



EFFECT OF POMEGRANATE SAUCE ON THE QUALITY OF MARINATED COMMON CARP FILLETS DURING COLD STORAGE

Amirā E.A. El-Hanafy*

Central Lab. For Aquaculture Res., Agric. Res. Cent., Egypt

ABSTRACT

This study was carried out to evaluate the effect of pomegranate sauce on the chemical, microbiological and sensory quality attributes of marinated common carp fillet storage at 4°C for 3 months. Common carp fillet were marinated with 3% acetic acid and 15% sodium chloride (salt) put into glass jars, filled with either sunflower oil or pomegranate sauce and stored at 4°C. Total volatile basic nitrogen (TVB-N), Trimethylamine (TMA) values, Thiobarbituric acid (TBA), pH values, total bacterial count, psychrophilic bacteria, total yeast and lactic acid bacteria increased significantly during storage. *Staph. aureus*, Enterobacteraceae were not detected in all marinated samples and during cold storage. Sensory scores of both samples significantly decreased throughout the storage, marinated carp in pomegranate sauce had a desirable taste and flavour in comparison with those in sunflower oil. It can be concluded that pomegranate sauce have the ability to delay chemical changes, inhibit lipid oxidation, maintain the sensory attributes in addition to their desirable taste and flavour, therefore it can be used as natural preservative for marinated common carp fillets

Key words: Common carp fish, pomegranate sauce, marinated, fillet.

INTRODUCTION

Pomegranate (*Punica granatum* L.), belongs to the family Punicaceae, has been used extensively in the folk medicine of many countries (Lansky and Newman, 2007). It could be consumed as: fresh fruit, fruit juice, fruit juice concentrate, marmalade, wine or liquor.

Pomegranate fruit contains many different kinds of polyphenolic antioxidants and commercial pomegranate juice has been shown to possess antioxidant activity three times higher than those of red wine and green tea (Gil *et al.*, 2000). The soluble polyphenolic content of pomegranate juice includes punicalagins, anthocyanins, catechins, ellagic tannins, and gallic and ellagic acids (Aviram *et al.*, 2000; Gil *et al.*, 2000). A linear relationship between total phenolic content, antioxidant capacity and antibacterial activity against several microorganisms has been reported (Shan *et al.*, 2007).

Antimicrobial activities of phenolic compounds may involve multiple modes of action. The type of the microorganism and its cell wall structure are thought to play an important role (Shan *et al.*, 2007). Phenolic compounds can denature enzymes (Furneri *et al.*, 2002) but they can also bind to substrates such as minerals, vitamins and carbohydrates making them unavailable for microorganisms (Stern *et al.*, 1996; Shahidi and Naczki, 2004). Similarly, phenolic compounds can also exhibit antioxidant activity by reducing protein oxidation. A significant reactive site can easily be oxidized by oxidizing agents generated during meat storage. Then the oxidation state is of great importance regarding biological activity (Batifoulier *et al.*, 2002).

The protein binding capacity of phenolics is involved in antimicrobial and antiviral activity (Kumar and Vaithyanathan, 1990).

Fish marinades are popular ready-to-eat seafood products. Due to its high nutritional

* Corresponding author: Tel. : +201223869564
E-mail address: aelhanafy68@hotmail.com

value and non necessity of additional preparation by the consumer, the consumption of marinades is constantly growing (Szymczak and Kolakowski, 2012). The term “marinades” or “marinated fish” is used to define fish products which consist of fresh, frozen or salted fish or portions of fish processed by treatment with an edible organic acid, usually acetic acid, and salt and put into brines, sauces, or oil (Meyer, 1965).

Nevertheless polyunsaturated fatty acids are susceptible to oxidation which is responsible for rancidity taste and loss in nutritional value. Various synthetic antioxidants, such as butylated hydroxytoluene (BHT) butylated hydroxyanisole (BHA), tert-butylhydroxyquinone (TBHQ) and propyl gallate (PG) have been used in various food products in order to prevent lipid oxidation but there is a growing demand for naturally derived antioxidants obtained from wide variety of different plant sources (Kindleysides *et al.*, 2012).

Generally fish marinades are packed with various vegetable oils or sauces considering to consumers preferences. Although there are many studies about marination of fish, studies on marinated fish packed with sauce are limited. Pomegranate juice are rich in polyphenols. These polyphenols exhibit various biological activities, such as eliminating free radicals, inhibiting oxidation and microbial growth, and decreasing the risk of cardio and cerebrovascular diseases and some cancers (Caliskan and Bayazit, 2012).

