Journal of Animal Research: v.6 n.3, p. 423-430. June 2016

DOI: 10.5958/2277-940X.2016.00040.1

Effect of Antioxidants Mixture on the Quality Characteristics of Pork Sandwich Spread Stored under Refrigeration (4±1ºC)

Anurag Pandey, R.C. Keshari and R.R. Kumar*

Division of Livestock Products Technology, Indian Veterinary Research Institute, Izatnagar, U.P., INDIA

*Corresponding author: RR Kumar; E-mail: dr_rajivranjan@yahoo.com

Received: 09 February, 2016 **Accepted:** 19 March, 2016

ABSTRACT

Effect of antioxidant level butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT), 1:1) on the quality characteristic of pork sandwich spread during storage was studied. Three levels of antioxidant mix viz:100 ppm, 200 ppm and 400 ppm were tried and product was evaluated weekly for physiochemical, microbiological and sensory properties along with the control during refrigerated storage (4±1ºC) period of 28 days. The pH and water activity of the developed product were stable for a week during initial storage period followed by progressive decline, however, pH was again stable during latter part of storage period. Thiobarbituric acid reactive substances (TBARS) value as well as Total plate count (TPC) increased significantly at weekly intervals. Treated samples had lower TBARS value and TPC as compared to control. No Psychrotroph was detected till 14th day but after that it increased significantly. Psychrotrophic count of treatments and control did not vary significantly. No coliform or yeast and molds were detected throughout study period. There was no effect of antioxidant treatment on the scores of color, texture, juiciness, adhesion ability and spreadability of pork sandwich spread. However, flavour and overall acceptability scores increased with the increase in antioxidant levels. The scores of color, texture, juiciness, adhesion ability, spreadability did not vary significantly with progressive storage period. But the flavour and overall acceptability scores decreased significantly ($P<0.05$) at every week. Study concluded that antioxidant (BHA + BHT, 1:1) treatments significantly improved the sensory and microbiological properties of pork sandwich spread at refrigerated storage (4±1°C).

Keywords: Pork Sandwich spread, Physico-chemical properties, Microbiological quality, Sensory attributes, Shelf life

A spread is food that is spread with a knife onto bread, crackers, or other bread products to provide flavour and texture. Common spreads include dairy spreads such as cheeses and creams, plant spreads such as jams and jellies, margarines, yeast spreads such as vegemite and Marmite, and meat spreads such as pate, fleischbutter and cretons. Invariably the spread are rich in fat content, which contributes to its spreadability. Moreover, the rigorous grinding of ingredients that is used in preparation of such products increases its surface area and makes it prone to oxidative rancidity and microbial spoilage. Meat based spread products being rich in quality proteins and other nutrients can be a better alternative to ensure nutritional security to masses particularly in developing countries. Attempts have been made to prepare meat sandwich spread in UK with meat content close to regulation (minimum of 70%) and non meat portion mainly consisting of rusk and water with a proportion of 1% and 3 -3.5% respectively. Campbell *et al.* (1950) developed a formula for preparation of chicken sandwich spread utilizing chicken meat and skin, chicken broth, spices (pepper, clove and mace), condiments (onion), salt and wheat flour. Pates are product similar to meat sandwich spread is fat rich and the fat level may reach upto 32% (Viana *et al.* 2004). However the basic problems found to be associated with meat based spread products are separation of water and fat, short shelf-life and rancidity (Ranken, 2000).

Quality of meat and meat products is adversely affected by oxidation of lipids causing changes in sensory attributes (color, texture, odor, and flavor) and nutritional quality (Decker and Mei, 1996). Application of antioxidants as a remedial measure to block or delay the lipid oxidation

