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EFFECT OF SOAKING AND STORAGE CONDITIONS ON QUALITY OF SILVER CARP (*HYPOPHTHALMICHTHYS MOLITRIX)* FILLETS

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Abstract

Some physiochemical, chemical, microbiological and organoleptical properties of silver carp *(Hypophthalmichthys molitrix)* fillets soaked in different solutions [salt solution (salt + spices) (S.S.) as control, salt solution with acetic acid 2% (S.S.+A.A.), tomato sauce (S.S.+T.) or solution of their mixture (S.S.+A.A.+T.)] were investigated during cold storage for 12 days at 4±1°C. The effect of different soaked solution and storage temperature on shelf life of silver carp *(Hypophthalmichthys molitrix)* fish were examined for all treatments.

Results showed that, the protein, fat, pH values and sensory evaluation scores were reduced, while moisture, ash and salt were increased during storage at 4±1°C. Also, the results indicated that total volatile bases nitrogen (TVBN), trimethylamine nitrogen (TMAN), thiobarbituric acid (TBA), total bacterial count (TBC), psychrophilic bacterial count (PsBC) and halophilic bacterial counts (HBC) were increased with prolonged of cold storage period. These results corresponded to the gradually decrease in sensory evaluation (appearance and flavor**)** for all samples during cold storage period. At the finally the increasing was less in fillets soaked in salt solution, acetic acid and tomato sauce compared with the solution of their mixture (S.S.+A.A.+T.). Hence, soaking in solution of their mixture (S.S.+A.A.+T.), and cold storage at 4±1°C led to extend the shelf life of silver carp *(Hypophthalmichthys molitrix)* fillets

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INTRODUCTION

Carp fish is considered one of the mainstays of fish aquaculture, it obtain lower market price due to presence of intramuscular bones, and therefore it could be pasteurized to add high value by processing it into some convenient products. Carp, as a freshwater fish species, has been one of the most widely cultured species all over the world due to its fast growth rate, easy cultivation and high feed efficiency ratio (Tokur *et al.*, 2006). In Egypt, silver carp (*Hypophthalmichthys molitrix),* common carp (*Cyprinus carpio)* and grass carp (*Ctenopharyngodon idella)* species are extensively cultured. Total carp production in Egypt through aquaculture increased from 687 tons to 61805 tons between 2001 and 2008 (GAFRD, 2008).

Fresh fish is susceptible to spoilage caused by both microbiological and chemical reactions. Lipid deterioration easily takes place and limits the shelf-life of oily fish during storage. Both hydrolytic and oxidative rancidities in fish fatty muscle are associated with quality deterioration. Hydrolysis, induced by lipases and phospholipases, produces free fatty acids that undergo further oxidation to produce low-molecular weight compounds that are responsible for the rancid off-flavour and taste of fish and fish products. The lipid components of post-mortem fish muscle tissue are prone to oxidation because fatty acids of fish lipids are much more unsaturated than those of mammals and birds. (Chaijan *et al.*, 2006).

Initial quality of raw materials, considering their freshness, microbiological load and physical damage, is an important factor which influences the quality of the end product. Keeping qualities depend largely upon storage temperatures. Marinades stored at cooler temperatures (4–6°C) keep a long time. Marinated fish is preserved by the simultaneous action of organic acids, such as acetic acid and salt. The combined preservative action prevents the growth of pathogenic bacteria and most spoilage bacteria. The products obtained have a pleasant taste

without being too tough and have a reasonable shelf-life (Gokoglu *et al*., 2004).

The chemical indices of freshness; peroxide value (PV) and total volatile bases nitrogen (TVBN) showed that increasing trends were considerable lower in the products stored at lower temperature (Periago *et al.*, 2003).

The present work was carried out to investigate some physico-chemical, chemical, microbiological and organoleptical properties of silver carp *(Hypophthalmichthys molitrix)* fillets soaked in different solutions [salt solution (salt + spices) (S.S.) as control, salt solution with acetic acid (S.S.+A.A.), salt solution with tomato sauce (S.S.+T.) or solution of their mixture (S.S.+A.A.+T.)] during storage period for 12 days at 4±1°C.

