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Irradiation Delayed Oxidative Rancidity in Tuna Loins

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ABSTRACT

TBA numbers of irradiated and control tuna samples reached a maximum after 25 and 10 days of cold storage, respectively. A decline occurred thereafter for both samples. These changes may be correlated with sensory acceptability scores.

INTRODUCTION

During cold storage of fish flesh oxidizing processes take place, including changes in the physical and chemical parameters that govern organoleptic characteristics. Irradiation with ^{60}Co gamma rays (Curzio & Quaranta, 1982) and X-rays delays the establishment and development of the microbial flora and hence those oxidative reactions which are induced by microbial growth.

End products of oxidative processes in fat-containing fish products and foodstuffs can be tested through the direct thiobarbituric acid (TBA) extraction method. Vyncke (1970; 1974) evaluated the possibilities of this method in trichloroacetic acid extracts of redfish, cod, mackerel, plaice, spurdog and herring, and concluded that they were promising. Curzio & Quaranta (1982) reached similar conclusions in their studies on irradiated hake fillets. Favourable results were also reported by Witte *et al.* (1980) on

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pork and beef with an extraction mixture of trichloroacetic acid and phosphoric acid.

Irradiation of tuna loins with X-rays was studied. It was observed that, after irradiation, the samples initially showed higher TBA values than the control fish. During storage at 4–6 °C, however, control samples showed greater TBA values than the irradiated ones due to the microbial-induced synthesis of oxidized products.

MATERIAL AND METHODS

Tuna fish caught by commercial vessels are conditioned for market at commercial factories on land.

Fish coming from fishing grounds of the Argentinean platform (South Atlantic Ocean)—and kept on ice after catching during their way to the factory—were processed.

Four days after being caught, the ice-preserved tuna fish were deboned and the loin samples were quick-frozen in a plate freezer to -30 °C and sealed in 100 μm-thick polyethylene bags (250 g each). After packaging the samples were stored until irradiation at -18 °C in a commercial freezer.

Half of the batch was irradiated under dry ice refrigeration to a dose of 2·20 kGy using a Phillips X-ray machine. The dose rate was 2·60 Gy min^{-1} at the $6 \times 6\,cm^2$ irradiation field. The remaining bags were left for control. Both the irradiated and non-irradiated samples were stored at 4–6 °C in a commercial refrigerator and were removed periodically for testing. The average composition of tuna fish muscle was reported to be: water, 77·9 %; lipids, 2·7 %; proteins, 17·9 % and ash, 1·4 %. (R. A. Rothe, private communication, 1983). The procedure for the TBA extraction method was carried out according to Vyncke (1970): 10 g of tuna fish muscle (triplicate) was homogenized for 2 min with 50 ml of 9·0 % trichloroacetic acid solution containing also 0·12 % of both propyl gallate (PG) and ethylenediaminetetraacetic acid (EDTA). This was then filtered. Taking into account the water content of the fish (77·63 % for these experiments), the final concentrations of trichloroacetic acid, PG and EDTA in the extract were 7·5, 0·1 and 0·1 %, respectively.

Calibration of the spectrophotometer was carried out with five different dilutions of tetraethoxypropane (Sigma) in 7·5 % trichloroacetic acid (Merck) solution (0·1 % of both PG [Merck] and EDTA [Merck]).

In the determination of the standard curve, quintuplicates of standard

dilutions were taken and read, while for tuna fish samples triplicates of each were assayed for malonaldehyde content. The assay proceeds by allowing 2·5 ml of 0·02M 2-thiobarbituric acid (Merck)—in distilled water—to react with 2·5 ml of filtered extract and with 2·5 ml of each standard solution in test tubes with Teflon sealing screw caps; colour was developed during 40 min in a boiling water bath and then the tubes were cooled in tap water and absorbance read at 535 nm in a Beckman DU spectrophotometer with 1·00 cm path length stoppered quartz cells. Results were expressed as micrograms of malonaldehyde (MA) per 100 g of fish. For calculations the recovery of 95% (Vyncke, 1970) was taken into account. Sensoric quality was recorded for both irradiated and fresh control samples through the whole storage period. Organoleptic evaluation of the samples was carried out by a five-judge taste panel; the members received portions (*ca* 50 g) of raw and boiled fish meat coming from irradiated samples and fresh control tuna loins, and were asked to score sensoric characteristics such as coloration and texture of fish muscle, odour, presence of exudate and general appearance, using the 9-point hedonic scale. Results from the organoleptic tests showed the course of the degree of acceptability of irradiated and fresh samples for human consumption during the storage period.

