COMBINED EFFECT OF ORGANIC ACIDS AND IRRADIATION ON SHELF LIFE OF PORK LOINS

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Background

The antimicrobial effects of organic acids in various food items have long been known. Consequently, a number of researches on the bactericidal and bacteriostatic effects of organic acids have been done on carcasses and meat(Smulders & Greer, 1998). The efficacy of organic acids is affected by various factors(Smulders, 1995) such as nature of the meat surfaces, initial bacterial load, the kind of acids(Kang et al., 2001), and concentration and temperature of the acid. The USDA-FSIS suggested a list of antimicrobial interventions for reducing bacterial contaminations on muscle food surfaces, one of them being irradiation(Cutter, 1998). Min et al.(1997) reported that irradiation at 2 kGy extended the microbiological shelf life of fresh pork loin. As a result, it brings up the possibility that after carcasses are washed with organic acid solution, meat from those carcasses could be treated by irradiation.

Objectives

This research was conducted to examine the combined effect of organic acids and irradiation on shelf life of pork loin in terms of microbial counts and lipid oxidation during the cold storage.

Methods

Organic acids spray at 2% was done on fresh pork loins as described in Kang et al.(2001). The irradiation was carried out on both sides of packages by electron-beam with a Samsung electrostatic type linear accelerator(Model 2LV4) at Central Lab of Samsung Heavy Industry Co., Inc. Microbial measurements were done as in Kang et al.(2001) and lipid oxidation by Witte et al.(1970) during storage at 4 ±1°C.

Results and Discussion

The reduction of total plate counts was larger with both organic acid and irradiation treatment than with either organic acid or irradiation treatment alone(Table 1). At 14 days of the storage time, acetic acid was most effective in combination with irradiation. Kang et al.(2001) showed that acetic acid was most effective in reducing TPC when organic acids alone were sprayed on pork loins. Bhide et al.(2001) reported that presensitization of microorganisms by acid followed by low dose gamma irradiation reduced the total viable count. Table 2 illustrates that organic acids and irradiation together or separately had bactericidal effect on coliforms and at 14 days of storage the effect was greater when both organic acid and irradiation together were used. Acid pretreatment and irradiation resulted in an added effect on the microbiological quality of mutton(Bhide et al., 2001). The synergistic effect of acid and irradiation did not seem to be due to the lower pH by organic acid spray because pH values of pork loins were not changed much after acids spray in this study. Lipid oxidation was increased by irradiation while not affected by organic acids(Table 3). Irradiation induces oxidation but packaging after irradiation is more important in lipid oxidation of pork(Ahn et al., 1998). The combination of organic acid and irradiation increased lipid oxidation at the beginning but after 14 days of storage lipid oxidation was lower with the combination group than with irradiation group. The reason for this remains to be studied further.

Conclusions

The combination of organic acid and irradiation was more effective in reducing total plate counts and coliforms numbers in pork loins. The combination of organic acid and irradiation increased lipid oxidation more than irradiation alone did at the beginning but after 14 days of storage, lipid oxidation was lower with the combination group than with irradiation group. Therefore, the combined treatment could be used for the extension of shelf life of pork loins during cold storage without much problems of lipid oxidation.

Table 1. Effect of organic acid spray or/and electron beam irradiation on total plate counts* on pork loins(unit:log CFU/cm²)

Treatment/storage days	1	3	7	14
0% acid	3.09 ± 0.06^{a}	3.39 ± 0.06^{a}	5.45 ± 0.06^{a}	7.33 ± 0.51^{a}
1 KGy	0.56 ± 0.60^{cd}	1.28 ± 0.24^{bcd}	1.33 ± 0.48^{c}	3.65 ± 0.24^{bc}
2 KGy	0.45 ± 0.39^{cd}	1.32 ± 0.38^{bcd}	1.30 ± 0.26^{c}	2.89 ± 0.82^{de}
3 KGy	0.25 ± 0.43^{de}	0.82 ± 0.81^{cdef}	1.38 ± 0.60^{c}	3.23 ± 0.66^{cd}
2% La	0.64 ± 0.06^{c}	1.23 ± 0.22^{bcd}	2.74 ± 0.22^{b}	4.27 ± 0.20^{b}
2% Ca	0.74 ± 0.23^{c}	1.73 ± 0.37^{b}	2.96 ± 0.04^{b}	3.45 ± 0.17^{cd}
2% Aa	1.23 ± 0.08^{b}	1.33 ± 0.10^{bcd}	1.79 ± 0.65^{c}	2.57 ± 0.18^{ef}
2% La + 1 KGy	-	0.28 ± 0.49^{fg}	-	1.02 ± 0.38^{h}
2% La + 2 KGy	-	0.97 ± 0.16^{cde}	-	1.88 ± 0.43^{g}
2% La + 3 KGy	-	1.51 ± 0.46^{bc}	0.20 ± 0.35^{d}	0.53 ± 0.59^{hi}
2% Ca + 1 KGy	-	-	0.46 ± 0.41^{d}	2.21 ± 0.03^{fg}
2% Ca + 2 KGy	-	0.43 ± 0.51^{efg}	-	2.14 ± 0.12^{fg}
2% Ca + 3 KGy	-	0.64 ± 0.57^{defg}	-	2.10 ± 0.12^{fg}
2% Aa + 1 KGy	-	-	-	0.02 ± 0.08^{i}
2% Aa + 2 KGy	-	-	-	0.05 ± 0.09^{i}
2% Aa + 3 KGy	-	-	-	-

0% acid - the sample sprayed with sterilized distilled water.
La : Lactic acid, Ca : Citric acid, Aa : Acetic acid
* : values with different superscript letters in the same column are significantly different($p<0.05$).

