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Chemical and antimicrobial properties of silver carp surimi enriched by Thyme leaves extract

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Abstract

In this study, effect of Thyme (*Thymus vulgaris*) ultrasonic extract on the quality of *Hypophthalmichthys molitrix* surimi was evaluated. For this purpose, the leaves of *Thymus vulgaris* were dried, grinded and soaked in methanol (1:10 w/v) for 30 min at 45˚C and sonicated at 30 kHz for 15 min at 40˚C. The extract was suspended by Dimethyl sulphoxide and mixed with surimi (0.4 and 0.8% w/w). Then, the analysis of chemical (free fatty acid, peroxide value, Thiobarbituric acid and total volatile base nitrogen) and microbial (mesophilic and psychrotrophic viable count) properties of the samples were done at specific intervals after zero, 4, 8, 12 and 16 days of storage at 2 ºC. Results of chemical and microbial analysis showed that 0.8% concentration of *T. vulgaris* could increase the shelf life of *Hypophthalmichthys molitrix* surimi and there is significant difference between control and treated samples. Moreover, the results could be claimed that the *T. vulgaris* due to marvelous antioxidant and antimicrobial component such as thymol (52.17%), ρ-cymene (14.42%), carvacrol (9.11%) and γ- terpinene (4.45%) has significant effect on preventing the *Hypophthalmichthys molitrix* surimi oxidation and microbial growth. The results also showed ultrasound was the effective way to extract the *Thymus vulgaris* beneficial compounds.

Keywords: Antioxidant; Fish; Shelf life; Surimi, Thyme

Introduction

Rancidity caused by oxidation of fish lipids is one of the major problems encountered in fish processing, producing off-flavor and reducing their nutritional value (M. Asnaashari, Farhoosh, & Sharif, 2014). Many efforts have been carried out for supplying fresh fish according to consumer's demand (Farhoosh *et a*l,. 2016).

The use of natural antioxidants is one of interest to processing industry (Asnaashari *et al*,. 2015; Eshghi *et al.*, 2014). Many natural compounds have been extracted and used as antimicrobial agents in food preservation like essential oils and extracts from herbal plants acting against food spoilage and suppressing a wide variety of pathogens (Asnaashari *et al*., 2015; Asnaashari *et al*., 2016; Farahmandfar, *et al*., 2015). Thyme (*Thymus vulgaris*), belongs to *Lamiaceae* family (Gandomi *et al*., 2009) is extensively used as a flavor ingredient in a wide variety of food in Iran. This plant possesses carvacrol, thymol as main phenolic compounds and p-cymene as main non-phenolic compounds (Sharififar *et al*., 2007). Its antioxidant property is due to free radical production chain with one hydrogen atom to break up fat oxide and subsequent delay that able to inhibit linoleic acid oxidation (Asnaashari *et al*., 2015). Thyme has also antibacterial effect and could be used as an antibacterial preservative in hamburger or other meat products (Sharafati Chaleshtori, *et al*., 2013).

Production of fish protein ingredients such as surimi, minced fish and fish protein isolate is common (Farahmandfar *et al*., 2016; Ruusunen & Puolanne, 2005; Shaviklo & Johannsson, 2006). Surimi contains about 76% water, 15% protein, 6.85% carbohydrate, 0.9% fat and 0.03% cholesterol (Chaijan *et al*., 2004; Jin *et al*., 2007). Suitable properties of surimi such as light color, bland odor, low fat

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content and high in myofibrillar proteins as well as considerable functional characteristics due to the unique gelling property of its concentrated proteins, make surimi as a perfect functional ingredient to make up new food products (Lanier *et al*., 2013).

In recent years, ultrasound-assisted maceration (UAM) has received considerable attention for the recovery of different compounds from various sources. This technique is attractive because of its simplicity and low equipment cost and temperature (avoid thermal damage), high efficiency and saving time of extraction compared with solvent extraction. It has been suggested that improvement of solvent extraction from material by ultrasound is due to mainly the mechanical effects of acoustic cavitation, which enhances mass transfer and solvent penetration into the plant material by disrupting the cell walls (Farahmandfar *et al*., 2015)

The aim of this study was to use of ultrasound-assisted maceration for extraction of *T. vulgaris* and its effect on quality properties of *Hypophthalmichthys molitrix* surimi after 0, 4, 8, 12 and 16 days of storage at 2°C.

