

Studies on the Effect of Leaching on the Quality of Ice-Stored Fish

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A comparative ice storage study of milk fish (*Chanos chanos*) in direct contact and out of contact (in 200 gauge polyethylene bag) with ice was taken up to assess the effect of leaching on quality of ice-stored fish. It was observed that the leaching effect was more significant on TVN and NPN than that on α amino nitrogen components while there was very little effect on bacterial load. It is concluded that under similar conditions of icing, fish out of contact with ice will have longer shelflife and more acceptability than the fish preserved in contact with ice.

In a developing tropical country like India where frozen fish industry for internal market may not flourish in near future due to lack of facility of cold chain, the preservation of fish by icing will play a vital role in the distribution of fish. Average consumers prefer fresh fish to iced fish showing same chemical indices of spoilage. This is probably due to the leaching of some constituents by ice melt water. Leaching may remove components responsible for good organoleptic characteristics, but it might remove some undesirable components of spoilage also. The extent of leaching occurring during ice storage of different species of fish and the effect of leaching on overall quality of ice stored fish are not fully studied. If leaching could be stopped, the overall quality and acceptability of the fish may improve.

Although some studies have been made on ice storage of few species of fish both fresh water and marine (Kamasastri *et al.* 1967; Madhavan *et al.* 1970; Nair *et al.* 1971; Shenoy *et al.* 1972; Solanki *et al.* 1977; 1978), muscles, clams, crabs (Chinnamma *et al.* 1970), squid (Joseph *et al.* 1977), the exact pattern of change in the chemical indices were not clear due to leaching. During long distance transportation of iced fish also (Rao *et al.* 1978; 1979) the exact pattern of change occurring in fish was not clear due to leaching effect of ice melt water.

Therefore to get a clear picture of the phenomena of leaching and to understand thoroughly the changes occurring in ice stored fish and also the probable agents responsible for such changes this study was taken up.

Materials and Methods

The milk fish (*Chanos chanos*) having average weight 325 g was used for the study. The fish was caught from the local brackish water fish farm, brought to the laboratory and immediately iced in two different ways. 15 kg fish was packed in crushed ice in three layers (fish to ice ratio 1:1) in thermocole (2.5 cm thick) insulated second hand tea chest (36 cm $\times$ 49 $\times$ 36 cm), half of the fish in direct contact with ice (unpacked) and the remaining half out of contact with ice packed in heat sealed leak proof polyethylene (200 gauge) bags. In each layer, half of the fish was in direct contact with ice and half out of contact with ice.

The temperature of the fish was noted using an alcohol thermometer by piercing the muscle. Temperature was found to be maintained at 0 to 1°C throughout the experiment. Samples were drawn at definite intervals for analysis. Icing was done after every 24 h keeping the fish to ice ratio as 1:1. The muscle portion from the dorso-lateral part of the fish was taken out after removing the scales and used for analysis.

Moisture was determined by AOAC method (1975). Non-protein nitrogen (NPN) was determined by Kjeldahl method, total volatile nitrogen (TVN) by micro-diffusion method (Conway, 1947) and α amino nitrogen by the method of Pope & Stevens (1939) using the trichloro acetic acid extract of the muscle. Total bacterial count (TBC) was determined by the standard pour plate method using tryptone glucose agar medium.

Results and Discussion

Changes in the moisture content of the muscle during ice storage are shown in Fig. 1. Quite opposite trends were observed in packed and unpacked samples. In case of unpacked samples a slight decrease in moisture value was observed upto 3 days after which gradual increase in moisture values was observed upto 19 days, after which there was a fall. During rigor development, muscle toughens due to muscular contraction (Holston & Slavin, 1965) and water binding capacity of the fish muscle decreases (Partmann, 1965). The initial decrease may be due to the contraction of the muscle and the pressure of ice on the muscle in rigor which was set in after icing (Partmann, 1965). Thereafter the gradual rise in moisture is due to the absorption of ice melt water by the muscle by which time the rigor might have been resolved. After 19 days the muscle has become very soft and so due to the pressure of ice there was final fall in moisture value. In case of packed sample as there was no direct contact of muscle with ice, there was no absorption of ice melt water. Since water binding

