Biotechnology in Animal Husbandry 23 (5-6), p 141 - 154 , 2007 ISSN 1450-9156
Publisher: Institute for Animal Husbandry, Belgrade-Zemun UDC 637.05

EFFECT OF PACKAGING MATERIALS AND TREATMENTS ON THE SHELF LIFE OF CHICKEN BREAST TREATED WITH ANTIMICROBIAL AGENTS AND STORED UNDER REFRIGERATED CONDITION **

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** Plenary invited paper

Abstract: Sliced chicken breast were treated by dippin in 8% Sodium lactate (SL) for 2 minutes or in 5 % Potassium sorbate (PS) for 5 minutes. The treated and untreated slices were packaged in two different packaging materials, Low density polyethylene bags (LDPE) at atmospheric pressure, and Laminated pouches (B-650) undervacuum, then stored refrigerated at 4 ºC for 24 days. Color evaluation, total volatile basic nitrogen (TVBN), total bacterial count (TC), psychrophilic bacterial count, coliform group, and sensory evaluation were done in order to study the effect of treatments on the quality and the shelf life of the product.

The data indicated that the treatment by (SL) or (PS) solutions was significantly increased the shelf life of the product compared with the untreated samples. It is also showed that the influence of (PS) treatment was the most effectinve in prolonging the shelf life of the sliced chicken breast among all samples.

The influence of vacuum storage in keeping quality was better than storage in (LDPE) at atmosheric pressure condition. Also, the shelf life of vacuum packaged treated samples was significantly increased compared with the samples packaged in (LDPE) without vacuum.

In conclusion, samples treated by (PS) and packaged under vacuum had the longest shelf life and the best quality than the others.

Key words: Packaging, chicken breast, antimicrobial agent, refrigeration, shelf life.

Introduction

Poultry meat constitutes a substantial portion of protein in the present day diets, hence the concern to market a safe, high quality product. The presence of pathogenic microorganisms, spoilage microorganisms, or both in poultry is undesirable but unavoidable (*Goncalves et al.,* 2004). Fresh poultry meat undergoes major undesirable changes during storage. Microbiological changes predominate during refrigeration, and the rapid growth of psychrotrophic microorganisms results in microbial spoilage and limited shelf life. The refrigerated shelf life of poultry varies from one to two weeks, depending on the initial microbial load. Large numbers of additives have been studied as possible preservatives to minimize and control undesirable changes in fresh poultry.

Sodium or potassium salts of lactic acid have been shown to delay growth of meat spoilage microorganisms (*Shelef,* 1994*; Tan and Shelef,* 2002*; Ahmed, et al.,* 2003*; Goncalves, et al.,* 2004*). O'connor et al,* (1993) reported that 3% Sodium lactate significantly reduced aerobic plate count (APC) based on spoilage level of 10^6 CFU/g of fresh ground pork and extended its shelf life by about 12 days compared to control. 2% lactic acid spray was effective in reducing numbers of *E. coli* and could be useful as pathogen intervention steps in lamb slaughter processing (*Ramirez et al.,* 2001). A concentration of 0.10% Potassium sorbate delayed or retarded total counts, growth of salmonellae, and *Staphylococcus. Aureus*, and growth and toxin production by *C. botulinum* (*Sofos and Busta,* 1981*; Robach and Sofos,* 1982). 10% potassium sorbate dip extended the shelf life of the drumsticks from 6 to 10 days at 4°C (*Cunningham,* 1981).

Modified atmosphere packaging by reducing oxygen and or increasing gases such as Co_2, in the food environment was found to extend the product shelf life. *Wolf* (1980), *Ogrydziak and Brown* (1982)*; Sheridan et al.* (1997), *Marth* (1998), *Saucier et al.* (2000) reported that modified or controlled atmosphere packaging extends shelf life of poultry, meat and seafood, and inhibits the growth of gram-negative bacteria and other related psychrotrops which produce off odors and flavors. In 2004 chicken meat production in Egypt was 547.000 metric ton (FAO, 2005). Control of microbial growth with bacteiostatic ingredients and packaging may have adverse effects on a product's color, odor, flavor, appearance or palatability, which can be considered as quality indicators to consumers (*Maca et al.,* 1999*; Loneggan et al.,* 2003). The objective of this study was to determine the effect of sodium lactate and potassium sorbate dip with different packaging materials

and treatments on microbial counts, chemical, color, sensory attributes and shelf life of chicken meat breast during storage at 4°c.

