

STUDIES ON PACKAGING OF FRESH FISH

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[Studies conducted in the laboratory and field have shown that iced fish can be preserved for longer periods in fresh and edible condition in conventional bamboo baskets by providing additional insulated linings of double layer of gunny and polythene or bitumen coated kraft paper. The quality of fish is adjudged by chemical and organoleptic evaluations.]

Introduction

Fish, one of the most perishable protein foodstuffs, starts spoiling soon after its death. The most important factor causing the spoilage of fish, if not stored at low temperatures, is the bacterial decomposition although enzymatic and oxidation reactions are important in certain cases. One of the most effective ways to retard the spoilage by these factors will be to reduce the temperature of fish. Spoilage of fish can significantly be reduced and kept fresh for a limited length of time by holding in melting ice. It was reported that spoilage rate of fish would be twice as fast at 2.5°C (36.5°F) as at -1.1°C (30°F)¹ and at 5.5°C (42°F) is twice as fast as it is at 0°C (32°F) but at 11°C (52°F) it is about 4 times². However as the use of more ice will raise the cost of fish, every effort should be made to reduce the melting rate of ice to the minimum. In India, the scattered landing of fish over a long coastline, as well as the delay involved between time of catching and distribution etc., contribute to the problem of distribution of fresh marine fish in an economical manner without considerable wastage due to spoilage³. Use of 300 gauge polyethylene film as a lining to the conventional fish baskets has been tried by Central Food Technological Research Institute, Mysore, for reducing the rate of melting of ice (Private communication, Central Food Technological Research Institute, Mysore). Studies have been made in this Institute to find out whether rate of melting of ice can be reduced by providing other insulated linings like double layer of gunny and polythene or bitumen coated union kraft paper lining to these baskets and thereby extend the storage life of fish in fresh condition. The need for developing suitable packaging for fresh fish has been stressed by the conference of State Ministers for fisheries in 1958³.

Materials and Methods

The baskets used were of shallow type made from split bamboo having about 1.5 and 2.5 c. ft. capacities. The gunny was stitched to the inner surface of the basket and 300 gauge polythene was spread over it to protect the gunny from becoming wet when iced fish was kept. The union kraft paper lining was also similarly used for the inner surface of the basket. Holes were made to the liners at the bottom to drip away water from melting ice.

Fresh fish like jew fish and sardines (30 Nos/kg) obtained from the catches made by fishing boats operating from Manasserri (Fort Cochin) were used in these studies. The fish were kept iced from the time of catching till they were used for the experiments, the duration not exceeding four hours. Trials were conducted using 5 kg. to 10 kg. fish suiting the size of the baskets and the ratio of fish to ice was kept 1:1.

Temperature measurements were made at regular intervals in the fish muscle at top, bottom and central layers of the material in the baskets by means of 26 SWG copper constantan thermocouples over a Cambridge pyrometer to an accuracy of $\pm 0.25^{\circ}\text{C}$. Time taken for the material to reach the maximum temperatures of 5°C (41°F)/ 5.8°C (42.5°F) and 7.2°C (45°F)/ 9.4°C (49°F) were noted.

Trimethylamine (TMA), total volatile base (TVB) and organoleptic evaluation were determined at suitable intervals during the storage period. TMA (Trimethylamine) and TVB (Total volatile base) were estimated as follows:

10 gm. of muscle was ground with 95% ethanol and final volume was made upto 100 cc. TMA was estimated by microdiffusion technique of Conway⁴. TVB was determined by distilling a known volume of the alcohol extract with excess of saturated sodium borate. The total basic compounds evolved are absorbed by boric acid and titrated against N/70 HCl.⁵

Results and Discussion

The results are recorded in tables I to VI. The initial temperature of the fish ranged from 26.7°C to 29.5°C (80 to 85°F) and if ice and fish are properly mixed as suggested elsewhere in the paper, takes about 2 hours to come to a temperature of 5°C (41°F) and below.⁶ During this period of 2 hours about half the quantity of ice has been expended. Ice would continue to melt thereafter due to the heat transferred by the air within, which would be at a higher temperature than the material and heat losses from leakage and the heat evolved by fish during spoilage. The fish attains the lowest equilibrium temperature of (33°F)/(35°F) during the next 2 to 3 hours and gradually rises to 5°C (41°F)/ 5.8°C (42.5°F) in the next 5, 6, 10, 12 hours in the baskets (a) without lining (b) with 300 gauge polythene lining (c) with double layer of gunny and 300 gauge polythene film and (d) with union kraft paper lining respectively. Further temperature rise to 7.2°C (45°F)/ 9.4°C (49°F) was noticed during the next 2, 2, 3 to 4, 4 to 5 hours respectively in the baskets in the above same order.

