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GENERAL INFORMATION

Abbassa International Journal for Aquaculture is Egyptian specific publication in aquaculture of the Egyptian society for water, aquaculture and environment. The journal is published in four volumes per year to include results of research in different aspects of aquaculture sciences. The journal publishes also special issues of advanced topics that reflect applied experiences of importance in aquaculture sector.

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EFFECT OF SODIUM ACETATE AND SODIUM CITRATE ON SOME QUALITY PROPERTIES OF GRASS CARP FILLETS DURING CHILLING STORAGE

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Abstract

The effects of sodium acetate, sodium citrate and their mixture on some chemical, bacteriological and organoleptic characteristics of grass carp fillets (*Ctenopharyngodon idella*) were studied. Fillets were dipped for 30 min in 1, 2 and 3% of each solution at room temperature (20°C) then drained for 3 min and stored at (4±1°C) for 18 days.

The results indicated that using concentration the mixture (3%) of sodium acetate and sodium citrate maintained grass carp fish fillets in good condition for the longest duration since chemical, bacteriological and organoleptic evaluation was non significant changed appreciably through the whole period of cold storage compared with the control and other treatments.

INTRODUCTION

Fish and shellfish are excellent protein sources for human consumption; in addition they have a high content of hydro soluble and lip soluble vitamins, minerals and polyunsaturated fatty acids (PUFAs) of the n-3 family. Interestingly, omega-3 fatty acids, found mainly in fat-rich fish such as salmon, mackerel, herring, and sardines confer health benefits in humans not found in any other foods. Omega-3 fatty acids from fish can lower blood triglycerides, reduce abnormal heart rhythms, reduce blood pressure by small but significant amounts, and improve blood clotting regulation (Nettleton, 1995).

Studies have shown that minimally processed, vacuum-packaged and refrigerated seafood products have become more popular as they have improved quality and prolonged shelf-life. Microbial growth reduces fresh seafood quality and results in economic loss. Psychrotrophic bacteria are the major group of microorganisms responsible for spoilage of fresh seafood (Zhuang *et al.,* 1996). Fish, is more perishable than chicken or red meat as it contains relatively large quantities of free amino acids and volatile nitrogen bases. (Ashie *et al.,* 1996). Enzymatic and chemical reactions are usually responsible for the initial loss of freshness whereas microbial activity is responsible for the obvious spoilage and thereby establishes product shelf life (Gram and Huss, 996). The large amount of polyunsaturated fatty acid found in fish lipids makes them highly susceptible to oxidation. Oxidative rancidity is an important organoleptic characteristic for rejection or approval of fish after prolonged storage (Amanatidou *et al.,* 2000). The use of good manufacturing practices and hazard analysis of critical control point (HACCP) is crucial in the production, storage, distribution and retailing of refrigerated foods, and because of consumer demand for fresh refrigerated foods with extended shelf life, considerable research has been directed toward using various preservation strategies to preserve or prolong the shelf life, while ensuring the safety, of fresh foods including fishery products. Sodium salts of the low molecular weight organic acids; such as acetic, lactic, and citric have been used to control microbial growth, improve sensory attributes and extend the shelf life of various food systems including meat (Sallam and Samejima, 2004), and fish (Boskou and Debevere, 2000).

Greer (1982) indicated that dipping fresh beef in a 10% potassium sorbate solution inhibited growth of psychrotrophic bacteria and extended retail shelf life. Mayers *et al.* (1983) reported that spraying or dipping 5% or 10% potassium sorbate solutions, for vacuum-packaged pork roasts

stored at 5°C for 21 days, resulted in 97–99% reduction of psychrotrophic bacteria.

In addition to their suppressing effect on the growth of food spoilage bacteria, organic salts of sodium acetate, lactate, and citrate were shown to possess antibacterial activities against various food-borne pathogens including Staphylococcus aureus and Yersinia enterocolitica (Lee *et al.* 2002).

Enzymatic and chemical reactions are usually responsible for the initial loss of freshness whereas microbial activity is responsible for the obvious spoilage and thereby establishes product shelf life (Gram and Huss 1996). The large amount of polyunsaturated fatty acid found in fish lipids makes them highly susceptible to oxidation. Oxidative rancidity is an important organoleptic characteristic for rejection or approval of fish after prolonged storage (Amanatidou *et al*., 2000).

