J.Meat Sci., 2012, 8(1&2) : 16 - 23 Research Paper

Quality Characteristics of Fermented Semi-Dry Chicken Sausages during Storage at Refrigeration (4±1^{0}C) Temperature

*Eswara Rao, B. Moorthy P.R.S. and Sudhakara Redy, K.
Department of Livestock Products Technology, College of Veterinary Science, Tirupati.

ABSTRACT

In this investigation, proximate composition, physico-chemical, microbiological and oganoleptic characteristics of semi-dry fermented chicken sausages using different lactic acid bacteria viz., *Lactobacillus casei*, *Lactobacillus plantarum* and *Pediococcus pentosaceus* were evaluated at regular intervals during storage at refrigeration (4+1^{0}C) temperature. The per cent moisture of semi-dry fermented mutton sausages as effected by lactic acid bacteria were significantly (P>0.01) lower where as protein and fat were higher than control. Among treatments lower per cent moisture and higher protein and fat were observed in sausages fermented with LP followed by PP and LC. Significantly (P>0.01) lower pH, water activity, TBARS values and cooking yield were observed in sausages fermented with LC, LP and PP than control. Significantly (P>0.01) higher shrinkage values were observed in semi- dry fermented sausages than control at refrigeration temperatures. Among treatments significantly (P>0.01) lower pH, water activity, TBARS values and cooking yield were observed in chicken sausages fermented with LP than PP and LC at refrigeration temperatures. Shrinkage values were significantly (P>0.01) higher in sausages fermented with LP followed by PP and LC. Significant (P>0.01) decrease in water activity, TBARS values and cooking yield and increase(P>0.01) in shrinkage during storage at refrigeration temperature. There was higher (P>0.01) total plate count, yeast and mould count, coliform count and salmonella count were noticed in control than sausages treated with LC, LP and PP at refrigeration storage. Among the treatments significantly (P>0.01) higher total plate count, yeast and mould count and lower (P>0.01) *Salmonella* and *Coliform* count were observed in sausages fermented with LP followed by PP and LC. There was a significant (P>0.01) increase in total plate count and yeast and mould count whereas *Coliform* and *Salmonella* counts were decreased during storage at refrigeration temperatures in semi-dry fermented chicken sausages. The psychrophilic count was not detected in semi-dry fermented chicken sausages treated with LC, LP and PP during 10 days of storage. Among treatments significantly (P>0.01) lower psychrophilic counts were noticed in sausages fermented with LP followed by PP and LC. With regards to the organoleptic characteristics significantly (P>0.01) higher colour, flavour and overall acceptability and lower juiciness and tenderness were noticed in sausages fermented with LC, LP and PP than control at refrigeration storage. Among treatments significantly higher colour and overall acceptability scores and lower juiciness and tenderness scores were noticed in sausages fermented with LP followed by PP and LC. But no significant difference in flavour was noticed in sausages fermented with LC, LP and PP at refrigeration temperature. There was a significant (P>0.01) decrease in colour, flavour, juiciness, tenderness and overall acceptability scores

Key words: *Chicken, semi-dry fermented sausages, lactic acid bacteria.*

INTRODUCTION

Fermented sausages can be defined as meat products prepared using a mixture of meat and fat particles, salt, curing agents and spices, which have been stuffed into a casing, fermented (ripened) and dried (Fernandez *et al.* 2000). Fermentation of meat is a means of preservation and the use of various microbial cultures, as a preservative and appears to be more promising for India and other developing countries having inadequate

*Corresponding author, e-mail: beraolpt@gmail.com

refrigeration facilities. During recent years, addition of chemical preservatives has been restricted and the present trend is towards natural antimicrobial substances or biopreservatives (Sagdic *et al.*, 2003) for the preservation of meat and meat products. Food biotechnology, notably the employment of bacteria in food processing is becoming popular. The LAB commonly found in meat belongs to the genera *Lactobacillus, Pediococcus, Streptococcus* and *Leuconostoc*. The LAB strains currently most employed in meat starter cultures are *Lactobacillus casei, L. curvatus, L. pentosus, L. plantarum, L. sakei, Pediococcus acidilactici* and *P. pentosaceus.* A commercial starter culture was developed (Deibel and Niven, 1957) and offered to the meat industry in 1957 (Harris *et al*., 1957). The present study provides an insight into the technology, microbiology and organoleptic quality of fermented semi-dry sausages. Specifically the present study was carried out to find the effect of different types of starter cultures on semi-dry fermented chicken sausages and to assess the shelf- life and organoleptic quality of the product stored at refrigeration temperatures.

