

## USE OF POTASSIUM SORBATE AND SODIUM ASCORBATE FOR EXTENDING THE SHILFLIFE OF REFRIGERATED GROUND BUFFALO MEAT

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### Abstract

Ground buffalo meat was preblended with either 0.3% potassium sorbate, 0.05% sodium ascorbate, and 0.3% potassium sorbate. 0.05% sodium ascorbate stored in refrigerator at  $4^{\circ}\text{C} \pm 1^{\circ}\text{C}$ . Color (L, a, b), pH value, water holding capacity (WHC), cooking loss 2-Thiobarbituric acid (TBA) number, and total volatile bases, (TVB) were determined. Aerobic plate counts (APC), anaerobic bacterial count, psychrophilic bacterial count, total coliform and sensory properties were also determined. The results revealed that ground buffalo meat treated with 0.3% potassium sorbate and 0.05% sodium ascorbate had the highest Hunter "a" value (redness). pH values, TBA number, and TVB increased along with storage period. Ground buffalo treated with potassium sorbate alone or potassium sorbate mixed with sodium ascorbate had lower anaerobic and psychrophilic bacterial counts than samples treated with sodium ascorbate alone and still accepted for panelist after 10 days of refrigerated storage.

**Keywords:** buffalo meat, potassium sorbate, sodium ascorbate.

### INTRODUCTION

The ground meat is produced mainly from very old unproductive animals which results in it being coarse and tough in texture, and dark in color. Such meat is profitably utilized by comminuting and using in a variety of meat products (Sahoo and Anjaneyulu, 1997a). Spent male and female buffalo meat is more suitable for processing in chunks (Kandeepan et al., 2009). Ground meat tends to become brown and rancid more rapidly than whole muscle retail cut since grinding exposes more of the muscle surface to air and microbial contamination (Mitsumoto et al., 2005). Such changes are attribute to rapid formation of metmyoglobin, the undesirable brown color and oxidative rancidity. Lipid oxidation in meats leads to the development of off-flavour, loss of color and nutritive value (Pearson et al., 1983). Microbial growth in fresh meat is the primary factors associated with meat quality reduction, and spoilage. The off-odour compounds that characterize spoilage meat originate largely from the nonprotein nitrogen compounds. Spoilage flora attacks the nonprotein nitrogen components and produces

amines and ammonia from these simple components (Jay and Shelef, 1978).

Extended shelf life and meat product safety require maintaining low microbial numbers during fabrication, packaging, and storage of meat at refrigeration temperature. A variety of additives which have the potential for inhibiting microorganisms associated with fresh meat products have been investigated. A concentration of 0.1% potassium sorbate delayed the growth of the spoilage microflora, retarded growth of *Salmonellae*, and *Staphylococcus aureus*, and growth and toxin production by *C. botulinum* (Sofos and Busta, 1981; Robach and Sofos, 1982; Sofos, 1989). The sorbate has also inhibited bacteria (i.e., total *Psychrotrophs*, *Pseudomonas spp.*, *B. thermosphacta*, *Lactobacillus spp.*, *Enterobacteriaceae*, *Sallmonella* and *Staphylococcus aureus*, *Cl. botulinum* yeast and molds) and extended the shelf life of raw beef (Robach and Ivey, 1978; Zamora and Zaritzky, 1987b; Zamora and Zaritzky, 1987a; Sofos, 1989).

The use of antioxidant like ascorbic acid had a significant effect in reducing oxidation of pigments and lipids of ground and beef steaks

(Greene et al., 1971; Shivas et al., 1984; Okayama et al., 1987; Mitsumoto et al., 2005). Sodium ascorbate (SA) at 500 ppm retarded pigments and lipids oxidation and extended the shelf life of ground buffalo meat from 4 to 8 days under refrigerated storage at 4°C±1°C (Sahoo and Anjaneyulu, 1997a). Extending the shelf life of fresh meat is very important consideration for both consumers and meat packers. The storage life of fresh meat can prolong by limiting the extent of discoloration, lipid oxidation and microbiological contamination.

The objectives of this study were to evaluate effect of adding potassium sorbate and sodium ascorbate used alone or in combination on the quality of ground buffalo meat during refrigerated storage.