Kim *et al.* (1995) found that, the activity of monopotassium phosphate could be increased if sodium acetate was added. Sodium acetate alone or sodium acetate combined with monopotassium phosphate is recommended to extend the microbiological shelf life of refrigerated catfish fillets.

A second group of compounds that may find useful applications for treating fresh-meat surfaces are the Acetates. Kim and Hearnsberger (1994) indicated that acetates have previously been shown to inhibit gram-negative spoilage bacteria on catfish fillets at 4°C. Kim *et al.* (1995) reported that the activity of monopotassium phosphate could be increased if sodium acetate was added. Sodium acetate alone or sodium acetate combined with monopotassium phosphate is recommended to extend the microbiological shelf life of refrigerated catfish fillets.

The main objective of this study was to investigate the antimicrobial and antioxidant effects of sodium acetate, sodium citrate

and a mixture of them on some chemical, microbiological and organoleptic of grass carp fillets during chilling storage at (4±1°C) for 18 days.

MATERIALS AND METHODS

Samples and experimental design:

Grass carp (*Ctenopharyngodon idella*) fillets were immediately obtained after catching from Abbasa farm in Sharkia Governorate, Egypt. All samples of the fillets weighted 9 Kg. Treatment solutions were prepared by mixing 2 L tap water with appropriate amounts (V/W) of sodium acetate, sodium citrate and a mixture of them (El-Nasr Pharmaceutical and Chemical Company, Egypt). Fillets were allocated to the following experimental trials:

(A) 0, 1, 2 and 3% sodium acetate dip for 30 min.

(B) 0, 1, 2 and 3% sodium citrate dip for 30 min.

(C) 0, 1, 2 and 3% combinations of sodium acetate and sodium citrate (1:1 – W/W) dip for 30 min. Fish fillets were submerged in each solution at room temperature (20±1°C) for required times then drained on sanitized stainless-steel grill for 3 min. at room temperature. Control fillets were dipped in 2L. tap water for 30 min and drained for 3 min. at room temperature. After dipping and drainage fillets were placed individually in polyethylene bags, stored at 4±1°C and periodically removed for analyses at 0, 3, 6, 9, 12, 15 and 18 days. On each sampling occasion, three fish samples from every batch were evaluated for the chemical, microbiological and organoleptic changes.

Analytical methods:

Thiobarbituric acid value (TBA) was estimated as described by Tarladgis *et al.* (1960). Total volatile bases nitrogen (TVB-N) was determined in flesh by the method of Kjeldahl described by Furuichi *et al.* (1997), and trimethylamine nitrogen (TMAN) analysis was carried out

according to the method described by (AOAC, 2000). Total bacterial count (TBC) and psychrophilic bacterial count (PsBC): were detected according to the method described by Swanson *et al.* (1992). Sensory evaluation: Samples were organoleptically evaluated for appearance of refrigerated grass carp fillets during storage at (4±1°C) for 18 days 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

Chemical changes:

Thiobarbituric acid (TBA) is an index of lipid oxidation. Fish samples with TBA-values more than 2 will probably smell and taste rancid (Bonnell, 1994). According to Connell (1990), TBA values of 1–2 mg. malonaldhyde/ kg of fish flesh are usually regarded as the limit beyond which fish will normally develop an objectionable odour. Data listed in Table 1 show the changes in Thiobarbituric acid (mg. malonaldhyde/ Kg.). of grass carp fillets treated with different percentages 0, 1, 2 and 3% of Sodium acetate and Sodium citrate and mixture of them (sodium acetate + sodium citrate 1:1) during storage at 4±1°C. Results revealed an increase in Thiobarbituric acid content in all treated samples till the end of storage period and significantly difference ($P<0.05$) between the different treatments. Thiobarbituric acid content in control sample showed an increase from 0.13 to 8.80 mg. malonaldhyde/ Kg. following 18 days of storage period. Minimum increase in Thiobarbituric acid content was observed in samples treated with 3% mixture of sodium (acetate + citrate 1:1) respectively, as Thiobarbituric acid content were 0.13 (mg. malonaldhyde/ Kg.) at the beginning of

storage period and reached to 3.89, 2.71 and 2.00 (mg. malonaldhyde/ Kg.) at the end of 18 days of storage at 4±1°C. The results of TBA values of the present work suggesting that Sodium citrate has a potent antioxidant effect more than Sodium acetate. The increment in TBA presumably resulted from the concentration of pigments in fish fillets which can act as proxidant. These results are in agreement with those reported by Khuntia *et al.* (1993).

