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EFFECT OF SALTING METHOD AND STORAGE TEMPERATURE ON QUALITY OF SALTED SILVER CARP (*HYPOPHTHALMICHTHYS MOLITRIX*)

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Abstract

Some chemical, physicochemical, bacteriological and organoleptical changes in dry and mixed-salted silver carp (*Hypophthalmichthys molitrix*), were investigated. Butterfly silver carp which had been salted were stored for 6 months at room temperature (25±5°C) and under cold storagfe at (5±1°C). During the storage period, chemical indices of freshness and the bacterial count showed increasing trends; they were considerably lower in the dry and mixed-salted stored at the lower temperature. Sensory evaluation indicated that storage at the lower temperature could considerably extend the shelf-life of salted fish.

INTRODUCTION

When the temperature of fish is higher than 10°C during processing the flesh may become sour or it can be spoiled by red bacteria. The finished product may also be holding at temperature exceeding 8-10°C (Varga *et al.*, 1979 and Shetty *et al.*, 1996).

FAO (1981) and Wheaton & Lawson (1985) showed that salting is one of earliest and most wide spread preservation techniques. About 15% of the world, caught fish are preserved by curing methods such as salting, drying and smoking, or a combination of these treatments.

Roberts (1986) revealed that some typical salting types for fish to reach saturation are: 30-40 h for small pelagic fish (headed and gutted); 50-60 h by kench cure for intermediate size split fish; 60-70 h by kench cure for shark flesh (2 cm thick).

Martis & Mihalik (1989) and Perrez & Pozo (1992) reported that the ripening of salted and pickled fish depends on the activity of proteolytic enzyme, on acetic acid and salt concentrations, the activity of microbial proteases and on biochemical and histological properties of raw fish. Total bacterial counts reached a maximum at 4-5

months period. Maturing the salted anchovy at 30°C reduced ripening time by 2 months compared to 20°C. Colour, odor, flavour and texture followed a linear correlation with ripening time.

Takiguchi and Aminaka (1990) filleted mackerel which had been salted for 10 days, stored for 56 days at ambient temperature during storge period, and reported that moisture content in the non-packaged salted product decreased from 40-39%, while, that in the packaged salted one remained unchanged. Lipid oxidation in non-packaged product proceeded rapidly as judged by peroxide value (POV) and oxidized acid content. Total extractive N and free amino acid contents increased slowly in non-packaged product, but rapidly in the packaged one.

Srikar *et al.* (1993) noticed that dry-salted and pink perch were stored at two ambient temperatures (26±3.3°C) and (2.5±1°C). Loss of moisture and absorption of salt were considerably higher in the products stored at ambient temperature (26±3.3°C) and (2.5±1°C). Although peroxide value (PV), free fatty acid (FFA), total volatile bases nitrogen (TVBN) and the halophilic counts showed increasing trends, they were considerably lower in the products stored at the lower temperature.

Nafissa *et al.* (1996) declared that common salted fish products consumed in Egypt like imported smoked herring and 3 fresh spp., i.e. mullet, sardine and dogfish) were analyzed for proximate composition and protein values (rat assays). Moisture content of salted fish ranged from 52.9±1.0 in herring to 60.0±2.1 (% dry matter basis) in dogfish. Protein levels were correspondingly, 52.1±1.3 to 59.4±1.1%; fat levels ranged from 17.8±2.1 (dogfish) to 31.1±1.5% (herring) and ash levels ranged from 13.1±1.1 (sardine) to 20.1±0.9 % (dogfish).

Vilhelmsson *et al.* (1996) showed that a total of 128 strains of moderately halophilic bacteria was isolated from wet, dry and desalted bachalao (salted codfish), as well as, from fresh cod and curing salt. Viable counts of these bacteria in fully cured wet and dry bachalao had ranged from 10^3 to 10^7 per g.

Sakai (1997) demonstrated that volume changes in fish flesh (swelling or shrinking) are caused by long time immersion in salt soultions. The amount of penetrated salt cannot be estimated by a conventional diffusion model. Salt is transported by diffusion and by flow of absorbed or released solutions. Concentration of these solutions were assumed to be the same as the concentrate of the outer solution.