MATERIALS AND METHODS

Samples and experimental design:

Silver carp (*Hypophthalmichthys molitrix*) was immediately obtained after catching from Abbasa Farm in Sharkia Governorate Egypt. Each sample weighted 10 Kg, while the mean of individual weight of silver carp fish was about 2.5 Kg. The fish samples were washed using tap water, then the head, scales and all fins of silver carp fish were removed using a sharp knife. The internal viscera were removed by hand then washed the fish using tap water. The fish samples were cut to fillets and divided to four groups then soaked in different solutions. The first group contained (salt solution, 5%) with spices 6gm/100ml (2.0 g red pepper, 1.0 g mustard seed, 2.0 g garlic seed, 1.0 g bay leaf) (S.S.), the second group contained salt solution with spices and acetic acid (2% / 100 ml salt solution) (S.S.+A.A.), the third group contained salt solution and spices with tomato sauce (total solids 23%) (S.S.+T.) and the fourth group, contained solution of their mixture (S.S+A.A.+T.), and fish

samples were packed in glass cans. Two hundred grams of silver carp fillets were packed in glass cans of 325 ml capacity using 125 ml of packing solution, with ratio of 1.6: 1 (f : ps) fish: packing solution. All treated samples were stored in refrigerator at 4±1ºC for 12 days. At the end of 0, 2, 4, 6, 8, 10 and 12 days, samples were randomly withdrawn for analysis.

Analytical methods:

Moisture content, total protein, lipids and ash were determined according to the methods described in AOAC (2000). pH-value was determined according to Pacheco *et al.* (1989). Salt content was determined using the method described by Lees (1975). Total volatile bases nitrogen (TVBN) and trimethylamine nitrogen (TMAN) were determined according to AMC (1979). Thiobarbituric acid value (TBA) was estimated as described by Tarlagis *et al.* (1960). Total bacterial count (TBC) and Psychrophilic bacterial count (PsBC): were detected according to the method described by Swanson *et al.* (1992). Halophilic bacterial count (HBC) was counted according to the method mentioned by Baross and Lenovich (1992). Sensory evaluation of samples were organoleptically evaluated for appearance and texture of uncooked fillets during storage at 4±1°C as described by Teeny and Miyauchi (1972).

Statistical analysis:

Three replications of each trial were analyzed using Analysis of Variance (ANOVA) and the means were separated by Duncan' test (1955) at a probability level of $P<0.05$ SAS (2000).

RESULTS AND DISCUSSION

Some physiochemical, chemical and microbiological changes:

The effect of storage period at 4±1 ºC for 12 days on moisture and protein content of silver carp *(Hypophthalmichthys molitrix)* fillets soaked in different solutions [salt solution (salt + spices) (S.S.) as control, salt

solution with acetic acid (S.S.+A.A.), salt solution with tomato sauce (S.S.+T.) or solution of their mixture (S.S.+A.A.+T.)] during storage are presented in Table 1. The obtained results indicated a significant increase ($P<0.05$) in moisture and slight decrease in protein content in all samples up to 12 days of storage period.

Table 1. Effect of storage period for 12 days at 4±1°C on moisture and protein contents (%) of silver carp *(Hypophthalmichthys molitrix)* fillets soaked in different solutions (salt with spices (S.S.), salt with spices and acetic acid (S.S.+A.A.), salt and spices with tomato sauce (S.S.+T.) and solution of their mixture (S.S.+ A.A.+T.).

Parameter		**Moisture%**				**Protein%**			
Packaging solution		**Control S.S.**	**S.S. + A.A.**	**S.S.+T.**	**S.S+ A.A.+T**	**Control S.S.**	**S.S.+ A.A.**	**S.S.+T.**	**S.S+ A.A.+T**
Storage period (days)	**0**	**75.20± 0.5 ^{a}**	**75.20± 0.6 ^{a}**	**75.20± 0.7 ^{a}**	**75.20± 0.6 ^{a}**	**71.63± 0.6 ^{a}**	**71.63± 0.7 ^{a}**	**71.63± 0.5 ^{a}**	**71.63± 0.6 ^{a}**
	2	**76.00± 0.5 ^{a}**	**75.49± 0.5 ^{ab}**	**75.61± 0.6 ^{a}**	**75.36± 0.5 ^{ab}**	**71.27± 0.5 ^{a}**	**71.30± 0.6 ^{a}**	**71.23± 0.6 ^{a}**	**71.50± 0.6 ^{a}**
	4	**76.75± 0.7 ^{a}**	**75.95± 0.5 ^{ab}**	**76.21± 0.5 ^{a}**	**75.66± 0.6 ^{ab}**	**70.78± 0.7 ^{ab}**	**71.00± 0.5 ^{a}**	**70.80± 0.7 ^{ab}**	**71.34± 0.6 ^{a}**
	6	**77.56± 0.6 ^{a}**	**76.45± 0.7 ^{ab}**	**76.86± 0.6 ^{ab}**	**76.18± 0.5 ^{b}**	**70.25± 0.7 ^{b}**	**70.68± 0.7 ^{ab}**	**70.40± 0.5 ^{ab}**	**71.13± 0.5 a**
	8	**78.40± 0.5 ^{a}**	**77.00± 0.6 ^{b}**	**77.51± 0.5 ^{ab}**	**76.33± 0.7 ^{bc}**	**69.83± 0.5 ^{b}**	**70.35± 0.7 ^{ab}**	**70.02± 0.7 ^{ab}**	**70.90± 0.7 ^{a}**
	10	**79.29± 0.7 ^{a}**	**77.54± 0.5 ^{b}**	**78.22± 0.7 ^{ab}**	**76.80± 0.6 ^{bc}**	**69.40± 0.6 ^{bc}**	**69.71± 0.5 ^{ab}**	**69.71± 0.7 ^{b}**	**70.67± 0.5 ^{a}**
	12	**80.32± 0.5 ^{a}**	**78.19± 0.6 b**	**79.11± 0.7 ^{ab}**	**77.36± 0.5 ^{bc}**	**69.07± 0.5 ^{bc}**	**69.86± 0.5 ^{ab}**	**69.57± 0.7 ^{b}**	**70.55± 0.5 ^{a}**