TABLE 1. Changes in Thiobarbituric acid (mg. malonaldhyde / Kg.). of grass carp fillets treated with different percentages of sodium acetate, sodium citrate and their mixture (sodium acetate+ citrate 1:1) during storage at 4±1 ºC.

Treatments		Control	Sodium acetate			Sodium citrate			Sodium (acetate + citrate 1:1)		
		0%	1%	2%	3%	1%	2%	3%	1%	2%	3%
Storage Period (Days)	0	0.13± 0.003^{a}	0.13± 0.002^{a}	0.13± 0.002^{a}	0.13± 0.001^{a}	0.13± 0.002^{a}	0.13± 0.002^{a}	0.13± 0.001^{a}	0.13± 0.003^{a}	0.13± 0.001^{a}	0.13± 0.002^{a}
	3	1.40± 0.02^{a}	0.99± 0.03^{ab}	0.86± 0.02^{b}	0.65± 0.01^{bc}	0.96± 0.03^{ab}	0.75± 0.01^{b}	0.59± 0.01^{bc}	0.84± 0.02^{b}	0.68± 0.02^{bc}	0.46± 0.01^{c}
	6	2.11± 0.03^{a}	2.09± 0.03^{ab}	1.49± 0.02^{b}	1.20± 0.02^{bc}	1.41± 0.02^{b}	1.15± 0.02^{bc}	0.99± 0.03^{c}	1.26± 0.03^{b}	1.07± 0.02^{bc}	0.85± 0.03^{c}
	9	3.45± 0.04^{a}	2.79± 0.04^{ab}	2.10± 0.02^{b}	1.74± 0.03^{bc}	2.03± 0.03^{ab}	1.60± 0.02^{b}	1.23± 0.03^{bc}	1.67± 0.04^{b}	1.16± 0.02^{bc}	1.00± 0.01^{c}
	12	5.62± 0.05^{a}	3.49± 0.05^{b}	2.89± 0.03^{bc}	2.01± 0.03^{c}	2.88± 0.04^{bc}	2.11± 0.03^{c}	1.50± 0.02^{cd}	2.04± 0.03^{c}	1.36± 0.03^{cd}	1.29± 0.02^{d}
	15	7.41± 0.05^{a}	4.28± 0.04^{b}	3.90± 0.03^{bc}	3.34± 0.03^{c}	3.76± 0.03^{bc}	2.39± 0.03^{c}	2.01± 0.02^{cd}	2.71± 0.02^{c}	2.03± 0.02cd	1.72± 0.01^{d}
	18	8.81± 0.08^{a}	6.40± 0.06^{b}	5.06± 0.05^{c}	4.68± 0.04^{cd}	4.00± 0.04^{cd}	3.27± 0.03^{d}	2.95± 0.02^{de}	3.89± 0.03^{d}	2.71± 0.03^{de}	2.00± 0.02^{e}

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

Total volatile bases nitrogen (TVBN):

Results presented in Table 2 indicated that the formation of total volatile bases nitrogen TVBN (mg./ 100g) were affected by all treatments. During cold storage for 18 days TVBN values started with 9.20 (mg/100g) at zero time, then reached to 59.4; 54.9, 50.1 and 49.7; 52.6, 46.7 and 41.1 and 36.4, 33.1 and 30.0 (mg/100g) after 18 days of

cold storage for samples of grass carp fillets treated with 0, 1, 2 and 3% of Sodium acetate and Sodium citrate and mixture of them (Sodium acetate + Sodium citrate 1:1) during storage at 4±1ºC, respectively. The lowest values of TVBN were observed in samples treated with mixture of (sodium (acetate + citrate 1:1), while maximum TVBN were found in control samples followed by samples treated with 1 and 2% Sodium acetate and Sodium citrate and mixture of them solution. The increment in TVBN during cold storage could be explained due to the decomposition and degradation of nitrogenous compounds as a result of microbial action. These findings are in line with those obtained by Khuntia *et al.* (1993).