Material and methods

Fifty broilers chicken 7 weeks age and 1940±50g live weight were slaughtered, scalded, mechanically picked in commercial picker, eviscerated and washed. Breast muscles were removed from carcasses trimmed, weighed, immediately breast fillet divided into 3 groups.

Treatment and packaging

The first group was submerged for 5 min in 4-litter solution of 5% (W/V) potassium sorbate, drained for 10 min (*Toledo-Flores and Zall,* 1992). The second group was dipped for 2 min in 4-litter of 8%sodium lactate, drained for 10 min 2(*Huang and Huang,* 1994). The third group was left as control. Each group was divided into two portions. The first one packaged in1 mil low-density polyethylene (LDPE), from Dow Co. Midland, MI. USA) 200 ±10g each package. The second one was packaged under vacuum in 3 mil laminated (Nylon/PE) from Koch Co. Kansas City, MO. USA. (1 mil=0.001 inch). All samples treated or untreated were stored at 4°C for 24 days. Sample of each treatment was randomly removed from refrigerator at zero time and every 3 days interval for analysis.

Microbiological analysis

Aerobic plate count (APC), Anaerobic count, Psychrophilic count, and coliform count of treated and untreated packaged chicken breast were determined as (CFU/g) according to the methods described in the standard methods of (*APHA,* 1985; and *Vaderzant and Splittstoesser,* 1992). The BBLGasPak^{R} anaerobic chamber with BBL GasPak Co_2 gas packs (Becton Dickinsin Microbiology System, Boston, MA.) were used to create an anaerobic environment for incubation.

Color evaluation

Hunter color values (lightness L*, redness a*, and yellowness b*) were measured for treated and untreated packaged chicken breast meat at zero time and during storage period with a colorimeter (Color Tec PCM Color Meter Tec. NJ. USA). Four random measurement spots on each sample were made and the average data were recorded according to (*Holownia et al.,* 2003).

Total volatile basic nitrogen (TVBN)

Total volatile basic nitrogen was measured according to the *Person,* (1975).

Sensory evaluation

Samples from each group were randomly assigned for sensory evaluation according to *Sahoo and Anjaneyulu,* (1997). Twelve semi-trained panelists were participated to evaluate chicken breast odor and color discoloration during storage. Sensory score for odor was obtained by following a 5-point scale where 1 = very unpleasant, 2 = moderately unpleasant, 3 = moderately pleasant, 4 = pleasant and 5= very pleasant. The score for color discoloration was 1 = total discoloration, 2 = moderately discoloration, 3 small discoloration, 4 slight discoloration and 5 = no discoloration).

Results and Discussion

The Hunter color values L*, a* and b* of potassium sorbate or sodium lactate treatment and packaging with or without vacuum were presented in (Table 1).

Table 1. Effect of potassium sorbate, sodium lactate and packaging materials and treatments on color (L, a, and b) of chicken breast meat stored at 4C for 24 day.