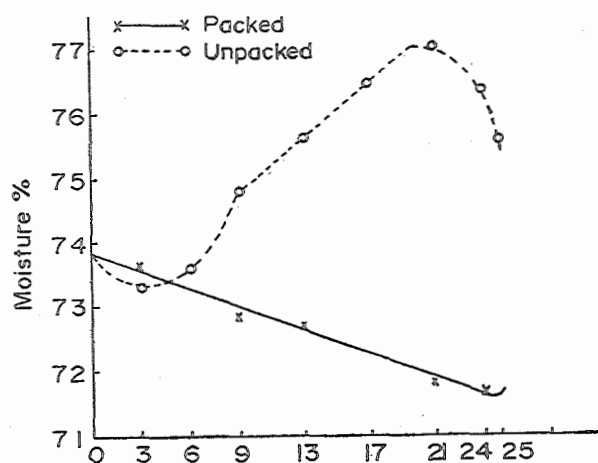


Fig. 1. Changes in moisture during ice storage.

capacity of fish muscle decreases during rigor development, which causes an increasing amount of water to be exuded during the following days even at low temperature (Partmann, 1965), a gradual decrease was observed throughout from the beginning. The pressure of ice positively helped the exudation (Partmann, 1965). Also it was observed that some drip has accumulated in polyethylene bag after 19 days from the softened muscle which has also contributed to the steep fall in moisture in the final stage.

Changes and percentage of leaching in NPN, during ice storage are shown in Fig. 2. In unpacked samples there was gradual decrease due to constant leaching

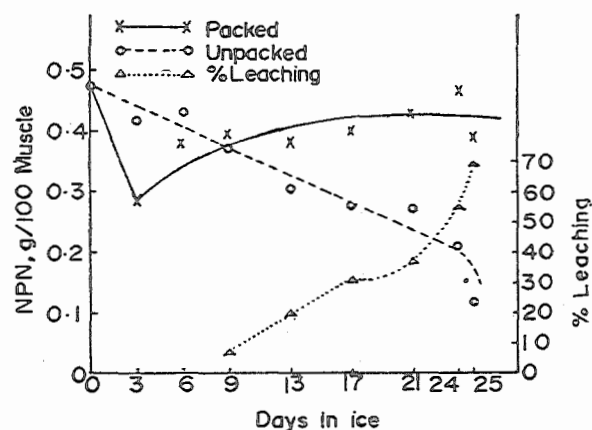


Fig. 2. Changes in NPN during ice storage and percentage leaching.

effect of the ice melt water. Due to low temperature of preservation, the rate of production by bacteria was very low whereas in case of the packed one, due to the probable consumption of NPN fraction by bacteria, there was slight initial fall and afterwards due to breakdown of protein (Partmann, 1966; Davey & Gilbert, 1966; Lerke *et al.* 1967; Nair *et al.* 1971; Shewan, 1974, 1976) slow rate of increase was observed. Very low value of NPN on 3rd day may be due to individual sample variation.

Fig. 3 represents the changes and percentage of leaching in α amino nitrogen in ice stored fish. In both packed and unpacked samples, there is gradual decrease in α -amino nitrogen values upto 9 days after which there is gradual increase in

packed sample and gradual decrease in unpacked sample. The decrease upto 9 days may be attributed to bacterial consumption and to some type of deamination reaction as observed by *Nair et al.* (1971).