Pomegranate fruit posses effective anti-bacterial, anti-inflammatory, anti-oxidative, anti-tumor, and anti-cancer properties both *in vitro* and *in vivo* (Lansky and Newman, 2007). This study aims to investigate the quality changes of marinated common carp fillet in pomegranate sauce during storage at 4 °C compared with marinated common carp fish in sunflower oil. This study aims to investigate the quality changes of marinated common carp fillet in pomegranate sauce during storage at 4 °C compared with marinated common carp fillet in sunflower oil.

MATERIALS AND METHODS

Materials

Common Carp fish (*Cyprinus carpio*) was obtained from El-Abbassa farm, Abu Hammad-Sharkia.

Commercial pomegranate juice concentrate (PJC) was purchased from a local supermarket.

Preparation of fish samples

Common carp fish transferred directly in ice boxes to the laboratory. Fish samples were immediately washed with tap water, and eviscerated, filleted and washed.

Methods

Preparation of Pomegranate sauce

Pomegranate sauce was prepared using pomegranate juice concentrate and distilled water. The brix of pomegranate juice concentrate which was 52 as measured by hand refractometer. The selected ratio of pomegranate sauce to water was 2:1. This ratio was determined in preliminary trials. In these trials, different ratios were tested and the most suitable ratio giving the best taste and aroma was determined by sensory evaluation.

Marination Process

All fish samples were immersed into a solution consisting of 3% acetic acid and 15% NaCl. The ratio of fish to solution was 1:1.5 (w: v). The immersing process was performed at ambient temperature (25 ± 2 °C). The maturation process was completed within 30 hr. The marinated fish was removed from the solution and put into glass jars. Jars filled with marinated fish were divided into two groups. The first group of jars was filled with sunflower oil, and the second group with pomegranate sauce. All samples were stored at 4 °C and analyzed to determine the quality changes at monthly intervals.

Chemical Analyses

Fish samples from each jar were randomly taken drained and homogenized using a kitchen blender. All assays were conducted on triplicate samples of the homogenates.

Determination of Total Phenolic Content in Pomegranate Juice

The concentration of phenolics in pomegranate juice concentrate was determined by the method of Negi and Jayaprakasha, (2003). Samples (0.2 ml) were mixed with 1.0 ml of 10-fold diluted Folin–Ciocalteu reagent (Merck, Darmstadt, Germany) and 0.8 ml of 7.5 g/100 g sodium carbonate solution (Merck, Darmstadt, Germany). After standing for 30 min at room temperature,

the absorbance was measured at 765 nm using Shimadzu, Japan, UV-visible spectrophotometer, total phenolic contents were expressed as milligram gallic acid equivalents (GAEs) per 100 g of extract.

pH Value

The pH value was determined by dipping a pH electrode into homogenates of filleted common carp muscle in distilled water (1:1). All measurements were performed at room temperature ($25\pm 1^\circ\text{C}$) using pH-meter, according to the method of Osman *et al.* (2014).

Total Volatile Bases Nitrogen (TVB-N) and Trimethylamine (TMA)

Fish extracts for determination of total volatile bases nitrogen (TVB-N) and trimethylamine (TMA) were prepared by homogenizing 100 g of fish sample with 200 ml of 7.5% (v/v) aqueous trichloroacetic acid (TCA) solution in a laboratory homogenizer for 1 min at high speed. The homogenate was centrifuged at 3000 rpm for 5 min and the supernatant was then filtered through Whatman No. 1 filter paper. TVB-N was measured by steam-distillation of the TCA-fish extract, using the modified method of Malle and Tao (1987). Twenty-five millilitres of the filtrate were loaded into a Kjeldahl-type distillation tube, followed by 5 ml of 10% (w/v) aqueous NaOH solution. Steam-distillation was performed using a vertical steam distillation unit, and the distillate was received into a beaker containing 15 ml of 4% (v/v) aqueous boric acid solution up to a final volume of 50 ml. The titration was allowed to run against aqueous 0.05 M sulphuric acid solution, using an automatic titrator (DL 25 Titrator, Mettler-Toledo AG, Greifensee, Switzerland) equipped with stirrer and pH electrode. The same experimental procedure as for TVB-N was used for the TMA measurement (Malle and Poumeyrol, 1989). The only difference was the addition of 20 ml of 35% (v/v) formaldehyde to the distillation tube to block the primary and secondary amines, whilst leaving only the tertiary amines to react. The amounts of TVB-N and TMA were calculated from the volume of 0.05 M sulphuric acid used for titration and the results were expressed in mg nitrogen/100 g of sample.

