Research Journal of Food and Nutrition
Volume 2, Issue 3, 2018, PP 39-47
ISSN 2637-5583

The Effect of Modern Packaging Systems on the Quality and Shelf Life of Salted Fish

Mahmoud. F.S.A. Kdous[1],Khaled S. A. Nagy[2] and Manal A. Sorour[2]

[1]Meat & Fish Technol. Res. Dept., Food Technology Research Institute, A.R.C.
[2]Food Engineering & Packaging Dept., Food Technology Research Institute, A.R.C.

***Corresponding Author:** Mahmoud. F.S.A. Kdous, [1]Meat & Fish Technol. Res. Dept., Food Technology Research Institute, A.R.C.*

ABSTRACT

Tiger and fresh water sardine were the most important fish found in Nasser Lake, Aswan, which is based on the salinity fish industry in Egypt. Salinity fish samples were packaged in barrier bags polyamide/polyethylene (30/40 micron) samples were divide into two groups, the first group was packed under vacuum and the other were injected (5-10 minutes) with ozone for sterilization and packed under vacuum, then all samples were stored at room temperature for 6 months. The effect of packaging system on quality attributes of tiger and fresh water sardine were investigated during storage. Also, chemical (TVN, TBA, pH) and microbial evaluation (TPC) were studied. The results observed that salinity fish packed in polyamide/polyethylene and injected with ozone then packed under vacuum may be recommended to extend the shelf life of salinity fish (tiger fish – fresh water sardine) to maintain the quality attributes during storage period. Also, sterilizing with ozone had the best chemical, microbial and sensory evaluation compared to control samples.

Keywords: *Fish, modern packaging systems, extend shelf life, sterilizing*

INTRODUCTION

Fish is a vital source of nutrients to humans due to its protein acetous nature, high content of unsaturated fatty acids and low contents of carbohydrates. In their natural environments fish are exposed to a myriad of microorganisms some of which compromise the shelf life of the product and/or safety in humans. Most fish factories located along coasts find it economical to use processed sea water during processing. It is an extremely perishable commodity and quality loss can occur very rapidly after catch (Khan and Khan, 2001; Musa et al., 2010; Dewi et al., 2011). Curing of fish is an ancient method of preservation in the world that primarily involves two stages, salting and drying (Anon, 2001). Salted fish products have been shown to be safe for consumption. It decreases the water activity and is governed by various physical and chemical factors such as diffusion, osmosis and a series of complicated chemical and biochemical processes (Turan et al., 2007). Salting is one of the oldest and commonly used processing techniques for fish preservation all over the world because of simplicity of the process and low production cost (Martinez-Alvarez & Gomez-Guillen, 2013). Salt is effective as a preservative because it reduces the water activity of fish muscle, consequently bacterial growth and enzymatic spoilage are inhibited. On the other hand, the current demand for salted fish is driven more by sensorial alteration purposes, rather than preservation (Mujaffar & Sankat, 2005). Ozone is one the most powerful antimicrobial substance (natural sanitizing and disinfecting agents) in the world destroying up to 99.9% of pesticides and microorganisms commonly found on food due to its potential oxidizing capacity. Any pathogen or contaminant that can be disinfected, altered or removed via an oxidation process will be affected by ozone. (King, 2001; Duguet, 2004). Ozone does not produce significant toxic residues in the environment after the treatment and without affecting on taste, odor and color food (Kim et al., 1999; Graham, 1997). In the United States, ozone has received in 1997 GRAS (Generally Recognized as Safe) classification, and in 2001 the FDA officially approved media containing ozone for use in the food industry, also for direct contact with food products, including fish, meat and poultry (Vaz-Velho et al., 2006; Zentox, 2007). One way of extending the shelf life and quality of a salted fish is using vacuum packaging, which is a way

for delaying lipid oxidation (auto oxidation), as it is one the major problems in the salted fish. Lipid oxidations had negative affect on taste, odor and color of salted fish, (Taheri and Motallebi, 2012). The aim of the study is to evaluate the effect of packaging system on quality of salted fish to enhance shelf life, more safe and marketability.

MATERIALS AND METHODS

Materials

Tiger (hydrocynus vittatus) and fresh water sardine fish (S. pilchardus) had been collected from Lake Nasser in Aswan-Egypt and the fish was brought to Agriculture research center, Giza, Egypt using ice boxes.

Packaging materials

A double-layer film high gas barrier made from Polyamide/Polyethylene PA/PE (40/30 micron) were purchased from Arab Pharmaceutical Packaging Company (Felxpack, www.flexipack-eg.com/ar) 6th October City and formed as a bags (15*30 cm). Oxygen permeability of the plastic film was (0.001cm^2/m^2/day) and water vapor permeability was (zero)

Sodium chloride

Sodium chloride was purchased from Emisal Salts Company Fayoum Governorate.