## MATERIALS AND METHODS

12 kg meat chunks of about 2 kg size from top round of spent female buffalo, about 10 years age was obtained within 4 hours of slaughter from local market in Minia city. Meat chunks were packed in polyethylene bags, transported to Food Science Department, Faculty of Agriculture, Minia University and kept for conditioning in a refrigerator at 4°C±1°C for about 24 hr. The meat chunks were trimmed of separable fat and loose connective tissue, cut into small cubes and ground by using a meat grinder (Moulinex, HV2, Model A14, France) with a 8-mm hole plate with adding 20% fat. Ground buffalo meat 20% fat was divided into 4 portions and mixed with either 0.3% potassium sorbate (Sofos, 1989), 0.05% sodium ascorbate was bought from Sigma Chemical Company (St. Louis, MO, USA), (Sahoo and Anjaneyulu, 1997b), 0.3% potassium sorbate/0.05% sodium ascorbate, and minced again with 4 mm hole plate for uniform dispersion of additives. Both control and treated ground buffalo meat were divided into 200 g, placed in Styrofoam tray and overwrapped with stretch film (saran). All trays were stored in refrigerator at 4°C ±1°C for 12 days. The samples were examined for quality parameters at 4 days intervals during storage.

## Microbiological analysis

Aerobic plate counts (APC), Anaerobic count, Psychrophilic count, and coliform count of the treated and the untreated ground buffalo meat were determined as CFU/g according to the methods described in the standard methods (APHA, 1985; Vanderzant and Splittstoesser, 1992). BBLGasPak<sup>R</sup> anaerobic chamber with BBL GasPak CO<sub>2</sub> gas packs (Becton Dickinson Microbiology System, Boston, MA) was used to create an anaerobic environment for incubation.

Color values (lightness L\*, redness a\*, and yellowness b\*) were measured for treated and untreated ground buffalo 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). pH was determined by homogenizing 10 g of ground meat in 90 ml distilled water using a homogenizer (VIRTIS Model 6-105 AF, The VIRTIS Company, NY, USA) for 5 min and measuring the pH of the resulting slurry with a digital pH meter (Model 41250, ICM, OR, USA), standardized at pH 4 and 7 (Lee and Yoon, 2001). The average of three reading was recorded.

Expressible water was determined according to Alvarez et al. (1992), while water-holding capacity (WHC) was calculated. Thiobarbituric acid reacting substances (TBARS) number, TBARS was determined following the distillation method described by Tarladgis et al. (1960). Total volatile basic nitrogen was measured according to Pearson (1975). Cooking loss, Meat samples (25 g each) were tightly wrapped in polyethylene bags and cooked, totally immersed, in water bath at 80°C for 20 min. After cooking they were cooled, dried with paper towels and cooking losses were determined from the weights before and after cooking (Anjaneyulu et al., 1989).

Sensory evaluation. Samples from each group were randomly assigned for sensory evaluation according to Sahoo and Anjaneyulu (1997a). Twelve panel members with previous panel experience were chosen to evaluate ground meat buffalo 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 = pale pink, 2 = pink, 3 = pinkish red, 4 = bright red and 5 = reddish-brown.

Statistical analysis. Data was analyzed with GLM (General Linear Model) program using statistical analysis system (SAS, 1987). Mean values were compared by Duncan's Multiple Test.

## RESULTS AND DISCUSSION

Data in Table 1 revealed that the L values (lightness) of all samples increased during storage time. The value (redness) of all sample decreased after 4 days of storage except samples treated with sodium ascorbate (SA) only, SA and potassium sorbate. No changes were found in the redness of samples treated with sodium ascorbate and potassium sorbate after 8 days of storage. Sahoo and Anjaneyulu (1997a) found that 500 ppm sodium ascorbate treatment increased the lovibond tintometer red color units of ground buffalo during storage at 4°C. Redness of control and sample treated with potassium sorbate only was sharply decreased after 4 days of storage.