Assessment of Lipid Oxidation

Thiobarbituric acid

The 2-thiobarbituric acid (TBA) assay, as an index for lipid oxidation, was carried out according to the procedure of Schmedes and Holmer (1989). Fish sample (10 g) was mixed with 25 ml of 20% trichloroacetic acid (w/v) and homogenized in a blender for 30 s. After filtration, 2 ml of the filtrate were added to 2 ml of 0.02 M aqueous TBA in a test tube. The test tubes were incubated at room temperature in the dark for 20 hr., then the absorbance was measured at 532 nm by using a UV-VIS spectrophotometer (model UV-1200, Shimadzu, Japan). TBA value was expressed as mg malonaldehyde (MA) per kg of fish sample.

Microbiological examination

Total bacterial count and psychrophilic bacteria

Total bacterial count (TBC) and psychrophilic bacterial count were determined using plate count agar medium APHA (1992)

Total Mould and yeast count

Mould and yeast counts were determined using Oxytetracycline glucose yeast extracts agar (Oxoid CM 545) medium Oxoid Manual (1982).

Enterobacteriaceae

The count of *Enterobacteriaceae* was determined on violet red bile dextrose agar medium after incubation at 37°C for 20-24 hr., (Roberts *et al.*, 1995)

Staphylococcus aureus

Staphylococcus aureus was enumerated on Baird Parker medium using surface plating technique (IAEA 1970).

Lactic Acid Bacteria

Lactic acid bacteria were determined by using the pour plate method. MRSA (LAB M 93) was used as medium. Plates were incubated at 30°C for 3-5 days (Dalgaard and Jorgensen, 1999).

Sensory Evaluation

Sensory evaluation was performed by a test panel of five panelists. The panelists evaluated the samples for odour, appearance and taste on a nine-point hedonic scale. A score of 9-7

indicated "very good", a score of 6.9–4.0 "good", a score of 3.9–1.0 denoted as spoiled (Amerina *et al.*, 1965).

Statistical Analysis

One-way analysis of variance (ANOVA) was used and means comparison was performed by Duncan's multiple range tests (Steel and Torrie, 1980). Statistical analysis was carried out using SPSS statistic program (Version 10.0) for Windows (SPSS Inc. Chicago, IL).

RESULTS AND DISCUSSION

Total Phenolic Content of pomegranate juice

Phenolic compounds of plant origin have attracted considerable attention due to their beneficial functional and nutritional effects including antioxidant and antimicrobial activity. In addition to extending shelf-life of foods by inhibition of lipid peroxidation. The phenolics act in the scavenging of free radical and can protect the human body against damage caused by them (Bubonja *et al.*, 2011).

In this study the total phenolic contents of pomegranate juice (PJ) was 60 mg gallic acid equivalents (GAE)/100g. Total phenolic concentrations in pomegranate juice varies within the limits of 0.2–1.0%, depending on variety and include mainly tannins, ellagic tannins, anthocyanins, catechins, gallic and ellagic acids (Ignarro *et al.*, 2006).

Quality Characteristics and Microbiological Aspects of Raw and Marinated Common Carp Immersed in Sunflower Oil or Pomegranate Sauce after Preparation

Total Volatile Basis Nitrogen (TVBN) has been widely used to evaluate fish quality. TVBN content of 25–35 mg/100 g has been established as critical limits for the acceptability of fish. These values could be vary depending on whether the fish is fresh or processed (Dalgaard, 2000). TVBN of raw fish was 11.69 mg/100g (Table 1). This means that the fish was in good quality according to European Union (1995). There was a significant reduction ($p < 0.05$) in TVB-N value of samples in pomegranate sauce, this results agreed with those obtained by Gokoglu *et al.* (2009) and Osman *et al.* (2014).

The quantity of TMA found in fish is used as an index of spoilage. In fresh fish, the TMA-N value is about 1 mg/100 g; in spoiled samples it is above 8 mg/100 g (Kilinc and Cakli, 2005). In this study the TMA-N value of raw carp fish was found to be 0.41 mg/100 g. TMA of samples in pomegranate sauce significantly decreased in comparison to those in sunflower oil. This may be resulted from the inhibitory effect of the pomegranate juice on the microbial proliferation, including the TMAO reducing microorganisms as reported by Osman *et al.* (2014).

It has been proposed that a maximum TBA value (indicating the good quality of the fish frozen, chilled or stored with ice) is 5 mg malonaldehyde /kg, while the fish may be consumed up to a level of 8 mg malonaldehyde/kg in TBA value (Schormüller, 1969). TBA value of raw material was found to be 0.45 mg malonaldehyde/kg. However TBA value of samples in sunflower oil was significantly higher ($p < 0.05$) compared to raw fish samples and samples in pomegranate sauce (Table 1).

