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# Effect of Delay in Icing on Quality and Shelf Life of Fish in India

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The effect of delay in icing on quality and shelf life of 14 Indian fishes was studied. The quality changes during ice storage were addressed by sensory methods and Intelectron Fish Tester VI. Spoilage rate in ice was not affected by the previous pre-icing histories. The potential storage lives, if the fishes had been iced immediately after death were, 16.0, 14.1, 12.4, 12.3, 9.2, 8.6, 10.1, 6.8, 6.4, 6.4, 6.0 and 5.3 days, respectively for *Otolithes cuvieri, Johnieops sina, Gerres filamentosus, Lactarius lactarius, Alepes djedaba, Liza parsia, Caranx para, Thryssa mystax, Tilapia mossambica, Osteogeneiosus militaris, Sardinella longiceps* and *Sardinella gibbosa*. The shelf life in ice for *Decapterus russelli* and *Stolephorus devisi* were 2 and < 1 day(s), respectively when the fishes were exposed to ambient temperature for 3 h before icing. At the critical region for acceptance / rejection, Intelectron Fish Tester VI can be a reasonably accurate indicator of freshness.

**Key words : Delayed icing, quality, shelf life, tropical fish.**

Icing of fish immediately after catch keeps them in acceptable condition from a few days to a couple of weeks depending on their inherent characteristics. However, in commercial practice the shelf life is shortened, because of delayed, insufficient, and/or improper icing. Immediate cooling of the catch is more important in tropical conditions as the ambient temperature is high which results in rapid spoilage. The earlier the fish is iced the better will be the keeping quality. Icing of fish immediately after catch, however, may not be practical onboard small boats because of limited facilities. Non availability of ice may also be a factor in certain areas. Under these circumstances fish may be iced on landing, if ice is available. Even when facilities exist onboard, as on bigger trawlers, occasional delays of a few hours occur, resulting in fish of poor or unacceptable quality at the time of landing. Hence there exists the necessity to determine the maximum period of exposure of the catch to ambient temperature which does not significantly affect quality and shelf life.

The influence of delayed icing on quality and storage life of fish has been studied by some workers. *Scomber colias* left on the deck at 30°C and exposed to sunrays, showed evident deterioration of quality within 1 h in the outer layer of the fish pile and within 2.5 to 3 h in the middle of the pile (Kordyle & Karnicki, 1969). If lean fish is held at 20°C for 16 to 18 h before cooling to 0°C, quality is kept for only half as long as when immediately cooled down to 0°C (Meyer *et al.*, 1969). For *Cirrhina mrigala* a delay of 7 h after death before chilling does not cause any noticeable decrease in subsequent shelf life in ice (Nair *et al.*, 1974). Tilapia from Uganda kept for 6 h prior to icing had practically the same storage life as if they had been iced immediately after capture (Disney *et al.*, 1974). For South American hake (Huss & Asenjo, 1977) and *Sardinella aurita* (Herzberg *et al.*, 1977) delay in icing decreased quality and shortened shelf life. Limited evidence shows that delay of some 6 h at ambient temperature is permissible for some species of tropical fish before icing, without harming longer term shelf life (Jones & Disney, 1977). Fourteen percent loss in shelf life of *Caranx* sp. by with pre-icing delay of 6 h and 79% for 9 h delay were observed by Mu *et al.*, (1977). Delays up to 4 h prior to icing did not adversely affect shelf life of fishes like *Labeo rohita*, *Cirrihinus mrigala* and *Tilapia mossambica* (Durairaj & Krishnamurthi, 1986). Thus, there is no general agreement on the adverse effect of delay in icing on quality and shelf life of different species of fish. The maximum delay permissible varies from 2.5 to 9 h according to the above authors. The present study was undertaken to establish maximum delay prior to icing of Indian fishes, without detriment to quality and storage life.

## Materials and Methods

*Otolithes cuvieri* (Trewavas), *Johnieops sina* (Cuvier), *Gerres filamentosus* (Cuvier), *Lactarius lactarius* (Bloch & Schneider), *Alepes djedaba* (Forsskal), *Liza parsia* (Hamilton & Buchanan), *Caranx para* (Cuvier) *Thryssa mystax* (Schneider), *Tilapia mossambica* (Peters), *Osteogeneiosus militaris* (Linnaeus), *Sardinella longiceps* (Valenciennes), *Sardinella gibbosa* (Bleeker). *Decapterus russelli* (Ruppell) and *Stolephorus devisi* (Whiteley) were studied. The details of procurement of these fishes are shown in Table 1. The size of the fish in each species was uniform. Live fishes were killed by a blow on the head with a strong stick. Where live fishes were available, a part of the lot was iced and stored in insulated boxes immediately after death. The rest of the material and the fish already dead at the time of collection were exposed to ambient temperature (27-30°C) for 3, 6 and 8 h before icing. The time lag between harvest and collection as ascertained from the fishermen was considered when computing the pre-icing delay. The ratio of fish to crushed block ice was 1:2. The insulated boxes were kept in a chill room maintained at 0-2°C.

