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ANTIMICROBIAL RINSE EFFECTS ON THE SHELF LIFE CHARACTERISTICS OF CHICKEN THIGH MEAT STRIPS VACUUM-PACKAGED IN HIGH OXYGEN PERMEABLE FILM

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Background:

The relatively short shelf life of fresh boneless poultry meat held at refrigeration temperatures is a major limitation in the marketing of this type of perishable product. The primary factor limiting shelf life is the growth of spoilage bacteria on the meat surface. During spoilage, off-odors are produced and surface slime may develop. A secondary factor that limits shelf life is the product's appearance. Vacuum-packaging with a film having a high oxygen transmission rate (non-barrier film) can help in maintaining appropriate fresh meat color. Solutions of solutes such as acids (Dickens, 1994), hydrogen peroxide (Fletcher and Russell, 1993), nisin (Natrajan and Sheldon, 1995) and ethanol (Heath and Owens, 1987; Tsou, 1995) have been applied as sprays or rinses and evaluated for antimicrobial effects on chicken carcasses and cut-up parts. For the processor and consumer, the ideal prepackaging treatment of poultry products would yield low bacteria levels and provide high maintenance of quality characteristics such as odor and color.

Objectives:

The objective of this study was to determine the effect of various antimicrobial rinse treatments on the shelf life characteristics of fresh vacuum-packaged chicken thigh meat strips. The rinses were applied singly or in a sequence prior to packaging and extended storage.

Methods:

The antimicrobial rinse solutions were 28% NaCl, 10% $CaCl_2$ and 50% ethanol. Each solution and a distilled water rinse (control) were used singly as four treatments and two additional treatments involved rinsing first with the ethanol solution followed by rinsing with either NaCl or $CaCl_2$ solution. All 3°C rinses were 5 min in duration and applied at the ratio of 2 liters to 42 thigh strips. Using fresh deboned chicken thighs, one to two strips were cut from each piece using a 6.6 cm x 2.5 cm template. Strip thickness varied between 0.5-1.0 cm. After rinsing and a 2 min draining period, 6 strips were vacuum-packaged in a pouch formed with film having an oxygen transmission rate of $\geq$12,000 ml/m^2/24 hr at 23°C, 0% RH and 1 atm. The packaged strips were held at 3°C for 12 days. Single packages from each treatment were utilized for conducting all analyses except for color evaluation where one package remaining in storage was used. Analyses were conducted on days 0, 3, 6, 9 and 12 for each of two or three replications per treatment.

At each storage period, packages were opened, air allowed to enter and then panelists previously trained in odor evaluation sniffed the strips and scored the surface odor. The 7 point scoring system had descriptors as follows: 7=normal, no off-odor, 6=slightly perceptible, 5=perceptible, 4=slightly pronounced, 3=moderately pronounced, 2=pronounced, 1=very pronounced off-odor. Following odor evaluation, the total aerobic bacteria count was determined following APHA (1992) methods. A 30 ml aliquot of 0.1% peptone was added to each package of 6 strips and the package was shaken by hand for 2 min. This 30 ml was used as the 10^o dilution and then serial dilutions were made. 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 36°C. CIE L* (lightness), + a* (redness) and + b* (yellowness) values were measured at 3 randomly chosen spots on the surface of each of the six thigh strips in a package (n=18 per treatment per storage day) using a Minolta Chroma Meter CR-300. The hue angle (CIE h*) describing the color in the CIE L*a*b* color space was calculated from CIE +a* and +b* values. The Chroma Meter was calibrated using the white calibration plate and Illuminant C was chosen as the source of illumination.

The main effects of antimicrobial rinse treatment and storage time (days) and their interaction on the response variables were analyzed with general linear model analysis of variance (SAS, 1990). Mean separation was accomplished by a LSD test of paired means.

Results and Discussion:

During 12 days of storage, the fastest rate of aerobic bacteria outgrowth and sensory odor deterioration was found for the water-rinsed control thigh meat strips (Figures 1 and 2). For rinses containing the salts, NaCl was more bacteriostatic than CaCl2, allowing only a 1.5 log CFU/ml outgrowth in 12 days versus 3.2 and 3.7 CFU/ml increases for CaCl2-rinsed and water-rinsed strips, respectively. All rinse treatments utilizing ethanol effectively impeded bacterial growth and reduced the rate of off-odor development. Panelists rated odor of control strips at 12 days as "very pronounced off-odor" and the NaCl-rinsed strips as "slightly pronounced off-odor." When an ethanol rinse preceded the NaCl rinse, strips were scored as having a "perceptible odor" difference from "fresh" at 12 days. Panelists did express difficulty in rating the odor of the packaged strips due to the masking effect of residual ethanol.