Osman *et al.* (2014) showed that the sauce contains 50% pomegranate juice, which containing high proportion of pomegranate juice, showed the highest antioxidant activity during the storage of marinated anchovy.

The data obtained in the present study suggest that TBA values of marinated fish were within the good quality limits after preparation of the study. These results agreed with Gokoglu *et al.* (2009).

The pH of fresh fish is often between 6.0 and 6.5 (Kilinc and Cakli, 2005). pH value in raw carp flesh was 6.52 (Table 1). After marination process, pH dropped down to 4.96 and 5.03 for samples in pomegranate sauce (PS) and sunflower oil (SF), respectively, Gokoglu *et al.* (2009) and Osman *et al.* (2014).

Results of microbiological examination are given in Table 1. The total bacteria, psychrophilic bacteria, total yeast; total mould; lactic acid bacteria, *Staphylococcus aureus* and Enterobacteriaceae counts of raw carp were 4.48; 2.41; 2.34; 1.1; 3.03; 1.1 and 1.2 log₁₀ CFU/g, respectively. After marination, significant reduction in microorganisms was observed with

Table 1. Quality characteristics and microbiological aspects of raw marinated common carp immersed in pomegranate sauce (PS) or sunflower oil (SF) after preparation

Parameter	Fresh carp fillets	PS	SF
Quality characteristics			
TVBN (mg nitrogen /100g)	11.69±0.03a	10.83±0.04 ^A	11.62±0.06 ^a
TMA(mg nitrogen /100g)	0.41±0.03a	0.29±0.03 ^A	0.40±.03 ^a
TBA (mg malonaldehyde /kg)	0.45±0.03a	0.43±0.03 ^a	0.63±0.02 ^A
pH	6.52±0.05a	4.96±0.03 ^A	5.03±0.03 ^A
Microbiological aspects (Log₁₀ cfu/g)			
Total bacterial count	4.48±0.02a	2.36±0.02A	2.38±0.02A
Psychrophilic	2.41±0.01a	1.10±0.03 ^A	1.13±0.04 ^A
Yeast	2.34±0.01a	1.22±0.01 ^A	1.24±0.02 ^A
Mould	1.1	<10	<10
Lactic acid bacteria	3.03±0.1a	1.08±0.01A	1.07±0.02A
<i>Staphylococcus aureus</i>	1.2	ND	ND
Enterobacteriaceae	1.1	ND	ND

Means in rows with different superscripts are significantly different within each fish species ($p < 0.05$). by Duncan's multiple range test ; ND: not detected.

samples immersed PS and SF. The counts of *staph aureus* and Enterobacteriaceae were not detected after marination, these results are in agreement with Kilinc and Cakli, (2005).

Changes in pH Values of Marinated Common Carp immersed in Sunflower Oil (SF) and Pomegranate Sauce (PS) During Storage at 4 °C±1

Marinades have a low pH due to the acetic acid content. During storage of marinated common carp slightly increment was happened in both samples (Fig. 1) which were 4.96 and 5.03 for samples in Ps and samples in SF, respectively, at zero time of cold storage reached to 4.80 and 5.50 at the first and third month. This may be due to that heterofermentative lactic acid bacteria can grow during the storage of marinades and cause the amino acids to degrade. Thus, formation of carbon dioxide and other decarboxylation products. (Shenderyuk and Bykowski, 1989).

According to statistical variance analysis, this increase was ($p > 0:05$) not significant for samples in pomegranate sauce and significant for samples in sunflower oil. Insignificant change in pH values of marinated anchovy

sauced with concentrated pomegranate juice was reported by Gokoglu *et al.* (2009) during their storage at the refrigerated temperature.

TVBN Values of Marinated Common Carp in Sunflower Oil (SF) or Pomegranate Sauce (PS) During Storage at 4 °C±1

During storage of fish, the TVBN values significantly ($p < 0.05$) increased Fig. 2, reached 12.91 and 22.10 mg N/100g for samples in PS or in SF, at the end of the storage period, respectively. Higher TVB-N values were found in samples of sunflower oil compared to those samples in pomegranate sauce. A similar pattern of the increase in TVB-N was reported for Pacific saury (Sallam *et al.*, 2007), for marinated anchovy sauced with concentrated pomegranate juice and for sardine marinades sauced with tomato during refrigerated storage(Gokoglu *et al.*, 2009).

