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Original Article

The effects of washing with Tamarind (*Tamarindus indica* L.) water solution on shelf life of silver carp (*Hypophthalmichthys molitrix*) fillet during refrigerator storage

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Abstract: This study evaluated the antibacterial and antioxidant effects of tamarind water solution on shelf life of silver carp (*Hypophthalmicthys molitrix*) fillet during refrigerator storage. Treatments of this study were unwashed samples (control), and samples washed with 1% and 2% tamarind water solution. Microbial, physicochemical and sensory analysis including total viable count (TVC), peroxide value (PV), thiobarbituric acid (TBA), total volatile base (TVB-N) and pH were measured during 15 day storage at refrigerator (with 3 days intervals). Proximate analysis of samples also measured at day 0. TVC content was 0.93, 0.50 and 0.10 log CFU/g for control and treatments 1% and 2%, respectively and reached to 6.24, 5.82 and 5.21 log CFU/g at the end of storage period. At the end of storage period, the PV, TBA and TVB-N content were 8.4, 4.3, and 3.0 meq O_2/Kg for control, 2.75, 1.35, and 0.50 mg/100g for 1% treatment, and 33.17, 23.90, and 22.10 mg N/100g for 2% treatment, respectively. This results showed the positive effect of tamarind to inhibit and delay fish fillet spoilage. According to sensory evaluation, the density of 1% tamarind was selected as the best density.

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Introduction

Seafoods with high quality proteins, high content of unsaturated fat, vitamins and minerals are noticed as a useful food for human health (Venugopal, 2006). Many efforts have been done to supply fresh seafood rather than frozen or other processed products with high quality according to increasing consumer's demands (Hassan, 2002; Fernández et al., 2009). Fish are very perishable food due to large amounts of free amino acids, volatile nitrogen bases, highly unsaturated fatty acids and higher final pH (Liston, 1980; Razavi Shirazi, 2001). Therefore, they are very susceptible to bacterial spoilage and oxidative rancidity during storage (Mexis et al., 2009).

Different methods have been presented to inhibit or delay of seafood rancidity and spoilage such as temperature control, vacuum packaging, modified atmosphere packaging (MAP), and supplying of antioxidants (Lin and Lin, 2005). Various compounds such as chemical antimicrobials and antioxidants are used to prevent the spoilage of fresh fish (Lu et al., 2010). As artificial antioxidants have some undesirable effects such as creating mutation, intoxication and carcinogenic; hence, application of natural antioxidants with the same inhibitory effect on oxidation is increasing (Sakanaka et al., 2005). Applying herbal compounds as natural preservatives in fish fillets can be effective especially on shelf life increasing during storage in refrigerator.

Tamarind (*Tamarinad indica* L.) belongs to the family Fabaceae and the subfamily of Caesalpinioideae, which is the third extensive family of flowering plants (Lewis and Neelakantan, 1964). Its chemical compositions includes 20.6% water, 3.1% protein, 0.4% lipid, 70.8% carbohydrate, 3% fiber and 1.2% ash (El-Siddig et al., 1999). Tamarind

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is used as an appropriate food preservative compound that inhibits food infectious bacteria growth. Tamarind has also showed oxidation inhibitory activity due to high content of phenolic composition (El-Siddig et al., 2006). Although there are many studies regarding to usage of synthetic and natural antioxidant and antimicrobial compounds on shelf life extension of seafoods, information regarding to effects of tamarind in this area is rare (Pezeshk et al., 2010). Therefore, the present research was conducted to study the effect of tamarind water solution preservative effect on microbial, physicochemical and sensory characteristics of silver carp (*Hypophthalmichthys molitrix*) fillet during the storage in refrigerator.

Materials and Methods

Sample preparation: Fifteen silver carp with the average weight and length of 1000 (±100) g and 40 (±5) cm, respectively, were purchased from a local fish market (Zabol, Iran) in January 2014. They were transferred in insulated boxes with ice to seafood processing laboratory. Immediately, the fish were rinsed with drinking water and then eviscerated, headed and filleted by hand. The fillets were rinsed again and cut into 5×5×1 cm pieces. These pieces were soaked in tamarind water solution for 5 min based on Mohsin et al. (1999) and then put on the strainer for 1 min to drip the water. Three treatments, including unwashed samples (as control), washed with 1% and 2% tamarind water solution were considered in this study. After treating, all samples were battered, breaded, packaged and then kept in refrigerator for 15 days.