MATERIALS AND METHODS

Freeze dried cultures of the Lactic acid bacteria *Lactobacillus casei, Lactobacillus plantarum* and *Pediococcus pentosaceus* were procured from National Collection of Dairy culture, Dairy Microbiology Division, National Dairy Research Institute, Karnal-132001. The lactic acid bacteria were sub cultured in skim milk solution in duplicate and incubated at 37ºC for 16-18 hrs. Hubbard broiler strain birds of 6 weeks of age were procured from local private farm. The birds were hygienically processed and deboned and were packed in LDPE bags and stored at 10 ºC for 24 hours. The chilled meat was cut into small cubes of about 2 cm size. The giblets and skin in natural proportion were also used with lean meat in the sausage preparation. The cubes of above meats were minced twice using a meat mincer (Model TC12E, Italy) with a plate hole diameter of 5 mm to obtain uniform mix. The method of preparation and processing of fermented sausages by using chicken were standardized during preliminary trials. Common salt and sodium nitrite were added and mixed for 1-2 minutes. Vegetable oil was added and the content was again mixed for 1 minute. This was followed by addition of condiment mix, spice mix, refined wheat flour and mixed for 1-2 minutes. Glucose and starter culture were added to the above mixture and mixed for 0.5 to 1 minute. Sufficient care was taken to keep the end point temperature below 10 ºC and the emulsion was kept in refrigerator for 20-30 minutes. Sausage mix was stuffed into casings with manual sausage stuffer. The raw sausages were linked at about 6.5 cm apart to make sausages of uniform length. The sausages were washed with chilled water after linking and allowed 1-2 minutes for draining. These sausages were subjected for fermentation and drying (ripening) in fabricated fermentation chamber at temperature of 25-27 ºC and RH of 90 ±5 % for 12-14 hours and 6-8 ºC at relative humidity 70 ± 5 % inside the chamber for 8 days, respectively.

Table 1 : Formulation for fermented sausages using chicken meat

Ingredients	Percent
Meat (Chicken)	74
Refined wheat flour	10
Vegetable fat	5
Ginger + garlic (2:1)	4
Cloves	0.5
Cinnamon	1
Cardamom	0.5
Pepper	1
Salt	2
Nitrite	0.005
Dextrose	1
Culture	1

The shelf-life of fermented sausages using chicken meat and different cultures were evaluated at refrigeration (4±1ºC) temperatures. All four-formulation groups (Control; without LAB and 3 treatments) of fermented sausages after drying were packed aerobically in low-density polyethylene (LDPE) covers, heat-sealed and subjected to refrigeration temperature storage. Samples stored at refrigeration temperatures were withdrawn at 10 days interval up to 40 days and

analyzed for Proximate composition, physico-chemical, microbiological and organoleptic qualities, The percent moisture (oven drying), percent protein (Kjeldhal method) and percent fat (using Soxhelet's apparatus) were estimated as per the procedures of AOAC (1995). The pH of the sample was determined by following the procedure of Keller *et al.* (1974). The pH was recorded by immersing the combined glass electrode of digital pH meter (Model: 101 E Deluxe pH meter) in the homogenate. The water activity of the samples were determined by Lerici *et al.* (1983). Loss of weight in samples during storage was calculated by difference in initial and stored weight and expressed as shrinkage percentage. The 2–thiobarbituric acid reactive substance value of the samples was determined by following the procedure of Tarladgis *et al.* (1960). The total plate count per gram of samples were estimated as per the procedure recommended by Chestnut *et al.*, (1977). Procedure and media for psychrophil counts were similar but the incubation temperature was maintained at 7°C. For estimation of yeast and molds the procedure used for estimation of total plate count was adopted except that Sabourads dextrose agar was used. Mac Conkey agar was used for *Coliform* count and Brilliant green agar was used for *Salmonella* count. The fermented meat sausages were cooked by placing in boiling water to reach the internal temperature of 60 ºC and then oil fried with refined vegetable oil. Sensory evaluation was conducted by a five-member taste panel to evaluate colour, flavour, juiciness, tenderness and overall acceptability. The data obatained was subjected for statistical analysis as per the SPSS (Version 10.0) software.