Voranch and Marshall (1998) concluded that catfish frames stored at 25±°C were considered microbiologically acceptable for 10.3 h with aerobic plate counts (APC) reaching $\leq 10^7$ cfu/g or 18 h with total coliform counts (TCC) being > 10^6cfu/

g. Sensory storage life was limited to 6 h. At 5°C, catfish frames had microbiological acceptability for 3.5 days and sensory acceptability for 4 days, with a significant increase in TCC counts after 2 days. Catfish frames stored at O°C had the longest storage life, up to 8 days, with acceptable sensory properties and APC. TCC of frames stored at O°C declined.

The present work was carried out to study the effect of two methods of salting (mixed and dry salting) on preservability of silver carp fish. Besides, chemical, microbiological and oraganoleptical evaluation of raw salted fish samples were carried out immediately after processing and storage at room temperature (25±5°C) and in refrigerator (5±1°C).

MATERIALS AND METHODS

Samples preparation

Silver carp *(Hypophthalmichthys molitrix)* was immediatly obtained after harvesting from Abbassa fish farm at Sharkia governorate Egypt. The head, scales and all fins of the fish were removed using a sharp knife. Thereafter, the fish were washed, dressed in a butterfly style and divided into two lots 10 kg each; fish were mixed and dry-salted under low temperature (5±1°C). In dry salting method, crystalline salt was spread on the surface of the dressed fish using a salt (Sodium chloride [1% Magnesium carbonate and 30-70 ppm. Potassium iodate] obtained from El-NASR-Saline's Co. Alex. Egypt at a ratio of 1:4). Salted fishes were stacked in plastic troughs in lays interspersed with salt, and weights were kept on the top to prevent the fish from floating. In mixed-salting method, fish samples were mixed with dry salt at a ratio of 1kg. salt/ 4kg. sample (for 4 hours). After that, fish samples were soaked in salt solution 25%. Samples were stored for 6 months at room temperature (25±°C) and under storage at (5±1°C) and were periodically removed for analysis.

Analysis

Moisture content was determined using drying oven method at 105°C according to the method described in AOAC (1990). Salt content was determined using the method described by Lees (1975). Formal titration (FAN) was applied as described in AOAC (1990). Thiobarbituric acid (T.B.A) was measured according to the method described by Tarladgis *et al.* (1960). Total bacterial count (T.B.C) was carried out by the plate count method as documented by Frazier and Foster (1959). Halophilic bacterial count was counted according to the method mentioned by Foster (1959). Organoleptic evaluation for overall acceptability was carried out according to the DLG method

(1973). Flavour was evaluated according to Teeny and Miyauchi (1972).

Statistical Analysis

Three replications of each trial were performed. Moisture, salt, free amino nitrogen (FAN), thiobarbituric acid (TBA), total bacterial count (TBC), halophilic bacterial count (HBC) and sensory data were analyzed using ANOVA and means were separated by Duncan at a Probability level of $P < 0.05$ (SAS, 1992).

RESULTS AND DISCUSSION

Some physico-chemical and chemical changes during storage period

Our results presented in Table 1 and Fig.1-A showed the effect of storage period at room temperature (25±5°C) and (5±1°C) on moisture content. The analysis of variance for moisture content showed that the dry salted samples stored at 5±1°C was significantly ($P<0.01$) higher than other treatments and followed by salting samples stored at (25±5°C) was 66.0±0.15%, mixed salted samples at (5±1°C) was 65.4±0.03% and mixed salted samples stored at (25±5°C) was 63.3±0.09%.

Fig.1-B and Table 1 showed the effect of storage period at room temperature (25±5°C) and (5±1°C) on salt content of dry and mixed salted silver carp during 6 months storage period. The statistical analysis indicated that the salt content was significantly higher ($P<0.05$) in mixed salted samples especially those stored at room temperature 25±5°C (20.5±0.12%) at the end of 6-months of storage.

The higher salt and lower moisutre contents in the products stored at ambient temperature may be due to the accelerated rate of diffusion (salt uptake and moisture removal). The present data are in agreement with those reported by Srikar *et al.* (1993), Sakai (1997) and Chyuan-Yuan *et al.* (1998).