Preparation of tamarind water solution: 200 g Thai tamarind was purchased from a retail shop (Zabol, Iran). Water solution was prepared based on Bekar and Hamzeh (1997). Thus, the paste was dissolved in boiled water, and its shell, seed and fiber were separated using a strainer. The solution was heated over a flame and the obtained paste was dissolved in distilled water (w/v) to get required concentration i.e. 1 and 2%.

Microbiological analysis: Microbiological counts were determined by placing 10 g sample in 90 ml of 0.85% NaCl solution, and homogenizing with a stomacher (Moulinex, France) for 60 second. From this dilution, other decimal dilutions were prepared and plated in the appropriate media. Meanwhile, the total viable counts (TVC) were determined using tryptic soy agar (TSA, Merck) after incubation for 48 hrs at 25°C (AOAC, 2005). The microbiological data were transformed into logarithms of the number of colony-forming units (CFU/g).

Chemical analysis: The moisture content of flesh was measured by drying to constant weight at 105°C for 24 hrs according to AOAC (2005). The crude ash was determined after heating the sample overnight at 550°C (AOAC, 2005). The crude protein content was measured by the Kjeldahl method (AOAC, 2005), employing the 6.25 conversion factor. The crude lipid was determined by ether extraction using a Soxhelet method (AOAC, 2002). PV value was determined based on AOAC (2000) and expressed as meq O_2/kg lipid sample. TBA value was measured according to Namaulema et al. (1999), and was expressed as mg malondialdehyde/kg sample. Total volatile base nitrogen (TVB-N, mg N/100 g) was determined according to AOAC (2005).

Sensory evaluation: Sensory evaluation was performed by seven half-trained persons based on Hedonic (ASTM, 1969). After deep frying the samples in Sunflower oil (Bahar, Iran), properties of colour, odour, texture, taste and overall acceptability were evaluated by assessors. The samples were scored from 0-7: highest quality = 7, good quality = 5, fair quality = 3 and rejectable quality = 0.

Statistical analysis: Statistical analysis were performed using the SPSS program, version 16. Tukey's test was performed to evaluate the significance of differences among mean values. A nonparametric ANOVA of Kruskal Wallis test was used for sensory evaluation.

Results

Proximate analysis of the control and treated samples of silver carp fillet are shown in Table 1. According to the results, silver carp is a fish with moderate fat

Table 1. Chemical composition (%) of raw and treated samples of *H. molitrix* with tamarind solution.

Chemical composition	Control group	1% tamarind treatment	2% tamarind treatment
Total protein	2.70^{A}±17.80	0.90^{A}±17.60	2.00^{A}±17.77
Total fat	1.20^{A}±4.79	0.63^{A}±4.69	0.50^{A}±4.20
Moisture	2.02^{A}±75.80	1.00^{A}±75.80	0.64^{A}±76.80
Ash	0.21^{A}±1.61	0.45^{A}±1.91	1.40^{A}±1.23

Values are means and S.D. of triplicate.

Means with the same capital letter in a row were not significantly different at $P<0.05$ level.

Table 2. Changes in TVC (Log CFU/ g) in different treatments during refrigerator storage.

Days of storage	Treatments		
	control	1% tamarind	2% tamarind
0	0.93 ± 0.08^{Af}	0.50 ± 0.15^{Be}	0.10 ± 0.02^{Cd}
3	1.50 ± 0.04^{Ae}	0.70 ± 0.20^{Be}	0.30 ± 0.02^{Bd}
6	3.80 ± 0.07^{Ad}	3.30 ± 0.06^{Bd}	3.00 ± 0.00^{Cc}
9	5.20 ± 0.04^{Ab}	4.70 ± 0.00^{Bc}	4.34 ± 0.05^{Cb}
12	5.60 ± 0.35^{Ab}	5.10 ± 0.10^{Bb}	5.01 ± 0.02^{Ba}
15	6.24 ± 0.05^{Aa}	5.82 ± 0.10^{Ba}	5.21 ± 0.01^{Ca}

Values are means and S.D. of triplicate.

Means with the same capital letter in a row were not significantly different at $P<0.05$ level in different treatment.

Means with the same small letter in a column were not significantly different at different at $P<0.05$ level during storage at 4˚C.

Table 3. Changes in pH of control and treated samples of *H. molitrix* during refrigerator storage.