RESULTS AND DISCUSSION

Semi-dry fermented chicken sausages had significantly (P<0.01) lower per cent moisture and higher protein and fat when treated with LC, LP and PP than control during storage (Table 2). Among treatments significantly (P<0.01) lower per cent moisture and higher protein and fat were noticed in sausages fermented with LP followed by PP and LC. Significant (P<0.01) decrease in

Table 2: Mean ± SE of per cent Moisture ,Protein and fat of fermented semi-dry chicken sausages as influenced by different starter cultures at refrigeration (4 ± 1ºC) temperature during storage

Parameter	Storage periods	Chicken Sausage			
		C	LC	LP	PP
Moisture %	0 DAY	61.17^{a1}±0.01	58.21^{b1}±0.010	51.13^{d1}±0.014	52.17^{c1}±0.011
	10 DAY	60.74^{a2}±0.009	57.94^{b2}±0.015	51.03^{d2}±0.011	51.14^{c2}±0.014
	20 DAY	Spoiled	56.97^{a3}±0.009	49.95^{c3}±0.011	50.04^{b3}±0.013
	30 DAY	Spoiled	56.86^{a4}±0.013	48.95^{c4}±0.006	49.13^{b4}±0.007
	40 DAY	Spoiled	56.74^{a5}±0.008	46.03^{c5}±0.013	48.93^{b5}±0.007
Protein %	0 DAY	24.83^{d2}±0.014	25.34^{b4}±0.012	25.96^{a5}±0.011	24.96^{c5}±0.003
	10 DAY	24.97c1±0.006	25.53^{b3}±0.009	26.14^{a4}±0.012	25.54^{b4}±0.010
	20 DAY	Spoiled	25.64^{c2}±0.012	26.75^{a3}±0.008	25.74^{b3}±0.011
	30 DAY	Spoiled	25.94^{b1}±0.008	26.84^{a2}±0.003	25.95^{b2}±0.013
	40 DAY	Spoiled	25.94^{c1}±0.010	26.95^{a1}±0.012	26.04^{b1}±0.015
Fat%	0 DAY	15.92^{d1}±0.003	16.96^{c4}±0.012	17.84^{a5}±0.011	17.64^{b4}0.009
	10 DAY	15.94^{d1}±0.010	17.52^{c3}±0.006	18.15^{a4}±0.010	17.97^{b3}0.011
	20DAY	Spoiled	17.96^{c2}±0.010	18.97^{a3}±0.003	18.05^{b2}0.009
	30 DAY	Spoiled	18.13^{c1}±0.010	19.14^{a2}±0.009	18.95^{b1}0.007
	40 DAY	Spoiled	18.14^{c1}±0.01	19.65^{a1}±0.011	18.96^{b1}0.013

C-Control,LC- Lactobacillus Casei,LP-Lactobacillus plantarum and PP-Pediococcus pentosaceus

Mean values between cultures with different alphabetical superscripts differ significantly (P< 0.01)

Mean values between storage periods with different numerical superscripts differ significantly (P< 0.01)

per cent moisture and increase in protein and fat values were noticed during 40 days of storage in semi-dry fermented chicken sausages. The results were in accordance with Mukherjee *et al*. (2006) in fermented goat meat sausage and Ahmad and Srivastava (2007) in fermented semi dry buffalo meat sausages. Higher protein and fat values might be due to corresponding loss of moisture during storage.

Lower (P>0.01) pH, higher shrinkage and lower cooking yield values were noticed in semi-dry fermented chicken sausages treated with LC, LP and PP than control (Table3). Among treatments, significant (P>0.01) difference in pH was noticed in LC, LP and PP but lower water activity, cooking yield and TBARS values and higher shrinkage values were noticed in sausages fermented with LP than PP and LC. There was no significant (P>0.01) decrease in pH, significant (P>0.01) decrease in water activity and cooking yield by 2 per cent, significant (P>0.01) increase in shrinkage by 2 per cent and TBARS values during 40 days of storage in semi-dry fermented chicken sausages (Table 3). The decline in pH during storage was due to growth of lactic acid bacteria and production of lactic acid from residual carbohydrates. The results in this study were in accordance with Subsoontorn (1985) in Thuringer sausages, Salahuddin (1992) in fermented mutton sausages and Erkkila (2001) in dry sausages. Significant (P>0.01) decrease in water activity during 40 days of storage were in agreement with Stiebing and Rodel (1988). Increase in TBA value

Table 3 : Mean ± SE of pH , water activity,TBARS Value, shrinkage % and Cooking yield% of fermented semi-dry chicken sausages as influenced by different starter cultures periods at refrigeration (4± 1ºC) temperature during storage

