pomfret *(Pampus argenteus)*, Jew fish *(Pseudosciaena spp.)*, rainbow sardine *(Dussumieria hasseltii)*, ribbon fish *(Lepturacanthus savala)*, squid *(Loligo duvaceli)* and two species of prawns, *(Metapenaeus dobsoni)* and *Parapenaeopsis stylifera)* were caught by trawling at a depth of 25-30m in the Arabian sea off Cochin during early 1994. Immediately after emptying the net, live fishes were killed and kept iced, in insulated boxes. The prawns were beheaded before icing. The samples for the entire study were collected during the two cruises of the research vessel R.V. Matsyakumari. The samples were brought to the laboratory in 3 h time. The average length and weight of the samples are given in Table 1., two storage trails were carried out in each case. Squid and prawn samples were kept in thin polythene bags before icing in order to prevent excess leaching in ice. Iced fish were sampled at different intervals for 20 days. The nucleotide and related compounds in the muscle (taken from the anterior dorsal region) is determined by the method of Ryder (1985) using High performance Liquid Chromatography. Extraction of the muscle was done using 0.6 M perchloric acid at 0° C and neutralised using 1 M KOH. It was then filtered through a millipore (0.45 um) syringe filter. Nucleotide standard and potassium phosphates were obtained from Sigma chemical company. A Hewlett Packard HPLC (model 1090) and a computing integrator model 3392 A) were used. An ODS Hypersil column 5 μ (250 mm x 4.6 mm) from Shandon Scientific Ltd. England was used for the separation of nucleotides. Operating pressure was 100-110 bar and column temperature was 30 ±1° C (ambient). The mobile phase Comprised of 0.06 M K_2HPO_4 and 0.04 M KH_2PO_4 at pH 6.5-6.8. The buffer solutions were prepared every other day in glass double distilled water and filtered through a millipore filter (0.45 μM). The flow rate was 1ml/min and the eluate was monitored at 254 nm. The detector response of each of the six nucleotides found in fish muscle was calibrated daily by injecting 20 μl of 0.2 μM solutions of each reference compound. All solutions were passed through a 0.45 μm aquos filter before injection on to the column. The K-value was computed from the results. Total volatile base nitrogen (TVB-N) and trimethylamine nitrogen (TMA-N) were determined by the microdiffusion method of Conway (1962). Sensory evaluation was carried out by a trained panel of six to eight members on raw and cooked samples using a 10 -point hedonic scale. Cooked samples were prepared by steaming the meat for 15 minutes. Cooked flavour score of 4 was taken as the limit of acceptability.

Results and Discussion

The changes in the levels of IMP, inosine, hypoxanthine and K-values are presented in Fig. 1 to 4. The total pool of nucleotide catabolites and the initial K-values in each of the species are given in Table 1. As the concentrations of

Table 1. **Average length, weight, total nucleotide pool and initial K-value of finfish, prawns and squid**

Species Name	Lenght (cms) Mean, Range ±S.D	Weight (gms) Mean, Range ± S.D	Total Nucleotide Pool umole/g	Initial K-value (%)
1. *Pampus argenteus*	20.6 ± 1.1 19-22	196.3±2.5 193-200	9.85	4.04
2. *Pseudosciaena spp.*	14.3±.6 13.5-15	51±3.5 44.8-55	8.53	11.04
3. *Dussumieria hasseltii*	15±.4 14.5-15.5	28.2±2.4 24.9-31.9	7.74	7.44
4. *Lepturacanthus savala*	37.2±3 32-42	101.1±14.2 80-120	17.81	3.95
5. *Loligo duvaceli*	23.9±1.02 22.5-25	120.4±13.4 97.7-136.5	8.04	6.40
6. *Metapenaeus dobsoni*	9.8±0.5 8.8-10.5	8.4±.4 7.8-9.2	8.95	2.10
7. *Parapenaeopsis stylifera*	9.1±.6 8.2-9.6	7.5±.3 7.2-8.0	18.50	0.24

adenosine nucleotides (ATP, ADP, AMP) decreased sharply in these species and reduced to insignificant level in a shortwhile, they are not further discussed. The initial K-value in these species were <7% (except for Jew fish) which had an initial K-value of 11%). For freshly caught fish, the initial K-value reported was around 5% (Aleman *et al.*, 1982; Barlie *et al.*, 1985) and for prawns it ranged from 2-3% (Reiley *et al*,. 1984).