Methods

Preparation of salted fish

Viscera of the fish were removed and washed with large amount of water. Tiger and fresh water sardine fish were salted using NaCl (25%) for 30 days. The salted fish were divided into four groups

- Control samples air were packaed in polyamide/polyethylene (40/30 micron) bags
- Sample were packed under vacuum in polyamide / polyethylene bags
- Samples were packed in polyamide/polyethylene bags and injected with ozone for 5 minutes using Ozanator device/(400 mg/h), then vacuumed.
- Samples were packed in polyamide/polyethylene bags and injected with ozone for 10 minutes using Ozanator device/(400mg/h), then vacuumed.

All samples were stored at room temperature for 6 months.

Chemical analysis:

Proximate analysis including moisture, total protein, fat, ash and were carried out according to **(AOAC, 2005),** sodium chloride content was determined according to (**Prearson, 1970).**

Chemical quality attributes

Total volatile nitrogen (T.V.N) and thiobarbituric acid (T.B.A) value were determined according to (**AMC, 1979)** and **(Kirk & Sawyer, 1991)** and pH value was estimated according to (**Goulas and Kontominas, 2005).**

Microbiology evaluation

The bacteria count was then calculated as (cfu/g) of samples as reported by **(Fda Bam, 2001).**

Estimation of sensory evaluation

Determination of the quality of salinity fish was made by six members in ARC in terms of sensory characteristics such as color, odor, texture and overall acceptability according to **(Suderman et al., 1981)**, the panel was requested to rate each sensory feature of the samples after manufacturing and the average score was considered to be the borderline of acceptability

Statistical analysis

The obtained data were exposed to analysis of variance followed by multiple comparisons between means ($P \leq 0.05$) applying LSD. The analysis was carried out using the PRO ANOVA procedure of Statistical Analysis System **(Sas, 1996).**

RESULTS AND DISCUSSION

Chemical Analysis

Moisture, protein, fat, and ash contents for fresh and salted fish were determined according to **(A.O.A.C, 2005)** as shown in table (1). The results observed that moisture content, protein and pH of fresh samples were higher than salted ones while fat, ash, TVN and TBA content were higher in salted samples than fresh ones, this may be due to that During salting, the mass transfer occurs basically between salt and water: the fish muscle takes up salt and loses water **(Chaijan, 2011; Oliveira, et al., 2012**), also Nutritional components, such as lipid and ash were increased due to the loss of water in fish muscle in the salt in process **(Bras & Costa, 2010; Chaijan, 2011).** However, protein content was decreased in some cases, such as

transference of water soluble proteins to the salt solution (**Abbas Bakhiet & Khogalie, 2012; Hasan & Fatma, 2015**). Protein in salted samples were lower than fresh ones as shown in table 1, the major change in protein are caused by increasing salt concentration that increase protein degradation consequently. The pH value decrease was explained by the increasing the ionic strength of the solution inside the cells **(Goulas & Kontominas, 2005)**.

Table1. *Chemical composition of fresh and salted fish.*

(Wet weight) %	Tiger fish		Fresh water sardine	
	Fresh	salted	Fresh	Salted
Moisture	72.8	49.5	72.6	49.1
Protein	19.8	17.6	18.75	16.8
Fat	4.7	10.6	6.15	12.2
Ash	2.7	22.3	2.5	21.9
pH	6.2	5.8	6.1	5.7
TVN	7.3	13.6	7.2	13.4
TBA	0.53	0.70	0.55	0.75
Salt (NaCl)	-	14.70	-	14.72

Changes in TVN (Total volatile Nitrogen value)

TVN has been used as an index for the determination of freshness of fish, Volatile nitrogenous bases increase in concentration during the spoilage of fish **(Farzana, et al., 2014).** The changes in TVN values of salted and fresh fish during storage were determined as shown in table (2), the results observed that TVN increased during storage time significantly in treatment (1) followed by treatment (3) and (4), this may be due to that salinity fish was packed under vacuum in treatment (2) and this reduced the amount of oxygen present in the package as it enhance the shelf life of the product by inhibiting the growth of aerobic spoilage bacteria **(Mendes & Goncalvez 2008; Mohan, et al., 2016)**, which disintegrates protein led to increase the rate of TVN compared to treatment (1). Treatment (4) was the lowest value of TVN followed by treatment 3, 2 and 1, respectively this may be due to the use of ozone and then packing under vacuum, this reduce the aerobic and anaerobic bacteria and improve the microbial quality attributes of treatment (4 and 3), as previously discussed by (**Alex, 2009 & Marcilene and Heidmann, 2005 & Kocatepe et al., 2014).**

Table2.*Effect of packaging methods on total volatile nitrogen (TVN as mg /100 gm) of salted fish stored at room temperature for 6 months.*