Parameter	Storage periods	CHICKEN			
		C	LC	LP	PP
pH	0 DAY	4.64^{a5}±0.025	4.23^{b1}±0.008	4.02^{c1}±0.037	3.97^{c1}±0.009
	10 DAY	4.73^{a4}±0.007	4.25^{b1}±0.007	3.93^{c2}±0.013	3.96^{b1}±0.010
	20 DAY	Spoiled	4.24^{a1}±0.006	3.95^{b2}±0.015	3.95^{b1}±0.013
	30 DAY	Spoiled	4.22^{a1}±0.003	3.86^{c3}±0.012	3.96^{b1}±0.011
	40 DAY	Spoiled	4.23^{a1}±0.012	3.86^{c3}±0.012	3.88^{d2}±0.024
Water activity	0 DAY	0.973^{a1}±0.001	0.973^{a1}±0.0008	0.974^{a1}±0.001	0.974^{a1}±0.0007
	10 DAY	0.916^{a4}±0.0004	0.912^{a2}±0.0009	0.914^{a2}±0.001	0.914^{a2}±0.0005
	20 DAY	Spoiled	0.812^{a3}±0.001	0.803^{b3}±0.0008	0.812^{a3}±0.001
	30 DAY	Spoiled	0.805^{a4}±0.0006	0.803^{b3}±0.001	0.805^{a4}±0.001
	40 DAY	Spoiled	0.804^{a4}±0.001	0.767^{b4}±0.0009	0.796^{a5}±0.001
TBARS Value	0 DAY	0.084^{a2}±0.0007	0.083^{a5}±0.001	0.083^{a5}±0.001	0.086^{a5}±0.001
	10 DAY	0.275^{a1}±0.0004	0.174^{b4}±0.001	0.153^{d4}±0.001	0.163^{c4}±0.0007
(mg malon	20 DAY	Spoiled	0.244^{a3}±0.001	0.195^{c3}±0.001	0.203^{c3}±0.001
aldehyde /kg)	30 DAY	Spoiled	0.643^{a2}±0.001	0.599^{c2}±0.001	0.609^{c2}±0
	40 DAY	Spoiled	0.765^{a1}±0.001	0.703^{c1}±0.001	0.754^{c1}±0.001
Per cent shrinkage	0 DAY	3.92^{d2}±0.011	17.76^{c2}±0.010	18.82^{a2}±0.012	18.35^{b4}±0.010
	10 DAY	5.15^{d1}±0.010	18.3^{3c2}±0.009	18.86^{a2}±0.010	18.53^{b3}±0.009
	20 DAY	Spoiled	19.44^{b1}±0.014	19.75^{a1}±0.009	19.06^{c2}±0.014
	30 DAY	Spoiled	19.43^{b1}±0.012	19.76^{a1}±0.008	18.12^{c5}±0.016
	40 DAY	Spoiled	19.45^{b1}±0.012	19.76^{a1}±0.011	19.24^{c1}±0.013
Per cent cooking yield	0 DAY	93.06^{a1}±0.012	91.53^{b1}±0.005	89.15^{d1}±0.011	90.63^{c1}±0.008
	10 DAY	92.95^{a2}±0.013	90.54^{b2}±0.015	89.03^{d2}±0.013	89.12^{c2}±0.006
	20 DAY	Spoiled	89.14^{a3}±0.016	88.25^{c3}±0.012	88.74^{b3}±0.009
	30 DAY	Spoiled	89.07^{a4}±0.007	88.24^{c3}±0.014	88.45^{b4}±0.009
	40 DAY	Spoiled	88.96^{a5}±0.018	88.16^{c4}±0.009	88.25^{b5}±0.011

C-Control, LC-*Lactobacillus Casei,* LP-*Lactobacillus plantarum* and PP-*Pediococcus pentosus*

Mean values between cultures with different alphabetical superscripts differ significantly (P< 0.01)

Mean values between storage periods with different numerical superscripts differ significantly (P< 0.01)

during storage could be attributed to oxidation of polyunsaturated fatty acids of phospholipids fraction (Brewer *et al*, 1992). The rapid increase in TBA value under aerobic packaging may be related to oxygen concentration (Fu *et al*., 1992) and oxygen permeability of packaging material (Brewer *et al*., 1992). The shrinkage of fermented sausages during refrigerated storage is due to evaporation of moisture. Similar results were observed by Acton and Keller (1974) in summer sausages and Stiebing and Rodel (1988) in dry sausages. Reduction in cooking yield during storage may be attributed to decline in pH, which reduced the water holding capacity of meat products (Lawrie, 1998).

