KEEPING QUALITY EXTENSION OF NILE FISH BY GAMMA IRRADIATION

SALWA B. EL-MAGOLI, A.A. IBRAHIM, Y.I. SALLAM, and E.T. EL-ASHWAH

Cairo University, Egypt.

INTRODUCTION

Aswan High Dam lake is an important fish resource in Egypt. Its potential anual yield is presently estimated at 20,000 metric tons; 90% of which is Bolti fish (Tilapia nilotica). The basic problem facing the exploitation of the lake is transportation, on the lake itself and from the lake to the retail markets in Cairo. Usually this process takes place in crushed ice and requires a period of time not less than a week. As a result, distribution to the consumer is irregular, many rural areas are inadequately supplied with fish and moreover the fish generally reach the consumer in a far from satisfactory hygienic state.

Radurization and radicidation in the range of 0.1 Mrad doses have been successfuly used to reduce the yeasts, molds and nonspore forming bacteria counts that cause spoilage or diseases (Sinskey et al., 1976). Since the effects of ionizing radiation on the appearance, odor, and taste of marine products vary widely with species and dosage (Hashish et al., 1966; Lerk et al., 1967), the characteristics and optimum dose for each species must be determined.

Trimethyl amine (TMA), total volatile basis (TVB), and bacterial counts have been shown by (Spinelli et al., 1965) to be useful indicators of product quality in irradiated and non-irradiated fishery products.

The present study aimed for:

1- Determination of suitable radiation doses for extending the shelf-life of fresh Bolti fish during cold storage transportation.
2- The chemical, bacteriological, and sensory changes occuring during the storage of irradiated fish compared with frozen samples.

MATERIALS AND METHODS

Medium size fish samples (approx. 500 gm) of Bolti "Tilapia nilotica" freshly cought from the Nile river were selected. The fish were kept in crushed ice for 2 days before preparation, representing the period lapsing between catching and delivering to the shore depot. Thereafter, the fish was washed eviscerated, rinsed and cut into 100-150 gms portions to be packed in sealed polyethylene bags before further treatments.

Fish samples were subjected to irradiation using a cobalt-60 gamma cell 220, at a dose rate of 50 rad/sec. The exposure levels applied were 100, 250 and 350 Krads. After irradiation the fish samples were stored at 2°C ± 1°C as the control samples. For comparison, samples of prepared fish were frozen at -18°C and stored frozen at -8°C.

Determinations

Fish samples were analyzed every 2 days during the storage period of 34 days. Total volatile basis (TVB) was determined according to the method of Sinnhuber et al.,(1966) while Trimethyl amine (TMA) was determined according to Dyer (1955). Thiobarbituric acid (TBA) was determined using the procedure of Tarladgis et al (1960), and the free fatty acids (FFA) according to the AOAC (1975). Total viable counts and total viable moulds and yeasts were estimated as described in the method of Lodder (1952), using nutrient agar medium and wart-agar medium respectively. The organolyptic properties of deep-fat fried samples were judged subjectively by a trained panel of 15 members. Fish was served according to the procedure of Ampola et al., (1969), and scored by a five points hedonic scale. Analysis of variance and LSD was calculated according to Walter and Duncan (1969).

RESULTS

A- Changes before processing: Fish samples were examined directly after catching and after 2 days holding in crushed ice before evisceration. Results are presented in table (1).

No evident changes occured in moisture, protein and fat content before processing. However, the total extractable nitrogen (TEN) and soluble protein nitrogen (SPN) decreased by 9.4 and 11.1% respectively. The decrease in protein solubility could be attributed to the onset of rigor mortis and formation of contractile actomyosin complex (Baliga et al., 1969).

The degree of deterioration in freshness as could be indicated from the values of TMA, TVB, FFA and TBA showed that the values obtained after 2 days holding in ice are within the border lines reported for fresh fish (Spinelli et al., 1965). The slight increase could be mainly attributed to microbial activity as indicated by their increase in numbers. The organolyptic characteristics of raw and deep fat fried fish samples indicated wholesomeness

Table (1): Chemical Composition and Quality Attributes of Fresh Bolti Fish.