Regarding free amino nitrogen (FAN) and thiobarbituric acid (TBA) Fig.2 and Table 2, the data in Fig.2-A and Table 2 indicated significantly a gradual increase ($P<0.05$) in FAN contents in all samples up to the end of storage period, however, the increment rate was higher in dry and mixed-salted fish samples stored at room temperature than in dry and mixed-salted fish samples stored at 5±1°C. The FAN content, recorded the value of 0.231±0.0009% at zero time, while, at the end of storage period were 0.873±0.0012; 0.742±0.0015; 0.651±0.0006 and 0.521±0.0009% for dry and mixed-salted silver carp stored at room and cold temperatures, respectively.

Additionally, from the foregoing results, the increment in FAN during storage could be resulted from the decomposition of nitrogen substances which may be due to the activity of microoganisms. These results are in harmony with those obtained by Roberts (1986), Takiguchi and Aminaka (1990) and Eun *et al.* (1995), Jasinska and Olejniczak (1995) and Nafissa *et al.* (1996).

Respecting the thiobarbituric acid (TBA) value used as an index for lipid oxidation taking place in fish and fish products, fish and fish products of good quality will have a TBA value less than 2.0, while, poorer quality fish will have TBA value ranging between 3 and 27. Moreover, fish with TBA number greater than 27 will probably smell and taste rancid (Bonnell, 1994). Results shown in Fig.2-B and Table 2 show significant increase in TBA value observed up to 6 months of storage period. Accordingly, all fish samples TBA values started with 0.11±0.007 (mg. malonaldehyde/kg.) at zero time of storage at room temperature (25±5°C) and at (5±1°C), reached to 3.04±0.003; 2.70±0.015; 2.61±0.009 and 2.21±0.012 (mg. malonaldehyde/kg.) to dry and mixed-salted after 6 months of storage, respectively. These results are in agreement with those reported by Eun *et al.* (1995).

Microbial evaluation during storage period

The effect of storage at room temperature (25±5°C) and at (5±1°C) for 6 months on the total bacterial count TBC (Log10 CFU/g.) of dry and mixed-salted silver carp, are illustrated in Fig.3-A and Table 3. The results showed significant decrease ($P<0.05$) in total bacterial count in all samples up to 6 months of storage, however, the decrement was higher in samples stored (5±1°C) compared with those stored at room temperature (25±5°C) during a storage period of 6 months.

On the other hand, changes in halophilic bacterial count (H.B.C.) (Log10 CFU/g.) during storage at room temperature at (25±5°C) and (5±1°C) for dry and mixed-salted silver carp are shown in Fig.3-B and Table 3. Results indicated that, through the whole period of storage, a significant increase ($P<0.05$) in H.B.C. started with 3.25±0.07 [Log10 CFU/g.] at zero time, and reached 3.55±0.02; 3.55±0.01; 3.48±0.01 and 3.45±0.01 [Log10 CFU/g.] for dry and mixed-salted fish stored at room and cold temperatures after 6 months of storage, respectively. The increment was higher in samples at room temperature (25±5°C) rather than those stored at (5±1°C).

The lower H.B.C. observed in the products stored at (5±1°C) might have resulted from the inhibitory effect of low temperature on the growth and metabolism of the

microorganisms. These results coincide with those reported by Varga *et al.* (1979), Leira-Sanmartin (1995), Vilhelmsson *et al.* (1996), Gancel *et al.* (1997) and Voranuch and Marshall (1998).

Organoleptical changes during storage period

The sensory scores of flavour and overall acceptability of the dry and mixed-salted fish during storage period for 6 months at room and cold temperature (25±5°C) and at (5±1°C) are illustrated in Fig. 4-A and Table 4. The flavour and overall acceptability scores decreased significantly ($P<0.05$) with each increase in the storage period. Products stored at (5±1°C) received higher scores than those stored at ambient temperature (25±5°C) .

The gradual decrease in flavour and overall acceptability throughout the whole period of storage could be attributed to the protein denaturation, hydrolysis and fat oxidation which are the major factors influencing the changes in organoleptic properties during storage period. These resuults are in line with those obtained by Srikar *et al.* (1993), Jasinska and Olejniczak (1995), Leira-Sanmartin (1995) and Voranuch and Marshall (1998).

The result of the above investigation revealed that mixed-salted silver carp can be stored for longer periods in refrigerated conditions (5±1°C) compared with the other treatments and the ambient temperature (25±5°C).