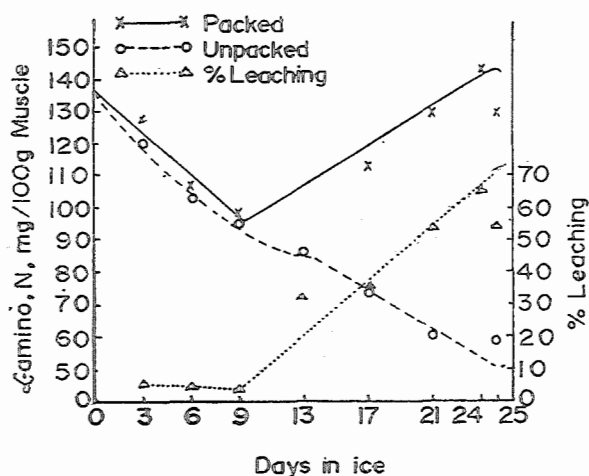


Fig. 3. Changes in ∞ amino nitrogen during ice storage and percentage leaching.

An interesting point here is that although the increase was observed in NPN values in packed samples from 3rd day onwards, in case of amino nitrogen values the increase was observed from 9th day onwards. This clearly shows the stepwise breakdown of proteins into polypeptides and further breakdown of polypeptides into free amino acids, again confirming the presence of proteolytic activity as contended by the workers mentioned above.

Fig. 4 shows the changes and percentage of leaching in TVN values during ice storage. From the figure it is quite clear that TVN value increases gradually in packed sample whereas in unpacked sample it falls gradually which clearly indicates the leaching of volatile nitrogen materials by ice melt water. The high initial value and very slow increase of TVN values in packed sample may be attributed to species characteristics of the brackish water fish.

Now comparing the rate of percentage leaching of ∞ amino nitrogen and TVN values, it can be seen that the rate of percentage leaching of TVN values is much faster than ∞ amino nitrogen. As rate of percentage leaching of total volatile nitrogen material is very high, it cannot

be considered as an index of spoilage in case of fish stored in ice in direct contact.

It is well known that volatile nitrogenous compounds impart undesirable flavour to the product while generally the free amino acids impart desirable one. Now when packed and unpacked samples are compared with reference to the TVN and ∞ amino nitrogen content of the ice stored muscle, it is seen that in unpacked samples most of the volatile nitrogenous compounds are leached out while a good amount of ∞ amino nitrogenous compounds produced in the muscle are retained. In packed sample all the volatile nitrogenous and ∞ amino nitrogenous compounds produced during ice storage are present in the muscle as leaching is absent there. From the organoleptic evaluation it is observed that the packed sample is always more acceptable than the unpacked sample upto 21 days so far as flavour is concerned. It is also observed from organoleptic evaluation

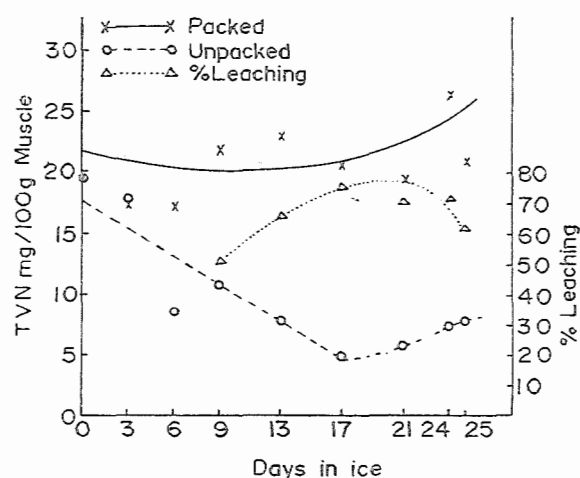


Fig. 4. Changes in TVN during ice storage and percentage leaching.

that on any particular stage of storage the texture and colour are more acceptable, texture being firmer and colour being more attractive in the case of packed sample compared to the unpacked sample.

