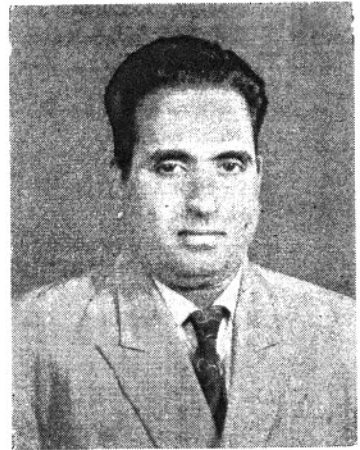


Irradiation and its Scope in Fish Preservation



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INTRODUCTION

Fish is the most perishable of human food materials and the chain of spoilage changes caused by the action of bacteria, enzymes and oxidising agents starts the moment the fish dies. The major cause of deterioration, however, is the numerous varieties of bacteria originally present in the intestinal tracts and the slime on the surface and those of terrestrial origin that find their way into the fish after they are caught. Hence, if the bacteria are either destroyed or kept under control, it will go a long way in preserving the fish without much deterioration. The oldest, simplest and cheapest method of preserving fish is by drying them in the sun in which process we actually bring down the moisture level in the fish below the limit required for growth and multiplication of bacteria. In the process of salt curing, the majority of the bacteria associated with the fish which are sensitive to salt are destroyed. Taking the case of refrigeration, whether it is

simple icing and chill storage or freezing and frozen storage, the temperature of the fish is lowered to such an extent that the micro-organisms normally acclimatised to the atmospheric temperature are either destroyed or inactivated. In canning, the fish is heat-sterilised, killing the bacteria almost completely and since their further entrance into the fish is prevented by the hermetical sealing, deteriorative changes are arrested. A more recent method of controlling the micro-organisms causing spoilage in fish is to poison them out by means of chemicals and antibiotics. Very much like the organisms causing diseases in man are destroyed by injection or oral administration of antibiotics, those present in fish also are amenable to the action of these poisons. Chlorotetracycline, oxytetracycline, penicillin etc. have been widely employed in the preservation of fish either incorporated in the ice used for chilling or by giving dip treatments to the fish before refrigeration. However, the dosages of the

antibiotics have to be strictly controlled so that their residual quantities retained in the fish do not become deleterious to the health of men who consume them. Intensive investigations intended at inventing newer and more effective bactericidal agents resulted in nuclear energy being used for the purpose.

NUCLEAR ENERGY

Unfortunately, our first acquaintance with nuclear energy appears to have been through its vast destructive forces. The havoc played by the world's first ever atom bombs dropped in Hiroshima and Nagasaki in Japan towards the close of II World War was probably the earliest news about the use of atomic energy to attract the attention of the common man. The thousands of innocent human lives lost immediately, the consequent sufferings from diseases like cancer, leukemia etc. due to which thousands of human beings are still suffering and the potential genetic ill effects to which even the future generations are liable to be subjected to bear ample testimony to the unlimited destructive capacities of this novel source of energy. Eventhough much more powerful destructive weapons like the hydrogen bomb making use of nuclear energy have been subsequently developed and tested successfully, a healthy trend which shows out a silvery ray of hope for the human race not to be devastated completely from the face of the earth is the growing awareness on the part of the big powers responsible for its development to harness this gigantic giant of energy for serving the human beings and to prevent it from being used for destructive purposes. The "Nuclear non-proliferation treaty" and the "atom for peace" programme are the direct results of this endeavour. There are numerous peaceful uses to which nuclear energy can be put which can add to the

comfort and prosperity of the human society. Among them may be mentioned large scale production of electricity which has now become common in the advanced countries. Our country is also not lagging behind in this respect. Nuclear electricity has already started flowing into our grids from the Tarapore power plant and two more in Ranapartap Sagar in Rajasthan and Kalpakkam in Tamil Nadu are expected to become "critical" soon. Nuclear energy is now applied in several other fields like agriculture, (in the form of radio active tracers etc), medicine (radio therapy) and various industries. One of the most important uses for which nuclear energy has been successfully tried is the preservation of food materials like vegetables, fruits, grains, meat, fish etc.

IRRADIATION

The principle involved in preservation of food material with nuclear energy is to allow ionising radiations to pass through them, when the micro-organisms present in them are partially or wholly destroyed depending upon the degree of exposure. This process is called irradiation. The sources of radiations generally employed are radio active elements like Co-60, Cs-137 and Sr-90. X-rays and high speed electrons are also useful for the purpose. Their efficiency to destroy bacteria, however, depends upon their ability to penetrate matter and from that respect gamma rays and fast electron beams alone are of practical importance. It has been estimated that gamma rays penetrate 10 cm, fast electron beams 8 cm and X-rays 13 cm of water mass from one side. Complete sterilisation of materials is possible by exposing them for sufficiently long durations to the radiations which however is usually accompanied by serious changes in colour, odour, texture and flavour. Peculiar flavours described as "burnt" or "radiation" flavours are generated

which are not relished by the consumers. Controlled doses of radiations are capable of causing partial sterilisation (pasteurisation) of materials prolonging their storage lives by two or three times without causing any appreciable change in the organoleptic characteristics.

