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유기산으로 처리한 냉장 광어의 이화학적 평가

김 광 현 · 김 창 렬*
전남대학교 동물자원학과, 서강정보대학 식품영양과*

Physical and Chemical Evaluations of Refrigerated Flatfish Treated with Organic Acids

Kwang H. Kim and Chang R. Kim*

Department of Animal Science, Chonnam National University, 300 Yongbong-dong, Buk-ku, Kwangju 500-757, Korea

**Department of Food and Nutrition, Seo Kang College, 789-1 Woonam-Dong, Buk-ku, Kwangju 500-742, Korea*

Abstract

Flatfish strips were treated with 0.5% (v/v) acetic acid (AA), 0.5% (v/v) lactic acid (LA), or 0.5% (v/w) citric acid (CA) for 5 min. All strips were individually placed in Whirl-Pak sample bags and stored at 4 or 10℃. pH, TBA, color, and sensory quality of strips were evaluated after 0, 3, 6, 9, and 12 days of storage time. The pH of samples treated with AA for 5 min ranged from 5.39 to 6.64 for 12 days at 4 ℃, which had a significantly ($P < 0.05$) lower level compared to the controls during storage time. Acid treatments had a significantly ($P < 0.05$) higher levels of TBA values compared to the controls for 12 days at 4℃. All acid treatments had lower Hunter a and b color scores compared to the controls. Acid treatments were liked less by sensory panels than the fresh controls due to acidic odor and flesh discoloration.

Key words : flatfish, acetic acid, lactic acid, citric acid, pH, TBA, color, sensory.

INTRODUCTION

Currently, fish are gutted and usually either frozen or refrigerated individually without any special handling or packaging considerations. Hence, there has been found to subsantially reduce oxidative deterioration in fish and fishery products[1].

Josephson et al.[1] noted that rapid lipid deterioration during frozen storage led to very poor flavor quality with concommitant economic penalties for whitefish. They reported that samples with the higher TBA numbers exhibited more bland flavors than fresh whitefishes, and geneally exhibited a lack of the melon-like flavor notes of very fresh whitefish.

During storage and handling of fish and meat, quality and safety of refrigerated foods have been enhanced by preventing growth or destroying those microorganisms using food additives[2-12]. Researchers[7-10] noted that various organic acids have been utilized in an attempt to extension shelf-life of fish. Marshall and Kim[10] found that catfish fillets treated with 1.0～3.0% acetic acid was the most effective for preventing the growth of aerobic spoilage bacteria. However, organic acids are gen-

Corresponding author : Chang R. Kim

erally known to bleach color and react with oxymyoglobin to form methemoglobin. Since the keping quality for refrigerated flatfish after acid treatments is not known, it is should be considered for deteration of its quality. The evaluations of physicochemical quality would be essential to the continued acceptance of flatfish as a high-quality product and provide processors with an important criterion to measure product.

However, there was not reported on keeping quality of refrigerated flatfish treated with organic acids. Thus, the objective of the present study was to evaluate the physical and chemical qualities in refrigerated flatfish treated with acetic, lactic, and citric acids.

MATERIALS AND METHODS

1. Flatfish preparation

Fresh flatfish strips were obtained from a commercial source less than 1 hr postmortem, transported to meat laboratory on ice, and used within 2 hr. Three treatment solutions were prepared by mixing 1 L tap water with appropriate amounts (v/v or w/v) of acetic, lactic, or citric acids, respectively. Each one and half kilogram of strips (average weight 20g per strip) was dipped in 1 L sanitizer for 5 min. Strips were allocated to the following experimental trials : (1) 0.5% acetic acid (AA, Sae Won Chemical Co., Korea) dipping for 5 min, (2) 0.5% lactic acid (LA, Moo Jang Ya Chemical Co., Japan) dipping for 5 min, (3) 0.5% citric acid (CA, Dong Yang Glovel Chemical Co., Korea) for 5 min. Strips were submerged in each solution for required times then drained on a sanitized stainless-still grill for 2 min at room temperature. Control strips were dipped in 1 L tap water for 5 min and drained for 2 min to compensate for possible physical removal of bacteria and for moisture uptake. After dipping, strips were placed in Whirl-Pak sample bags (Fisher Scientific Chemical Co., Norcross, GA, USA), stored at 4° and 10℃.

2. Measurement of pH

Fish surface pH was measured with a standardized pH meter (Beckman Zeromatic^R Ⅳ, Model 34, Irvine, CA) using a surface electrode. Mean pH values were reported as averages of duplicate readings for each triplicate fish.

3. Measurement of TBA

2-Thiobarbituric acid (TBA) values were measured in triplicate 10g samples according to the modified procedure of Konieck[13]. Flatfish strips were blended for 15 sec before triplicate 10-g samples were removed for analysis. Spectrophotometric measurements were made with a Beckman model 25 spectrophotometer (Beckman Instr. Inc., Fullerton, CA). A standard curve was preparing using TEP reagent (1,1,3,3-tetraethoxypropane) for each duplicate.