Changes in the bacterial count are presented in Fig. 5. In both packed and unpacked samples, initially a definite decrease in total count was observed, which is due to the sudden chilling effect of ice on bacteria. Thereafter the count increased very

slowly upto 17 days, the rate of increase being faster thereafter upto 21 days. On 25th day the count was high and fish

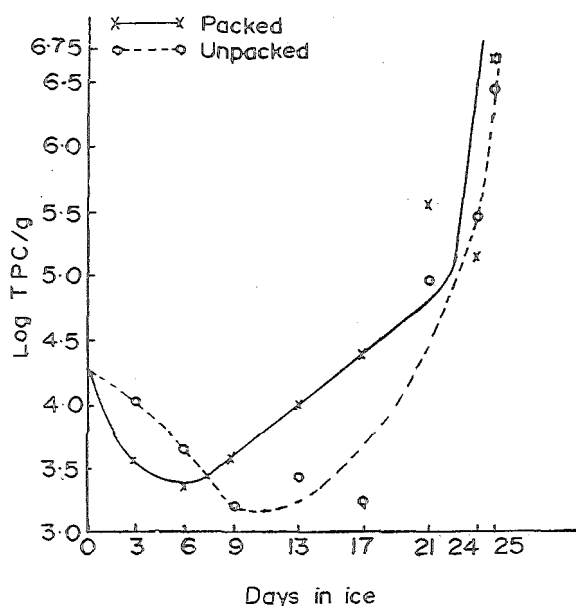


Fig. 5. Changes in TPC during storage.

was in spoiled condition as judged chemically and organoleptically. There was no significant leaching effect of ice melt water on bacterial population.

So it is concluded that under similar conditions of icing, packed fish will have longer shelf-life and give more acceptable product than unpacked fish.

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References

- A.O.A.C. (1975) *Official Methods of Analysis*, 12th edn. Association of Official Agricultural Chemists, Washington
- Chinnamma, P.L., Choudhuri, D.R. & Pillai, V.K. (1970) *Fish. Technol.* 7, 137
- Conway, E.J. (1947) *Microdiffusion Analysis*. Revised edn. Van Nostrand Co. Inc., New York
- Davey, C.L. & Gilbert, K.V. (1966) *J. Fd Sci.* 31, 135
- Holston, J. Slavin, J.W. (1965) in *Technology of Fish Utilization*. (R. Kreuzer, ed.) F.A.O., p. 41
- Jose Joseph, Varma, P.R.G. & Venkataraman, R. (1977) *Fish. Technol.* 14, 13
- Kamasastri, P.V., Ghadi, S.V. & Rao, D.R. (1967) *Fish Technol.* 4, 71
- Lerke, P., Farber, L. & Adams, R. (1967) *Appl. Microbiol.* 15, 770
- Madhavan, P., Balachandran, K. K. & Choudhuri, D.R. (1970) *Fish. Technol.* 7, 67
- Nair, R.B., Tharamani, P.K. & Lahiri, N.L. (1971) *J. Fd Sci. Technol.* 8, 53
- Partmann, W. (1965) in *Technology of Fish Utilization* (R. Kreuzer, ed.) F.A.O., p.4
- Partmann, W. (1965) *Z. Lebensm. unters-Forsch.* 129, 205
- Pope, C.G. & Stevans, M.F. (1939) *Biochem. J.* 33, 1070
- Rao, C.C.P., Govindan, T.K., Gupta, S.S. & Chattopadhyay, P. (1979) *Fish. Technol.* 16, 11
- Shenoy, A. V. & Arul James, M. (1972) *Fish. Technol.* 9, 34
- Shewan, J.M. (1974) in *Industrial Aspects of Biochemistry* (O. B. Spenser, Ed.) pp. 475 - 490, Federation of European Biochemical Societies
- Shewan, J.M. (1976) in *Handling, Processing and Marketing of Tropical Fish*, Tropical Products Institute, London, p.51-63
- Solanki, K.K., Radhakrishnan, A.G., Jose Joseph & Venkataraman, R. (1977) *Fish. Technol.* 14, 119
- Solanki, K.K. & Venkataraman, R. (1978) *Fish. Technol.* 15, 7