Table 1. Details of fishes studied for effect of delayed icing

| Name of fish | Average weight of fish, g | Time lag between harvest & collection, h | Condition of the fish at the time of collection |
|---|---|---|---|
| Lesser tigertooth croaker *Otolithes cuvieri* | 70 | 1.5 | Pre-rigor |
| Sin croaker *Johnieos sina* | 35 | 3.0 | In rigor |
| Whiofin silverbiddy *Gerres filamentosus* | 70 | 0.0 | Alive |
| False trevally *Lactarius lactarius* | 20 | 1.5 | Pre-rigor |
| Shrimp scad *Alepes djedaba* | 100 | 3.0 | In rigor |
| Gold-spot mullet *Liza parsia* | 25 | 3.0 | In rigor |
| Banded scad *Caranx para* | 10 | 1.5 | Pre-rigor |
| Moustached thryssa *Thryssa mystax* | 20 | 3.0 | In rigor |
| Tilapia *Tilapia mossambica* | 30 | 0.0 | Alive |
| Soldier catfish *Osteogeneiosus militaris* | 125 | 3.0 | In rigor |
| Indian oil sardine *Sardinella longiceps* | 60 | 3.0 | In rigor |
| Goldstripe sardinella *Sardinella gibbosa* | 60 | 1.5 | Pre-rigor |
| Indian scad *Decapterus russelli* | 25 | 3.0 | In rigor |
| Devis' anchovy *Stolephorus devisi* | 10 | 3.0 | In rigor |

*Tilapia mossambica* from freshwater; the rest are marine fish

Ten fishes from each lot of pre-iced fishes were examined for quality characteristics at intervals till they were spoilt. Each fish was individually measured with an Intelectron Fish Tester VI (Intelectron, International Electronics GMBH & Co., Hamburg) and the average of 10 readings was taken. The fish were then assessed for

Table 2. Regression of sensory scores on storage time and potential storage life

| Species | Delay in icing, h | Pooled slope b | Intercept a | Storage time in days for sensory score of 10 | 4 | Potential storage life, days |
|---|---|---|---|---|---|---|
| *Otolithes cuvieri* | 3 | -0.3737 | 8.90 | -2.9 | 13.1 | 16.0 |
| | 6 | | 7.04 | -7.9 | 8.1 | |
| | 8 | | 4.95 | -13.5 | 2.5 | |
| *Johnieops sina* | 3 | -0.4240 | 8.52 | -3.5 | 10.6 | 14.1 |
| | 6 | | 6.77 | -7.6 | 6.5 | |
| | 8 | | 4.42 | -13.2 | 0.9 | |
| *Gerres filamentosus* | 0 | -0.4855 | 9.77 | -0.5 | 11.9 | 12.4 |
| | 3 | | 8.70 | -2.7 | 9.7 | |
| | 6 | | 6.04 | -8.2 | 4.2 | |
| *Lactarius lactarius* | 3 | -0.4867 | 8.32 | -3.4 | 8.9 | 12.3 |
| | 6 | | 6.94 | -6.3 | 6.0 | |
| | 8 | | 5.10 | -10.1 | 2.3 | |
| *Alepes djedaba* | 3 | -0.6548 | 8.79 | -1.8 | 7.3 | 9.2 |
| | 6 | | 6.47 | -5.4 | 3.8 | |
| | 8 | | 4.65 | -8.2 | 1.0 | |
| *Liza parsia* | 3 | -0.6953 | 8.54 | -2.1 | 6.5 | 8.6 |
| | 6 | | 6.67 | -4.8 | 3.8 | |
| | 8 | | 5.04 | -7.1 | 1.5 | |
| *Caranx para* | 3 | -0.5980 | 7.63 | -4.0 | 6.1 | 10.1 |
| | 6 | | 6.00 | -6.7 | 3.3 | |
| | 8 | | 5.00 | -8.4 | 1.7 | |
| *Thryssa mystax* | 3 | -0.8781 | 8.90 | -1.3 | 5.6 | 6.8 |
| | 6 | | 6.76 | -3.7 | 3.1 | |
| | 8 | | 4.88 | -5.8 | 1.0 | |
| *Tilapia mossambica* | 0 | -0.9413 | 9.51 | -0.5 | 5.9 | 6.4 |
| | 3 | | 9.00 | -1.0 | 5.3 | |
| *Osteogeneiosus militaris* | 3 | -0.9302 | 8.78 | -1.3 | 5.1 | 6.4 |
| | 6 | | 7.08 | -3.1 | 3.3 | |
| *Sardinella longicepts* | 3 | -1.0000 | 8.17 | -1.8 | 4.2 | 6.0 |
| | 6 | | 7.00 | -3.0 | 3.0 | |
| *Sardinella gibbosa* | 3 | -1.1189 | 8.53 | -1.3 | 4.0 | 5.3 |
| | 6 | | 7.27 | -2.4 | 2.9 | |