Days of storage	Treatments		
	control	1% tamarind	2% tamarind
0	6.37 ± 0.02^{Ac}	6.16 ± 0.05^{Ba}	6.16 ± 0.01^{Ba}
3	5.97 ± 0.01^{Ad}	5.83 ± 0.05^{Ab}	5.63 ± 0.10^{Bb}
6	6.17 ± 0.15^{Ad}	5.80 ± 0.09^{Bb}	5.51 ± 0.12^{Bb}
9	6.42 ± 0.03^{Ac}	6.23 ± 0.05^{Ba}	6.12 ± 0.03^{Ca}
12	6.92 ± 0.09^{Aa}	5.76 ± 0.06^{Bb}	5.54 ± 0.04^{Cb}
15	6.96 ± 0.04^{Aa}	5.55 ± 0.03^{Bc}	5.21 ± 0.07^{Cc}

Values are means and S.D. of triplicate.

Means with the same capital letter in a row were not significantly different at $P<0.05$ level indifferent treatment.

Means with the same small letter in a column were not significantly difference at different at $P<0.05$ level during storage at 4˚C.

content.

Microbial analysis: The content of total viable count (TVC) for control treatment, 1% tamarind and 2% tamarind was 0.93, 0.50 and 0.10 log CFU/g at day 0, respectively (Table 2). Increasing the values of TVC were found in all the treatments during storage, but the changes of TVC in control treatment was higher than those of treatments. The results showed that treating the silver carp fillets with tamarind water solution significantly decrease TVC (Table 2).

pH: The changes in pH of silver carp fillets as a function of treatments and storage time are presented in Table 3. The pH of control samples at day 0 was 6.37 and significantly ($P<0.05$) lower pH values were found for treated samples with tamarind solution. For control samples, the highest pH was observed at day 15 and the least content of pH at day 3. For fillets treated with tamarind solution, the highest pH was observed at day 0 and least at day 15.

Peroxide value (PV): PV values of control and treated samples, and their changes during refrigerator storage are shown in Table 4. The initial PV value of the control samples at day 0 was 1.34 meq O_2/kg. This amount was higher as compared with raw samples of silver carp reported by Zakipour Rahimabadi and Divband (2012). Lower PV values were found in treated samples with 1 and 2% of tamarind solution at initial of storage period (Table 4). PV values increased significantly ($P<0.05$) with time of storage at 4ºC for all treatments. PV value was significantly lower ($P<0.05$) for treated samples during the storage period compared with those of the

Table 4. Changes in PV values in different treatments during storage at 4°C.

Days of storage	Treatments		
	control	**1% tamarind**	**2% tamarind**
0	1.34 ± 1.20^{Ac}	0.73 ± 0.50^{Ab}	0.26 ± 0.06^{Ac}
3	2.98 ± 0.23^{Abc}	2.87 ± 0.80^{Aa}	2.90 ± 0.10^{Aa}
6	0.92 ± 0.09^{Ac}	0.72 ± 0.26^{Ab}	0.68 ± 0.28^{Abc}
9	5.13 ± 1.01^{Ab}	3.17 ± 0.80^{Aa}	2.73 ± 1.40^{Aab}
12	3.90 ± 0.70^{Abc}	3.70 ± 0.60^{Aa}	2.50 ± 0.50^{Ab}
15	8.40 ± 1.90^{Aa}	4.30 ± 0.70^{Ba}	3.00 ± 0.27^{Ba}

Values are means and S.D. of triplicate.
Means with the same capital letter in a row were not significantly different at $P<0.05$ level in different treatment.
Means with the same small letter in a column were not significantly different at $P<0.05$ level during storage at 4˚C.

Table 5. Changes in TBA values in control and treated samples during refrigerator storage.

Days of storage	Treatments		
	control	1% tamarind	2% tamarind
0	0.05 ± 0.01^{Ad}	0.04 ± 0.01^{Ac}	0.00 ± 0.00^{Bb}
3	0.12 ± 0.03^{Ad}	0.06 ± 0.00^{Bc}	0.01 ± 0.00^{Cb}
6	1.37 ± 0.17^{Ac}	0.08 ± 0.01^{Bc}	0.03 ± 0.01^{Bb}
9	1.75 ± 0.15^{Ab}	0.37 ± 0.20^{Bb}	0.06 ± 0.01^{Bc}
12	1.93 ± 0.08^{Ab}	1.20 ± 0.08^{Ba}	0.13 ± 0.06^{Cb}
15	2.75 ± 0.19^{Aa}	1.35 ± 0.50^{Ba}	0.50 ± 0.14^{Ca}

Values are means and S.D. of triplicate.
Means with the same capital letter in a row were not significantly different at $P<0.05$ level in different treatment.
Means with the same small letter in a column were not significantly different at $P<0.05$ level.