Samples	Color	Storage time (day) at 4°C								
		0	3	6	9	12	15	18	21	24
Control WOV	L	56.44	50.42	49.81	47.06	____		____	____	____
	A	4.64	4.38	4.13	4.03					
	b	3.94	2.03	2.80	1.86					
Potassium sorbate WOV	L	55.53	49.98	48.56	49.28	49.23	48.63	49.37	48.86	49.19
	A	5.12	6.24	6.22	6.05	5.11	5.23	4.99	4.42	4.25
	b	3.32	1.75	2.53	2.65	2.77	2.21	2.87	2.08	2.30
Sodium lactate WOV	L	55.51	49.96	49.77	47.91	47.24	47.72	46.24	____	___
	A	5.45	5.44	5.27	5.01	5.26	5.03	4.32		
	b	3.76	1.35	1.99	2.21	2.33	1.73	0.73		
Control WV	L	56.44	49.62	48.76	49.80	49.54	49.62	47.32	47.30	_____
	A	4.64	6.24	5.32	4.89	4.66	4.75	4.53	4.23	
	b	3.94	1.94	1.92	1.87	1.57	1.71	1.67	1.45	
Potassium sorbate WV	L	55.53	50.82	49.97	49.66	49.85	49.19	48.23	47.06	47.12
	A	5.12	5.34	5.13	5.08	4.95	4.30	4.52	4.26	4.39
	b	3.32	1.78	2.12	1.98	2.05	2.12	2.14	1.86	1.61
Sodium lactate WV	L	55.51	50.31	49.45	49.68	49.04	48.75	48.44	47.21	47.43
	A	5.45	5.44	4.79	5.18	4.22	4.39	4.20	4.13	4.22
	b	3.76	2.12	2.35	2.16	1.89	1.81	1.73	1.62	1.70

N=4. , WOV = Without vacuum packaging; WV = With vacuum packaging.

Little differences were found in the Hunter color L*. a*, and b* among samples at zero time. *Qiao et al.,* (2002) found that the variation in breast

chicken color may be due to long term genetic factors as well as short term antemortem stress. L* (Lightness) b* (yellowness) values for all samples sharply decreased after 3 days of storage and then gradually decreased with increasing the storage time. The a* (redness) values for all samples slightly changes in the first 12 days of storage and decreased at the end of storage period. *Huang and Huang* (1994) reported that neither lactates treatment nor packaging system had no effect on hunter color values of tilapia fillets stored at 4°c for 16 days. Darker broiler breast meat fillets stored at 3°C have a shorter shelf life than lighter breast fillets; the shorter shelf life may be attributed to the differences in pH (*Allen et al.,* 1997).

The total volatile basic nitrogen (TVBN) could be used as a quality indicator for fish products (*Jay,* 1992) and it is associated with the amino acid decarboxylase activity of microorganisms during storage. The changes in TVBN value during storage are shown in Fig. 1.

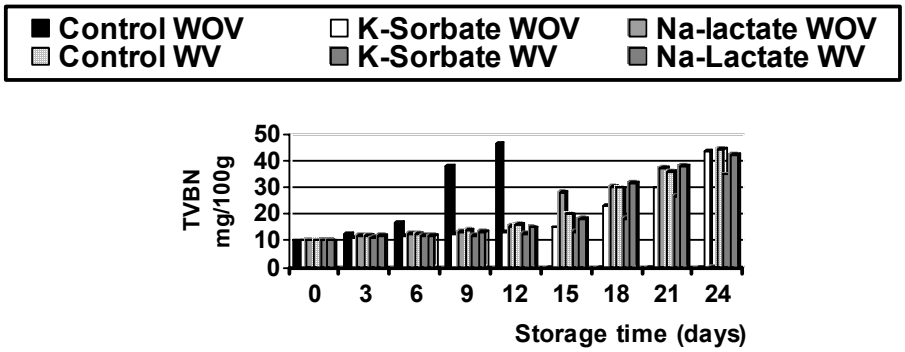

Figure 1: Influence of potassium sorbate and sodium lactate in combination with modified atmosphere packaging on the total volatile basic nitrogen (TVBN) value of refrigerated chicken breast muscles.

WOV = without vacuum packaging. WV = with vacuum packaging.

Total volatile basic nitrogen (TVBN) values of all samples were increased with increasing the storage time and the greatest changes occurred between the 18^{th} and 24^{th} days of storage. Samples treated with potassium sorbate had the lowest levels of TVBN compared to the other samples. The chicken parts dipped in 10% potassium sorbate had a 20 days shelf life at 4ºC based on off-odor development and time for total counts to reach 10^7 (*Cunningham,* 1979). Total volatile basic nitrogen content of the control

packaged without vacuum in LDPE rapidly increased after 6 days of storage. While control sample packaged under vacuum had low TVBN values in the same period of storage. Treated and untreated samples packaged under vacuum had lower values of TVBN than the other samples. Modified atmosphere packaging inhibits the growth of aerobic spoilage microorganisms, such as *pseudomonas* species, but allows facultative anaerobic such as lactic acid bacteria to grow (*Marth,* 1998). Samples packaged in LDPE without vacuum remained at higher TVBN level suggesting greater bacterial populations and activity, which are in agreement with its microbial counts.

