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EFFECT OF RADURIZATION AND PACKAGING ON THE SHELF-LIFE AND QUALITY OF THE ANCHOVY (ENGRAULİS ENCRASİCALUS) 1

İ. Öztaşıran[2], B. Mutluer[2], S. Ersen[2], B. Kaya[2], M. Akkuş[2], G. Siyakuş[2]

Radurizasyon ve Paketlemenin Hamsi Balığının Korunma Süresi ve Kalitesi Üzerine Etkisi

Özet: *Bu çalışma ile radurizasyon ve paketlemenin* 0–3 C° *de depolanan hamsi balığının korunma süresi, duyusal, kimyasal ve mikrobiyolojik kalitesi üzerine etkileri incelendi. Vakum,* CO_2*: hava* (60+40) *ve normal atmosfer altında paketlenen taze balık örneklerine* 1 *kGy doz uygulandı. Depolama öncesi çiğ ve pişirilmiş olarak yapılan organoleptik muayenelerde, ışınlanmış ve ışınlanmamış balık örnekleri arasında önemli bir farklılık bulunmadı.* 1 *kGy dozla ışınlanan hamsi örneklerinin* 0–3 *C° deki korunma süreleri normal atmosfer altında paketlemelerde* 10 *gün, vakum ve* CO_2 *ortamlı paketlemelerde* 13 *gün olarak bulundu. Vakum–ışınlama ve* CO_2*–ışınlama kombinasyonlarının aerobik mezofilik ve anaerobik ve fakültatif anaerobik mikroorganizmalar üzerine daha etkili oldukları görüldü. Işınlanmış ve ışınlanmamış örneklerin TVB-N değerlerinin depolama süresince organoleptik değişikliklerle iyi korelasyon verdiği belirlendi. Sonuçta vakum paketleme ile birlikte* 1 *kGy doz uygulamasının, taze hamsi balığının* 0–3 °*C de korunma süresini kontrola göre* 9 *gün daha fazla uzatarak tercih edilir durumda olduğu bulundu.*

Summary: *Effect of radurization and packaging on the shelf-life, sensory, chemical and microbiological quality of anchovy (Engraulis encrasicalus) stored at* 0–3 °*C was studied. Fresh fish samples were sealed: in air, under vacuum, in* 60 % *carbon dioxide* – 40 % *air and a dose of* 1 *kGy applied. In the sensory evaluation of the raw and cooked fish, the panel found no marked difference between the unirradiated and irradiated samples before storage. The shelf-life of anchovy with irra-*

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2 Lalahan Nuclear Research Institute in Animal Health, Ankara

diation at 1 kGy was observed as 10 days for the air irradiated, 13 days for the vacuum-irradiated and CO_2 – irradiated samples at 0–3 °C. Vacuum-irradiation and CO_2 – irradiation treatments were much more effective on the aerobic and facultative anaerobic microorganisms than the other treatments.

TVB-N values of both the untreated and treated samples gave significant correlation with organoleptic changes during storage. It was observed that combination of vacuum packaging and radurization at 1 kGy is the preferable treatment which would extend the shelf-life of fresh anchovy fish for 9 days over the untreated one at 0–3 °C.

Introduction

The use of radurization treatment has shown considerable promise for the purpose of extending the shelf-life of fresh fish and fish products. The process can reduce the microbial load and the number of certain pathogenic microorganisms in packaged fish and fish products, at the average dose up to 2,2 kGy (6, 14). Combination of certain packaging and radurization treatments have been shown to enhance shelf-life of fresh fish (3, 4, 7, 11). In 1981, the joint FAO /WHO Expert Committe declared that any irradiated food was toxicologically safe up to a dose of 10 kGy (6). It has been estimated that the total operating costs for the extension of shelflife for fresh fish varies from 0,2 to 2 % of the final price depending upon the throughput capacity (2, 16). The fishery industry is mainly located on the cost. For that reason the transportation of fish in a fresh state poses serious problems for inland distribution. Combined with modern packaging and transportation techniques, the use of radurization for extending the shelf-life of fresh fish can facilitate distribution of these items into the interior regions.

