INFLUENCE OF MONOPOTASSIUM PHOSPHATE AND SODIUM ACETATE ON QUALITY CHANGES OF COMMON CARP FILLETS STORED IN CHILLING

A. ZAKKAR HASABALLAH

Central Laboratory for Aquaculture Research, Abbassa, Agricultural Research Center, Ministry of Agriculture, Dokki, Giza, Egypt.

(Manuscript received 27 April 2005)

Abstract

The effects of mono potassium phosphate (MKP), sodium acetate (SA) and their mixture on some physiochemical, microbiological and organoleptic characteristics of common carp (*Cyprinus carpio L.*) fillets ware studied. Fillets were dipped for 15 min in 0 (control), 1, 2 and 3% of each salt solution at room temperature (20±1°C) drained for 3 min and stored at (5±1°C) for 12 days. The results indicated that the use of concentrations over 2% for 15 min of the aforementioned salts kept common carp fish fillets in good condition for a longest duration since chemical, microbiological and organoleptic evaluation were not appreciably changed through the whole period of chilling storage.

INTRODUCTION

Change fluctuation of temperature during handling, transportation and storage of fish in chilled state causes deterioration reflected on the keeping quality, and reduces consumer acceptance (Harrison *et al.,* 1991). Studies have shown that minimally processed, vacuum-packaged and refrigerated seafood products have become more popular as they have improved quality and prolonged shelf-life. Microbial growth reduces fresh seafood quality and results in economic loss. Psychrophilic bacteria are the major group of microorganisms responsible for spoilage of fresh seafood (Zhuang *et al.,* 1996).

Phosphate treatment did not affect dimethylamine and formaldehyde formation. Sensory evaluation of phosphated fillets stored at −26°C to −30°C showed more tender and acceptable quality after 26 weeks of storage (Woyewoda & Bligh, 1986). Kim and Hearnsberger (1994) concluded that phosphates have broad-spectrum antimicrobial activity and prolong the shelf life of some muscle foods. The anti listerial action of nitrite was predominantly bacteriostatic in nature. Kim *et al.* (1995) found

that the activity of monopotassium phosphate could be increased if sodium acetate was added. SA alone or SA combined with MKP is recommended to extend the microbiological shelf life of refrigerated catfish fillets.

A second group of compounds that may find useful applications for treating fresh-meat surfaces are the acetates. Kim and Hearnsberger (1994) indicated that acetates have previously been shown to inhibit Gram-negative spoilage bacteria on catfish fillets at 4°C. Also, Ez-El-Rigal (1998) found that using the aforementioned organic acids led to increase the shelf life of common carp fillets through the whole period of storage in ice.

The purpose of this study was to examine the effects of monopotassium phosphate (MKP), sodium acetate (SA) and a mixture of them as dipping solutions on some physiochemical, microbiological and organoleptic changes of refrigerated common carp fillets during storage at (5±1°C) for 12 days.

MATERIALS AND METHODS

Common carp preparation and treatments

Fillets weighing approximately *carpio* 100g of fresh common carp (*Cyprinus L.*) were obtained from Aquaculture at Abbassa Abou-Hammad-Sharkia, and transported to the laboratory. Treatment solutions were prepared by mixing 2 L tap water with appropriate amounts (V/W) of monopotassium phosphate (MKP), sodium acetate (SA) and a mixture of them (manufactured by El-Nasr Pharmaceutical & Chemical Company, Egypt). Fillets were allocated to the following experimental trials:

(A) 0 (control), 1, 2 and 3% monopotassium phosphate dip for 15 min.

(B) 0 (control), 1, 2 and 3% sodium acetate dip for 15 min.

