Preservation of Bombay duck (*Harpodon nehereus*) and Rohu (*Labeo rohita*) by Gamma Irradiation

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The gamma irradiation procedures for preservation of Bombay duck and rohu were studied in collaboration with Bhabha Atomic Research Centre, Bombay. Irradiation at 0.1 M rad extended the storage life of Bombay duck to 20–22 days at 0–2°C due to partial destruction of spoilage organisms as against rapid deterioration of un-irradiated samples within 5–6 days. In the case of the fresh water fish, rohu, the storage life was enhanced by about 7–10 days by the same dose of irradiation over the control under identical storage condition. In all the cases, empirical relations were worked out between organoleptic rating and total volatile nitrogen.

Ionization radiation is an important tool in the hands of the technologists for extending storage life of food including fish which is by nature very susceptible to spoilage. The hot and humid climate particularly prevailing in most part of India is conducive to rapid spoilage of fresh fish. Due to unscientific method of handling even fish transported under ice may not reach the destination in a marketable form. The problems of handling, storage and transportation are particularly important in India where the consuming centres are far away from fish landing areas.

Bactericidal effect of gamma radiation have been utilized extensively for extension of storage life of fish (Anon 1966, 1970) due to suppression of rapid spoilers (Mavinkurve *et al.*, 1967; Kumta & Mavinkurve, 1971; Kazanas, 1966; Licciardello *et al.*, 1967; Laycock & Regier, 1970). However, radio-pasteurization process does not reduce all food borne micro-organisms (Quinn et al., 1967 and Alur *et al.*, 1971) in a fixed proportion due to differences in their radiation sensitivity, repair mechanism and dose modifying capacity (Quinn *et al., loc cit;* Schmidt Lorenz & Farkas, 1961; Thornby, 1963; Serianni & Bruce, 1968). Usually radiation dose levels of 0.1 M rad to 1.0 M rad are applied for extension of storage life of sea food (Quinn *et al., loc cit*; Alur *et al., loc cit;* Coleby & Shewan, 1965; Kumta & Sreenivasan, 1966). Fish radurised in doses of 100–200 K rad, can be consumed safely, provided the temperature of storage is strictly maintained below 3.8°C (Kumta & Mavinkurve, *loc cit.*).

The present study was undertaken in collaboration with Bhaba Atomic Research Centre, Trombay, with a view to exploring the scope of radio pasteurisation of sea foods for internal transportation and distribution, and reports some of the significant results in respect of a marine and fresh water lean fish.

Materials and Methods

Fish procured from Bombay markets were eviscerated, degilled, washed and sealed in polythene pouches and irradiated in C_o60 Food Package Irradiator (Atomic Energy of Canada Ltd.) at specified dose levels at the Biochemistry and Food Technology Division of BARC, Trombay. Irradiated and control samples were packed separately in insulated ice boxes with fish to ice ratio of 1:3 to 1:4 and transported by rail to Calcutta. They were received at the destination on the 3rd or the 4th day of despatch and held in ice (0–2°C) till the examinations and observations were over. Organoleptic ratings were carried out by a taste panel comprising of seven members according to Miyachi *et al.* (1964). Bacterial counts were estimated according to the methods described by Bhadra *et al.* (1973).

Total volatile nitrogen (TVN) was estimated according to the method of Beatty and Gibbons (1957).

Results and Discussion

Fig. 1 (a) shows the typical pattern of organoleptic scores of control and irradiated samples of Bombay duck (100 K rad) during storage at 0–2° C. The borderline

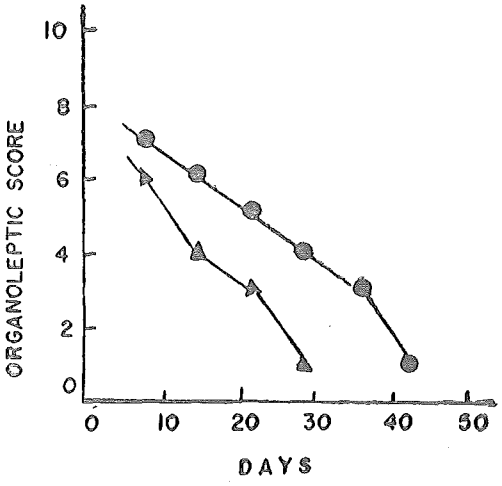

Fig. 1a. *Pattern of organoleptic scores of control and irradiated samples of Bombay duck*