Table 1. Effect of potassium sorbate and sodium ascorbate on the color (L\*, a\* and b\*) of ground buffalo meat during refrigerated storage at 4°C

Treatments	Storage time days				
	Color	0	4	8	12
Control	L	42.12b	42.90a	44.96	
	A	19.63a	b	a	
	B	10.27a	12.59b	13.43	
			10.43a	b	8.76b
Potassium sorbate	L	45.44b	46.16b	47.09	45.72
	A	20.13a	13.64b	b	b
	B	8.69ab	10.20a	13.59	11.44
			b	c	
			9.66a	7.65b	
Sodium ascorbate	L	45.49a	45.49a	45.21	45.50
	A	23.56a	23.06a	a	a
	b	12.77a	10.44a	16.08	12.79
			b	c	
			10.52	11.09	
			a	a	
Potassium sorbate + Sodium ascorbate	L	43.69b	42.33c	45.37	45.22
	A	c	23.82a	b	b
	b	23.56a	11.26a	23.21	22.80
		11.63a	a	a	
			11.56	11.19	
			a	a	

a,b,c Mean values in the same row not followed by the same letter are significantly different ( $P \leq 0.05$ )

Generally, the pH was increased gradually with increased storage time (Table 2). The highest values of pH were found in sodium ascorbate (5.24) and control (5.20) at the fourth day and at the eighth day of storage (Table 1). Shelef and Jay (1970) reported that the difference between freshness and incipient spoilage ground beef usually does not exceed 0.3-0.5 of a pH unit during the first 4 days of storage. The increase of pH may have been owing to bacterial metabolic by-products, such as amino sugar during storage (Jay, 1992).

Table 2. Effect of potassium sorbate and sodium ascorbate on the pH and water holding capacity (WHC) % of ground buffalo meat during refrigerated storage at 4°C±1°C

Treatments	Storage (Time Days)				
		0	4	8	12
Control	pH	4.9c	5.20b	6.17a	
	WHC*	31.36	38.81	37.83	
		c	a	b	
Potassium sorbate	pH	5.33b			
		c	5.08c	5.22b	5.53a
	WHC	34.77	37.06	36.02	36.03
		c	a	b	b
Sodium ascorbate	pH	4.85c	5.24b	5.81a	5.95a
	WHC	32.49	39.69	38.53	38.20
		c	a	b	b
Potassium sorbate + Sodium ascorbate	pH	4.97b	5.06a	5.23a	4.98b
	WHC				
		31.94	32.81	35.75	35.22
		b	b	a	a

a,b,c Mean values in the same row not followed by the same letter are significantly different ( $P \leq 0.05$ )

\*WHC = Water Holding Capacity

Water holding capacity (WHC) for all samples increased during storage time and the lowest values of WHC was found in the sample treated with potassium sorbate and sodium ascorbate at 4, 8, and 12 days of storage (Table 2).

It is well known that lower WHC is associated with lower pH. Both increasing a pH as a result of ammonia production and amino sugar complex formation has the effect of increasing the WHC of meats during refrigerated storage (Jay and Shelef, 1978).

Cooking loss gradually decreased along with storage time. The treated samples with potassium sorbate had higher values of cooking loss than that of sodium ascorbate treated samples at 4 and 8 days of storage (Figure 1).

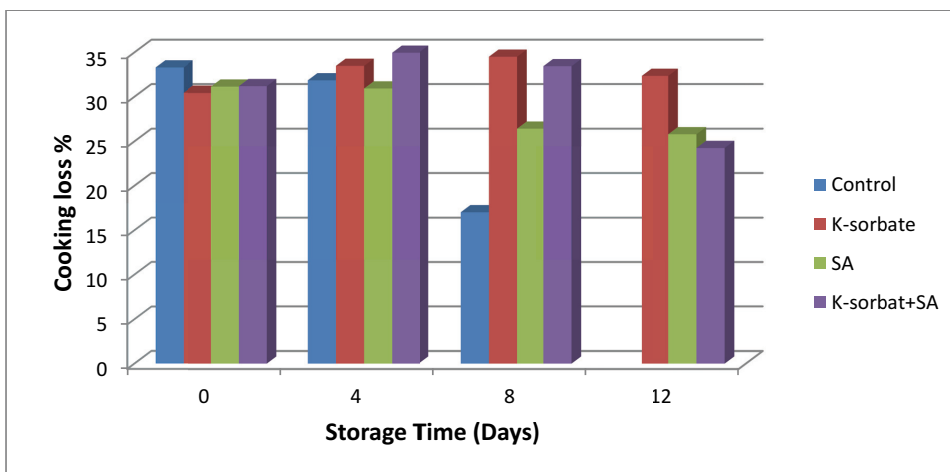


Figure 1 Effect of potassium sorbate and sodium ascorbate on cooking loss % of ground buffalo meat during refrigerated storage at 4°C±1°C

Jay (1992) reported that free amino acids and related simple nitrogenous compounds utilized by bacteria during the first days of refrigerated storage and the primary proteins are not attacked until the supply of simpler constituents has been exhausted. The total volatile basic nitrogen (TVBN) could be used as a quality indicator for fish products and is associated with the amino acid decarboxylase activity of microorganisms during storage (Jay, 1992). Changes in TVBN values during storage are shown in Figure 2.

