EFFECTS OF CHELATING AGENTS ON LIPID OXIDATION, pH, AND COLOR CHANGE IN REDUCED SODIUM AND LOW-FAT PORK PATTIES

Jen-Hua Cheng[1*], Shu-Tai Wang[2], and Herbert Wood Ockerman[3]

[1]Department of Food Science, China University of Science and Technology, Taipei, Taiwan

[2]Department of Hospitality Management, Tunghai University, Taichung, Taiwan

[3]Department of Animal Sciences, The Ohio State University, Columbus, Ohio, USA

[*]Corresponding author (phone: 8864-24633812; fax: 8864-23506053; e-mail: jhcheng115@yahoo.com.tw)

Abstract

Chelating agents can be used to tie up metals during the initiation of autooxidation. The purpose of this study was to evaluate the effectiveness of adding chelating agents to inhibit lipid oxidation and color change in precooked pork patties. The reduced sodium and low fat patties were used because of health concern by consumers.

Sodium tripolyphosphate and EDTA did not increase cooking yield compared to the control that had no added chelating agents. The pork patties with 0.5% sodium tripolyphosphate had significantly higher pH values than samples with 500ppm EDTA; however, the pH values of pork patties with chelating agents were the same as the control. The pork patties with EDTA had a significantly highest Hunter b value compared to the other samples. The Hunter L values of precooked pork patties were significantly higher at day 7 when compared to that at day 0. The redness of precooked pork patties decreased during refrigerated storage, except for the sample with 0.5% sodium tripolyphosphate.

There was a significant interaction between treatment and storage time for TBA values. At day 0, samples with 500ppm EDTA and with sodium tripolyphosphate (0.5%) had a significantly lower TBA values than the control; however, the TBA values of samples with chelating agents were at the same levels. At day 7, the control without any chelating agents had a significantly higher TBA value than pork with sodium tripolyphosphate and EDTA. During refrigerated storage, TBA values of samples with chelating agents maintained lipid oxidation up to 7 days. TBA values were significantly decreased by chelating agents in precooked pork patties.

According to these results, addition of chelating agents did solve the problems of lipid oxidation and color evaluation in reduced sodium and low-fat precooked pork samples.

***Index Terms*—Chelating agents, lipid oxidation, color change, pork patties**

I. INTRODUCTION

Today, consumers not only care about flavor and convenience of food, but are also concerned with hygiene, safety, and nutrition of food. The consumption of food has changed and healthy food is popular. The consumers like to eat low-fat food (Egbert, Huffman, Chen & Dylewski, 1991). However, fat increases the juiciness and tenderness of meat, and it affects the flavor, mouthfeel, and color of meat.

Sodium chloride is usually used in the meat curing process. Its functions include inhibition of microorganisms, increase of flavor, and extraction of salt soluble proteins. Usually, sodium chloride is added at 2.5-3.0% of cured product weight. However, the sodium ion can cause hypertension; therefore, it has been recommended to reduce daily intake of salt. Thus, a new method has been developed to reduce the amount of sodium in meat. However, the reduction of sodium chloride in meat products causes lose of cooking yield, changes in flavor and shorter shelf life (Sofos, 1986).

Lipid oxidation causes the quality of meat to change, produces off flavor, and decreases flavor, color, texture, nutritive value, and acceptance (Buckley et al., 1989). Autoxidation is one aspect of lipid oxidation, which is a chain reaction of free radicals, and can be separated into three steps: initiation, propagation and termination (Min, 1998).

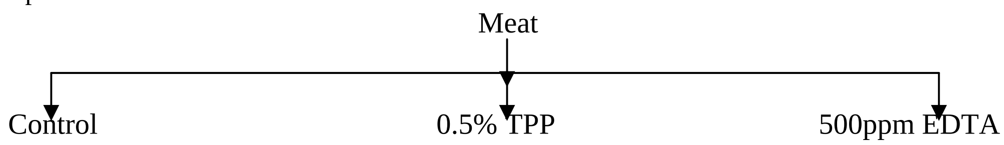
Chelating agents have been used to tie up metals in the initiation of autooxidation. Chelating agents bind with heavy metals in the initiation of autoxidation and cause metal ions to lose their ability to catalyze lipid oxidation. It is an effective method to inhibit lipid oxidation by attacking metal ions directly. The metal ions in muscle, especially iron ions, catalyze lipid oxidation (Min, 1998). The basic hypothesis of this study is the utilization of chelating agents which bind with metal ions, and it is a useful method to inhibit lipid oxidation.

The purpose of this study was to evaluate the effectiveness of adding chelating agents to inhibit lipid oxidation and color changes in precooked pork patties.

II. MATERIALS AND METHODS

The 24 hours post-mortem pork ham was ground through a 3-mm plate and then divided into 3 groups. NaCl was added at the level of 0.5%, and the raw meat was previously blended with chelating agents (no addition, 0.5% sodium tripolyphosphate or 500ppm EDTA). Pork patties were prepared by molding 90 gm of ground pork in a Petri dish with a diameter of 90 mm and the thickness of patties were 5mm. Pork patties were cooked on both sides for a total of 20 minutes on a hot plate until the internal temperature of the patties reached 75℃. These precooked pork patties were placed in a tray, covered with aluminum foil, and stored at 4^{o}C. Measurements of cooking yield, TBARS values, a*, b*, L* color values and pH value were tested on precooked pork patties at 0 and 7 days of storage. This test was repeated 3 times.

Figure 1 Experimental treatments



Cooking yield

Cooking Yield = (final product weight/fresh meat weight)*100%

pH measurement

The pH values of samples were measured with a pH meter (Ockerman, 1985).