TABLE 2. Changes in Total volatile bases nitrogen (mg/100g.) of grass carp fillets treated with different percentages of sodium acetate, sodium citrate and their mixture (sodium acetate+ citrate 1:1) during storage at 4±1 ºC.

Treatments		Control	Sodium acetate			Sodium citrate			Sodium (acetate+ citrate 1:1)		
		0%	1%	2%	3%	1%	2%	3%	1%	2%	3%
Storage Period (Days)	0	9.20± 0.02^{a}	9.20± 0.02^{a}	9.20± 0.03^{a}	9.20± 0.02^{a}	9.20± 0.03^{a}	9.20± 0.03^{a}	9.20± 0.02^{a}	9.20± 0.03^{a}	9.20± 0.02^{a}	9.20± 0.02^{a}
	3	21.3± 0.3^{a}	18.4± 0.2^{b}	16.9± 0.2^{bc}	14.6± 003^{c}	16.4± 0.2^{bc}	14.8± 0.2^{c}	13.5± 0.3^{cd}	14.7± 0.3^{c}	13.2± 0.3^{cd}	12.7± 0.3^{d}
	6	31.3± 0.4^{a}	30.2± 0.2^{ab}	23.7± 0.3^{b}	17.8± 0.2^{c}	23.0± 0.4^{b}	20.4± 0.3^{c}	16.9± 0.2^{d}	19.9± 0.3^{c}	17.6± 0.2^{cd}	16.0± 0.2^{d}
	9	38.1± 0.4^{a}	35.5± 0.4^{b}	30.9± 0.4^{c}	23.2± 0.3^{d}	30.0± 0.2^{c}	25.0± 0.4^{d}	22.7± 0.3^{de}	24.8± 0.3^{d}	21.5± 0.4^{de}	21.4± 0.2^{e}
	12	45.3± 0.5^{a}	41.7± 0.5^{b}	35.0± 0.4^{c}	30.0± 0.4^{d}	36.2± 0.4^{c}	30.5± 0.4^{d}	26.0± 0.3^{e}	30.1± 0.4^{d}	25.8± 0.3^{de}	24.5± 0.3^{e}
	15	52.6± 0.6^{a}	47.4± 0.5^{b}	43.5± 0.5^{c}	38.6± 0.4^{d}	46.4± 0.5^{c}	37.5± 0.4^{d}	30.1± 0.4^{e}	33.3± 0.4^{de}	30.2± 0.4^{e}	27.0± 0.3^{f}
	18	59.4± 0.6^{a}	54.9± 0.6^{b}	50.1± 0.6^{c}	49.7± 0.5^{cd}	52.6± 0.6^{c}	46.7± 0.5^{d}	41.1± 0.5^{de}	36.4± 0.4^{e}	33.1± 0.4^{ef}	30.0± 0.4^{f}

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

TABLE 3. Changes in Trimethylamine nitrogen (mg/100g) of grass carp fillets treated with different percentages of sodium acetate, sodium citrate and their mixture (sodium acetate+ citrate 1:1) during storage at 4±1 ºC.

