# EFFECT OF GARLIC AND MONOSODIUM PHOSPHATE ON SOME HISTOLOGICAL, MICROBIOLOGICAL, CHEMICAL AND ORGANOLEPTICAL PROPERTIES OF SILVER CARP FISH FILLETS DURING COLD STORAGE

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***Abstract***

The objective of this work was undertaken to evaluate the effect of minced garlic (G), monosodium phosphate (MSP) and their mixture (G+MSP) on histological structure, microbial count, chemical properties and sensory evaluation of silver carp fillets (*Hypophthalmichthys molitrix*). Fillets were dipped for 15 min in 0, 1, 2 and 3% of each solution at room temperature (20±1°C) then drained for 3 min and stored at 5±1°C for 12 days. The results indicated that using 3% concentration for 15 min of the aforementioned solutions kept silver carp fish fillets in good condition for 6th day under cold storage period when compared with the control sample, which showed the highest changes in its characteristics through the cold storage period.

## INTRODUCTION

Refrigerated storage of fish and fishery products results an increase in a shelf life of 5 to 10 days depending on species, harvest location, and season (Pedrosa and Regenstein, 1990). Refrigeration is of particular importance as regards fish .So, cold storage of fish for limited periods is usually used to extend shelf life for direct consumption and/or processing (Nabih, 1997).

Garlic oil and its diallyl constituents are antibacterial sulfides with more than two sulfur atoms, such as diallyl trisulfide, diallyl tetrasulfide, diallyl pentasulfide, and diallyl hexasulfide. This antimicrobial activity is stronger than that of diallyl disulfide or other sulfides with fewer sulfur atoms (Ross *et al.,* 2001). Kyung *et al.* (2002) observed that essential oils of garlic containing various kinds of sulfides might also prove to be valuable natural preservatives, similar to fresh garlic and mustard, which are already used as preservatives in some foods. Eldaly and Eleiwa (2006) reported that garlic can be used as natural preservatives in chilling fresh fish that are spoiled by microbial activity.

Showed that polyphosphate and sorbate produced a marked listericidal effect, as they reduced the population by 6.7 logs and 5.4 logs, respectively. Also, reported that the activity of monopotassium phosphate (MKP) could be increased if sodium acetate (SA) was added. SA alone or SA combined with MKP is recommended to extend the shelf life of refrigerated catfish fillets (Kim *et al.,* 1995). Also, Badr *et al.* (2001) found

that using concentration greater than 2% for 15 min of sodium monophosphate (MSP), maintained common carp fish fillets in good condition for the longest duration since chemical, microbiological and organoleptic evaluation were not changed appreciably through the whole period of chilling storage.

**On the other hand,** histological studies can be used to confirm the quality of fish products (Tremlova, 2000).

The present work was undertaken to examine the effects of using minced garlic, monosodium phosphate and a mixture of them on histological, microbiological, chemical and organoleptical changes of silver carp fillets during storage at (5±1°C) for 12 days.

## MATERIALS AND METHODS

### Sampling and treatments

Fresh silver carp (*Hypophthalmichthys molitrix*) fillets were obtained from Aquaculture Abbassa Abou-Hammad Sharkia, and then transported to the laboratory. Treatment solutions were prepared by mixing 2 L tap water with appropriate amounts (V/W) of minced garlic, monosodium phosphate (El-Nasr Pharmaceutical & Chemical Company, Egypt) and a mixture of them. Fillets were submerged in the following solutions:

(A) 0, 1, 2 and 3% solution of minced garlic (G) for 15min.

(B) 0, 1, 2 and 3% solution of monosodium phosphate (MSP) for 15 min.

(C) 0, 1, 2 and 3% mixture solution of G+MSP (1:1 – W/W) for 15min.

Fish fillets (100 gm each) were submerged in each solution at room temperature (20±1°C) for 15 min. then drained on sanitized stainless-steel grill for 2min at room temperature. Control fillets were dipped in 2L. tap water for 15min and drained for 2min. at room temperature. After dipping and drainage, fillets were individually packaged in polyethylene bags, stored at 5±1°C. The fillets were periodically removed every 3 days (0, 3, 6, 9 and 12 days) till the end of the storage for analyses.

### Analytical procedures

**Histological evaluation:** Muscle samples were removed from the dorsal region of the fish. Samples of approximately 4x4x10 mm were fixed in 10% neutral buffered formalin as described by Taylor *et al.* (1995). Paraffin sections of 5 microns thickness were stained with hematoxylin and eosin (H&E) then examined by light microscope.

**Total bacterial count (TBC):** It was detected according to Kato *et al.* (1985).

**Chemical evaluation:** Moisture content, total protein and lipids, were determined according to **AOAC (2000). Thiobarbituric acid (T.B.A.):** It was determined according to the method described by Tarladgis *et al.* (1960). The TBA value was calculated per one kilogram of samples according to the following equation.

TBA value / kg = O.D. at 538nm. × 7.8

**Total volatile bases nitrogen (T.V.B.N.)**: It was determined according to AMC (1979).

**Sensory evaluation**: Samples were organoleptically evaluated for appearance of uncooked fillets during storage at (5±1°C). Judges checked the organoleptic properties of the samples and grades ranged from zero to 10 according to Teeny and miyauchi (1972).

**Statistical Analysis**: Three replications of each trial were analyzed using Analysis of Variance (ANOVA) and means were separated by Duncan at a probability level of < 0.05 (SAS, 2000).