$^{a-bc}$ Means within a raw with the same superscript significantly different ($P<0.05$). Values are expressed as Mean ± SD.

From these results, it could be noticed that, reduction in crude protein content may be mainly attributed to autolysis leading to formation of some soluble protein fraction, which leached out gradually to packing medium; these results are in a good agreement with those reported by El-Samkary *et. al.,* (1997) and Baltasar *et. al.*, (1998); they found that, crude protein in mackerel was deceased during storage of canned samples at room temperature.

The abovementioned changes might be due to uptake of the salt solution into the fish fillets during cold storage period which led to increase water retention by the fish muscles, denaturation of proteins and oxidation of fat. These results are in agreement with those reported by Arannilewa *et al.* (2005).

The increment in moisture and the decrement in protein contents in all samples which stored at 4±1 °C for up to 12 days could be attributed to the effect of salt in fish tissue which leads to accelerating the rate of diffused moisture up take. These results are in agreement with those obtained by Srikar *et al.* (1993) and Periago *et al.* (2003).

Regarding fat and ash contents of silver carp *(Hypophthalmichthys molitrix*) fillets soaked in different solution during storage period are presented in Table 2. The data indicated significantly a gradual decrease ($P<0.05$) in fat and increase in ash contents in all samples up to the end of storage period; especially fillets which socked in (salt solution 5%) with spices. Moreover the decrement in fat during storage may be due to the activity of microorganisms, and the increment in ash during storage may be due to the increment in salt content. These results are in harmony with those obtained by Srikar *et al.* (1993) and Periago *et al.* (2003).

Table 2. Effect of storage period for 12 days at 4±1°C on fat and ash contents (%) of silver carp *(Hypophthalmichthys molitrix)* fillets soaked in different solutions (salt with spices (S.S), salt with spices and acetic acid (S.S.+A.A.), salt and spices with tomato sauce (S.S.+T.) and solution of their mixture (S.S.+ A.A.+ T.).

Parameter		Fat%				Ash%			
Packaging solution		Control S.S.	S.S. + A.A.	S.S.+T.	S.S+ A.A.+T	Control S.S.	S.S.+ A.A.	S.S.+T.	S.S+ A.A.+T
Storage period (days)	0	17.92± 0.06 ^{a}	17.92± 0.08 ^{a}	17.92 0.06 ^{a}	17.92± 0.05 ^{a}	10.45± 0.04 ^{a}	10.45± 0.03 ^{a}	10.45 0.02 ^{a}	10.45± 0.05 ^{a}
	2	17.69± 0.07 ^{a}	17.73± 0.05 ^{a}	17.70 0.05 ^{a}	17.78± 0.06 ^{a}	11.04± 0.03 ^{a}	10.97± 0.04 ^{ab}	11.07± 0.05 ^{a}	10.72± 0.04 ^{a}
	4	17.42± 0.08 ^{ab}	17.53± 0.06 ^{a}	17.46± 0.08 ^{ab}	17.63± 0.07 ^{a}	11.80± 0.05 ^{a}	11.47± 0.03 ^{ab}	11.47± 0.03 ^{ab}	11.03± 0.03 ^{b}
	6	17.12± 0.05 ^{ab}	17.30± 0.07 ^{ab}	17.20± 0.07 ^{ab}	17.47± 0.05 ^{a}	12.63± 0.03 ^{a}	12.02± 0.05 ^{b}	12.40± 0.04 ^{b}	11.40± 0.05 ^{b}
	8	16.78± 0.06 ^{b}	17.07± 0.07 ^{ab}	16.92± 0.07 ^{b}	17.30± 0.06 ^{a}	13.39± 0.05 ^{a}	12.58± 0.03 ^{b}	13.00± 0.05 ^{ab}	11.79± 0.03 ^{c}
	10	16.39± 0.07 ^{b}	16.84± 0.05 ^{ab}	16.60± 0.06 ^{b}	17.11± 0.07 ^{a}	14.21± 0.04 ^{a}	13.06± 0.03 ^{b}	13.69± 0.04 ^{b}	12.22± 0.04 ^{c}
	12	15.94± 0.05 ^{c}	16.52± 0.06 ^{ab}	16.24± 0.06 ^{b}	16.90± 0.08 ^{a}	14.90± 0.05 ^{a}	13.62± 0.05 ^{c}	14.19± 0.04 ^{b}	12.55± 0.03 ^{d}