		Zero time	2 month	4 months	6 months
1	T.f	$13.6^{a}\pm0.3$	$18.0^{a}\pm0.3$	$25.2^{a}\pm0.4$	$32.7^{a}\pm0.3$
	F.s	$13.4^{a}\pm0.4$	$17.8^{a}\pm0.3$	$24.2^{a}\pm0.2$	$31.8^{a}\pm0.5$
2	T.f	$13.6^{a}\pm0.2$	$16.2^{b}\pm0.2$	$17.8^{b}\pm0.2$	$25.2^{b}\pm0.2$
	F.s	$13.4^{a}\pm0.2$	$15.9^{b}\pm0.3$	$17.3^{b}\pm0.2$	$24.8^{b}\pm0.3$
3	T.f	13.6a±0.2	$15.3^{c}\pm0.3$	$16.1^{c}\pm0.3$	$23.5^{c}\pm0.3$
	F.s	$13.4^{a}\pm0.2$	$14.8^{c}\pm0.2$	$15.7^{c}\pm0.3$	$23.2^{c}\pm0.4$
4	T.f	$13.6^{a}\pm0.2$	$14.2^{d}\pm0.2$	$15.2^{d}\pm0.2$	$22.1^{d}\pm0.2$
	F.s	$13.4^{a}\pm0.2$	$13.9^{d}\pm03$	$14.9^{d}\pm0.2$	$22.0^{d}\pm0.4$
LSD	T.f	0.552	0.480	0.740	0.564
	F.s	0.541	0.524	0.431	0.761

Mean values in the same column as letter or row with the same letter are not significant different at 0.05 level.
T.f= Tiger fish
F.s= Fresh water sardine
1=Salted fish (control).
2=Salted fish was packaged under vacuum in polyamide/polyethylene bags.
3=Salted fish was packaged under vacuum polyamide/polyethylene bags after sterilization by injection Ozone (O_3) for 5 minute thin sealed.
4=Salted fish was packaged under vacuum polyamide/polyethylene bags after sterilization by injection Ozone (O_3) for 10 minute thin sealed.

Changes in pH value

pH is an indicator of the extent of microbial spoilage in fish and some proteolytic microbes produce acid after decomposition of carbohydrate, thereby increasing the acid level of the medium **(Eyo, 1993).** The pH in fresh

condition fresh- water fish flesh is almost neutral **(Virta, 2009).** In the post-mortem period, decomposition of nitrogenous compounds leads to an increase in pH in the fish flesh **(Shenderyuk and Bykowski, 1989).** The increase in pH indicates the loss of quality. Table (3) shows pH values of fresh and salted tiger and fresh water sardine fish during storage at room temperature, the results observed that pH of fresh fish is higher than salted fish as it decreased from 6.2 to 5.8 for tiger fish and from 6.1 to 5.7 for fresh water sardine, this may be due to the increase of acidic compound. Also, pH increased during storage in all treatments studied, this may be due to the increase of basic compounds as microbial spoilage and degradation of protein compounds. pH values was significantly higher in treatment (1) followed by treatments 2, 3 and 4 due to the direct relation between TVN and pH value and the microbial spoilage which leads to a autolysis in the tissue. The same results were presented by (**Farzana, et al, 2014; Marcilene and Heidmann, 2005**)

Table3. *Effect of packaging methods on PH values of salted fish stored at room temperature for 6 months.*

		Zero time	2 month	4 months	6 months
1	T.f	5.8^{a}±0.35	6.65^{a}±0.25	6.95^{a}±0.1	7.5^{a}±0.2
	F.s	5.7^{a}±0.3	6.55^{a} ±0.2	6.75^{a}±0.23	7.3^{a}±0.2
2	T.f	5.8^{a}±0.2	6.3^{b}±0.2	6.55^{ab}±0.3	6.95^{b}±0.22
	F.s	5.7^{a}±0.18	6.2^{b}±0.14	6.45^{ab}±0.25	6.8^{b}±0.13
3	T.f	5.8^{a}±0.15	6.11^{b} ±0.11	6.25^{bc}±0.2	6.5^{c}±0.18
	F.s	5.7^{a}±0.22	6.1^{b}±0.18	6.22^{bc}±0.15	6.45^{c}±0.2
4	T.f	5.8^{a}±0.15	6.0^{b} ±0.15	6.05^{bc} ±0.23	6.2^{c}±0.13
	F.s	5.7^{a}±0.28	5.9^{b}±0.15	6.0^{c}±0.2	6.1^{d}±0.11
LSD	T.f	0.395	0.349	0.424	0.349
	F.s	0.470	0.321	0.397	0.311

Mean values in the same column as a letter or row with the same letter are not significant different at 0.05 level.
T.f= Tiger fish
F.s= Fresh water sardine
1=Salted fish (control).
2=Salted fish was packaged under vacuum in polyamide/polyethylene bags.
3=Salted fish was packaged under vacuum polyamide/polyethylene bags after sterilization by injection Ozone (O_3) for 5 minute thin sealed.
4=Salted fish was packaged under vacuum polyamide/polyethylene bags after sterilization by injection Ozone (O_3) for 10 minute thin sealed.