	Fresh fish after catch	After 2 days in crushed ice
I- Chemical composition		
1- Moisture	80.36	80.40
2- Total Protein	2.84	2.83
A- TEN	2.63	2.38
B- SPN	2.25	2.00
C- SNPN	0.37	0.38
3- Crude fat	1.69	1.68
II- Chemical Quality Attributes		
1- TVB (mg/100gm)	6.28	7.45
2- TMA (mg/100gm)	0.28	0.46
3- PH value	6.67	6.40
4- FFA %	0.55	0.65
5- TBA value	0.11	0.13
III- Microbiological load		
1- TBC	1.6×10^5	5.8×10^5
2- Total mold & yeast	1.3×10^3	3.7×10^5
IV- Freshness and Acceptability.		
1- Raw state		
Appearance	4.8	4.8
Odor	4.6	4.5
Texture	4.7	4.6
2- Deep fat fryed		
Taste	4.3	4.1

B- Changes in eviscerated prepared samples during treatments and subsequent storage:-

Sensory evaluation:
The acceptability scores for appearance, odor, texture and taste of irradiated fish are presented in table 2. The results indicated that the dose of irradiation greatly affected the acceptability scores of the stored fish. Fish samples recieving 100 Krad were equal in their palatability scores to the reference frozen control samples up to 17 days of storage. After this period the acceptability tended to decrease significantly. On the other hand, samples recieving 250 Krad and 350 Krad did not show any appreciable changes in their palatability characteristics up to 21 and 28 days of storage respectively. The control samples kept at 2°C were completely rejected after the first week of storage. Hence it could be concluded that the storage life of the prepared portions of Bolti fish could be extended by at least 4 times its original shelf life by low doses of irradiation without significantly affecting its quality attributes.

TMA and TVB values:
Figs. 1 & 2 show the changes that took place in both TMA & TVB during storage of control and irradiated fish samples. The control unirradiated samples showed an increase in both

Table (2): Effect of Gamma Irradiation on the Organolyptic Properties of Bolti Fish.

Storage time at 2°C.		1 Week				2 Weeks				3 Weeks				4 Weeks			
Organolyptic Properties		Apperance	Odor	Texture	Taste	Apperance	Odor	Texture	Taste	Apperance	Odor	Texture	Taste	Apperance	Odor	Texture	Taste
Unirradiated		3.2	3.1	3.4	3.1	R	R	R	R	R	R	R	R	R	R	R	R
Irradiated (Krad)	100	4.1	4.1	4.4	4.0	3.9	3.6	4.0	3.6	3.2	2.9	3.4	3.0	R	R	R	R
	250	4.4	4.2	4.5	4.1	4.1	4.0	4.2	3.7	3.5	3.5	3.7	3.4	2.4**	2.0**	2.8**	2.6**
	350	4.3	4.3	4.5	4.2	4.3	4.1	4.3	3.9	4.0	3.8	4.1	3.6	3.1*	2.9*	3.3*	3.2*
Frozen		4.5	4.4	4.2	4.0	4.3	4.2	4.1	4.0	4.3	4.2	4.0	3.6	4.0	4.0	3.9	3.1

R = Rejected * = Significant at the 0.05 level
** = ,, ,, ,, ,, 0.01 level.

TMA and TVB during storage at 2°C and were completely rejected after 7 days. This is mainly due to the bacterial action leading to fish protein degradation (Hashish et al., 1966). Irradiated samples at 100 Krad also showed a similar increase during storage. However both TMA & TVB values remained within the safe border lines for humen acceptability (20 mg/100 gm) until 17 days of storage. At higher dosage levels i.e., 250 & 350 Krad the same percentages were reached after 24 and 28 days respectively. This could be attributed to the elimination effect of irradiation, especially of the high doses on the microbial load.

A plot of mean score values of sensory evaluation and TMA and TVB against storage time, in Fig. 3, clearly reveals that sensory characteristics decreased with increasing TMA & TVB during storage. This negative relationship is expected since TMA & TVB are good indices of the deteriorative changes taking place in fish during storage.