(C) 0 (control), 1, 2 and 3% combinations of monopotassium phosphate and sodium acetate (1:1 – W/W) for 15min. Fish fillets were submerged in each solution at room temperature (20±1°C) for required times, then drained on sanitized stainless-steel grill for 2min at room temperature. Control fillets not treated (0%) with acids were dipped in 2L tap water for 15 min and drained for 2min at room temperature. After dipping and drainage, all treated and control fillets were placed individually in polyethylene bags, stored at 5 ± 1°C and periodically removed for analysis.

Measurement of pH

Was estimated according to the method mentioned by Aitken *et al.* (1962); 0.5g of sample was blended with 100.0ml distilled water for 5min and the pH was determined using pH-meter (Orion Research Digital Ion analyzer, Model 420 a).

Measurement of Thiobarbituric acid (T.B.A.)

Was measured according to the method described by **Tarladgis** *et al.* **(1960)**. The optical density of the resultant pink colour was measured in a colorimeter model Bosch & Lomb spectronic 20 at 538nm. The TBA value was calculated per one kilogram of samples according to the following equation:

TBA value / kg = O.D. at 538nm. × 7.8

Measurement of Total volatile bases nitrogen (T.V.B.N.) and trimethylamine nitrogen (T.M.A.N.)

The method recommended by the AMC (1979)was usea. Extracts were rendered alkaline with sodium hydroxide. The bases are steam distilled into standard acid and back titrated with standard alkaline. Formaldehyde is added to the neutralized mixture and the acid released is equivalent to the volatile bases other than trimethylamine nitrogen.

Calculation

$$\text{TVBN} = \frac{14(300 + \text{w}) \times \text{V}_1}{500} \text{mg./100g.}$$

$$TVBN = \frac{14(300 + w) \times V_2}{500} mg./100\,g.$$

Where: V_1 ml. = volume standard acid consumed in the first titration.

V_2 ml. = volume standard acid released for the second titration.

W = Water content of the sample mg. / 100gm.

Bacteriological analysis

The plate count method described by Frazier & Foster (1959) was adopted using nutrient agar medium which contained 3.0g. beef extract, 5.0g peptone and 15.0g agar in a liter of distilled water pH 7.0. One ml from each dilution was plated in the above medium in replicates and incubated at 37°C for 48 h. The bacterial count was expressed as mean $\log_{10}$ CFU/g sample (colony form unit / gram sample).

Sensory evaluation

Samples were organoleptically evaluated for appearance of uncooked fillets during storage at (5±1°C). A group of 10 staff members of technology and quality control department, central laboratory for Aquaculture research Abbassia Abouhammad Sharkia as judges checked the organoleptic properties of the samples and grades ranged from zero to 10 according to Teeny & Miyauchi (1972) as follows:

Score	Description	Score	Description
10	Ideal	4	Fair
9	Excellent	3	Poorly fair
8	Very good	2	Poor
7	Good	1	Very poor
6	Fairly good	0	Repulsive
5	Acceptable		

The means of all descriptions are explained to the judges in the scorer sheets, for example, ideal means bright appearance typically of fresh fish.

Statistical analysis

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

RESULTS AND DISCUSSION

Physiochemical changes

pH-value

Table 1 showed a decrease in pH-values in all treated samples, during storage as compared with the control sample. Maximum decrease in pH-values were observed in samples treated with 1% MKP, SA and a mixture of them, respectively, as pH values were 7.06, 7.08 and 7.08 at the beginning of storage period and reached 6.27, 6.49 and 6.37 at the end of 12 days of storage at (5±1°C).

Decreases in pH-values may be due to the microbial enzyme and autolysis producing organic acids or the treatment of the fillets with mixtures of phosphate and sorbate. These results agree with those reported by Kim *et al.* (1995) and Marshall & Jindal (1997).

Thiobarbituric acid (TBA)

Results presented in Table 2 indicated a gradual increase in TBA-value up to 12 days of storage. Minimum TBA was found in fish fillets treated with 3% mixture of MKP+SA followed by SA and MKP, after 12 days of storage period, respectively. On the other hand, untreated samples recorded a value of 5.63 mg/Kg. The increment in TBA presumably resulted from the concentration of pigmets fish fillets which can act as proxidant. These results are in agreement with those reported by Ez-El-Rigal (1998).