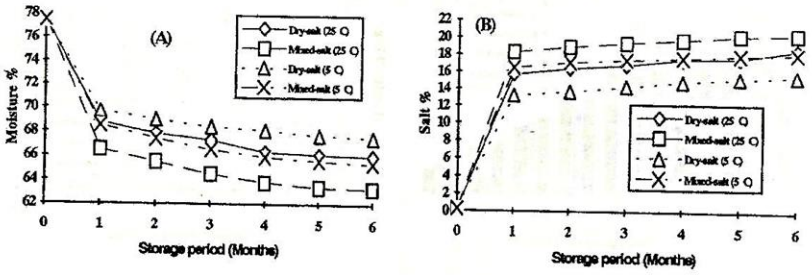

Fig.1. Effect of storage temperature 25±5°C and 5±1°C on Moisture and Salt (%) of dry and mixed-salted processed silver carp during 6 months storage period (On dry weight basis).

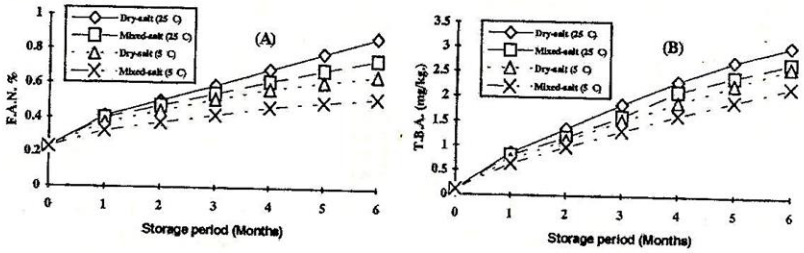

Fig.2. Effect of storage temperature 25±5°C and 5±1°C on Free amino nitrogen (FAN) and Thiobarbituric acid (TBA)% of dry and mixed-salted processed silver carp during 6 months storage period (On dry weight basis).

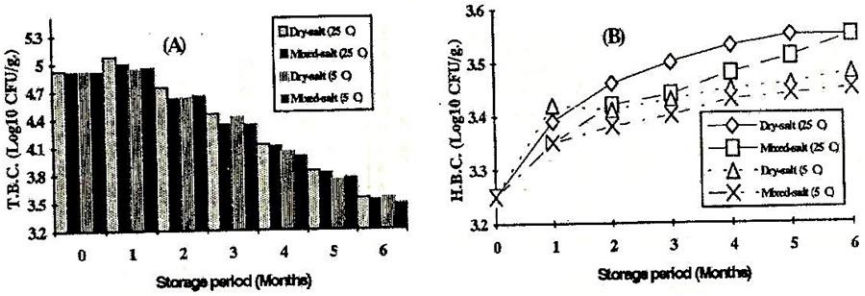

Fig.3. Effect of storage temperature 25±5°C and 5±1°C on total bacterial count TBC and Halophilic bacterial count HBC (Log10 CFU) of dry and mixed-salted processed silver carp during 6 months storage period.

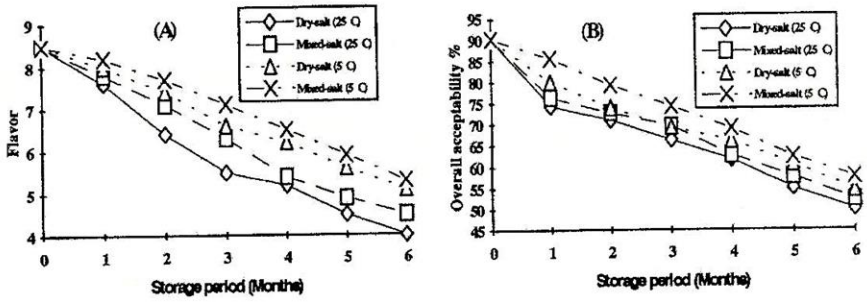

Fig.4. Effect of storage temperature 25±5°C and 5±1°C on Flavour and Overall acceptabiliy of dry and mixed-salted processed silver carp during 6 months storage period.

Table 1. Effect of storage temperature 25±5°C and 5±1°C on Moisture and Salt (%) of dry and mixed-salted processed silver carp during 6 months storage period (On dry weight basis).