$^{a-d}$ Means within a raw with the same superscript significantly different (P<0.05). Values are expressed as Mean ± SD.

Results presented in Table 3 showed the effect of storage period at 4±1ºC for 12 days on pH and salt values of silver carp *(Hypophthalmichthys molitrix)* fillets soaked in different solutions. The analysis of variance for pH-values during storage period, showed slight significantly decrease (P<0.05) and increment in salt contents. Decreasing of pH-values could be attributed to the decomposition of fillets by microorganisms and the attack of rigor mortis which led to the breakdown

of glycogen and formation of lactic acid or due to protein denaturation, formation of amino nitrogen and free fatty acids which were produced in different amounts during the storage period. These results are in an agreement with these reported by Marshall and Jindal (1997).

Table 3. Effect of storage period for 12 days at 4±1°C on pH and salt contents (%) of silver carp *(Hypophthalmichthys molitrix)* fillets soaked in different solutions (salt with spices (S.S), salt with spices and acetic acid (S.S.+A.A.), salt and spices with tomato sauce (S.S.+T.) and solution of their mixture (S.S.+ A.A.+T.).

Parameter		**pH-value**				**Salt content%**			
Packaging solution		**Control S.S.**	**S.S. + A.A.**	**S.S.+T.**	**S.S+ A.A.+T**	**Control S.S.**	**S.S.+ A.A.**	**S.S.+T.**	**S.S+ A.A.+T**
Storage period (days)	**0**	**6.60± 0.01 [a]**	**6.49± 0.02 [a]**	**6.66± 0.03 [a]**	**6.52± 0.02 [a]**	**0.70± 0.021[a]**	**0.70± 0.031[a]**	**0.70± 0.019[a]**	**0.70± 0.022[a]**
	2	**6.10 ± 0.02 [a]**	**6.28 ± 0.01 [a]**	**6.35 ± 0.02 [a]**	**6.44 ± 0.03 [a]**	**1.06 ± 0.015[a]**	**0.90 ± 0.023[b]**	**0.96 ± 0.018[ab]**	**0.89 ± 0.021[c]**
	4	**5.68 ± 0.01 [b]**	**6.06 ± 0.02 [ab]**	**5.97 ± 0.02 [b]**	**6.35 ± 0.03 [a]**	**1.43 ± 0.017[a]**	**1.20± 0.018[bc]**	**1.25 ± 0.017[ab]**	**1.13 ± 0.030[c]**
	6	**5.09 ± 0.01 [b]**	**5.80 ± 0.01 [b]**	**5.66 ± 0.01 [b]**	**6.24 ± 0.02 [a]**	**1.70 ± 0.020[a]**	**1.49 ± 0.022[bc]**	**1.57 ± 0.021[b]**	**1.38 ± 0.025[c]**
	8	**4.80 ± 0.02[c]**	**5.52 ± 0.02[b]**	**5.41 ± 0.01[b]**	**6.15 ± 0.01[a]**	**2.04 ± 0.020[a]**	**1.82 ± 0.021[b]**	**1.97 ± 0.022[b]**	**1.70 ± 0.019[c]**
	10	**4.59 ± 0.03[c]**	**5.49 ± 0.03[b]**	**5.30 ± 0.02[b]**	**6.10 ± 0.01[a]**	**2.31 ± 0.013[a]**	**2.00 ± 0.025[b]**	**2.18 ± 0.025[b]**	**1.96 ± 0.023[c]**
	12	**4.00 ± 0.02[c]**	**5.36 ± 0.03[b]**	**5.09 ± 0.01[bc]**	**6.02 ± 0.01[a]**	**2.69 ± 0.018[a]**	**2.36 ± 0.019[b]**	**2.50 ± 0.019[b]**	**2.19 ± 0.025[c]**

[a-c] Means within a raw with the same superscript significantly different (P<0.05). Values are expressed as Mean ± SD.

