Effects of Sodium Lactate, Potassium Sorbate and Cetylpyridinium Chloride on Physicochemical Properties and Microbial Count of Cold Ground Beef Meat

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ABSTRACT

The objective of the present study was to investigate the effects of: 3% sodium lactate (SL), 0.2% potassium sorbate (KS) and 0.5% cetylpyridinium chloride (CPC) on the physicochemical properties ,microbial count and sensory evaluation of ground beef, stored at 4°C for O, 3, 6 and 9 days.

All treatments showed significant increase in dry matter content (protein, fat and ash) ($P<0.05$) and decrease in moisture content with elongation storage time. The SL, KS and CPC significantly increased the pH and water holding capacity (WHC) during all the storage periods. Total volatile nitrogen (TVN), thiobarbituric acid value (TBA), peroxide value (PV) and free fatty acids (FFA) were lower ($P<0.05$) in SL, KS and CPC treated samples, as compared with the control sample at any refrigerated storage period. The SL, KS and CPC caused significant ($P<0.05$) decrease in drip loss and cooking loss. Results indicated significant sensory evaluation improvement ($P<0.05$) in the organoleptic characteristics of ground beef (flavour, juiciness, tenderness, colour and overall palatability). The SL, KS and CPC significantly reduced ($P<0.05$) the total plate count and psychrophilic count during refrigerated storage periods. It can be concluded that SL, KS and CPC had positive significant influence on quality characteristics, sensing and microbial safety of ground beef when stored under refrigeration at 4C° up to 9 days.

Keywords : sodium lactate, potassium sorbate, cetylpyridinium chloridesansan, ground beef.

INTRODUCTION

Although much research had been directed toward the use of organic acids to control microbial growth on carcasses, retail cuts and ground beef (Woolthuis & Smulders, 1985, Kotula & Thelappurate, 1994, Dorsa *et al.*, 1997, Stivarius *et al.*, 2002), data are limited on the use of organic acid salts, such as sodium lactate and potassium sorbate. Sodium lactate is used as humectant or flavour enhancer in cooked meat and poultry products (Federal Register, 1990). Microbial growth is inhibited by incorporation of up to 2% sodium lactate in fresh pork sausage thus, increasing the storage stability and reducing off-odour (Kuo *et al.*, 1994). Moreover, Papadopoulas *et al.* (1991) reported that cooked beef containing 3-4% sodium lactate had 2 log units reduction in microbial population during storage. The USDA (1999), issued final rule that increased the permissible levels of sodium lactate to 4-4.8% completely inhibited growth of *L. monocylogenes* and *botulinum* in meat and poultry (Buncic *et al.*, 1995, Kathleen *et al.*,1999).

Potassium sorbate is widely used as food preservative. It is non-toxic even in large quantities. It breaks down and it is effective against yeasts, molds and some select bacteria (CFNP 2002). Microbiological safety of some food products was best ensured by addition of potassium sorbate (Shahidi *et al.*, 1988). Cetylpyrid-inium chloride is a quaternary ammonium compound. Its antimicrobial activity is due to an interaction of basic cetylpyridinium ions with acid groups of bacteria, which subsequently inhibits bacterial metabolism by forming weak ionic compounds that interfere with bacterial respiration (Kim & Slavik, 1996), the permissible levels of cetylpyridinium chloride 0.5% according to Pohlman *et al.* (2002). While, the antimicrobial properties of reagents are well documented, no studies are available in the literature as to their effect on physicochemical properties, sensory evaluation and lipid oxidation.

Therefore, the objective of the present study was to evaluate the physicochemical properties, microbial stability and sensory properties of ground beef treated with sodium lactate, potassium sorbate and cetylpyridinium chloride during refrigeration storage at 4C°.

MATERIALS AND METHODS

External fat and heavy connective tissue were trimmed off from top round of beef. Muscles were removed and formulated with addition of fat to target final level of 15% (on wet weight basis). Meat was ground twice through 0.8cm plate using electric grinder (National).The minced beef was then divided into four batches 500g each. Each batch was mixed by hand for 5 min in a plastic bag with 30 ml (or 6%) of each of the treatment solutions: (1) distilled water as control (C), (2) 3% sodium lactate (SL) (60% (w/w) solid content pH 5.3), (3) 0.2% potassium sorbate (KS) and (4) 0.5% (w/v) cetylpyridinium chloride (CPC), SL, KS and CPC treatments were used according to Lin & Lin (2002) and Pohlman *et al.* (2002). All treatments were prepared using deionized water. Multiple trays of minced beef from each treatment were packed pending for microbial, physicochemical analysis and sensory evaluation and stored in a refrigerator (4C°) for 0, 3, 6 and 9 days.