Treatments		Control	Sodium acetate			Sodium citrate			Sodium (acetate + citrate 1:1)		
		0%	1%	2%	3%	1%	2%	3%	1%	2%	3%
Storage Period (Days)	0	1.05± 0.0^{a}	1.05± 0.01^{a}	1.05± 0.01^{a}	1.05± 0.02^{a}	1.05± 0.02^{a}	1.05± 0.01^{a}	1.05± 0.01^{a}	1.05± 0.01^{a}	1.05± 0.02^{a}	1.05± 0.02^{a}
	3	8.47± 0.07a	6.67± 0.06^{ab}	5.97± 0.05^{b}	4.37± 0.05^{bc}	5.87± 0.05^{b}	4.50± 0.04^{bc}	3.65± 0.04^{c}	4.36± 0.05^{bc}	3.75± 0.04^{c}	3.11± 0.04^{cd}
	6	16.1± 0.12^{a}	16.1± 0.08^{ab}	9.21± 0.10^{b}	7.60± 0.11^{bc}	11.9± 0.21^{ab}	8.93± 0.22^{b}	6.20± 0.13^{bc}	7.30± 0.12^{b}	6.44± 0.21^{bc}	5.73± 0.20^{c}
	9	19.80± 0.15^{a}	18.0± 0.11^{ab}	16.5± 0.10^{b}	11.0± 0.09^{c}	16.0± 0.11^{b}	12.3± 0.10^{c}	8.86± 0.08^{d}	10.5± 0.10^{cd}	9.15± 0.09^{d}	7.84± 0.08^{de}
	12	22.50± 0.22^{a}	20.6± 0.20^{b}	18.0± 0.19^{c}	16.2± 0.17^{d}	18.2± 0.18^{c}	16.8± 0.17^{d}	11.5± 0.11^{e}	16.0± 0.16^{d}	12.8± 0.11^{e}	9.93± 0.10^{f}
	15	25.33± 0.24^{a}	23.1± 0.22^{b}	20.4± 0.19^{c}	18.4± 0.17^{d}	20.5± 0.19^{c}	18.7± 0.18^{d}	16.1± 0.15^{e}	18.8± 0.18^{d}	16.1± 0.17^{e}	12.9± 0.13^{f}
	18	28.32± 0.27^{a}	25.8± 0.24^{b}	23.2± 0.22^{c}	21.7± 0.20^{d}	22.9± 0.21^{c}	21.7± 0.20^{d}	19.3± 0.19^{e}	21.1± 0.20^{d}	19.1± 0.19^{e}	16.0± 0.17^{f}

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

Data illustrated in Table 3, represent the effect of storage at 4±1ºC for 18 days on Trimethylamine nitrogen TMAN (mg/100g) of grass carp fillets treated with different percentages 0, 1, 2 and 3% of sodium acetate and sodium citrate and mixture of them (sodium acetate + sodium citrate 1:1) during storage at 4±1°C. Results revealed an increase in Trimethylamine nitrogen content in all treated samples till the end of storage period and significantly difference ($P<0.05$) between the different treatments Moreover, the lowest levels of The TMAN values recorded 21.10, 19.13 and 16.00 mg. N/100 gm. for samples treated with mixture of (sodium acetate + sodium citrate 1:1) respectively, These results coincide with those given by Connel (1990) who reported that, the content of total volatile bases is useful for estimating the freshness of Lean fish and suggested 30-40 mg./100 gm. and 60 mg./100 gm. (on fresh weight basis) as the upper limit for fresh-water fish and marine fish,

respectively. Also, Maga (1978) reported that perfectly fresh fish had 3.37 mg./100 gm. of TMA, good grade fish showed 3.79-5.90 mg./100 gm., fair fish had 12.65-16.02 mg./100 gm. while spoiled fish contained as high as 59.01 mg./100 gm. This level was not obtained up to the end of storage period of all treatments.

Bacteriological changes:

Results presented in Table 4 indicate that, gradually increase in total bacterial count (Log_{10} CFU/g) and significantly different ($P<0.05$) between the different treatments of silver carp fillets during storage at 4±1°C were observed. Maximum TBC was observed in control samples followed by the fish fillets treated with 1 and 2% of sodium acetate, sodium citrate and mixture of them (sodium acetate + sodium citrate 1:1), respectively. These numbers were the highest after 18 days of storage at 4±1°C. It did not exceed the maximal permissible limit of 7.0 log_{10} CFU/g for the bacterial count in fish, treated with 3% mixture of (sodium acetate + sodium citrate 1:1), while the TBC of control and samples treated with 1 and 2% of sodium acetate and sodium citrate solutions reached about 7.1 log_{10} CFU/g in the 6, 9, 12 and 15 day during storage at 4±1ºC. The result of the contrast indicated that 3% mixture of (sodium acetate + sodium citrate 1:1), was equally effective for extending during storage at 4±1ºC life of the fish sample to 18 days compared with 0, 1 and 2% sodium acetate, sodium citrate solutions and mixture of (sodium acetate + sodium citrate 1:1).). Dipping of grass carp fillet in 3% aqueous solution of sodium acetate, sodium citrate solutions and mixture of them (sodium acetate + sodium citrate 1:1) significantly delayed the microbial growth and extended the shelf life of the product up to 6, 9, 12, 15 and 18 days, respectively.