Regarding total volatile bases nitrogen (TVBN), trimethylamine nitrogen (TMAN) and thiobarbituric acid value (TBA) of silver carp *(Hypophthalmichthys molitrix)* fillets soaked in different solutions, the data

in tables 4 and 5 indicated a gradual significantly increase ($P<0.05$) in TVBN, TMAN and TBA-value contents in all samples up to the end of storage period; specially silver carp fillets soaked in (salt solution 5%) with spices. The increment in TVBN, TMAN and TBA-values during storage period could be resulted from the decomposition and degradation of nitrogen substances which may be due to the activity of microorganisms.

These results are in harmony with those obtained by Srikar *et al.* (1993) and Periago *et al.* (2003). Results shown in Table 5, show significant increase in TBA value up to 12 days of storage period. Respecting the thiobarbituric acid TBA value used as an index for lipid oxidation taking place in 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).

Microbiological evaluation:

The effect of storage period at 4±1 ºC for 12 days on the total bacterial count TBC (Log10 CFU/g) of silver carp *(Hypophthalmichthys molitrix)* fillets soaked in different solutions, are illustrated in Table 5. The results showed significant increase ($P<0.05$) in TBC in all samples up to 12 days of storage, however, fillets socked in salt, spices, acetic acid, and tomato sauce (S.S.+A.A.+T.) showed the lowest TBC at the beginning and throughout storage period until 12 days of storage. While fillets socked in salt and spices (S.S.) showed the highest TBC at the beginning and throughout storage period until 12 days of storage at 4±1° C.

Table 4. Effect of storage period for 12 days at 4±1°C on Total volatile bases nitrogen (TVBN) and Trimethylamine nitrogen (TMAN) (mg/100g) contents of silver carp *(Hypophthalmichthys molitrix)* fillets soaked in different solutions (salt with spices (S.S), salt with spices and acetic acid (S.S.+A.A.), salt and spices with tomato sauce (S.S.+T.) and solution of their mixture (S.S.+A.A.+T).

Parameter		Total volatile bases nitrogen (TVBN) (mg/100g)				Trimethylamine nitrogen (TMAN) (mg/100g)			
Packaging solution		Control S.S.	S.S. + A.A.	S.S.+T.	S.S+ A.A.+T	Control S.S.	S.S.+ A.A.	S.S.+T.	S.S+ A.A.+T
Storage period (days)	0	4.16 ± 0.03 [a]	4.16 ± 0.02 [a]	4.16 ± 0.03 [a]	4.16 ± 0.03 [a]	0.89 ± 0.02 [a]	0.89 ± 0.03 [a]	0.89 ± 0.03 [a]	0.89 ± 0.02 [a]
	2	14.80± 0.21 [a]	10.77± 0.23 [c]	12.07± 0.22[b]	8.96 ± 0.22 [d]	7.09 ± 0.18 [a]	3.68 ± 0.15 [c]	5.03 ± 0.16 [b]	3.27 ± 0.17 [c]
	4	25.26± 0.32 [a]	16.35± 0.33 [c]	20.01± 0.35 [b]	13.76± 0.30 [d]	13.18± 0.17 [a]	7.06± 0.19 [c]	10.12± 0.18 [b]	5.79± 0.19 [d]
	6	36.10± 0.51 [a]	23.47± 0.51 [c]	27.96± 0.52 [b]	18.26± 0.49 [d]	19.50± 0.22 [a]	11.38± 0.23 [c]	15.59± 0.20 [b]	8.39± 0.18 [d]
	8	44.46± 0.55 [a]	29.80± 0.57 [c]	35.82± 0.57 [b]	23.18± 0.59 [d]	23.80± 0.33 [a]	15.60± 0.35 [c]	18.75± 0.31 [b]	11.09± 0.32 [d]
	10	52.97± 0.61 [a]	37.22± 0.65 [c]	42.81± 0.59 [b]	27.66± 0.61 [d]	28.00± 0.31 [a]	20.09± 0.33 [c]	24.05± 0.37 [b]	13.80± 0.31 [d]
	12	61.20± 0.59 [a]	45.50± 0.55 [c]	50.02± 0.61 [b]	32.71± 0.58 [d]	36.70± 0.39 [a]	25.00± 0.41 [c]	30.85± 0.38 [b]	16.85± 0.42 [d]

[a-d] Means within a raw with the same superscript significantly different (P<0.05). Values are expressed as Mean ± SD.