Higher (P>0.01) total plate count and Yeast and Mould count where as lower *Coliform, Salmonella* and *Psychrophilic* counts were found in semi-dry fermented chicken sausages as effected by different Lactic acid bacteria than control. Among treatments significantly higher total plate counts, and Yeast and Mould counts and lower (P>0.01) *Coliform, Salmonella* and *Psychrophilic* counts were observed in sausages fermented with LP followed by PP and LC. During storage there was significant (P>0.01) increase in total plate count, by 2 log, Psychrophilic count and yeast and mould counts were observed where as *Coliform* count and *Salmonella* counts were decreased during storage in semi-dry fermented chicken sausages (Table 4). TPC of fermented chicken sausages during refrigerated storage was effectively controlled by multiple hurdles *viz*. low pH, low a_w, low redox potential, bacterial competition for

Table 4: Mean ± SE of Total plate count ,Coliforms, Salmonella count and Yeast and Mould count (log CFU/g) of fermented semi-dry chicken sausages a as influenced by different starter cultures periods at refrigeration (4 ± 1ºC) temperature during storage

Parameter	Storage periods	Chicken Sausage			
		C	LC	LP	PP
Total Plate Count	0 DAY	4.985^{a2}±0.001	4.453^{b5}±0.0009	4.273^{d5}±0.001	4.354^{c5}±0.001
	10 DAY	6.944^{a1}±0.0009	5.156^{d4}±0.0007	5.366^{b4}±0.0006	5.245^{c4}±0.001
	20 DAY	Spoiled	5.365^{c3}±0.0009	5.855^{a3}±0.001	5.775^{b3}±0.001
	30 DAY	Spoiled	5.484^{c2}±0.001	5.987^{a2}±0.0004	5.882^{b2}±0.0008
	40 DAY	Spoiled	6.195^{c1}±0.001	6.983^{a1}±0.001	6.862^{b1}±0.0008
Coliform count	0 DAY	3.873^{a2}±0.0009	1.573^{b1}±0.001	1.394^{d1}±0.001	1.444^{c1}±0.0009
	10 DAY	4.394^{a1}±0.001	1.383^{b2}±0.001	1.174^{d2}±0.001	1.285^{c2}±0.001
	20 DAY	Spoiled	1.193^{a3}±0.0008	0.934^{c3}±0.0009	1.155^{b3}±0.001
	30 DAY	Spoiled	0.996^{a4}±0.001	0.776^{c4}±0.001	0.986^{b4}±0.001
	40 DAY	Spoiled	0.992^{a4}±0.001	0.734^{c5}±0.001	0.974^{b5}±0.001
Salmonella count	0 DAY	0.995^{c2}±0.001	1.205^{a1}±0.001	0.985^{d1}±0.0003	1.194^{b1}±0.0006
	10 DAY	2.694^{a1}±0.0006	1.123^{b2}±0.001	0.873^{c2}±0.001	1.125^{b2}±0.001
	20 DAY	Spoiled	0.982^{a3}±0.001	0.763^{c3}±0.001	0.974^{b3}±0.001
	30 DAY	Spoiled	0.894^{a4}±0.001	0.675^{c4}±0.0009	0.885^{b5}±0.0008
	40 DAY	Spoiled	0.897^{a4}±0.0004	0.663^{b5}±0.0007	0.894^{a4}±0.0006
Psychrophilic count	0 DAY	ND	ND	ND	ND
	10 DAY	1.875±0.001	ND	ND	ND
	20 DAY	Spoiled	1.462^{a3}±0.001	1.281^{c3}±0.0008	1.383^{b3}±0.0002
	30 DAY	Spoiled	1.573^{a2}±0.001	1.373^{c2}±0.001	1.463^{b2}±0.001
	40 DAY	Spoiled	1.583^{a1}±0.0009	1.392^{c1}±0.001	1.472^{b1}±0.001
Yeast and Mould count	0 DAY	3.343^{a2}±0.001	2.173^{d5}±0.001	2.592^{b3}±0.0004	2.477^{c3}±0.0008
	10 DAY	3.943^{a1}±0.0007	2.263^{d4}±0.0009	2.295^{b5}±0.001	2.284^{c5}±0.001
	20 DAY	Spoiled	2.444^{c3}±0.0009	2.476^{a4}±0.001	2.463^{b4}±0.001
	30 DAY	Spoiled	2.655^{c2}±0.0006	2.693^{a2}±0.001	2.684^{b2}±0.001
	40 DAY	Spoiled	3.143^{c1}±0.001	3.184^{a1}±0.001	3.162^{b1}±0.0008

C-Control, LC-*Lactobacillus Casei,* LP-*Lactobacillus plantarum* and PP-*Pediococcus pentosaceus*

Mean values between cultures with different alphabetical superscripts differ significantly (P< 0.01)

Mean values between storage periods with different numerical superscripts differ significantly (P< 0.01)

Table 5 : Mean ± SE of Colour, Flavour, Juiciness, Tenderness and Overall acceptability of fermented semi-dry chicken sausages as influenced by different starter cultures at refrigeration (4 ± 1ºC) temperature during storage