◀—◀ Control; ●—● 100 K rad

of acceptability in irradiated samples was prolonged while that in control samples ended abruptly. In spite of several limitations organoleptic method is still regarded as one of the best methods for assessing the quality of fish. Irradiated samples were acceptable upto 22 days while the control samples were rejected after 5–6 days.

The typical pattern of changes in total bacterial counts occurring during storage in the case of Bombay duck are shown in the Fig. 1 (b). On the eighth day of storage microbial counts of control and irradiated samples were in the order of 10^5–10^6 and 10^4–10^5/g respectively. Drip volumes collected in irradiated samples were several times (6–14) higher than those in controls, but the bacterial counts in the drip were of the same order as those in fish muscle. However, in some cases the counts were higher by a log cycle. There was a progressive increase in microbial load of the samples on storage. It is interesting to note that at this stage of advanced spoilage the bacterial counts of the control samples were in the range of 10^5–10^6/g when compared to 10^8–10^9 in the irradiated samples, which may probably be due to reduced metabolic activity or post irradiated flora, necessitating a greater microbial load to produce an equivalent degree of spoilage. Similar observations were made by Laycock & Regier (*loc cit.*), Kumta & Sreenivasan (*loc cit.*) and Cutting (1969)

The typical changes in TVN of control and irradiated samples of Bombay duck during storage at 0–2° C are shown in Fig.1 (c). When TVN values of irradiated and control samples recorded 30–35mg/100g and 20–25mg/100g respectively the samples were generally regarded as organoleptically unacceptable. A linear relationship was obtained between organoleptic rating and

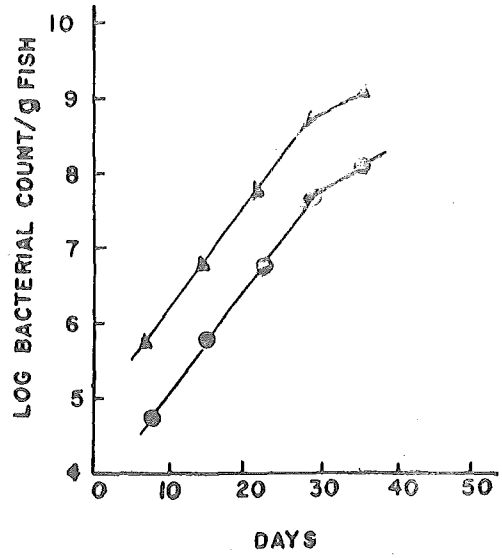

Fig. 1b. *Pattern of changes in total bacterial counts during storage in Bombay duck*

▶—▶ Control; ●—● 100 K rad

the total volatile bases when a graph was ploted using organoleptic scale (F) as ordinate and log (1+V) as abscissa, where V=TVN. The straight line as indicated in the Fig. 1 (d) for irradiated samples may be represented by the equation,

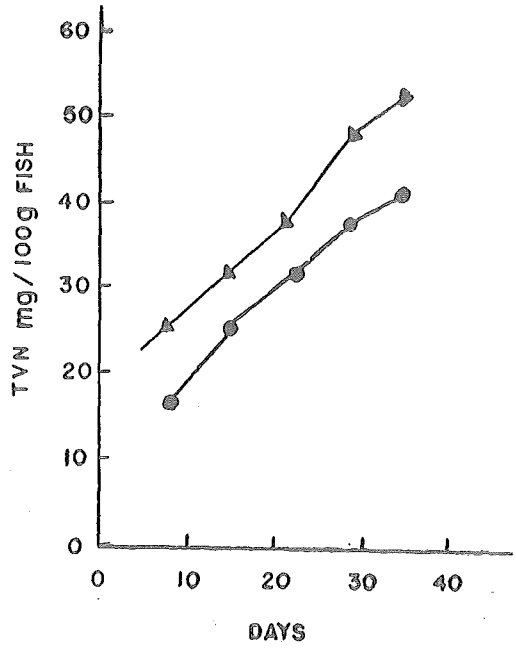

Fig. 1c. *Changes of TVN in control and irradiated samples of Bombay duck during storage at 0–2°C*