## RESULTS AND DISCUSSION

**Histological changes:**

The microscopical examination, revealed the changes in histological structure of silver carp fillets treated with different concentrations of minced garlic (G) (Fig. 2 and 3), monosodium phosphate (MSP) (Fig. 4 and 5) and their mixture (G+MSP) (Fig. 6 and 7) during storage at 5±1°C. In the control sample at zero time of storage, the muscle fibers were straight. Moreover the connective tissues (endomysium and myosepta) were closely joined with the neighboring muscle fibers and intact nucleus in myofibers (Fig. 1-A). The control samples after 3 and 6 days showed mild granulation in some muscle fibers and the interstitial areas increased. Fig. (1-B) showed the changes after 6 days. While the control samples after 9 and 12 days of storage period, revealed gradual spoilage, breakage and granulation of muscle fibers with connective tissues as well as sarcomeres looseness (Fig. 1-C). Clear interstitial areas increased possibly because the loss of tissue fluids. After 12 days, all muscles fibers were granulated leaving continuous layers of granulated substances.

All treatments after 3 and 6 days of storage period the muscles revealed, an increase in diameters as a result of water retention by the muscles with breakdown of amino and fatty acids. Lysis in muscle fibers treated with 1% solutions were noticed while those treated with 3 % solutions showed hyalinization in the muscle fibers Fig. (2, 4 and 6). Samples at 9 and 12 days of storage period, in all treatments, the muscle fibers revealed gradual breaks to granulated substances as a result of the effect of proteolysis Fig. (3, 5 and 7) showed the changes after 9 days.

Maximum lysis was observed after 12 days in control samples followed by those treated with 1% minced G, MSP and their mixture, respectively. These findings may be attributed to proteolytic enzymes hydrolyzed the tropomyosin bridges which held the myosin and actin filaments. These results coincide with those given by Tremlova (2000) and Aaraas *et al.* (2004).

**Microbial changes:**

Results presented in Table 1 indicate that, gradually increase in total bacterial count (Log CFU/g) and significantly different ($P<0.05$) between the different treatments of silver carp fillets during storage at 5±1°C were observed. Maximum TBC was observed in control samples followed by the fish fillets treated with 1% minced G, MSP and their mixture, respectively. These numbers were the highest after 12 days of storage at 5±1°C. These results are in accordance with those reported by Kyung *et al.* (2002) and Eldaly and Eleiwa (2006).

**Chemical changes:**

Data listed in Table 2 show the changes in moisture content % of silver carp fillets treated with different concentrations of minced G, MSP and their mixture during storage at 5±1 °C. Results revealed an increase in moisture content in all treated samples till the end of storage period and significantly difference ($P<0.05$) between the different treatments. Moisture content in control sample showed an increase from 77.25% to 80.32% following 12 days of storage period. Minimum increase in moisture content was observed in samples treated with 3% G+MSP, MSP and G, respectively, as moisture content were 76.50, 76.56 and 76.62% at the beginning of storage period and reached 78.21, 78.21 and 78.33% at the end of 12 days of storage at 5±1°C.

The effect of different concentrations of minced G, MSP and their mixture on total protein % of silver carp fillets during storage at 5±1 °C are shown in Table 3. Results indicated a significant difference ($P<0.05$) through the cold storage period between the treatments, total nitrogen values decreased in all samples until $12^{th}$ days of storage. Maximum decrease in total protein was observed in samples treated with 1% minced G, MSP and their mixture, respectively, as total protein content were 71.45, 71.66 and 71.74% at zero time of storage period and reached 69.62, 70.21 and 70.70% after 12 days of storage period at 5±1°C.

Results in Table 4 revealed a significant difference ($P<0.05$) in total lipids content between the treatments through the cold storage. Total lipids % slightly decreased in all samples until $12^{th}$ day of storage. Also, results showed that, the maximum decrease in total lipids was observed in the samples treated with 1% of minced G, MSP and their mixture, respectively, whereas the minimum decrease in total lipids was observed in the samples treated with 3% G+MSP, MSP and minced G, respectively.

The abovementioned changes might be due to uptake of the solutions inside the fish fillets during cold storage period which led to increase water retention by the fish muscles, as well as breakdown of amino and fatty acids. These results are in agreement with Santerre *et al.* (2000) and Arannilewa *et al.* (2005).

**Thiobarbituric acid (TBA)**

Fish samples with TBA-values more than 2 will probably smell and taste rancid (Bonnell, 1994). Results presented in Table 5 indicated a gradual increase in TBA-values up to 12 days of cold storage. Minimum TBA-values were found in fish fillets treated with 3% G+MSP mixture followed by MSP and G, when TBA-values reached to 3.41, 3.50 and 3.64 mg/Kg. respectively, after 12 days of cold storage period. On the other hand, untreated samples recorded 6.28 mg/Kg at the end of cold storage period. 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).

**Total volatile bases nitrogen (TVBN)**

Results presented in Table 6 indicated that the formation of total volatile bases nitrogen TVBN (mg./100g) were affected by all treatments. During cold storage for 12 days TVBN values started with 2.89 (mg/100g) at zero time, then reached to 40.76; 34.87, 33.70 and 30.15; 33.93, 33.17 and 28.70 and 33.56, 31.89 and 27.70 (mg/100g) after 12 days of cold storage for samples treated with 0, 1, 2 and 3% minced G, MSP and their mixture, respectively. The lowest values of TVBN were observed in samples treated with mixture of (G+MSP), while maximum TVBN were found in control samples followed by samples treated with minced garlic 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).

**Sensory Evaluation:**

Table 7 showed the changes in appearance of silver carp fillets treated with minced G, MSP and their mixture, at 5±1°C. Appearance showed a significantly differences ($P<0.05$) between the treatments. Samples treated with mixture of G+MSP showed the highest grade at the end of storage period 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 the cold storage 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.