TMA Values of Marinated Common Carp in Sunflower Oil (SF) or Pomegranate Sauce (PS) During Storage at 4 °C±1

In this study, TMA values of all samples, significantly increased ($p < 0.05$) during the storage (Fig. 3) which were 0.29 and 0.39 mg/100 g at zero time of storage and reached 2.30

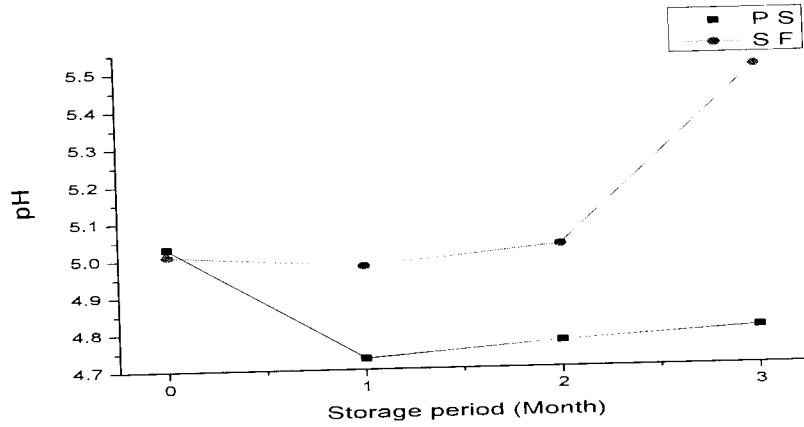


Fig. 1. Changes in pH values of marinated common carp in sunflower oil (SF) or pomegranate sauce (PS) during storage at 4 °C±1

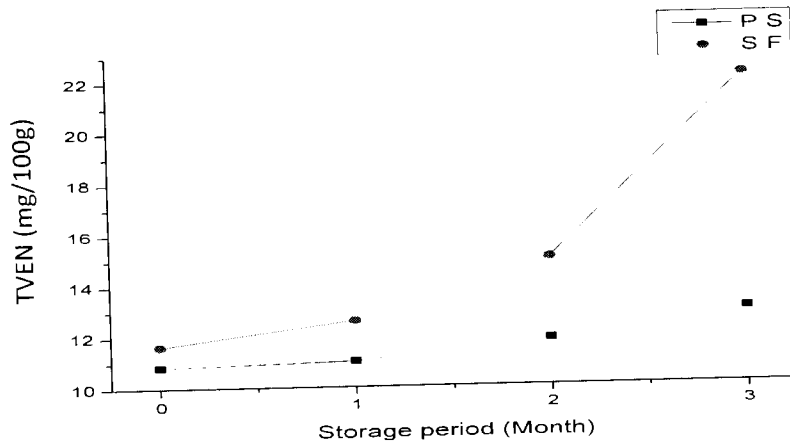


Fig. 2. Changes in TVBN values of marinated common carp in sunflower oil (SF) or pomegranate sauce (PS) during storage at 4 °C±1

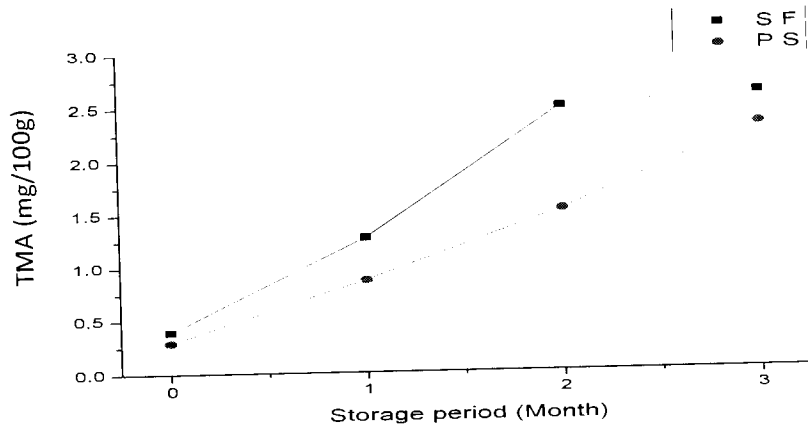


Fig. 3. Changes in TMA (mg/100g) values of marinated common carp in sunflower oil (SF) or pomegranate sauce (PS) during storage at 4 °C±1

and 4.59 mg/100 g for samples in pomegranate sauce and samples for sunflower oil, respectively. Higher ($p < 0.05$) TMAN values were found for samples in sunflower oil compared to those samples in pomegranate sauce this may be attributed to the inhibitory effect of the pomegranate juice on the microbial proliferation, including the TMAO reducing microorganisms as reported by (Osman *et al.*, 2014). Similar results were reported in the previous researches (Dokuzlu 2000; Gokoglu *et al.*, 2009).