TABLE I

Temperature distribution of fish stored in bamboo baskets provided with different linings
(Ratio of fish : ice :: 1 : 1)

| Type of packaging | No. of hours elapsed after packing | Temperature range in C (F) | | |
|--|------------------------------------|-----------------------------|---------------------------|--------------------------|
| | | Bottom layer of material | Central layer of material | Top layer of material |
| 1. Basket without lining | 9 to 10 hours | 3.1 (37.5) to 5 (41) | 2.2 (36) to 3.1 (37.5) | 5 (41) to 5.8 (42.5) |
| | 11 to 12 hours | 5.8 (42.5) to 6.7 (44) | 2.8 (37) to 4.2 (39.5) | 6.7 (44) to 8.6 (47.5) |
| 2. Basket with 300 gauge polythene lining | 11 to 12 hours | 3.1 (37.5) to 5 (41) | 1.7 (35) to 3.1 (37.5) | 4.1 (40) to 5.6 (42) |
| | 12 to 13 hours | 4.4 (40) to 5 (41) | 1.7 (35) to 3.3 (38) | 5.8 (42.5) to 8.6 (47.5) |
| 3. Basket with union kraft paper lining | 15½ to 16½ hours | 4.4 (40) to 5.8 (42.5) | 2.8 (37) to 3.1 (37.5) | 3.1 (37.5) to 5.8 (42.5) |
| | 19½ to 21 hours | 5.6 (42) to 7.8 (46) | 2.8 (37) to 5.6 (42) | 6.7 (44) to 9.4 (49) |
| 4. Basket with double layer of gunny and 300 gauge polythene | 16½ to 18 hours | 3.1 (37.5) to 4 (39) | 1.1 (34) to 3.3 (38) | 4.4 (40) to 5 (41) |
| | 21 to 22½ hours | 5.8 (42.5) to 6.7 (44) | 4 (39) to 5.6 (42) | 6.7 (44) to 9.4 (49) |

TABLE I-A

*Temperature Distribution of fish packed in bamboo baskets provided with different linings during transport
(Ratio of ice : fish 1 : 1) (Based on three trials).*

| Type of Packaging | No. of hours elapsed after packing | Temperature range in °C (F) | | |
|---|------------------------------------|------------------------------|---------------------------|--------------------------|
| | | Bottom layer of material | Central layer of material | Top layer of material |
| 1. Basket with union kraft paper lining | 15 to 17 hours | 1.7 (35) to 5 (41) | 1.1 (34) to 3.1 (37.5) | 5 (41) to 6.7 (44) |
| | 19 to 20½ hours | 3.1 (37.5) to 5.8 (42.5) | 2.8 (37) to 3.3 (38) | 5.8 (42.5) to 8.6 (47.5) |
| 2. Basket with double layer of gunny and 300 gauge polythene film | 17 to 18 hours | 3.1 (37.5) to 4 (39) | 0.3 (33) to 2.2 (36) | 5 (41) to 5.8 (42.5) |
| | 20½ to 22 hours | 4.4 (40) to 5.8 (42.5) | 3.1 (37.5) to 4 (39) | 5.8 (42.5) to 8.6 (47.5) |

The limiting temperature of 41°F (5°C) was chosen for judging the quality of fish as the rate of spoilage at this temperature was only twice as fast as at 0°C (32°F). The fish remained fresh until this maximum temperature of 5°C (41°F) to 5.8°C (42.5°F) was attained by the fish, as shown also by chemical indices and organoleptic evaluation (IV to VI tables). The maximum temperature of 5°C (41°F) to 5.8°C (42.5°F) was observed first at the top layers while the middle and bottom layers recorded still lower temperatures around 3.9°C (39°F).

