PAPER

DIFFERENT PACKAGING METHODS EFFECTS ON SENSORY QUALITY AND CHEMICAL CRITERIA OF MARINATED SHAD (*ALOSA IMMACULATA*, B., 1838)

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ABSTRACT

In this study the sensory and chemical parameters of marinated shad (*Alosa immaculata*, Bennett, 1838) were determined. Fish were marinated with different package methods (in brine, oil and vacuum packed) and stored at 4±1°C. During the storage period, diffusion of proximate composition, acetic acid and sodium chloride into the fish fillets were determined. At the end of 7 months storage period, TVB-N were 8.05, 16.81 and 17.56 (mg/100 g), TMA were 2.28, 2.53 and 2.73 (mg/100 g), TBA were 7.08, 7.13 and 6.05 (mg malonaldehyde/kg) and pH were 4.42, 4.72 and 4.77 for brine, oil and vacuum packed samples, respectively. Throughout the storage period, effect of different package methods on TVB-N, TMA, TBA, pH, aw, acetic acid, sodium chloride and sensory issues were significant ($p<0.05$).

- Keywords: chemical-sensory quality, marinating, shad, shelf life -

INTRODUCTION

Fish is really healthy food and is known as the only food having a life-sustaining balanced ratio of protein, fat, carbohydrates, vitamins and minerals, which are essential to maintain good health. In addition, because of having low fat content, cholesterol and calories, fish meat is preferable for consumers (KORAL, 2006).

Shad is a close relative to sardines has an average length of 30-33 cm. shad are a Black Sea fish, but it can be found in the Marmara, Aegean and the Mediterranean seas. Shad live close to the coast as herd by shoal, they enter in the river to spawn at reproduction time in the spring. Today, shad is also heavily fished in the United States and around. According to Turkish Statistical Institute-TSI (2013), 1699 tons shad were caught in Turkey at 2012. Turkish consumers generally prefer as fresh, salted or smoked shad.

Marinating is traditionally a fish preservation method. Meat tenderization and flavoring are consequences of the marinating process. Sodium chloride, polyphosphates, sugars spices and sauces are considered important ingredients of marinades and they improve meat tenderness and flavor (SINDELAR *et al.,* 2003; SUDERMAN, 1993). The purpose of bringing rigidity to the marinated product, enriching the meat flavor and preserving the meat longer (CHEN, 1982; RESURRECCIÓN, 2003). The immersion of meat in the marinating solution is done not only in Turkey.

The physical characteristics of fish change in acid and salt in several days. Muscle tissue softens; skin and bones can be removed easily. Marinate generally contains 4-5% vinegar and 7-10% salt. Acetic acid leads to breakdown of structural proteins and enables the tearing of muscle membrane (MEYER, 1965; ERDEM *et al.,* 2005). Muscle tissue, which has been softened during initial days by the joint effect of acid and salt, lost 15-20% of raw material weight at the end of the process (ALPARSLAN *et al.,* 2013).

The aim of the present study is to determine the sensory and chemical changes of marinated and brine, oil and vacuum packed shad fillets. Therefore, the use of shad as an alternative to the other fish species used in marinade production will be investigated.

MATERIALS AND METHODS

A total of 186 pontic shad (*Alosa immaculata)* samples with an average weight of 191.53±33.63 g and average length of 28.71±1.58 cm were purchased from a local fish market in Trabzon, Turkey. They were stored in a thermally insulated container, brought to the laboratory and stored at –30°C with the purpose of eliminating the risk of parasites until the marinating process.

Marination process

Before marinating process, fishes were cleaned at the head, and the integral organs, after that fillet and washed with clean water. Approximately 36 kg fillets were immersed into the following different marinating solutions for 48 h (1:2 fish:solution ratio) in a refrigerator. After two days of storage in refrigerator, the fillets were dipped in 4.5% acetic acid, 0.2% citric acid and 10% salt marination solutions, the marinated fishes were divided into tree groups (brine, sunflower oil and vacuum packaging). 70 grams of marinated shad fillets were packed into plastic box of 250 mL capacity with 150 mL brine, 150 mL sunflower oil, vacuum packaged and than were stored at 4±1°C for 7 months. Proximate, chemical quality and sensory analyses were performed in triplicate on days 1, 30, 90, 150, and 210th.

