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COMBINED EFFECT OF CHEMICAL TREATMENT AND RADURIZATION ON THE EXTENSION OF STORAGE LIFE OF ANCHOVY (Engraulis encrasicalus).[1]

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Kimyasal işlem ve radurizasyonun birlikte uygulanmasının hamsi balığının dayanma süresi üzerine etkisi

Özet: *Bu araştırma, kimyasal katkı maddeleri (sodyum klorür ve sodyum tripolifosfat), radurizasyon ve bu kimyasal katkı maddeleri ile radurizasyonun birlikte tatbik edilmesinin, hamsi balığının kimyasal, mikrobiyolojik ve organoleptik niteliklerine etkilerini belirlemek amacıyla yürütülmüştür. Kimyasal olarak toplam uçucu baz-nitrojen (total volatile base-nitrogen: TVB–N), tiyobarbütirik asit (TBA) ve peroksik değeri (PV) saptanmış; mikrobiyel olarak aerobik mesofilik, aerobik psikrofilik, S. aureus, koliform ve E. coli sayılmış; ve ayrıca organoleptik muayene yapılmıştır.*

Hamsi balığının sodyum klorür ve sodyum tripolifosfat çözeltilerinde (10 %) *sırasıyla* 15 ve 60'*şar dakika bekletilmesi hem kimyasal, hem de mikrobiyolojik kalitelerini çok az derecede etkilemiş ve dayanma süresini artırmamıştır. Hamsi balığının düşük ısı derecesinde* 1 *kGy dozla ışınlanması mikroorganizmaların üremelerini büyük ölçüde önlemiş ve buna bağlı olarak bozulma süresi belirli derecede artmıştır. Araştırma bulguları, hamsi balığının sodyum tripolifosfat ile birlikte radurizasyona tabi tutulmasının diğer uygulamalara kıyasla daha etkin olduğunu ortaya koymuştur. Bu uygulamaya tabi tutulan hamsi balığı numunelerinden en yüksek organoleptik puanlar elde edilmiştir. Böylece, hamsi balığının dayanma süresinin, radürizasyonun sodyum tripolifosfat ile birlikte tatbiki sonucunda* 12 *gün kadar uzatılabileceği saptanmıştır.*

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Summary: *This investigation was undertaken to study the effect of chemical treatment (sodium chloride and sodium tripolyphosphate), radurization and combine treatment of anchovy with chemicals and radurization on the chemical, microbial and organoleptic properties of anchovy fish. For this purpose, total volatile base-nitrogen (TVB–N), thiobarbutiric acid (TBA) and peroxide value (PV) were determined as chemically. For microbiologically, aerobic mesophilic, aerobic psychrophilic, S. aureus, coliforms and E. coli were counted and in adition to the organoleptic attributes were also evaluated.*

The dip treatment of anchovy in sodium chloride and sodium tripolyphosphate did not effect much both chemical and microbiological attributes and therefore did not increased the storage life. Radurization itself 1 *kGy dose (at* 0–3 °C*) retarted the growth of microorganisms, only small extent. The experimental results showed that anchovy treated with both radurization and sodium tripolyphosphate was more effective than the other treatments. Anchovy treated with combination of radurization and sodium tripolyphosphate gave higher sensory scores than the others. It was observed that treating anchovy in this way could extend the sheef-life of fresh anchovy for approximately* 12 *days.*

Introduction

Seafoods have always been prefered by consumer in fresh state. For this reason, preservation by some means is absolutely essential for prolonging the self-life and for storage of all seafoods. The most common methods for prolonging the shelf-life of seafoods are the use of icing, refrigeration, freezing and irradiation. Eventhough, the seafoods are preserved by these methods, deterioration of them is a frequent problem in most of the countries (3,11,15).

Turkey has high fish catching and producing capacity. The seas around Turkey contain various types of fish, particularly anchovy (in Turkish called as hamsi) in planty amount. In 1984, the amount of anchovy harvested was over 330.000 tons at the Black Sea Region of Turkey (1). Fish including anchovy are stored mostly in ice during the distribution and marketing in Turkey, the length of shelf-life of anchovy stored in ice (3–4 days) is not enough for transportation of anchovies to the some parts of Turkey for away from the anchovy harvesting areas, such as the interior and the eastern parts of Anatolia. Deteriora-

tive changes and spoilage are therefore mostly occurred in anchovy during the trasportation and marketing (10).

