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THE EFFECT OF RADURIZATION ON THE EXTENSION OF STORAGE LIFE OF HORSE MACKEREL "TRACHURUS TRACHURUS"

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ABSTRACT

This study was undertaken to investigate the effect of radurization on the extension of storage time of horse mackerel. The fresh fish samples obtained from the fish market in Ankara, were irradiated at 1, 2 and 3 kGy doses. Microbiological, chemical and organoleptic analyses were done on unirradiated and irradiated fish samples kept in the cold-room at +3 ± 1°C. It was observed that irradiation doses of 2 and 3 kGy significantly extended the storage life of horse mackerel and a dose of 2 kGy was found to be preferable.

ÖZET

Bu çalışma ile radurizasyonun istavrit balığının muhafaza süresi üzerine etkileri incelendi. Ankara balık pazarından taze olarak temin edilen balık örnekleri 1, 2 ve 3 kGy dozlarla ışınlandılar. +3 ± 1°C'de soğuk odada depolamaya alınan kontrol ve ışınlanmış örneklerin mikrobiyolojik kimyasal ve organoleptik analizleri yapıldı. Alınan sonuçlara göre 2 ve 3 kGy doz uygulamalarının istavrit balığının depolama süresini önemli derecede uzattığı ve 2 kGy'in diğer doz uygulamalarına göre daha avantajlı olduğu belirlendi.

INTRODUCTION

The aim of this study is to prolong the extension of shelf-life and marketing period of the horse mackerel using radurization technique. Horse mackerel is 11,8 % of the annual fish products of Turkey and it is an important protein source. 87 % of the total sea products has been consumed freshly in the coastal area of Turkey /1,2/. Transportation of fish from the Black Sea to the interior Anatolia is difficult, since fish products get easily spoiled.

The present method for the preservation of fresh fish topped with ice is not efficient to prevent spoilage. Low doses of ionizing radiation are known to reduce the food spoiling microorganisms and the number of certain pathogenic microorganisms in packed or unpacked fish and fish products and thereby extend the storage life of irradiated products /3,4/. For that reason, the ionizing radiation has been used in various countries as a successful method for the prolonging the shelf-life of different fish species. The Netherlands approved the use of irradiation of shrimp (0,5-1 kGy) for human consumption in 1970, Canada cleared the use of irradiated cod and haddock fillets (up to 1,5 kGy) in 1973 /5/.

Many workers reported that radurization at doses up to 5 kGy is the most suitable method to extend the shelf-life of sea foods by about three to four times of its original storage period, without any significant changes in its overall quality attributes, i.e. color, flavour and odour /6-8/.

The objective of this study is to determine the optimal radiation dose and the effect of radurization on shelf-life, microbial flora, chemical parameters and organoleptic assesments of horse mackerel, as well.

MATERIAL AND METHODS

The samples of horse mackerel were obtained from the fish market of Ankara, after 12-24 hours of catching. The fish samples were transported to the laboratory at Lalahan under melting ice and packed in polyethylene bags in 0,3 kg. portions. The doses used in this experiment on whole fish were 1, 2 and 3 kGy in a Cs 137 source Mark 1-22M Irradiator J.L. SHEPHERD and ASSOCIATES with a dose rate of $1,6.10^5$ rad/h measured by a Fricke dose-meter. Then the irradiated and unirradiated samples were stored in a cold-room at $3 \pm 1^{\circ}C$ and analyses of the samples were carried out immediately after irradiation and continued twice a week intervals.

Sensory evaluation

The sensory evaluation tests were carried out with a slight modification of the method used by Nanyaro and Bon /9/ and the colour, odour, skin, eyes and gills of the raw fish samples and the odour, texture and flavour of cooked materials were judged.

Microbiological evaluation

The microbial analyses were done in parallel to chemical and sensory testing. For this purpose, whole fish were sampled taking approximately 10 g. of muscle tissue under sterile conditions and homogenized after addition of peptone (0,1 %) + sodium chloride (0,85 %) solution so as to form a 10 % dilution. From this dilution inoculations were made to obtain the numbers of microorganisms (bac./g.) for microflora as follows:

a. Aerobic Mesophilic Count (for fish): Plate Count Agar (PCA) (Oxoid CM 325) with sodium chloride (0,5 %) was used as culture media. Incubation lasted 72 hours at 30°C in the incubator /10/.

b. Aerobic Psychrophilic Plate Count: Plate Count Agar (Oxoid CM 325) with salt (0.5 %) was used as culture media for enumeration these bacteria. Incubation at 4-6°C lasted for 12 days.

c. Anaerobic Bacteria Counting: In order to count anaerobic microorganisms, containing AC Medium (Difco) tubes (160 x 16mm) after inoculation and obtaining anaerobic medium using 2 % Bacteriological agar gel (Agar No. 3 Oxoid) were incubated at 30°C for 3 days.

d. Coliform Bacteria Counting: The coliform bacteria was determined using Desoxycholate Agar (Oxoid). Incubation lasted for 24 hours at 37°C /11/.

e. Staphylococcus aureus Determination: Staphylococcus aureus was studied using Baird Parker Medium and Egg Yolk Tellurite Em. (Oxoid) and inoculated surface plates were incubated at 37°C for 24-26 hours /10/.