Microbial sampling

On days 0, 3, 6 and 9, twenty five grams of ground beef were aseptically removed from each package, mixed with 225ml sterilized 0.1% peptone solution and blended for 30 sec. with stomacher. Total plate counts and psychrotrophic counts were determined following the method used by Lin & Lin (2002).All microbial counts were reported as colony formimg units (CFU/g meat sample).

Physicochemical analysis

Samples were taken for proximate analysis including moisture, protein, fat and ash contents (AOAC, 1980). The pH of samples was measured (Xiong *et al.*, 1993), together with water holding capacity "WHC" (Den Hertog-Meischke *et al.*, 1997). Total volatile nitrogen (TVN), peroxide value (PV), free fatty acids (FFA) and thiobarbituric acid (TBA) value were also determined (Pearson *et al.*, 1981). Myoglobin concentration was measured according to Zessin *et al.* (1961). Drip loss and cooking loss were determined according to Honike (1998), and Purchas & Barton (1976), respectively.

Sensory evaluation

A trained sensory panel of eight members was requested to evaluate: flavour, juiciness ,tenderness, colour and overal palataibility of cooked ground beef samples (Al-Rawi, 2005). A judging scale was as follows on a 8 point scale: 8 = extremely desirable, extremely juicy, extremely tender, dark brown, extremely desirable and 1= extremely undesirable, extremely dry, extremely tough, very dark red and extremely undesirable.

Statistical analysis

A 4×4 factorial design including two factors, (treatment and storage time), with three replications was analyzed by the analysis of variance (SAS, 2001). Significance between means was tested by Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Table (1) indicates the changes in proximate composition among treatments during refrigerated storage. All treatments showed significant ($P<0.05$) increase in dry matter (protein, fat and ash contents) and decrease in moisture content with storage extending period (0, 3, 6 and 9 days). The CPC treatment had the least ($P<0.05$) dry matter and the highest moisture content at any storage period, as compared with other treatments (Table 1). The results confirm those of Lin & Lin (2002) and Pohlman *et al.* (2002) on low fat Chinese- style sausages, and on ground beef, respectively, probably due to the decrease of the moisture content which was associated with storage proceeding (Xiong *et al.*, 1993, Ageena, 2001).

The effect of salt treatments and storage period on pH pattern were significant ($P<0.05$) (Table 2). The CPC treatment was the highest in pH ($P < 0.05$) at any storage period, which was attributed to its increase in the total negative charges leading to raise the pH of meat (Kim & Slavik, 1996), consequently increasing the ionic strength (IS) and increasing moisture binding. The SL treatment tended to remain the pH stable throughout the storage preiod that was possibly due to its buffering capacity (Papadopolous *et al.*, 1991, Banks *et al.*, 1998). All treatments showed a decreasing pH pattern (Table 2) with extending storage period. Similar results were reported by Brewer *et al.*, 1991, Wang, 2000, Lin & Lin, 2002 on fresh pork sausages, low fat Chinese-style sausages, and other sausages.

Table (3) presents comparisons of water holding capacity (WHC) values for treatments under investigation. Salts treatments affected WHC values positively. The CPC treatment had significantly ($P<0.05$) higher WHC than the other treatments at

Table 1: Effect of SL, KS and CPC on proximate composition of ground beef during cold storage (on dry weight basis)

Treatment*	Traits	Storage time (days)			
		0	3	6	9
C	Dry Matter	39.77±0.23^{Ad}	42.25±0.18^{Ac}	45.42±0.20^{Ab}	47.84±0.13^{Aa}
	Protein	50.35±0.19^{Cb}	49.96±0.15^{Bb}	51.56±0.22^{Aa}	52.04±0.25^{Aa}
	Fat	44.72±0.25^{Aa}	44.97±0.30^{Aa}	43.70±0.20^{Ab}	44.20±0.10^{Aab}
	Ash	2.89±0.10^{Ba}	3.38±0.12^{Aa}	3.30±0.12^{Aa}	3.21±0.10^{Aa}
SL	Dry Matter	34.33±0.15^{Ba}	41.10±0.12^{Bc}	43.20±0.22^{Bb}	44.81±0.30^{Ba}
	Protein	53.45±0.18^{Ba}	50.97±0.20^{Ab}	51.13±0.20^{Ab}	51.57±0.22^{Bb}
	Fat	41.50±0.15^{Bb}	43.97±0.10^{Ba}	43.75±0.10^{Aa}	43.89±0.20^{Aa}
	Ash	2.91±0.05^{Ba}	3.40±0.01^{Aa}	3.40±0.01^{Aa}	3.34±0.01^{Aa}
KS	Dry Matter	32.89±0.00^{Cd}	39.80±0.00^{Cc}	42.37±0.00^{Cb}	43.10±0.00^{Ca}
	Protein	53.20±0.22^{Ba}	50.95±0.20^{Ab}	51.33±0.33^{Ab}	51.78±0.30^{Bb}
	Fat	41.31±0.15^{Bb}	44.02±0.12^{Ba}	43.40±0.15^{Ab}	42.83±0.10^{Be}
	Ash	3.41±0.02^{Aa}	2.88±0.02^{Ba}	3.18±0.01^{Aa}	3.24±0.02^{Aa}
CPC	Dry Matter	31.58±0.23^{Dd}	38.45±0.20^{De}	41.61±0.18^{Db}	42.97±0.20^{Ca}
	Protein	56.30±0.15^{Aa}	50.61±0.10^{Ad}	51.55±0.25^{Ac}	52.59±0.20^{Ab}
	Fat	38.50±0.14^{Cd}	45.01±0.10^{Aa}	43.38±0.11^{Ab}	43.16±0.10^{Bc}
	Ash	2.81±0.01^{Ba}	2.41±0.02^{Ba}	2.64±0.01^{Ba}	2.60±0.01^{Ba}