Our earlier studies have indicated that a radurization dose of 1 kGy could significantly enhance the shelf-life of anchovy at 0–3 °C (12). The purpose of this investigation was to study the combined effect of radurization and packaging treatment on shelf-life, microbial, chemical and organoleptic quality of anchovy at 0–3 °C.

Materials and Methods

Anchovy samples were obtained from the Samsun which is a city at the Middle Part of Black Sea Region of Turkey and transported to the Food Irradiation Laboratory at Lalahan Nuclear Research Institute in Animal Health, Lalahan, Ankara under melting ice. Fish samples in bags (poliamide-ianomer-poliethylene) in about 0,4 kg protions were sealed; in an air atmosphere, under vacuum and in an atmosphere of 60 % carbon dioxide - 40 % air and irradiated at 1 kGy dose in the. Cs 137 source (Mark 1–22 M) Irradiator, 10.000 Ci J.L. SHEPHERD and ASSOCIATES with a dose rate of 1, 86.10^3 Gy/h measured by a Fricke dose-meter. The temperature was maintained at 1–4 °C during irradiation. Both the unirradiated and irradiated fish samples were stored in a cold-room at 0–3 °C during storage and analyses of the samples carried out immediately after irradiation and twice a week intervals.

Sensory Evaluation:

The sensory evaluation tests were carried out with a slight modification of the method used by Nanyora and Bon (10) and the colour, odour of the raw fish samples and the odour, texture and flavour of cooked materials were judged by a trained panel of 5–6 and scored on a ten-point scala on which 5 was taken as the limit of acceptability.

Shelf-life study:

The shelf-life was studied by evaluating changes in biochemical properties, microbial growth and sensory quality during storage period.

Biochemical properties:

Total volatile base-nitrogen (mg TVB-N %), was estimated by the steam–distillation–procedure in Micro Kjeldahl Distilling Unit (7052–J10 THOMAS SCIENTIFIC) (9). Thiobarbituric acid (TBA as mg malonaldehyde/1000 g. samples) was determined as spectrophotometrically using the extraction and filitration procedure with trichloracetic acid (9). Peroxide value (PV as the number of mg-equivalents of peroxide oxygen/1000 g. samples) (9). pH values of the samples were determined with the EMAF pH Meter (Model Em 78x).

Microbiological analyses:

From each samples, 10g. of muscle tissue was weighted under sterile conditions and homogenized after addition of peptone (0,1 %)

and sodium chloride (0,85 %) solution so as to from a dilution in a stormacher for 2 minutes. From this homogenate, a series of dilutions (10^2 to 10^8) were prepared. The number of colony forming units (CFU /g) was determined for microflora as follows.

Aerobic mesophilic count was obtained by using Plate Count Agar (Oxoid CM 325) with sodium chloride (0,5 %). Incubation lasted 72 hours at 30 °C (15). Anaerobic and facultative anaerabic count was determined by using Schoedler Agar (Oxoid CM 437). Incubation was done at 30 °C in a gas-pack (BBL) for 3 days. Clostridia were studied by the 5 tube most probable number (MPN) method using Reinforced Clostridial Medium (Oxoid CM 149) as culture media. Incubation at 30 °C lasted 1–7 days (8). Staphylococcus aureus was examined by the 3 tube MPN method using Tryticase Soy Broth (Oxoid CM 129) and Baird Parker Medium (Oxoid CM 275) (1). Selected colonies were tested for coagulase activity.

Statistical analysis: Two-way analysis of variance was carried out to study the differences among treatment groups (13).

Results and Discussion

The results of sensory assesments and quality indices of anchovy at 0–3 °C have been presented in Table 1 and Fig. 1. 2. 3. 4. In the sensory evaluation of the raw and cooked fish, the panel found no marked difference between the unirradiated and irradiated samples before storage. The shelf-life was observed as 10 days for the air-irradiated, 13 days for the vacuum-irradiated and CO_2-irradiated anchovy fish samples at 0–3 °C. As shown in Table 1, Fig. 1, vacuum-irradiated and CO_2–irradiated treatments were much more effective on the aerobic mesophilic and anaerobic and facultative anaerobic microorganisms than the other treatments. In the vacuum-irradiated and CO_2–irradiated samples, the initial aerobic mesophilic count of 6,4 10^3 /g. and 5,0.10^3/g. increased to 9,8.10^5 /g. and 1,4. 10^5 /g. and anaerobic and facultative anaerobic count reached to 2, 1.10^4 /g. on the 13 th day of storage. The coagulase positive Staphylococcus aureus and genera Clostridium were not present in all samples during storage at 0–3 °C.

