

EFFECT OF SODIUM LACTATE ON SOME PHYSICO-CHEMICAL QUALITY OF FRESH FISH FILLETS AT LOW TEMPERATURE

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ABSTRACT

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The purpose of this investigation was to determine the effects of sodium lactate (SL) on physico-chemical characteristics of fresh fish fillets stored at 4°C for six days. Untreated Fish fillets (as control (T1)) samples. Sodium lactate (SL) solutions were prepared at the concentration of 2% and 4% (v/v). Fillets samples were dipped and sprayed with SL up to 10 minutes (T2: 2% immersion, T3: 2% spraying, T4: 4% immersion, T5: 4% spraying). The samples were then kept in refrigeration at 4.0°C for 6 days and evaluated for some physical and chemical characteristics, in WHC percentage, After 6 days, It observed that there were no significant differences ($P>0.05$) among treatments. For cooking loss, results showed there were no significant differences ($P>0.05$) among treatments after 6 days. It observed that T1 treatment had higher pH values (7.110) than other treatments. The results showed that T1 had higher ($P\leq 0.05$) Thiobarbituric acid (TBA) values (4.065 mg malonaldehyde/ kg) as compared with fish fillets treated with sodium lactate. The highest percentage of free fatty acids recorded in T1 (2.950%), while the lowest percentage recorded in T3 and T4 (0.350 and 0.150% respectively). Results of sensory evaluation showed no significant differences among treatment during storage periods. It can be concluded that we can treated fish fillets with sodium lactate as antioxidants for prolonging the shelf-life of fresh common carp fish (*Caprinus caprio*) fillets during cold storage for 6 days.

Key words: Sodium lactate, fresh fish fillets, lipid oxidation, WHC, pH.

INTRODUCTION

Throughout history, the meat industry has utilized non-meat ingredient, to extend in the shelf life of products. The classic use of salt and /or nitrate to control and limit microbial growth and to provide flavor stability during storage has provided needed insurance for meat product shelf life. Consumers concern for food safety continues to make methods of extending meat product shelf life a high priority throughout the meat industry (Miller, 1992).

Many organic acids are approved as food additive by USDA legislation and they are added to foods for different purposes (Stratford and Eklund, 2003).

Sodium lactate (SL) is an organic acid, colorless, non- volatile compound that has an acid taste, is used in ready to eat meat products as humectants and flavor enhancer as well as an antimicrobial agent in meat and poultry products (Shelef, 1994), as shelf life extender and in some times used as a replacement, at least partially, for sodium chloride resulting in a less

salty taste (Houtsma *et al.*, 1996). Also, SL is applied to beef, sheep and poultry carcasses as 1-4 % dipping or spraying solution to lower viable microbial count during storage (Wicklund *et al.*, 2006). Sodium lactate is a chelate of metal in food and may be able to stabilize fatty acids and reduce lipid oxidation in food system (Shelef, 1994); it can also reduce cooking loss of meat products (Williams and Phillips, 1998), also have been proposed for prolonging the shelf life of meat (Maca *et al.*, 1997) fish muscle (Zhuang *et al.*, 1996) as well as poultry flesh (Williams and Philips, 1998).

Marine lipids with their high level of polyunsaturated fatty acids (PUFA) largely contribute to human diet (Ackman, 1999). Also, they may act as primary agents in autoxidative damage (Flick and Martin, 1992). Most important problem for safeguarding seafood during either storage or processing is the Lipid oxidation (Tang *et al.*, 2001).

Therefore, the objectives of this study were to determine the effects of sodium lactate in two

concentrations (2 and 4%) and in two methods (immersion and spraying) on some physico-chemical characters of fresh fish fillets stored at 4 °C for six days.

MATERIALS and METHODS

Fresh common carp fish (*Caprinus caprio*) was purchased after being harvested, from a local market. The fish were headed, eviscerated, washed and immediately transported to the laboratory in boxes containing enough slurry ice. The fish were skinned and filleted manually. The muscular part of the truck was used for the analysis.

Fish fillets were untreated as control (T1) sample. Sodium lactate (SL) solutions were prepared at the concentration of 2 and 4% (v/v). Fillets were dipped and sprayed with pre-chilled SL up to 10 minutes (T2: 2% immersion, T3: 2% spraying, T4: 4% immersion, T5: 4% spraying). The samples were then stored under refrigerated conditions (4.0°C).