Total volatile bases nitrogen (TVBN) and trimethylamine nitrogen (TMAN)

Results presented in Tables 3 and 4 indicate that the formation of total volatile bases nitrogen TVBN and trimethylamine nitrogen TMAN (mg/100g) were affected by all treatments. Throughout storage, a gradual increase in TVBN and TMAN occurred and were 7.36 and 0.97 (mg/100g) at zero time, respectively, then, reached 43.52, 38.24, 36.80 and 29.28, 37.2, 32.48 and 25.84 and 30.64, 26.0 and 24.32 (mg/100g) for TVBN, and 21.77, 18.98, 17.20 and 13.77, 17.26, 13.77 and 10.94 and 13.68, 10.90 and 10.17 (mg/100g) for TMAN for samples treated with 0, 1, 2 and 3% M K P, SA and M K P+SA, respectively.

The lowest values TVBN and TMAN occurred in samples treated with mixture of MKP and SA, while, maximum TVBN and TMAN were found in control samples followed by samples treated with MKP solution.

However, the increment in TVBN and TMAN during chilling storage could be the result of decomposition and degradation of nitrogen substance which may be due to the activity of microorganisms. These results are in line with those obtained by Woyewoda & Bligh (1986) and Ez-El-Rigal (1998).

Bacterial changes

Table 5 illustrated the changes in total bacterial count TBC (Log10 CFU/g)of common carp fillets treated with 1,2 and 3% MKP, SA and mixture of MKP+SA for 15 min during chilling storage (5±1°C) for 12 days. At zero time of storage, the highest level of TBC was observed in case of control samples followed by the fish fillets treated with 1% MKP, SA and MKP+SA, 2% MKP, SA and MKP+SA and 3% MKP, SA and MKP+SA, respectively. Samples treated with 1, 2 and 3% MKP showed the highest level TBC compared with those of samples treated with 1, 2 and 3% SA and mixture of MKP+SA. Also, during the storage period at 5±1°C, the results showed a

gradual increase in TBC especially in the fillets treated with 1% MKP, SA and MKP+SA, respectively, compared with the fillets treated with 3 and 2% of the same solutions. TBC levels were the lowest in fillets treated with 3, 2 and 1% mixture of MKP+SA, respectively, during 12 days of storage compared with all the other treatments.

These results coincide with those given by Molins *et al.* (1987a,b,c), Kim *et al.* (1995), Zhuang *et al.* (1996) and Marshal & Jindal (1997) who reported that some phosphates inhibit the growth of bacteria in patties that were subsequently held at different temperatures. Molins *et al.* (1987a) also, reported that sodium acid pyrophosphate (SAPP) was inhibitory to psychrophilic bacteria when added at 1% to fresh ground pork meat stored at 5°C. Addition of SAPP at 1% resulted in 50% shelf life extension compared with that in untreated meat or in meat that received 0.5% and 1% orthophosphate. SAPP at 0.5% was also effective in reducing microbial growth in uncooked meat stored at 5°C.

Sensory evaluation

Results in Table 6 show that the changes in appearance of common carp fillets treated with monopotassium phosphate (MKP), sodium acetate (SA) and a mixture of them for 15 min, during storage were significantly decreased ($P < .0.05$) during storage of all samples. Control and treated samples showed higher scores at zero day of storage period. Treatment samples with mixture o MKP+SA showed the highest grade at the end of storage period.

The gradual decrease in appearance throughout storage could be attributed to the protein hydrolysis and its degradative products (TVBN) and fat oxidation which are considered major factors of changes in organoleptic properties. These results are in agreements with those given by Woyewoda & Bligh (1986) and Kim *et al.* (1995).