▷—▷ Control; ●—● 100 K rad

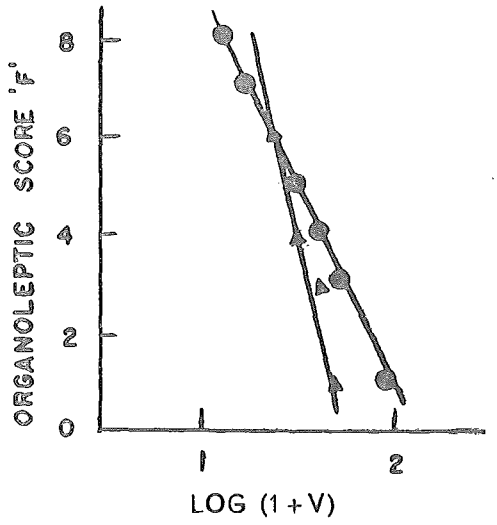

Fig. 1d. *Relation between organoleptic rating and total volatile bases in Bombay duck*

▷—▷ Control; ●—● 100 K rad

$F+5.28 \log (1+V)=13.58$

The equation representing the relation between F and V for control will be,

$F+6 \log (1+V)=15$

Same type of relation has been obtained with cod (Cutting *loc cit.*).

In the case of rohu, irradiated samples were organoleptically acceptable upto three to four weeks at 0–2° C depending upon the dose, while the control sample was rejected after 12–14 days of storage under identical condition. Fig. 2 (a) shows the typical pattern of organoleptic scores of control and irradiated samples (100 K rad and 200 K rad) during storage at 0-2° C.

The typical changes in pattern of total microbial counts of control and irradiated samples are represented in the Fig. 2 (b). On the first 14 days of storage microbial counts of control samples were of the order of 6.2×10^5/g, while irradiated samples under idential condition showed counts of the order 1.5×10^5, 9.6×10^3/g at 100 and 200K

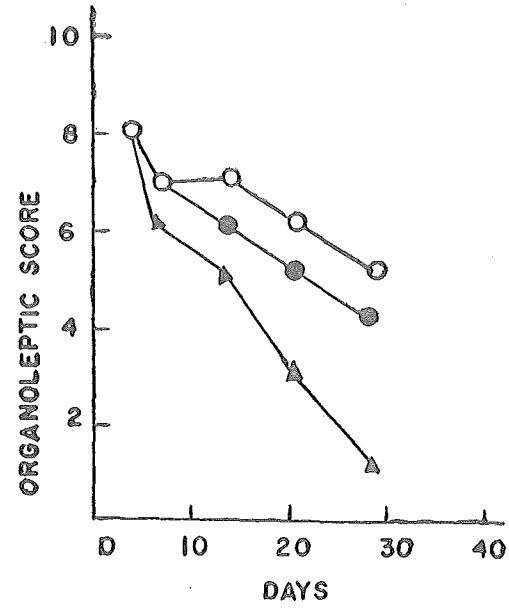

Fig. 2a. *Pattern of organoleptic scores of control and irradiated samples of L. rohita*

▽—▽ Control; ●—● 100 K rad;