Sensory panelists were unable to detect any differences between treatments for overall color on day 0 of display (Fig. 2).

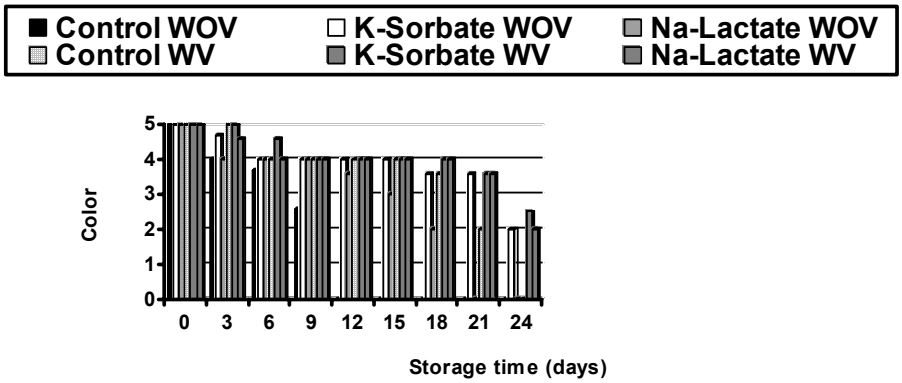

Figure 2: Influence of potassium sorbate and sodium lactate in combination with modified atmosphere packaging on the color of refrigerated chicken breast muscles.

WOV = without vacuum packaging. WV = with vacuum packaging.

However, no color discoloration was observed on the day 3, 6 and 9 of storage for potassium sorbate treated samples with vacuum packaging. On the other hand, color of control sample without vacuum became unaccepted on the day 9. Slight discoloration was detected in vacuum packaged treated samples during the 18 days of storage. Color scores of sodium lactate treated sample without vacuum packaging decreased on the day 12 and became unaccepted on the day 18.

Off odor was detected in the control samples on the day 9 of storage

(Fig. 3). *Van Laack* (1994) reported that off-odors become noticeable when bacterial numbers are between 7.0 and 7.5 $\log_{10}$ CFU/cm^2. Potassium sorbate and sodium lactate treated samples with vacuum packaging had higher odor scores than other samples. *Robach and Sofos*, (1982) reported that off odors from the sorbate treated birds were not noticed until the 19th day of storage at 3°C. From these data it could be concluded that the average shelf life of control sample without vacuum packaging was 3 to 6 days and for control with vacuum packaging was 12 to 15 days. Potassium sorbate and sodium lactate treatments with vacuum packaging extended the shelf life of breast chicken to 21 days at 4°C. However the shelf life of sodium lactate or potassium sorbate without vacuum were 12 and 18 days respectively.

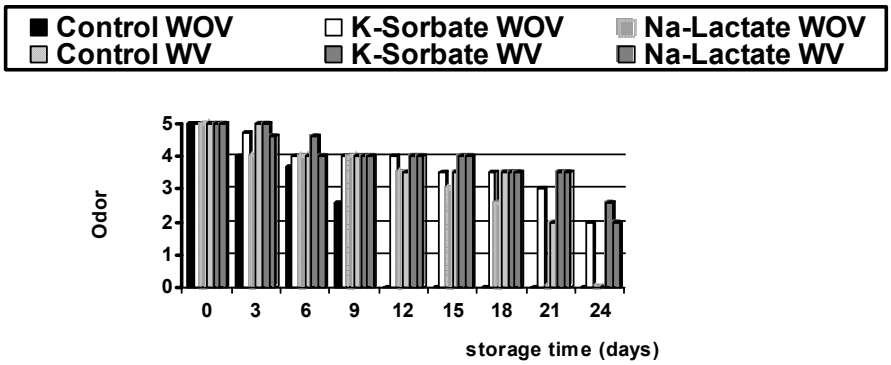

Figure 3: Influence of potassium sorbate and sodium lactate in combination with modified atmosphere packaging on the odor of refrigerated chicken breast muscles.