TVBN values of all treatments increased with increasing storage time and potassium sorbate / potassium sorbate and sodium ascorbate had lower TVBN values than other treatments. Control, and SA treatments remained at higher TVBN values suggesting greater bacterial populations and activity, which in agreement with microbial counts (Figures 4, 5, 6, and 7). Only control sample had 34.56 mg/100 g TVBN and became unacceptable after 8 days of storage.

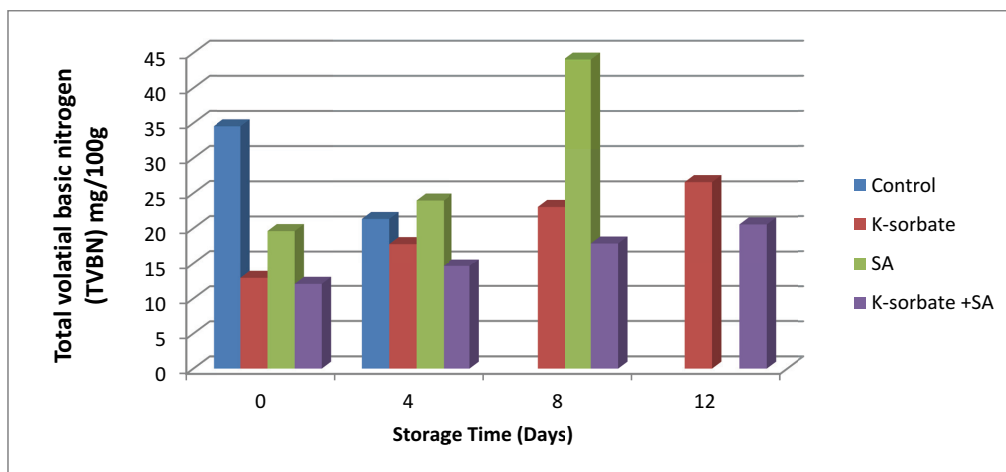


Figure 2- Effect of potassium sorbate and sodium ascorbate on the total volatile basic nitrogen (TVBN) mg/100 g of ground buffalo meat during refrigerated storage at 4°C±1°C

TBARS values increased over time for all samples. The increment was rapid for the

control samples and the greatest changes occurring between the 8 and 12 days of storage.

Samples treated with SA had lower TBARS than other samples (Figure 3). On the other hand, Rhee et al. (1997) reported that TBARS were higher in antimicrobial treated samples, which suggested that microorganisms in the untreated meat may have removed

malonaldehyde and other TBARS. Sahoo and Anjaneyulu (1997a) reported that sodium ascorbate at 500 ppm contributed to the lowest TBARS value (0.26 mg malonaldehyde/kg) in refrigerated ground buffalo meat indicating that it inhibited lipid oxidation.