○—○ 200 K rad

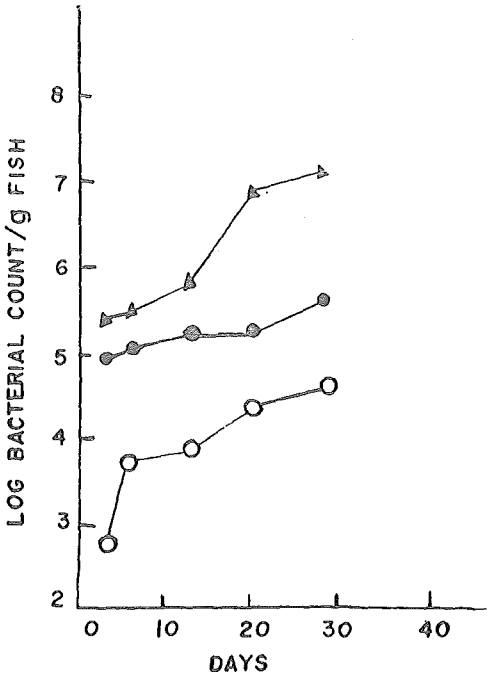

Fig. 2b. *Changes in the pattern of total microbial counts of control and irradiated samples of L. rohita*

▶—▶ Control: ●—● 100 K rad;

O—O 200 K rad

rad respectively. Control and low dose (100 K rad) irradiated samples showed more or less same microbial loads of the order 10^5–10^6/g when spoiled. Drip volumes released from the samples were found to be proportional to the dose. Microbial counts of the drip were of the same order as those of the muscle but in some cases the counts were higher by a log cycle or two.

Changes in TVN values in control and irradiated samples of rohu during storage at 0–2°C are shown in Fig. 2 (c). At the range 28–32mg/100g of TVN, both the control and irradiated samples were regarded as organoleptically unacceptable. A linear relation was obtained between organoleptic rating and total volatile bases when graph was plotted using organoleptic score (F) as ordinate and log (1+V) as abscissa as in the case of Bombay duck.

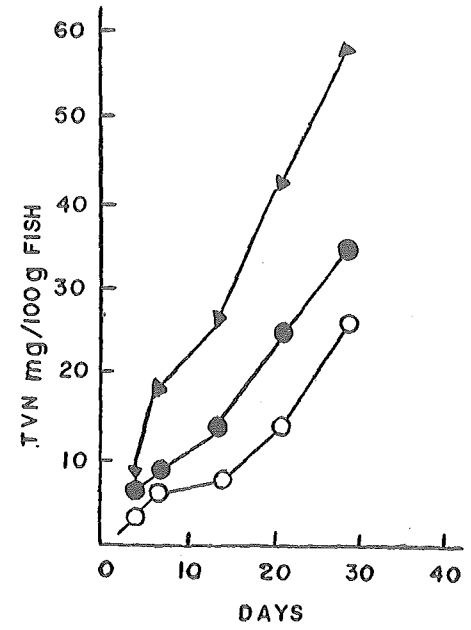

Fig. 2c. *Changes in TVN values in control and irradiated samples of L. rohita during storage at 0–2°C*

▶—▶ Control; ●—● 100 K rad.,

O—O 200 K rad

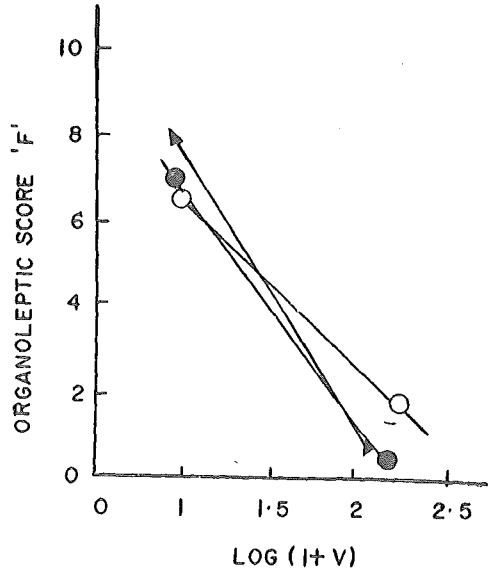

Fig. 2d. *Relation between organoleptic rating and total volatile bases in L. rohita*

◀—◀ Control; ●—● 100 K rad;

O—O 200 K rad

The straight lines indicated in the Fig. 2 (d) may be represented by the following equations:

$F+6.17 \log (1+V)=13.9$
$F+5.23 \log (1+V)=12.1$
$F+3.82 \log (1+V)=10.4$

for control and irradiated (100 and 200 K rad) samples in the order.

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