The study indicated that the rate of nucleotide degradation differed greatly between species. The variation is caused by the difference in the rate of IMP decomposition in various species. Thus,

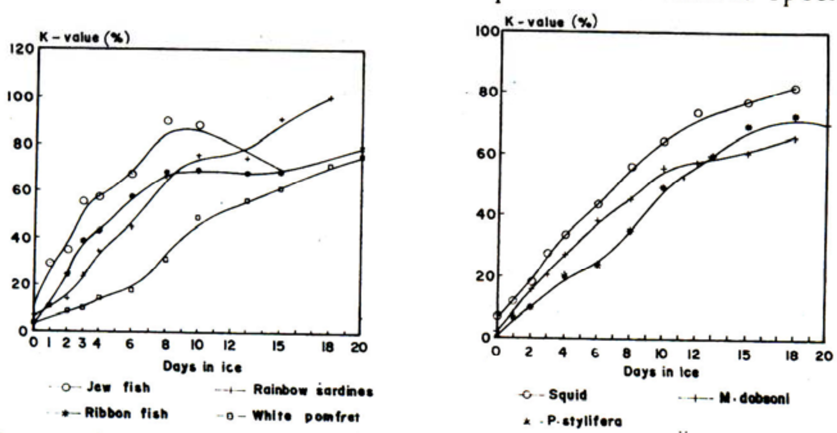

Fig. 1. Changes in K values of finfish, prawns & squid during iced storage

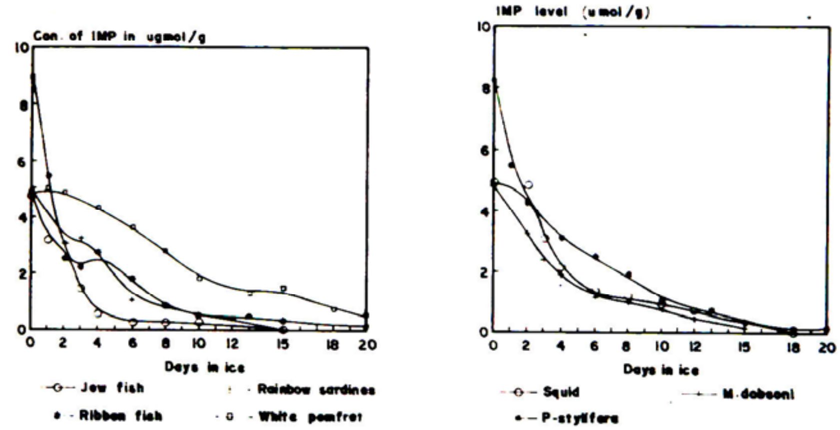

Fig. 2. Changes in IMP level in marine finfish, prawns & squid during iced storage

the dephosphorylation of IMP was very fast in jew fish, ribbon fish and rainbow sardine (Fig. 2). In Jew fish, IMP level decreased from 4.819 to 0.562 μmol^{-1} after 3 days of storage and those of ribbon fish and rainbow sardine were reduced to <1 umol g^{-1} after 6 days from high initial values of 8.95 and 5.06 $\mu molg^{-1}$, respectively. However, the dephosphorylation of IMP was lower in white pomfret and at the end of 15 days, it still had > 30% IMP (1.5 u mol g -1). As IMP is the flavour bearing compound, a reduction in its level, naturally affected the fish flavour.

The K-values of these species are most strongly influenced by the rate of IMP decomposition. Thus K-values of jew fish, ribbon fish and rainbow sardine exceeded 50% respectively in 3, 6 and 7 days of iced storage, whereas that of white pomfret reached only after 13 days. Hattula and Kiesvaara (1992) found that K-value of pike, flounder and white bream exceeded 50% before the third day of iced storage whereas the K-values of bream, sea trout and vimbu were still below 50%. Similarly, in pacific cod Alaska pollack K-value increased to 60% within 2 days of iced storage and the IMP level was reduced to less than 1 umol g^{-1} (Ehira & Uchiyama, 1974). Ehira and Uchiyama (1986) had established K-value (20%) as the reference level for very fresh fish. In the present study, the K-values associated with very fresh fish (around 20%) had reached respectively in 1, 2, 3 and 7 days of iced storage in jew fish, ribbon fish, rainbow sardine and pomfret. After 7 days in ice, the K-value of jew fish had rose to ,89%. In all other fish species K-value reached 60-75% in to 15 days storage.