TABLE 4. Changes in Total bacterial count. of grass carp fillets treated with different percentages of sodium acetate, sodium citrate and their mixture (sodium acetate+ citrate 1:1) during storage at 4±1 ºC.

Treatments		Control	Sodium acetate			Sodium citrate			Sodium (acetate + citrate 1:1)		
		0%	1%	2%	3%	1%	2%	3%	1%	2%	3%
Storage Period (Days)	0	3.70± 0.02^{a}	3.47± 0.02^{a}	3.67± 0.01^{a}	2.78± 0.02^{a}	3.72± 0.02^{a}	3.51± 0.02^{a}	2.61± 0.01^{a}	3.65± 0.02^{a}	3.40± 0.02^{a}	2.50± 0.01^{a}
	3	5.52± 0.03^{a}	4.89± 0.03^{ab}	4.34± 0.02^{b}	3.75± 0.01^{bc}	4.33± 0.03^{b}	4.01± 0.03^{bc}	3.31± 0.02^{c}	4.05± 0.03^{bc}	3.75± 0.02^{c}	2.90± 0.01^{cd}
	6	6.15± 0.04^{a}	6.09± 0.04^{ab}	5.15± 0.03^{b}	4.18± 0.02^{bc}	5.00± 0.03^{b}	4.53± 0.03^{bc}	3.91± 0.02^{c}	4.52± 0.03^{bc}	4.11± 0.03^{c}	3.61± 0.02^{cd}
	9	6.80± 0.04^{a}	6.50± 0.04^{ab}	6.10± 0.04^{b}	4.87± 0.04^{bc}	6.13± 0.04^{b}	5.00± 0.03^{bc}	4.45± 0.03^{c}	4.99± 0.04^{bc}	4.47± 0.04^{c}	3.93± 0.03^{cd}
	12	7.60± 0.05^{a}	7.09± 0.05^{ab}	6.52± 0.04^{b}	6.17± 0.04^{bc}	6.88± 0.05^{b}	6.17± 0.05^{bc}	5.13± 0.04^{c}	5.26± 0.04^{c}	4.84± 0.03^{cd}	4.32± 0.03^{d}
	15	8.20± 0.06^{a}	7.91± 0.05^{ab}	7.30± 0.05^{b}	6.63± 0.04^{bc}	7.50± 0.05^{b}	6.60± 0.04^{bc}	6.15± 0.04^{c}	5.85± 0.03^{c}	5.30± 0.04^{cd}	5.12± 003^{d}
	18	9.00± 0.06^{a}	8.47± 0.06^{ab}	8.19± 0.06^{b}	7.89± 0.05^{bc}	8.21± 0.05^{b}	7.75± 0.05^{bc}	6.65± 0.04^{c}	6.22± 0.04^{c}	6.01± 0.04^{cd}	5.90± 0.03^{d}

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

On the other side, Psychrophilic bacterial count (Ps.B.C.) in Table (5) showed significant increase ($P<0.05$) with the progress of storage time at zero time, 2.30; 1.57, 1.47 and 0.58; 1.52, 1.31 and 0.40 and 1.45, 1.20 and 30.0 (Log CFU/g) for samples of grass carp fillets treated with 0, 1, 2 and 3% of Sodium acetate and Sodium citrate and mixture of them (Sodium acetate + Sodium citrate 1:1) and then reached to 7.58; 6.37, 6.09 and 5.49; 5.30, 4.15 and 3.85 and 4.02, 3.81 and 2.64 (Log CFU/g) during storage at 4±1ºC.after 18 days of cold storage respectively. Although, the count of psychrophilic bacteria was significant increase ($P<0.05$) by storage.

TABLE 5. Changes in Psychrophilic bacterial count. of grass carp fillets treated with different percentages of sodium acetate, sodium citrate and their mixture (sodium acetate+ citrate 1:1) during storage at 4±1 ºC.