TBA (Mgmalonaldehyde/kg) Values of Marinated Common Carp in Sunflower Oil (SF) or Pomegranate Sauce (PS) During Storage at 4°C±1

Thiobarbituric acid is used to determine secondary oxidation products in oil and oily foods (Shahidi and Wanasundara, 1998).

TBA value of all samples significantly ($p < 0.05$) increased during cold storage (Fig. 4) These increase in sunflower oil samples was higher ($p < 0.05$) compared to samples in pomegranate sauce (Fig. 4). These results indicated that the use of pomegranate sauce in marinated carp is effective to reduce lipid oxidation. Similar results were obtained by Gokoglu, *et al.* (2009).

Microbiological Examination

Total bacterial count

The initial microbiological quality is very important for the shelf life of fish products. Total bacterial count (TBC) is an important criterion for quality evaluation. A significant increase in total bacterial count of marinated carp samples were observed (Fig. 5). Wherever TBC of marinated common carp in SF significantly higher than marinated common carp in PS at the end of cold storage period. This may be attributed to high proportion of polyphenolic compounds that exists in pomegranate sauce which posses' antimicrobial activity (Gil *et al.*, 2000).

Psychrophilic bacteria

Pseudomonas spp. has been incriminated as the main spoilage bacteria in fish stored in ice mainly because of their short generation time (Papadopoulos *et al.*, 2003).

The changes in psychrophilic bacteria count of marinated carp in PS and marinated carp in

SF during cold storage are illustrated in Fig. 6. During storage psychrophilic bacteria count was increased in all samples. Samples in SF were significant increase in comparison with samples in PS. This may attributed to the high proportion of polyphenolic compounds that exists in pomegranate sauce which posses' antimicrobial activity (Gil *et al.*, 2000).

A significant increase in psychrotrophic count with time has also been reported for anchovies brined in 14% NaCl solution and stored at 4°C for 150 days (Karacam *et al.*, 2002)

Total yeast count

The changes in yeast count of marinated carp in PS and marinated carp in SF during cold storage are shown in Fig. 7. During storage yeast count was increased in all samples. Samples in SF were significant increase in comparison with samples in PS; this may be attributed to the inhibitory effect of the pomegranate juice on the microbial proliferation (Osman *et al.*, 2014).

Lactic acid bacteria (LAB)

Fig. 8 shows the changes in LAB count of marinated carp in PS and marinated carp in SF during cold storage. During storage Lactic acid bacteria count was increased in all samples. These results agreed with (Kilinc and Cakli, 2005). However, samples treated with SF were significantly higher in comparison with samples in PS (Gil *et al.*, 2000).

Sensory evaluation

The sensory analysis results are presented in Table 2. Sensory scores (appearance, odour and taste) of both samples were significantly decreased ($p < 0.05$) throughout the storage. Appearance scores of samples in pomegranate sauce were significantly lower ($p < 0.05$) than those found in sunflower oil because of the penetration of pomegranate sauce into fish tissue caused darkening of fish. In general consumers preferred white colour in marinated fish. For this reason low scores for appearance of samples in pomegranate sauce were given by the panelists. However, higher ($p < 0.05$) odour and taste scores for samples in pomegranate sauce were found compared to samples in sunflower oil. Pomegranate sauce also produced desirable taste and flavour in marinated carp fillets. Decreasing of sensory scores with the increasing of storage was also reported by (Gokoglu *et al.*, 2009; Sallam *et al.*, 2007).

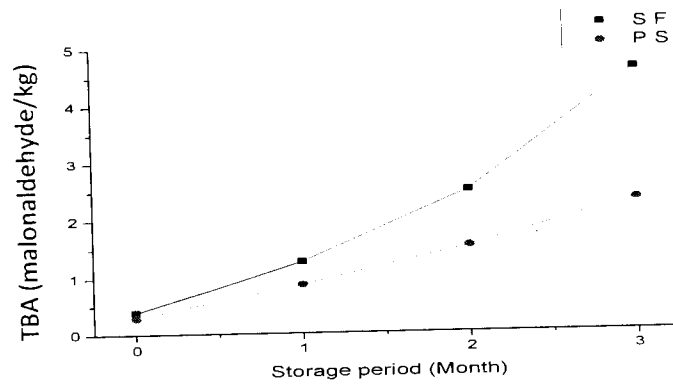


Fig. 4. Changes in TBA (mg malonaldehyde/kg) values of marinated common carp in sunflower oil (SF) or pomegranate sauce (PS) during storage at $4^{\circ}\text{C}\pm 1$