* C (control), SL (sodium lactate), KS (potassium sorbate) and CPC (cetylpyridinium chloride).
Means±SE within the column for the same test item having unlike letters (A–D) are significantly different among treatments (P<0.05). Means±SE within the same row having unlike letters (a–d) are significantly different among storage time in treatment (P<0.05).

Table 2: Effect of SL, KS and CPC on pH of ground beef during cold storage

Treatment*	Storage time (days)			
	0	3	6	9
C	5.57± 0.03^{Cb}	5.65± 0.02^{Ca}	5.64± 0.03^{Ba}	5.60± 0.01^{Ba}
SL	6.25± 0.02^{Ba}	6.15±0.01^{Bb}	6.12±0.01^{Ab}	6.10± 0.01^{Ab}
KS	6.31± 0.01^{ABa}	6.22±0.02^{ABa}	6.10± 0.03^{Ab}	6.05±0.01^{Ab}
CPC	6.39±0.01^{Aa}	6.30±0.03^{Aa}	6.18±0.01^{Ab}	6.15±0.03^{Ab}

* C (control), SL (sodium lactate), KS (potassium sorbate) and CPC (cetylpyridinium chloride).
Means±SE within the column for the same test item having unlike letters (A-B) are significantly different among treatments (P<0.05). Means±SE within the same row having unlike letters (a-b) are significantly different among storage time in treatment (P<0.05).

Table 3: Effect of SL,KS and CPC on water holding capacity (WHC) of ground beef during cold storage

Treatment*	Storage time (days)			
	0	3	6	9
C	56.20±0.20^{Da}	49.25±0.10^{Db}	46.19±0.10^{Dc}	45.42±0.20^{Dd}
SL	63.23±0.10^{Ca}	56.32±0.20^{Cb}	53.28±0.30^{Cc}	52.04±0.10^{Bd}
KS	66.70±0.20^{Ba}	61.60±0.25^{Bb}	56.790.10^{Bc}	50.05±0.20^{Cd}
CPC	70.10±0.25^{Aa}	66.12±0.10^{Ab}	62.30±0.20^{Ac}	56.65±0.20^{Ad}

* C (control), SL (sodium lactate), KS (potassium sorbate) and CPC (cetylpyridinium chloride).
Means±SE within the column for the same test item having unlike letters (A-B) are significantly different among treatments (P<0.05). Means±SE within the same row having unlike letters (a-b) are significantly different among storage time in treatment (P<0.05).

any storage time. On the other hand, C treatment exhibited lower WHC than others at any storage period. Addition of CPC (its mean ions Cl^-) not only raised the pH of meat but also increased the total negative charges on myofibrillar proteins (Kerry *et al.*, 2002). Both actions accounted for increased WHC. All treatments showed a gradual decrease in WHC (Table 3) as storage time was extended. Such results agree with the findings of Lin & Lin (2002) who showed a decrease in the values of WHC in salt treatments in low fat Chinese- style sausages was associated with extending storage period.

The total volatile nitrogen (TVN) could be used as a quality indicator for meat (Ageena, 2001), and in association with the amino acid decarboxylase activity of microorganisms during storage. Changes in TVN value during storage are shown in Table (4). The SL had significant (P<0.05) lower TVN value than other treatments, while C treatment remained at higher (P<0.05) TVN suggesting greater bacterial population and activity, which confirmed Lin & Lin (2002) findings on TVN for low-fat Chinese-style sausage with addition of 3% SL than for the control. All treatments showed significant (P<0.05) increases in TVN value with increasing refrigerated storage (Table 4). The present data support those reported by Celik (1995) who found that the TVN value in raw beef meat of 9.39 mg N/100g meat to increase to 75.44 mg N/100 meat after 15 days of storage under refrigeration.Thus, TVN in meat increased with increasing storage time possibly due to changes and proteolysis in myofibrillar protein during storage, also might be due to increased action of proteolytic enzyme that contribute to increased accumulation of free nitrogen groups that might lead to higher TVN value (Ageena, 2001).