WOV = without vacuum packaging. WV = with vacuum packaging.

Aerobic plate counts (APC)were increased with increasing the storage time except the samples treated with potassium sorbate their APC decreased on the day 3 and starting to increase on the day 6 (Fig. 4). The increment was rapid for the control ample packaged in LDPE without vacuum and the greatest changes occurred between the 9th and twelfth days. Samples treated with potassium sorbate with or without vacuum packaging had lower APC than the other samples. *McMeekin et al.(*1984) reported that a 30 second dip of poultry pieces and fillets in 5% potassium sorbate and vacuum packaging delayed microbial growth and extended the shelf life to 35 days at 2°C. Vacuum packaging with potassium sorbate and sodium lactate treatments

retarded microbial growth on chicken breast and prolonged the shelf life compared to that without vacuum packaging. Potassium sorbate treatment with vacuum packaging increased the time to reach aerobic count *of 6.5 log CFU/ cm^2 for beef slices stored at 4°C. (Zamora* and Zaritzky, 1987). According to the guidelines from the Meat Hygiene Manual (Canadian Food Inspection Agency) these maximum values are 7 and 3 log CFU/g for total aerobic mesophilic and coliform count (Saucier et al., 2000). Aerobic plate count of control sample WOV packaging was over the acceptable limit on the day 12 but exhibited off-odor on the day 9. However, control sample WV packaging exhibit off-odor on the day 12 of storage. *Van Laak,* (1994) reported that off-odors become noticeable in chilled meat and poultry when bacterial numbers are between 7.0 and 7.5 logCFU/ cm^2 . Aerobic plate count remained under the maximum value (7 log CFU/g) after 15 day of storage for all samples except the control sample packaged without vacuum.

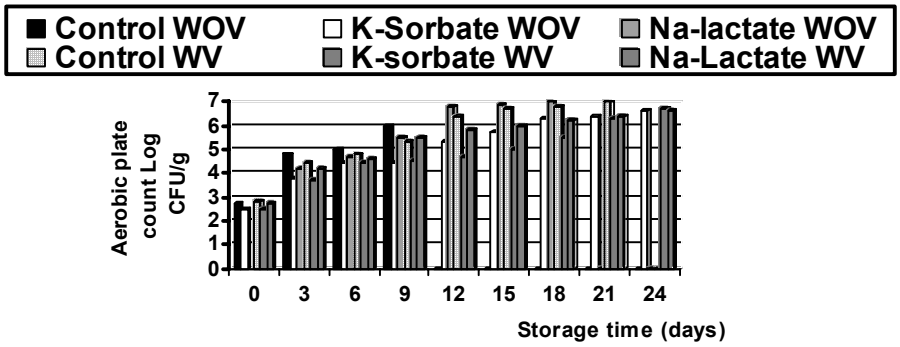

Figure 4: Influence of potassium sorbate and sodium lactate in combination with modified atmosphere packaging on the aerobic plate count of refrigerated chicken breast muscles.

WOV = without vacuum packaging. WV = with vacuum packaging.

Anaerobic counts of all samples increased along the storage time. The increment rate was lower in the vacuum packaged and potassium sorbate treated samples than the other samples (Fig.5). *Saucier et al.,* (2000) reported that modified atmosphere packaging extends shelf life of poultry and inhibits the growth of gram-negative bacteria and other related psychrotrophs which produce off-odors and flavors. Sodium lactate treated samples packaged in LDPE without vacuum had the highest number of

anaerobic counts. Anaerobic plate counts increased rapidly for control sample packaged in LDPE without vacuum.