The hypoxanthine concentration increased rapidly in jew fish, ribbon fish and rainbow sardine as a direct consequence of the velocity of IMP degradation. In white pomfret, Hx increased slowly but steadily and reached 2. 93 $\mu mol\ g^{-1}$ after 15 days. The initial levels of Hx in these species were high (1.15 in jew fish, 0.74 in ribbon fish, 0.52 in rainbow sardine and 0.24 umol g-1 in white pomfret) probably due to the degradations started in the net by struggling. The Hx content reached maximum values of 3.93, 4.82, 3.26 and 3.42 $\mu mol\ g^{-1}$ in jew fish (4 days), ribbon fish (6 days), rainbow sardine (10 days) and

Table 2. **Changes in sensory characteristics and average overall acceptability score of marine finfish during iced storage**

Time - days	0	2	4	6	8	10	12	15
Raw charact-eristics	Bright shining appearance Transparent Surface slime, gills clean red	Characteristics of very fresh fish	Very good appearance, seaweedy odour, firm belly	**White pomfret** Bright shining red gills, firm belly, thick slime. No off odour.	Faded appearance, red gills, sl. sunken eyes no off odour.	Faded appearance sl. soft red gills. No. of odour	Faded appearance Sl. soft pale gills. no off odour	Yellow discolou-ration, Gas formation, no off odour
Cooked charact-eristics	Sweet, juicy, flavour soft & firm texture	-do-	Very good flavour & texture	Sweet juicy flavour, soft & firm texture	Less sweet soft and firm texture	good flavour sl. soft texture	Loss of flavour sl. rancid	Rancid flavour
Raw charact-eristics	Bright shining Red gills, firm belly	Characteristics of very fresh fish. fish in rigor	Good appear-ance. Sl. seaweedy odour. Firm belly	**Jew fish** Good appearance seaweedy odour Sl. soft	Appearance good. Soft texture. No off odour	Faded appearance Pale red gills. No off odour	Faded appearance pale red gills, soft texture	Appearance poor, soft.
Cooked charact-eristics	Sweet, juicy flavour. Firm and soft texture	Flavour and texture very good	Less sweet flavour. Soft texture	Loss of flavour, soft texture	Bland taste soft texture	Sl. rancid, soft texture	Bland rancid	Poor flavour rancid soft
Raw charac-teristics	Bright shining appearence, Red gills, firm belly	Charcteristics of very fresh fish.	Bright shining appear. Red gills, Sl. soft belly	**Rainbow sardine** Bright shin-ing. Few cases of belly burst. Soft texture	Belly burst. Soft texture No off odour	Shining appearance But belly burst in many samples	Belly burst Rancid odour soft texture	Poor appearance very soft Rancid odour
Cooked charact-eristics	Sweet, juicy flavour. Firm and soft texture	Very good. flavour as texture	Good flavour and texture	Less sweet Loss of flavour	Loss of flavour. soft texture	Loss of flavour Rancid soft	Rancid flavour. Poor. texture	poor flavour rancid
Raw charact-eristics	Characteristics of very fresh ribbon fish	Stiff, bright, shining appearnce	Bright shining stiff	**Ribbon Fish** Bright shining stiff, red gills	Bright shining belly brust, No off odour	Belly burst in more fish, Fishy odour	Belly burst. Rancid odour	Poor appearance belly burst
Cooked charact-eristics	Characteristics flavour and texture of very fresh fish	very good flavour and texture	Good flavour and texture	Sl. loss of flavour good texture	Loss of flavour. No off odour	Sl. rancid, soft texture	Rancid taste, soft texture	Rancid falvour