From the aforegoing results, it is concluded that, surface treatment with solutions containing (w/v) 1, 2 and 3% monopotassium phosphate MKP, sodium acetate SA and a mixture of MKP+SA for 15 min, prolonged shelf-life in all common carp fillets samples kept at (5±1°C) for 12 days. Common carp fillets treated with water (control), was spoiled after 3 days of storage at (5±1°C). Accordingly, treatment with 3% monopotassium phosphate (MKP) sodium acetate (SA) and a mixture of them for 15min are the best mixtures to extend shelf-life of common carp fillets during storage at (5±1°C).

Table 1. Changes in pH-value of common carp fillets treated with different percentages of monopotassium phosphate (MKP), sodium acetate (SA) and a mixture of them (MKP + SA) during storage at 5±1°C.

Treatments		Control	(MKP)			(SA)			(MKP + SA)		
		0%	1%	2%	3%	1%	2%	3%	1%	2%	3%
Storage Period (Days)	0	7.00	7.06	7.12	7.20	7.08	7.17	7.26	7.08	7.12	6.74
	3	6.55	6.89	6.98	7.07	6.96	7.06	7.16	6.93	7.02	6.48
	6	6.11	6.71	6.82	6.92	6.81	6.94	7.05	6.76	6.83	7.08
	9	5.71	6.51	6.63	6.75	6.65	6.80	6.93	6.60	6.71	6.85
	12	5.40	6.27	6.44	6.60	6.49	6.66	6.83	6.37	6.54	6.62

Table 2. Changes in Thiobarbituric acid (mg Malonldehyde / Kg) of common carp fillets treated with different percentages of monopotassium phosphate (MKP), Sodium acetate (SA) and a mixture of them (MKP + SA) during storage at 5±1°C.

Treatments		Control	(MKP)			(SA)			(MKP + SA)		
		0%	1%	2%	3%	1%	2%	3%	1%	2%	3%
Storage Period (Days)	0	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
	3	1.19	0.73	0.64	0.55	0.71	0.55	0.53	0.65	0.56	0.47
	6	2.27	1.50	1.26	1.02	1.31	1.04	1.02	1.22	1.04	0.88
	9	3.91	2.68	2.21	1.88	2.15	1.70	1.49	2.05	1.75	1.43
	12	5.63	3.27	2.94	2.57	2.81	2.36	1.88	2.63	2.23	1.89

Table 3. Changes in Total volatile bases nitrogen (mg/100g) of common carp fillets treated with different percentages of monopotassium phosphate (MKP), Sodium acetate (SA) and a mixture of them (MKP + SA) during storage at 5±1°C.

Treatments		Control	(MKP)			(SA)			(MKP + SA)		
		0%	1%	2%	3%	1%	2%	3%	1%	2%	3%
Storage Period (Days)	0	7.360	7.360	7.360	7.360	7.360	7.360	7.360	7.360	7.360	7.360
	3	17.00	15.60	13.92	12.40	13.84	12.56	11.44	12.72	11.36	10.80
	6	27.44	26.88	22.32	18.00	22.40	18.64	15.84	18.88	15.68	14.88
	9	38.08	33.84	32.00	25.20	32.24	27.60	22.24	26.56	21.92	20.64
	12	43.52	38.24	36.80	29.28	37.20	32.48	25.84	30.64	26.00	24.32

Table 4. Changes in Trimethylamine nitrogen (mg/100g) of common carp fillets treated with different percentages of monopotassium phosphate (MKP), Sodium acetate (SA) and a mixture of them (MKP + SA) during storage at 5±1°C.