## CONCLUSION

Treating of silver carp fillets with solutions containing (w/v) 1, 2 and 3% minced garlic (G); monosodium phosphate (MSP) and a mixture of them (G+MSP) for 15 min., lead to increase its shelf-life up to 6 days during samples storage at (5±1°C), however, control samples was spoiled after 3 days of storage at (5±1°C)

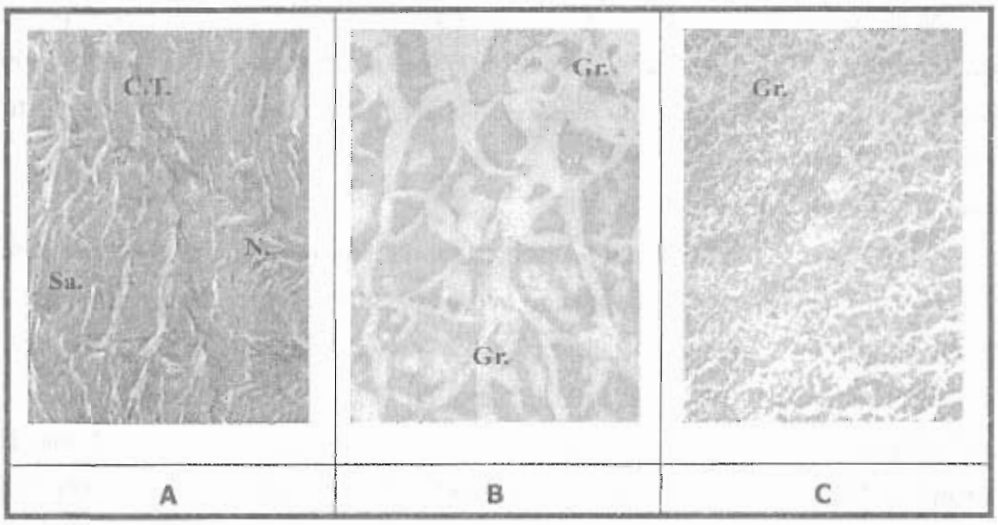


Fig. 1. Histology of control silver carp fillets at zero time (A), after 6 days (B) and after 9 days (C) of storage at 5±1°C. C.T.= connective tissues, Sa.= sarcomeres, N.= nucleus, Gr.= granulation of muscle fibers. (H & E., X 100).

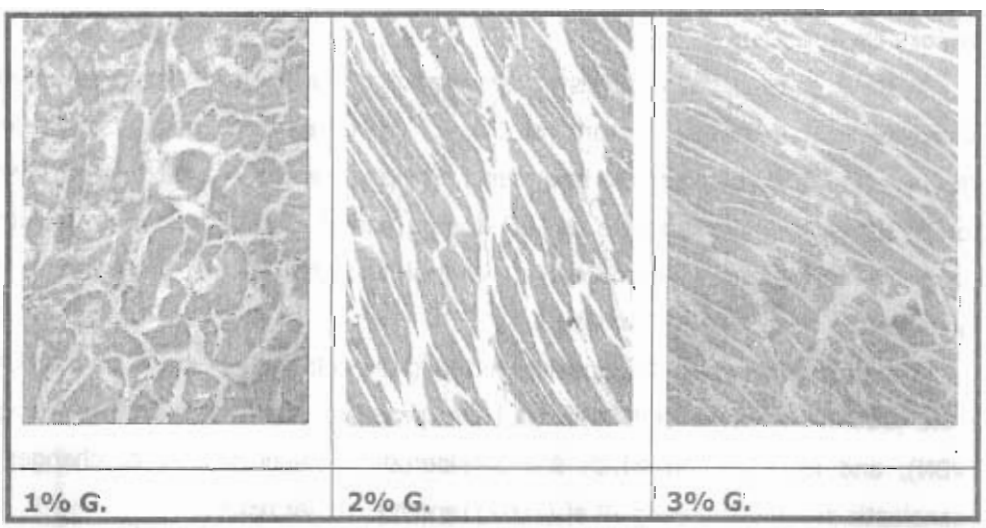


Fig. 2. Histology of silver carp fillets treated with 1, 2 and 3% minced garlic (G) after 6 days of storage at 5±1°C (H & E., X 100).

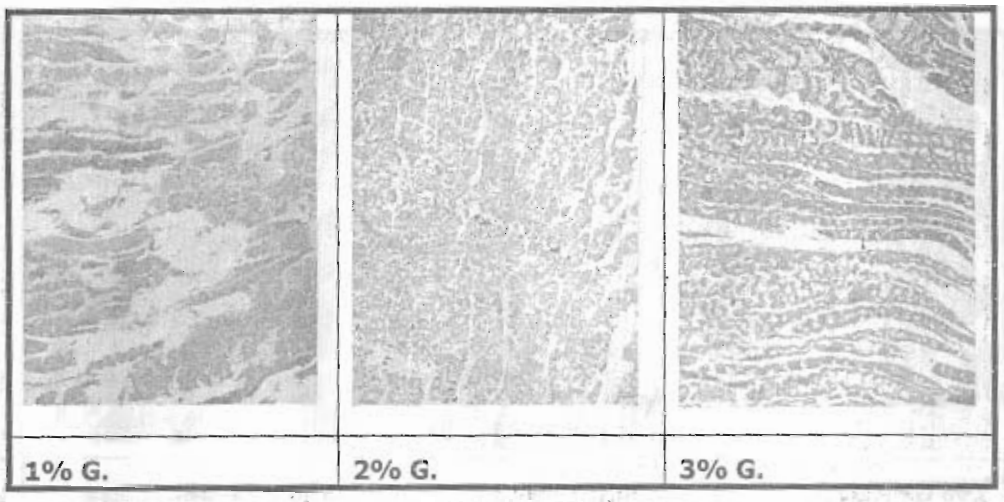


Fig. 3. Histology of silver carp fillets treated with 1, 2 and 3% minced garlic (G) after 9 days of storage at 5±1°C (H & E., X 100).