Changes in Thiobarbituric Acid (TBA) Value

TBA is widely used as an indicator for the assessment of degree of secondary lipid oxidation. Even though hydro peroxidases are odorless and flavorless compounds and not related directly to the actual sensorally objectionable rancification and discolouration, lipids are highly susceptible to oxidation because they contain 50 - 60% of polyunsaturated fatty acids including 15 -18 %, eicosapentaoic acids (EPA) and 35 - 38% docosahexaenoic acid (DHA). The oxidative breakdown of lipids is also evidenced by the incidence of high TBA values in the respective samples. Generally the increase in TBA indicated

the formation of secondary oxidation products such as aldehydes and other volatile compounds responsible for rancid flavor and off odors as well as color and texture deterioration. The oxidative breakdown of lipids is also evidenced by the incidence of high TBA values in the respective samples **(Kolakowska, 2002 and Immaculate, 2016)**.

Table (4) shows that TBA values of salted (fresh water sardine and tiger fish) during storage time. The results observed that TBA values of treatment (1) was significantly highest followed by treatment 2, 3 and 4 respectively, this may be due to packaging system as there is absence of O_2 for packaging under vacuum, which retarded the oxidative process of the polyunsaturated fatty acids in this treatment **(Marcilene and Heidmann, 2005).** Treatment (4) had the lowest value of TBA followed by treatment 3, 2 and 1 respectively, this may be due to that ozone treatment (4 and 3) for sterilization reduced the aerobic and anaerobic bacteria this led to the improvement of the microbial quality attributes of treatment 4 and 3 compared with treatment 2 and 1 of salted (fresh water sardine and tiger fish), respectively, this

results agreed with the obtained results by (**Alex,2009 & Kocatepe et al., 2014)**.

Table4. *Thiobarbeturic acid (TBA as mg malonaldehyde/kg).of salted fish stored at room temperature for 6 months*

		Zero time	2 month	4 months	6 months
1	T.f	0.70^{a}±0.3	1.64^{a}±0.14	2.75^{a}±0.23	3.23^{a}±0.2
	F.s	0.75^{a}±0.22	1.83^{a}±0.3	2.88^{a}±0.27	3.35^{a}±0.13
2	T.f	0.70^{a}±0.25	1.51^{ab}±0.11	1.90^{b}±0.17	2.66^{b}±0.22
	F.s	0.75^{a}±0.13	1.55^{ab}±0.24	1.95^{b}±0.18	2.73^{b}±0.15
3	T.f	0.70^{a}±0.3	1.31^{b}±0.11	1.75^{bc}±0.14	2.15^{c}±0.21
	F.s	0.75^{a}±0.17	1.48^{ab} ±0.2	1.78^{bc}±0.21	2.25^{c}±0.13
4	T.f	0.70^{a}±0.12	1.23^{b}±0.13	1.43^{c}±0.18	1.65^{d}±0.16
	F.s	0.75^{a}±0.12	1.35^{b}±0.18	1.47^{c}±0.16	1.76^{d}±0.14
LSD	T.f	0.523	0.238	0.344	0.734
	F.s	0.310	0.442	0.394	0.259

Mean values in the same column as a letter or row with the same letter are not significant different at 0.05 level.
T.f= Tiger fish.
F.s= Fresh water sardine.
1=salted fish control).
1=Salted fish (control).
2=Salted fish was packaged under vacuum in polyamide/polyethylene bags.
3=Salted fish was packaged under vacuum polyamide/polyethylene bags after sterilization by injection Ozone (O_3) for 5 minute thin sealed.
4=Salted fish was packaged under vacuum polyamide/polyethylene bags after sterilization by injection Ozone (O_3) for 10 minute thin sealed.

The Effect of Packaging System on Microbiological Evaluation

Table (5) shows the microbiological evaluation of salted fish (tiger fish and fresh water sardine) during storage period (6 months) at room temperature. The results observed that the total plate count (TPC) of control samples (treatment 1) was higher than treatment (2, 3 and 4), respectively at zero time and during storage time. On other hand, it could be noticed that TPC of treatment (2, 3 and 4) after 2 month of storage lower than TPC at zero time, this may be due to that samples packed under vacuum in treatment (2) leads to the reduction of oxygen concentrate which inhibit the growth of aerobic spoilage bacteria and extend the shelf life of product **(Mendes & Goncalvez 2008; Mohan, et al., 2016)**, and using the injection of Ozone gas for sterilization before vacuum in treatments (3 and 4), showed that the reduction of the aerobic and anaerobic bacteria improve the microbial quality attributes, the same results were obtained by **(Alex, 2009 & Marcilene and Heidmann, 2005 & Kocatepe et al., 2014),** this may be due to the increase in simple nitrogen compound (such as amino acids) and fatty acid when produced by hydrolysis of protein and fat, which consequently leads to a suitable condition for the growth of not only proteolytic and lipolytic bacteria but also other microorganisms **(El-Kordy, 2006).** Also, **(Abd EL-Aziz 2000)** who reported that the increase in bacterial count at end of storage period could be attributed to increase in pH value at the end of storage consequently support the bacterial growth.