Table 6. Changes in TVB-N content in different treatments during storage at 4°C.

Days of storage	Treatments		
	control	1% tamarind	2% tamarind
0	10.33 ± 0.76^{Af}	9.03 ± 0.71^{Ae}	9.10 ± 0.80^{Ad}
3	14.40 ± 1.00^{Ae}	12.27 ± 0.71^{Bd}	11.06 ± 0.44^{Bd}
6	20.23 ± 1.03^{Ad}	14.37 ± 0.60^{Bc}	13.33 ± 1.00^{Bc}
9	22.87 ± 0.81^{Ac}	15.84 ± 0.40^{Bc}	13.70 ± 0.90^{Cc}
12	27.74 ± 0.65^{Ab}	20.21 ± 0.92^{Bb}	19.10 ± 0.86^{Bb}
15	33.17 ± 1.15^{Aa}	23.91 ± 1.08^{Ba}	22.11 ± 0.60^{Ba}

Values are means and S.D. of triplicate.
Means with the same capital letter in a row were not significantly different at $P<0.05$ level in different treatment.
Means with the same small letter in a column were not significantly difference at different at $P<0.05$ level during storage at 4°C.

control samples. There were no significant changes from day 3 until 9 but there were significant changes from day 9 afterward (Table 4).

Thiobarbituric acid (TBA) value: The TBA values of control and treated samples were 0.053, 0.04 and 0.006 mg malondialdehyde/kg of lipid at initial of storage period, respectively. A continues increase in TBA value was observed in control samples and other treatments throughout of 15 days storage period ($P<0.05$). The TBA of treated samples with tamarind solution was lower than those that of control samples ($P<0.05$) (Table 5).

TVB-N: The initial TVB-N value in raw silver carp fillets was 10.33 mg/100 g. Treatment with tamarind water solution did not produce a significant effect on the initial TVB-N values decrease. The TVB-N was significantly ($P<0.05$) decreased in the 1% samples than that of the control samples. TVB-N content in 2% samples was significantly lower than that of 1% treatment ($P<0.05$) (Table 6).

Sensory evaluation: The results of sensory evaluation for control and treated fillets with tamarind solution are presented in Table 7. At the beginning of the storage period, all treatments had a

Table 7. The results of sensory evaluation for different treatments during storage at 4°C.