Table (5) gives changes in myoglobin concentration during refrigerated storage of ground beef among the studied treatments. All treatments showed significant (P<0.05) increase in myoglobin concentration as storage time proceeded, due to oxidation of myoglobin pigment to metmyoglobin during storage (Chen *et al.*, 1992, Banks *et al.*, 1998). The CPC treatment was the highest (P<0.05) at any storage time, while C treatment had the least values (P<0.05) at any storage time , the magnitudes of differences among salt treatments were small. Such results agree with those of Al-Rawi (2005) on minced and frozen beef.

The effect of salt treatments on thiobarbituric acid (TBA) values is summarized in Table (6). The TBA values among treatments followed a similar increasing (P<0.05) trends with refrigerated storage period ,but the values in all treatments were less (P<0.05) than that in C treatment .Similar findings were observed by Brewer *et al.* (1992) and Celik (1995) who showed that TBA values in raw fresh beef of 0.22 mg malonaldehyde /kg meat increased to 0.91 mg malonaldehyde /kg meat after 15 days refrigeration, and that was probably due to lipid oxidation resulting from action of lipase or phospholipase (Raharjo *et al.*, 1992). The COSQC (1987) issued a final rule that if the TBA value increased to more than 2.0 mg malonaldehyde /kg of meat the meat is inadmissible or refused.

Peroxide values (PV) for the treatments under study are shown in Table (6). All salt treatments had the least significant (P<0.05) PV at any storage period. On the other hand, the C treatment recorded the highest significant (P<0.05) PV at any storage period. Generally, all treatments showed significant increase in PV with increasing refrigerated storage, and which had thought to be due to action of lipolysis enzymes such as, lipase and phospholipase on lipids in meat particularly their phospholipids components undergoing degradation to produce a large number of compounds such as, hydroperoxides, aldehydes and ketones being are responsible for the development of undesirable aroma and deterioration in flavour (rancidity) during storage (Kerry *et al.*, 2002). Similar results were reported by Smith *et al.* (1985) and Berry (1991) on frozen ground beef patties. The COSQC (1987) issued a final rule that the increase of the PV more than 10 milli equivalents peroxide /Kg of meat resulted in that the meat is inadmissible or refused.

Free fatty acid (FFA) values for salt treated ground beef during refrigerated storage are listed in Table (6). Nonsignifcant differences in FFA among the treatments were found at any storage period. In general, FFA values among treatments followed similar increasing trends with storage period ,but C treatment was the highest significant (P<0.05) at any storage period, possibly due to the action of lipolytic enzymes (lipase and phosphplipase) on lipid leading to increase the release of free fatty acids which contribute positively to the generation of undesirable aromas as well as flavour. On the other hand, the salt treatments recorded the lowest significant (P<0.05) FFA at any storage period, which may lead to the desirable aroma and flavour. Similar results were reported by Kim *et al.* (1988) and Muller

Table 4: Effect of salt treatment (SL, KS and CPC)on total volatile nitrogen (TVN) (mgN/100) of ground beef during cold storage

Treatment*	Storage time (days)			
	0	3	6	9
C	8.20±0.10^{Ad}	12.60±0.20^{Ac}	15.50±0.10^{Ab}	16.80±0.10^{Aa}
SL	5.10±0.30^{Cc}	8.10±0.10^{Cb}	10.80±0.25^{Cad}	11.30±0.10^{Ca}
KS	6.60±0.20^{Bc}	10.22±0.20^{Bb}	12.01±0.15^{Ba}	12.82±0.30^{Ba}
CPC	6.90±0.10^{Bc}	10.31±0.10^{Bb}	12.25±0.15^{Ba}	13.05±0.15^{Ba}

* C (control), SL (sodium lactate), KS (potassium sorbate) and CPC (cetylpyridinium chloride).
Means±SE within the column for the same test item having unlike letters (A-B) are significantly different among treatments (P<0.05). Means±SE within the same row having unlike letters (a-b) are significantly different among storage time in treatment (P<0.05).

Table 5: Changes in myoglobin concentration (mg/g meat) of ground beef containing various salt treatments (SL, KS and CPC) during cold storage

Treatment*	Storage time (days)			
	0	3	6	9
C	4.40±0.10^{Ab}	4.53±0.03^{Ca}	4.54±0.05^{Ca}	4.57±0.03^{Ba}
SL	4.51±0.05^{Ab}	4.87±0.05^{Bb}	4.93±0.03^{Aa}	5.10±0.05^{Aa}
KS	4.43±0.05^{Ab}	4.55±0.02^{Cab}	4.71±0.03^{Ba}	4.91±0.02^{Aa}
CPC	4.55±0.03^{Ab}	5.06±0.02^{Aa}	5.10±0.01^{Aa}	5.14±0.02^{Aa}

* C (control), SL (sodium lactate), KS (potassium sorbate) and CPC (cetylpyridinium chloride).
Means±SE within the column for the same test item having unlike letters (A-B) are significantly different among treatments (P<0.05). Means ± SE within the same row having unlike letters (a-b) are significantly different among storage time in treatment (P<0.05).