Parameter		Moisture % (A)				Salt % (B)			
Termperature		25±5°C		5±1°C		25±5°C		5±1°C	
Salting method		Dry	Mixed	Dry	Mixed	Dry	Mixed	Dry	Mixed
	0	77.5±0.12 a	77.5±0.12 a	77.5±0.12 a	77.5±0.12 a	0.26±0.01 a	0.06±0.01 a	0.26±0.01 a	0.26±0.01 a
	1	68.8±0.06 b	66.5±0.09 b	69.7±0.06 a	68.5±0.12 c	15.7±0.11 c	18.3±0.09 a	13.2±0.15 d	16.5±0.03 b
Storage	2	67.8±0.06 b	65.5±0.09 b	69.0±0.09 a	67.4±0.03 c	16.4±0.1 c	18.9±0.03 a	13.7±0.12 d	17.1±0.1 b
Period	3	67.3±0.24 b	64.5±0.06 d	68.4±0.07 a	66.5±0.12 d	16.8±0.13 c	19.4±0.09 a	14.3±0.12 d	17.4±0.08 b
Months	4	66.3±0.12 b	63.8±0.06 d	68.1±0.09 a	65.9±0.03 c	17.5±0.07 b	19.8±0.1 a	14.9±0.09 c	17.7±0.03 b
	5	66.1±0.07 b	63.4±0.07 d	67.7±0.09 a	65.6±0.12 c	17.7±0.12 b	20.3±0.06 a	15.3±0.15 c	18.0±0.12 b
	6	66.0±0.15 b	63.3±0.09 d	67.5±0.03 a	65.4±0.03 c	18.7±0.03 b	20.5±0.12 a	15.6±0.07 c	18.2±0.15 b

[a-d] Means within a raw with the same superscript are significantly differet ($P<0.05$).

Table 2. Effect of storage temperature 25±5°C and 5±1°C on Free amino nitrogen (FAN) and Thiobarbituric acid (TBA) % of dry and mixed-salted processed silver carp during 6 months storage period (On dry weight basis).

Parameter		F.A.N. % (A)				T.B.A. mg/kg (B)			
Termperature		25±5°C		5±1°C		25±5°C		5±1°C	
Salting method		Dry	Mixed	Dry	Mixed	Dry	Mixed	Dry	Mixed
	0	0.231±.0009	0.231±.0009	0.231±.0009	0.321±.0009	0.11±.007	0.11±.007	0.11±.007	0.11±.007
		a	a	a	a	a	a	a	a
	1	0.412±.0009	0.401±.0010	0.373±.0009	0.327±.0007	0.86±.007	0.81±.009	0.717±.009	0.64±.003
		a	b	c	d	a	b	c	d
Storage	2	0.501±.0007	0.473±.0009	0.442±.0012	0.376±.0006	1.36±.015	1.18±.009	1.13±.006	0.98±.007
		a	b	c	d	a	b	c	d
Period	3	0.591±.0009	0.544±.0007	0.511±.0010	0.421±.0009	1.85±.009	1.61±.009	1.52±.015	1.32±.015
		a	b	c	d	a	b	c	d
Months	4	0.683±.0003	0.616±.0006	0.572±.0012	0.466±.0009	2.31±.007	2.11±.012	1.89±.009	1.63±.009
		a	b	c	d	a	b	c	d
	5	0.777±.0006	0.681±.0009	0.613±.0007	0.497±.0009	2.72±.009	2.41±.006	2.25±.012	1.92±.009
		a	b	c	d	a	b	c	d
	6	0.873±.0013	0.742±.0015	0.651±.0006	0.521±.0009	3.04±.003	2.70±.015	2.61±.009	2.21±0.12
		a	b	c	d	a	b	c	d

[a-d] Means within a raw with the same superscript are significantly different ($P<0.05$).

Table 3. Effect of storage temperature 25±5°C and 5±1°C on Total bacterial count TBC Halophilic bacterial count HBC (Log10 CFU) of dry and mixed-salted processed silver carp during 6 months storage period.