Factors	Treatments	Days of storage					
		0	3	6	9	12	15
Texture	control	0.00^{Aa}±7.00	0.00^{Bb}±5.00	0.22^{Bc}±3.50	0.00^{Bc}±3.00	0.00^{Bd}±1.00	0.00^{Bd}±1.00
	1%	0.00^{Aa}±7.00	0.00^{Aa}±7.00	0.00^{Ab}±5.00	0.00^{Ab}±5.00	0.16^{Ab}±4.83	0.21^{Ab}±4.66
	2%	0.00^{Aa}±7.00	0.00^{Aa}±7.00	0.00^{Ab}±5.00	0.00^{Ab}±5.00	0.00^{Ab}±5.00	0.33^{Ab}±4.70
Color	control	0.00^{Aa}±7.00	0.21^{Ab}±5.00	0.01^{Bb}±4.46	0.27^{Bc}±3.65	0.21^{Bc}±3.33	0.08^{Bd}±2.60
	1%	0.00^{Aa}±7.00	0.16^{Ab}±4.83	0.16^{Ab}±4.83	0.21^{Ab}±4.66	0.21^{Ab}±4.66	0.21^{Ac}±4.30
	2%	0.00^{Aa}±7.00	0.00^{Ab}±5.00	0.16^{Ab}±4.83	0.16^{Ab}±4.83	0.21^{Ab}±4.66	0.16^{Ab}±4.66
Odor	control	0.00^{Aa}±7.00	0.16^{Ab}±4.83	0.16^{Bc}±3.16	0.00^{Bc}±3.00	0.00^{Bd}±2.00	0.00^{Be}±1.00
	1%	0.00^{Aa}±7.00	0.08^{Ab}±4.66	0.34^{Ab}±4.66	0.34^{Ab}±4.50	0.20^{Ab}±4.30	0.00^{Ac}±4.00
	2%	0.00^{Aa}±5.90	0.20^{Ab}±4.30	0.00^{Ab}±4.00	0.21^{Cc}±2.60	0.00^{Cd}±1.00	0.00^{Bd}±1.00
Taste	control	0.00^{Aa}±7.00	0.02^{Bb}±4.34	0.02^{Bc}±3.16	0.00^{Bd}±1.00	0.00^{Bd}±1.00	0.00^{Bd}±1.00
	1%	0.00^{Aa}±7.00	0.00^{Ab}±5.00	0.08^{Ab}±4.66	0.00^{Ac}±4.00	0.00^{Ac}±4.00	0.00^{Ac}±4.00
	2%	0.00^{Aa}±5.90	0.20^{Bb}±3.16	0.21^{Cc}±2.60	0.00^{Bd}±1.00	0.00^{Bd}±1.00	0.00^{Bd}±1.00
Overall acceptability	control	0.00^{Aa}±7.00	0.00^{Bb}±4.00	0.20^{Cc}±3.16	0.21^{Cd}±2.60	0.00^{Ce}±1.00	0.00^{Be}±1.00
	1%	0.00^{Aa}±7.00	0.00^{Ab}±5.00	0.08^{Ab}±4.66	0.08^{Ab}±4.66	0.00^{Ac}±4.00	0.00^{Ac}±4.00
	2%	0.34^{Ba}±4.50	0.33^{Aa}±4.50	0.00^{Ba}±4.00	0.21^{Bb}±3.60	0.21^{Bc}±2.60	0.00^{Bd} ±1.00

Values are means and S.D. (n= 7)

Means with the same capital letter in a row were not significantly different at $P<0.05$ level in different treatment.

Means with the same small letter in a column were not significantly different at $P<0.05$ level during storage at 4°C.

high quality of examined sensory indicators (texture, color, odor, taste, and overall acceptability). Treated samples with 2% tamarind solution had lower sensory scores than those of 1% treatment and control one at day 0 in odor and taste indicators but this difference was not significant ($P>0.05$). In all treatments, the score of all sensory indicators decreased by passing the time in control treatment. As the score of texture and color at day 9 and the other indicators at day 6 reached to acceptable quality of minimum score. Assessors expressed that the samples treated with 2% tamarind solution were unacceptable but the samples treated with 1% tamarind solution had a good quality score until day 15.

Discussion

The results showed that washing silver carp fillets with tamarind solution has significant effects on all measured parameters. The highest growth of spoilage pathogens in control samples was occurred as reported in other works (Samelis et al., 2001; Schillinger et al., 1996). The number of total bacteria load in control samples was significantly higher than those treated fillets with tamarind solution showing inhibitory effects of tamarind on bacteria which it is in agreement with the results of Parhusip Adolf et al. (2011). The most outstanding characteristic of tamarind is its sweet acidic taste (El-Sidding et al., 1999). Phytochemical components such as tannins, flavonoids, alkaloids and several other aromatic compounds are secondary metabolites of plants that serve as defense mechanisms against microorganisms, insects and herbivores (Lutterodt et al., 1999). Phenolic compounds act on double membrane of phospholipid cells and causes increasing the penetration and leak of interacellular's necessary elements (e.g. iron, ATP, nucleic acid and amino acid) (Yaldaei et al., 2013). In addition, it possibly harms the enzymatic system of bacteria causing bacteria's death (Hyytiä et al., 1999).

The low initial muscle pH value reflects the good nutritional state of fish. The pH value in tamarind treatments decreased slowly during the storage period. This could be due to production of lactic acid produced during glycolysis (Massa et al., 2005). Furthermore, denaturation of proteins starts to produce some products such as amines (Massa et al., 2005; Woywoda et al., 1986). The degradation of nitrogen compositions is led to the increase of pH in meat during the storage, and also pH increases due to the production of alkaline compositions during

this process. Increasing pH can indicate the bacteria growth, reduction of quality and finally fish spoilage (Gram and Huss, 1996). Low pH of the treated fillets with tamarind solution can be related to tamarind anti-bacterial characteristic (De et al., 1999). Such process may contribute to decline muscle pH, by inhibiting growth of bacteria, as well as buffering the basic metabolites (Calo-Mata et al., 2008). It can be concluded that the lower pH values of 1 and 2% treated fillets may restrain microbial growth and inhibit the activity of the endogenous proteases, leading the extension of the preservation of silver carp fillets.