Materials and Methods

Materials

T. vulgaris wild leaves were collected from Mazandaran (north of Iran), and dried in oven (Behdad, Iran) then leaves were powdered by mixer (Panasonic, MK-G20NR). 5 Silver carp (*Hypophthalmichthys molitrix*) were purchased from warm water fish farm in Mazandaran province (north of Iran). Average characteristics of fish were male, 1 year, 40 cm length, 10 cm width and 1.25 kilograms. They were transferred to laboratory under cool chain and stored at 2˚C for 4h for further processing. All chemical reagents used for experiments were analytical grade.

Ultrasound-assisted extraction

Crushed dried *T. vulgaris* leaves were added to appropriate methanol (1:10 w/v) in a sample bottle. The leaves were extracted in a shaking water bath for 30 min at 45˚C. The mixture was sonicated with an ultrasonic probe system (Branson, 8510R-Mt, Canada) at 30 kHz for 15 min at 40˚C. The extracts were filtered through Whatman No.1. The organic solvents were concentrated to near dryness using rotary evaporator bath (Buchi EL 141, Switzerland) under reduced pressure (Albu, Joyce, Paniwnyk, Lorimer, & Mason, 2004).

GC-MS analysis

The GC-MS was carried out on an Agilent model 5975C USA mass spectrometry operating in the ionizing energy mode at 70 eV, combined with the GC. The separation was done on a 30 m × 0.25 mm column coated with 0.25 μm HP5-MS. The analytical conditions were as follows: carrier gas, He, 1.3 mL/min in the constant flow mode; injector temperature, 250 ℃; injection volume, 1 μL; split ratio, 15:1; temperature program, 2 min at 40 ℃, raised at 3 ℃/min to 180 ℃, raised at 10 ℃/min to 280 ℃; transfer line to MSD, 280 ℃; MSD, 170 ℃. The ionization energy was 70 eV. The range *m/z* 40-300 was scanned at a rate of 0.52 scans/s. A mixture of the *n*-alkanes (C_9-C_{30}) was analyzed under the same conditions to calculate the retention indices. The compounds were identified according to their mass spectra and their retention indices (Sparkman, 2005).

Sample preparation

The fish were eviscerated, deboned and washed prior to be minced by a meat grinder (Panasonic, MK-G20NR), then the minced fish fillets were processed to surimi. The process involved three washing steps by cold water (10±1°C) for removing water soluble proteins and then dewatered using cloth filtration. In each step, the ratio of water to the minced meat was 3:1 (v/w). During each washing step, the mixture was stirred for 5 min. For more dewatering, at the third step, 0.2% NaCl was added to the mixture (Moosavi-Nasab *et al*., 2005). The extract was suspended by Dimethyl sulphoxide (DMSO) and two concentrations of ultrasound-assisted extraction of *T. vulgaris* (0.4 and 0.8%) were

added to surimi. The surimi was packaged in 100 g containers without open air exposure and evaluated in triplicate for microbial and chemical properties after zero, 4, 8, 12 and 16 days of storage at 2±1ºC. Control experiment was surimi untreated without any *T. vulgaris* extract.

Chemical analyses

Determination of free fatty acids (FFA)

The lipid extraction was performed using the ratio of 20 parts of 2:1 dichloromethane/methanol to 1 part of tissue. A weak salt solution (e.g., 0.66% NaCl) was then added to achieve a final ratio of 8:4:3 dichloromethane/methanol/water including the water contained within the tissue. The dichloromethane phase was concentrated in a rotary evaporator to 20 mL at ambient temperature. The flask was totally covered with a black material to avoid light influence. The lipid extract was deposited in tubes. All of the solvent was evaporated with nitrogen, and 3 mL of cyclohexane was added, followed by 1.0 mL of cupric acetate-pyridine reagent with agitation of the biphasic system for 30 s. After centrifugation at 2000*g* for 10 min, the upper layer was read at 710 nm (Bernárdez *et al*., 2005).