Table 5. Effect of storage period for 12 days at 4±1°C on thiobarbituric acid value (TBA) (mg. malonldehyde / Kg.) and total bacterial count (TBC) (Log10 CFU/g) contents of silver carp *(Hypophthalmichthys molitrix)* fillets soaked in different solutions (salt with spices (S.S), salt with spices and acetic acid (S.S.+A.A.), salt and spices with tomato sauce (S.S.+T.) and solution of their mixture (S.S.+ A.A.+T).

Parameter		Thiobarbituric acid values (TBA) (mg. malonldehyde / Kg.)				Total bacterial count (TBC) (Log10 CFU/g)			
Packaging solution		Control S.S.	S.S. + A.A.	S.S.+T.	S.S+ A.A.+T	Control S.S.	S.S.+ A.A.	S.S.+T.	S.S+ A.A.+T
Storage period (days)	0	0.31 ± 0.012^{a}	0.31 ± 0.013^{a}	0.31 ± 0.012 ^{a}	0.31 ± 0.011^{a}	3.25 ± 0.03 ^{a}	2.90 ± 0.04 ^{b}	3.02 ± 0.03 ^{ab}	2.79 ± 0.03 ^{b}
	2	1.05 ± 0.015 ^{a}	0.76 ± 0.017^{c}	0.88 ± 0.015^{b}	0.55 ± 0.014^{d}	4.26 ± 0.05 ^{a}	3.51 ± 0.04 ^{bc}	3.89 ± 0.05 ^{b}	3.28 ± 0.05 ^{c}
	4	2.02 ± 0.033 ^{a}	1.14 ± 0.032^{c}	1.58 ± 0.035^{b}	0.81 ± 0.035^{d}	5.55 ± 0.06 ^{a}	4.16 ± 0.05 ^{c}	4.86 ± 0.05 ^{b}	3.78 ± 0.07 ^{d}
	6	2.29 ± 0.029 ^{a}	1.59 ± 0.025^{c}	1.99 ± 0.027 ^{b}	1.04 ± 0.021 ^{d}	6.90 ± 0.07 ^{a}	4.83 ± .06 ^{c}	5.57 ± .06 ^{b}	4.29 ± 0.05 ^{d}
	8	3.00 ± 0.025 ^{a}	2.19 ± 0.021^{c}	2.46 ± 0.031^{b}	1.29 ± 0.018^{d}	8.53 ± 0.05 ^{a}	5.54 ± 0.07 ^{c}	6.46 ± 0.07 ^{b}	4.80 ± 0.04 ^{d}
	10	3.81 ± 0.031^{a}	2.58 ± 0.030^{c}	3.20 ± 0.025^{b}	1.58 ± 0.015 ^{d}	9.07 ± 0.07 ^{a}	6.28 ± 0.05 ^{c}	7.37 ± 0.05 ^{b}	5.38 ± 0.06 ^{d}
	12	5.79 ± 0.026^{a}	3.29 ± 0.028^{c}	4.45 ± 0.032^{b}	2.10 ± 0.029 ^{d}	9.83 ± 0.06 ^{a}	7.80 ± 0.07 ^{c}	8.31 ± 0.06 ^{b}	6.09 ± 0.05 ^{d}

$^{a-d}$ Means within a raw with the same superscript significantly different (P<0.05). Values are expressed as Mean ± SD.

On the other hand, changes in halophilic bacterial count (HBC) and psychrophilic bacterial count (PsBC) (Log10 CFU/g) during storage period at 4±1 ºC for 12 days of silver carp *(Hypophthalmichthys molitrix)* fillets soaked in different solutions, are illustrated in Table 6.

Table 6. Effect of storage period for 12 days at 4±1°C on Psychrophilic and Halophilic bacterial count (Log10 CFU/g) contents of silver carp *(Hypophthalmichthys molitrix)* fillets soaked in different solutions (salt with spices (S.S), salt with spices and acetic acid (S.S.+A.A.), salt and spices with tomato sauce (S.S.+T.) and solution of their mixture (S.S.+A.A.+T.).