Four replicate samples were taken on 0 (before treatment), 3 and 6 days of the storage time.

Analysis:

Water holding capacity (WHC) was measured according to Wardlaw *et al.* (1973), A meat sample (8 g) and 12 ml of 0.6 M NaCl solution were put into a tube. The tubes were placed into a water bath (5 °C) for 15 min. Then, the tubes were centrifuged at 4100 rpm (5°C) for 15 min. The tubes were poured into a volumetric cylinder in order to collect the separated fluid. The WHC was calculated using the volume of separated fluid (ml)/ 100g meat.

Cooking loss was measured according to Cyril *et al.* (1996), Twenty gram of chicken meat samples were placed in open aluminum boxes and cooked for 15 minute in the oven, pre-heated to 200 C°, after cooking, the samples were dried with a paper towel (cooled for 30 min to 15 C°). Total cooking loss was estimated on each sample as percentage ratio between cooked and raw weight.

The pH of the meat specimens were measured according to Naveena and Mendiratta (2001), A 10 g of samples were homogenized with (50 ml) of distilled water then filtered through whatman no.1 filter paper. The pH of filtrate samples were measured using digital pH meter (WTW 2f40-11420 D. Germany).

Thiobarbituric acid (TBA) value analysis was analyzed according to Tarladgis *et al.* (1960) as adopted by Witte *et al.* (1970), TBA values were expressed as mg malonaldehyde/ kg, A twenty gram

of meat was blended with 50 ml of the extracting solution containing 20% Trichloroacetic acid (TCA) in 2 M phosphoric acid. The sample was diluted to 100 ml with distilled water and homogenized by shaking. 50 ml portion was filtered through whatman No. 1 filter paper, 5 ml of filtrate was transferred to the test tube followed by 5 ml Thiobarbituric acid (0.005 M in distilled water). The tube was stoppered and the solution mixed by inversion and kept in the dark place for 15-17 hour at room temperature. The resulting color was measured at 530 nm using UV spectrophotometer (Shimadzu, Japan). TBA values were calculated by multiplying absorbance value of sample by 5.2, the TBA values were calculated as mg MDA /kg meat.

FFA was analyzed as method described by Egan *et al.* (1981), A 100 gm of homogenized with 250 ml of chloroform, blend the mixture for 2-3 min and filter it immediately through a large filter paper. Then re-filter it through a paper containing a small amount of anhydrous sodium sulphate, twenty five ml of 95% ethanol neutralized with drops of 0.1 N NaOH after adding phenolphthalein. The solution was added to 25 ml of the filtered above and the mixture titrated with 0.1 N NaOH until the pink colour persists for 15 seconds. The F.F.A. calculates as oleic acid as percentage of the sample.

For organoleptic evaluation, the meat samples were placed in open aluminium boxes and cooked for 15 min in a pre-heated oven at 200°C (Castellini *et al.*, 2002). After cooking, nine teaching staff of the Department of Animal Production, Agricultural Sciences Faculty, University of Sulaimani gave their opinion for the sensory evaluation.

Statistical analysis:

The XL Stat program for Windows was used to study factors examined (treatment and period) in traits. Duncan multiple ranges used to significantly compare between means ($p < 0.05$) (Steel *et al.*, 1996).

RESULTS

Water holding capacity and cooking loss percentages:

The results of Water holding capacity (WHC) percentage are showed in (Table, 1), results showed T1 and T3 significantly differ ($P \leq 0.05$) from T5, the highest WHC percentage recorded in T4 and T5 (4% immersion and spraying) (46.500 and 46.500% respectively) while the lowest WHC percentage recorded in T1 (control) (39.00 %) at 0 day, while after 3 days of storage the fillets; samples were treated with SL at concentrations 2% (T2 (immersion)) and 4% (T3 (immersion)) had higher

WHC (41.00 and 46.50% respectively) as compared to the T1 (control treatment) and other treatments. After 6 days, It observed that there were no significant differences ($P>0.05$) among treatments.

When compared WHC percentages of same treatment in different periods, results showed there were no significant differences ($P>0.05$) in WHC at 0, 3, and 6 days for T1 and T2, while percentage of WHC at 6 day differ significantly at 0 and 3 day, for T3 and T5, the results recorded a lower WHC percentage as compared to other periods (Table, 1).