pomfret (18 days), respectively . After reaching the maximum, Hx level declined, probably due to leaching effect. The rapid formations of Hx in the former three species indicated that these species are hypoxanthine accumulators. In white pomfret also, the formation of the Hx was steady, although slow and seemed to be Hx accumulation type. The Hx accumulation in the muscle had reduced the flavour score in these species (Table 2). Inosine did not show any significant build up in these species (fig. 3). In jew fish inosine was in the range of 0.27 to 0.47 $\mu molg^{-1}$ and very little left after 10 days storage. In ribbon fish, no detectable quantity of inosine was noticed during the entire period, suggesting that the breakdown of inosine to Hx was occuring at a faster rate than the degradation of IMP to inosine. In rainbow sardine, it ranged from 0.12 to 0.49 $\mu molg^{-1}$ and only traces was left after 12 days. In white pomfret, inosine gradually increased from 0.03 to 0.78 umol g^{-1} in 8 days and then declined and after 15 days no inosine could be detected.

The rate of nucleotide degradation in squid muscle and in the two prawn species were comparable. Thus, the K-value exceeded 50% level at 8th day in squid and after 10 days in prawns. K-value reached the range of 60-75% during 12-15 days in iced storage. The 20% K-value, which is used as a reference level was attained during 3-4 days in prawns and 2-3 days in squid.The maximum IMP level was attained in the first day itself in squid. The maximum IMP level was attained in the first day itself in squid and prawns, the values being 4.889, 4.791 and 8.212 $\mu molg^{-1}$ in squid, *M. dobsoni* and *P. stylifera* respectively. The IMP levels was reduced to < 1 $\mu molg^{-1}$ after 8 days in squid and *M. dobsoni* and after 10 days in *P. stylifera*. Hypoxanthine content gradually increased and reached maximum level of 4.22 umol g-1 in squid, 2.01 umol g^{-1} in *M. dobsoni* and 2.31 $\mu molg^{-1}$ in *P. stylifera* at 12, 12 and 15 days of iced storage respectively. Both species had comparatively higher levels of inosine (Fig. 3) upto 12 *(M. dobsoni)* and 15 days *(P. stylifera)*; whereas the squid had only little inosine and disappeared altogether in six days.

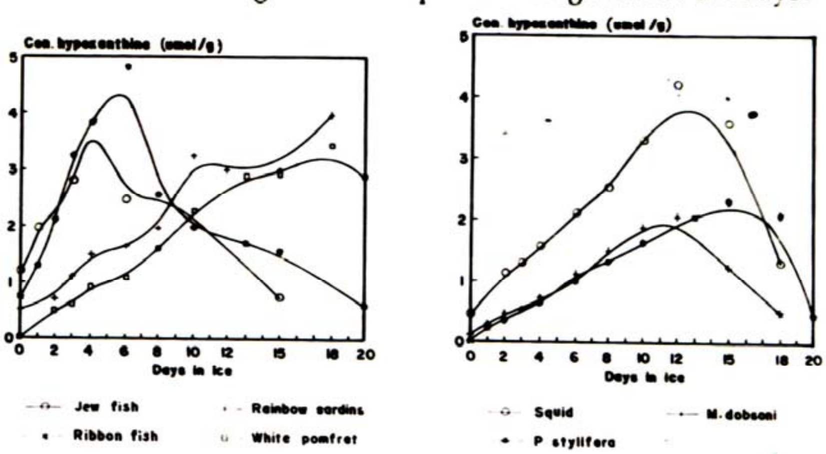

Fig. 3. Changes in Hypoxanthine con. of finfish, prawns & squid during iced storage

Table 3. **Changes in sensory characteristics and average overall acceptability score of marine finfish during iced storage**