Shifts in overall color characteristics in CIE L*a*b* color space were minimal for the control and ethanol treated thigh strips over the 12 day period (Table 1). All strips treated with CaCl2 showed a "bleached" appearance compared to other strips due to a higher lightness (L*) and yellowness (b*). Conversely, all strips treated with NaCl had a darker (lower L*) and redder (higher a* combined with lower b*values) appearance than all other treated strips. Both salts exhibited their differing color effect even when ethanol was used as a pretreatment. The hue (h*) of the NaCl-rinsed strips agreed with visual observations of the intense redness of the strips (days 0-6) which was eventually followed by a maroon-red appearance (days 9-12). There were many instances of significant differences in L* and b* between day 0 and day 3 values. This was possibly the result of measuring color immediately after surface rinsing at day 0 which was followed by pigment or color equilibration by day 3.

Conclusions:

Rinsing the chicken thigh meat strips with NaCl solution appeared the best overall antimicrobial treatment to retard microbial growth, slow off-odor development and enhance desirable color characteristics. All rinse treatments containing ethanol were most effective in increasing shelf life of the strips by preventing typical microbial spoilage. Due to a residual ethanol odor, described as "medicinal," effective means to remove ethanol from meat surfaces after rinsing must be found before it can effectively be utilized.

Literature:

Dickens, J.A., Lyon, B.G., Whittemore, A.D. and Lyon, C.E. 1994. The effect of acetic acid dip on carcass appearance, microbiological quality and cooked breast meat texture and flavor. Poultry Sci. 73:576-581.

Fletcher, D.L. and Russell, S.M. 1993. An evaluation of a rinse procedure using bicarbonate and hydrogen peroxide on the recovery of bacteria from broiler carcasses. Poultry Sci. 72:2152-2156.

Heath, J.L. and Owens, S.L. 1987. Effect of tumbling solutions containing ethanol on tenderness and yield of broiler breasts. J. Food Proc. Preserv. 11:159-169.

Natrajan, N. and Sheldon, B.W. 1995. Evaluation of bacteriocin-based packaging and edible film delivery systems to reduce Salmonella in fresh poultry. Poultry Sci. 74 (Suppl. 1):31.

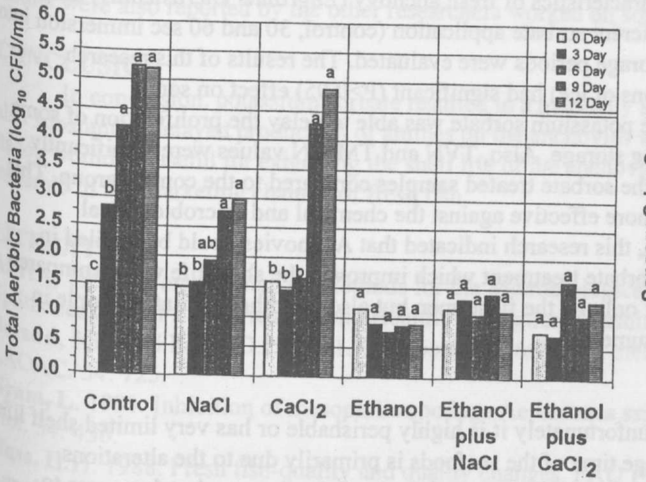

Figure 1. Total aerobic bacteria count (log10 CFU/ml) for chicken thigh meat strips rinsed with various antimicrobial solutions, vacuum-packaged in oxygen permeable film and stored for 12 days at 3°C. (Means within an antimicrobial rinse not having a common superscript letter are different ($p<0.05$).