process is quiet prevalent in food industries. Out of huge number of compounds that have been proposed to possess antioxidant activity only a few can be used in food products. Regulatory laws of a country or international standards control the use of antioxidants in food products. Antioxidants most commonly used in industrial processing of meat and poultry products include butylated hydroxyanisole, butylated hydroxytoluene and propyl gallate (Biswas *et al.* 2004, Formanek *et al.* 2001 and Jayathilakan *et al.* 2007). BHA and BHT have GRAS permission in the USA at up to 0.02% of fat or oil content of a food. The 0.02% GRAS level is based on the fat or oil content of foods, rather than being permitted at 0.02% of the final food product. As per the gazette of India BHA is permitted in snacks/ savouries (fried product), sweets (carbohydrates based and milk products), edible oils and fats such as tallow, lard, internally processed vegetables, soup powder, fruit powder, vegetable powder, instant fruit/ vegetable chutney mixed (dry), culinary powder, seasoning mixed powder, soups and culinary paste/other sauces at the level of 200ppm. For various types of meat and meat products including poultry and game FSSAI has permitted TBHQ at the level of 100ppm. There are limited studies on the use of antioxidant combination in meat products particularly comminuted meat products of pork origin, which are otherwise more susceptible because of higher unsaturated fatty acids. Thus the present study was envisaged to evaluate the preservative effect of BHA and BHT in combination by determining the physiochemical, microbiological and sensory characteristics of meat based pork sandwich spread during refrigeration storage.

MATERIALS AND METHODS

Preparation of pork sandwich spread

The pig belonging to breed Large White Yorkshire upgraded indigenous breed, around 7 months old male and reared at Institute Pig farm were slaughtered in experimental abattoir of Division of Livestock Products Technology, IVRI, Izatnagar. Lean meat from the ham portion of pork carcass was deboned. It was packed in clean polyethylene bags and brought to the laboratory and frozen at -18 ± 1°C until use.

At the time of processing to sandwitch spread the pork was partially thawed overnight, cut in small cubes followed by grinding through 8 mm plate first and subsequently by 4 mm plate in *Syndelmann Stuffgart* meat mincer. Pre-weighed ingredients (Common salt, Black salt, sodium tripolyphosphate, sodium nitrite and nitrate, Sodium ascorbate, skimmed milk powder and carrageenan) as per formulation of meat spread given in table 1 were added. Mixture was minced in bowl chopper for 2 minutes along with ice. After that, pork fat was added and again chopped for 2 minutes to make it of a fine consistency. Pre weighed spices and condiments were browned in a pan then minced mixture from bowl chopper was added to it. The contents were braised for 30 minutes at 84±2°C. Later on antioxidants (BHA plus BHT, 1:1) along with pre-pasteurized molten butter was added to the product. Product in unbearable hot condition was chopped in a bowl chopper pre-rinsed with hot water for another 2 minutes with simultaneous addition of rusk to it.

Table 1: Formulation of pork sandwich spread

Ingredients	Percentage
Meat	65
Lard	15
Skimmed milk powder	2.5
Rusk	2
Spice mix	3
Condiment	6
Common salt	0.5
Black salt	1.0
Sugar	0.25
Ice	1.83
Sodium nitrite + nitrate (1:1)	0.02
Sodium ascorbate	0.1
Citric acid	0.2
Sodium Tripolyphophate	0.4
Carrgeenan	0.2
Glycerol	2.0
Antioxidant (BHA/BHT 1:1 ratio)	varying levels of antioxidants Viz: 100,200,400 ppm
Total	100

Three levels of antioxidant i.e. 100 ppm 200 ppm and 400 ppm were tried and products were compared for physiochemical, microbiological and sensory properties along with the control during refrigerated storage (4±1°C). All the parameters were evaluated at weekly intervals up to 28th days.

Table 2: Effect of antioxidant treatment on the physiochemical and microbial characteristics of pork sandwich spread during refrigeration storage (4±1°C)