TABLE II

The safe periods the fish can be preserved in different packaging below the temperature ranges (a) 5°C (41°F) - 5.8°C (42.5°F) and (b) 7.2°C (45°F) to 9.4°C (49°F)

| Packaging | Storage period in hours | |
|---|--------------------------------|--------------------------------|
| | 5°C (41°F) - 5.8°C (42.5°F) | 7.2°C (45°F) - 9.4°C (49°F) |
| 1. Bamboo basket without lining. | 9 to 10 | 11 to 12 |
| 2. Bamboo basket lined with 300 gauge polythene | 11 to 12 | 13 to 15 |
| 3. Bamboo basket lined with union kraft paper | 15½ to 16½ | 19½ to 21 |
| 4. Bamboo basket lined with gunny and 300 gauge polythene | 16½ to 18 | 21 to 22½ |

The fish was found to be in edible condition during the next 3-4 hours when the temperature attained by the fish was between 7.2°C to 9.4°C (45°-49°F). Thereafter spoilage rate was quicker with time as at room temperature, as shown by chemical indices and organoleptic evaluation in tables IV to VI.

TABLE III

Changes in organoleptic evaluation and TMA and TVB expressed in terms of mg/100 g. of fish stored at room temperature without ice (R. T. 29°C, R. H. 84%)

| Time in hours | TMA | | TVB | | Organoleptic evaluation |
|---------------|---------|----------|---------|----------|------------------------------|
| | Sardine | Jew fish | Sardine | Jew fish | |
| 0 | 0.69 | 0.81 | 12.16 | 5.23 | Good |
| 3 | 0.81 | 0.84 | 12.28 | 5.55 | Good |
| 5 | 0.90 | 0.95 | 13.02 | 5.96 | Acceptable |
| 7 | 0.98 | 1.76 | 13.07 | 6.67 | Border line of acceptability |
| 8 | .. | 2.81 | .. | 10.96 | Not acceptable |
| 9 | 2.97 | .. | 26.80 | .. | Not acceptable |

TABLE IV

Changes in organoleptic evaluation and TMA and TVB expressed in terms of mg/100 g. of fish packed in bamboo basket without lining (Ratio of fish to ice 1 : 1)

| Time in hours | TMA | | TVB | | Organoleptic evaluation |
|---------------|---------|----------|---------|----------|------------------------------|
| | Sardine | Jew Fish | Sardine | Jew Fish | |
| 0 | 0.69 | 0.81 | 12.16 | 5.23 | Good |
| 3 | 0.88 | .. | 12.56 | .. | Good |
| 4 | .. | 0.82 | .. | 5.62 | Good |
| 9 | 0.94 | 1.20 | 12.60 | 5.90 | Acceptable |
| 12 | .. | 1.41 | .. | 5.92 | Acceptable |
| 14 | 0.97 | .. | 12.91 | .. | Acceptable |
| 16 | .. | 1.82 | .. | 7.01 | Border line of acceptability |
| 18 | 1.06 | 2.50 | 13.32 | 8.77 | Not acceptable |
| 20 | 2.62 | .. | 18.40 | .. | Putrid |

TABLE V

Changes in organoleptic evaluation and TMA and TVB expressed in terms of mg/100 g. of fish packed in kraft paper lined bamboo basket (Ratio of fish to ice 1 : 1).

| Time in hours | TMA | | TVB | | Organoleptic Evaluation |
|---------------|---------|----------|---------|----------|------------------------------|
| | Sardine | Jew fish | Sardine | Jew fish | |
| 0 | 0.69 | 0.81 | 12.16 | 5.23 | Good |
| 3 | 0.89 | .. | 12.35 | .. | Good |
| 4 | .. | 1.27 | .. | 5.52 | Good |
| 9 | 0.97 | .. | 12.47 | .. | Good |
| 10 | .. | 1.42 | .. | 6.08 | Acceptable |
| 14 | 0.98 | .. | 12.59 | .. | Acceptable |
| 17 | .. | 1.57 | .. | 6.27 | Acceptable |
| 18 | 1.10 | .. | 13.06 | .. | Acceptable |
| 19.5 | 1.11 | .. | 13.51 | .. | Border line of acceptability |
| 22 | .. | 1.73 | .. | 6.78 | do |
| 23 | 1.62 | .. | 14.96 | .. | Not acceptable |
| 25 | .. | 3.01 | .. | 11.54 | Not acceptable |