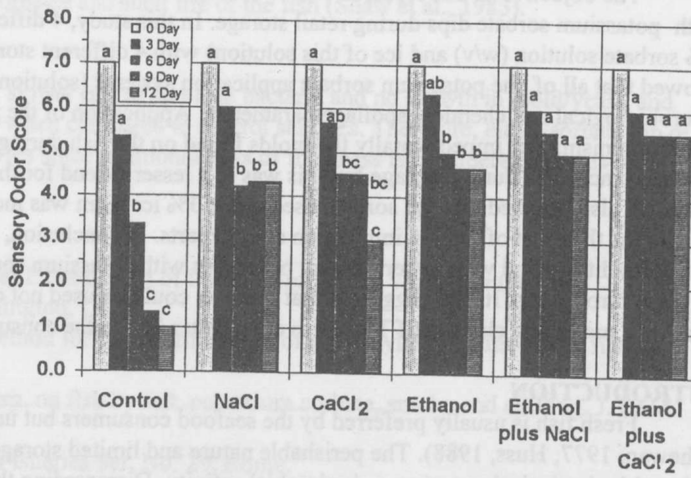

Figure 2. Sensory odor score for chicken thigh meat strips rinsed with various antimicrobial solutions, vacuum-packaged in oxygen permeable film and stored for 12 days at 3°C. (Descriptors for the 7-point odor score:7=normal, no off-odor and 1=very pronounced off-odor.)

Table 1. CIE lightness (L*), redness (+ a*), yellowness (+b*) and hue (h*) for chicken thigh meat strips rinsed with various antimicrobial solutions, vacuum-packaged in oxygen permeable film and stored at 3°C for 12 days.

		Antimicrobial Rinse Solution[1]					
CIE Color Attribute	Days at 3 C	Control (H_2O)	NaCl (28%)	$CaCl_2$ (10%)	Ethanol (50%)	Ethanol plus NaCl	Ethanol plus $CaCl_2$
Lightness (L*)	0	55.6^{a}	48.1^{bc}	63.0^{b}	54.0^{c}	49.1^{a}	62.8^{b}
	3	54.6^{b}	47.2^{d}	65.7^{a}	55.0^{b}	47.4^{b}	68.2^{a}
	6	51.3^{d}	47.5^{cd}	65.9^{a}	55.2^{b}	47.6^{b}	68.5^{a}
	9	52.7^{c}	48.5^{b}	66.2^{a}	55.9^{a}	48.2^{b}	68.5^{a}
	12	52.2^{c}	49.4^{a}	65.9^{a}	56.1^{a}	49.1^{a}	68.7^{a}
Redness (+a*)	0	2.9^{a}	4.2^{a}	2.9^{b}	3.5^{ab}	4.1^{a}	2.1^{a}
	3	3.4^{a}	3.8^{ab}	3.5^{b}	4.1^{a}	3.1^{b}	2.3^{a}
	6	3.0^{a}	3.5^{ab}	4.5^{a}	3.7^{ab}	3.0^{b}	2.5^{a}
	9	3.5^{a}	3.1^{b}	3.1^{b}	3.4^{ab}	3.0^{b}	2.6^{a}
	12	3.6^{a}	2.2^{c}	3.4^{b}	3.1^{b}	2.6^{b}	2.6^{a}
Yellowness (+b*)	0	2.7^{d}	3.3^{a}	1.6^{d}	2.5^{b}	3.7^{ab}	2.0^{c}
	3	4.6^{a}	2.6^{b}	6.3^{c}	5.4^{a}	4.0^{a}	8.4^{b}
	6	4.0^{ab}	1.3^{c}	6.9^{bc}	5.5^{a}	3.1^{bc}	8.9^{ab}
	9	3.6^{bc}	0.6^{d}	7.5^{ab}	5.4^{a}	2.7^{c}	9.2^{a}
	12	3.0^{cd}	0.0^{d}	7.8^{a}	5.4^{a}	2.5^{c}	9.5^{a}
Hue (h*)	0	43.2^{b}	35.9^{a}	29.3^{b}	35.6^{c}	41.7^{b}	47.4^{b}
	3	53.6^{a}	33.9^{a}	60.8^{a}	52.7^{b}	53.0^{a}	74.5^{a}
	6	52.7^{a}	20.8^{b}	56.8^{a}	55.9^{ab}	46.5^{a}	74.1^{a}
	9	46.0^{b}	10.6^{c}	67.6^{a}	58.0^{ab}	42.2^{b}	74.2^{a}
	12	40.0^{b}	1.0^{d}	66.6^{a}	60.6^{a}	44.0^{ab}	74.7^{a}

[1] Within a color attribute, means in the same column not having a common superscript letter are different ($p<0.05$).