Measurement of peroxide value (PV)

Peroxide value (PV) was measured according to the AOAC method (Willian, 2000). Three samples (each sample 5 g) were weighed in a 250-mL glass and heated in a water bath at 60 °C for 3 min, then thoroughly agitated for 3 min with 30 mL acetic acid–chloroform solution (3:2 v/v) to dissolve the fat. The sample was filtered under vacuum through Whatman No. 1. Saturated potassium iodide solution (0.5 mL) was added to the filtrate, which was transferred into titrator equipped with stirrer and pH electrode. The titration was allowed to run against standard solution of sodium thiosulfate (25 g/L). PV was calculated and expressed as milliequivalent of oxygen per kg of sample:

$$PV = \left(\frac{S \times N}{W}\right) \times 1000 \qquad (1)$$

Where: S is the volume of titration (ml), N the normality of sodium thiosulfate solution (N=0.01), and W the sample weight (kg) (Namulema *et al*.,1999).

Determination of thiobarbituric acid reactive substances (TBARS)

The thiobarbituric acid value was determined colorimetrically (Pezeshk *et al*., 2011). A portion (200 mg) of sample was weighed into a 25 ml volumetric flask. An aliquot (1 ml) of 1-butanol was added to dissolve the sample. A portion (5.0 ml) of the mixture was added into 5 ml of TBA reagent. The test tubes were vortexed and placed in a water bath at 95°C for 120 min, then cooled. Absorbance (As) was measured at 530 nm against water blank. A reagent blank was run and absorbance (Ab) recorded. TBA value (mg of malonaldehyde equivalents/kg of tissue) was obtained by the formula.

$$TBA = \frac{50 \times (As - Ab)}{200} \qquad (2)$$

Determination of total volatile basic nitrogen (TVB-N)

Total volatile basic nitrogen (TVB-N) was determined by distillation after the addition of magnesium oxide to fillet sample (Willian, 2000). The distillate was collected in an Erlenmeyer containing 3% aqueous solution of boric acid and mixed indicator from dissolution of 0.1 g of methyl red and 0.05 g of methylene blue to 100 ml of ethanol 96%. Finally, the boric acid solution was titrated with a 0.1 N hydrochloric acid solution (Namulema *et al.*, 1999).

Microbiological analyses

Ten grams of fish fillet samples (3 samples) were aseptically removed from the trays and homogenized for 1 min in a stomacher (VRN-200, Taiwan R.O.C) containing 90 ml of physiological saline solution (0.85% NaCl) (Merck, Darmstadt, Germany) in triplicate. After resuscitation (for 30 min at 25°C) further decimal serial dilutions were prepared from this homogenate in the same sterile diluent. The appropriate dilutions were subsequently used for enumeration in the samples, at each of

the pre-determined time intervals, during refrigerated storage. Mesophilic and psychrotrophic viable count (MVC and PVC) were determined by inoculating 0.1 mL of the sample homogenate onto triplicate sterile plates of dried Tryptic Soy Agar (Liofilchem, Italy) using the surface spread technique, then the plates were incubated for 48 h at 35 °C and for 10 days at 2°C for MVC and PVC, respectively. All counts were expressed as log CFU/g (Amin, 2012).

Statistical analysis

The obtained data were subjected to one-way analysis of variance using SPSS statistical software, release 18.0. Duncan's new multiple range test was performed to determine the significant differences of the means at the 5% probability level ($P<0.05$).

Results and Discussion

GC-MS analysis of thyme extract

According to GC-MS analysis, the main phenolic and non-phenolic active compounds in Thyme UAM extract were as: thymol (52.17%), ρ-cymene (14.42%), carvacrol (9.11%), γ- terpinene (4.45%), α- terpineol (1.25%), sabinene hydrate (1.56%), linalool (7.32%) and geraniol (1.78%). Thymol, ρ-cymene, carvacrol, γ- terpinene, α- terpineol, sabinene hydrate, linalool and geraniol were the most important compounds in Thymus. In comparison with other studies, recovery of different compounds in conventional method (solvent extraction) were more than UAE technique, however there was not any significant difference (Chizzola *et al*., 2008). In the present experiments, quantitative changes observed in the contents of γ-terpinene, *p*-cymene, carvacrol and thymol can be attributed to their localization in the biosynthetic pathway (Kowalski & Wawrzykowski, 2009). The increase of γ-terpinene concentration may result from the UAM influences on the shift of chemical balance through the conversion of thymol, carvacrol, and *p*-cymene in the biosynthetic pathway in the direction of γ-terpinene synthesis. Researchers found a reduction of the content of important components in tea extract after ultrasonically assisted extraction (Xia, *et al*., 2006). The quantity of these compounds can be also varied due to harvesting season, plant age, soil, climate, geographical sources and herb drying method (Bagamboula *et al*., 2004; Shafiee & Javidnia, 1997).