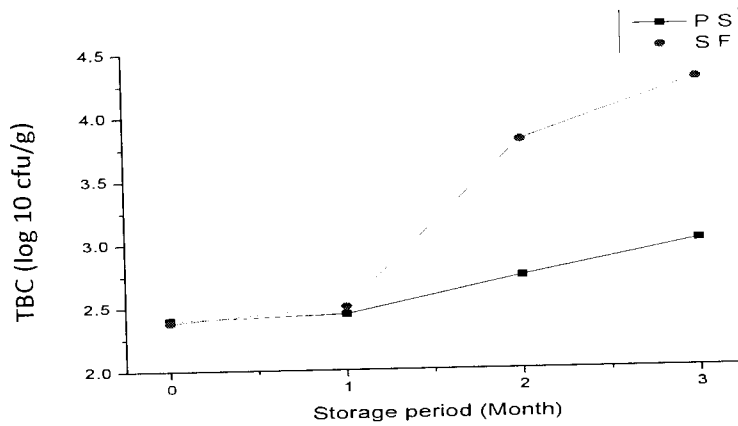


Fig. 5. Changes in Total bacterial count (TBC) (\log_{10} cfu/g) of marinated common carp in sunflower oil (SF) or pomegranate sauce (PS) during storage at $4^{\circ}\text{C}\pm 1$

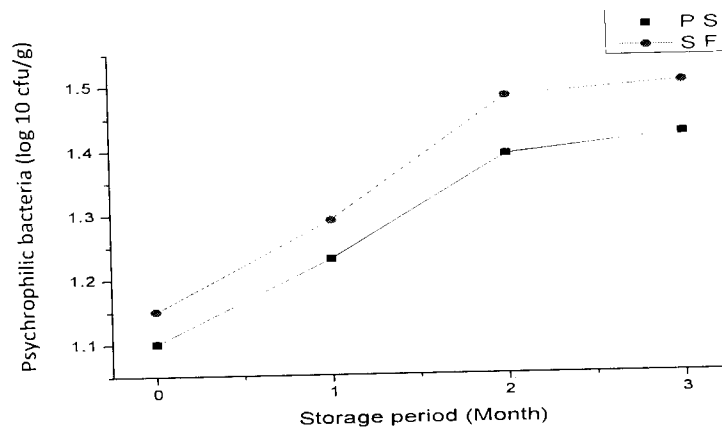


Fig. 6. Changes in Psychrophilic bacteria (\log_{10} cfu/g) of marinated common carp in sunflower oil (SF) or pomegranate sauce (PS) during storage at $4^{\circ}\text{C}\pm 1$

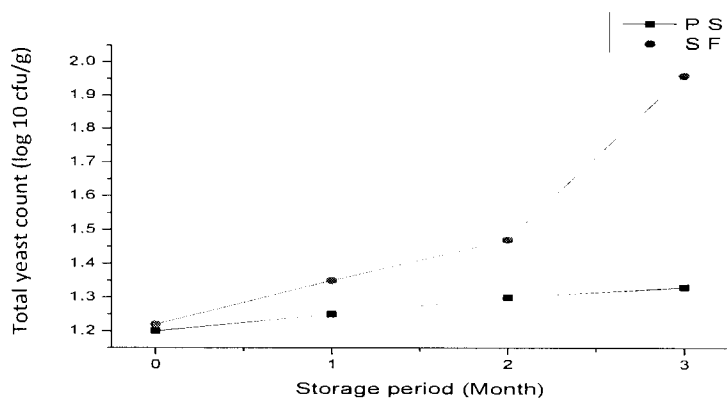


Fig. 7. Changes in Total yeast count (\log_{10} cfu/g) of marinated common carp in sunflower oil (SF) or pomegranate sauce (PS) during storage at $4^{\circ}\text{C}\pm 1$