Time - days	0	2	4	6	8	10	12	15
				Squid				
Raw charact-eristics	Squid odour sheen red brown colour	Sl. squid odour. Rigor like stiff	Appearance good. Sl. stiff. Firm	Moderately bright. No offensive odour	Colour O.K. Flabby No. off	Sl. reddish discolouration Flabby texture	Red discolour-ation	Discoloured Flabby texture, Sl. (ammoniacal)
Cooked charact-eristics	Fresh squid odour, cream white. Sweet meaty flavour Firm and juicy texture	Character-istic flavour and texture of very fresh squid	Good flavour & texture	Off white Sl. tough texture	Sl. yellow Loss of flavour Sl. tough texture	Sl. yellow bland taste tough texture	Discoloured Bitter taste, tough and dry texture	Rancid flavour
				M.dobsoni				
Raw charact-eristics	Bright crisp dry shell. Sweedy odour (good smell) cool to touch	Characteristics flavour and texture of prawns	Very good flavour and texture	Good appearance shell sl. soft	Shells soft 10% blacken-ing odour	Shells soft 20% blacken-ing. No. off odour	Bleached colour soft complete blackening, sl. ammonia smell	Blackening soft shell ammonia smell
Cooked charact-eristics	Sweet, meaty flavour. Firm and juicy texture	Character-istic flavour and texture of prawns	Very good flavour & texture	Loss of sweet-ness texture good	Loss of flavour but soft texture	Blend taste soft texture	Poor, bitter flavour	
				P.stylifera				
Raw charac-teristics	Character-istics of fresh prawn cool to touch	Bright, crisp dry shell. seaweedy odour	Good appearance No blackening	Appearance good. Sl. seaweedy odour	Shell sl. soft. No blackening	Shell soft No blackening No off odour	Shell soft Faded appearance Fishy odour	Shell soft Sl. discol-ouration. very blackening
Cooked charact-eristics	Sweet, meaty flavour. soft juicy	Characteris-tic flavour and texture	Sweet flavour Soft, juicy texture	Sl. sweet to bland, texture	Loss of flavour. soft	Bland taste soft texture	Bland neutral or fishy flavour	poor flavour

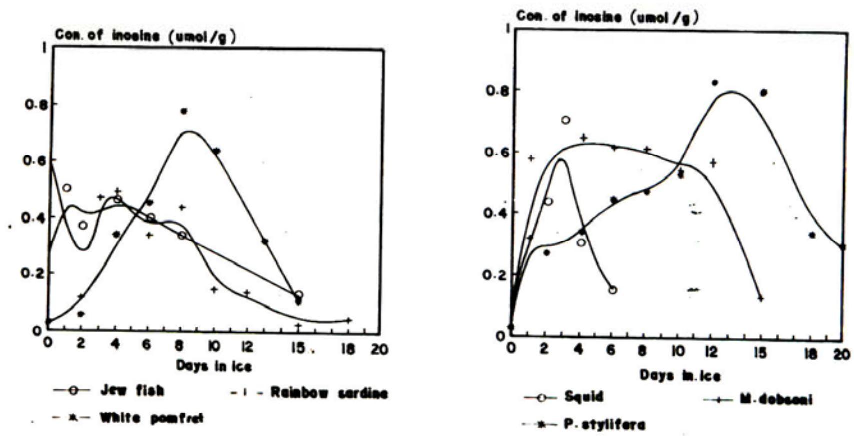

Fig. 4. Changes in Inosine con. of finfish, prawns & squid during iced storage

Sensory analyses: The organoleptic characteristic including taste panel study are presented in Tables 2 & 3. Among the finfish species, white pomfret retained freshness upto 6 days ribbon fish for 4 days, rainbow sardine and jew fish for 3 days each as indicated by transparent surface slime, fresh seaweedy odour, clean red gills free from coloured slime and firm belly. As storage days advanced, the slime thickened, abdominal walls discloured, gills became pale or dirty red, flesh became softened or flabby and offensive smell. In rainbow sardine, the belly had become soft from 4th day onwards and belly bursting started from 6th day onwards . As days passed, more fish had belly bursting and by 12 days almost 100% had belly bursting. The fish was soft and had rancid odour. In ribbon fish, belly bursting started from 8th day onwards and the incidence of belly bursting increased with storage time. The fish had developed rancid and fishy odour.

Fresh squid had sheen red brown colour with squid odour and remained stiffened just like in rigor mortis for 3-4 days of iced storage. As spoilage advanced , mantle lost its white translucent appearance and changed to dull milky and reddish appearance. Prawns remained very fresh with bright crisp dry shell and fresh seaweedy odour for 4 days and then slowly lost their freshness. Softening of shell started from 6 days onwards and the incidence of blackspot from 8th day onwards in *M. dobsoni*. By 12 days of storage, there was complete blackening in this species, with soft shell and ammoniacal odour. No blackening was observed in *P. stylifera*, however, bleaching and softening of shells and ammoniacal odour marked spoilage.