Treatments		Control	(MKP)			(SA)			(MKP + SA)		
		0%	1%	2%	3%	1%	2%	3%	1%	2%	3%
Storage Period (Days)	0	0.970	0.970	0.970	0.970	0.970	0.970	0.970	0.970	0.970	0.970
	3	6.690	5.250	3.970	2.850	3.760	3.180	2.410	2.930	2.450	1.930
	6	12.82	11.11	6.480	6.460	8.720	6.500	5.300	6.350	4.930	4.100
	9	18.82	16.58	14.39	11.29	14.45	11.37	8.990	12.45	8.700	7.900
	12	12.77	18.98	17.20	13.77	17.26	13.77	10.94	13.68	10.90	10.17

Table 5. Changes in Total bacterial count of common carp fillets treated with different percentages of monopotassium phosphate (MKP), Sodium acetate (SA) and a mixture of them (MKP + SA) during storage at 5±1°C.

Treatments		Control	(MKP)			(SA)			(MKP + SA)		
		0%	1%	2%	3%	1%	2%	3%	1%	2%	3%
Storage Period (Days)	0	3.17	2.99	2.84	2.24	2.95	2.79	2.12	2.90	2.70	2.14
	3	4.64	4.23	3.34	3.11	3.41	3.24	2.88	3.35	3.18	2.67
	6	6.03	5.64	4.85	4.25	4.94	4.16	3.27	4.35	4.08	3.62
	9	6.83	6.43	5.80	5.51	5.99	5.46	5.15	5.54	5.11	5.03
	12	6.99	6.74	6.58	5.96	6.39	5.90	5.60	5.95	5.64	5.49

Table 6. Changes in Appearance of common carp fillets treated with different percentages of monopotassium phosphate (MKP), Sodium acetate (SA) and a mixture of them (MKP + SA) during storage at 5±1°C.

Treatments		Control	(MKP)			(SA)			(MKP + SA)		
		0%	1%	2%	3%	1%	2%	3%	1%	2%	3%
Storage Period (Days)	0	9.00± 0.07a	9.00± 0.06a	9.00± 0.07a	9.00± 0.12a	9.00± 0.09a	9.00± 0.06a	9.00± 0.12a	9.00± 0.06a	9.00± 0.03a	9.00± 0.03a
	3	6.50± 0.12c	7.00± 0.12b	7.10± 0.07b	7.30± 0.09b	7.00± 0.12b	7.20± 0.06b	7.40± 0.09b	7.50± 0.03b	8.30± 0.06a	8.20± 0.09a
	6	5.30± 0.03d	6.00± 0.06c	6.40± 0.09bc	6.50± 0.03b	6.00± 0.12c	6.4± 0.09bc	6.80± 0.03b	6.50± 0.12b	7.10± 0.09a	7.30± 0.03a
	9	4.40± 0.09d	5.00± 0.09c	5.30± 0.07b	5.50± 0.09b	5.2± 0.09c	5.60± 0.07b	5.80± 0.07b	5.50± 0.03b	6.10± 0.09a	6.30± 0.09a
	12	3.00± 0.06e	4.40± 0.12d	4.90± 0.03c	5.00± 0.06b	4.50± 0.03c	5.00± 0.07b	5.20± 0.07b	5.00± 0.09b	5.50± 0.06a	5.70± 0.12a

[a-e] Means within a raw with the same superscript are significantly different (P<0.05).