Table5. *Effect of packaging system on the total count bacteria of salted fish stored at room temperature for 6 months.*

		Zero time	2 month	4 months	6 months
1	T.f	$10^{3}\times7.0$	9.2×10^{3}	5.1×10^{4}	8.5×10^{6}
	F.s	$\times10^{3}6.8$	8.8×10^{3}	4.3×10^{4}	7.8×10^{6}
2	T.f	5.0×10^{3}	2.6×10^{3}	8.5×10^{3}	2.3×10^{4}
	F.s	4.8×10^{3}	2.3×10^{3}	8.3×10^{3}	2.1×10^{4}
3	T.f	3.2×10^{2}	2.2×10^{2}	2.1×10^{3}	8.3×10^{3}
	F.s	3.1×10^{2}	2.1×10^{2}	3.0×10^{3}	8.0×10^{3}
4	T.f	2.3×10^{2}	1.5×10^{2}	7.2×102	2.8×10^{3}
	F.s	2.0×102	1.3×102	6.8×102	2.6×103

T.f = Tiger fish.
F.s = Fresh water sardine.
T.f = Tiger fish
F.s = Fresh water sardine

1= Salted fish (control).
2= Salted fish was packaged under vacuum in polyamide/polyethylene bags.
3= Salted fish was packaged under vacuum polyamide/polyethylene bags after sterilization by injection Ozone (O_3) for 5 minute thin sealed.
4= Salted fish was packaged under vacuum polyamide/polyethylene bags after sterilization by injection Ozone (O_3) for 10 minute thin sealed.

The results observed that after storage (6 months) at room temperature the bags treated by ozone or under the vacuum air individually combined the microbial count were less than 10^4 CFU/g, and still safe and this agreed with the Gulf standard specifications which states that the total bacteria not more than 10^6 CFU/g While the number of microbial 10^6 in the control sample after storage (6 months) at room temperature

Sensory Evaluation

Sensory evaluation tests have been conducted by members in ARC to evaluate the goodness and badness of food **(Meilgaard et al., 1999)** via their senses (i.e. tasting, smelling, touching, etc.). The descriptive analysis involves the detection (discrimination) and the description of both the qualitative and quantitative sensory aspects of a product by trained panels. Tables (6 and 7) presented the average values obtained in the evaluation of different attributes related with: color, odor, taste, texture and overall acceptability of sensory evaluation of salted tiger and fresh water sardine fish by the sensory panel. The results observed that no significant differences in values of color, odor, taste, texture and overall acceptability of salted (tiger and fresh water sardine) fish between all treatments at zero time of storage. But during storage, it could be indicated that sensory evaluation (color, odor, taste, texture and Overall acceptability) was significantly higher in treatment (4 and 3) followed by treatment (2 and 1) respectively. This results confirmed with chemical quality attributes (TVN, TBA and pH) and Microbiological quality attributes.

Table6. *Sensory evaluation of salted tiger fish stored at room temperature for 6 months.*

		1	2	2	4	LSD
Zero time	Color	8.0^{a}±0.5	8.0^{a}±1.0	8.0^{a}±1.0	8.0^{a}±0.5	1.489
	Taste	7.6^{a}±0.58	7.6^{a}±1.0	7.6^{a}±0.8	7.6^{a}±0.5	1.405
	Odor	7.8^{a}±0.75	7.8^{a}±0.9	7.8^{a}±0.8	7.8^{a}±0.65	1.469
	Texture	7.5a±0.7	7.5a±0.6	7.5a±0.75	7.5a±0.45	1.196
	Overall Acceptability	7.725a±0.25	7.725a±0.35	7.725a±0.37	7.725a±0.4	0.653
2 month	Color	8.0^{a}±0.85	8.0^{a}±0.75	8.0^{a}±0.55	8.0^{a}±0.45	1.259
	Taste	7.6^{a}±0.7	7.6^{a}±0.65	7.6^{a}±1.1	7.6^{a}±0.9	1.612
	Odor	7.65^{a}±0.55	7.7^{a}±0.4	7.8^{a}±0.5	7.8^{a}±0.35	0.860
	Texture	7.2^{a}±0.6	7.5^{a}±0.65	7.5^{a}±0.55	7.5^{a}±0.7	1.181
	Overall Acceptability	7.613^{a}±0.45	7.7^{a}± 0.4	7.725^{a}±0.38	7.725^{a}±0.27	0.717
4 months	color	7.5^{a}±0.8	8.0^{a}±0.5	8.0^{a}±0.6	8.0^{a}±0.5	1.153
	taste	6.15^{b}±0.5	7.0^{ab}±0.55	7.35^{a}±0.6	7.5^{a}±0.5	1.015
	odor	6.45^{b}±0.4	7.2^{ab}±0.5	7.5^{a}±0.6	7.65^{a}±0.5	0.950
	texture	6.35^{b}±0.4	6.8^{ab}±0.5	7.35^{a}±0.45	7.4^{a}±0.30	0.789
	Overall Acceptability	6.613^{b}±0.53	7.25^{ab}±0.3	7.55^{a}±0.3	7.638^{a}±0.2	0.666
6 months	color	6.5^{b}±0.5	7.3^{ab}±0.7	8.0^{a}±0.5	8.0^{a}±0.6	1.093
	taste	5.3^{c}±0.6	6.3^{b}±0.5	7.1^{ab}±0.5	7.35^{a}±0.3	0.0917
	odor	5.25^{c}±0.6	6.25^{b}±0.4	7.35^{a}±0.6	7.45^{a}±0.4	0.960
	texture	5.15c±0.35	6.2b±0.45	7.1a±0.4	7.2a±0.55	0.835
	Overall Acceptability	5.55^{c}±0.43	6.513^{b}±0.2	7.388^{a}±0.25	7.5^{a}±0.3	0.578