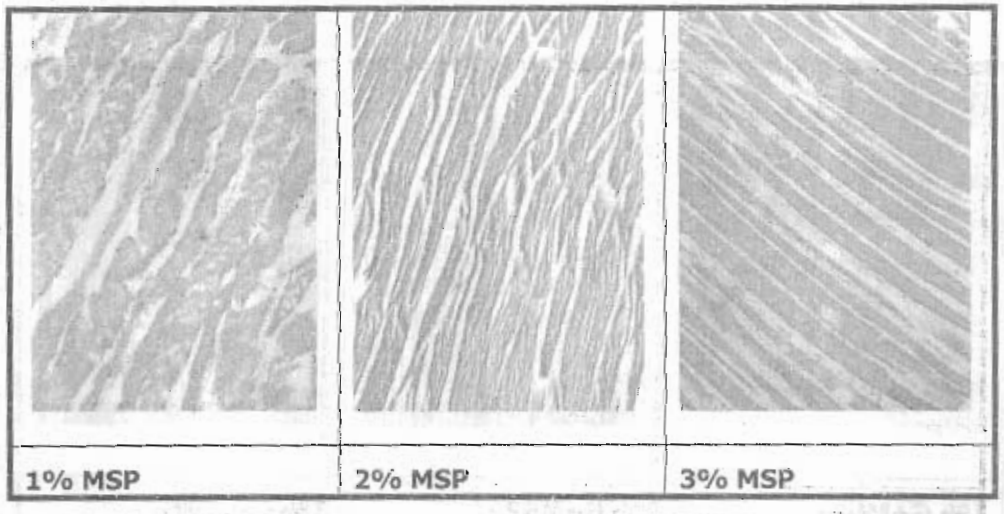


Fig. 4. Histology of silver carp fillets treated with 1, 2 and 3% monosodium phosphate (MSP) after 6 days of storage at 5±1°C (H & E., X 100).

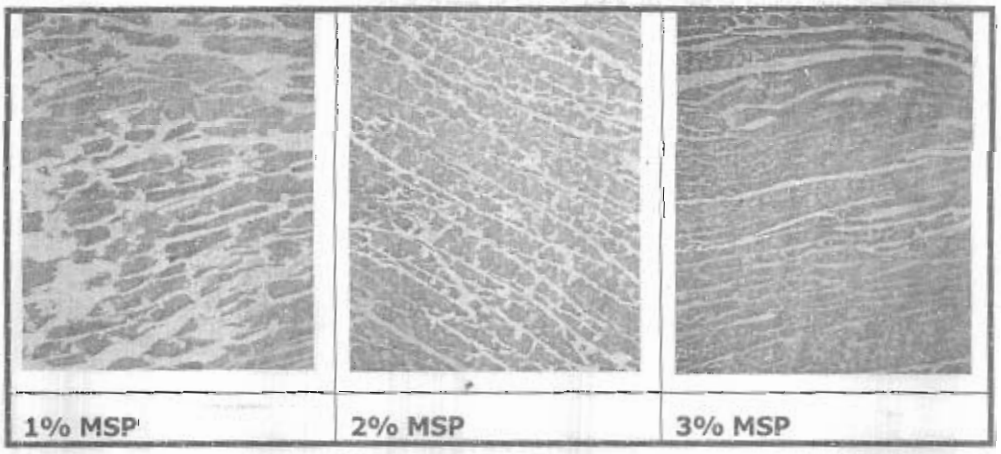


Fig. 5. Histology of silver carp fillets treated with 1, 2 and 3% monosodium phosphate (MSP) after 9 days of storage at 5±1°C (H & E., X 100).

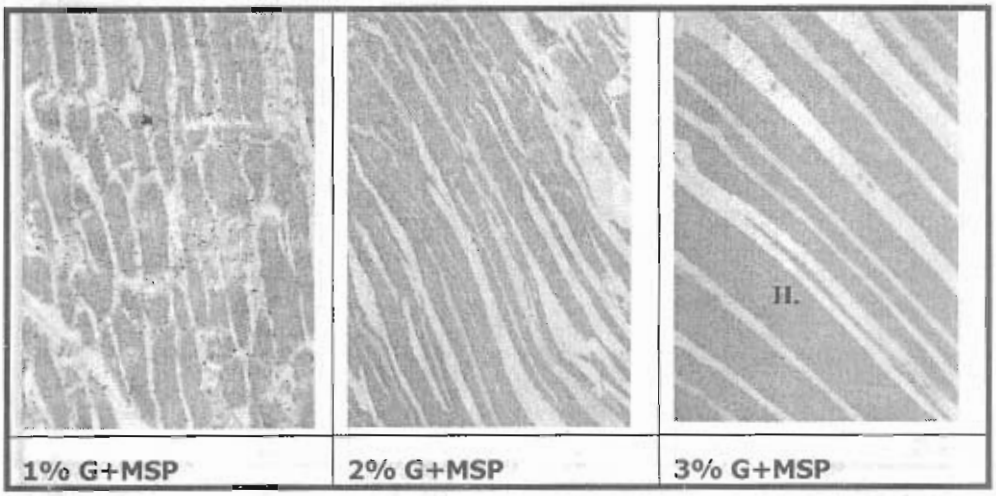


Fig. 6. Histology of silver carp fillets treated with 1, 2 and 3% mixture of G+MSP after 6 days of storage at 5±1°C. H.= hyalinization in the muscle fibers (H & E., X 100).