Chemical analyses of surimi

Free Fatty Acids (FFA)

Free Fatty Acids in fish muscle develop undesirable flavors and tissue damage by a combination of muscle protein. They also accelerate the degeneration and loss of product quality and increase of fat oxidation (Sayyari & Farahmandfar, 2016). The results of FFA in different treatments of *Hypophthalmichthys molitrix* surimi were shown in Table 1. The initial FFA value in all samples at first was 0.41 - 0.51 oleic acid. According to the results, the amount of FFA in all treatments was increased with the passage of time and reached 4.17, 2.43, and 2.11% oleic acid for control, 0.4 and 0.8% thyme, respectively. Similar results were reported by (Zolfaghari *et al*., 2011) study. Although the amount of FFA was increased during storage, but this increase was not regular. The time and concentration had a significant effect on the formation of FFA during storage. The results showed that in the higher concentrations of thyme, formation of FFA was less compared to the other treatments.

Table 1. FFA formation in *Hypophthalmichthys molitrix* surimi samples including 0.4% and 0.8% ultrasound thyme extracted during storage

Storage time (days)	Control	0.4% Extract	0.8% Extract
zero	0.51 ± 0.02^{aE}	0.41 ± 0.02^{aE}	0.45 ± 0.05^{aE}
4	1.21 ± 0.02^{aD}	0.64 ± 0.04^{bD}	0.52 ± 0.07^{bD}
8	2.35 ± 0.04^{aC}	1.29 ± 0.04^{bC}	0.95 ± 0.03^{cC}
12	3.12 ± 0.03^{aB}	1.85 ± 0.07^{cB}	1.43 ± 0.08^{dB}
16	4.17 ± 0.12^{aA}	2.43 ± 0.05^{cA}	2.11 ± 0.08^{dA}

Means with the same small letters in a raw and capital letters in a column were not significantly different ($P < 0.05$).

Peroxide value (PV)

PV values in treated and control samples of *Hypophthalmichthys molitrix* surimi are shown in Figure 1. The initial PV value in all samples at the beginning of storage period was 0.83-0.86 meqO_2/kg. PV values after 16 days of storage period were 5.13, 4.24 and 4.13 meqO_2/kg for control, 0.4 and 0.8% of thyme UAM extracts, respectively. Significant lower PV value was observed for treated samples during the storage period at 4ºC ($P<0.05$).

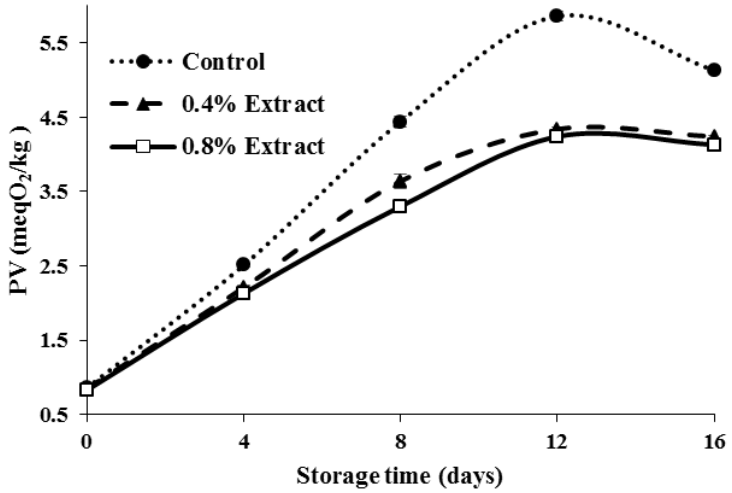

Fig. 1. Hydroperoxide formation (PV) in Hypophthalmichthys molitrix surimi samples including 0.4 and 0.8% ultrasound thyme extracted during storage

The PV value is an index of lipid oxidation measuring primary oxidation products (Farhoosh *et al*., 2016). Fish are very susceptible to both microbiological and chemical deteriorations, due to their chemical composition (Goulas & Kontominas, 2007). Storage of food products is accompanied by oxidation of unsaturated fatty acids. This process is important in seafood due to higher poly-unsaturated fatty acid content. Degradation of products formed during oxidation of unsaturated fatty acids is followed by the formation of low-molecular-weight volatile compounds, which accounts for foreign shades of odor and flavor (Misharina & Polshkov, 2005).