sensory characteristics in the raw and in the cooked state (Connell, 1980; Varma *et al.*, 1983) by an expert panel of 3 members. Fish were cooked in 3 per cent common salt solution for 7 min after dressing and washing. The samples were assessed after cooling to room temperature. Based on the observations in the raw and cooked stage, a score for each of the samples was given on a scale of 0 to 10 where 10 is excellent, 9 very good, 8 good, 7 slightly good, 6 border-line plus, 5 border-line, 4 border-line minus (limit of acceptability), 3 slightly poor, 2 poor, 1 very poor and 0 extremely poor (Amerine *et al.*, 1965). The average of the scores of the panel members were calculated and corrected to the nearest whole number if necessary.

The regression of sensory scores on storage period as well as those of $\log_{10}$ Intelectron readings vs. sensory scores were worked out for each species of fish. The equality of the slopes of regression lines was tested by analysis of covariance (Snedecor & Cochran, 1973)

**Results and Discussion**

The regression lines of sensory scores on storage time in ice for each period of delay for these fishes (excluding *D. russelli* and *S. devisi*) were drawn and two representative gfaphs are given in Fig. 1 & 2. Broadly these figures showed that the regression lines in each fish were parallel. The equality of the slopes of the different regression lines in each figure reflects the fact that the rate of reduction in sensory scores (i.e., rate of spoilage) were uniform. Hence it can be concluded that spoilage rate was the same whether the fish was kept at ambient temperature for 0, 3, 6 or 8 h before icing i.e., spoilage rate in ice was not affected by the previous pre-icing histories. The deviation observed in the figures was only due to the small number of observations made as a result of short shelf life and did not dispute the statement that the rates of spoilage were similar in each species of fish irrespective of initial delay in icing. In all cases, the period for which the iced fish received sensory scores above 4 (acceptable level) was reduced with increased delay in icing after catch. The regression lines shown in the figure can be used for determining the predicted storage life i.e., storage time corresponding to a sensory score of 4.

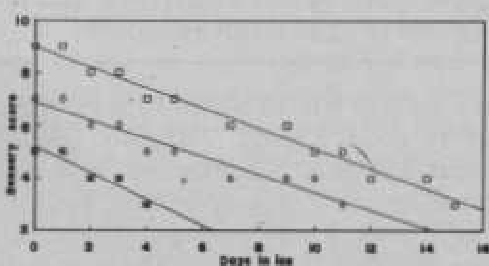


Fig. 1. Regression of sensory evaulation scores on iced storage time for *Otolithes cuvieri*

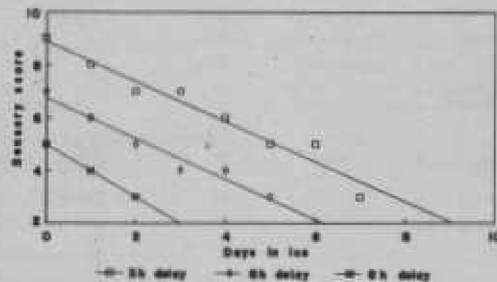


Fig. 2. Regression of sensory evaluation scores on iced storage time for *Alepes djedaba*

Regression of sensory score on storage time in ice for each period of delay in icing for the different species of fish are given in Table 2. Regression slopes for each fish not differing significantly ($p > 0.05$) were pooled. The pooled regression slopes (b) for each fish gave the best estimate of the spoilage rate in ice and was used to calculate the regression equations for the 3 data sets separately. From these equations extrapolation back to a score of 10 gave a negative storage time equivalent to the number of days in ice storage that was lost by storage at ambient temperature before icing. The sum of time lost before icing and subsequent storage life in ice gives an estimate of potential storage life for the particular species; had the fish been iced immediately after death.

The potential storage lives thus calculated are shown in Table 2 for 12 of the fishes studied.