The length of the storage time during which optimum acceptability is maintained depends upon the preservative methods used. Over the past several decates, much attention has been given to application of ionising radiation as a methods of meat preservation including fish. Ionising radiation destroys microorganisms in and on fish without raising the temperature of the products. It is therefore referred to as cold sterilization (5,15).

Ionising radiation applied at higher doses and temperatures causes a number of undesirable changes in fish including discoloration and the production of very objectionable odours and flavors (3). However, recent studies have indicated that ionising radiation at lower deoss and temperatures (radurization) in conjuction with other measures, such as chemicals, spices and controlled atmosphore has led the fresh meat and fish for about three weeks shelf-life. Such a long shelf-life for fresh fish is adequate for transfering and marketing. Radurization process with chemical treatment such as predip treatments in salt solutions like sodium chloride, sodium polyphosphate is presently in the experimental development stage (3,6,7,14).

The objective of this study was to investigate the possible combined effect of radurization and chemical treatment on chemical, microbial, organoleptic properties and shelf-life of anchovy.

Materials and Methods

Preparation of samples: The samples of fresh anchovy were obtained from the fish market in Samsun which is a city in the Middle Part of Black Sea Region of Turkey. The anchovy samples were transported on the catching date in ice to the food Irradiation Laboratory at Lalahan Nuclear Research Institute in Animal Health, Lalahan, Ankara. The samples were first separated into three groups; one of them was chosen as a control; second group was dipped in 10 % sodium tripolyphospate (NaTPP) solution for 15 minutes; and third group was dipped in 10 % sodium chloride (NaCl) solution for one hour. After that the samples including control group were divided into two parts and then packed into polyethylene bags in thickness of 0,05 mm. One of the bag from each group of samples was irradiated with 1 kGy dose in

the Cs^{137} source (Mark 1–22 Irradiator, 10.000 Ci J.L. Sheppard and Associates) at a dose rate of 1,86 x 10^3 Gy / h measured by the Fricke Dosimeter. The temperature was maintained at 1–4 C° during the irradiation. Both the irradiated and unirradiated anchovy samples were stored at 0–3°C during the 15 days experimental period. The samples were appllied to aech analysis shown below on the days of the 0,5,8,12 and 15 th respectively.

Chemical analysis: Changes in leves of total volatile base-nitrogen (mg TVB–N %); Thiobarbituric acid (TBA as mg malonaldehyde / kg samples); and the peroxide value (PV) were determined with the methods of Mwansyemala (8).

Microbiological analysis: From each samples, 10 gr of muscle tissue was weighted under the sterile conditions and homogenized after addition of peptone (0,1 %) and sodium chloride (0,85 %) solution so as to form a 10 % solution in a stomacher for 2 minutes. From this homogenized samples, a series of dilutions (10^2 to 10^7) were prepared. The number of colony forming units (cfu / g) was determined for microflara as follows:

Aerobic mesophilic count was obtained by using plate count agar (PCA) (Oxoid CM 325) with sold (0,5 %). Incubation was done at 30°C for 72 hours (13). Aerobic psychrophilic plate count was also determined on plate count agar (PCA) (Oxoide 325) including 0,5 % sold and incubating at 4–6°C. For total coliforms and Escherichia coli were detected by using the 3–tube MPN procedure (4). Staphyloccus aureus was examined by the 3–tube MPN method using Trypticase Soy Broth (Oxiod CM 129) and Baird Parker Medium (Oxoid CM 275) (4). Selected colonies were tested for cuagulase activitiy (2).

Sensory evaluation: The sensory or organoleptic evaluation was done with the slight modification of the method used by Nanyora and Bon (9).

The colour, odour of raw anchovy samples and the odour, texture and flavor of cooked samples were judged by the 5–6 trained panelists and scored on a tenpoint scale on which 5 was taken as acceptable limit.

Statistical analysis: Two-way analysis of variance was carried out to determine the statistical differences among the treatment groups (12).