Treatments		Control	Sodium acetate			Sodium citrate			Sodium (acetate + citrate 1:1)		
		0%	1%	2%	3%	1%	2%	3%	1%	2%	3%
Storage *Period* (Days)	0	2.30± 0.03^{a}	1.57± 0.02^{b}	1.47± 0.02^{b}	0.58± 0.01^{bc}	1.52± 0.02^{b}	1.31± 0.02^{b}	0.40± 0.01^{c}	1.45± 0.02^{b}	1.20± 0.02^{b}	0.30± 0.01^{c}
	3	3.12± 0.03^{a}	2.99± 0.02^{ab}	2.14± 0.02^{b}	1.55± 0.01^{c}	2.13± 0.02^{b}	1.81± 0.01^{bc}	0.90± 0.01^{c}	1.85± 0.01^{bc}	1.55± 0.01^{c}	0.70± 0.01^{cd}
	6	4.16± 0.03^{a}	4.11± 0.03^{a}	2.95± 0.02^{b}	1.98± 0.02^{c}	2.80± 0.02^{b}	2.33± 0.02^{bc}	1.40± 0.01^{c}	2.25± 0.02^{bc}	1.91± 0.01^{c}	1.01± 0.01^{cd}
	9	5.00± 0.04^{a}	4.70± 0.04^{ab}	3.80± 0.03^{b}	2.67± 0.02^{c}	3.68± 0.03^{b}	2.80± 0.02^{c}	1.85± 0.01^{d}	2.79± 0.02^{c}	2.27± 0.02^{cd}	1.32± 0.01^{d}
	12	5.60± 0.04^{a}	5.09± 0.04^{ab}	4.32± 0.03^{b}	3.23± 0.03^{c}	4.18± 0.03^{b}	3.37± 0.03^{c}	2.43± 0.02^{d}	3.31± 0.03^{c}	2.64± 0.02^{d}	1.62± 0.01^{e}
	15	6.80± 0.05^{a}	5.71± 0.05^{b}	5.00± 0.04^{bc}	4.22± 0.03^{c}	4.70± 0.04^{c}	4.00± 0.03^{cd}	2.95± 0.02^{d}	3.45± 0.03^{d}	3.00± 0.02^{de}	2.12± 0.02^{e}
	18	7.58± 0.05^{a}	6.37± 0.05^{b}	6.09± 0.05^{bc}	5.49± 0.04^{c}	5.30± 0.05^{c}	4.15± 0.04^{d}	3.85± 0.04^{de}	4.02± 0.03^{d}	3.81± 0.02^{de}	2.64± 0.02^{e}

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

Generally, the psycrophilic bacteria gave high values throughout storage period which may be due to the presence of psycrophilic spors forming bacteria which are again activated by refrigerator. These results are in agreement with those obtained by Boknaes *et al.* (2000) and Aaraas *et al.* (2004).

Sensory Evaluation:

From Table (6), data indicated that the effect of storage at 4±1ºC for 18 days on appearance scores of grass carp (*Ctenopharyngodon idella)* treated with different percentages 0, 1, 2 and 3% sodium acetate, sodium citrate and their mixture (sodium acetate+ citrate 1:1). The analysis of the grades, showed that the scores were significantly decrease ($P<0.05$) during storage period. The highest grade at the end of storage period showed in samples treated with mixture of (sodium acetate +

sodium citrate 1:1) as compared with the other treatments and control ones. However, control and treated samples showed the highest scores at zero day of storage.

The gradual decrease in appearance during storage period at 4±1ºC could be attributed to the protein hydrolysis and its degradative products; total volatile basis nitrogen (TVBN), and fat oxidation which are considered as major factors of changes in organoleptic properties. Kyung *et al.* (2002) reported similar results.

TABLE 6. Changes in Appearance. of grass carp fillets treated with different percentages of sodium acetate, sodium citrate and their mixture (sodium acetate+ citrate 1:1) during storage at 4±1 ºC.