The unit by which radiations are measured is called "rad" which is equivalent to 100 ergs of energy absorbed per gram of material treated. Its multiples are kilorad (1,000 rads) and mega rad (one million rads), the latter being equivalent to 2.4 calories of heat per gram of material. The unit of measurement of high velocity electrons is MeV i.e., million electron volts.

FISH PRESERVATION

Fish and other seafoods have been found to respond quite well to radiation treatment. Two to three times increase in storage life at chill temperatures has been observed in the case of raw and cooked shrimp irradiated at 0.15 M rad, crab meat treated with 0.2 M rad and several fishes like cod, haddock, sole, halibot etc exposed to 0.25 to 1.0 M rad. Research work in India has shown that fresh eviscerated Bombay duck treated with 0.25, 0.5 and 1.0 M rad keeps in sound condition for 12, 21 and 41 days respectively at 10 to 12°C while untreated fish becomes unacceptable in 3 days under the same conditions. Besides bringing down the total bacterial loads in fish, this treatment has been found to have specific action against some types of micro-organisms like pseudomonas which are renowned fish spoilers, eliminating them almost completely even at low dosages. The pathogenic clostridium botulinum which are at times encountered in fishery products can be completely destroyed only by 4.5 M rads of radiation. However in order to avoid undesirable side effects, the dosage has to be limited to as low as possible.

One way to achieve this is to employ combination treatments i.e., to treat the fish first with bactericidal agents like chemicals and/or antibiotics and supplement the same by irradiation. Treatment in the frozen condition, exclusion of oxygen and addition of anti-oxidants like ascorbic acid also help in keeping the side reactions under control.

APPLICATION TO FROZEN FISH

The fact that irradiation in the frozen condition is preferable is of special significance to our frozen fish industry. At times our frozen prawns for export are either detained here by the Pre-shipment Inspection Authorities or at the destination ports by the importing countries due to the presence of bacterial loads greater than permissible. Pasteurisation doses of radiation treatment after freezing can solve this problem satisfactorily. However it has to be strictly cautioned here that utmost care in maintenance of good hygienic conditions during processing and using top quality raw material should not in any way be slackened placing undue confidence in the effects of the radiation treatment. The reason is that some bacteria leave toxic substances in the material even though they are destroyed. Hence this treatment has to be used only as a supplement and should not be made a substitute for hygienic practices.

CANNED AND DEHYDRATED FISH

It suggests that the treatment can be used as a supplement in the canning process also. A very low dosage of radiation on the canned product after the usual autoclaving can ensure better sterilisation of the product without in any way affecting its other qualities. Our cured and dried fish products at present undergo very rapid deterioration due to several reasons, the most important among which are bacteria,

fungus and insects which get access into them in the course of the processing. A low dose of radiation of the order of 0.05 M rad at the final stages solves this problem to a great extent. All micro-organisms, insect eggs and larvae are destroyed in the process and if their further entry into the product is prevented by proper packaging, the products remain in good condition for quite a long time.

FISH MEAL

Fish meal which is generally used for poultry and cattle feed is sometimes found to be contaminated with a pathogenic strain of bacteria called salmonella which has been responsible for serious food poisoning in cattle. These bacteria as well as others are completely eliminated by radiations at as low a level as 0.5 M rad without any side effects at all.

ENZYMES

Enzymes are not affected by this treatment and are left in tact which fact has been effectively exploited to elucidate the specific roles played by bacteria and enzymes in the phenomenon of spoilage of fresh fish. Even after irradiation mackerel was found to undergo fairly rapid deterioration even

though practically free of bacteria, showing that enzymes are the major causes of spoilage in this fish, while irradiated haddock kept in sound condition for the expected duration indicating that autolysis does not have any significant influence in the spoilage of this fish. Inactivation of enzymes by hot water or steam blanching etc therefore becomes essential prior to irradiation so that the products may have the desired storage life.

CONCLUSION

If properly made use of, the new process of irradiation can help a good deal in the proper and more economic utilisation of our vast fishery resources. With some of our interior markets lying thousands of kilometers away from the coast line, distribution of fresh fish in such places is a difficult problem. Application of this technique helps in prolonging the freshness of the fish so that sufficient time interval is made available for reaching them to larger areas before they get spoiled. It can also improve our export trade in frozen, canned and dried fish products as well as fish meal by imparting them longer shelf lives by destroying the micro and macro organisms which cause quick deteriorative changes in them.