	0	7	14	21	28	Treatment mean±SE
			pH			
Control	6.266±0.07	6.266±0.06	6.212±0.04	6.166±0.06	6.105±0.02	6.200±0.01
100 ppm	6.333±0.04	6.273±0.03	6.166±0.06	6.177±0.04	6.166±0.02	6.223±0.03
200 ppm	6.300±0.04	6.312±0.08	6.211±0.04	6.200±0.03	6.088±0.04	6.220±0.04
400 ppm	6.300±0.08	6.230±0.04	6.200±0.03	6.200±0.04	6.100±0.06	6.206±0.01
Days Mean±SE	6.301±0.03a	6.271±0.02a	6.194±0.01b	6.186±0.03b	6.119±0.03b	
			Water Holding Capacity			
Control	0.713±0.06	0.724±0.09	0.721±0.09	0.720±0.05	0.726±0.06	0.720±0.05
100 ppm	0.708±0.02	0.710±0.06	0.710±0.06	0.710±0.02	0.736±0.05	0.715±0.05
200 ppm	0.710±0.02	0.710±0.08	0.720±0.08	0.720±0.04	0.730±0.08	0.718±0.06
400 ppm	0.706±0.04	0.713±0.05	0.707±0.06	0.723±0.04	0.723±0.09	0.715±0.04
Days Mean±SE	0.710±0.05b	0.714±0.07ab	0.714±0.04ab	0.718±0.04ab	0.729±0.06a	
			Water Activity			
Control	0.913±0.08	0.915±0.02	0.903±0.06	0 .905±0.04	0.897±0.09	0.905±0.03
100 ppm	0.916±0.06	0.916±0.03	0.908±0.01	0.906±0.02	0.898±0.06	0.905±0.04
200 ppm	0.917±0.07	0.913±0.05	0.906±0.03	0 .900±0.04	0.896±0.08	0.906±0.02
400 ppm	0.916±0.06	0.916±0.04	0.903±0.05	0.902±0.01	0.894±0.05	0.905±0.01
Days Mean±SE	0.919±0.03 a	0.914±0.08a	0.905±0.08b	0.903±0.06c	0.896±0.08d	
			TBARS value (mg malonaldehyde / kg)			
Control	0.386±0.12	0.436±0.09	0.560±0.08	0.680±0.09	0.710±0.08	0.554±0.02a
100 ppm	0.383±0.11	0.432±0.08	0.560±0.07	0.620±0.07	0.650±0.05	0.529±0.05a
200 ppm	0.378±0.09	0.420±0.11	0.530±0.06	0.583±0.08	0.606±0.02	0.503±0.02ab
400 ppm	0.360±0.08	0.410±0.13	0.516±0.04	0.573±0.06	0.593±0.04	0.494±0.05b
Days Mean±SE	0.378±0.08 e	0.424±0.03 d	0.542±0.03 c	0.614±0.07 b	0.640±0.02 a	
			Total plate count (log10 CFU/gm)			
Control	2.336±0.06	2.486±0.05	2.673±0.12	2.853±0.11	3.123±0.08	2.695±0.04a
100 ppm	2.320±0.08	2.460±0.04	2.650±0.09	2.840±0.04	3.090±0.03	2.672±0.04ab
200 ppm	2.343±0.05	2.446±0.06	2.555±0.06	2.766±0.06	2.983±0.06	2.619±0.03ab
400 ppm	2.226±0.09	2.403±0.07	2.513±0.11	2.733±0.08	2.953±0.04	2.566±0.03b
Days Mean±SE	2.306±0.05e	2.449±0.08d	2.598±0.05c	2.798±0.08b	3.037±0.03a	
			Psychrotrpic count (log10 cfu/gm)			
Control	Not detected	Not detected	Not detected	1.846±0.05	2.143±0.06	0.798±0.10
100 ppm	Not detected	Not detected	Not detected	1.826±0.02	2.146±0.04	0.795±0.12
200 ppm	Not detected	Not detected	Not detected	1.716±0.04	2.116±0.01	0.767±0.12
400 ppm	Not detected	Not detected	Not detected	1.653±0.09	2.100±0.04	0.751±0.14
Days Mean±SE	0.000±0.00	0.000±0.00	0.000±0.00	1.760±0.03b	2.126±0.03a	
			Coliform count (log10 cfu/gm)			
Control	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected
100 ppm	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected
200 ppm	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected
400 ppm	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected

			Yeast and mold count (log10 cfu/gm)			
Control	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected
100 ppm	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected
200 ppm	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected
400 ppm	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected

n = 9 for each treatment, Mean with different superscripts differ significantly (P<0.05)

Analytical procedure

Moisture protein and fat of the pork sandwich spread were estimated by using procedures mentioned in AOAC (1995). The pH of meat, batter mix, meat emulsion and cooked meat spread were measured (Trout *et al.* 1992) with digital (Century, Model : CP-901 : Sonar) pH meter equipped with a combined glass electrode for meat. Filter paper press method of Kaufman et al (1986) was followed to know the water holding capacity of the product. The water activity (a_w) of the meat sandwich spread was measured by a Paw kit water activity meter (Decagon Devices, U.S.A.). The distillation method of Tarladgis *et al.* (1960) was followed for determination of 2-Thiobarbituric acid reacting substances (TBARS) number. Total plate count, psychrotrophic count, coliform count, and yeast and mold count in the samples were determined following the methods as described by APHA (1984). The developed products were evaluated for various sensory parameters namely appearance and colour, flavour, juiciness, texture, adhesion ability, spreadability and overall acceptability on 8-point descriptive scale (Keeton, 1983), where, 8 = extremely liked and 1 = extremely disliked to determine their optimum level of incorporation. The panelists for sensory evaluation were trained, comprising of scientist and research scholars of the Division of Livestock Products Technology, IVRI, Izatnagar and were having almost similar experience, knowledge and wisdom about product evaluation. The product samples were slightly warmed (40°C) coded and served in quantity enough for at least two bites to each panelists evaluating in separate booths. De-mineralized water was provided to rinse the mouth between tasting of each sample. Seven panelists were included each each experimental replicate.

The experimental trails were replicated thrice with almost similar ingredients, processing conditions and others. Assumptions were that raw materials, their processing and sensory panelists did not contributed to variation, only the formulations did. Four different formulations (Treatments viz: control, 100, 200, 400ppm) were compared in completely randomized design with three replications using fixed effect model ANOVA. Triplicate samples were taken for each quality parameter, total being nine observations (n=9). Number of observations for sensory attributes were 21 for each treatment group. The data were analyzed using SPPSS software version 17.0 . The data were subjected to analysis of variance (one way ANOVA), least significant difference (Snedecor and Cochran 1989), Duncan's multiple range tests (Steel and Torris, 1981 Chap. 8) to determine significant differences among means of different treatments. A significance level of 0.05 was chosen.

RESULTS AND DISCUSSION

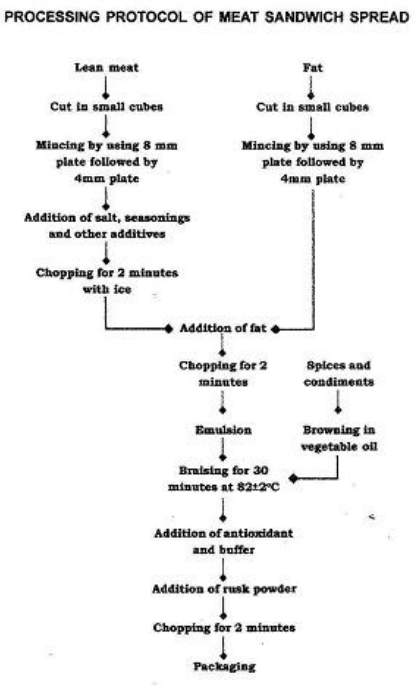
The mean and standard error of the physicochemical, microbiological and sensory scores of sandwich spread with varying levels of antioxidants during refrigerated (4±1°C) storage are presented in Table 2 and 3. There was no significant effect (P>0.05) of antioxidant treatment on the pH of the pork sandwich spread but the storage period imparted a highly significant effect (P<0.01) on the pH values of treatments as well as control. The pH of product did not vary significantly up to 7 days after which it decreased. The pH values from 14th day up to 28th day declined slightly but did not differ significantly (P>0.05). This reduction in pH might be due to the action of microbes and production of acid leading to decrease in the pH. Although the differences in pH of treatments and control were insignificant however, the values in control samples were lower than those in treated samples. This might be due to inhibition of microbial growth by antioxidants in the treatment. There was also no significant effect (P>0.05) of antioxidant treatment on the water holding capacity of product as the treatments did not differ significantly from control. But storage days imparted a significant effect (P<0.05) on the water holding capacity of the product. This significant increase in water holding capacity especially in