For cooking loss (CL) percentage, at the same period, results showed there were no significant differences ($P>0.05$) between treatments before treated (0 day) with sodium lactate. After 3 day of storage, results showed that T1 was significantly ($P\leq 0.05$) differentiated than T3 and T4 treatments, fillets samples were un treated (T1) had higher CL percentage (43.500%) while the lowest percentage of CL recorded in T3 and T4 (40.00 and 39.500% respectively). After 6 day, results showed there were no significant differences ($P>0.05$) in CL among treatments. When compared cooking loss percentages of same treatment in different period, results showed there were no significant ($P>0.05$) differences in CL at 3 and 0 day, while after 6 days of storage, the results recorded a higher CL percentage (only for T1) (50.00%) as compared with CL percentages as measured at 3 and 0 day (43.50 and 44.00% respectively).

pH value:

The initial pH values in fresh fish fillets at 0 day (before treatment) which ranged from 6.710 to 6.475 (Table, 2). After 3 day of storage, results showed that there were no significant differences ($P>0.05$) in pH values among treatments which ranged from 6.715 in T1 to 6.485 in T2. After the 6 day of storage, results showed that T1 recorded a higher ($P\leq 0.05$) pH values (7.110) as compared to T2, T3, T4 and T5 which had pH values were 6.980, 6.785, 6.825 and 6.670 respectively. When compared pH values of same treatment in different periods, results showed that pH values after 6 day of storage recorded higher ($P\leq 0.05$) pH value as compared to other periods except T5 treatment.

Thiobarbituric acid (TBA) values and free fatty acids values:

Effects of different concentration of sodium lactate (SL) on Thiobarbituric acid values (TBA) of fresh

fish fillets during storage at 4°C for 6 days are presented at table (3). Results showed there were no significant ($P>0.05$) differences among treatments at 0 day. After 3day of storage, the results showed that control treatment(T1) recorded, highest TBA values (1.275 mg malonaldehyde/ kg) as compared with TBA values for T2, T3, T4 and T5 treatment which were 0.640, 0.600, 0.555 and 0.500 mg malonaldehyde/ kg respectively. After 6 day of storage, also T1 treatment gave a higher TBA values (4.065 mg malonaldehyde/ kg) as compared with TBA values for T2, T3, T4 and T5, (1.725, 1.400, 1.500 and 1.415 mg malonaldehyde/ kg respectively).

When compared TBA values of same treatment in different periods, results showed that TBA values after 6 day of storage, recorded highest TBA value compared to other periods (Table, 3).

When compared among treatments at the same periods, results of free fatty acids (FFA) percentage are showed (Table, 3) no significant differences ($P>0.05$) among treatments at 0 day and 3 day of storage. After 6 days of storage, there were significantly ($P\leq 0.05$) differences among treatments except between T3 and T4, the results showed that T1 treatment gave a higher FFA (2.950%) after 6 days of storage, while the lowest percentage recorded in T3 and T4 (0.350 and 0.150% respectively).

When compared FFA percentages of same treatment in different periods, results showed that FFA percentages after 6 day of storage, recorded highest FFA value as compared to other periods except for T4 results showed no significant differences between periods.

Sensory evaluation:

Table (4) showed the sensory traits of fresh fish fillets treated with sodium lactate storage under refrigeration. Results of sensory traits at 0 day (before treated) and after 6 day of storage showed there were no significantly differences ($P>0.05$) between all treatment for color, flavor-aroma, tenderness, juiciness and over all acceptability.

When compared sensory trait of same treatment in different periods, results showed that sensory trait after 6 day of storage no significant differences ($P>0.05$) than to other storage periods for all treatment, which recorded lowest values as compared with other sensory traits at 0 day (figure .1).

Table 1: Effect of different concentrations of sodium lactate (SL) on water holding capacity (WHC) percentages and cooking loss (CL) percentages of fresh fish fillets during storage at 4°C for 6 days.