Table 5: Changes in myoglobin concentration (mg/g meat) of ground beef containing various salt treatments (SL, KS and CPC) during cold storage

Traits	Treat.*	Storage time (days)			
		0	3	6	9
TBA (mg malonaldehyde/ kg meat)	C	0.35±0.05^{Ac}	0.51±0.06^{Ab}	0.64±0.06^{Aa}	0.70±0.05^{Aa}
	SL	0.26±0.03^{Bb}	0.29±0.01^{Bb}	0.31±0.01^{Bab}	0.36±0.02^{Bab}
	KS	0.22±0.01^{Bb}	0.24±0.001^{Bb}	0.29±0.01^{Bab}	0.33±0.02^{Ba}
	CPC	0.25±0.01^{Bb}	0.31±0.01^{Bab}	0.35±0.001^{Ba}	0.38±0.002^{Ba}
PV (millieq. peroxide/kg meat)	C	2.23±0.01^{Ac}	3.55±0.01^{Ab}	4.39±0.01^{Aa}	4.67±0.05^{Aa}
	SL	1.50±0.06^{Bb}	1.67±0.05^{BCb}	1.80±0.05^{Ba}	2.05±0.03^{Ba}
	KS	1.45±0.06^{Bc}	1.56±0.05^{Cbc}	1.68±0.04^{Cb}	1.98±0.03^{Ba}
	CPC	1.52±0.05^{Ba}	1.74±0.03^{Bb}	1.87±0.05^{Bb}	2.09±0.05^{Ba}
FFA (%)	C	0.31±0.05^{Ac}	0.64±0.06^{Ab}	0.83±0.05^{Aa}	0.92±0.01^{Aa}
	SL	0.20±0.01^{Bb}	0.30±0.01^{Ba}	0.30±0.01^{Ba}	0.37±0.02^{Ba}
	KS	0.18±0.05^{Bb}	0.25±0.01^{Ba}	0.27±0.01^{Ba}	0.31±0.01^{Ba}
	CPC	0.22±0.03^{Bb}	0.29±0.03^{Bb}	0.36±0.03^{Ba}	0.41±0.01^{Ba}

* C (control), SL (sodium lactate), KS (potassium sorbate) and CPC (cetylpyridinium chloride).
Significantly different among treatments (P<0.05). Means±SE within the same row having unlike letters (a-d) are significantly different among storage time in treatment (P<0.05).

et al. (1991), on frozen stored beef and structured beef steak. The COSQC (1987) issued a final rule that increase the FFA more than 1.5% resulted in that the meat is inadmissible or refused.

Drip loss and cooking loss percentage are present in Table (7). All salt treatments recorded significant (P<0.05) decrease in both drip loss and cooking loss percentages at any storage period as compared with the C treatment probably due to the role of salts in increasing moisture binding, water holding capacity and decreasing free water percent which led to increase ability of meat tissue to retain water and reducing moisture loss during storage and cooking (Lin & Lin, 2002, Al-Rawi, 2005). The results obtained here supported earlier findings where salts used in meat greatly influenced moisture retention and reduction drip loss and cooking loss percentages during storage time (Louis *et al.*, 1987, Al-Rawi, 2005).

Sensory panel evaluation values for the stored ground beef are listed in Table (8). The organoleptic scores for flavour, juicinees, tenderness, colour and overall palatability of cooked ground beef were significantly (P<0.05) different for all the treatment at any storage time .After storage, salt treatments were much significantly (P<0.05) better than that of the C treatment in overall organoleptic properties. This was due to increasing juiciness and tenderness of the treated meat with salts which affected flavour and caused the increasing of overall palatability of ground beef. Such results are in agreement with the findings of Al-Rawi (2005) who found significant improvement in sensory evaluation of meat treated with salts (NaCl, sodium tripolyphosphate) during frozen storage.

The number of total plate count (TPC) for ground beef stored under refrigeration are presented in Fig. (1). Ground beef containing SL had siginficantly (P<0.05) lower TPC at any storage period than the other treatments. Brewer *et al.* (1993) reported similar results in retarding microbial growth when 2 or 3% SL was included in pork sausage. Bacteriostatic effect on microbial growth and shelf life extenstion to 25 days at 20°C were demonstrated in Chinese-style sausage with 3%SL added (Wang, 2000). The C treatment appeared to be higher (P<0.05) in TPC than all treatments indicating that higher microbial populations in ground beef was associated with increasing storage time. The KS was currently used as preservation in great variety of meat in Taiwan (Lin & Lin, 2002) and the results obtained here indicated an intermediate antibacterial action. The CPC treatment had been shown to be effective significantly (P<0.05) in reducing microbial populations as compared to C. Such results agree with the findings of Pohlman *et al.* (2002) who showed that using 0.5% CPC during the production of ground beef significantly (P<0.05) inhibited microbial growth.