Mean values in the same column as a small letter or row with the same letter are not significant different at 0.05 level
1=salted fish (Control).
2=salted fish was packed under vacuum in polyethylene/polyamide packages.
3=salted fish was packed under vacuum polyethylene/polyamide packages after sterilization with Ozone (O_3) for 5 minute.
4= salted fish was packed under vacuum polyethylene/polyamide packages after sterilization with Ozone (O_3) for 10 minute.

Table7. *Sensory evaluation of salted fresh water sardine fish stored fish stored room temperature for 6 months.*

		1	2	2	4	LSD
Zero time	color	8.0^{a}±0.7	8.0^{a}±0.9	8.0$^{a.}$±1.0	8.0^{a}±0.85	1.637
	taste	7.65 ^{a}±0.70	7.65^{a}±0.8	7.65^{a}±0.65	7.65^{a}±0.85	1.420
	odor	7.85^{a}±0.55	7.85^{a}±0.75	7.85^{a}±0.8	7.85^{a}±0.5	1.247
	texture	7.5^{a}±0.6	7.5^{a}±0.45	7.5^{a}±0.55	7.5^{a}±0.70	1.095
	Overall Acceptability	7.75a±0.4	7.75a±0.5	7.75a±0.35	7.75a±0.6	0.889
2 month	color	8.0^{a}±0.65	8.0 ^{a}±0.55	8.0 ^{a}±0.70	8.0 ^{a}±0.45	1.208
	taste	7.65^{a}±0.35	7.65^{a}±0.45	7.65^{a}±1.	7.65^{a}±0.75	1.293
	odor	7.6^{a}±0.75	7.85^{a}±0.65	7.85^{a}±0.55	7.85^{a}±0.65	1.231
	texture	7.0^{a}±0.6	7.45^{a}±0.55	7.45^{a}±0.65	7.45^{a}±0.7	1.181
	Overall Acceptability	7.563±0.5	7.788^{a}± 0.55	7.788^{a}±0.4	7.788^{a}±0.6	0.974
4 months	color	7.1 ^{a}±0.45	8.0 ^{a}±0.3	8.0 ^{a}±0.25	8.0 ^{a}±0.4	0.676
	taste	6.2^{b}±0.35	7.1^{ab}±0.7	7.45^{a}±0.5	7.55^{a}±0.35	0.934
	odor	6.33^{b}±0.35	7.15^{ab}±0.5	7.4^{a}±0.55	7.50^{a}±0.45	0.882
	texture	6.20^{b}±0.35	6.65^{ab}±0.45	7.20^{a}±0.5	7.35^{a}±0.40	0.807
	Overall Acceptability	6.458^{b}±0.5	7.225^{ab}±0.6	7.513^{a}±0.35	7.60^{a}±0.25	0.839
6 months	color	6.35^{b}±0.35	7.25^{ab}±0.75	8.0^{a}±0.45	8.0^{a}±0.55	1.026
	taste	5.35^{c}±0.7	6.4^{b}±0.55	7.25^{ab}±0.35	7.4^{a}±0.35	0.958
	odor	5.2^{c}±0.4	6.2^{b}±0.4	7.35^{a}±0.35	7.40^{a}±0.4	0.733
	texture	5.1^{c}±0.40	6.15^{b}±0.50	7.0^{a}±0.35	7.15^{a}±0.40	0.783
	Overall Acceptability	5.50^{c}±0.6	6.50^{b}±0.6	7.40^{a}±0.4	7.488^{a}±0.3	0.927

Mean values in the same column as a small letter or row with the same letter are not significant different at 0.05 level

1=salted fish (Control).