Chemical analysis

Samples were homogenized and subjected to moisture and ash analyses using AOAC (1990) methods. Crude protein content was calculated by converting the nitrogen content according to Kjeldahl's method (AOAC 1990), and lipid content was determined according to the method of the BLIGH and DYER (1959). Thiobarbituric acid (TBA) amounts were determined using the method of TARLADGIS *et al.,* (1960), expressed as mg malonaldehyde/kg sample using a conversion factor of 7.8. The pH was determined from homogenates of minced samples in distilled water in a ratio of 1:10 (w/v) by using a digital pH meter (Hanna, Germany) (CURRAN *et al.,* 1980). Total volatile basic nitrogen (TVB-N) was determined on steam distillation using the Kjeldahl distillation apparatus and until red color was titrated, for clarification (ANTONOCOPOULUS 1973). The method of AOAC (1990) was used for trimethylamine nitrogen (TMA-N) analysis.

The water activity determination Aqualab 3 TE (0.100 to 1.000 ± 0.003), were measured by U.S. brand equipment. Salt content was measured using the method proposed by KARL (1994). 20 g fish were homogenized for 5 minutes with 100 mL distilled water, and than 150 mL distilled water was added and it was filtered. To this solution was added 2.5 mL of 10% K_2CrO_4. Until red color was titrated with $AgNO_3$ 0.1 N and according to the following formula amount of salt (%) was calculated:

$$\text{NaCl (\%)} = \text{A} \times 0.00585 \times 100 \times 500 / \text{Amount of sample (g)} \times 50$$

A: $AgNO_3$ consumption (mL)

For the sensory evaluation of the marinated products five panelists were used. Sensory analysis to assess appearance, odor, flavor and texture criteria were used, and analyises results,

Table 1 - The proximate composition in percentage of fresh and different marinating process of shad (*Alosa immaculata,)* fillets during storage.

Storage days	Protein (%)	Lipid (%)	Dry Matter (%)	Ash (%)
Fresh fish	17.41±0.51[a]	18.98±0.66[a]	39.15±0.15[a]	2.17±0.16[a]
Brine	18.83±0.28[b]	20.14±0.11[c]	47.11±0.16[b]	10.28±0.04[c]
Oil Marinated	18.06±0.33[b]	20.30±0.19[c]	47.05±0.70[b]	8.68±0.11[c]
Vacuum Marinated	18.16±0.15[b]	20.21±0.33[c]	47.05±0.02[b]	8.12±0.07[b]

Data are expressed as means±standard deviation.

which were scored on a scale of 1 to 9. In the scoring system points from 9 to 7 indicates "very good", from 4.1 to 6.9 indicates "good", 4 indicates "expendability" (4 is the rejection line), and from 1 to 3.9 indicates unacceptability (VARLIK *et al.,* 1993).

Statistical analysis

The statistical analysis was performed using Minitab Release 13.20 (Minitab Inc., State College, PA, USA). Differences were analyzed by one-way analysis of variance and Tukey's test. In all statistical tests, $P<0.05$ was considered as statistically different (SUMBULOGLU and SUMBULOGLU, 2000).

RESULTS AND DISCUSSION

The proximate composition of the shad fillet in each stage of the process is shown in Table 1. These results are wet fish sample and marinated shad. Protein, lipid, dry matter and ash of fresh shad fillets were 17.41%, 18.98%, 39.15% and 2.17%, respectively. At the end of the storage, all of these values have increased. Maximum protein value was brining sample (18.83%) while maximum values at the lipid and dry matter were 20.30% and 47.11% at Oil marinated and brining, respectively. GUNER *et al.* (1998), and BORAN and KARACAM (2011) reported 22.42% and 19.80% for protein and 15.91% and 9.34% lipid in fresh shad fillets, respectively. In another experiment, at the end of the brining stage the protein and lipid content were 18.32 g.100 g_{-1} and 3.20 g.100 g_{-1} of fish fillets (YEANNES and CASALES 2008). The results of proximate analysis of fresh shad fillets were in agreement with our study.