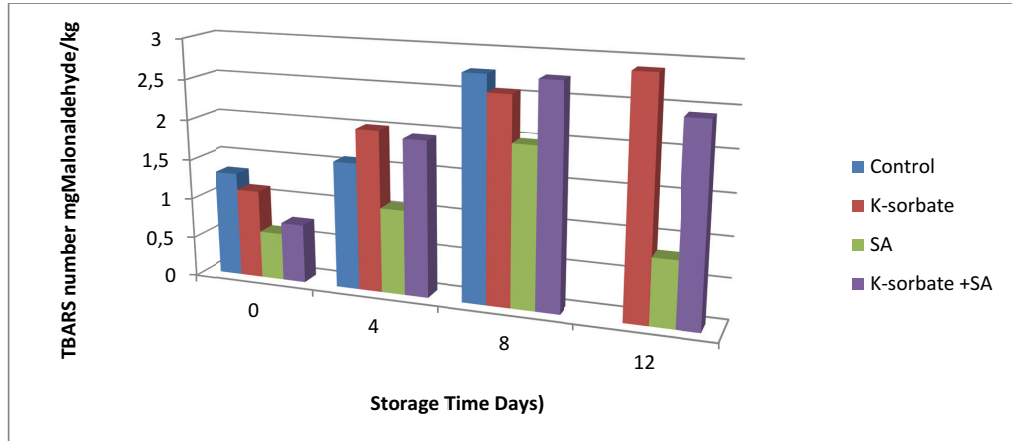


Figure 3. Effect of potassium sorbate and sodium ascorbate on the thiobarbituric acid reacting substances (TBARS) number of ground buffalo meat during refrigerated storage at  $4^{\circ}\text{C}\pm 1^{\circ}\text{C}$

The growth of microbes in meat is one of the main factors that cause discoloration and spoilage. Aerobic plate counts (APC) for samples treated with SA increased with increasing storage time and reached 6 Log CFU/g after 8 days (Figure 4). However, APC for K-sorbate, K-sorbate and SA, treated samples decreased after 4 and 8 days and then increased after 12 of storage. 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 was over the accepted limit on

the day 12 but exhibited off-odor on the day 8. APC of samples treated with K-sorbate alone or K-sorbate mixed with SA were less than 5 log CFU/g after 12 days of storage. Aerobic plate count remained under the maximum value (7 log CFU/g) after 12 day of storage for all samples except the control. Zamora and Zaritzky (1987a,b) reported that potassium sorbate treatment inhibited the bacterial growth and extended the shelf life of refrigerated beef slices. Sorbic acid is a lipophilic acid preservative with a short chain length and this kind of substances inhibits both gram positive and gram negative bacteria (Sofos and Busta, 1981).

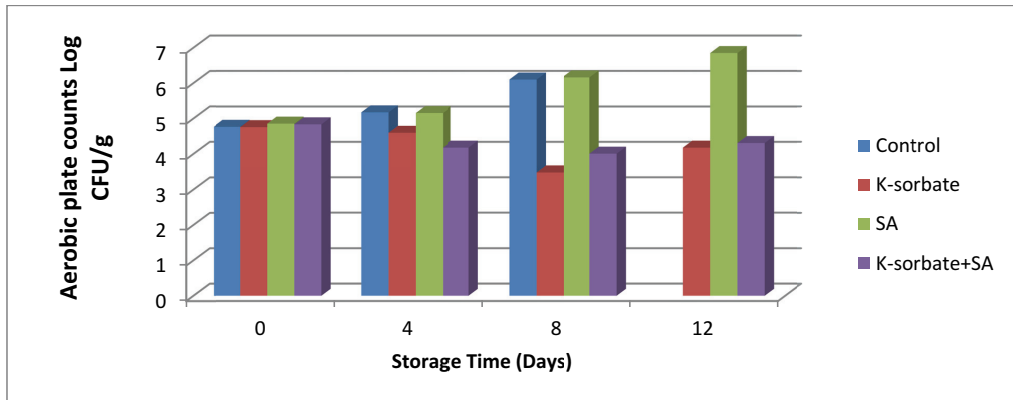


Figure 4. Effect of potassium sorbate and sodium ascorbate on the aerobic plate counts in ground buffalo meat during refrigerated storage at  $4^{\circ}\text{C}\pm 1^{\circ}\text{C}$

Psychrophilic counts and anaerobic count of all samples increased with storage time (Figure 5 and 6). In case of refrigerated meat under aerobic conditions, the spoilage flora is dominated by *Pseudomonas spp.* and under anaerobic condition by *Lactobacillus spp.* (Marth, 1998). Coliform counts had the same

trend of APC. The control sample had the highest number of coliform during storage time. The sample treated with K-sorbate alone or mixed with SA had lower coliform count than other treatments and its coliform counts less than 3 Loge after 12 days of storage (Figure 7).