FFA % and TBA values:

It is clear from Figs. 4 & 5 that both FFA % and TBA values were higher at zero time of storage of irradiated samples than in untreated and frozen samples. The increase in irradiated samples were directly proportional to the irradiation dose level, and is presumably due to the libration of free radicals enhancing lipid oxidation (Nawar, 1972). The increase proceeded up to 21 days and thereafter the values became more or less constant. The rate of increase in frozen samples was much lower than that in irradiated ones, while that of unirradiated samples was quite close to that of samples recieving a 100 Krad dose. The increase in the FFA% and TBA values during storage may be attributed to the hydrolysis and/or oxidation of lipids. Inspite of the evident increase in the FFA% and TBA values of irradiated samples, the observed values were still lower than the safe border lines reported for fresh fish (Spinelli et al., 1965) even at the highest investigation level (350 Krad) after 28 days of storage. The maximum FFA% was 1.55 while, the TBA value was 0.76.

It may also be concluded that the rejection of the unirradiated samples after 7 days of storage at 2°C is not primarily due to lipid oxidation, but is probably due to other factors such as microbiological load, TMA and TVB values.

Microbiological load:

The border line of fish acceptability for bacterial counts was found to be 10^7 cell/gm by Sinskey et al., 1976. It appears that the maximum shelf life of the fresh fish at the refrigerated temperature does not exceed 7 days (Fig. 6). It is clear that a great reduction in total bacterial counts took place directly following the irradiation process at all dose levels investigated. At 100 Krad the percentage reduction reached was 90.3%, at 250 Krad it was 98.7% while at 350 Krad it reached 99.9%. A plot of mean values of bacterial counts against time indicated their progressive increase during storage at 2°C. This was true for all the treatments under investigation. However, the dose level of 350 Krad appears to be the most effective in keeping microbial counts at low levels during refrigerated storage of irradiated Bolti fish. Almost the same trend was observed in total mold and yeast counts. Mold and yeast are also apparently among the factors affecting irradiated fish spoilage.

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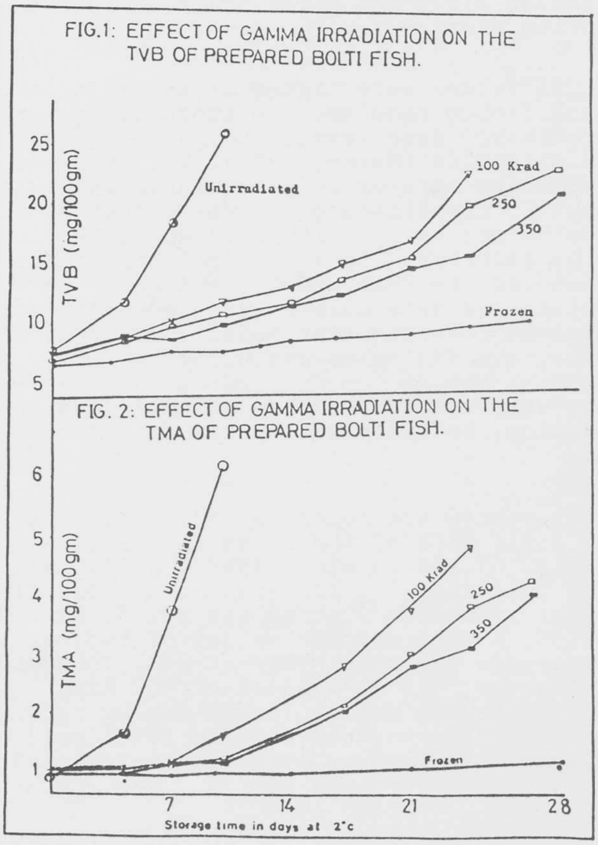

FIG.1: EFFECT OF GAMMA IRRADIATION ON THE TVB OF PREPARED BOLTI FISH.

FIG. 2: EFFECT OF GAMMA IRRADIATION ON THE TMA OF PREPARED BOLTI FISH.