TVB-N of raw material was 14.01(mg/100 g) (Table 2). At the end of 7 months storage period for marinated shad that were packaged differently in brine, oil and vacuum packed, TVB-N values were 8.05, 16.81 and 17.56 (mg/100 g), respectively. Statistically difference was found between the brine group with the other groups on TVB-N value ($P<0.05$). ÖZDEN and ERKAN (2006) reported that TVB-N in fresh fish and marinated trout were 7.35 mg/100 g and 6.78 mg/100 g, respectively. TVB-N values increased to 12.08 mg/100 g and 11.98 mg/ 100 g at the end of storage in vacuum and oil packed samples, respectively. Similar results obtained in marinated fish packaged in vacuum and stored in refrigerator at a different time (AKSU *et al.,* 1997, METİN *et al.*, 2000 and ARIK *et al.,* 2001).

TBA was 0.99 malonaldehyde/kg at the beginning of the this study (Table 2). This value increased to 7.08 in the brine, 7.13 in the oil and 6.05 mg malonaldehyde/kg in the vacuum packaged group on the last day (210^{th} day) of storage. Statistically difference was found between the vacuum group with the other groups on TBA value ($P<0.05$). TBA value is an important indicator and is excessively used to determine the level of lipid oxidation in fish (SALLAM 2007; CADUN *et al.*, 2008; TURHAN *et al.*, 2009). VARLIK *et al.* (1993) reported that a consumable limit was between 7-8 mg malonaldehyde/ kg TBA in sea fish.

ÖZDEN and ERKAN (2006) reported 0.45 mg malonaldehyde/kg TBA values for fresh rainbow trout and 2.8 mg malonaldehyde/ kg TBA values for marinated fish after 90 days, while 9.5 mg malonaldehyde/kg for vacuum and 10.26 mg malonaldehyde/kg for oil packaged marinated trout fillets were determined.

Water activity (a_w) of the raw material changed from 0.98 to 0.99, indicating that, it is the most suitable period for microbial growth (Table 2). The water activities (a_w) at the marination were 0.93-0.94 between each group. The findings regarding to the a_w value are in compliance with BORGSTROM'S (1968) with YEANNES and CASALES (2008).

In this study, pH level was 4.42, 4.72 and 4.77 in the brine, oil and vacuum packaged samples at 210 days, respectively and there were no significant differences between groups ($p>0.05$). The pH of fresh raw fish was initially approximately 6.30 and then changed during the maturation process to 4.29 after 90 days (ÖZDEN and ERKAN 2006). In another study, pH values in anchovy marinated with 2% and 4% acetic acid increased was changed from 4.25 to 4.53 (AKSU *et al.,* 1997).

The sodium chloride content of the fillet remained stable during the marinating stage while the salt level becomes richer in the brin-

ing stage and the salt concentration in the marinating solution becomes lower. According to KOLAKOWSKI and BEDNARCZYK (2002), the acetic acid in the marinating solution caused the decrease in the water content of fillet. Sodium chloride in fresh fish muscle was 0.27%, while at the end of the study, it was reached to 6.32%, 4.39% and 4.51% for brine, oil and vacuum package groups, respectively. According to DUERR and DYER (1952), FENNEMA (1977) and HONIBEL (1989), myosin denaturation, as measured by salt solubility, occurs at a definite salt concentration, about 8 to 10% sodium chloride in the tissue.

MEYER (1965) stated that the amount of the acid in high quality marine products should be between 2-3% in fish tissue at the end of the ripening period. In this study the acid amount changed between 1.20-1.66 during the trial.