Treatment		Water holding capacity (WHC)%			Cooking loss (CL) %		
		Storage time (day)					
		0	3	6	0	3	6
control	T1	39.00 ^c A	37.50 ^b A	37.00 ^a A	44.00 ^a B	43.50 ^a B	50.00 ^a A
	IM T2	41.50 ^{bc} A	41.00 ^{ab} A	37.50 ^a A	41.00 ^a A	42.500 ^{ab} A	48.00 ^a A
2% SL	SP T3	44.00 ^{ab} A	35.00 ^b B	36.50 ^a B	39.50 ^a A	40.00 ^b A	36.50 ^a A
	IM T4	46.50 ^a A	46.50 ^a A	37.50 ^a B	39.50 ^a A	39.500 ^b A	36.00 ^a A
4% SL	SP T5	46.50 ^a A	40.50 ^{ab} B	38.50 ^a B	39.00 ^a A	41.050 ^{ab} A	37.50 ^a A

-Means having different lower-case at the same column and upper-case at the same row are significantly different at (p < 0.05). IM: immersion, SP: spraying.

Table 2: Effect of different concentrations of sodium lactate (SL) on pH values of fresh fish fillets during storage at 4°C for 6 days.

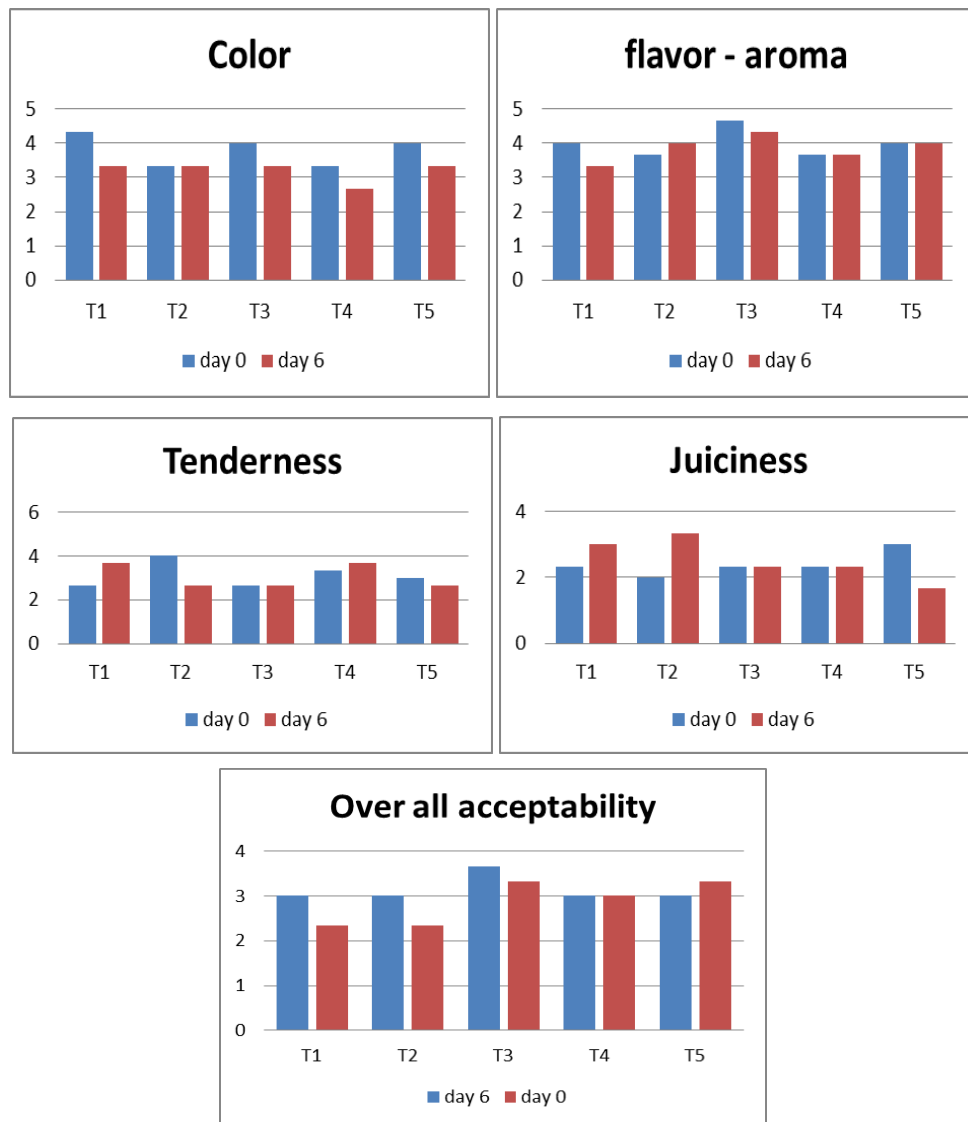
Treatment		Storage time (day)		
		0	3	6
control	T1	6.710 ^a B	6.715 ^a B	7.110 ^a A
	IM T2	6.475 ^a A	6.485 ^a A	6.980 ^b A
2% SL	SP T3	6.500 ^a B	6.560 ^a B	6.785 ^b A
	IM T4	6.500 ^a B	6.565 ^a B	6.825 ^b A
4% SL	SP T5	6.530 ^a A	6.570 ^a A	6.670 ^b A