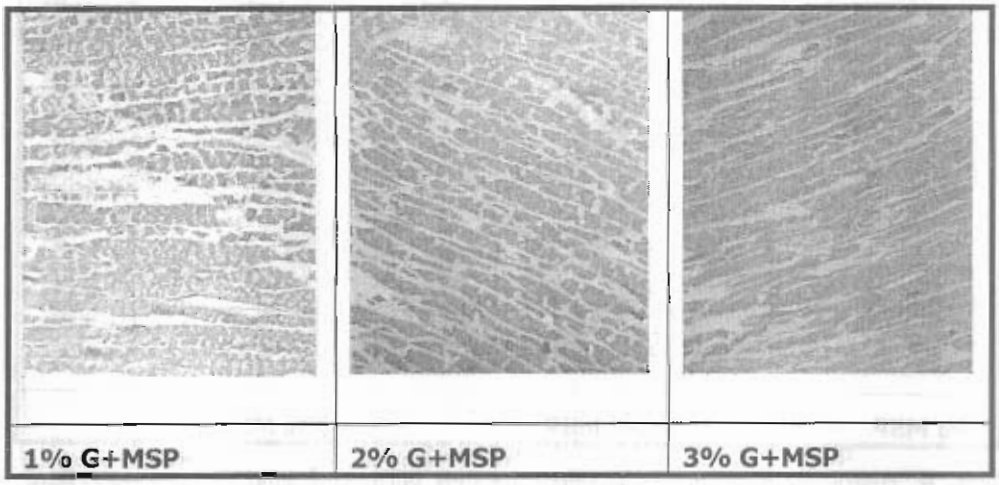


Fig 7. Histology of silver carp fillets treated with 1, 2 and 3% mixture of G+MSP after 9 days of storage at 5±1°C (H & E., X 100).

Table 1. Changes in Total bacterial count (Log CFU/g.) of silver carp fillets treated with different percentages of minced garlic (G), monosodium phosphate (MSP) and their mixture (G+ MSP) during storage at 5±1°C.

| Treatments | | Control | (G) | | | (MSP) | | | (G + MSP) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0% | 1% | 2% | 3% | 1% | 2% | 3% | 1% | 2% | 3% |
| Storage Period (Days) | 0 | 3.51± 0.03$^{a}$ | 3.47± 0.02$^{a}$ | 3.33± 0.04a | 3.33± 0.02$^{a}$ | 3.24± 0.02$^{ab}$ | 3.22± 0.01$^{ab}$ | 3.19± 0.03$^{ab}$ | 3.18± 0.02$^{ab}$ | 3.17± 0.02$^{ab}$ | 3.15± 0.03$^{ab}$ |
| | 3 | 4.92± 0.02$^{a}$ | 4.65± 0.03$^{b}$ | 4.31± 0.03$^{c}$ | 4.09± 0.01$^{d}$ | 4.53± 0.04$^{b}$ | 4.43± 0.03b$^{c}$ | 3.98± 0.03$^{c}$ | 4.53± 0.05$^{b}$ | 4.32± 0.02$^{c}$ | 4.15± 0.04$^{d}$ |
| | 6 | 6.52± 0.01$^{a}$ | 5.95± 0.02$^{b}$ | 5.56± 0.05$^{c}$ | 4.36± 0.03$^{cd}$ | 5.92± 0.03$^{b}$ | 5.90± 0.04$^{b}$ | 5.32± 0.03$^{c}$ | 6.09± 0.03$^{a}$ | 5.51± 0.05$^{c}$ | 5.24± 0.02$^{c}$ |
| | 9 | 8.24± 0.02$^{a}$ | 8.11± 0.03$^{a}$ | 7.02± 0.04$^{b}$ | 6.57± 0.02$^{c}$ | 8.21± 0.04$^{a}$ | 6.78± 0.05$^{c}$ | 6.71± 0.02$^{c}$ | 7.77± 0.02$^{b}$ | 7.00± 0.03b$^{c}$ | 6.45± 0.03$^{c}$ |
| | 12 | 9.98± 0.03$^{a}$ | 9.71± 0.04$^{a}$ | 8.95± 0.03$^{b}$ | 8.09± 0.01$^{b}$ | 9.14± 0.02$^{a}$ | 8.39± 0.04$^{b}$ | 7.74± 0.03$^{c}$ | 8.96± 0.05$^{ab}$ | 8.12± 0.01$^{b}$ | 7.57± 0.04$^{c}$ |

$^{a-d}$ Means within a row with the different superscript are significantly different ($P<0.05$).

Values are expressed as Mean ± SE.

Table 2. Changes in moisture content (%) of silver carp fillets treated with different percentages of minced garlic (G), monosodium phosphate (MSP) and their mixture (G+ MSP) during storage at 5±1°C.