The primary value of PV in *Hypophthalmichthys molitrix* surimi was lower than raw and unwashed compared samples of *Hypophthalmichthys molitrix* reported by Asgharzadeh, Shabanpour, Aubourg, and Hosseini (2010). The results of present study indicate that the UAM is effective in retarding the production of primary lipid oxidation. Similar results, conventional maceration, were obtained by Mexis, Chouliara, and Kontominas (2009) and Ojagh, Rezaei, Razavi, and Hosseini (2010). The major protective effect of UAM thyme extract is owed to its carvacrol, thymol content (Mexis *et al*., 2009). Similar consequences were expressed by Ojagh *et al*. (2010).

Thiobarbituric acid reactive substances (TBARS)

TBA value in treated and control samples of *Hypophthalmichthys molitrix* surimi are shown in Table 2. The initial TBA value in all samples at first was 0.55-0.65 mg of malonaldehyde/kg fat. TBA value increased with time of storage at 2˚C for all treatments and reached 3.65, 3.22, and 2.87 for control, 0.4 and 0.8% thyme, respectively. Significant lower of TBA value was observed for treated samples and 0.8% of thyme during the storage period at 4˚C ($P<0.05$). TBA values of control and 0.4% samples reached the maximal

recommended limit (Lakshmanan, 2000) for TBA values of fish (2 mg of malonaldehyde/kg of tissue) at 8th of storage, while for 0.8% treatment, TBA content was still lower than upper acceptability limit.

Table 2- TBA value changes in *Hypophthalmichthys molitrix* surimi samples including 0.4% and 0.8% ultrasound thyme extracted during storage

Storage time (days)	Control	0.4% Extract	0.8% Extract
zero	0.55 ± 0.01^{aE}	0.65 ± 0.05^{aE}	0.61 ± 0.03^{aE}
4	1.85 ± 0.05^{aD}	1.32 ± 0.02^{bD}	1.25 ± 0.04^{bD}
8	2.65 ± 0.12^{aC}	2.25 ± 0.11^{bC}	1.84 ± 0.01^{cC}
12	3.25 ± 0.17^{aB}	2.56 ± 0.02^{bB}	2.29 ± 0.04^{cB}
16	3.65 ± 0.23^{aA}	3.22 ± 0.06^{bA}	2.87 ± 0.03^{cA}

Means with the same small letters in a raw and capital letters in a column were not significantly different ($P < 0.05$).

Thiobarbituric acid (TBA) is a common indicator for the assessment of degree of lipid oxidation (Manju *et al*., 2007). Results of Pezeshk *et al*. (2011) indicated that the effect of the turmeric extract and shallot extract on the rainbow trout samples decreased the TBA value and increased the shelf life of fish sample during the refrigerated storage. Similar results have been reported by Mexis *et al*. (2009) during storage of oregano essential oil-treated rainbow trout fillets at 2°C.

Total volatile basic nitrogen (TVB-N)

TVB-N values in treated and control samples of *Hypophthalmichthys molitrix* surimi are presented in Fig. 2. The initial TVB-N value in all samples at first was 11.22-11.27 mg N/100g. TVB-N values increased progressively with time of storage at 2˚C for all treatments and reached to 65.7, 53.98 and 38.13 for control, 0.4 and 0.8% thyme UAM extracts, respectively. However, significant lower TVB-N value was observed for treated samples during the storage period at 2˚C ($P<0.05$). TVB-N values of control and 0.4% samples reached the upper acceptability limit set by the EU (European-Union, 1995) for TVB-N values of fish (30 mg/ 100 g of fish flesh) at day 12 of storage, while for 0.8% treatment, TVB-N content was still lower than upper acceptability limit.