Parameter		Psychrophilic bacterial count (Log10 CFU/g)				Halophilic bacterial count (Log10 CFU/g)			
Packaging solution		Control S.S.	S.S. + A.A.	S.S.+T.	S.S+ A.A.+T	Control S.S.	S.S.+ A.A.	S.S.+T.	S.S+ A.A.+T
Storage period (days)	0	1.63 ± 0.017^{a}	1.45 ± 0.15 ^{a}	1.51 ± 0.016^{a}	1.39 ± 0.015^{ab}	1.36 ± 0.021 ^{a}	1.21 ± 0.022 ^{a}	1.27 ± 0.021^{a}	1.17 ± 0.020^{ab}
	2	2.13 ± 0.018^{a}	1.76 ± 0.17 ^{b}	195 ± 0.018^{ab}	1.46 ± 0.016^{bc}	1.78 ± 0.022^{a}	1.46 ± 0.020^{ab}	1.65 ± 0.020 ^{a}	1.37 ± 0.021^{b}
	4	2.78 ± 0.017 ^{a}	2.08 ± .020^{bc}	2.43 ± 0.020^{b}	1.89 ± 0.019 ^{c}	2.34 ± 0.025 ^{a}	1.74 ± 0.026^{b}	2.04 ± 0.025^{a}	1.59 ± 0.027^{bc}
	6	3.45 ± 0.021^{a}	2.42 ± 0.019 ^{c}	2.94 ± 0.021^{b}	2.15 ± 0.018 ^{c}	2.87 ± 0.023 ^{a}	2.01 ± 0.023 ^{b}	2.47 ± 0.027^{ab}	1.79 ± 0.021^{c}
	8	4.28 ± 0.025 ^{a}	2.79 ± 0.021^{c}	3.23 ± 0.022^{b}	2.41 ± 0.025^{d}	3.59 ± 0.027^{a}	2.33 ± 0.027^{c}	2.71 ± 0.025^{b}	2.01 ± 0.026^{cd}
	10	4.54 ± 0.030^{a}	3.15 ± 0.029 ^{c}	3.69 ± 0.025 ^{b}	2.69 ± 0.028 ^{d}	3.80 ± 0.026^{a}	2.63 ± 0.024^{c}	3.10 ± 0.023 ^{b}	2.24 ± 0.025^{cd}
	12	4.92 ± 0.029^{a}	3.90 ± 0.031 ^{c}	4.16 ± 0.032 ^{b}	3.05 ± 0.030 ^{d}	4.12 ± 0.031 ^{a}	3.28 ± 0.030 ^{c}	3.49 ± 0.025 ^{b}	2.55 ± 0.029^{c}

$^{a-d}$ Means within a raw with the same superscript significantly different (P<0.05). Values are expressed as Mean ± SD.

The fillets socked in salt, spices, acetic acid, and tomato sauce (S.S.+A.A.+T.) showed the lowest number of (HBC) and (PsBC) at the beginning and throughout storage period until 12 days of storage, while fillets socked in salt and spices (S.S.) showed the highest number of (HBC) and (PsBC) at the beginning and throughout storage period until

12 days. The foregoing results are coincidence in with those reported by Setty *et al.* (1996), Periago *et al.* (2003) and Eklund *et al.* (2004). Moreover, the increase in HBC may be due to the water activity was more suitable for growth of the most halophilic bacteria, also the growth of halophilic bacteria might have been further favored by the high salt concentrations in the products. These results are in agreement with those reported by Marshall and Jindal (1997).

Organoleptic changes:

The sensory scores of appearance and flavor of silver carp *(Hypophthalmichthys molitrix)* fillets soaked in different solutions, are illustrated in Table 7. The appearance and flavor scores decreased significantly ($P<0.05$) with prolonging the storage period.

The gradual decrease in appearance and flavor 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 results are in agreement with those obtained by Srikar *et al.* (1993).

The abovemention results recommended that the fillets soaked in salt, spices, acetic acid, and tomato sauce (S.S.+A.A.+T.) can be stored for 12 days with lowest changes of its characteristics during storage at 4±1 ºC compared with the other treatments.

Table 7. Effect of storage period for 12 days at 4 ±1°C on flavor and appearance of silver carp *(Hypophthalmichthys molitrix)* fillets soaked in different solutions (salt with spices (S.S), salt with spices and acetic acid (S.S.+A.A.), salt and spices with tomato sauce (S.S.+T.) and solution of their mixture (S.S.+ A.A.+T.).