| Treatments | | Control | (G) | | | (MSP) | | | (G + MSP) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0% | 1% | 2% | 3% | 1% | 2% | 3% | 1% | 2% | 3% |
| Storage Period (Days) | 0 | 77.25± 0.10 $^{a}$ | 76.87± 0.20$^{ab}$ | 76.76± 0.10$^{ab}$ | 76.62± 0.10$^{ab}$ | 76.75± 0.20$^{ab}$ | 76.61± 0.20$^{ab}$ | 76.56± 0.10$^{ab}$ | 76.67± 0.10$^{ab}$ | 76.56± 0.10$^{ab}$ | 76.50± 0.20$^{ab}$ |
| | 3 | 77.78± 0.30$^{a}$ | 77.38± 0.10$^{a}$ | 77.21± 0.20$^{ab}$ | 76.95± 0.10$^{b}$ | 77.20± 0.30$^{ab}$ | 77.02± 0.10$^{b}$ | 76.88± 0.10$^{bc}$ | 77.11± 0.10$^{b}$ | 76.97± 0.20$^{bc}$ | 76.85± 0.10$^{c}$ |
| | 6 | 78.49± 0.20 $^{a}$ | 77.95± 0.20$^{b}$ | 77.72± 0.10$^{bc}$ | 77.33± 0.10$^{c}$ | 77.71± 0.30$^{bc}$ | 77.48± 0.20$^{bc}$ | 77.23± 0.10$^{c}$ | 77.59± 0.10$^{bc}$ | 77.42± 0.20$^{bc}$ | 77.23± 0.30$^{e}$ |
| | 9 | 79.32± 0.10$^{a}$ | 78.65± 0.20$^{b}$ | 78.27± 0.10$^{bc}$ | 77.78± 0.10$^{c}$ | 78.26± 0.20$^{bc}$ | 78.00± 0.10$^{bc}$ | 77.65± 0.20$^{e}$ | 78.11± 0.20$^{bc}$ | 77.93± 0.30$^{e}$ | 77.68± 0.10$^{e}$ |
| | 12 | 80.32± 0.30$^{a}$ | 79.41± 0.30$^{b}$ | 78.89± 0.10$^{bc}$ | 78.33± 0.30$^{c}$ | 79.07± 0.20$^{b}$ | 78.62± 0.20$^{bc}$ | 78.21± 0.10$^{c}$ | 78.78± 0.30$^{bc}$ | 78.48± 0.10$^{c}$ | 78.21± 0.20$^{c}$ |

$^{a-c}$ Means within a row with the different superscript are significantly different ($P<0.05$).

Values are expressed as Mean ± SE.

Table 3. Changes in total protein (%) of silver carp fillets treated with different percentages of minced garlic (G), monosodium phosphate (MSP) and their mixture (G+ MSP) during storage at 5±1°C.

| Treatments | | Control | (G) | | | (MSP) | | | (G + MSP) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0% | 1% | 2% | 3% | 1% | 2% | 3% | 1% | 2% | 3% |
| Storage Period (Days) | 0 | 71.10± 0.04$^{a}$ | 71.45± 0.03$^{a}$ | 71.55± 0.03$^{a}$ | 71.68± 0.05$^{a}$ | 71.66± 0.04$^{a}$ | 71.79± 0.03$^{a}$ | 71.84± 0.04$^{a}$ | 71.74± 0.03$^{a}$ | 71.84± 0.04$^{a}$ | 71.90± 0.05$^{a}$ |
| | 3 | 70.67± 0.05$^{c}$ | 71.07± 0.06$^{b}$ | 71.22± 0.04$^{b}$ | 71.41± 0.05$^{ab}$ | 71.35± 0.03$^{ab}$ | 71.55± 0.05$^{ab}$ | 71.69± 0.03$^{a}$ | 71.53± 0.05$^{ab}$ | 71.69± 0.06$^{a}$ | 71.78± 0.04$^{a}$ |
| | 6 | 70.21± 0.06$^{c}$ | 70.65± 0.05$^{b}$ | 70.84± 0.03$^{b}$ | 71.10± 0.04$^{ab}$ | 71.02± 0.05$^{b}$ | 71.29± 0.06$^{ab}$ | 71.50± 0.05$^{a}$ | 71.28± 0.03$^{ab}$ | 71.52± 0.04$^{a}$ | 71.66± 0.05$^{a}$ |
| | 9 | 69.68± 0.05$^{d}$ | 70.20± 0.03$^{c}$ | 70.39± 0.05$^{c}$ | 70.75± 0.06$^{bc}$ | 70.64± 0.04$^{bc}$ | 70.99± 0.05$^{b}$ | 71.29± 0.03$^{ab}$ | 71.01± 0.05$^{b}$ | 71.32± 0.04$^{ab}$ | 71.51± 0.03$^{a}$ |
| | 12 | 69.07± 0.04$^{d}$ | 69.62± 0.50$^{c}$ | 69.91± 0.03$^{c}$ | 70.36± 0.04$^{bc}$ | 70.21± 0.06$^{bc}$ | 70.66± 0.05$^{b}$ | 71.03± 0.04$^{ab}$ | 70.70± 0.06$^{b}$ | 71.08± 0.05$^{ab}$ | 71.32± 0.04$^{a}$ |

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

Table 4. Changes in total lipids (%) of silver carp fillets treated with different percentages of minced garlic (G), monosodium phosphate (MSP) and their mixture (G+ MSP) during storage at 5±1°C.