As *D. russelli* and *S. devisi* had very short shelf lives in ice, the data were not sufficient to carry out the statistical analysis. The shelf lives of *D. russelli* were as follows: 2, < 1 and < 1 day(s) for 3, 6 and

8 h deays in icing, respectively. Similarly *S. devisi* had a shelf life of less than one day for 3 and 6 h delays. This species had a shelf life of less than 8 h at ambient temperature.

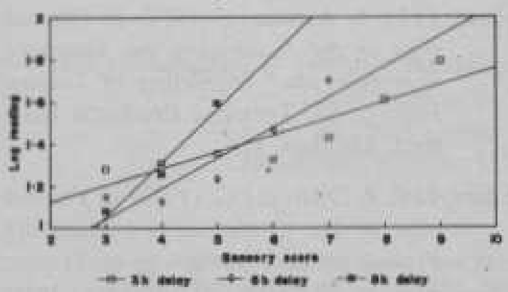

Fig. 3. Regression of log Intelectron readings on sensory scores for *Johnieops sina*

The results of this study show that any delay in icing of the fishes studied does cause some loss of quality and shelf life. Hence it is not feasible to specify a permissible delay period (maximum) before icing, without first defining or stipulating an expected shelf life for each species.

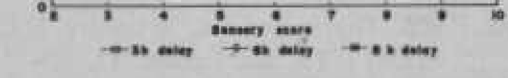

Fig. 4. Regression of log Intelectron readings on sensory scores for *Alepes djedaba*

The Intelectron Fish tester readings were found to describe a concave curvilinear plot with storage time. Hence the readings were plotted after logarithmic transformation vs. sensory scores to get a linear relationship. The results are depicted in Figures 3 and 4 (only two representative graphs). The regression of the log Intelectron readings vs. sensory scores are shown for each fish species and delayed icing period. It was observed that the slopes of the regression lines increased with the delay in icing as shown in Table 3. Hence the pre-icing history affects the rate at which the meter readings decrease during subsequent iced storage. However,

Table 3. Regression of log Intelectron readings on sensory score.

| Species | Delay in icing, h | Intercept a | Slope b |
|---|---|---|---|
| *Otolithes cuvieri* | 3 | 0.79 | 0.1132 |
| | 6 | 0.35 | 0.2095 |
| | 8 | 0.53 | 0.2414 |
| *Johnieops sina* | 3 | 0.99 | 0.0745 |
| | 6 | 0.56 | 0.1489 |
| | 8 | 0.28 | 0.2559 |
| *Gerres filamentosus* | 0 | 1.13 | 0.0637 |
| | 3 | 0.98 | 0.0824 |
| | 6 | 0.83 | 0.1385 |
| *Lactarius lactarius* | 3 | 1.15 | 0.0747 |
| | 6 | 1.12 | 0.0907 |
| | 8 | 0.78 | 0.1937 |
| *Alepes djedaba* | 3 | 0.30 | 0.1222 |
| | 6 | 0.27 | 0.1506 |
| | 8 | -0.17 | 0.2720 |
| *Liza parsia* | 3 | 0.72 | 0.1041 |
| | 6 | 0.72 | 0.1140 |
| | 8 | 0.67 | 0.1505 |
| *Caranx para* | 3 | 1.13 | 0.0673 |
| | 6 | 1.03 | 0.0967 |
| | 8 | 0.73 | 0.1505 |
| *Thryssa mystax* | 3 | 1.39 | 0.0359 |
| | 6 | 1.33 | 0.0450 |
| | 8 | 1.30 | 0.0642 |
| *Tilapia mossambica* | 0 | 1.31 | 0.0574 |
| | 6 | 0.81 | 0.1628 |
| *Osteogeneiosus militaris* | 3 | 1.23 | 0.0558 |
| | 6 | 0.88 | 0.1033 |
| | 8 | -0.27 | 0.4075 |
| *Sardinella longiceps* | 3 | 1.06 | 0.0572 |
| | 6 | 1.21 | 0.0877 |
| *Sardinella gibbosa* | 3 | 1.23 | 0.0735 |
| | 6 | 1.21 | 0.0916 |
| | 8 | 1.10 | 0.1298 |

the meter readings could not effectively predict the sensory scores, unless the pre-icing history of the samples were known. But the regression lines were observed to be either close or intersect in the region of sensory scores 3-5. Since this is a critical region for acceptance/rejection, it would appear that Intelectron Fish Tester can be used as a reasonably accurate indicator of freshness for the border-line samples of fish. However, as the regression lines appear to become steeper with increased delay in icing, there is a possibility of using the meter readings over a suitable period of time to detect fish samples which have been iced after considerable delay.

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