-Means having different lower-case at the same column and upper-case at the same row are significantly different at (p < 0.05). IM: immersion, SP: spraying.

Table 3: Effect of different concentrations of sodium lactate (SL) on Thiobarbituric acid values and free fatty acids percentages of fresh fish fillets during storage at 4°C for 6 days.

Treatment		Thiobarbituric acid value (mg malonaldehyde/ kg)			Free fatty acids value (%)		
		Storage time(day)					
		0	3	6	0	3	6
Control	T1	0.275 ^a B	1.275 ^a B	4.065 ^a A	0.020 ^a B	0.035 ^a B	2.950 ^a A
	IM T2	0.275 ^a B	0.640 ^b B	1.725 ^b A	0.030 ^a B	0.035 ^a B	1.250 ^b A
2% SL	SP T3	0.415 ^a B	0.600 ^b B	1.400 ^b A	0.021 ^a B	0.027 ^a B	0.350 ^d A
	IM T4	0.385 ^a B	0.555 ^b B	1.500 ^b A	0.030 ^a A	0.022 ^a A	0.150 ^d A
4% SL	SP T5	0.335 ^a B	0.500 ^b B	1.415 ^b A	0.022 ^a B	0.022 ^a B	0.900 ^c A

-Means having different lower-case at the same column and upper-case at the same row are significantly different at (p < 0.05). IM: immersion, SP: spraying.



T1: control, T2: 2% immersion, T3: 2% spraying, T4: 4% immersion, T5: spraying.

Figure (1): Effect of different concentrations of sodium lactate (SL) on sensory traits of fresh fish fillets during storage at 4°C for 6 days.

DISCUSSION

The determination of the WHC and cooking loss allows conclusions to be drawn about the degree of denaturation of the proteins and therefore the quality of the fish (Skipnes *et al.*, 2007).

The results were showed that there are no significant differences ($p > 0.05$) among treatments after 6 days of cold storage at 4° C, on the other hand, all treatments showed a gradual decrease in WHC as a storage time was progressed, it may be due to the protein lose their buffering capacity as the distance from isoelectric point increases (Offer and Trinick, 1983) or due to increase moisture loss during storage (Lawrie, 2002).

Our study showed that increase of cooking loss in all treatments after increase of storage, and cooking loss percentage is higher in T1(control) than other treatments, Wang (2000) observed that the cooking

loss increased with extending storage period, and AL-Haju (2005) who recorded the increase in cooking loss associated with advancing in storage period. The moisture loss through cooking was mentioned to be associated with weight loss which leads to loss of meat juice or drips, water evaporation, evaporation of volatile materials, some nutritious elements loss, extracting of meat juice due to cooking shrinkage and loss of water soluble nutritional elements (Gorge, 2000).

In the current study, sodium salts have significant ($P \leq 0.05$) effect on pH changes of fish fillets as compared with the control and as well no significant ($P > 0.05$) differences were observed between different treatments which treated with sodium lactate, Benjakul *et al.* (2002) showed that the decomposition of nitrogenous compounds caused increase in pH of fish flesh with the storage time ($P > 0.05$). The results revealed that pH values increased with progress in

storage period, which was observed by Jayesh and Venkatarmanujam (2000) and Kandeepan and Diswas (2007). Significant increase in pH with prolonged storage time may be attributed to the fact that meat undergoes autolysis resulting in a decrease in water holding capacity (Strange *et al.*, 1977).