4. Color values

The sample L (lightness), a (redness), b (yellowness) color values were measured with a Hunter Labscan (Hunter Laboratory, Inc., Reston, VA, USA). Color measurements were taken at four locations on each flatfish strips, and the results were averaged.

5. Sensory evaluation

Sensory evaluations of samples were performed by an ten member untrained panel. Odor and appearance of uncooked flatfish strips were evaluated during storage at 4℃. Treated flatfish strips were judged against fresh control flatfish strips (fresh daily), which were assigned a score of 5. Samples liked less than the control were scored 1 to 4, where 1 = disliked most. Samples liked more than the control were scored 6 to 9, where 9 = liked most. Untreated control flatfish strips also were stored at 4℃ for comparison against fresh control flatfish strips and treated flatfish strips.

6. Statistical analyses

GNC, pH, TBA, and sensory data were analyzed using analysis of variance (ANOVA), and means were seperated by the least significant difference (LSD) test at $P < 0.05$[14].

RESULTS AND DISCUSSION

1. Changes in pH

The surface pH of the flatfish strips was monitered after 0.5% AA dipping and was found to increase from pH 5.39 immediately after treatment to 6.64 after 12 days at 4℃ (Table 1). Acid treatments had significantly ($P < 0.05$) decreased pH values for 12 days compared to the controls. Ray and Sandine[15] noted that gram-negative bacteria are normally more sensitive to lower pH than gram-positive bacteria when using organic acid dips. It is considered that the effects are produced not by lowering the internal pH and neutralizing the proton motive force, but also by causing sublethal injury and unidentified effects[15].

2. Changes in TBA values

Acid treatments had a significant ($P < 0.05$) effect on TBA values immediately after treatments compared to the controls (Table 2). After 3 days of storage at 4℃, TBA values of acid treatments significantly increased after 6 days compared to the controls. Kanner and Kinsella[16] suggested that lipid deterioration in fish muscle may be initiated by myeloperoxidases from phagocytic leucocytes. Thus, enzymatic hydroperoxidation of lipids in fresh fish appears to affect the rate of oxidative deterioration during subsequent storage and handling. It is considered that flatfish strips cause extensive damage to the integrity of the skin after acid treatments.

3. Changes in color values

Hunter L, a and b color scores are presented in Table 3. Hunter L values is an indication of lightness, with perfect white 100 and black 0. L values had an significant difference ($P < 0.05$) between acid treatments and controls during storage at 4℃. Additionally, there was sig-

Table 1. pH values[1] of refrigerated (4℃) flatfish treated with acetic acid (AA), lactic acid (LA), and citric acid (CA) for 5 min.

Storage time(days) / Treatment	pH value 0	3	6	9	12
Control	6.84[b]	7.14[b]	7.47[b]	7.41[b]	7.67[b]
0.5% AA	5.39[a]	6.43[a]	6.21[a]	6.42[a]	6.64[a]
0.5% LA	5.26[a]	6.46[a]	6.28[a]	6.91[ab]	7.44[b]
0.5% CA	5.47[a]	6.64[a]	6.66[a]	7.08[b]	7.49[b]

[a-b]Means within the same column with different superscripts are significantly different ($P<0.05$). [1]Means of 3 replications.

Table 2. TBA values[1] of refrigerated (4℃) flatfish treated with acetic acid (AA), lactic acid (LA), and citric acid (CA) for 5 min.

Storage time(days) / Treatment	TBA value 0	3	6	9	12
Control	0.125[a]	0.304[a]	0.320[a]	0.354[a]	0.382[a]
0.5% AA	0.148[b]	0.357[b]	0.410[b]	0.450[b]	0.655[b]
0.5% LA	0.156[b]	0.355[b]	0.406[b]	0.454[b]	0.649[b]
0.5% CA	0.164[b]	0.367[b]	0.450[b]	0.496[b]	0.675[b]

[a-b]Means within the same column with different superscripts are significantly different ($P<0.05$). [1]Means of 3 replications.

Table 3. Hunter color values[1] of refrigerated (4℃) flatfish treated with acetic acid (AA), lactic acid (LA), and citric acid (CA) for 5 min.

Hunter value	Treatment	Storage time(day)				
		0	3	6	9	12
L	Control	52.2[a]	42.0[a]	52.9[a]	50.5[a]	49.4[a]
	0.5% AA	58.9[c]	57.6[c]	60.2[c]	57.4[c]	55.2[c]
	0.5% LA	54.8[b]	51.1[b]	55.7[b]	56.5[c]	56.0[c]
	0.5% CA	57.1[c]	52.9[b]	55.6[b]	54.5[b]	54.6[bc]
a	Control	0.5	3.5	0	1.9	1.6
	0.5% AA	−1.0	−1.2	−0.5	−2.0	−0.2
	0.5% LA	−0.7	−1.6	−0.7	−1.5	−1.1
	0.5% CA	−0.8	−1.2	−0.4	−2.1	−0.1
b	Control	−3.0	−3.8	−3.1	−5.2	−3.1
	0.5% AA	−3.4	−3.4	−2.2	−3.9	−4.4
	0.5% LA	−2.5	−3.3	−3.0	−4.4	−1.9
	0.5% CA	−4.2	−4.0	−4.4	−3.9	−1.6