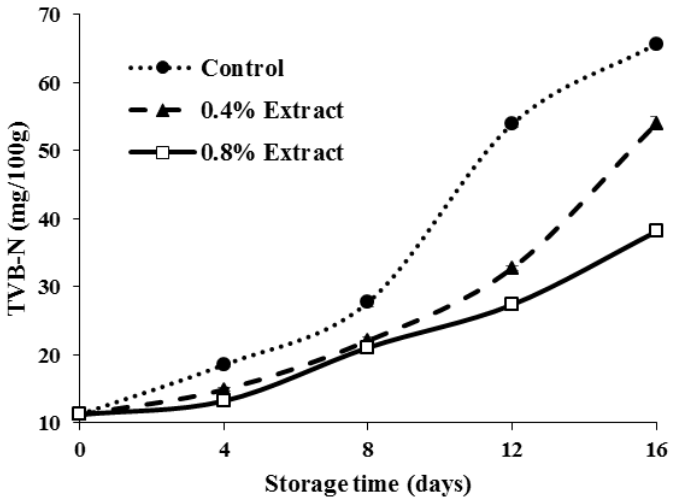

Fig. 2. TVB-N value changes in Hypophthalmichthys molitrix surimi samples including 0.4 and 0.8% ultrasound thyme extracted during storage

TVB-N content in fish muscle is not only different among species but also is variable in same species due to age, sex, season and environment (Razavi Shirazi, 2007). Some researchers concluded that TVB-N was not a good quality index for fish (Mexis *et al.*, 2009), but it could be used as a quality index. Because increasing TVB-N content of fish samples during storage is directly related to the activity of spoilage bacteria and endogenous enzymes (Goulas & Kontominas, 2007; Özogul, Polat, & Özogul, 2004). TVB-N is composed of different compounds including ammonia, methylamine, dimethylamine as well as trimethylamine (Razavi Shirazi, 2007) which are produced by spoilage bacteria and endogenous enzymes.

The lower TVB-N content in samples treated by thyme UAM extract may be attributed to the antibacterial properties of phenolic compounds such as carvacrol, thymol and linalool. Low levels of TVB-N in treated samples can be attributed to either decreased bacterial population or reduced capacity of bacteria for oxidative deamination of nonprotein nitrogen compounds or both (Manju *et al.*, 2007), which was due to the effect of thyme UAM extract. Similar results have been reported by Fahimdezhban, *et al.*, (2014) regarding to *Zataria multiflora* and *Rosemarinus officinalis* extracts on quality of minced frozen *Hypophthalmichthys molitrix*.

Bacteriological analysis of surimi

Changes in MVC and PVC of control and two concentrations of thyme UAM in *Hypophthalmichthys molitrix* surimi, during the refrigerated storage, are shown in Table 3. The initial MVC and PVC (log CFU/g) of samples were from 3.28 to 3.48 and from 3.24 to 3.34 ranges, respectively. By the day 12 of storage, however, MVC and PVC in 0.8% of thyme UAM was still below 7 log CFU/g, while that of controls and 0.4% of thyme UAM attained a count of 8.45 and 7.44 for MVC and 8.20 and 6.47 for PVC. There was a significant difference between control, 0.4 and 0.8% of thyme UAM ($P<0.05$).

Table 3- MVC and PVC changes in *Hypophthalmichthys molitrix* surimi samples including 0.4 and 0.8% ultrasound thyme extracted during storage

Storage time (days)	MVC			PVC		
	Control	0.4%Extract	0.8% Extract	Control	0.4%Extract	0.8% Extract
zero	3.48 ± 0.28^{aE}	3.47 ± 0.19^{aE}	3.28 ± 0.14^{aE}	3.25 ± 0.09^{aE}	3.34 ± 0.06^{aE}	3.24 ± 0.07^{aE}
4	5.44 ± 0.19^{aD}	4.59 ± 0.2^{bD}	4.26 ± 0.1^{bD}	5.31 ± 0.10^{aD}	4.35 ± 0.09^{bD}	4.19 ± 0.03^{bD}
8	6.72 ± 0.37^{aC}	6.07 ± 0.22^{bC}	5.49 ± 0.16^{cC}	6.37 ± 0.04^{aC}	5.51 ± 0.09^{bC}	5.23 ± 0.10^{cC}
12	8.45 ± 0.19^{aB}	7.44 ± 0.2^{bB}	6.36 ± 0.1^{cB}	8.20 ± 0.04^{aB}	6.47 ± 0.09^{bB}	6.24 ± 0.08^{cB}
16	9.36 ± 0.26^{aA}	8.4 ± 0.17^{bA}	7.4 ± 0.12^{cA}	3.25 ± 0.09^{aE}	3.34 ± 0.06^{aE}	3.24 ± 0.07^{aE}

Means with the same small letters in a raw and capital letters in a column were not significantly different ($P < 0.05$).