Table 3: Effect of antioxidant treatment on the sensory attributes of pork sandwich spread during refrigeration storage (4± 10C)

	0	7	14	21	28	Treatment mean±SE
			Colour			
Control	7.026±0.03	7.000±0.05	7.024±0.02	6.958±0.02	7.005±0.06	6.987±0.07
100 ppm	6.958±0.04	7.026±0.02	6.958±0.02	6.979±0.03	6.958±0.02	6.975±0.01
200 ppm	6.979±0.03	7.020±0.02	6.895±0.04	6.979±0.02	6.979±0.02	6.966±0.01
400 ppm	7.020±0.05	7.022±0.02	6.979±0.03	6.958±0.02	6.979±0.02	6.991±0.01
Days mean±SE	6.989±0.01	7.015±0.08	6.958±0.01	6.958±0.01	6.979±0.05	
			Flavour			
Control	7.000±0.02	6.854±0.04	6.416±0.06	6.166±0.04	5.750±0.06	6.425±0.04c
100 ppm	7.083±0.01	6.958±0.02	6.812±0.05	6.687±0.05	6.291±0.05	6.766±0.03b
200 ppm	7.083±0.03	6.958±0.02	6.958±0.02	6.895±0.04	6.895±0.04	6.962±0.01a
400 ppm	7.041±0.03	6.937±0.03	6.937±0.03	7.0000±0.04	6.875±0.06	6.970±0.01a
Days mean±SE	7.052±0.01a	6.927±0.01b	6.781±0.03c	6.687±0.03d	6.458±0.05e	
			Texture			
Control	6.937±0.03	6.937±0.03	6.875±0.04	6.916±0.03	6.916±0.03	6.925±0.01
100 ppm	6.812±0.07	6.875±0.08	6.875±0.06	6.937±0.03	6.875±0.06	6.875±0.03
200 ppm	6.958±0.04	6.958±0.02	6.895±0.04	6.937±0.03	6.937±0.03	6.937±0.01
400 ppm	6.955±0.02	6.958±0.03	6.914±0.02	6.893±0.02	6.914±0.02	6.913±0.09
Days mean ±SE	6.932±0.02	6.942±0.02	6.890 ±0.02	6.942±0.01	6.93±0.02	
Juiciness						
Control	6.937±0.03	7.000±0.06	6.937±0.03	7.018±0.02	6.875±0.04	6.950±0.01
100 ppm	7.016±0.02	6.937±0.03	6.875±0.04	6.875±0.04	6.875±0.04	6.912±0.01
200 ppm	6.958±0.02	6.958±0.02	6.937±0.03	7.0000±0.01	6.875±0.04	6.950±0.02
400 ppm	6.978±0.02	6.875±0.03	6.938±0.02	6.896±0.03	6.979±0.02	6.934±0.01
Days mean ±SE	6.953±0.01a	6.937±0.01a	6.932±0.01ab	6.921±0.01ab	6.875±0.02b	
			Adhesion ability			
Control	6.937±0.03	6.937±0.03	7.011±0.05	6.854±0.04	6.916±0.03	6.937±0.01
100 ppm	6.937±0.03	6.916±0.03	6.937±0.03	7.013±0.02	6.937±0.03	6.945±0.01
200 ppm	6.958±0.02	6.958±0.02	6.979±0.02	6.916±0.03	6.958±0.02	6.950±0.01
400 ppm	6.958±0.02	6.979±0.02	6.979±0.02	6.958±0.02	6.97±0.02	6.970±0.01
Days mean±SE	6.947±0.01	6.947±0.01	6.9740±0.01	6.932±0.01	6.953±0.01	
			Spreadability			
Control	6.937±0.03	7.000±0.02	6.937±0.03	6.937±0.03	6.937±0.03	6.950±0.03
100 ppm	6.937±0.03	6.708±0.08	6.562±0.09	6.833±0.07	6.937±0.08	6.795±0.03
200 ppm	6.979±0.03	7.020±0.02	6.958±0.02	6.979±0.02	6.958±0.02	6.975±0.01
400 ppm	7.000±0.04	6.937±0.03	7.000±0.02	6.958±0.02	6.979±0.02	6.975±0.09
Days mean±SE	6.963±0.01	6.916±0.02	6.864±0.03	6.921±0.02	6.953±0.02	
			Overall acceptability			
Control	7.066±0.05	6.875±0.04	6.375±0.06	6.145±0.04	5.729±0.06	6.412±0.04a
100 ppm	7.062±0.03	6.937±0.03	6.875±0.04	6.666±0.05	6.166±0.04	6.741±0.03c
200 ppm	7.062±0.03	6.979±0.03	6.958±0.02	6.895±0.04	6.895±0.04	6.962±0.01b
400 ppm	7.062±0.03	6.958±0.02	6.958±0.02	6.958±0.02	6.854±0.07	6.970±0.01a
Days mean ±SE	7.046±0.01a	6.937±0.01b	6.791±0.03c	6.666±0.04d	6.416±0.05e	