TBARS values

A 5-gram sample was analyzed by the modified extraction method of TBARS (Pensel, 1990).

Color measurement

Minolta colorimeter (CR-10, Konica Minolta Sensing, Inc., Japan) was used to detect a*, b* and L* values of samples. The a* measures redness; b* indicates yellowness; and L* indicates lightness. Each value was the mean of 10 determinations.

2.3 Statistical analysis

Data were analyzed using the General Linear Model procedure of SAS (2009). Differences among means were detected at the 5% level using Duncan's New Multiple Range Test by SAS.

III. RESULTS AND DISCUSSION

The effect of adding different antioxidants on the cooking yields of pork patties shows that there was no significant difference among the three treatments. Sodium tripolyphosphate and EDTA did not increase cooking yield compared to the control that had no added chelating agents.

Table 1 Main effect of b*, L* values, pH values of reduced sodium and low-fat pork patties with chelating agents during refrigerated (4°C) storage

Main effect	pH	b value	L value
Treatment			
T1	6.44^{AB}	17.45^{B}	36.08^{C}
T2	6.55^{A}	19.13^{B}	40.79^{B}
T3	6.39^{B}	22.29^{A}	46.05^{A}
Storage Time			
Day 0	6.48^{a}	18.57^{a}	38.40^{b}
Day 7	6.43^{a}	20.68^{b}	43.54^{a}

T1: Control, with no antioxidant
T2: with 0.5% sodium tripolyphosphate
T3: with 500ppm EDTA
^{AB}Means with different uppercase superscripts within a column, within main effect of the treatments are significantly different ($p<0.05$)
^{ab}Means with different lowercase superscripts within a column, within main effect of storage time are significantly different ($p<0.05$)

There were no significant interactions between treatment and storage time for pH, b and L values; therefore, main effects are shown as results of these measurements. The addition of 0.5% sodium tripolyphosphate had higher ($p<0.05$) pH value than samples with 500ppm EDTA, but the pH values of pork patties with chelating agents were the same as control.

Treatment with sodium tripolyphosphate had the same Hunter b value compared to control ($P>0.05$). The pork patties with EDTA had the significantly highest Hunter b value among samples. Also, the yellowness of precooked pork patties did increase during refrigerated storage ($p>0.05$).

The control had significantly lower Hunter L value compared to samples with sodium tripolyphosphate that had the lowest yellowness value when compared to pork patties with EDTA ($p<0.05$). The Hunter L values of precooked pork patties were significantly higher at day 7 compared to that at day 0.

There was significant interaction between treatment and storage time for Hunter a value. Treatments had the same Hunter a values at day 0 and 7 ($p>0.05$). However, the redness of precooked pork patties was decreased during refrigerated storage, except for samples with 0.5% sodium tripolyphosphate ($p<0.05$).

There was significant interaction between treatment and storage time for TBA values. Table 2 shows that TBA values of precooked pork patties were affected by adding chelating agents. At day 0, samples with 500ppm EDTA and with sodium tripolyphosphate (0.5%) had the significantly lower TBA values than the control; however, the TBA values of samples with chelating agents were at the same levels ($p>0.05$). At day 7, control without any chelating agents had significantly higher TBA values than pork with sodium tripolyphosphate and EDTA. The TBA values of samples with sodium tripolyphosphate were the same as those of the EDTA treatment ($p>0.05$). It seems that chelating agents significantly decreased lipid oxidation in precooked pork patties.

During refrigerated storage, TBA values of control were increased ($p<0.05$); however, chelating agents maintained the lipid oxidation up to 7 days of refrigerated storage ($p>0.05$). According to this result, the addition of 0.5% sodium tripolyphosphate and 500ppm EDTA effectively inhibited lipid oxidation in precooked pork patties.

IV. CONCLUSION

Chelating agents have been used to tie up metals in the initiation of autooxidation. The reduced sodium and low fat patties was used for health concerns of consumers. The redness of precooked pork patties was decreased during refrigerated storage, except for samples with 0.5% sodium tripolyphosphate. For TBA values, chelating agents significantly decreased lipid oxidation in precooked pork patties. According to these results, addition of chelating agents did solve problems of lipid oxidation and color evaluation in reduced sodium and low fat meat models.

Table 2 Effect of adding chelating agents on TBARS[1] values of reduced sodium and low-fat pork patties during refrigerated (4°C) storage

	Storage time	
Treatment	Day 0	Day 7
Control, 0%	0.435^{Ab}	2.090^{Aa}
Chelating agent	(0.088)[2]	(0.890)
0.5%	0.303^{Ba}	0.360^{Ba}
Phosphate	(0.048)	(0.127)
500ppm EDTA	0.230^{Ba}	0.460^{Ba}
	(0.056)	(0.310)

[1]TBARS= mg malonaldehyde/ kg muscle

[2] indicates standard deviation

[AB] Different uppercase superscripts in the same column indicate significantly different ($p<0.05$)

[ab] Different lowercase superscripts in the same row indicate significantly different ($p<0.05$)

Table 3 Effect of adding chelating agents on Hunter a* values of reduced sodium and low-fat pork patties during refrigerated (4°C) storage

	Storage time	
Treatment	Day 0	Day 7
Control, 0%	13.06^{Aa}	10.73^{Ab}
Chelating agent	(0.46)[1]	(1.54)
0.5%	13.14^{Aa}	11.97^{Aa}
Phosphate	(1.65)	(2.68)
500ppm EDTA	15.13^{Aa}	9.83^{Ab}
	(2.09)	(0.69)

[1] indicates standard deviation

[AB] Different uppercase superscripts in the same column indicate significantly different ($p<0.05$)

[ab] Different lowercase superscripts in the same row indicate significantly different ($p<0.05$)

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