In the present study, initial MVC and PVC counts indicate good surimi quality (Mexis *et al.*, 2009). Most of the available literature on fresh fish total viable count (TVC) reports bacterial counts of 2-4 (log CFU/g) (Gelman *et al.*, 2001). Fan *et al.*, (2008) have demonstrated the increase of TVC in fish meat during storage. By the day 12 of storage, TVC counts in controls and 0.4% treatments were higher than the maximal recommended limit of 7 log CFU/g for TVC in raw fish (Sallam, 2007).

Most of plant extracts have been shown to inhibit growth of pathogenic bacteria. A number of these agents appear to have structures and modes of action that are distinct from those of the antibiotics in current use, suggesting that cross-resistance with agents already in use may be minimal (Zaehner & Fiedler, 1995).

The gram-negative psychrotrophic bacterial count is major group of microorganisms responsible for spoilage of aerobically stored fish at chilled temperatures (Sallam, 2007). In the current study, the growth pattern of PVC was similar to MVC in different times. A significant increase in PVC with time has also been reported for salmon stored at 1˚C for 15 days (Sallam, 2007). The active compound for the inhibition of *E. coli* and *Salmonella*

enteritidis was identified as Gallic acid. It has been reported that gram-negative bacteria have low susceptibility to plant extracts when compared to gram-positive bacteria. The resistance of gram-negative bacteria to antibacterial substances is related to presence of lipopolysaccharides in their outer membrane. Generally, the extent of the inhibitory effects of the extracts could be attributed to their phenolic composition (Hasani & Hasani, 2014; Tesaki *et al*., 1999).

Conclusion

The shelf life of silver carp surimi is due to the chemical and bacteriological activities in fish leading to loss of quality and succeeding spoilage. Current study showed that silver carp surimi treated with Thyme leaves extract had lower microbiological and chemical indices, during refrigerated storage, because of the antimicrobial and antioxidant properties of the extract. It can be concluded that natural extract from Thyme leaves can be used by the food industry to extent the shelf life because they exhibited promising antioxidant and antimicrobial effect.

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خصوصیات شیمیایی و میکروبی سوریمی ماهی کپور نقره‌ای غنی شده با عصاره برگ آویشن

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چکیده

در این تحقیق، تاثیر عصاره فراصوت آویشن بر خصوصیات ماهی کپور نقره‌ای مورد ارزیابی قرار گرفت. به این منظور، برگ‌های آویشن خشک، آسیاب و در متانول (10:1 وزنی/ حجمی) به مدت 30 دقیقه در دمای 45°C خیسانده و در فرکانس 30 kHz به مدت 15 دقیقه در 40°C فراصوت‌دهی شد. عصاره در دی‌متیل سولفوکسید حل و با سوریمی (0/4 و 0/8 درصد وزنی/ وزنی) مخلوط شد. سپس آنالیز شیمیایی (اسید چرب آزاد، عدد پراکسید، اسید تیوباربیتوریک و ترکیبات فرار بر پایه نیتروژن) و میکروبی (میزان باکتری‌های مزوفیل و سرمادوست) نمونه‌ها در فاصله‌های زمانی معین صفر، 4، 8، 12 و 16 روز در دمای 2 °C انجام شد. نتایج آنالیز شیمیایی و میکروبی نشان داد که غلظت 0/8% آویشن می‌تواند عمر ماندگاری سوریمی کپور نقره‌ای را افزایش دهد و تفاوت معنی‌داری بین نمونه شاهد و تیمارها وجود دارد. علاوه بر این، نتایج نشان دادند که به دلیل مقادیر زیاد ترکیبات آنتی‌اکسیدانی و ضد میکروبی همچون تیمول (52/17%)، p- سیمن (14/42%)، کارواکرول (9/11%) و γ-ترپینن (4/45%) تاثیر معنی‌داری بر جلوگیری از اکسیداسیون و رشد ضد میکروبی سوریمی دارد. نتایج نشان داد که فراصوت روش مفید برای استخراج ترکیبات مؤثره گیاهی می‌باشد.

واژه‌های کلیدی: آنتی‌اکسیدان، ماهی، مدت ماندگاری، سوریمی، آویشن

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