Chemical Analyses

a. Total Volatile Bases (TVB): TVB was estimated by the distillation method. The results were determined as mg Nitrogen in 100 g fish samples /12/.

b. Trimethylamine (TMA): TMA was determined spectrophotometrically according to the extraction procedure. The TMA quantities as mg in 100 g. sample were calculated using a standart curve which was obtained from various concentration of trimethylamine hydrochloride solution (Sigma No. T. 7630) /13/.

c. Thiobarbituric acid (TBA): TBA values were

determined as spectrophotometrically using the extraction and filtration procedure with trichloroacetic acid. TBA value as mg molonaldehyde of 1000 g. sample were calculated using the standard curve which was obtained from various concentrations of 1.1.3.3 tetraethoxypropane solution (Sigma No T. 9889) /13/.

RESULTS AND DISCUSSION

The microbiological test results are shown in Table-1. Table-2 gives the results obtained from chemical analyses during the storage period of the level of decomposition in the control samples and those irradiated at different doses. On the other hand Table-2 shows the mean sensory assesments of the control and irradiated fish samples as a function of irradiation dose and storage time.

By irradiation the whole horse mackerel with doses between 1 and 3 kGy microbial content was reduced approximately by an inactivation factor ranging from 10^2 to 10^3. This is in agreement with the findings of several workers /6, 8, 11/. It was noticed that coliform group bacteria show greater radiation sensitivity, than the others /4,11/. Staphylococcus aureus was not detected in control and irradiated samples due to low storage temperature in accordance with literature information /4/.

The chemical indices (content of TMA and TVB) increased considerably slowly in the irradiated samples more than in the unirradiated ones. (Figs. 2,3). TMA and TVB gave significant correlation with organoleptic changes during storage for control samples. Immediately after irradiation a slight difference between the TBA value of the control and irradiated samples (Fig. 1.) was found due to the effect of radiation doses. But no rancid flavour and odour in the control and irradiated samples were detected during the storage period. In this experiment, the organoleptic control, microbiological and chemical analyses results have shown that irradiation doses of 2 and 3 kGy significantly extended the storage life of horse mackerel and a dose of 2 kGy was found to be preferable. The unirradiated fish samples spoiled after 5 days while those treated with 2 kGy were acceptable up to 15 days (Fig. 4).

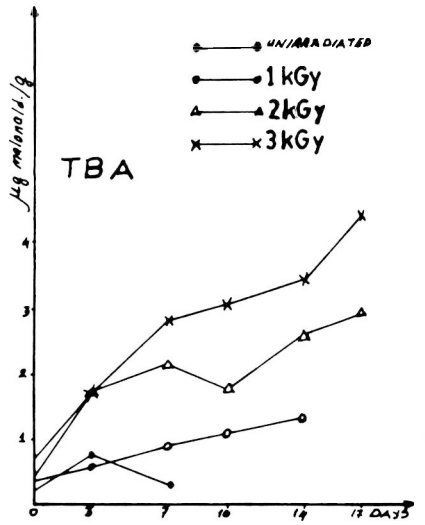

Fig.1: Changes in TBA of irradiated and unirradiated horse mackerel at 3 ± 1°C

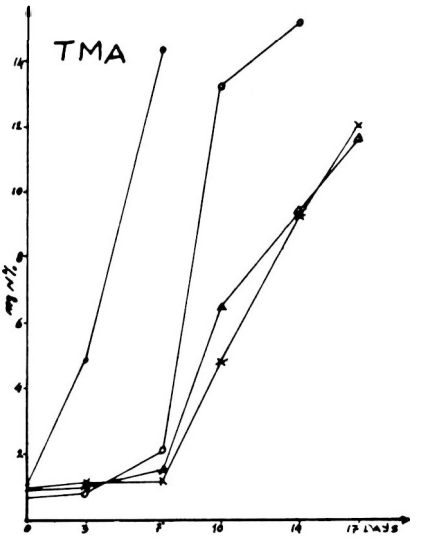

Fig.2: Changes in TMA of irradiated and unirradiated horse mackerel at 3 ± 1°C

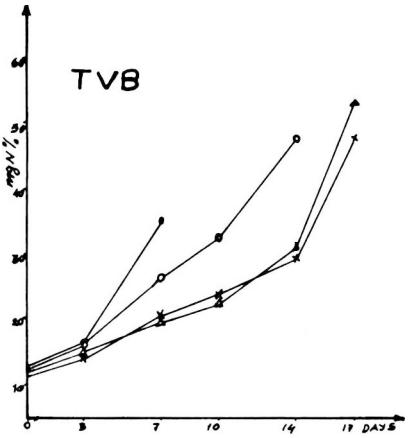

Fig.3: Changes in TVB of irradiated and unirradiated horse mackerel at 3 ± 1°C

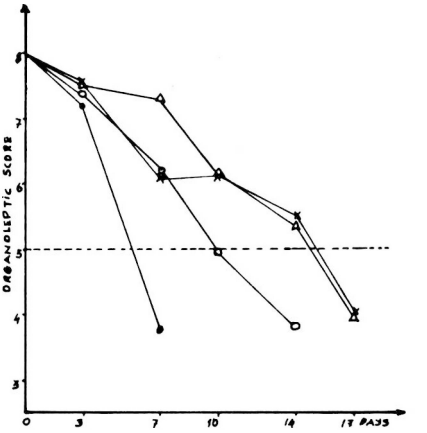

Fig.4: Average organoleptic scores of the irradiated and unirradiated fish samples as a function of irradiation dose and storage time