REFERENCES

1. Aitken, a., J. G. Casey, I. F. Penny and C. A. Voyle. 1962. Effect of drying temperature in the accelerated freeze drying of pork. J. Sci., Food Agriculture. 13, 439.
2. AMC. 1979. Recommended method for the examination of fish and fish products. Analyst, 104. 433.
3. Ez-El-Rigal, A. I. 1998. Influence of some organic acids on quality changes of common carp fillets stored in ice. Egypt. J. Appl. Sci., 13 (12): 551-562.
4. Frazier, W. C. and E.M. Foster 1959. Laboratory Manual for Food Microbiology 3rd ed. Burgess publishing Company, USA.
5. Harrison, M. A., Y. W. Huang, C. H. Chao and T. Shineman. 1991. Fate of *Listeria monocytogenes* on packaged, refrigerated and frozen seafood. J. Food Prot., 24: 524.
6. Kim, C. R. and J. O. Hearnsberger. 1994. Gram-negative bacteria inhibition by lactic acid culture and food preservatives on catfish fillets during refrigerated storage. J. Food Sci., 59. 513.
7. Kim, C. R., J. O. Hearnsberger, A. P. Vickery, C. H. White and D. L. Marshall. 1995. Extending shelf life refrigerated catfish fillets using sodium acetate and monopotassium phosphate. J. Food protection, 58(6): 644.
8. Marshall, D. L. and V. Jindal. 1997. Microbiological quality of carfish frames treated with selected phosphates. J. Food Protection, 60(9): 1081.
9. Molins, R. A., A. A. Kraft and J. A. Marcy. 1987a. Extension of the shelf-life of fresh ground pork with polyphosphates. J. Food Sci., 52: 513.
10. Molins, R. A., A. A. Kraft, H. W. Walker, R. E. Rust, D. G. Olson and K. Merkenich. 1987b. Effect of inorganic polyphosphates on ground beef characteristics: microbiological effects on frozen beef patties. J. Food Sci., 52: 46.
11. Molins, R. A., A. A. Kraft, H. W. Walker, R. E. Rust, D. G. Olson and K Merkenich. 1987c. Effect of inorganic polyphosphates on ground beef characteristics: Some chemical, physical and sensory effects on frozen beef patties. J. Food Sci., 52: 50.
12. SAS. 2000. SAS User's Gude: Statistics, SAS Institute Inc., Cary, NC.
13. Tarladgis, B. G., B. M. Watts, M. I. Younathan and I. Dugan. 1960. Distillation method for the quantitative determination of malonaldhyde in rancid foods J. American oil Chemists Soc., 37: 44.

14. Teeny, F. M. and D. Miyauchi. 1972. Preparation and utilization of frozen block of minced block fish muscle. J. Milk & Food Technology, 35(7): 414.
15. Woyewoda, A. D. and E. G. Bligh. 1986. Effect of phosphate blends on stability of cod fillets in frozen storage. J. Food Sci., 51(4): 932.
16. Zhuang, R. Y., Y. W. Huang and L. R. Beuchat. 1996. Quality changes during refrigerated storage of packaged shrimp and catfish fillets treated with sodium acetate, sodium lactate or propyl gallate. J. Food Sci., 61(1): 241.

تأثير فوسفات البوتاسيوم الأحادي و خلاّت الصوديوم على تغيرات الجودة لشرائح سمك المبروك العادى المخزن بالتبريد

احمد ذكار حسب الله

المعمل المركزي لبحوث الثروة السمكية بالعباسة – مركز البحوث الزراعية- وزارة الزراعة – الدقى- الجيزة

فى هذا البحث تم دراسة التأثير الناتج من معاملة شرائح سمك المبروك العادى باستخدام محاليل من فوسفات البوتاسيوم الاحادى وخلات الصوديوم وخليط منهما على بعض الخواص الفيزيوكيميائية، البكتريولوجية وكذلك على الخواص الحسية، خلال تخزين تلك الشرائح على درجة (٥±١م) لمدة ١٢ يوماً. حيث أشارت النتائج إلى أن استخدام تركيز ٢% فأكثر لمدة ١٥ دقيقة من المواد سالفة الذكر كانت من افضل المعاملات التى تحافظ على خواص الجودة لشرائح سمك المبروك العادى طوال فترات التخزين، نتيجة لقلة التغيرات الكيميائية والبكتيرية والحسية خلال فترات التخزين. وعلى ذلك يمكن الإشارة إلى أن استخدام تركيز ٢% من محاليل فوسفات البوتاسيوم الأحادي وخلات الصوديوم أو خليطيهما مناسبا للحفاظ على جودة شرائح سمك البروك العادى المخزنة بالتبريد.