| Treatments | | Control | (G) | | | (MSP) | | | (G + MSP) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0% | 1% | 2% | 3% | 1% | 2% | 3% | 1% | 2% | 3% |
| Storage Period (Days) | 0 | 21.58± 0.02$^{a}$ | 21.69± 0.01$^{a}$ | 21.72± 0.03$^{a}$ | 21.76± 0.01$^{a}$ | 21.72± 0.02$^{a}$ | 21.76± 0.02$^{a}$ | 21.77± 0.01$^{a}$ | 21.74± 0.01$^{a}$ | 21.77± 0.03$^{a}$ | 21.79± 0.01$^{a}$ |
| | 3 | 21.43± 0.01$^{b}$ | 21.56± 0.02$^{ab}$ | 21.60± 0.01$^{a}$ | 21.64± 0.02$^{a}$ | 21.58± 0.01$^{ab}$ | 21.63± 0.02$^{a}$ | 21.66± 0.01$^{a}$ | 21.61± 0.03$^{a}$ | 21.66± 0.03$^{a}$ | 21.70± 0.01$^{a}$ |
| | 6 | 21.25± 0.02$^{b}$ | 21.41± 0.03$^{ab}$ | 21.45± 0.01$^{ab}$ | 21.51± 0.03$^{a}$ | 21.43± 0.02$^{ab}$ | 21.49± 0.01$^{ab}$ | 21.54± 0.02$^{a}$ | 21.47± 0.01$^{ab}$ | 21.53± 0.03$^{a}$ | 21.59± 0.01$^{a}$ |
| | 9 | 21.00± 0.03$^{b}$ | 21.21± 0.02$^{ab}$ | 21.29± 0.02$^{ab}$ | 21.37± 0.01$^{a}$ | 21.27± 0.01$^{ab}$ | 21.34± 0.01$^{ab}$ | 21.41± 0.03$^{a}$ | 21.31± 0.01$^{ab}$ | 21.39± 0.02$^{a}$ | 21.47± 0.02$^{a}$ |
| | 12 | 20.71± 0.02$^{b}$ | 20.98± 0.01$^{ab}$ | 21.10± 0.01$^{ab}$ | 21.21± 0.02$^{a}$ | 21.07± 0.03$^{b}$ | 21.17± 0.01$^{ab}$ | 21.27± 0.03$^{a}$ | 21.12± 0.01$^{ab}$ | 21.24± 0.03$^{a}$ | 21.34± 0.01$^{a}$ |

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

Table 5. Changes in thiobarbituric acid values (mg. malonldehyde / Kg.) of silver carp fillets treated with different percentages of minced garlic (G), monosodium phosphate (MSP) and their mixture (G+ MSP) during storage at 5±1°C.

| Treatments | | Control | (G) | | | (MSP) | | | (G + MSP) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0% | 1% | 2% | 3% | 1% | 2% | 3% | 1% | 2% | 3% |
| Storage Period (Days) | 0 | 0.16± 0.004$^{a}$ | 0.16± 0.005$^{a}$ | 0.16± 0.003$^{a}$ | 0.16± 0.006$^{a}$ | 0.16± 0.005$^{a}$ | 0.16± 0.007$^{a}$ | 0.16± 0.006$^{a}$ | 0.16± 0.004$^{a}$ | 0.16± 0.006$^{a}$ | 0.16± 0.005$^{a}$ |
| | 3 | 1.51± 0.02$^{a}$ | 1.34± 0.03$^{b}$ | 1.28± 0.02$^{b}$ | 1.03± 0.04$^{bc}$ | 1.15± 0.04$^{b}$ | 1.01± 0.03$^{bc}$ | 0.92± 0.04$^{c}$ | 0.96± 0.02$^{c}$ | 0.81± 0.03$^{cd}$ | 0.73± 0.02$^{d}$ |
| | 6 | 3.16± 0.03$^{a}$ | 2.02± 0.02$^{b}$ | 1.86± 0.02$^{bc}$ | 1.78± 0.01$^{c}$ | 1.73± 0.03$^{c}$ | 1.64± 0.01$^{cd}$ | 1.57± 0.03$^{d}$ | 1.60± 0.02$^{cd}$ | 1.48± 0.03$^{d}$ | 1.40± 0.01$^{d}$ |
| | 9 | 4.59± 0.02$^{a}$ | 3.87± 0.03$^{b}$ | 2.82± 0.02$^{c}$ | 2.65± 0.02$^{c}$ | 2.67± 0.03$^{c}$ | 2.51± 0.02$^{cd}$ | 2.43± 0.03$^{cd}$ | 2.40± 0.02$^{cd}$ | 2.36± 0.03$^{d}$ | 2.24± 0.03$^{d}$ |
| | 12 | 6.28± 0.03$^{a}$ | 3.99± 0.04$^{b}$ | 3.86± 0.04$^{b}$ | 3.64± 0.03$^{bc}$ | 3.85± 0.03$^{b}$ | 3.57± 0.05$^{bc}$ | 3.50± 0.04$^{c}$ | 3.69± 0.04$^{b}$ | 3.50± 0.05$^{c}$ | 3.41± 0.05$^{d}$ |

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

Table 6. Changes in total volatile bases nitrogen (mg/100g) of silver carp fillets treated with different percentages of minced garlic (G), monosodium phosphate (MSP) and their mixture (G+ MSP) during storage at 5±1°C.

| Treatments | | Control | (G) | | | (MSP) | | | (G + MSP) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0% | 1% | 2% | 3% | 1% | 2% | 3% | 1% | 2% | 3% |
| Storage Period (Days) | 0 | 2.890± 0.05$^{a}$ | 2.890± 0.04$^{a}$ | 2.890± 0.03$^{a}$ | 2.890± 0.05$^{a}$ | 2.890± 0.05$^{a}$ | 2.890± 0.04$^{a}$ | 2.890± 0.05$^{a}$ | 2.890± 0.04$^{a}$ | 2.890± 0.03$^{a}$ | 2.890± 0.03$^{a}$ |
| | 3 | 9.960± 0.07$^{a}$ | 9.300± 0.05$^{a}$ | 8.970± 0.07$^{ab}$ | 8.100± 0.06$^{b}$ | 8.500± 0.05$^{ab}$ | 7.690± 0.05$^{b}$ | 7.000± 0.06$^{bc}$ | 7.900± 0.06$^{b}$ | 6.820± 0.07$^{bc}$ | 5.980± 0.05$^{c}$ |
| | 6 | 17.69± 0.05$^{a}$ | 17.09± 0.04$^{a}$ | 16.00± 0.04$^{ab}$ | 14.99± 0.06$^{b}$ | 15.75± 0.07$^{b}$ | 14.79± 0.05$^{bc}$ | 14.40± 0.04$^{c}$ | 15.40± 0.05$^{b}$ | 14.79± 0.06$^{bc}$ | 14.36± 0.05$^{c}$ |
| | 9 | 28.50± 0.06$^{a}$ | 26.13± 0.07$^{ab}$ | 24.58± 0.06$^{b}$ | 21.63± 0.04$^{c}$ | 24.80± 0.05$^{b}$ | 22.69± 0.06$^{bc}$ | 20.26± 0.07$^{c}$ | 23.54± 0.04$^{b}$ | 21.64± 0.07$^{c}$ | 20.50± 0.05$^{c}$ |
| | 12 | 40.76± 0.05$^{a}$ | 34.87± 0.06$^{b}$ | 33.70± 0.04$^{b}$ | 30.15± 0.05$^{c}$ | 33.93± 0.06$^{b}$ | 33.17± 0.07$^{b}$ | 28.70± 0.06$^{c}$ | 33.56± 0.05$^{b}$ | 31.89± 0.05$^{bc}$ | 27.70± 0.07$^{c}$ |