Taste panel study showed that pomfret, ribbon fish and rainbow sardine had prime quality for 6, 4 and 4 days respectively based on sweet juicy and firm texture. Jew fish could retain such prime quality only for 3 days. In squid and two prawn species also prime quality was retained upto 4 days of iced storage. The corresponding K-values were 17.6 (white pomfret), 34.33 (jew fish), 38.57 (ribbon fish), 34.73 (rainbow sardine) 34.15 (squid), 27.19 *(M. dobsoni)* and 19.9 *(P. stylifera)*. The decrease in the level of IMP and a corresponding build up of Hx in the muscle

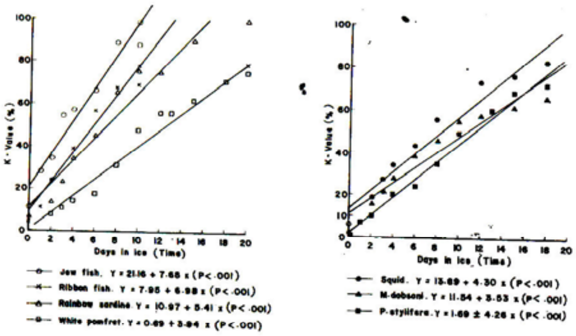

Fig. 5. Correlation of % K-value with storage time (days) on ice.

tend to reduce the flavour and acceptability of the fish. The acceptability of these species was closely related to the rate of change of K-value. Evaluation of the fish by taste panel was discontinued at the point of rejection when the fish had soft texture, rancid or putrid flavour and odour. Squid had developed discolouration, bitter taste, tough and dry texture. In the case of prawns bitter flavour, ammonical odour and soft texture were taken as indication of spoilage. At rejection, K-value had reached 61.2 (15 days) 89.3 (6-8 days), 69.11 (10 days) and 66.68 (8 days) in white pomfret, jew fish, ribbon fish and rainbow sardine respectively. Squid was rejected after 12 days when the K-value was 73.83 and IMP level of 0.73 $\mu mol\ g^{-1}$. Hx content had also reached 4.22 $umol\ g^{-1}$. Prawns were rejected after 12 days *(M. dobsoni)* and 13 days *(P. stylifera)* when their respective K- values had reached 57.58 and 59.65%. Hx level had crossed 2 $\mu molg^{-1}$ and the IMP level reduced to $<1 \mu molg^{-1}$ which indicates the poor quality. The rejection levels of K-value observed in the present study are close to the 60% limit set by Ehire (1976). Kiesvaara *et al.* (1990) proposed that for fish of good quality, the K-value should be less than 75% and the concentrations of IMP higher than 1.15 ug -1 which is well in agreement with the present study.

TVN and TMA -N values were found to be fluctuating in the iced storage fish. The initial TVN values in fish and squid were in the range of 7.2to 12.17 mg/ 100g Tables (4 & 5); whereas initial

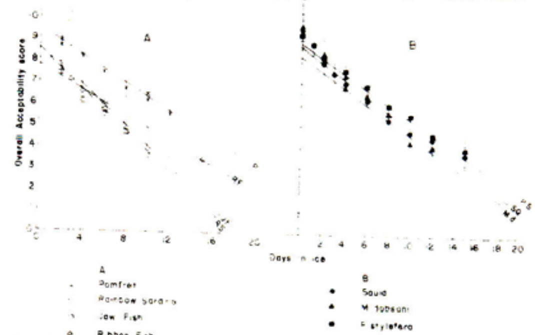

Fig. 6. Changes in the overall acceptability score during iced storage

levels of TVN in prawns were high (19.4 in *M. dobsoni* and 24.65 mg/100g in *P. stylifera).* Such higher levels of TVN, in very fresh prawns have been reported earlier (Susamma *et al.,* 1962; Lakshmanan *et al.,* 1988). At time of rejection TVN values in all the species had exceeded 30 mg/100g threshold of initial spoilage (Tables 4&5). TMA-N did not indicate any particular trend and often, the values remained below 5 mg/100 g. Comparatively higher levels of TVN and TMA-N in ribbon fish and rainbow sardine might be attributed to belly bursting and subsequent bacterial spoilage. Regression analysis of K-value with storage time and sensory score showed significant positive correlations with time and negative correlations with sensory score in all the species studied at 0.1% level. Significant positive correlations were also observed ($P < 0.001$) between IMP level and overall taste acceptability score. Fatima *et al.* (1981)