The peroxide value (PV) is used to measure the primary lipid oxidation especially hydro-peroxides. These are mainly due to chemical changes in muscle tissue as a result of a wide range of factors particularly the nature of lipid, process involving oxidation of the unsaturated fatty acids or triglycerides in fish (Ashie et al., 1996). Factors that may influence lipid oxidation are microbial spoilage, biochemical substances and environmental conditions (Erkan and Özden, 2008). Based on the results, PV of fillets was within the acceptable limit of 10-20 meq/kg of fat (Connell, 1990). The increase of PV in fillets treated with tamarind solution indicated the development of spoilage and rancidity during fish storage. The increase of PV during the storage period was significant for all treatments which it is in agreement with the results of Özogul et al. (2005) and Pacherco-Aguilar et al. (2000). The lipid oxidation value in fish commonly increases due to lipid oxidation by extending storage period. Lipid oxidation is one of the basic factors to make an unpleasant taste in meat (Guillén and Ruiz, 2004). Less peroxide value of fillets treated with tamarind solution is due to inhibiting the lipid oxidation by tamarind solution (El-Siddig et al., 2006). Tamarind absorbs free radicals because it has phenolic compositions with a convoluted basis, thus it inhibits spoilage, color change or lipid rancidity by impeding oxidation (El-Siddig et al., 2006). In addition, it has an important role to inhibit lipid oxidation (El-Siddig et al., 2006). There is a positive relationship between phenolic value and extracts, essences anti-oxidation property (Tsai et al., 2008). According to the results, the treatment of fish fillets with 2% tamarind solution has higher anti-oxidation properties and therefore, the peroxide value in 2% treatment was significantly lower than those of control one and 1% treatment.

In present study, TBA value in control treatment was about 3 mg/kg at day 15 and the values of 1% and 2% tamarind treatments were 1.35 and 0.5 mg/kg, respectively. These results showed a positive effect of tamarind to inhibit and delay of fillet spoilage. Increasing lipid oxidation during storage can be due to more free iron releasing and other per oxidants from the muscle with more analysis during the storage (Chaijan et al., 2006). Chaijan et al. (2006) pointed out that by increasing the storage period, hydrolysis and fish lipid oxidation increase and also hydroperoxids and paired DNs is produced. Therefore, time increases producing secondary reaction products of lipid oxidation that reacts with TBA reactor (Chaijan et al., 2006). The existence of such compositions in fish meat causes changes in its sensory characteristics such as taste and odor (Dragoev et al., 1998; Ladikos and Lougovois, 1990). The decrease of the content of thiobarbitoric acid at some days of storage may be due to decreasing hydroperoxids and reaction between malonede aldehyde and proteins, amino acids and glycogen that decrease the content of malonede aldehyde (Gomes et al., 2003; Ojagh et al., 2010). The results showed that tamarind has anti-oxidant effect and it can delay fish meat spoilage which accords with the results of Yaldaei et al. (2013).

Comparison of TVB-N value of the control sample with those of treated samples in different storage periods showed a significant difference from day 3 afterward. The increase of TVB-N value was presumably due to the bacteria activity during the storage period in refrigerator (Ibrahim and Desouky, 2009). The results also showed that TVB-N value in tamarind treatments was under the standard quantity (25 mg /100 g) at the end of the storage period. As it seems, tamarind causes less degradation of the

proteins via microorganisms by decreasing pH and microbial load and it also effects on TVB-N (Hebard et al., 1982; Giménez et al., 2002; Arashisar et al., 2004). The results of the present study was in agreement with the findings of Rostamzad et al. (2010) who studied anti-oxidant effect of the citric acid on lipid spoilage in the frozen fillets of *Acipenser persicus* during 6 months storage.

Sensory assessment is applied as one of the methods to evaluate fish quality during the storage period in many studies (Fan et al., 2008; Fan et al., 2009; Mexis et al., 2009; Ojagh et al., 2010). By storing the silver carp fillets in refrigerator, a considerable changes was found in its sensory attributes. The results of taste, odor, texture, color and total acceptability of silver carp fillets showed that all samples were in a very good condition at day 0 except 2% treatment that its odor and taste indicators were undesirable.