RESULTS

Figure 1 shows the development of malonaldehyde content (or TBA value) in tuna loins during the 30-day chill storage period. The initial value for control samples ranged between 30 and 39 (mean 35) μg MA per 100 g whilst, for irradiated tuna, the observed values, immediately after irradiation, ranged between 49 and 63 (mean 56) μg MA per 100 g fish. The maximum values were 158 (147–169) μg MA per 100 g for control fish and 165 (148–179) μg MA per 100 g for the irradiated samples, observed after 10 and 25 days of cold storage, respectively. The difference between the initial values for irradiated and non-irradiated samples was significant.

In sensory evaluation, the taste panel judged as unacceptable (4 on the 9-point hedonic scale), all the control samples after 7 days of cold storage, while the irradiated samples showed acceptable scores (6 points) until the twenty-fifth day.

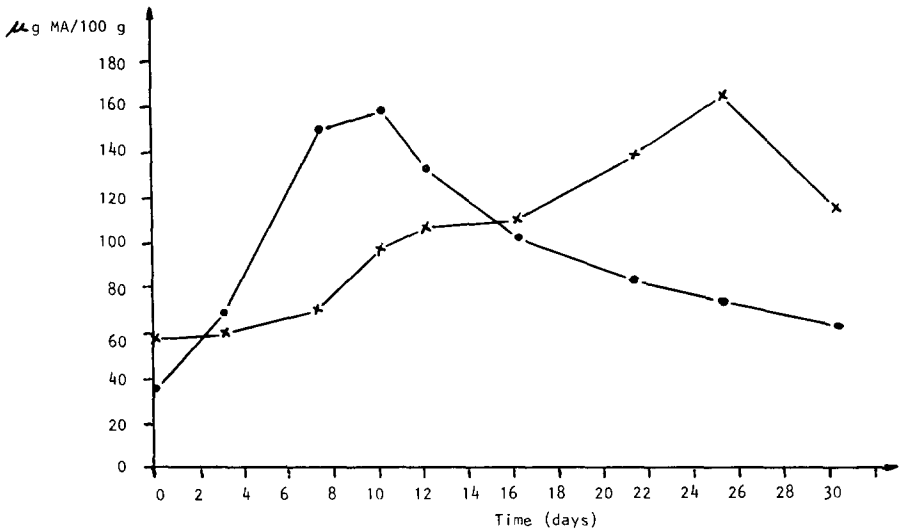

Fig. 1. Development of the malonaldehyde content during cold storage of control (●) and irradiated (×) tuna fish loins. Experimental points are the average of three determinations.

DISCUSSION

From Fig. 1, where the TBA values (or malonaldehyde content) of control and irradiated tuna are plotted against the time that the fish had been stored in the cold, measured values tend to increase with time, reaching a maximum on the tenth day (control) and the twenty-fifth day (irradiated) of cold storage; this is followed by a decline until the end of the storage period. The delay in reaching the malonaldehyde peak in the irradiated samples was consistently observed in different experiments. Similar results were reported by Curzio and Quaranta (1982) in their experiments on the radiation preservation of filleted hake and by Hussain *et al.*, (1978) in their studies with different fish species. The decline after the maximum can be attributed either to the interaction of thiobarbituric acid reactive products with other tissue constituents, such as amino acids, proteins or vitamins (Curzio & Quaranta, 1982), or their utilization by surviving microorganisms, as suggested by Smith & Alford (1968).

Close correlation has been observed between the taste panel results and the malonaldehyde content of tuna fish loins; unacceptable organoleptic scores were obtained just before the MA peak is reached in both control and irradiated samples.

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REFERENCES

Curzio, O. A. & Quaranta, H. O. (1982). *Lebensm.-Wiss. u.-Technol.*, **15**, 171.
Hussain, A. M., Qureshi, M. J., Haq, I. & Chaudhry, M. A. (1978). *Archiv Fur Lebensmittelhyg.*, **29**, 41.
Smith, J. L. & Alford, J. A. (1968). *J. Food Sci.*, **23**, 93.
Vyncke, W. (1970). *Fette-Seifen-Anstrichmittel*, **72**, 1084.
Vyncke, W. (1974). *Fette-Seifen-Anstrichmittel*, **76**, 239.
Witte, V., Krause, G. & Bailey, M. (1980). *J. Food Sci.*, **35**, 582.