Changes in chemical parameters of unirradiated and treated anchovy are shown in Fig. 2, 3, 4, 5 and Table 1. As shown in Fig. 3, 4 vacuum packaging of anchovy could cause considerable reduction in the PV an TBA values. After 10 days of storage, the PV and TBA va-

Table 1: Changes in microbiological, chemical and sensory parameters (X ∓ SD) of anchovy at 0-3 0C.

Treatment	Parameters							
	Day of storage	TVB-N (mg N %) (n=8)	TBA (mg mal. /kg) (n=8)	PV (mg.equ. / kg) (n=8)	pH (n=6)	Aero.mes. count / g. (n=6)	Anae.and fac. anae.count / g. (n=6)	Organoleptic score (n=12)
Unirradiated	0	10.25∓0.16	0.87∓0.02	0.50∓0.05	6.33∓0.01	$5.2.10^4$	$2.4.10^2$	8.5∓0.16
	3	27.58∓0.57	1.30∓0.23	2.70∓0.10	6.38∓0.02	$1.2.10^5$	$6.9.10^3$	5.9∓0.27
Vacuum	0	10.08∓0.06	0.57∓0.10	1.00∓0.10	6.32∓0.01	$6.1.10^4$	$1.1.10^2$	8.5∓0.17
	5	34.66∓0.95	0.89∓0.12	1.70∓0.12	6.39∓0.02	$5.7.10^5$	$2.4.10^4$	5.3∓0.39
CO_2	0	9.61∓0.50	0.83∓0.17	0.90∓0.10	6.36∓0.01	$3.4.10^4$	$1.8.10^2$	8.4∓0.21
	5	31.35∓1.36	1.74∓0.38	5.10∓0.21	6.46∓0.10	$1.1.10^5$	$2.7.10^3$	5. ∓30.37
Air-irrad.	0	10.28∓0.17	0.94∓0.12	1.10∓0.14	6.28∓0.10	$4.3.10^3$	< 30	8.3∓0.21
	10	33.60∓0.84	2.62∓0.22	5.60∓0.16	6.5∓0.02	$8.9.10^5$	$6.0.10^3$	5.2∓0.20
Vac-irrad.	0	8.06∓0.17	0.71∓0.08	0.80∓0.14	6.32∓0.01	$6.4.10^3$	< 30	8.4∓0.20
	13	30.91∓1.07	0.92∓0.17	3.95∓0.18	6.55∓0.02	$9.8.10^5$	$2.1.10^4$	5.5∓0.24
CO_2-irrad.	0	9.58∓0.18	1.25∓0.11	0.80∓0.10	6.34∓0.01	$5.0.10^3$	< 30	8.3∓0.21
	13	31.94∓1.16	3.19∓0.34	6.90∓0.25	6.57∓0.01	$1.4.10^5$	$1.5.10^3$	5.3∓0.22

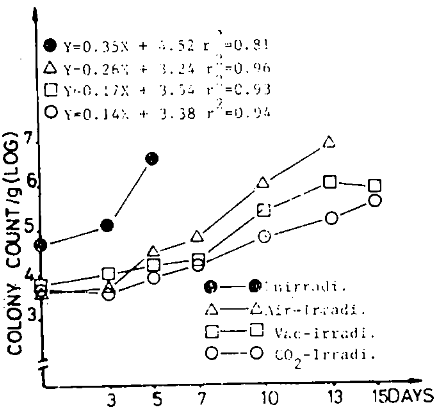

Fig 1. Aerobic mesophilic count of unirrdiated and treated anchovy during storage at 0–3 °C.