Treatments		Control	Sodium acetate			Sodium citrate			Sodium (acetate + citrate 1:1)		
		0%	1%	2%	3%	1%	2%	3%	1%	2%	3%
Storage Period (Days)	0	8.80± 0.04^{a}	8.80± 0.04^{a}	8.80± 0.03^{a}	8.80± 0.04^{a}	8.80± 0.05^{a}	8.80± 0.03^{a}	8.80± 0.03^{a}	8.80± 0.04^{a}	8.80± 0.03^{a}	8.80± 0.04^{a}
	3	6.30± 0.05^{cd}	6.80± 0.05^{c}	7.70± 0.06^{bc}	8.00± 0.07^{b}	6.90± 0.06^{c}	7.50± 0.07^{b}	8.00± 0.07^{b}	8.00± 0.07^{b}	8.25± 0.07^{ab}	8.00± 0.07^{a}
	6	5.00± 0.04^{cd}	5.30± 0.04^{c}	6.50± 0.05^{bc}	7.05± 0.06^{b}	5.80± 0.04^{bc}	7.00± 0.06^{b}	7.15± 0.06^{ab}	7.05± 0.06^{b}	7.25± 0.06^{ab}	7.50± 0.06^{a}
	9	4.50± 0.03^{cd}	4.60± 0.03^{cd}	5.02± 0.04^{c}	6.10± 0.05^{b}	5.01± 0.04^{c}	6.30± 0.05^{b}	6.60± 0.05^{b}	6.10± 0.05^{b}	6.50± 0.05^{ab}	6.80± 0.05^{a}
	12	4.00± 0.03^{cd}	4.10± 0.03^{cd}	4.56± 0.03^{c}	5.00± 0.04^{b}	4.75± 0.03^{c}	5.02± 0.04^{b}	5.60± 0.04^{ab}	5.03± 0.04^{b}	5.59± 0.04^{ab}	5.90± 0.05^{a}
	15	3.40± 0.02^{cd}	3.67± 0.02^{c}	4.15± 0.03^{bc}	4.48± 0.03^{b}	4.43± 0.03^{bc}	4.81± 0.03^{b}	5.05± 0.04^{ab}	4.87± 0.03^{b}	5.05± 0.04^{ab}	5.40± 0.04^{a}
	18	2.80± 0.02^{e}	3.20± 0.02^{d}	3.70± 0.02^{cd}	4.00± 0.03^{c}	4.10± 0.03^{c}	4.40± 0.03^{bc}	4.59± 0.03^{b}	4.77± 0.03^{b}	4.95± 0.04^{ab}	5.10± 0.04^{a}

$^{a-e}$ Means within a raw with the different superscript are significantly different ($p<0.05$).
Values are expressed as Mean ± SE.

CONCLUSIONS

Grass carp fillets treated with solutions containing (w/v) 1, 2 and 3% sodium acetate, sodium citrate and their mixture (sodium acetate+ citrate 1:1). for 30 min., lead to increase its shelf-life up to 12, 15 and 18 days during storage at (4±1°C), however, control samples was spoiled after 6 days of storage at (4±1°C). Therefore sodium acetate, sodium citrate and their mixture (sodium acetate + sodium citrate 1:1) can be utilized as safe organic preservatives for fish under refrigerated storage.

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تأثير خلات الصوديوم، سترات الصوديوم على بعض خواص الجودة لشرائح سمك مبروك الحشائش خلال التخزين بالتبريد

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الملخـــــص العربـــــى

فى هذه الدراسه تم بحث التأثير الناتج من معاملة شرائح سمك مبروك الحشائش بغمرها على درجة حرارة الغرفة ٢٠°م لمدة ٣٠ دقيقه فى محاليل املاح خلات الصوديوم او سترات الصوديوم او مخلوط منهما (بنسبة ١:١) بتركيزات ١، ٢، ٣% على بعض خواص الجودة الكيميائية، البكتريولوجيه والحسية خلال تخزين تلك الشرائح بالتبريد على درجة ٤±١°م لمدة ١٨ يوم، حيث أخذت عينات للتحليل كل ثلاثة أيام.

أوضحت النتائج إلى أن استخدام محاليل بتركيز ٣% من المواد سالفة الذكر كانت افضل المعاملات التى تحافظ على خصائص شرائح سمك مبروك الحشائش طوال فترات التخزين مقارنه بالعينات المقارنه والمعاملات الاخرى، وعلى ذلك يمكن التوصية بان استخدام تركيز ٣%من مخلوط خلات الصوديوم، سترات الصوديوم (بنسبة ١:١) مناسبا لخفض معدل التغير فى الخواص الكيميائية والحسية، المحتوى البكتريولوجى لشرائح مبروك الحشائش المخزنة بالتبريد على٤±١ °م.