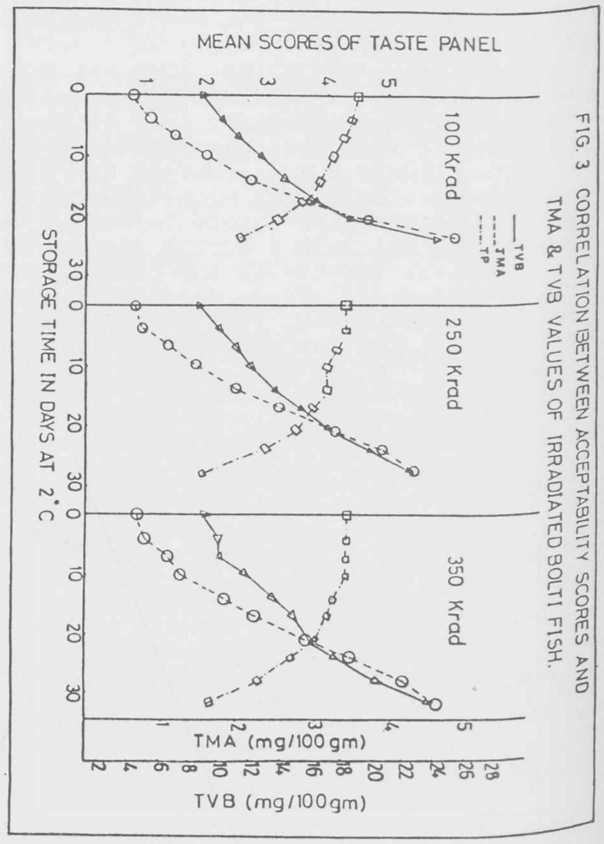

FIG. 3 CORRELATION BETWEEN ACCEPTABILITY SCORES AND TMA & TVB VALUES OF IRRADIATED BOLTI FISH.

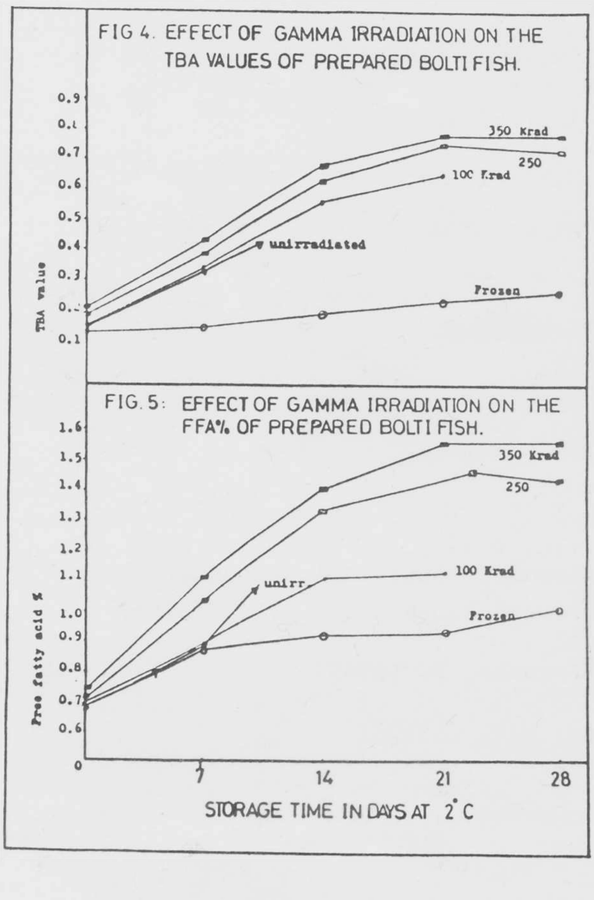

FIG 4. EFFECT OF GAMMA IRRADIATION ON THE TBA VALUES OF PREPARED BOLTI FISH.

FIG. 5: EFFECT OF GAMMA IRRADIATION ON THE FFA% OF PREPARED BOLTI FISH.

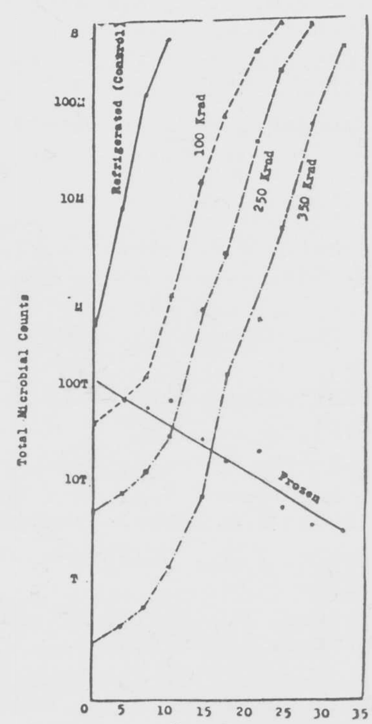

Fig. (6): Effect of gamma irradiation on the total microbial counts of prepared Bolti Fish during storage.