Results of the current study concerning the effect of salt treatments (SL, KS, CPC) on psychrotrophilic count (PTC) in ground beef are presented in Fig (2). Microbial growth followed similar trends in all salt treatments with SL being significantly (P<0.05) the lowest among PTC at any storage periods than other treatments. The C treatment appeared

Table 7: Effect of salt treatment (SL, KS and CPC) on drip loss and cooking loss of ground beef during cold storage

Traits	Treat.*	Storage time (days)			
		0	3	6	9
Drip loss (%)	C	1.89±0.01^{Ad}	2.39±0.01^{Ac}	3.05±0.03^{Ab}	3.86±0.02^{Aa}
	SL	1.71±0.05 ^{Bb}	1.79±0.02^{Bb}	1.95±0.02^{Ba}	2.06±0.01^{Ba}
	KS	1.66±0.03^{Bb}	1.75±0.02^{Bab}	1.84±0.02^{Ba}	1.95±0.03^{Ba}
	CPC	1.56±0.02^{Bb}	1.67±0.03^{Bb}	1.72±0.01^{Bab}	1.81±0.02^{Ba}
Cooking loss (%)	C	2.90±0.03^{Ac}	3.15±0.05^{Ac}	3.72±0.05^{Ab}	4.15±0.02^{Aa}
	SL	2.20±0.03^{Bb}	2.30±0.02^{Bb}	2.67±0.03^{Bab}	2.89±0.05^{Ba}
	KS	2.11±0.02^{Bb}	2.23±0.02^{Bab}	2.25±0.01^{Ca}	2.40±0.03^{Ca}
	CPC	1.90±0.01^{Bb}	2.10±0.03^{Bb}	2.39±0.03^{Cab}	2.52±0.02^{Ca}

* C (control), SL (sodium lactate), KS (potassium sorbate) and CPC (cetylpyridinium chloride).
Means±SE within the column for the same test item having unlike letters (A-B) are significantly different among treatments (P<0.05). Means ± SE within the same row having unlike letters (a-b) are significantly different among storage time in treatment (P<0.05).

Table 8: Effect of SL, KS and CPC on sensory characteristics of ground beef during cold storage

Storage time (days)	Treatment*	Flavour	Juiciness	Tenderness	Colour	Palatability
0	C	5.70±0.10 ^{Ba}	6.20±0.10 ^{Ca}	5.90±0.10 ^{Ca}	4.60±0.05 ^{Dc}	6.90±0.10 ^{SAa}
	SL	7.44±0.05 ^{Aa}	7.10±0.05 ^{Ba}	6.50±0.15 ^{Ba}	5.20±0.10 ^{Bc}	6.12±0.05 ^{Bc}
	KS	7.30±0.15 ^{Aa}	7.29±0.10 ^{ABa}	6.80±0.10 ^{Aa}	4.75±0.10 ^{Cc}	6.18±0.10 ^{Bc}
	CPC	7.57±0.10 ^{Aa}	7.50±0.10 ^{Aa}	6.94±0.20 ^{Aa}	5.50±0.10 ^{Ad}	6.25±0.07 ^{Bd}
3	C	5.52±0.10 ^{Bab}	6.00±0.07 ^{Ba}	5.75±0.15 ^{Bb}	4.93±0.05 ^{Bb}	6.85±0.10 ^{Aa}
	SL	7.22±0.05 ^{Aa}	6.90±0.10 ^{Aa}	6.41±0.20 ^{Aa}	5.50±0.10 ^{Bb}	6.53±0.10 ^{Bb}
	KS	7.18±0.07 ^{Aa}	7.02±0.10 ^{Aa}	6.66±0.10 ^{Ab}	5.23±0.10 ^{Cb}	6.61±0.07 ^{Bb}
	CPC	7.39±0.10 ^{Ab}	7.13±0.15 ^{Ab}	6.70±0.20 ^{Ab}	5.75±0.07 ^{Ac}	6.80±0.10 ^{Ac}
6	C	5.30±0.05 ^{Cb}	5.94±0.20 ^{Cb}	5.50±0.10 ^{Bc}	5.00±0.10 ^{Da}	5.79±0.07 ^{Ba}
	SL	6.82±0.15 ^{Bb}	5.50±0.05 ^{Bb}	6.30±0.15 ^{Ab}	6.10±0.10 ^{Bb}	6.91±0.10 ^{Aa}
	KS	6.74±0.10 ^{ABb}	6.67±0.10 ^{Bb}	6.45±0.10 ^{Ac}	5.81±0.10 ^{Ca}	6.95±0.10 ^{Aa}
	CPC	7.39±0.10 ^{Ab}	6.97±0.10 ^{Acb}	6.55±0.20 ^{Ac}	6.10±0.05 ^{Ab}	7.00±0.05 ^{Ab}
9	C	5.00±0.10 ^{Bb}	5.80±0.10 ^{Cb}	5.28±0.07 ^{Bd}	5.12±0.10 ^{Da}	5.30±0.10 ^{Bb}
	SL	6.63±0.05 ^{Ab}	6.33±0.10 ^{Bb}	6.20±0.10 ^{Ab}	6.25±0.10 ^{Ba}	7.00±0.07 ^{Aa}
	KS	6.61±0.10 ^{Ab}	6.43±0.20 ^{Bb}	6.38±0.10 ^{Ac}	5.90±0.10 ^{Ca}	7.09±0.10 ^{Aa}
	CPC	6.70±0.15 ^{Ad}	6.86±0.15 ^{Ac}	6.47±0.20 ^{Ac}	6.40±0.07 ^{Aa}	7.14±0.15 ^{Aa}