The sensory scores of marinated shad fillets indicated a good quality of the storage period (Table 3). There were significant differences between brine, oil and vacuum packaged shad marinades ($p<0.05$) for sensory value. These results are in agreement with the findings of ÖZDEN and BAYGAR (2003) for marinated chub mackerel, horse mackerel, sardine and anchovy packaged in jars with vegetable oil and vacuum packed in polyethylene bags, then stored at 4±1°C. In addition to these studies, YEANNES and CASALES (2008) reported that there were not quality changes on sensory analysis of marinated anchovy (*Engraulis anchoita*) throughout storage time.

Many studies showed that good quality marinated fish is between 3 and 6 months (ERKAN *et al.,* 2000; VARLIK *et al.,* 2000; ÖZDEN and BAYGAR 2003; KILINC and ÇAKLI 2004; GÖKOGLU *et al.,* 2004, ERDEM *et al.,* 2005; KABA *et al.,* 2013).

CONCLUSIONS

In this study, the effects of brine, oil and vacuum packing on chemical and sensory changes in marinated shad stored at 4°C were investigated. A quality assessment was performed by monitoring sensory quality, total volatile basic nitrogen and thiobarbituric acid, pH, aw, and salinity count. The results of this study indicate that the shelf life of brine and oil packed marinated shad fillets had a shelf life of 210 days. Accord-

Table 2 - Effects of brine, oil and vacuum packets on chemical changes of marinated shad (*Alosa immaculata*) fillets during refrigerated storage.

			Storage Days			
		After marinated	30	90	150	210
TVB-N mg/100 g	Brine	14.01±0.00^{a}	8.40±0.0.23^{bA}	5.80±0.00^{deC}	5.95±0.0.49^{cdC}	8.05±0.49^{bC}
	Oil	14.01±0.00^{a}	8.55±0.89^{aA}	12.01±0.00^{bB}	13.61±0.00^{cB}	16.81±0.00^{aB}
	Vacuum	14.01±0.00^{a}	8.86±0.50 ^{aA}	14.16±0.49^{bcA}	15.66±0.66^{cdA}	17.56±0.00^{eA}
TMA-N mg/100g	Brine	0.63±0.01^{aB}	0.70±0.01^{aB}	0.73±0.01^{bC}	1.06±0.04^{cC}	2.28±0.04^{eA}
	Oil	0.63±0.01^{aB}	0.69±0.01^{aB}	0.88±0.01^{abC}	1.94±0.04^{cA}	2.53±0.03^{dA}
	Vacuum	0.63±0.01^{aB}	0.93±0.03^{cA}	1.22±0.03^{dA}	1.48±0.02^{eB}	2.73±0.04^{fB}
TBA mg malonaldehyde /kg	Brine	0.99±0.01^{a}	1.82±0.06^{bcA}	3.21±0.36^{dA}	5.36±0.18^{eA}	7.08±0.06^{fA}
	Oil	0.99±0.01^{a}	1.92±0.06^{bcA}	3.66±0.15^{dA}	5.56±0.18^{eA}	7.13±0.06^{fA}
	Vacuum	0.99±0.01^{a}	1.28±0.04^{aA}	2.32±0.12^{cbB}	3.75±0.21^{dB}	6.05±0.35^{eB}
a_w	Brine	0.99±0.001^{a}	0.94±0.001^{cB}	0.93±0.001^{dB}	0.93±0.001^{eB}	0.93±0.001^{cB}
	Oil	0.98±0.001^{a}	0.95±0.001^{deA}	0.94±0.001^{eA}	0.94±0.001^{fA}	0.94±0.001^{fA}
	Vacuum	0.99±0.001^{a}	0.95±0.001^{bA}	0.94±0.001^{dA}	0.94±0.001^{cdA}	0.94±0.001^{bB}
pH	Brine	6.42±0.02^{a}	4.25±0.01^{cdB}	4.31±0.03^{bcdA}	4.33±0.04^{bcdB}	4.42±0.03^{bB}
	Oil	6.42±0.02^{a}	4.37±0.01^{fgA}	4.53±0.04^{deA}	4.65±0.01^{bcA}	4.72±0.01^{bA}
	Vacuum	6.42±0.02^{a}	4.39±0.01^{fgA}	4.49±0.01^{deA}	4.59±0.01^{cA}	4.77±0.01^{bA}
Acidity	Brine	0.15±0.00^{a}	1.28±0.00^{cA}	1.58±0.11^{dA}	1.65±0.00^{dB}	1.66±0.01^{dA}
	Oil	0.15±0.00^{a}	1.20±0.11^{cA}	1.38±0.11 ^{cdB}	1.53±0.11^{cdA}	1.65±0.00^{dA}
	Vacuum	0.15±0.00^{a}	1.35±0.00^{cB}	1.48±0.11 ^{dC}	1.53±0.11^{dA}	1.65±0.00^{eA}
Sodium chloride	Brine	0.27±0.12^{a}	6.29±0.29^{cA}	6.79±0.16^{cA}	6.00±0.37^{cA}	6.32±0.00^{cA}
	Oil	0.27±0.12^{a}	4.77±0.21^{bB}	4.92±0.50^{bB}	4.77±0.04^{bB}	4.39±0.08^{bB}
	Vacuum	0.27±0.12^{a}	4.75±0.42^{bB}	4.47±0.04^{bB}	4.65±0.37^{bB}	4.51±0.04^{bB}