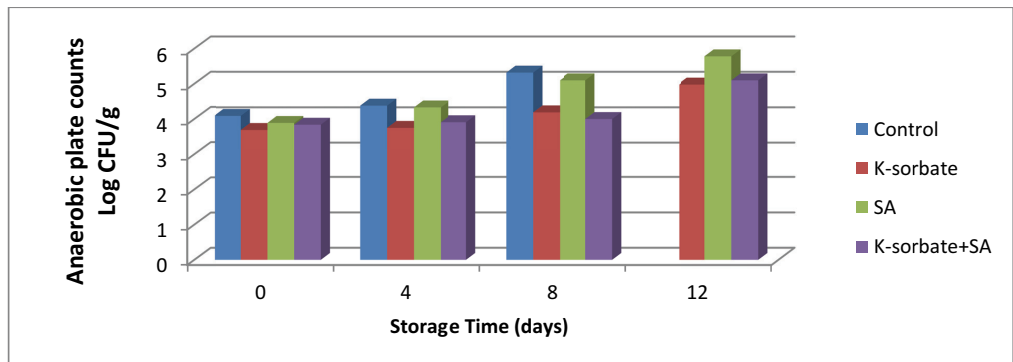


Figure 5. Effect of potassium sorbate and sodium ascorbate on the anaerobic plate counts in ground buffalo meat during refrigerated storage at  $4^{\circ}\text{C}\pm 1^{\circ}\text{C}$

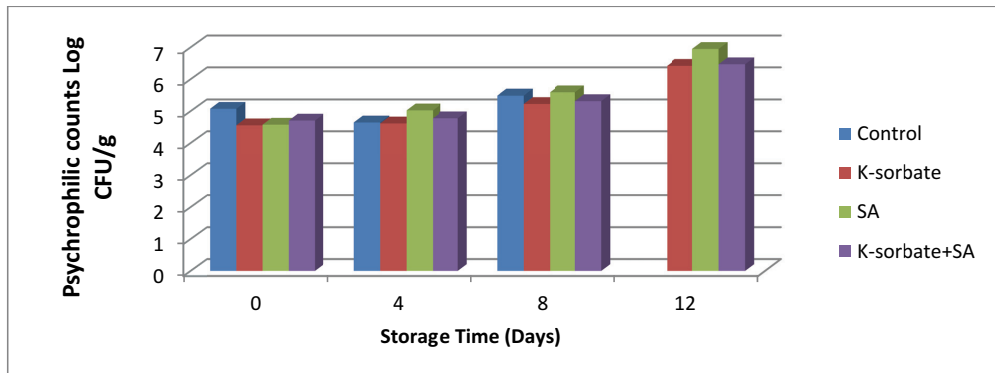


Figure 6. Effect of potassium sorbate and sodium ascorbate on the psychrophilic counts in ground buffalo meat during refrigerated storage at  $4^{\circ}\text{C}\pm 1^{\circ}\text{C}$

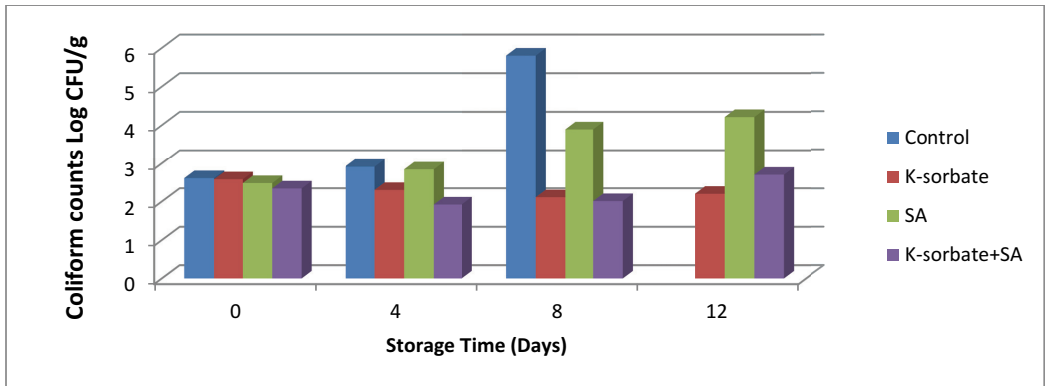


Figure 7. Effect of potassium sorbate and sodium ascorbate on the coliform counts in ground buffalo meat during refrigerated storage at 4°C±1°C

Color score of all samples slightly decreased after 4 days of storage (Figure 8). The control, K-sorbate, and SA treated samples have lower color score than treated sample with K-sorbate mixed with SA on the day 8. The samples treated with K-sorbate mixed with SA had the highest color score during 12 day of storage time. Discoloration may be attributed to

alteration or destruction meat pigments. Myoglobin may be oxidized to brown metmyoglobin. It may combined with H<sub>2</sub>S, produced by bacteria, to form sulphmyoglobin (Lawrie, 1998). Rancid flavor and odors arise from oxidative changes occurring in the meat during refrigerated storage.