TABLE-1. Results of microbiological studies of irradiated and unirradiated fish (horse mackerel) at temperature 3 ± 1°C

Dose (kGy)	Storage time (days)	Aerobic Mesophilic (bac./g.)	Aerobic Psychrophilic (bac./g.)	Anaerobic (bac./g.)	Coliforms (bac./g.)	Staph-aureus (bac./g.)
0	0	$6,6 \times 10^4$	$3,4 \times 10^6$	$1,5 \times 10^3$	$1,5 \times 10^3$	-
	3	$2,7 \times 10^6$	$7,1 \times 10^7$	$6,4 \times 10^3$	$1,7 \times 10^4$	-
	7	$1,9 \times 10^7$	$1,3 \times 10^9$	$1,4 \times 10^6$	$7,0 \times 10^4$	-
1	0	$2,4 \times 10^3$	$9,8 \times 10^4$	-	<10	-
	3	$1,3 \times 10^5$	$1,1 \times 10^6$	$1,0 \times 10^2$	$1,5 \times 10^2$	-
	7	$3,8 \times 10^6$	$2,9 \times 10^7$	$4,0 \times 10^3$	$3,5 \times 10^2$	-
	10	$7,5 \times 10^6$	$1,8 \times 10^8$	$2,3 \times 10^5$	$2,8 \times 10^3$	-
	14	$2,5 \times 10^7$	$2,5 \times 10^9$	$4,3 \times 10^5$	$4,1 \times 10^3$	-
2	0	$3,9 \times 10^2$	$7,0 \times 10^3$	-	-	-
	3	$1,0 \times 10^4$	$1,0 \times 10^5$	-	-	-
	7	$2,4 \times 10^5$	$2,9 \times 10^6$	-	-	-
	10	$1,9 \times 10^6$	$2,4 \times 10^7$	$1,4 \times 10^2$	-	-
	14	$7,8 \times 10^6$	$1,5 \times 10^8$	$9,0 \times 10^2$	-	-
	17	$2,4 \times 10^7$	$2,0 \times 10^9$	$2,2 \times 10^3$	-	-
3	0	$1,5 \times 10^2$	$3,9 \times 10^3$	-	-	-
	3	$1,1 \times 10^3$	$1,8 \times 10^4$	-	-	-
	7	$2,9 \times 10^4$	$2,7 \times 10^6$	-	-	-
	10	$5,4 \times 10^5$	$1,1 \times 10^7$	-	-	-
	14	$2,6 \times 10^6$	$1,0 \times 10^8$	$3,5 \times 10^1$	-	-
	17	$4,5 \times 10^7$	$4,8 \times 10^9$	$5,0 \times 10^2$	-	-

TABLE-2. The results obtained from chemical/analyses and sensory assesments of the control and irradiated fish samples.

Dose (kGy)	Storage Time (Days)	TVB (mg N %)	TMA (mg N %)	TBA (mg malon) % 0,1	Raw State	Cooked State		
					Odour	Odour	Texture	Flavour
	0	13,0	1,04	0,23	8,0	8,0	8,0	8,0
0	3	16,8	4,85	0,77	7,0	7,2	7,4	7,2
	7	35,0	14,36	0,33	3,6	4,0	3,5	4,0
	0	12,5	0,70	0,38	8,0	8,0	8,0	8,0
	3	16,0	0,81	0,61	7,6	7,2	7,4	7,2
1	7	26,4	2,09	0,92	5,8	6,5	6,5	6,5
	10	32,2	13,24	1,08	5,2	5,0	4,6	5,0
	14	47,8	15,22	1,34	3,5	4,0	4,0	3,8
	0	11,8	0,90	0,47	8,0	8,0	8,0	8,0
	3	15,0	0,99	1,71	7,6	7,4	7,4	7,6
2	7	19,6	1,48	2,15	6,4	7,0	7,0	6,8
	10	22,4	6,50	1,78	5,6	6,0	6,0	7,0
	14	30,8	9,41	2,60	5,2	5,5	5,5	5,2
	17	53,0	11,59	2,91	3,8	4,0	4,0	4,0
	0	11,4	0,93	0,72	8,0	8,0	8,0	8,0
	3	14,0	1,07	1,71	7,6	7,4	7,6	7,6
3	7	20,6	1,16	2,84	6,6	5,7	6,0	6,0
	10	24,0	4,81	3,06	5,6	6,4	6,2	6,2
	14	28,2	9,24	3,44	5,0	5,8	5,5	5,8
	17	47,6	12,03	4,41	4,0	4,2	4,0	4,0

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