Parameter		TBC log10 CFU/g. (A)				H.B.C. log10 CFU/g. (B)			
Temperature		25±5°C		5±1°C		25±5°C		5±1°C	
Salting method		Dry	Mixed	Dry	Mixed	Dry	Mixed	Dry	Mixed
Storage Period Months	0	4.93±0.01 a	4.93±0.01 a	4.93±0.01 a	4.93±0.01 a	3.25±0.01 a	3.25±0.01 a	3.25±0.01 a	3.25±0.01 a
	1	5.07±0.01 a	5.01±0.01 b	4.95±0.03 c	4.96±0.01 bc	3.39±0.04 a	3.35±0.02 b	3.42±0.03 b	3.35±0.01 b
	2	4.74±0.01 a	4.63±0.03 b	4.64±0.03 b	4.66±0.02 b	3.46±0.03 a	3.42±0.02 ab	3.41±0.02 a	3.38±0.02 b
	3	4.45±0.02 a	4.35±0.02 b	4.42±0.02 a	4.35±0.01 b	3.50±0.02 a	3.44±0.02 b	3.43±0.01 b	3.40±0.02 b
	4	4.12±0.02 a	4.11±0.01 ab	4.05±0.01 bc	4.00±0.03 c	3.53±0.01 a	3.48±0.02 b	3.45±0.02 b	3.43±0.02 b
	5	3.83±0.02 a	3.82±0.01 ab	3.74±0.03 a	3.77±0.01 bc	3.55±0.02 a	3.51±0.01 a	3.46±0.01 b	3.44±0.01 b
	6	3.54±0.02 ab	3.53±0.02 ab	3.55±0.02 a	3.48±0.02 b	3.55±0.02 a	3.55±0.01 a	3.48±0.01 b	3.45±0.01 b

[a-d] Means within a raw with the same superscript are significantly different (P<0.05).

Table 4. Effect of storage temperature 25±5ºC and 5±1ºC on Flavour and mixed-salted processed silver carp during 6 months storage period.

Parameter		Flavour (A)				Overall acceptability (B)			
Termperature		25±5˚C		5±1˚C		25±5˚C		5±1˚C	
Salting method		Dry	Mixed	Dry	Mixed	Dry	Mixed	Dry	Mixed
	0	8.5±0.2	8.5±0.2	8.5±0.2	8.5±0.2	90.3±1.5	90.3±1.5	90.3±1.5	90.3±1.5
		a	a	a	a	a	a	a	a
	1	7.6±0.2	7.8±0.2	8.0±0.3	8.2±0.1	74.3±1.8	76.3±0.7	80.0±2.3	85.7±0.7
		a	a	a	a	c	bc	b	a
Storage	2	6.4±0.2	7.1±0.1	7.1±0.3	7.7±0.1	71.0±0.6	72.7±1.8	74.0±1.0	79.3±2.3
		b	a	a	a	b	b	b	a
Period	3	5.5±0.1	6.3±0.1	606±0.2	7.1±0.2	66.3±0.7	69.7±1.2	69.3±2.3	74.3±1.8
		c	b	ab	a	b	ab	ab	a
Months	4	5.2±0.1	5.4±0.1	6.2±0.1	6.5±0.2	61.7±0.9	62.7±0.3	66.0±0.6	69.0±1.5
		b	b	a	a	b	b	a	a
	5	4.5±0.1	4.9±0.2	5.6±0.1	5.9±0.2	55.0±2.1	57.7±1.5	60.7±2.3	62.3±1.5
		b	b	a	a	b	ab	ab	a
	6	4.0±0.1	4.5±0.3	5.1±0.1	5.3±0.1	50.0±2.9	52.3±1.5	54.6±2.6	57.7±1.5
		c	bc	ab	a	b	ab	ab	a

[a-d] Means within a raw with the same superscript are significantly different (P<0.05).

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تأثير طريقة التمليح ودرجة حرارة التخزين على جودة سمك المبروك الفضى المملح

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تمت دراسة بعض التغيرات الكيميائية، الفيزيوكيميائية، البكتريولوجية وكذلك الخواص الحسية لأسماك المبروك الفضى المملح بطريقة التمليح الجاف والمختلط. قسمت كمية المبروك الفضى المملح (تمليح جاف ومختلط) على شكل فراشة. وخزنت لمدة ستة أشهر على درجة حرارة الغرفة (٢٥±١°م) وعلى درجة حرارة التبريد (٥±١°م). أظهرت الأسس الكيمائية للطزاجه وكذلك المحتوى البكتريولوجى ميلا نحو الزيادة خلال فترة التخزين، وكان واضحا انخفاض مستوى التغير فى العينات المملحة المخزنة على درجات حرارة منخفضة. كذلك أظهر التقييم للعينات المخزنة على درجات حرارة منخفضة إطالة كبيرة لفترة حفظ الأسماك المملحة.