* C (control),SL(sodium lactate),KS(potassium sorbate)and CPC(cetylpyridinium chloride).
Means ± SE within the column for the same test item having unlike letters (A-D)are significantly different among treatments ($P < 0.05$). Means ± SE within the same row having unlike letters (a-d) are significantly different among storage timein treatment ($P < 0.05$).

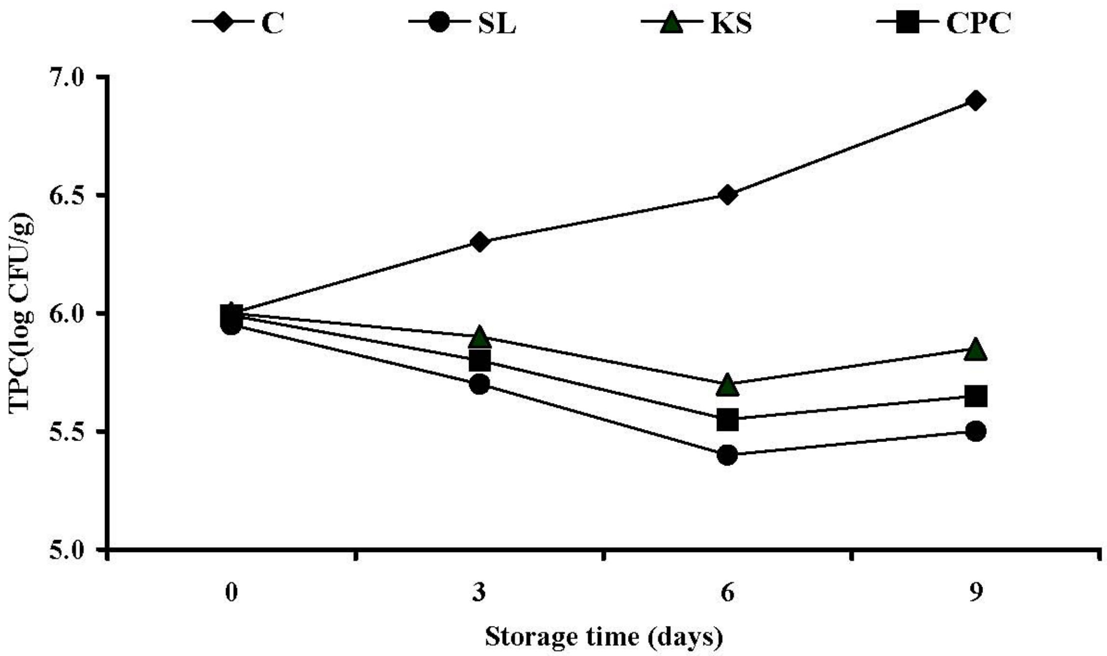

Fig. 1: Changes in total plate count (TPC) of ground beef containing salt treatment during cold storage