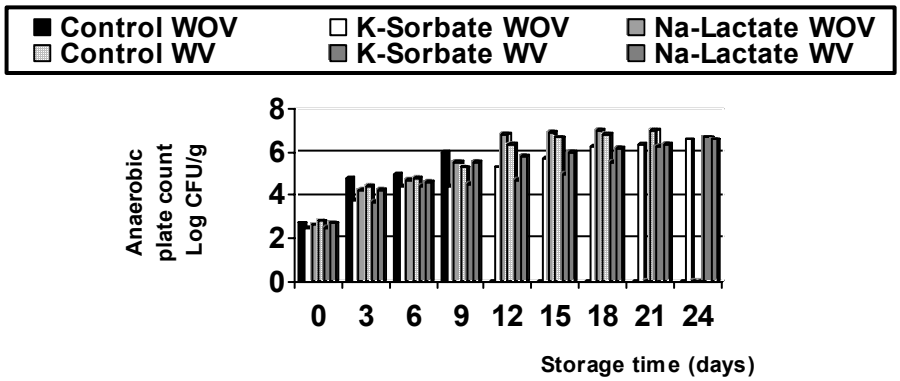

Figure 5: Influence of potassium sorbate and sodium lactate in combination with modified atmosphere packaging on the anaerobic plate count of refrigerated chicken breast muscles.

WOV = without vacuum packaging. WV = with vacuum packaging.

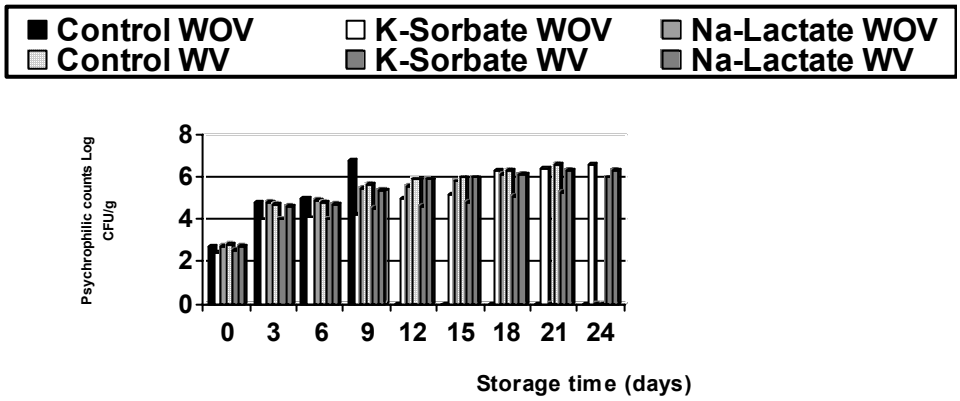

Figure 6: Influence of potassium sorbate and sodium lactate in combination with modified atmosphere packaging on the psychrophilic counts of refrigerated chicken breast muscles.

WOV = without vacuum packaging. WV = with vacuum packaging.

Psychrophilic count increased with increasing the storage time. Potassium sorbate treated sample with vacuum packaging had the lowest psychrophilic counts during the storage time (Fig. 6). Control sample without vacuum packaging had low psychrophilic count with acceptable color and odor score, by day nine of refrigerated storage the counts were rapidly increased with moderate discoloration and off odor, indicating complete spoilage. Chicken spoilage off-odors can be attributed to the growth of psychrotrophic bacteria degrading the amino acids found in the muscle (*Pooni and Mead,* 1984).

Potassium sorbate and sodium lactate with vacuum packaging reduce the growth of coliform bacteria compared to the control (Fig.7). A 2% lactic acid spray was effective in reducing the numbers of *E.coli* and could be also useful as pathogen intervention steps in lamb slaughter processing (*Ramirez et al.,* 2001). However, coliform counts for all samples were over the acceptable limit (3 log CFU/g) at day 21 except the sample treated with potassium sorbate with vacuum packaging. Control samples without vacuum packaging had higher coliform count than the other samples during the first week of storage and its count was greater than the acceptable limit (3 log CFU/g) at the day 9.