Results

The mean effects of chemical treatments and radurization on chemical examinations of anchovy during the storage time are presented in Table 1. The TVB–N values of all anchovy samples increased as the storage time was increased. However, the increase in these values was greater and faster in untreated anchovy than treated with chemicals, radurized and chemicals-radurized of anchovy samples. The untreated anchovy showed the highest TVB–N value (76,33 mg N %) on the 8 th day of storage, while anchovy treated with both NaTPP–radurization showed the lowest value (18,24 mg N %). The reducing effect of NaTPP was higher than NaCl. Radurization itself reduced the TVB–N formation of anchovy more than the chemicals. The combined treatment of radurization and NaTPP was found more effective than the others and it significantly reduced the TVN–B formation in anchovy during the storage time.

TBA and PV values in both untreated and treated anchovy samples markedly increased during the first 5 days of storage, thereafter they showed slightly fluctuations. TBA and PV values in the combine treated samples with radurization–NaCl and NaTPP showed significant increase after the 8 days of storage.

The microbiological results obtained from untreated and treated anchovies with both chemical and radurization are shown in Table 2. The initial aerobic mesophilic and psychrophilic counts of the plain anchovy increased almost to spoilage levels (1.8×10^7 and 1.2×10^8 respectivelly) after the 8 days of storage. In these samples coliform group, E.coli were present until the 8 days of storage. However, S. aeureus were present only at the beginning of the storage time. NaCl and NaTPP did not reduce much the microbial counts. Radurization of fresh anchovy with 1 kGy dose extend a little more the microbial quality than the chemicals. Coliforms and E. coli were destroyed after the application of radurization. The combined treatment of anchovies with radurization and chemicals particularly with NaTPP destroyed coliforms and E. coli and reduced in large extent the aerobic and psychrophilic counts and allowed the storage for 12 days. During the storage time, the aerobic mesophilic and aerobic psychrophilic counts increased from 1.3×10^2 and 2.3×10^3 to 1.6×10^3 and 1.6×10^7 in samples treated NaTPP-radurised respectively.

The results of sensory assesments of the chemical treatments and radurization of the raw and cooked anchovy samples are summarized

Table 1. The effect of chemical treatment and radurization (1 kGy) on chemical properties of anchovy during the storage at 0-3°C[a].

Anchovy sample	Chemical analysis	Storage time (days) 0	5	8	12	15
Plain anchovy (control)	TVB-N[b]	10.78 ± 0.29	34.27 ± 3.39	76.33 ± 6.88		
	TBA[c]	0.33 ± 0.02	2.10 ± 0.40	3.19 ± 0.33		
	PV	0.50 ± 0.27	4.60 ± 0.47	8.00 ± 0.93		
Anchovy treated with 10 % NaCl	TVB-N	13.44 ± 0.17	31.21 ± 2.62	62.89 ± 3.47		
	TBA	0.52 ± 0.05	3.66 ± 0.84	2.97 ± 0.53		
	PV	1.20 ± 0.24	3.70 ± 0.36	8.20 ± 0.99		
Anchovy treated wirh 10 % NaTPP	TVB-N	13.12 ± 0.32	30.02 ± 2.52	54.43 ± 4.19		
	TBA	0.71 ± 0.08	3.16 ± 0.67	2.76 ± 0.35		
	PV	0.40 ± 0.16	5.40 ± 0.52	8.50 ± 0.04		
Anchovy radurized	TVB-N	12.10 ± 0.30	17.40 ± 1.40	30.32 ± 1.28	41.05 ± 9.07	
	TBA	1.05 ± 0.08	3.85 ± 0.98	2.68 ± 0.34	6.30 ± 1.09	
	PV	3.00 ± 0.29	6.40 ± 0.57	4.40 ± 0.56	10.76 ± 1.21	
Anchovy radurized and treated with 10 % NaCl	TVB-N	10.75 ± 0.20	14.44 ± 1.58	19.81 ± 1.16	31.58 ± 9.03	51.87 ± 9.03
	TBA	0.77 ± 6.08	3.70 ± 0.43	3.09 ± 0.55	5.81 ± 0.84	5.62 ± 2.07
	PV	2.80 ± 0.27	3.40 ± 0.31	5.00 ± 0.61	11.30 ± 1.43	11.50 ± 1.97
Anchovy radurized and treated with 10 % NaTPP	TVB-N	10.70 ± 0.35	13.93 ± 1.39	18.24 ± 0.90	28.90 ± 3.57	40.43 ± 5.01
	TBA	0.56 ± 0.02	2.91 ± 0.94	2.68 ± 0.42	5.28 ± 0.37	3.01 ± 1.42
	PV	0.40 ± 0.16	5.30 ± 0.24	9.60 ± 1.25	12.80 ± 1.96	7.08 ± 1.66