Parameter	Storage periods	Chicken Sausage			
		C	LC	LP	PP
Colour	0 DAY	8.382^{d1}±0.0009	8.432^{c1}±0.001	8.522^{a1}±0.001	8.432^{b1}±0.001
	10 DAY	5.075^{d2}±0.001	7.712^{c2}±0.0009	7.964^{a2}±0.0006	7.713^{b2}±0.001
	20 DAY	Spoiled	6.523^{c3}±0.014	6.705^{a3}±0.0008	6.651^{b3}±0.001
	30 DAY	Spoiled	6.184^{c4}±0.0006	6.484^{a4}±0.0008	6.303^{b4}±0.001
	40 DAY	Spoiled	5.896^{c5}±0.001	6.176^{b5}±0.0006	6.213^{a5}±0.001
Flavour	0 DAY	6.826^{c1}±0.001	6.833^{b1}±0.001	6.842^{a1}±0.001	6.842^{a1}±0.0003
	10 DAY	5.353^{b2}±0.001	6.793^{a2}±0.001	6.795^{a2}±0.002	6.796^{a2}±0.001
	20 DAY	Spoiled	6.535^{a3}±0.001	6.533^{a3}±0.001	6.533^{a3}±0.0009
	30 DAY	Spoiled	6.364^{a4}±0.001	$6.363^{a4,\ 5}$±0.001	6.364^{a4}±0.001
	40 DAY	Spoiled	5.893^{b5}±0.001	5.696^{c5}±0.001	5.894^{a5}±0.001
Juiciness	0 DAY	7.665^{a1}±0.001	6.712^{b1}±0.001	6.613^{c1}±0.001	6.713^{b1}0.001
	10 DAY	6.862^{a2}±0.0009	6.682^{b2}±0.001	6.513^{d2}±0.001	6.673^{c2}0.001
	20 DAY	Spoiled	6.542^{a3}±0.001	6.432^{c3}±0.0009	6.532^{b3}0.001
	30 DAY	Spoiled	6.343^{a4}±0.001	6.182^{c4}±0.001	6.281^{b4}0.001
	40 DAY	Spoiled	6.231^{a5}±0.001	6.005^{c5}±0.001	6.213^{b5}±0.001
Tenderness	0 DAY	7.892^{a1}±0.001	6.982^{b1}±0.001	6.943^{d1}±0.001	6.963^{c1}±0.001
	10 DAY	6.893^{a2}±0.001	6.873^{b2}±0.0007	6.865^{b2}±0.001	6.861^{b2}±0.001
	20 DAY	Spoiled	6.761^{a3}±0.0005	6.736^{b3}±0.002	$6.752^{a,b3}$±0.001
	30 DAY	Spoiled	6.614^{a4}±0.001	6.623^{a4}±0.015	6.611^{a4}±0.0006
	40 DAY	Spoiled	6.553^{a5}±0.001	6.512^{b5}±0.001	6.514^{b5}±0.001
Overall acceptability	0 DAY	7.973^{a1}±0.001	7.825^{d1}±0.0004	7.863^{b1}±0.001	7.835^{c1}±0.001
	10 DAY	6.563^{d2}±0.001	6.703^{c2}±0.001	6.720^{a2}±0.0001	6.712^{b2}±0.001
	20 DAY	Spoiled	6.542^{c3}±0.0005	6.563^{a3}±0.0008	6.555^{b3}±0.001
	30 DAY	Spoiled	6.354^{c4}±0.001	6.383^{a4}±0.0008	6.364^{b4}±0.001
	40 DAY	Spoiled	6.216^{c5}±0.001	6.211^{a5}±0.0005	6.226^{b5}±0.001

C-Control,LC- Lactobacillus Casei,LP-Lactobacillus plantarum and PP-Pediococcus pentosaceus
Mean values between cultures with different alphabetical superscripts differ significantly (P< 0.01)
Mean values between storage periods with different numerical superscripts differ significantly (P< 0.01)

available nutrients, antimicrobial substances (bacteriocins) and metabolites (lactic acid, acetic acid, biogenic amines and Co_2) produced by LAB (Campbell-Platt and Cook, 1995). In addition to above, refrigeration (4±1ºC) is considered to be major means of preservation of meat (Jay, 1996). The results were also in accordance with Kirupasankar *et al.,* (2007) in fermented chicken sausages. The decrease in *coliform* and *Salmonella* count might be due to production of a variety of antagonistic factors like lactic acid, carbon dioxide, hydrogen peroxide, diacetyl and antibiotic like substances and bacteriocins by LAB (Klaenhammer, 1988). Similar results were observed by Faith *et al*. (1997), Capita *et al*. (2006) in Spanish dry fermented sausages. Hwang *et al.* (2009) in soudjouk-style semi-dry fermented sausage and Lindqvist and Lindblad (2009) in non-heat treated fermented sausages.The results were in agreement with Drosinos *et al*. (2005) in fermented sausages. Increase in psychrophilic count up to 40 days of storage in semi-dry fermented chicken sausages treated with LC, LP and PP were in accordance with Capita *et al. (*2006) in Spanish dry fermented sausages made with ostrich, deer, or pork meat. Increase in yeast and mould count during 40 days of storage in this study were in agreement with Bacus (1984) who had similar opinion regarding the growth of Yeast and moulds in fermented sausages, Ahmad and Srivastava (2007) in semi dry fermented buffalo meat sausages.