All treatment after 6 days of storage recorded TBA values within the good quality product (Günşen *et al.*, 2011) who suggested that TBA values in good quality product should not be more than 5mg malonaldehyde/kg. while Connell (1995) indicated that rancidity appears in fish when TBA become greater than 1-2mg malonaldehyde/kg, according to previous references TBA value in T1 recorded un acceptable value and other treatment recorded lowest value and this may due to effect of sodium lactate as antioxidant (Hagharast *et al.*, 2010, Sallam, 2007).

The production of free fatty acids (FFA) is measured to study the progress of lipid hydrolysis and can be used to determine the degree of deterioration of food products (Barthet *et al.*, 2008).

In the current study, sodium salts, conspicuously reduced the rate of lipid damage, Egan *et al.* (1997) suggested that the acidity could be felt when FFA calculated, as oleic acid, reach to 1.5%; only control treatment exceed this percentage.

Accumulation of FFA does not in itself affect quality attributes of the product but have been shown to interrelate with lipid oxidation and have been proposed to have a pro-oxidant effect on lipids (Rodriguez *et al.*, 2006). Therefore, the higher value of FFA is possibly due to the action of lipolytic enzymes on lipid from higher bacterial count leading to increase in the release of free fatty acids, which contribute positively to the generation of undesirable aroma and flavor (Al-Sherick, 2005).

CONCLUSIONS

Accordingly, inhibitory effects of sodium lactate on lipid hydrolysis and as antioxidants; they can be employed as useful antioxidants in prolonging shelf-life of fresh common carp fish (*Caprinus caprio*) fillets stored under refrigeration.

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تأثير لآكتات الصوديوم في بعض الصفات الفيزيوكيميائية لشرائح لحوم الأسماك الطازجة والمخزنة بدرجات حرارة منخفضة

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أجريت هذه الدراسة لغرض تحديد تأثير لآكتات الصوديوم في بعض الخصائص الفيزيائية والكيميائية لشرائح السمك الطازج والمخزنة في درجة 4 مئوية لمدة ستة أيام ، المعاملة الأولى (معاملة السيطرة) وهي شرائح السمك الغير معاملة ، لآكتات الصوديوم حضر بتركيزين 2 و 4% (حجم/ حجم) ، المعاملة الثانية شملت شرائح السمك المغمورة بتركيز 2% ، المعاملة الثالثة شملت شرائح السمك المعاملة برذاذ لآكتات الصوديوم تركيز 2% ، المعاملة الرابعة شملت شرائح السمك المغمورة بتركيز 4% ، المعاملة الخامسة شملت شرائح السمك المعاملة برذاذ لآكتات الصوديوم تركيز 4% ، حيث تم معالجتها بهذه التراكيز لمدة عشر دقائق وبعد ذلك خزنت المعاملات الخمسة بالتبريد (4 مئوية) لمدة ستة أيام ، وجرى تقييم بعض الصفات الفيزيائية والكيميائية لهذه الشرائح. نسبة قابلية حمل الماء (WHC) ، وبعد 6 أيام، ولاحظت أنه لا توجد فروق معنوية ($p > 0.05$) بين المعاملات. بالنسبة للفقد اثناء الطبخ لم تسجل فروقات معنوية بين المعاملات بعد 6 أيام من الخزن. لوحظ ان المعاملة الأولى سجلت اعلي قيم الاس الهيدروجيني وبفرق معنوي ($p \leq 0.05$) عن بقية المعاملات (7.11). بالنسبة لقيم حامض الثايوبرايبيوتريك فقد سجلت المعاملة الاولى اعلي القيم (4.065 ملغم مالونالديهيد/كغم) وبفرق معنوي عن بقية المعاملات. نسبة الاحماض الدهنية الحرة سجلت المعاملة الاولى اعلي النسب (2.950%) واقل النسب سجلت في المعاملة الثالثة والرابعة (0.350 و 0.150% على التوالي). وأظهرت نتائج التقييم الحسي عدم وجود فروق معنوية بين المعاملات خلال فترات التخزين. يمكن الاستنتاج أنه من الممكن معاملة شرائح السمك مع لآكتات الصوديوم كمضادات للاكسدة وإطالة الفترة التخزينية لشرائح أسماك الكارب الطازجة خلال التخزين بالتبريد بدرجة (4 مئوية) لمدة 6 أيام.