COLOR STABILITY AND SPOILAGE CHARACTERISTICS OF CHICKEN MEAT PATTIES PREPARED WITH THIGH MEAT FROM VARIOUS RINSE AND ADDITIVE TREATMENTS

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Background:

Fresh ground chicken meat, whether in bulk or patty form, has a relatively short shelf life which is related to the rate of outgrowth of spoilage bacteria, the development of off-odor, and the initiation of visually detectable changes in product appearance. Various rinses containing antimicrobial compounds have been evaluated in attempts to extend the shelf life of carcasses or cut-up chicken (Fletcher and Russell, 1993; Dickens, 1994; Acton et al., 1999). Other additives may also have a role in shelf life extension. Supplementation of diets with antioxidants improves broiler meat oxidative stability (Lin et al., 1989), added EDTA improves ground broiler meat water-holding capacity (Young et al., 1987), and NaCl enhances the redness attribute of turkey meat (Ahn and Maurer, 1989). Dawson et al. (1995) reported that specific poultry products would require different packaging conditions to optimize shelf life quality. For retail marketing, the majority of fresh meat and poultry is packaged in relatively high oxygen transmission rate films to optimize color properties since color is a primary determinant for consumer selection among product samples in the meat display.

Objective:

The objective of this study was to determine the effect of various meat rinse and additive treatments on the shelf life characteristics of fresh chicken patties. The rinses were applied prior to meat grinding and the additives were incorporated prior to a second grinding and packaging of the patties.

Methods:

Fresh boneless chicken thigh meat was trimmed and cut into pieces approximately 2 x 2 x 1 cm. Rinses were applied by placing 0.7 kg of pieces in either distilled water (control), 28% NaCl or 10% sodium erythorbate solution for 5 min at 3°C. After draining 2 min and grinding once (4-mm plate orifices), either 36ppm of EDTA or 12ppm of α-tocopherol were mixed into meat of each treatment (except control) and then reground. Chicken meat patties were formed (120 g each, 9 cm dia x 2 cm thick) and individually packaged in styrofoam containers with 60 gauge PVC film (OTR > 16,000 cc/m^2/24 hr at 23°C, 0% RH and 1 atm) overwrap, sealed and held at 3°C for 12 days. Analyses were conducted at days 0, 3, 6 and 12 for each of 2 or 3 replications/treatment, with treatment replication based on meat obtained on different weeks. Samples rinsed in sodium erythorbate solution were discarded after day 9 due to extensive spoilage.

At each storage interval, CIE L* (lightness), C* (chroma) and CIE H° (hue angle) were measured at 6 similarly located surface spots on a patty from each treatment using a calibrated Minolta Chroma Meter CR-300 with Illuminant C as light source. Also at each storage period, a 500 µl headspace sample from treatment packages was analyzed for percent O_2 and CO_2 (Gow-Mac 580 GC, with Alltech CTR column at 30°C). Then the packages were opened, air allowed to enter and trained panelists sniffed the patties and scored the sample odor. The 7 point odor scoring system of Dawson (1995) as inverted by Tsou et al. (1997) had range descriptors of 7=normal and 1=very pronounced off-odor. Total aerobic bacteria counts were determined following APHA (1992) methods. Using an 11g samples, stomacher homogenization and serial dilution, duplicate pour plates were prepared and bacterial counts expressed as $\log_{10}$ colony forming units per ml (CFU/ml) after incubation of the plates for 48 hr at 35°C. The main effects of rinse treatment (including additive where present), storage time (days) and their interaction were used in a general linear model analysis of variance (SAS, 1990) with the replication effect and remaining interaction used as the error term. The response means were separated utilizing the lsmeans command of SAS.

Results and Discussion:

Product shifts, as highest to lowest values, for lightness (CIE L*) were minimal within the control patties (56.7-55.2) and patties from the NaCl rinsed meat (57.7-55.0) compared to patties from sodium erythorbate rinses (55.3-50.2) which showed progressive darkening over 9 days of storage (Table 1). The range of L* values reported agree with results of Shahidi et al.(1991) for chicken meat following aqueous washings. Initial chroma values (CIE C*), representing color intensity, for patties from the NaCl treatments were greater ($P<0.05$) than those of the control and sodium erythorbate treatments. This initially higher intensity for patties of the NaCl treatments is similar to the color enhancement effect of NaCl found by Ahn and Maurer (1989). Chroma of all patties except the controls generally decreased over time in storage. Hue angles (H°) show that all products shifted from an initial visually described redness attribute (H° = 48-53) to a maroon-red (H° of 54-60) or complete brown appearance (H° > 60) as storage increased. The control product maintained hue (redness) better than product of the other treatments. As additives, the EDTA and α-tocopherol had no apparent effect on the color characteristics of the patties where incorporated.

The initial (day 0) aerobic bacteria counts among patties from all rinse and additive treatments did not differ and ranged from 3.2-3.4 log CFU/g (Table 2), similar to counts reported by Dawson et al. (1995) for fresh ground chicken leg meat. During 12 days of storage, the fastest rates of bacteria growth and off-odor development (Table 3) were found for product from both of the sodium erythorbate-rinse treatments. By day 6, patties from water-rinsed (control) and NaCl-rinsed thigh meat had a "perceptible" off-odor whereas those from the sodium erythorbate rinses had "slightly to moderately pronounced" off-odor. Package headspace changes reflected bacterial outgrowth as the O_2 decreased with CO_2 development (Table 4). Minimal changes in O_2/CO_2 were found in packages of patties from NaCl rinses versus a rapid shift for patties from sodium erythorbate rinses. The O_2/CO_2 data reflect microbial growth in the respective products. Within rinses, there appeared to be no effect on microbial growth or sensory characteristics due to the EDTA or α-tocopherol.