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

Table 7. Changes in appearance of silver carp fillets treated with different percentages of minced garlic (G), monosodium phosphate (MSP) and their mixture (G+ MSP) during storage at 5±1°C.

| Treatments | | Control | (G) | | | (MSP) | | | (G + MSP) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0% | 1% | 2% | 3% | 1% | 2% | 3% | 1% | 2% | 3% |
| Storage Period (Days) | 0 | 9.10 ± 0.03$^{a}$ | 9.10 ± 0.06$^{a}$ | 9.10 ± 0.04$^{a}$ | 9.10 ± 0.02$^{a}$ | 9.10 ± 0.03$^{a}$ | 9.10 ± 0.05$^{a}$ | 9.10 ± 0.01$^{a}$ | 9.10 ± 0.03$^{a}$ | 9.10 ± 0.03$^{a}$ | 9.10 ± 0.01$^{a}$ |
| | 3 | 5.70 ± 0.04$^{b}$ | 8.50 ± 0.01$^{ab}$ | 8.70 ± 0.04$^{ab}$ | 8.80 ± 0.03$^{a}$ | 8.80 ± 0.06$^{a}$ | 8.90 ± 0.02$^{a}$ | 9.00 ± 0.04$^{a}$ | 8.80 ± 0.02$^{a}$ | 8.90 ± 0.03$^{a}$ | 9.10 ± 0.06$^{a}$ |
| | 6 | 4.10 ± 0.06$^{b}$ | 7.50 ± 0.02$^{ab}$ | 7.40 ± 0.06$^{ab}$ | 7.70 ± 0.03$^{a}$ | 6.80 ± 0.01$^{b}$ | 7.30 ± 0.04$^{ab}$ | 7.70 ± 0.05$^{a}$ | 7.50 ± 0.04$^{a}$ | 7.60 ± 0.02$^{a}$ | 7.90 ± 0.05$^{a}$ |
| | 9 | 3.80 ± 0.02$^{c}$ | 5.80 ± 0.02$^{b}$ | 6.00 ± 0.03$^{b}$ | 6.30 ± 0.02$^{ab}$ | 6.40 ± 0.05$^{ab}$ | 6.50 ± 0.03$^{ab}$ | 6.90 ± 0.03$^{a}$ | 6.50 ± 0.03$^{a}$ | 6.60 ± 0.05$^{a}$ | 6.80 ± 0.06$^{a}$ |
| | 12 | 2.60 ± 0.05$^{c}$ | 4.60 ± 0.05$^{bc}$ | 4.90 ± 0.02$^{b}$ | 5.20 ± 0.03$^{b}$ | 4.80 ± 0.04$^{b}$ | 5.30 ± 0.02$^{ab}$ | 5.60 ± 0.02$^{a}$ | 5.30 ± 0.03$^{ab}$ | 5.60 ± 0.04$^{a}$ | 6.10 ± 0.04$^{a}$ |

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

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# تأثير الثوم وفوسفات الصوديوم الأحادي على بعض الخواص الهستولوجية ، الميكروبيولوجيه ، الكيميائيه والحسيه لشرائح سمك المبروك الفضى المخزن بالتبريد

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فى هذا البحث تم دراسة التأثير الناتج من معاملة شرائح سمك المبروك الفضى بغمرها على درجة حرارة الغرفة ٢٠±١م لمدة ١٥ق فى محاليل صفر، ١، ٢، ٣% لكل من مفروم الثوم ، فوسفات صوديوم أحادى ومخلوط منهما بنسبة ١:١ بالوزن على التركيب الهستولوجى، بعض الخواص الميكروبيولوجية، الكيميائية والحسية خلال تخزين تلك الشرائح على درجة ٥±١م لمدة ١٢ يوم، حيث أخذت عينات للتحليل كل ثلاثة أيام. أوضحت النتائج إلى أن استخدام تركيز ٣% من المواد سالفة الذكر كانت افضل المعاملات التى تحافظ على خصائص شرائح سمك المبروك الفضى طوال فترات التخزين حتى اليوم السادس مقارنة بعينة المقارنة التى ظهر فيها تغير شديد فى الخواص المدروسة للشرائح. وعلى ذلك يمكن التوصية بان استخدام تركيز ٣% من مفروم الثوم أو فوسفات الصوديوم الأحادي أو المخلوط منهما مناسبا لخفض التغير فى التركيب الهستولوجى، المحتوى الميكروبيولوجى، الخواص الكيميائية والحسية لشرائح المبروك الفضى المخزنة بالتبريد على ٥±١ م.