Table 2. Effect of organic acid spray or/and electron beam irradiation on coliforms* on pork loins(unit:log CFU/cm^2)

Treatment/storage days	1	3	7	14
0% acid	-	-	$1.96±0.06^{a}$	$3.32±0.33^{a}$
1 KGy	-	-	-	$3.65±0.24^{d}$
2 KGy	-	-	-	$2.89±0.82^{d}$
3 KGy	-	-	-	$3.23±0.66^{d}$
2% La	-	-	$0.78±0.16^{b}$	$2.57±0.21^{b}$
2% Ca	-	$0.10±0.17^{b}$	$0.40±0.46^{c}$	$2.50±0.29^{b}$
2% Aa	-	$0.33±0.35^{a}$	$0.20±0.35^{c}$	$1.33±0.31^{c}$
2% La + 1 KGy	-	-	-	-
2% La + 2 KGy	-	-	-	-
2% La + 3 KGy	-	-	-	-
2% Ca + 1 KGy	-	-	-	-
2% Ca + 2 KGy	-	-	-	-
2% Ca + 3 KGy	-	-	-	-
2% Aa + 1 KGy	-	-	-	-
2% Aa + 2 KGy	-	-	-	-
2% Aa + 3 KGy	-	-	-	-

* : values with different superscript letters in the same column are significantly different($p<0.05$).
0% acid - the sample sprayed with sterilized distilled water.   La : Lactic acid, Ca : Citric acid, Aa : Acetic acid

Table 3. The TBARS* change of pork loins sprayed with organic acid and irradiated with electron beam(unit: mg MDA/kg meat)

Treatment/storage days	1	3	7	14
0% acid	$0.04±0.01^{g}$	$0.04±0.01^{g}$	$0.32±0.16^{ab}$	$0.34±0.01^{hi}$
1 KGy	$0.07±0.01^{f}$	$0.15±0.01^{def}$	$0.17±0.10^{ef}$	$0.47±0.01^{def}$
2 KGy	$0.10±0.01^{e}$	$0.18±0.01^{bcd}$	$0.23±0.02^{bcde}$	$0.58±0.01^{bc}$
3 KGy	$0.13±0.02^{d}$	$0.17±0.01^{bcde}$	$0.21±0.02^{de}$	$0.63±0.01^{b}$
2% La	$0.03±0.01^{g}$	$0.06±0.02^{g}$	$0.10±0.01^{fg}$	$0.47±0.02^{def}$
2% Ca	$0.04±0.01^{g}$	$0.07±0.01^{g}$	$0.06±0.01^{g}$	$0.72±0.01^{a}$
2% Aa	$0.03±0.01^{g}$	$0.04±0.01^{g}$	$0.10±0.01^{fg}$	$0.22±0.01^{j}$
2% La + 1 KGy	$0.10±0.01^{e}$	$0.19±0.03^{bcd}$	$0.20±0.02^{de}$	$0.36±0.03^{ghi}$
2% La + 2 KGy	$0.14±0.02^{d}$	$0.20±0.01^{bc}$	$0.33±0.06^{a}$	$0.41±0.01^{fgh}$
2% La + 3 KGy	$0.22±0.02^{b}$	$0.20±0.00^{bc}$	$0.31±0.02^{abc}$	$0.43±0.00^{efg}$
2% Ca + 1 KGy	$0.19±0.01^{c}$	$0.21±0.04^{b}$	$0.26±0.02^{abcde}$	$0.53±0.04^{cd}$
2% Ca + 2 KGy	$0.18±0.01^{c}$	$0.14±0.03^{ef}$	$0.27±0.01^{abcd}$	$0.50±0.03^{de}$
2% Ca + 3 KGy	$0.18±0.01^{c}$	$0.16±0.01^{cdef}$	$0.18±0.02^{def}$	$0.50±0.01^{de}$
2% Aa + 1 KGy	$0.13±0.01^{d}$	$0.18±0.03^{bcd}$	$0.26±0.02^{abcde}$	$0.48±0.03^{def}$
2% Aa + 2 KGy	$0.10±0.01^{e}$	$0.13±0.02^{f}$	$0.22±0.02^{cde}$	$0.31±0.02^{i}$
2% Aa + 3 KGy	$0.36±0.02^{a}$	$0.31±0.05^{a}$	$0.21±0.02^{de}$	$0.31±0.05^{i}$

* : values with different superscript letters in the same column are significantly different($p<0.05$).
0% acid - the sample sprayed with sterilized distilled water.   La : Lactic acid, Ca : Citric acid, Aa : Acetic acid

Pertinent literature

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