Higher (P>0.01) colour, flavour and overall acceptability scores and lower juiciness and

tendernss scores were noticed in semi-dry fermented chicken sausages treated with LC, LP and PP than control. Among treatments significantly (P>0.01) higher colour and overall acceptability scores but lower juiciness and tenderness scores were noticed in sausages fermented with LP followed by PP and LC up to 30 days of storage. There was a significant (P>0.01) decrease in colour, flavour, juiciness, tenderness and overall acceptability scores during 40 days of storage in semi-dry fermented chicken sausages (Table 5). The decrease in colour scores might be due to oxidative fading of pigment and lipid oxidation resulting in non-enzymatic browning of the product. The decrease in the color scores with longer storage period might also be due to release of moisture from the product. Similar observations were made by Kirupasankar (2006) during storage of fermented chicken sausages at refrigeration termperature. The decrease in flavour scores during 40 days of storage in semi-dry fermented chicken sausages (Kirupasankar, 2006). Ordonez *et al.* (1999) observed several chemical changes occur during the ripening of dry-fermented sausages that determine the flavor and odor of the end product. The decreased flavour scores may be due to fat oxidation during storage, which can be noticed by increasing Thiobarbituric Acid Reactive Substance. The reduction of mean tenderness scores during refrigerated storage might be due to the relative reduction in moisture content, relative reduction of juiciness of the product and gradual loss of moisture that led to hardening of the product. These results were in agreement with Prabhakara Reddy and Vijayalakshmi (1998) in chicken meat sausages and Kirupakankar (2006) in fermented chicken sausages.The decrease in overall acceptability scores were also in accordance with Mukherjee *et al*. (2006) in fermented goat meat sausage and Hu *et al.* (2007) in Silver carp sausages.

CONCLUSION

The fermented Semi-dry Chicken sausages were acceptable physico-chemically, microbiologically and organoleptically upto 40 days during storage at refrigeration (4+1^{0}C) temperature. However, chicken sausages fermented with LP considered to be superior in respect to its quality characteristics that have low pH, water activity, TBARS values and microbial counts and higher organoleptic quality followed by PP and LP.

REFERENCES

Ahmad S and Srivastava PK (2007) Quality and Shelf Life Evaluation of Fermented Sausages of Buffalo Meat with Different Levels of Heart and fat. Meat Science 75(4): 603-609.

AOAC(1995) Official methods of analysis. 16th edn. Association of Official Analytical Chemists. Washington, DC.

Bacus JN (1984) Utilization of Microorganisms in Meat Processing: A Handbook for Meat Plant Operators John Wiley and Sons Ltd.,, Inc, New York. England.

Brewer MS, Ikins WG and Harbers CAZ(1992) TBA values, sensory characteristics and volatiles in ground pork during long term frozen storage: effect of packaging. J. Food Science **57**: 558-563, 580.

Campbell-Platt GP and Cook PE 1995 Fermented meats - a world perspective. In: Fermented Meats. 1st edn., Blackie Academic and Professional, UK.

Capita R, Llorente-Marigomez S, Prieto M and Alonso-Calleja C(2006) Microbiological profiles, pH, and titratable acidity of chorizo and salchichon (two Spanish dry fermented sausages) manufactured with ostrich, deer, or pork meat. J. Food Protection 69(5): 1183-9.

Chestnut CM, Emswiler BS, Kotula AW and Young EP(1977) Bacteriological quality of ingredients used in ground beef manufacture. J. Animal Science 44:213-217.

Deibel RH and Niven CF(1957) Pediococcus cerevisiae: a starter culture for summer sausage. Journal of bacteriol. Proc. Pp.14-15.

De Vuyst L and Vandamme EJ(1994) Antimicrobial potential of lactic acid bacteria. Bacteriocins of lactic acid bacteria: microbiology, genetics and applications. Blackie Academic & Professional;.. London, pp. 91-142.