a) Means and standart deviations of 8 observations
b) Total volatile Base-Nitrogen as mg N %)
c) Tiobarbituric acid as ug malonaldehyde (%)

Table 2. Effect of chemical treatment and radurization (1 kGy) on microflora of anchovy during the storage at 0-3 °C.

Anchovy sample	Microbial analysis	Storage time (days)				
		0	5	8	12	15
Plain anchovy (control)	Aerobic mesophilic[a]	$7.6x10^4$	$2.8x10^6$	$1.8x10^7$	—	—
	Aerobic psychrophilic[a]	$1.6x10^5$	$3.9x10^6$	$1.2x10^8$	—	—
	S. aureus[b]	< 3	—	—	—	—
	Coliforms[b]	4.3x10	$2.4x10^3$	$1.4x10^3$	—	—
	E. coli[b]	4	4	3		—
Anchovy treated with 10 % NaCl	Aerobic mesophilic	$1.7x10^4$	$2.5x10^6$	$6.0x10^6$	—	—
	Aerobic psychrophilic	$3.5x10^4$	$2.8x10^6$	$6.7x10^7$	—	—
	S. aureus	—	—	—	—	—
	Coliforms	4	$5.0x10^2$	4.0x10	—	—
	E. coli	4	4	3	—	—
Anchovy treated with 10 % NaTPP	Aerobic mesophilic	$7.9x10^3$	$6.8x10^5$	$3.7x10^6$	—	—
	Aerobic psychrophilic	$1.6x10^4$	$2.0x10^6$	$1.4x10^7$	—	—
	S. aureus	—	—	—	—	—
	Coliforms	23	20	40	—	—
	E. coli	4	< 3	—	—	—

Table 2. Continued.

Anchovy sample	Microbial analysis	Storage time (days)				
		0	5	8	12	15
Anchovy radurized	Aerobic mesophilic	4.1×10^{3}	1.9×10^{5}	1.1×10^{6}	1.0×10^{8}	—
	Aerobic psychrophilic	7.2×10^{3}	1.4×10^{5}	1.7×10^{6}	9.2×10^{7}	—
	S. aureus	—	—	—	—	—
	Coliforms	< 3	—	—	—	—
	E. coli	—	—	—	—	—
Anchovy radurized and treated with 10 % NaCl	Aerobic mesophlic	2.0×10^{3}	2.2×10^{5}	2.2×10^{6}	1.5×10^{8}	1.3×10^{8}
	Aerobic psychrophilic	6.0×10^{5}	2.8×10^{5}	2.8×10^{6}	9.8×10^{7}	1.7×10^{8}
	S. aureus	—	—	—	—	—
	Coliforms	—	—	—	—	—
	E. coli	—	—	—	—	—
Anchovy radurized and treated with 10 % NaTPP	Aerobic mesophilic	1.3×10^{3}	2.1×10^{4}	4.7×10^{5}	6.5×10^{6}	1.6×10^{7}
	Aerobic psychrophilic	2.3×10^{3}	1.8×10^{4}	5.0×10^{5}	8.5×10^{6}	1.5×10^{7}
	S. aureus	—	—	—	—	—
	Coliforms	—	—	—	—	—
	E. coli	—	—	—	—	—

a) Count / g.
b) MPN / g.

Table 3. The effect of chemical treatment and radurization (1 kGy) on the organoleptic quality of the raw and cooked anchovy during the storage at 0–3 °C[a].