Data are expressed as means±standard deviation.
a,b,c: Differences between groups expressed with different letters in the same column are important ($p<0,05$).
A,B,C: Differences between groups expressed with different letters in the same line are important ($p<0,05$).

Table 3 - Effects of different package methods on sensory property of marinated shad (*Alosa immaculata*) fillets during storage time.

			Storage Days			
		After marinated	30	90	150	210
Appearance	Brine	9.55±0.38^{aA}	9.00±0.38^{aA}	7.05±0.69^{bA}	6.40±0.98^{cA}	5.00±0.32^{dA}
	Oil	9.57±0.41^{aA}	8.50±0.55^{aB}	7.13±0.52^{bA}	6.04±0.39^{cA}	4.53±0.52^{dB}
	Vacuum	9.65±0.35^{aA}	930±0.61^{aC}	7.47±0.41^{aB}	5.81±0.32^{dA}	4.20±0.32^{dB}
Odor	Brine	9.25±0.25^{aA}	8.58±0.49^{abA}	7.42±1.02^{bcA}	5.92±0.92^{cA}	4.28±0.35^{dA}
	Oil	9.52±0.61^{aA}	8.60±0.41^{abA}	7.08±0.92^{bA}	6.25±0.76^{cA}	4.57±0.75^{dB}
	Vacuum	9.61±0.41^{aA}	8.70±0.32^{abA}	7.83±0.41^{cdA}	5.97±0.26^{dA}	3.91±0.29^{aC}
Flavor	Brine	9.63±0.05^{aA}	8.75±0.35^{abA}	7.25±0.15^{cA}	5.90±0.10^{dA}	4.13±0.18^{eA}
	Oil	9.63±0.05^{aA}	8.50±0.20^{bB}	7.25±0.20^{cA}	6.00±0.15^{dA}	4.50±0.06^{eB}
	Vacuum	9.63±0.05^{aA}	9.25±0.09^{abC}	7.75±0.18^{bA}	4.75±0.15^{cB}	3.50±0.00^{eC}
Texture	Brine	9.85±0.39^{aA}	8.58±0.41^{bA}	7.08±0.44^{cA}	6.00±0.33^{dA}	4.20±0.13^{eA}
	Oil	9.88±0.37^{aA}	8.79±0.20^{bA}	7.67±0.21^{cAB}	5.58±0.27^{dA}	4.40±0.15^{eA}
	Vacuum	9.93±0.23^{aA}	9.71±0.26^{aB}	7.93±0.24^{bB}	5.33±0.15^{cB}	4.00±0.21^{dB}

a,b,c Differences between groups expressed with different letters in the same column are important (p<0,05).
A,B,C Differences between groups expressed with different letters in the same line are important (p<0,05).

ing to this study, fishbones of the shad which has a large number of them melted as a result of the marination process.

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