Drosinos EH, Mataragas M, Xiraphi N, Moschonas G, Gaitis F and Metaxopoulos J (2005) Characterization of microbial flora from a traditional Greek fermented sausages. Meat Science 69(2): 307-317.

Erkkila S(2001) Bio-protective and probiotic meat starter cultures for the fermentation of dry susages. PhD Dissertation. Department of Food Technology, University of Helsinki.

Faith NG, Parniere N, Larson T, Lorang TD and Luchansky JB (1997) Viability of E. coli O157:H7 in pepperoni during the manufacture of sticks and the subsequent storage of slices at 21, 4 and -20°C under air, vacuum and Co_2. International J. Food Microbiology 37: 47-54.

Fernandez M, Ordunez JA, Bruna JM and Deelahoz L(2000) Accelerated ripening of dry fermented sausages. Trends Food Science and Technology 11: 201-209.

Fu AH, Molins RA and Sebranek RS(1992) Storage quality characteristics of beef rib eye steaks packaged in modified atmospheres. J. Food Science **57:** 283-87, 301.

Harris DA Chaiet L, Dudley RP and Ebert P(1957) The development of a commercial starter culture for summer sausages. Bacterial. Proc. pp. 15.

Hu Y, Xia W Changrung G (2007) Effect of mixed starter cultures fermentation on the characteristics of silver carp sausages. World Journal of Microbiology Biotechnology 23:1021-1031.

Hwang CA, Porto-Fett AC, Juneja VK, Ingham SC, Ingham BH and Luchansky JB (2009) Modeling the survival of Escherichia coli O157:H7, Listeria monocytogenes, and Salmonella Typhimurium during fermentation, drying, and storage of soudjouk-style fermented sausage. International Journal of Food Microbiology 129(3): 244-52.

Jay JM (1996) In: Modern Food Microbiology, 4th edn, C.B.S. Publishers and Distributors, New Delhi. pp. 38-39.

Klaenhammer TR 1988 Bacteriocins of lactic acid bacteria. Biochimie 70: 337-349.

Keller J E, Skelley GC and Action JC (1974) Effect of meat particle size and casing diameter on summer sausage properties during drying. Journal of Milk Food Technology 37:101-106.

Kirupasankar M (2006) Studies on development and quality evaluation of fermented chicken sausages. PhD thesis Submitted to deemed University, IVRI, Izathnagar, India.

Kirupasankar M, Pandey NK and Yadav AS (2007) Ambient shelf life of chicken sausages fermented with Pediococcus cerevisiae. Indian J.Poultry Science 42(3): 273-276.

Lawrie R A 1998 Meat Science (4th edn.) Pergamon Press, Oxford.

Lerici C R, Piva M and Rosa MD(1983) Water activity and freezing point depression of aqueous solutions and liquid foods. J. Food Science 48 : 1667-1669.

Lindqvist R and Lindblad M (2009) Inactivation of Escherichia coli, Listeria monocytogenes and Yersinia enterocolitica in fermented sausages during maturation/storage. International Journal of Food Microbiology 129(1): 59-67.

Ordonez JA, Hierro EM, Bruna JM and de la Hoz L 1999 Changes in the components of dry-fermented sausages during ripening. Critical reviews in Food Science and nutritrion 39(4): 329-67.

Prabhakara Reddy K and Vijayalakshmi K (1998) Effect of incorporation of skin, gizzard, heart and yolk on the quality of frozen chicken meat sausages. J. Food Science and Technology 35(3): 276-278.

Sagdic O, Karahan AG, Ozcan M and Ozcan G(2003) Effect of some spices extracts on bacterial inhibition. Food Science and Technology International 9: 353-359.

Salahuddin M(1992) Studies on processing and quality evaluation of fermented mutton sausages. PhD thesis Submitted to deemed University, IVRI, Izathnagar, India.

Shekhar Mukherjee R, Chowdhury BR, Chakraborty R and Chaudhuri UR (2006) Effect of fermentation and drying temperature on the characteristics of goat meat (Black Bengal variety) dry sausage. African J. Biotechnology 5 (16): 1499-1504.

Sirisopit Subsoontorn BS(1985) Indicators of spoilage in thuringer sausage A thesis in food technology Submitted to the Graduate Faculty of Texas Tech University in Partial Fulfillment of the Requirements for the Degree of Master of Science.

Steibing A and Rodel W(1988) Influence of relative humidity on the ripening of dry sausages.Fleischew 70:1039-1043.

Tarladgis BG, Watts BM, Younathan MT and Durgan LR(1960) A distillation method for the qualitative determination of melonaldehyde in rancid foods. J. American Oil chemistry Society 37:403-406.