Parameter		Flavor				Appearance			
Packaging solution		Control S.S.	S.S. + A.A.	S.S.+T.	S.S+ A.A.+T	Control S.S.	S.S.+ A.A.	S.S.+T.	S.S+ A.A.+T
Storage period (Days)	0	8.8 ± 0.05 ^{a}	8.8 ± 0.06 ^{a}	8.8 ± 0.05 ^{a}	9.0 ± 0.05 ^{a}	9.0 ± 0.06 ^{a}	9.0 ± 0.05 ^{a}	9.0 ± 0.07 ^{a}	9.2 ± 0.05 ^{a}
	2	7.8 ± 0.04 ^{b}	8.1 ± 0.05 ^{a}	7.8 ± 0.06 ^{b}	8.3 ± 0.06 ^{a}	8.0 ± 0.05 ^{ab}	8.3 ± 0.06 ^{a}	8.0 ± 0.05 ^{ab}	8.5 ± 0.07 ^{a}
	4	7.1 ± 0.5 ^{b}	7.8 ± 0.04 ^{a}	7.3 ± 0.03 ^{b}	7.8 ± 0.05 ^{a}	7.3 ± 0.04 ^{b}	8.0 ± 0.05 ^{a}	7.5 ± 0.07 ^{b}	8.0 ± 0.05 ^{a}
	6	5.0 ± 0.03 ^{d}	6.8 ± 0.5 ^{b}	6.3 ± 0.06 ^{c}	7.6 ± 0.03 ^{a}	5.2 ± 0.03 ^{d}	7.0 ± 0.04 ^{b}	6.5 ± 0.06 ^{c}	7.8 ± 0.04 ^{a}
	8	3.8 ± 0.04 ^{c}	6.2 ± 0.03 ^{ab}	5.6 ± 0.05 ^{b}	6.5 ± 0.04 ^{a}	4.0 ± 0.04 ^{c}	6.4 ± 0.04 ^{a}	5.8 ± 0.05 ^{b}	6.7 ± 0.05 ^{a}
	10	3.3 ± 0.03 ^{d}	5.1 ± 0.02 ^{b}	4.5 ± 0.03 ^{c}	6.0 ± 0.02 ^{a}	3.5 ± 0.05 ^{d}	5.3 ± 0.04 ^{b}	4.7 ± 0.03 ^{c}	6.2 ± 0.03 ^{a}
	12	3.1 ± 0.02 ^{d}	4.5 ± 0.02 ^{b}	3.4 ± 0.03 ^{c}	5.3 ± 0.02 ^{a}	3.0 ± 0.03 ^{cd}	4.7 ± 0.05 ^{b}	3.6 ± 0.02 ^{c}	5.5 ± 0.04 ^{a}

$^{a-d}$ Means within a raw with the same superscript significantly different (P<0.05). Values are expressed as Mean ± SD.

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تأثير ظروف النقع والتخزين على جودة شرائح سمك المبروك الفضى

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تم دراسة التغيرات في بعض الخواص الفيزيائية والكيميائية والميكروبيولوجية والحسية لشرائح سمك المبروك الفضى المنقوعة فى محاليل مختلفة (محلول ملحى مع توابل، محلول ملحى مع توابل مضاف اليه حمض خليك بنسبة ٢%، صلصة طماطم مع ملح وتوابل، صلصة طماطم مع ملح وتوابل وحمض خليك بنسبة ٢%) خلال التخزين بالتبريد لمدة ١٢ يوم على درجة حرارة ٤±١°م.

أوضحت النتائج حدوث انخفاض تدريجى فى كل من المحتوى البروتينى والدهن وقيم الـpH وقيم التقييم الحسى، بينما لوحظ ارتفاع تدريجى فى محتوى الشرائح من الرطوبة والرماد والملح لكل المعاملات خلال التخزين بالتبريد على درجة حرارة ٤±١°م. كما أشارت النتائج إلى حدوث ارتفاع تدريجى فى قيم القواعد النيتروجينية الطيارة وثلاثي ميثيل الأمين وحمض الثيوباربتيوريك، وكذلك ارتفاع مستوى كل من العدد الكلى للبكتريا والبكتريا المحبة للبرودة والبكتريا المحبة للملوحة لجميع المعاملات خلال فترة التخزين بالتبريد. وكانت هذه النتائج مطابقة للانخفاض التدريجى فى التقييم الحسى (المظهر العام، الرائحة) لجميع العينات خلال فترة التخزين بالتبريد على درجة حرارة ٤±١°م.

أشارت النتائج إلى أن أقل مستوى للتغير فى الخواص سالفة الذكر كانت في شرائح سمك المبروك الفضى المنقوعة فى صلصة طماطم مع ملح وتوابل وحمض خليك بنسبة ٢% مقارنة بالمعاملات الأخرى. وعلى ذلك فإن غمر شرائح سمك المبروك الفضى فى صلصة طماطم مع ملح وتوابل وحمض خليك بنسبة ٢% مع التخزين بالتبريد على درجة حرارة ٤±١°م أدى إلى المحافظة على فترة صلاحية تلك الشرائح.