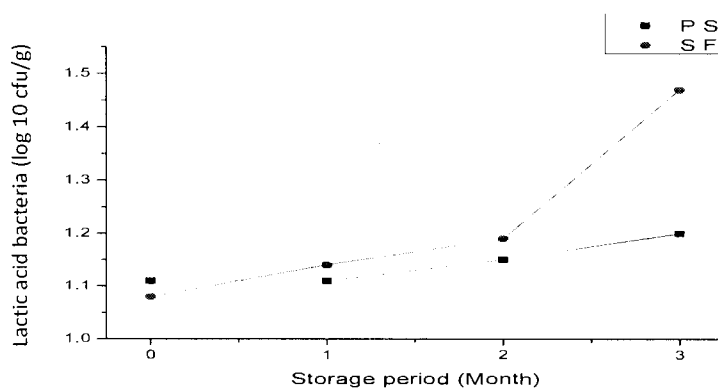


Fig. 8. Changes in lactic acid bacteria (LAB) (\log_{10} cfu/g) of marinated common carp in sunflower oil (SF) or pomegranate sauce (PS) during storage at $4^{\circ}\text{C}\pm 1$

Table 2. Sensory analyses of marinated common carp fillet in pomegranate sauce or sunflower oil during cold storage $4^{\circ}\text{C}\pm 1$

Storage period (month)	0		1		2		3	
Treatment	PS	SF	PS	SF	PS	SF	PS	SF
Appearance	9.00	9.00	8.52	8.90	7.20	8.40	5.07	6.90
	$\pm 00a$	$\pm 00a$	$\pm 0.2 a$	$\pm 0.06a$	$\pm 0.05b$	$\pm 0.03b$	$\pm 0.3c$	$\pm 0.06c$
Odour	9.00	9.00	8.60	7.50	8.30	6.80	7.10	4.90
	$\pm 00a$	$\pm 00a$	$\pm 0.09b$	$\pm 0.07b$	$\pm 0.08c$	$\pm 0.03c$	$\pm 0.01d$	$\pm 0.06d$
Taste	9.00	9.00	8.49	7.50	8.40	7.03	5.70	4.50
	$\pm 00a$	$\pm 00a$	$\pm 0.3b$	$\pm 0.03b$	$\pm 0.05b$	$\pm 0.2c$	$\pm 0.01c$	$\pm 0.03d$

Conclusion

It can be concluded that pomegranate sauce have the ability to delay chemical changes, inhibit lipid oxidation, maintain the sensory attributes in addition to their desirable taste and flavour; therefore it can be used as natural preservative for marinated common carp fillets.

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تأثير صوص الرمان علي جودة شرائح سمك المبروك العادي المخلل أثناء التبريد

أميرة إبراهيم علي الحنفي

المعمل المركزي لبحوث الثروة السمكية بالعباسة - مركز البحوث الزراعية - مصر

أجريت هذه الدراسة لتقييم تأثير صوص الرمان علي الجودة الكيميائية والميكروبية والحسية لشرائح سمك المبروك العادي المخلل والمخزن علي درجة ٤م لمدة ٣ شهور، تم تمليح وتحميض شرائح سمك المبروك العادي بإضافة ٣% حامض الخليك و ١٥% ملح طعام وتم تقسيمه لمجموعتين الأولى في عبوات زجاجية ويتم تعبئتها في زيت دوار الشمس (الطريقة التقليدية) والمجموعة الثانية في صوص الرمان و خزنت علي ٤م لمدة ٣ شهور، أوضحت النتائج زيادة معنوية في كل الاختبارات التي اجريت اثناء التخزين لجميع العينات تحت الدراسة ولكنها في حدود الجودة الكيميائية والميكروبية لكلا من القواعد الكلية النيتروجينية الطيارة وثلاثي ميثيل أمين وحمض الثيوباربيتوريك والرقم الهيدروجيني والعدد الكلي للبكتيريا والبكتيريا المحبة للبرودة والعدد الكلي للخمائر وبكتيريا حمض اللاكتيك، قضت المعاملات تماما علي البكتيريا العنقودية الذهبية والمجموعة المعوية، وأظهرت النتائج أن عينات صوص الرمان أفضل في المحافظة علي عوامل الجودة (الحدود الكيميائية والميكروبيولوجية) من عينات زيت دوار الشمس، جميع العينات تحت الدراسة اظهرت انخفاضا معنويا في الخواص الحسية (المظهر العام، الطعم والرائحة) أثناء التخزين، توصي هذه الدراسة باستخدام صوص الرمان في تعبئة شرائح المبروك العادي المخلل لزيادة مدة الحفظ اثناء التخزين بالتبريد.

المحكمون:

١- أ.د. عاطف عز الرجال إبراهيم
 ٢- أ.د. سامي محمد أبو المعاطي

أستاذ مراقبة جودة وتصنيع الأسماك- المعمل المركزي لبحوث الثروة السمكية بالعباسة.
 أستاذ الصناعات الغذائية - كلية الزراعة - جامعه الزقازيق.