Conclusions:

Rinses of thigh meat with NaCl solution improved initial chicken patty meat surface color as related to chroma and hue (redness).

NaCl rinses also decreased the rates of microbial outgrowth, off-odor development, and shift of in-package O_2/CO_2 levels. Rinses with sodium erythorbate were ineffective for patty quality retention. EDTA and α-tocopherol as additives had no effect on any quality measure.

Literature:

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Table 1. CIE lightness (L*), chroma (C*) and hue angle (H°) for chicken meat patties prepared with thigh meat from various rinse and additive treatments.

CIE Attribute	Days of Storage	Control H_2O Rinse	NaCl Rinse EDTA	NaCl Rinse TOC	NaErythorbate EDTA	NaErythorbate TOC
L*	0	56.2^{a}	56.4^{a}	56.9^{a}	54.9^{a}	55.3^{a}
	3	56.6^{a}	55.0^{b}	52.8^{c}	$53.1^{a,b}$	52.5^{b}
	6	56.7^{a}	$55.3^{a,b}$	$55.5^{a,b}$	52.3^{b}	52.4^{b}
	9	55.9^{b}	$55.7^{a,b}$	55.2^{b}	50.2^{c}	51.1^{c}
	12	55.2^{b}	57.7^{a}	57.0^{a}	--	--
C*	0	12.5^{b}	16.3^{a}	16.5^{a}	12.5^{a}	13.2^{a}
	3	12.2^{b}	13.3^{b}	11.8^{b}	10.5^{b}	10.0^{c}
	6	13.5^{a}	12.6^{b}	11.9^{b}	$11.6^{a,b}$	11.8^{b}
	9	12.1^{b}	12.8^{b}	11.9^{b}	12.5^{a}	$12.5^{a,b}$
	12	$12.9^{a,b}$	11.1^{c}	10.8^{c}	--	--
H°	0	48.7^{d}	49.8^{d}	49.0^{c}	48.6^{c}	47.2^{c}
	3	$50.9^{c,d}$	51.4^{d}	49.0^{c}	59.9^{b}	58.6^{b}
	6	52.3^{c}	57.7^{c}	61.7^{b}	69.9^{a}	68.3^{a}
	9	59.9^{a}	66.8^{b}	70.3^{a}	68.4^{a}	69.1^{a}
	12	55.8^{b}	72.8^{a}	73.6^{a}	--	--

[1]Within L*, C* or H°, column means with no common letter differ ($p<0.05$).

Table 2. Total aerobic plate count (Log_{10} CFU/g) for chicken meat patties prepared with thigh meat from various rinse and additive treatments.

Days of Storage	Treatment: Control H_2O Rinse	NaCl Rinse EDTA	NaCl Rinse TOC	NaErythorbate EDTA	NaErythorbate TOC
0	3.4^{d}	3.3^{c}	3.2^{c}	3.3^{c}	3.2^{c}
3	4.8^{c}	3.5^{c}	3.2^{c}	5.0^{b}	4.7^{b}
6	6.3^{b}	4.9^{b}	5.5^{b}	8.1^{a}	8.0^{a}
9	8.0^{a}	6.4^{a}	6.8^{a}	9.0^{a}	8.7^{a}
12	8.4^{a}	6.9^{a}	7.1^{a}	--	--

[1]Column means with no common superscript differ ($p<0.05$).

Table 3. Off-odor scores (7=normal to 1=very pronounced) for chicken meat patties prepared with thigh meat from various rinse and additive treatments.

Days of Storage	Treatment: Control H_2O Rinse	NaCl Rinse EDTA	NaCl Rinse TOC	NaErythorbate EDTA	NaErythorbate TOC
0	7.0^{a}	7.0^{a}	7.0^{a}	7.0^{a}	7.0^{a}
3	6.0^{b}	$6.0^{a,b}$	5.5^{b}	6.0^{b}	5.0^{b}
6	5.0^{c}	5.3^{b}	$5.3^{b,c}$	3.7^{c}	3.0^{c}
9	2.7^{d}	5.0^{b}	4.7^{c}	1.0^{d}	1.3^{d}
12	1.5^{e}	3.7^{c}	3.7^{d}	--	--

[1]Column means with no common superscript differ ($p<0.05$).

Table 4. Package headspace concentrations of O_2 and CO_2 (%) for chicken meat patties prepared with thigh meat from various rinse and additive treatments.

	Days of Storage	Treatment: Control H_2O Rinse	NaCl Rinse EDTA	NaCl Rinse TOC	NaErythorbate EDTA	NaErythorbate TOC
O_2	0	20.6^{a}	20.8	20.8	20.5^{a}	20.5^{a}
	3	20.2^{a}	20.7	20.5	19.2^{a}	19.1^{a}
	6	19.3^{b}	20.7	20.1	14.2^{b}	12.6^{b}
	9	15.5^{c}	20.3	19.7	7.2^{c}	7.5^{c}
	12	8.2^{d}	19.9	19.2	--	--
CO_2	0	0.03^{c}	0.00	0.00	0.00^{c}	0.02^{c}
	3	0.05^{c}	0.00	0.00	0.08^{c}	0.05^{c}
	6	0.17^{b}	0.00	0.00	0.53^{b}	0.68^{b}
	9	0.84^{a}	0.05	0.10	0.91^{a}	0.75^{a}
	12	0.99^{a}	0.07	0.07	--	--

[1]Within O_2 or CO_2, column means with no common letter differ ($p<0.05$).