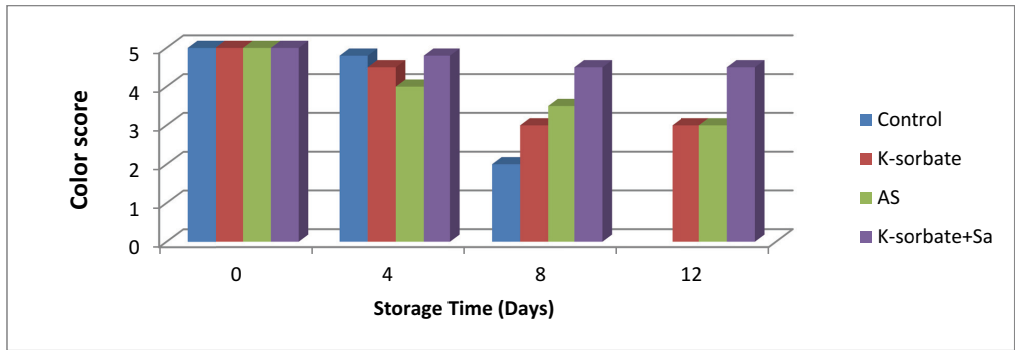


Figure 8. Effect of potassium sorbate and sodium ascorbate on the color score of ground buffalo meat during refrigerated storage at 4°C±1°C.

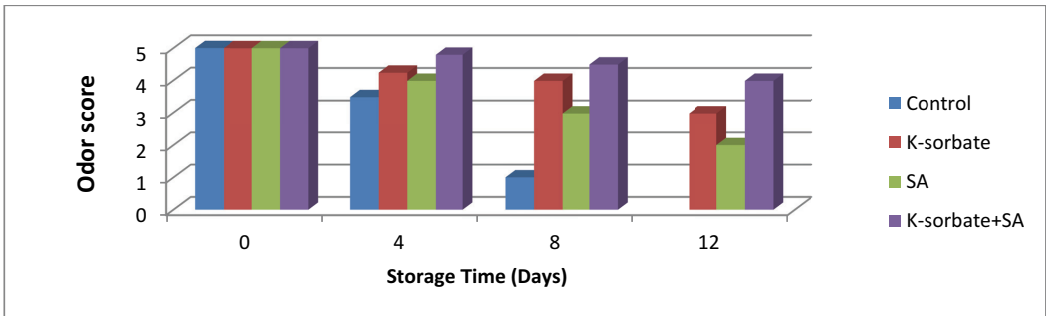


Figure 9. Effect of potassium sorbate and sodium ascorbate on the odor score of ground buffalo meat during refrigerated storage at 4°C±1°C

Odor score of control sharply decreased after 8 days of storage (Figure 9). The samples treated with SA have lower odor score than other treatments during storage time. The mixture and K-sorbate and SA treatments have higher odor scores than other treatment after 12 days of storage. The off-odor of meat may be due to the organisms attacked glucose initially and amino acids subsequently, producing hydrogen, carbon dioxide and ammonia (Jay, 1992). Van Laak (1994) reported that off-odors become noticeable in chilled meat and poultry, when bacterial numbers are between 7.0 and 7.5 log CFU/cm<sup>2</sup>. Sahoo and Anjaneyulu (1997a) found that 500 ppm sodium ascorbate extended the shelf life of ground buffalo meat from 4 to 8 days stored at 4°C.

## CONCLUSIONS

From these results it could be concluded that the shelf life of ground buffalo meat treated with potassium sorbate alone or mixed with sodium ascorbate (populations of microorganisms chemical and sensory quality) could be extended from 8 to 12 days. The sodium ascorbate treatment extended the shelf life of ground buffalo meat from 4 to 8 days under refrigerated storage.

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