TABLE VI

Changes in organoleptic evaluation and TMA and TVB expressed in terms of mg/100 g of fish packed in gunny and polythene lined bamboo basket (Ratio of ice to fish 1:1)

| Time in hours | TMA | | TVB | | Organoleptic evaluation |
|---------------|---------|----------|---------|----------|------------------------------|
| | Sardine | Jew fish | Sardine | Jew fish | |
| 0 | 0.69 | 0.81 | 12.16 | 5.23 | Good |
| 3 | 0.87 | .. | 12.26 | .. | Good |
| 5 | .. | 0.91 | .. | 5.34 | Good |
| 9 | 0.90 | .. | 12.75 | .. | Good |
| 10 | .. | 1.42 | .. | 5.90 | Good |
| 13 | .. | 1.58 | .. | 6.00 | Acceptable |
| 14 | 0.97 | .. | 13.01 | .. | Acceptable |
| 18 | 1.57 | .. | 13.60 | .. | Acceptable |
| 19 | .. | 1.67 | .. | 6.48 | Acceptable |
| 23 | 1.78 | .. | 14.92 | .. | Border line of acceptability |
| 25 | .. | 1.75 | .. | 6.81 | — do — |
| 27 | 1.91 | 2.72 | 16.68 | 9.72 | Not acceptable |

The safe periods the fish can be preserved below 5°C to 5.8°C (41°F to 42.5°F) and 7.2°C to 9.4°C (45° to 49°F) in different insulated lined baskets are shown in table II.

Field Trials:- In order to translate the results of the Laboratory trials to actual field conditions where the material would pass through different temperatures and humidities and experience heat gains due to friction imparted as a result of mechanical vibrations, ice-fish packs in the above type of improved containers were sent in railway parcel van from Ernakulam to Calicut and back. Temperature measurements were made as usual en route at intermediate stations. The results obtained were shown in Table I (A) and the mechanical vibrations or climate conditions have not adversely affected the storage period of ice fish packs.

It is seen using 300 gauge polythene film alone as an additional insulated lining does not have appreciable effect in reducing the rate of melting of ice over controlled basket, as it has little insulation property. Providing gunny as a secondary lining to this polythene film lining however has given better results. But it suffers from certain drawbacks and its tendency to get wet. Wet gunny has little insulation property and also adds considerably to the weight of the basket. For non-returnable packages, kraft paper lined baskets may be used whose insulation properties as nearly as good as gunny. The cost is also relatively cheaper and it does not impart any off flavour to the fish.

For equitable temperature distribution throughout the material, the ratio of fish to ice should be 1:1. It has been reported that when fresh fish with ice was put in polythene lined baskets in the ratio 3:1, the fish remained fresh and edible for a period of 18-24 hours (Private communication). But it had been observed in our trials that even with fish : ice in 2:1 proportion, temperature discrepancies were more at different layers of fish during the storage period; as the ice was not adequate to bring down the temperature of the whole material of fish to 1.7°C (35°F) or below. The temperature during first 4 to 5 hours varied from 1.7°C/35°F to 5.8°C/42.5°F and at the end of 12 hours of storage, the temperature of fish varied widely from bottom to top layers from 4.4°C (40°F) to 11.4°C (52.5°F).

Generally as it has been observed the middle layer of fish is comparatively at lower temperature than at top or bottom layers it is recommended that additional layers of ice should be spread at top and bottom.^{7,8} This way of addition of ice ensures better and uniform quality of fish throughout.

Acknowledgement

The authors are grateful to Dr. A. N. Bose, Director for his keen interest and guidance during the course of this work.

References

1. Hess, E. *Contributions to Canadian Biology and Fisheries*, 8, 491, (1934.)
2. Cutting C L. *Fish Saving*, Leonard Hill, London, 214. (1955).
3. Directorate of Marketing and Inspection, Ministry of Food and Agriculture, Government of India, Report on the Marketing of fish in India, Agricultural Marketing Series (C) (1961).
4. Conway, E. *Microdiffusion analysis* (Revised edition). D. Van Nostrand Co., Inc., New York. (1947).
5. Venkataraman, R, and Chari, S. T. *Proc. Ind. Acad. Sci.* 31 (1) B, 54, (1950):
6. Nicol, D. *J. Sci. Food. Agri.* 9 (2), 78 (1958).
7. Anon. *Bull. Internat. Inst. Refrig.* 46-49, (1959).
8. Grahl, J. F. *Irish Fishing and Fish Trades Gazette* (Dublin, Ireland), 3 (11), 81 (1955).