[a-c]Means within the same column with different superscrips are significantly different ($P < 0.05$). Means of 3 replications.

nificant difference ($P < 0.05$) between 0.5% AA and 0.5% CA treatments during storage of 12days at 4℃. Hunter a values show an indication of redness on the surface of flatfish. There was significant difference ($P < 0.05$) between acid treatments and controls during storage at 4℃. Hunter b values show an indication of yellowness on the surface of flatfish. b values were significantly different ($P < 0.05$) between acid treatments and controls after 12 days of storage at 4℃. Results show that all treatments significantly ($P < 0.05$) increased a and b values during storage at 4℃. Mendonca et al.[11] noted that acids are generally known to bleach color and cause to oxidation of myoglobin.

4. Changes in sensory scores

Sensory data of flatfish strips dipped in AA, LA, and CA for 5 min are shown in Table 4. Sensory scores indicated that acid treatments were in the "liked less" category in odor and appearance compared to the fresh controls for 9 days at 4℃. Odor scores of AA were statistically distingushible ($P < 0.05$) from both LA and CA treatments at 9 days of storage. Appearance scores of AA were significantly lower ($P < 0.05$) from both LA and CA treatments at 9 days of storage probably due to a brownish appearance. After 12 days of storage,

Table 4. Mean sensory evaluation scores[1] of refrigerated (4℃) flatfish treated with acetic (AA), lactic acid (LA), and citric acid (CA) for 5 min.

Storage time(days) / Treatment	Odor score					Appearance score				
	0	3	6	9	12	0	3	6	9	12
Fresh control	5.0[a]	5.0[b]	5.0[c]	5.0[c]	5.0[b]	5.0[b]	5.0[b]	5.0[b]	5.0[c]	5.0[b]
Untreated control	4.8[a]	3.9[a]	2.8[a]	1.3[a]	1.0[a]	5.2[b]	4.3[ab]	3.6[a]	2.3[a]	1.0[a]
0.5% AA	5.0[a]	3.9[a]	3.9[b]	3.3[b]	1.0[a]	4.6[a]	3.9[a]	3.9[a]	4.0[b]	2.3[a]
0.5% LA	4.6[a]	4.1[a]	3.0[a]	2.1[a]	1.0[a]	4.4[a]	3.7[a]	3.8[a]	2.0[a]	1.3[a]
0.5% CA	5.8[b]	3.4[c]	2.9[a]	2.0[a]	1.0[a]	4.6[a]	3.4[a]	3.9[a]	3.0[a]	1.7[a]

[a-c]Means within the same column with different superscripts are significantly different ($P < 0.05$). [1]Means of 3 replications.

flatfish strips treated with acids were "disliked most" catogery in odor and appearance compared to the fresh controls. On day 0, panelist's observation revealed that treated flatfish were less fishy smelling and had a acidic odor. For appearance, typical comments were slimy, slick, and gray. Researchers[2,17] have reported discoloration and off-odors of meat and fish after dipping or spraying with acids and using other preservative methods.

Similarly, Marshall and Kim[10] noted that catfish fillets treated with 1% AA for 30~60 sec had an acidic or vinegar-like odor, while treatment with 3% AA alone or 2% combination of AA and LA yielded fillets with strong acidic odors.

CONCLUSIONS

Results of this investigation demonstrate that acid treatments had a lower levels of pH values during storage at 4℃. TBA values of acid treatments were higher than the controls during storage at 4℃. All acid treatments had lower a and b values, but higher L value. Sensory data showed that acid treatments were "liked less" category in odor and appearance compared to the fresh controls. Therefore, it is concluded that flatfish strips treated with organic acids should be held for extended periods with only limited losses of fresh-like quality under refrigerated temperature.

요 약

4~10℃ 냉장조건에서 신선한 광어의 이화학적 저장 안정성 증진을 목적으로 초산 (v/v), 유산 (v/v), 및 구연산 (w/v) 침지 후 pH, TBA, 색도 및 관능평가에 대한 영향을 조사하였다. 4개의 처리구로 만든 광어는 각 0.5%의 초산, 유산, 및 구연산의 위생수에서 5분 침지 후 처리구별로 Whirl-Pak 저장백에 넣은 다음 실험에 사용하였다. 5분 동안 초산 처리구의 pH 값은 4℃, 12일 저장 동안 5.39에서 6.64의 범위에 존재하였다. 유기산 처리구는 저장기간 동안 대조구보다 낮은 pH 값을 유지하였으며 유산 및 구연산 처리구는 저장 9일 이후 유의적 차이가 없었다. 산 처리구의 TBA 값은 4℃ 저장동안 대조구보다 유의적($P<0.05$)으로 높게 유지되었다. 각 유기산 처리구의 Hunter a, b 값은 대조구보다 낮았으며, Hunter L값은 대조구보다 높았다. 산 처리구의 관능평가 결과는 산 냄새 및 변색으로 신선한 대조구보다 낮게 좋았다.

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