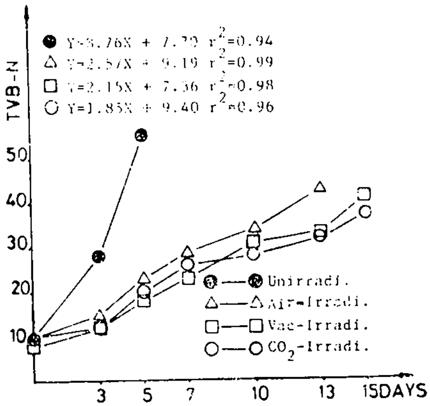

Fig 2. Changes in TVB-N values of unirradiated and treated anchovy during storage at 0–3 °C.

lues of 5, 60–6, 70 mg. equ /kg. and 2, 62–2, 84 mg /kg in the air-irradiated and CO_2-irradiated samples and the TBA values of 0, 65 mg /kg. and the PV of 3, 10 mg. equ /kg. in the vacuum-irradiated samples were obtained, respectively, TVB-N values increased considerably more slowly in the air-irradiated, vacuum-irradiated and CO_2-irradiated, than the unirradiated samples (Table 1, Fig. 2). In the unirradiated samples, the initial TVB-N value was 10, 25 mg /100g. which increased to 55, 31 mg /100g. in 5 days. In the vacuum-irradiated and CO_2-irradiated samples, the initial TVB-N values of 8, 06 mg /100g. and 9, 58 mg /100g. reached 40, 52 mg /100g. and 37, 44 mg /100g. within 15 days. pH values were slightly lower in the unirradiated samples as compared to the irradiated samples. The changes in pH values were similar for the irradiated samples during storage at 0–3 °C. PV and TBA values in both untreated and treated samples were markedly increased during the first 3 days of storage, thereafter showed fluctuations (Fig. 3, 4).

The changes in PV, TBA and pH did not correlate with sensory scores during storage. This suggests that these parameters are not good indices of spoilage for anchovy fish. In the unirradiated and irradiated samples, TVB-N showed a good correlation with sensory scores in agrement with several investigations (3, 5, 12). Therefore, this parameter would be a useful indicator to determine loss of acceptability or end of shelf-life for irradiated and unirradiated anchovy at 0–3 °C.

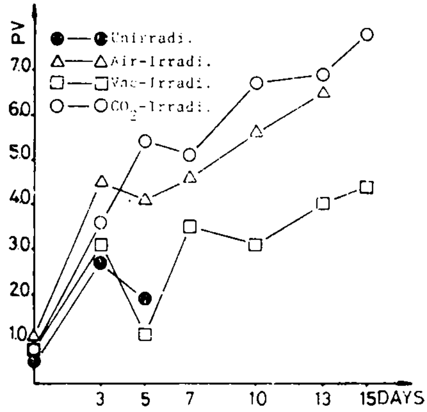

Fig 3. Changes in PV of unirradiated and treated anchovy during storage at 0–3 °C.

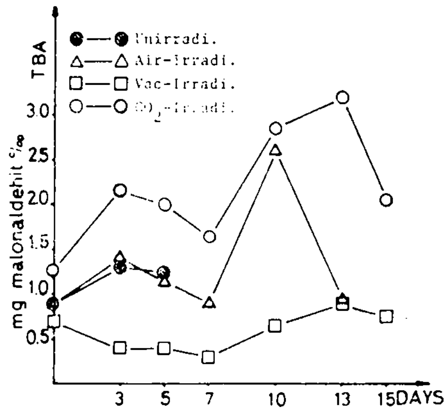

Fig 4. Changes in TBA values of unirradiated and treated anchovy during storage at 0–3 °C.

The TVB-N values of both irradiated and unirradiated samples were shown to be significantly different ($p < 0.01$) during storage. In the irradiated and unirradiated samples, the TBA and PV were significantly different ($p < 0.05$) before storage and thereafter which were found not to be significantly different ($p > 0.05$).

Conclusion

It appears that combination of vacuum packaging and radurization at 1 kGy is the succesful treatment which would extend the shelf-life of anchovy fish for 9 days over the untreated one at 0–3 °C.

TVB-N seems to be applicable as objective spoilage indicator of the irradiated and unirradiated anchovy. TVB-N values of approximately 35 mg % N can be recomended as spoilage indicator of fresh anchovy. The PV and TBA can not be used to determine loss of acceptability. or end of shelf-life of anchovy. pH is not good index of spoilage of irradiated and unirradiated anchovy.

As a result, it can be concluded that combination of vacuum packaging and radurization with 1 kGy treatment will facilitate distribution of fresh anchovy at 0–3 °C into the interior and eastern parts of Anatolia.

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