By passing the time, tamarind treated samples had more desirable conditions of all factors than control samples. This showed the role of tamarind solution anti-oxidant attributes to keep tamarind samples quality (El-Siddig et al., 2006). The total of evaluated sensory attributes expresses considerable prominence of 1% tamarind fillets in ratio with the other samples. Fan et al. (2008) reported that sensory scores of silver carp fillets treated with tea polyphenol decrease by increasing storage period, and its sensory attributes receive a higher score.

As conclusion, the chemical and microbial results of present study showed that using tamarind water solution as natural anti-oxidant and anti-bacterial compositions can decrease the intensity of bacteria activity which exists on the surface of fish meat. It can also delay the oxidation spoilage and therefore increases fish shelf life. The comparison between control samples, and 1 and 2% tamarind treatments showed a significant difference between them in terms of the examined chemical and bacterial parameters. The increases in the spoilage factor was significantly lower in the 1% samples than in the control samples and all the factors of 2% was significantly lower than 1%. According to the results, the concentration of 2% tamarind has more anti-oxidation properties and all the factors value in 2% treatment was significantly lower than those of control and 1% samples. This study showed the positive effect of tamarind to inhibit and delay fish fillet spoilage. According to sensory evaluation, the density of 1% tamarind was selected as the best concentration.

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چکیده فارسی

بررسی اثر شست‌وشو با محلول آبی تمبر هندی (*Tamarindus indica* L.) بر زمان ماندگاری فیله کپور نقره‌ای (*Hypophthalmichthys molitrix*) در خلال نگهداری در یخچال

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چکیده:

در مطالعه حاضر اثرات ضد باکتریایی و ضداکسیداسیونی محلول آبی تمبرهندی بر زمان ماندگاری فیله کپورنقره‌ای (*Hypophthalmichthys molitrix*) در خلال نگهداری در یخچال مورد بررسی قرار گرفت. تیمارهای تحقیق شامل فیله‌های بدون شست‌وشو با محلول آبی تمبرهندی (تیمار شاهد)، فیله شسته شده با محلول آبی ۱ درصد تمبرهندی و فیله‌های شسته شده با محلول آبی تمبر هندی ۲ درصد بودند. آزمایش‌های میکروبی، فیزیکوشیمیایی و حسی شامل شمارش بار باکتریایی کل (TVC)، محتوای پراکسید (PV)، شاخص تیوباربیتوریک اسید (TBA)، بازهای نیتروژنی فرار (TVB-N) و pH در یک دوره ۱۵ روزه نگهداری در یخچال (در فواصل زمانی ۳ روزه) مورد بررسی قرار گرفتند. آنالیز ترکیب تقریبی همچنین در روز صفر انجام پذیرفت. میزان باکتری کل در روز صفر در تیمار شاهد، تیمار ۱ درصد و تیمار ۲ درصد شست‌وشو با محلول آبی تمبرهندی به ترتیب برابر با ۰/۹۳، ۰/۵۰ و ۰/۱۰ log CFU/g بود که در انتهای دوره به ترتیب به میزان ۶/۲۴، ۵/۸۲ و ۵/۲۱ log CFU/g افزایش یافت. مقدار پراکسید، تیوباربیتوریک اسید و مجموع بازهای نیتروژنی فرار در انتهای دوره نگهداری برای نمونه شاهد، تیمار ۱ درصد و تیمار ۲ درصد شست‌وشو با محلول آبی تمبرهندی به ترتیب برابر به ۴/۸،۳/۴ و ۳/۰ میلی اکی‌والان گرم اکسیژن در کیلوگرم چربی ماهی، ۲/۷۵، ۱/۳۵ و ۰/۵۰ میلی‌گرم مالون آلدئید در ۱۰۰ گرم گوشت ماهی و ۳۳/۱۷، ۲۳/۹۰ و ۲۲/۱۰ میلی گرم نیتروژن در ۱۰۰ گرم گوشت ماهی رسید. نتایج نشان دهنده تاثیر مثبت شست‌وشو با محلول آبی تمبرهندی بر جلوگیری و تاخیر فساد فیله‌ماهی بود. بر اساس نتایج ارزیابی حسی، غلظت ۱ درصد تمبرهندی به عنوان بهترین غلظت انتخاب گردید.

کلمات کلیدی: کپورنقره‌ای، تمبر-هندی، زمان ماندگاری، نگهداری در یخچال.