Scores, 8 point hedonic scale (8-Extremly desirable, 1 - Extremely undesirable) n = 21 for each treatment, Mean with different superscripts differ significantly (P<0.05)

the end of study might be due to loss of moisture during storage period reflecting into lower meat juice area that increased resultant water holding capacity. There was no significant difference (P<0.05) in the water activity of the treatments and control throughout the study period which showed non significant effect of antioxidant treatment on water activity. But storage period imparted a significant effect on the water activity of the product. During storage period water activity remained stable up to 7th day but 14th day onwards there was a progressive significant (P<0.05) decrease. The progressive decrease in water activity might be due to increase in the microbial activity or due to loss of moisture during storage period.



Results of ANOVA revealed highly significant difference (P<0.01) between the treatment and control in TBARS values. The variation was also highly significant (P<0.01) among the days of storage. Within treatments, treatment having 400 ppm of antioxidants varied significantly for TBARS values from the control but the variation was insignificant from treatment having 200 ppm antioxidants. TBARS value of treatment having 200 ppm antioxidant was significantly lower than the treatment having 100 ppm of antioxidants and control. TBARS value of treatment having 100 ppm of antioxidants did not differ from control. The finding of significantly lower TBARS values of treatments was in agreement with the findings of Mc-Carthy *et al*. (2001). During the storage periods, the TBARS numbers differed significantly (P<0.05) at weekly intervals. During storage, the variation between the treatments and control was non significant until 1st week, but 14th day onwards the treatments had significantly lower TBARS values as compared to control. However, all the treatments and control samples were within the acceptable limit at the end of study period.

ANOVA of the data revealed a highly significant (P<0.01) increasing trend of total plate counts throughout the study period and treatments varied significantly (P<0.01) from the control. Within the treated groups, treatment having 400 ppm of the antioxidant fetched significantly lower (P<0.05) TPC as compared to control, but this variation was not significant (P<0.05) for treatments having 200 ppm and 100 ppm of antioxidants. The results revealed higher the levels of antioxidants, lower were the total plate counts in the samples. The TPC in treated and control samples increased significantly (P < 0.01) at weekly intervals. This difference in the TPC of treatments and control might be due to inhibitory property of antioxidant over the growth of microbes. The antimicrobial activity of phenolic antioxidants appears to depend on the presence of a hydroxyl group on the molecule, the lipid solubility of the compound and the degree of steric hindrance (Raccach M.1984).This finding is similar to that of Gailani (1984) in ground pork. The psychrotrophs were not detected till 21st day in both treatments and control but these numbers were found to be significantly higher (P<0.05) on 28th day over 21st day The mean values of psychrotrophic count on 28th day was 2.126 log10 cfu/g and was quite lower than the permissible limit of 4.6 log10 cfu/g in cooked meat and meat products described by Cremer and Chipley (1977). Coliforms were not detected during the entire study period in the treatments as well as in control. This could be due to destruction of bacteria during braising since the core temperature of the spread was higher (82±2^{o}C) than the thermal death point of coliforms i.e. 57^{o}C. Yeast and mold were not encountered throughout the storage.