Anchovy sample	Organoleptic attribute	Storage time (days)									
		0		5		8		12		15	
		raw	cooked	raw	cooked	raw	cooked	raw	cooked	raw	cooked
Plain anchovy (control)	Colour	8.6	—	4.0	—	2.0	—				
	Odour	8.8	8.8	4.8	4.3	1.0	—				
	Flavor	—	8.8	—	4.0	—	—				
	Texture	—	8.8	—	4.3	—	—				
Anchovy treated with 10 % NaCl	Colour	8.8	—	5.2	—	2.0	—				
	Odour	8.6	8.8	4.8	5.3	2.1	—				
	Flavor	—	8.8	—	4.7	—	—				
	Texture	—	8.8	—	5.0	—	—				
Anchovy treated with 10 % NaTPP	Colour	8.8	—	5.5	—	3.4	—				
	Odour	8.6	8.8	5.2	5.5	2.1	—				
	Flavor	—	8.4	—	4.7	—	—				
	Texture	—	8.8	—	5.0	—	—				
Anchovy radurized	Colour	8.6	—	5.8	—	5.2	—	3.0	—		
	Odour	8.2	8.8	6.0	5.8	5.5	2.2	—			
	Flavor	—	8.6	—	5.0	—	5.98	—	—		
	Texture	—	8.8	—	5.5	—	5.8	—	—		

Table 3. Continued.

Anchovy sample	Organoleptic attribute	Storage time (days)									
		0		5		8		12		15	
		raw	cooked	raw	cooked	raw	cooked	raw	cooked	raw	cooked
Anchovy radurized and treated with 10 % NaCl	Colour	8.8	—	6.0	—	5.8	—	5.0	—		
	Odour	8.6	8.8	6.0	5.8	6.0	6.2	5.0	5.2		
	Flavor	—	8.8	—	5.8	—	6.2	—	4.5		
	Texture	—	8.8	—	5.8	—	6.2	—	5.2		
Anchovy radurized and treated with 10 % NaTPP	Clour	8.8	—	6.2	—	6.0	—	5.0	—	3.4	—
	Odour	8.6	8.8	6.2	6.0	6.0	6.2	5.0	5.2	2.1	—
	Flavor	—	8.4	—	5.8	—	6.0	—	4.5	—	—
	Texture	—	8.8	—	6.2	—	6.2	—	5.2	—	—

a) Means of 12 observations.

in Table 3. There was not any significant changes amoung the colour, odour, flavor and texture of all samples on the first day of storage. In the unterated anchovy samples, spoilage was observed on the 5 th day of storage. However, anchovy treated even with NaCl and NaTPP were still acceptable at the 5 th day. Radurization improved the sensorial quality only small extent. Radurization conjucted with NaCl and NaTPP got the highest sensorial scores than the others even on the 12 and 15 days of storage respectively.

Discussion and Conclusion

The present study shows that two different chemicals (sodium chloride and sodium tripolyphasphate), radurization and combination of radurization with these chemicals influenced in various degrees of the quality and shelf-life of anchovy during the storage at 0–3 °C.

The reliable results were obtained when the radurization used with particularly NaTPP. This treatment reduced microbial count significantly and extended the shelf-life of anchovy. For instance, the shelf-life was observed as 5 days for untreated anchovy samples, 12 days for NaTPP–radurized anchovy samples.

The data obtained in this study were in agrement with several investigations (3,7,10). TVB–N values of both the untreated and treated samples gave significant correlation with organoleptic changes during the storage. The TBA and PV values in the NaTPP–radurized samples and NaCl-irradiated samples showed increase when a rancid flovor and odour was tasted by the panelists after the 12 days of storage. Because of the high fat content of anchovy (15.3 %).

Based on the results, the TVB–N would be a useful indicator for spoilage monitoring in the irradiated and unirradiated anchovy. At the borderline of acceptability, TVB–N value was approximately 35 mg / 100 g. of sample. The TBA and PV values may not be used to determine the loss of acceptability or the end of shelf-life of anchovy. It was observed that if the TBA was above 3–4 mg malonaddehyde / kg. and the PV value was over 8–10 mg. equ / kg. in anchovy fish it was possible to taste the rancid flavor and odour.

As a result, it can be concluded that the results obtained by the treatment of anchovy with NaTPP–radurization at 1 kGy dose seems quite reliable to prolong the shelf-life, but more study is needed to give a right decision for consumption to be safe.

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