2=salted fish was packed under vacuum in polyethylene/polyamide packages.

3=salted fish was packed under vacuum polyethylene/polyamide packages after sterilization with Ozone (O_3) for 5 minute.

4=salted fish was packed under vacuum polyethylene/polyamide packages after sterilization with Ozone (O_3) for 10 minute.

CONCLUSION

In conclusion, all analysis results show that the use of high barrier bags polyamide/polyethylene and modern packaging methods using Ozone for sterilization O_3 then vacuumed and sealed is more effective method to preserve chemical and microbiological quality of salted tiger and fresh water sardine fish stored at room temperature.

ACKNOWLEDGEMENT

This research was supported by World Fish Center (Kasd Karem company) for helping fishers and producers in Nasser Lake, Aswan to enhance the shelf life by the development of packaging system to be more acceptability and marketability.

REFERENCE

[1] **Abd EL-Aziz, H. A. (2000).** Chemical and technological studies on processing of beef burger .M.Sc. Thesis, Fac. of Agric., Minufiya Univ., Egypt.

[2] **Abbas Bakhiet, H. H., & Khogalie, F.A.E. (2012).** Effect of different salt concentrations on chemical composition of the fish *Hydrocynus* spp. Online Journal of Animal and Feed Research, 2, 461–464.

[3] **Alex A.G. (2009).** Ozone – an Emerging Technology for the Seafood Industry. Braz. Arch. Biol. Technol. v.52 n.6: pp. 1527-1539

[4] **AMC, 1979**. Analytical Method Committee. Recommended method for the examination of fish and fish products. The Analyst. 104, 434–439.

[5] **Anon (2001).** Hand book of Fisheries stastistics. 2000. Govt. of India, Ministry of Agriculture, New Delhi.

[6] **A.O.A.C. (2005).** Official methods of analysis of the Association of official Analytical Chemists, 17th Edn (edited by W. Horwitz Washington, D.C., U.S.A.

[7] **Bras, A., & Costa, R. (2010).** Influence of brine salting prior to pickle salting in the manufacturing of various salted dried fish species. Journal of Food Engineering, 100, 490–495.

[8] **Chaijan, M. (2011).** Physicochemical changes of tilapia (*Oreochromis niloticus*) muscle during salting. *Food Chemistry*, *129*, 1201–1210.

[9] **Dewi, R.S., Nurul Huda and R. Ahmad, (2011)**. Changes in the physicochemical properties, microstructure and sensory characteristics of shark dendeng using different drying methods. Am. J. Food Technol., 6: 149-157.

[10] **Duguet, J. P. (2004),** Basic concepts of industrial engineering for the design of new

ozonation processes. Ozone News, 32 (6), 15-19.

[11] **EL-Kordy, M. M. N. (2006).** Utilization of silver carp in production of semi-fried fish patties. M.Sc. Thesis, Fac.of Agric., Cairo Univ., Egypt.

[12] **Eyo, A A. (1993).** Traditional and improved fish handling, preservation and processing techniques. Paper presented at national workshop on fish processing storage, marketing and utilization.

[13] **Farzana, B. F., Gulshan, A. L., Mosarrat, N. N. and Mohajira, B. (2014)** Comparative study of the sensory scores, quality and shelf life study of dry and pickle salted shoal (*C. striatus;* Bloch, 1801) at room temperature (27-31 0C). International Journal of Fisheries and Aquatic Studies; 2(1): 157-163.

[14] **Fda Bam. 2001**. Bacteriological analytical manual, Aerobic plate count Chapter 3, January 2001 edition.

[15] **Hasan, B., O. and Fatma, A., C. (2015).** Nutritional and sensory properties of salted fish product, *lakerda*. Ormanci & Colakoglu, *Cogent Food & Agriculture*, 1: 1008348.

[16] **Immaculate, J. K., Sinduja, P., Jamila, P. (2016).** Wet and dry salting processing of double spotted queen fish *Scomberoides lysan* (Forsskål, 1775). International Journal of Fisheries and Aquatic Studies ; 4(3): 330-338.

[17] **Graham, D. M. (1997),** Use of ozone for food processing. Food Technology, 6 (51), 72-75.

[18] **Goulas, A. E., And Kontominas, M. G. (2005).** Effect of salting and smoking-method on the keeping quality of chub mackerel (Scomber japonicus): Biochemical and sensory attributes. Food Chemistry. 93, 511–520.

[19] **King, R. K. (2001),** The presence of bacterial pathogens in biofilms of recirculating aquaculture systems and their response to various sanitizers. PhD Thesis, Faculty of the Virginia Polytechnic Institute and State University, Virginia, Available in: http://scholar.lib.vt.edu/theses/available/etd042 4200100624/unrestricted/dissertation.pdf

[20] **Kim, J., Yousef, A., and Dave, S. (1999),** Application of ozone for enhancing the microbiological safety and quality of foods: A review. Journal of Food Protection, 62, 1071–1087.