Results of ANOVA revealed that there was no significant effect (P>0.05) of antioxidant treatment as well as refrigerated storage of 28 days on the color scores of the product within the treatments, the scores ranged from 6.96 to 6.99 and during storage period the color scores ranged

from 6.9 to 7.0. The panelists rated the color of product as 'good' to 'very good'. A highly significant effect (P<0.01) of anti-oxidant treatment as well as storage days on the flavour scores of the product was observed. The treatments had significantly higher (P<0.01) flavour scores over the control. Within the treatments, samples having 400 ppm of antioxidant did not differ significantly (P<0.05) with treatment having 200 ppm of antioxidant. But both these treatments varied significantly with treatment having 100 ppm antioxidant. With the increase in the storage period the flavour scores decreased (P<0.05) significantly at the weekly interval. This finding is in agreement with the findings of Resurreccion and Reynolds (1990) and Biswas (2004) on frankfurters and ground pork patties respectively. The textural scores ranged from 6.8 to 6.9 within treatments and from 6.90 to 6.94 during refrigerated storage. Panelists rated it as 'good' to 'very good'. No significant effect (P<0.05) of antioxidant treatment on the juiciness scores of the product was noticed but storage days caused a significant variation in the juiciness of product. Within the treatments, juiciness scores ranged from 6.91 to 6.97 and was not significantly different (P<0.05) from the juiciness score of control (6.95). During storage period the juiciness scores decreased progressively. Juiciness scores of 0 day and 7th day were significantly higher than those of 21st and 28th day. This decrease in juiciness might be due to loss of moisture during the storage periods. At the end of the storage period, the juiciness score was 6.9 which was rated as good. This finding is in agreement with those of Ziauddin SK. *et al.* (1995), claiming superior juiciness in buffalo meat patties treated with NaCl and ginger extract. The adhesion ability scores of the product ranged from 6.94 to 6.97 within the treatments as compared to the control having score of 6.93. During storage period the scores ranged from 6.93 to 6.97. Throughout the period of study, panelists rated adhesion ability as good to very good. The spreadability scores of the pork sandwich spread ranged from 6.7 to 6.9 within treatments and 6.8 to 6.9 during storage periods. Panelist rated the spreadibility of the product as good.

Results of ANOVA revealed a highly significant effect (P<0.01) of antioxidant treatment as well as of storage period on the overall acceptability scores of the product. All the treatments varied significantly (P<0.05) from control for overall acceptability scores. The treatment having 400 ppm antioxidant did not vary significantly (P<0.05) from the treatment having 200 ppm of antioxidant for over all acceptability scores, but both aforesaid treatments varied significantly (P<0.05) for the overall acceptability with treatment having 100 ppm of antioxidant. The over all acceptability scores also varied significantly (P<0.01) with the storage days. The scores were in the range of very good on the day 0 and transformed to a `moderately good' at the end of the study period. This finding is in agreement with that of Biswas (2004) on the enrobed pork patties.

CONCLUSION

Thus the study concluded that Antioxidant (BHA+BHT, 1:1) treatment significantly improve the storage stability of pork sandwich spread at refrigerated storage (4±1°C) by maintaining sensory and microbiological acceptability.

REFERENCES

AOAC 1995. Official Method of Analysis. 16 edn. Association of Official Analytical Chemists, Washington, DC.

APHA 1984. Compendium of Methods for the Microbiological Examination of Foods. 2nd end. (ed. M.L. Speck). Am. Pub. Health Assoc., Washington, DC

Baker, R.C. and Scott-Kline, D. 1988. Development of high protein coating using egg albumen. Poult. Sci., 67: 557-564.