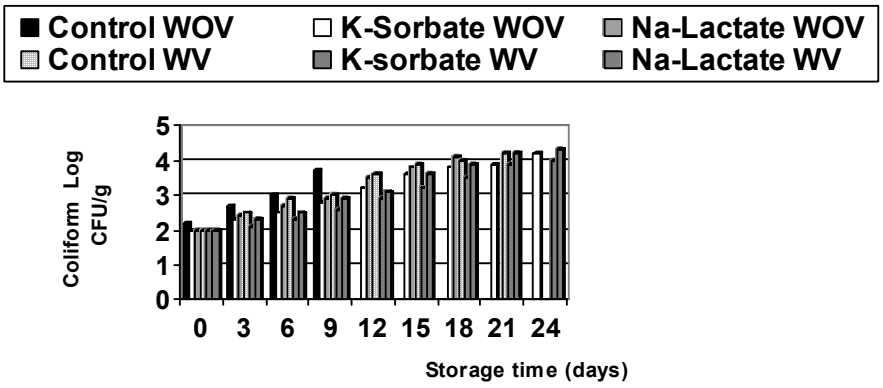

Figure 7: Influence of potassium sorbate and sodium lactate in combination with modified atmosphere packaging on the coliform counts of refrigerated chicken breast muscles.

WOV = without vacuum packaging. WV = with vacuum packaging.

UTICAJ MATERIJALA ZA PAKOVANJE I TRETMANA NA ROK TRAJANJA PILEĆIH GRUDI TRETIRANIH ANTIMIKROBIOLOŠKIM AGENSIMA I SKLADIŠTENIM U FRIŽIDERIMA

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Rezime

Pileće meso čini značajan deo proteina u našoj ishrani. Prisustvo patogenih i mikroroganizama koji utiču na kvarenje mesa tokom skladištenja nije poželjno jer ograničava rok trajanja Soli natrijuma ili kalijuma mlečne I sorbinske kiseline usporavaju porast mikrorganizama koji utiču na kvarenje mesa. Modifikovano atmosfersko pakovanje takože produžava rok trajanja piletine, mesa i morskih proizvoda.

U ovom istraživanju, meso pilećih grudi je tretirano sa 5% kalijumsorbata u trajanju od 5 minuta ili 8% natrijumlaktata u trajanju od 2 minuta, upakovano sa ili bez vakuuma u dve vrste materijala za pakovanje LDPE I laminirani (Nylon/PE), i skladišteno na 4°C. Hunter vrednosti za boju (L*, a*, i b*), ukupni isparljivi osnovni azot (TVBN), senzorni kvalitet, broj aerobnih ćelija (APC), broj anaerobnih ćelija, psihrofilni broj i koliformni broj su ocenjivani tokom perioda skladištetnja.

Rezultati su pokazali neznatne promene u Hunterovim vrednostima za boju tokom perioda skladištenja. Vrednosti ukupnog isparljivog osnovnog azota (TVBN) za sve uzorke su se povećavali sa produženjem perioda skladištenja. Uzorci tretirani kalijumsorbatom su imali najniži nivo (TVBN) u poređenju sa ostalim uzorcima. Uzorci tretirani kalijumsorbatom i natrijumlaktatom sa vakuumskim pakovanjem su imali bolje ocene boje i arome/mirisa nego ostali uzorci. Vakuumsko pakovanje sa tretmanom kalijumsorbatom i natrijumlaktatom je smanjilo mikrobijalni porast na pilećem mesu I produžilo rok trajanja u poređenju sa uzorcima koji nisu vakuumski upakovani. Podaci su pokazali da je prosečan rok trajanja kontrolnog uzorka bez vakuuma bio 3 do 6 dana I za kontrolu sa vakuumskim pakovanjem 12 do 15 dana. Rok trajanja mesa tretiranog natrijumlaktatom ili kalijumsorbatom bez vakuuma je bio 12 I 18 dana,

respektivno. Međutim, kalijumsorbat I natrijumlaktat tretmani sa vakuumskim pakovanjem su produžili rok trajanja pilećih grudi do 21 dana na 4°C.

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