[21] **Kolakowska A. (2002).** Lipid oxidation in food systems. In Z. Sikorski & A. Kolakowska (Eds.), Chemical and functional properties of food lipids, London, UK, 133-165.

[22] **Khan, M.A.A. and Y.S.A. Khan, (2001)**. Insects infestation and preventive measures in dry fish storage of Chittagong, Bangladesh. J. Biol. Sci., 1: 963-965.

[23] **Kirk, R. S., and Sawyer, R. (1991).** Pearson's composition and analysis of foods (9 third ed.). London: Longman Scientific and Technical.

[24] **Kocatepe D., Turan. C.O, Altan. G.G. (2014).** Effect of the Vacuum Packaging on the Shelf Life of Lakerda. Int J Food Sci. Nutr. Diet 3(9), 157-159.

[25] **Meilgaard, M., Civille, G. V., & Carr, B. T. (1999).** Sensory evaluation techniques (3rd ed.). Boca Raton, FL: CRC Press.

[26] **Marcilene C., Heidmann S. (2005).** Effects of Modified Atmosphere and Vacuum on the Shelf Life of Tilapia (Oreochromis niloticus) Fillets. Braz. J. Food Technol., v.8, n.1, p. 7-15

[27] **Martínez-Alvarez, O., & Gómez-Guillén, C. (2013).** Influence of mono- and divalent salts on water loss and properties of dry salted cod fillets. LWT - Food Science and Technology, 53, 387–394. Retrieved from (14) Nutritional and sensory properties of salted fish product, lakerda.

[28] **Mendes R., Goncalvez A. (2008)** Effect of soluble CO2 stabilization and vacuum packaging in the shelf life of farmed sea bream and sea bass fillets. Journal of Food Science and Technology 43(9): 1678-1687

[29] **Mohan, C., Ravi. S & Srinivasa G. (2016).** Packaging Interventions in Low Temperature Preservation of Fish- A Review. MOJ Food Process Technol, 2(1): 00026

[30] **Mujaffar Saheeda and Sankat K. Clement, 2005**. The mathematical modeling of the osmotic dehydration of shark fillets at different brine temperatures. Int. J. Food Sci. Tech., 40: 1-12.

[31] **Musa, U., S.S. Hati, Y.I. Adamu and A. Mustapha, (2010)**. Pesticides residues in smoked fish samples from North-Eastern Nigeria. J. Applied Sci., 10: 975-980.

[32] **Oliveira, H., Pedro, S., Nunes, M. L., Costa, R., & Vaz-Pires, P. (2012).** Processing of salted cod (*Gadus* spp.): A Review. Comprehensive Reviews in Food Science and Food Safety, 11, 546–564.

[33] **Pearson, D. (1970).** The chemical analysis of food. National college of reading. Wegbridge, Surry. J. and Chirchill, A.

[34] **Sas (1996).** SAS/STAT1 User's Guide, Version 8, SAS Institute Inc, Cary, NC.

[35] **Shenderyuk VI, Bykowski PJ. (1989).** Salting and Marinating of fish. In: Seafood Resources. Nutritional Composition and preservation, Sikorski, Z.E. (Ed.) CRC Press Inc. Boca. Raton Florida.

[36] **Suderman, D.R.; Wiker, J. and Cunningham, F.E. (1981).** Factors affecting adhesion of coating to poultry skin. effects of various protein and gum sources in the coating composition. Food Sci., 46: 1010-1011.

[37] **Taheri, S., Motallebi, A. A., Fazlara, A., (2012)**. Antioxidant effect of ascorbic acid on the quality of cobia (Rachycentron canadum) fillets during frozen storage. Iranian Journal of Fisheries Sciences, 11, 666-680.

[38] **Turan H, Sonmez G, Celic MY. Yalcin M. (2007)**. Effects of different salting process on the storage quality of Mediterranean Muscle (Mystus Galloprovincialis L. 1819) J Muscle Foods, 18:380-390

[39] **Vaz-Velho, M. et al. (2006),** Inactivation by ozone of Listeria innocua on salmon-trout during cold-smoke processing, Food Control, 17, 609–616.

[40] **Virta S. (2009).** Isolation and Identification of Rainbow Trout spoiling Microbiota. Bachelor's Thesis, Biotechnology and Food Technology, Turku University of Applied Science. Standardization Organization For G.C.C (Gso) Cfl Microbiological Criteria For Foodstuffs – Part 1 1016 / 2010

[41] **Zentox Corporation (2007),** Ozone in Food Processing Applications: Past Experience, Future Potential and Regulatory Issues.

Citation: *Mahmoud. F.S.A. Kdous,Khaled S. A. Nagy and Manal A. Sorouri," The Effect of Modern Packaging Systems on the Quality and Shelf Life of Salted Fish", Research Journal of Food and Nutrition, vol. 2, no. 3, pp. 39-47, 2018.*