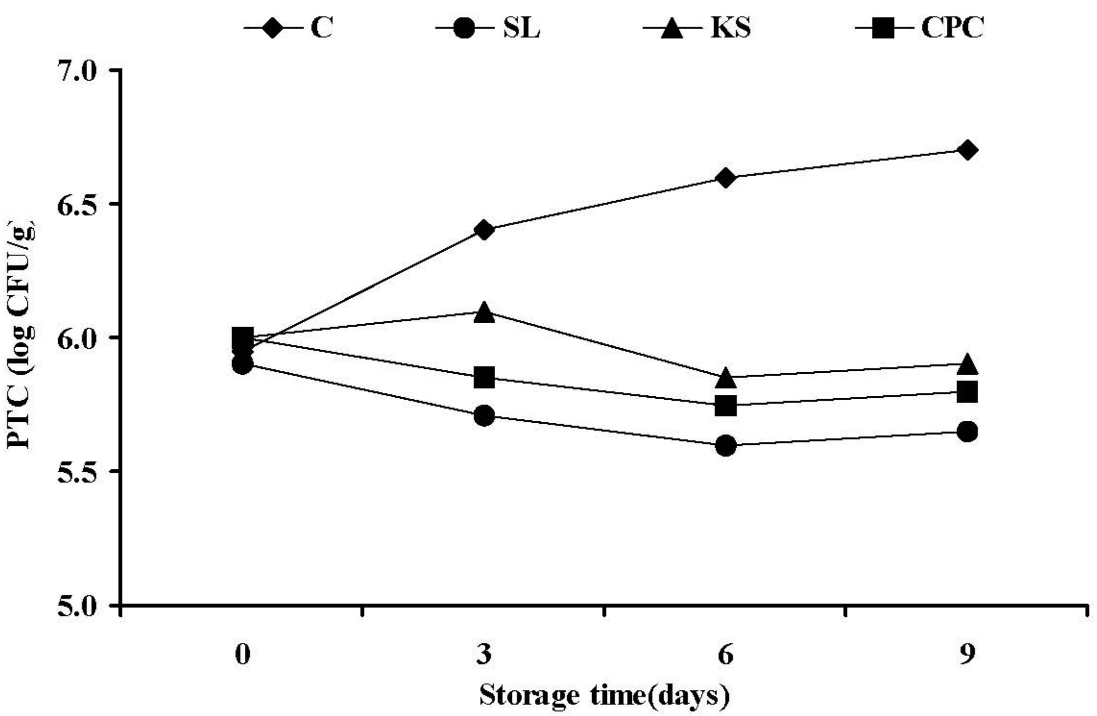

Fig. 2: Changes in psychrotrophilic count (PTC) of ground beef containing salt treatment during cold storage

to be (P<0.05) higher in PTC than all other treatments.The significant differences (P<0.05) among salt treatments were recorded .Similar results were reported by Pohlman *et al.* (2002) and Lin & Lin (2002) for low fat Chinese-style sausages.

CONCLUSION

Data of the present study suggested that salts (SL, KS and CPC) could be utilized to keep or improve the quality characteristics of cold stored ground beef for a limited period. The use of such salts which has no deleterious effects on the sensory characteristics, improved to some extend the microbial stability of ground beef during storage under refrigeration at 4C° for about 9 days as demonstrated in the present work.

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تأثير لاكتات الصوديوم وسوربات البوتاسيوم وكلوريد الستيلبايريدينيوم على الصفات الفيزيوكيميائية والحسية والعد الميكروبي للحم البقري المفروم المبرد

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استهدفت هذه الدراسة تتبع تأثير اضافة الأملاح الآتية: لاكتات الصوديوم ٣٪، (SL)، سوربات البوتاسيوم ٠,٢٪ (KS) وكلوريد الستيلبايريدينيوم ٠,٥٪ (CPC) الى لحم البقر المفروم على الصفات الفيزيائية والكيميائية والحسية والثبات الميكروبي.خزنت جميع المعاملات كلا على انفراد لمدة ٠، ٣، ٦، ٩ أيام على درجة حرارة ٤م° واخضعت المعاملات لمجموعة من القياسات الفيزيائية والكيماوية والحسية والميكروبية. اظهرت جميع المعاملات زيادة معنوية في نسبة المادة الجافة (البروتين والدهن والرماد) (P<٠,٠٥) وانخفاض في نسبة الرطوبة بتقدم فترات التخزين. لوحظ ارتفاع معنوي (P<٠,٠٥) في رقم الأس الهيدروجيني (pH) وقابلية مسك الماء (WHC) نتيجة استخدام الاملاح خلال فترات التخزين مقارنة مع المعاملة الضابطة .من جهة اخرى ادت عملية تمليح اللحوم الى انخفاض معنوي (P<٠,٠٥) في رقم حامض الثايوباربتيورك (TBA) والنيتروجين الكلي المتطاير (TVN) ورقم البيروكسيد (PV) والاحماض الدهنية الحرة (FFA)، وارتفعت في المعاملة الضابطة بتقدم فترات التخزين بالتبريد .أظهرت المعاملة بالأملاح (SL, KS, CPC) انخفاضاً معنوياً (P<٠,٠٥) في نسبة السائل الناضح والفقد بالوزن عند الطبخ وتحسناً معنوياً (P<٠,٠٥) في الصفات الحسية (النكهة, العصيرية, الطراوة, اللون ودرجة التقبل العام) مقارنة مع المعاملة الضابطة. أدت عملية تمليح لحم البقر المفروم بالاملاح (SL, KS, CPC) إلى خفض أعداد البكتيريا سواءً الكلية أو المحبة للبرودة خلال فترات التخزين بالتبريد.

يستنتج من نتائج الدراسة أن هناك تأثيراً معنوياً للأملاح (SL,KS,CPC) على الصفات النوعية والحسية والثبات الميكروبي للحم البقري المفروم خلال فترة التخزين بالتبريد عند ٤م° لمدة ٩ أيام .