Table 4. Changes in TVN and TMA-N(mg/100g) values of marine finfish during iced storage

Time/day	White pomfret		Jew fish		Ribbon fish		Rainbow sardine	
Species	TVN	TMA-N	TVN	TMA-N	TVN	TMA-N	TVN	TMA-N
0	7.20	Nil	9.30	2.80	11.67	2.80	12.17	1.4
2	12.60	1.4	24.10	4.20	23.17	4.20	16.42	1.4
4	18.40	2.8	28.3	4.20	30.87	4.9	21.53	2.8
6	21.2	3.5	35.77	6.3	27.56	4.9	24.90	3.5
8	23.7	4.2	34.94	6.3	35.4	5.6	36.74	4.2
10	28.7	4.2	34.40	5.6	32.8	5.6	38.30	6.30
12	31.9	4.9	29.56	4.2	42.00	6.3	34.62	5.4
15	35.6	5.6	28.2	4.2	46.70	6.3	37.20	4.2
18.	38.4	5.6	-	-	22.9	3.5	31.45	4.2
20	30.8	4.2	-	-	18.30	2.8	26.90	3.5

Table 5. Changes in TVN and TMAN values of squid and prawns during iced storage

Time	Squid		Prawns *(M. dobsoni)*		Prawns *(P. stylifera)*	
days species	TVN	TMAN	TVN	TMA-N	TVN	TMA-N
0	9.17	2.8	19.40	2.80	24.65	2.10
2	12.63	3.5	25.75	4.20	30.70	4.20
4	16.80	3.5	32.90	4.20	37.78	4.9
6	22.35	4.2	38.50	5.60	38.12	6.3
8	27.40	4.2	38.22	5.6	34.50	5.6
10	34.50	5.6	42.30	6.3	28.47	4.2
12	35.10	5.6	42.30	6.3	28.47	4.2
15	36.20	4.2	32.47	4.2	25.90	4.9
18	31.40	-	26.80	4.2	-	-
20	-	-	-	-	-	-

also found a good correlation between IMP level and sensory score. The regression lines for K-value and ice storage time and overall acceptability score and storage time are shown in Fig. 5 & 6 respectively. Thus, K-value and IMP concentration seemed good indices for estimating fish quality during iced storage. Hypoxanthine did not bear significant correlation with time in jew fish and ribbon fish, whereas significant correlation ($P < 0.001$) were obtained in all other cases.

Conclusion

In the present study K-value increased linearly with storage time in all the species and the acceptability was dependent on the rate of change of K-value and appeared to indicate the real

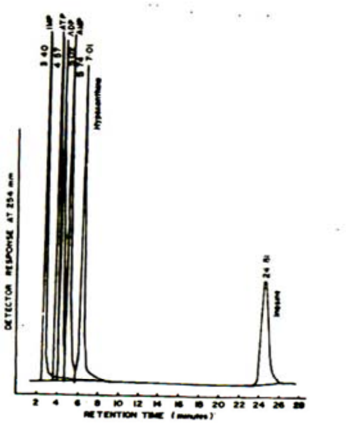

Fig. 7. Separation of standard solutions (0.2m M each) of ATP, ADP, AMP, IMP, Inosine and Hypoxanthine in phosphate buffer at PH 6.8 by High performance Liquid Chromatography

quality of fish. The decomposition of IMP in jew fish, ribbonfish and rainbow sardine was distinctly faster than in white pomfret, squid and prawns and hence a faster rate of increase in K-value. The IMP level clearly reflected the flavour characteristics as indicated in the taste panel study. All the species, in the present study are potential hypoxanthine accumulators.

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