Biswas, A.K., Keshri, R.C. and Bisht, G.S. 2004. Effect of enrobing and antioxidants on quality characteristics of precooked pork patties under chilled and frozen storage conditions. Meat Science, 66: 733-741.

Biswas, A.K. 2004. Studies on enrobing of pork patties. M.V.Sc. Thesis, Deemed University, IVRI, Izatnagar.

Campbell, C.H., Isker, R.A. and Maclinn, W.A. 1950. Campbell's Book, A Manual on Canning, Pickling and Preserving, 3rd Edition. Vance Publishing, Chicago.

Cremer, M.L. and Chipley, J.R. 1977. Satellite food service system. time and temperature and microbiological and sensory quality of pre-cooked hamburger patties. J. Food Prot., 40: 603-607.

Decker, E.A. and Mei, L.1996. Antioxidants mechanisms and applications in muscle foods, in: Proceedings of the Reciprocal Meat Conference, pp. 64-72.

Formanek, Z., Kerry, J.P., Higgins, F.M., Buckley, D.J., Morrissey, P.A. and Farkas, J. 2001. Addition of synthetic and natural antioxidants to alpha-tocopheryl acetate supplemented beef patties: Effects of antioxidants and packaging on lipid oxidation. Meat Science, 58: 337-341.

Gailani, M.B. and Fung, D.Y. 1984. Antimicrobial effect of selected antioxidants in laboratory media and in ground pork. J. Food Prot., 47(6): 428-433

Jayathilakan, K., Sharma, G.K., Radhakrishna, K. and Bawa, A.S. 2007. Antioxidant potential of synthetic and natural antioxidants and its effect on warmed-over-flavour in different species of meat. Food Chemistry, 105: 908-916.

Kaufman, R.G., Eikelenboom, G., Waal, P.G. van der, Engel, B. and Zaar, M. 1986. A comparison of methods to estimate water-holding capacity in post-rigor porcine muscle. Meat Sci., 18(4): 307±322.

Keeton, J.T. 1983. Effect of fat and NaCl/phosphate levels on the chemical and sensory properties of pork paties. J. Food Sci., 48: 878-881.

McCarthy, T.L., Kerry, J.P., Kerry, J.F., Lynch, P.B. and Buckley, D.J. 2001. Evaluation of antioxidant potential of natural foods plant extract as compared with synthetic antioxidants and vit. E in raw and cooked pork patties. Meat Sci., 57: 45-52.

Raccach, M.1984. The antimicrobial activity of phenolic antioxidants in foods: a review. J. Food Safty. 6(3): 141-170.

Ranken, M.D. 2000. Handbook of meat and meat products technology. Oxford Blackwell, pp. 145-146.

Snedecor, G.W. and Cochran, W.G. 1989. Statistical Methods. 8th edn, Iowa State University Press, Ames, Iowa.

Steel, R.G.D. and Torris, J.H. 1981. Principles and procedures of statistics: A biometrical approach (2nd ed.): McGraw Hill International Book Co, 173–175.

Syed Ziauddin, K., Subba Rao, H. and Nadecm, F. 1996. Effect of organic acid and spices on quality and shelf life of meats of ambient temperature. J. Food Sci. Technol., 33(3): 255-258.

Tarladgis, B.W., Watts, B.M., Younathan, M.T. and Dugan, L.R. Jr. 1960. A distillation method for quantitative determination of malonaldehyde in rancid foods. J. Am. Oil Chemist Sco., 37: 44.

Trout, E.S., M.C. Hunt, D.E. Johnson, J.R. Claus, C.L. Kastner and Kropf, D.H. 1992. Characteristics in low-fat ground beef containing texture modifying ingredients. J. Food Sci. 57(1): 19-24.

Viana, F., Ribeirio, Bizzoto, Carolina, S, Dias, Disney Ribeirio; Oliveira, Afonso L. and Silvester, Marialice, Pinto Coelho. 2004. Bovine blood constituents as fat replacer in ham pate. Food Technol. Biotechnol., 42(1): 5-10.