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Development and Evaluation of Fermented Semi-Dry Mutton Sausages during Storage at Ambient (29±1^{0}C) Temperature

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ABSTRACT

In the this study, semi-dry fermented mutton sausages were developed by fermentation and drying technology by three different lactic acid bacteria viz., *Lactobacillus casei*, *Lactobacillus plantarum* and *Pediococcus pentosaceus* and storage studies were conducted for the semi- dry fermented mutton sausages in regular intervals at ambient (29+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 whereas protein and fat were higher than control at room temperature storage. 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. Among treatments significantly (P>0.01) lower pH, water activity, TBARS values and cooking yield were observed in mutton sausages fermented with LP than PP and LC. There was significant (P>0.01) decrease in pH and cooking yield, non-significant decrease in water activity and significant (P>0.01) increase in TBARS values in semi-dry fermented mutton sausages during storage at ambient temperature.There was higher (P>0.01) total plate count, yeast and mould count, coli form count and salmonella count were noticed in control than sausages treated with LC, LP and PP at ambient 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 where as Coliform and Salmonella counts were decreased during storage at ambient temperature in semi-dry fermented mutton sausages. 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 ambient 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 differences in flavour was noticed in mutton sausages fermented with LC, LP and PP at room temperature. There was a significant (P>0.01) decrease in colour, flavour, juiciness, tenderness and overall acceptability scores during storage at ambient temperature in semi-dry fermented mutton sausages.

Key words: *Fermentation, semi-dry sausages, mutton, starter cultures.*

INTRODUCTION

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. Thus a more natural biological acidification would be the method of choice for production of low pH meat products by fermentation. Fermentation of meat is a means of preservation and the use of various microbial cultures, as a preservative appears to be more promising for India and other developing countries having inadequate refrigeration facilities. In this context development and evaluation of Semi- dry fermented mutton sausages carried

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out to study the effect of different types of starter cultures on semi- dry fermented mutton sausages , to assess the shelf- life of the product stored at ambient temperature and organoleptic evaluation of semi-dry fermented sausages by panel members.

MATERIALS AND METHODS

Fresh de-boned mutton of local desi sheep was obtained from the local retail market in Gannavaram. Mutton was 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 cubes of meats were minced twice using Meat Mincer (Model TC12E, Italy) with a plate hole diameter of 5 mm to obtain a unicorm mixture. 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. The concentration of bacteria was determined by total plate count method. The working bacterial suspension containing 10^8 CFU /ml was obtained by adjusting the dilution with normal saline solution.

The method of preparation and processing of fermented semi-dry sausages were standardized during preliminary trials. Common salt and sodium nitrite were added to minced meat and mixed for 1-2 minutes. Vegetable oil of 5% 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 in fabricated fermentation chamber at 25-27 ºC and RH of 90 ±5 % for 12-14 hours and drying (ripening) at 6-8 ºC , and relative humidity of 70 ± 5 % inside the chamber for 8 days (Table 1).

Table 1 : Formulation for fermented sausages using mutton

Ingradient	Percent
Meat **(Mutton)**	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 semi-dry fermented mutton sausages using different cultures were evaluated at room (29±1ºC) temperatures. Samples stored at room temperatures were withdrawn daily up to spoilage and analyzed for physico- chemical , microbiological and organoleptic qualities. Proximate composition, TBRS Values, cooking yield were estimated from 0 day to end of the storage period. The percent moisture (oven drying), percent protein (Kjeldhal method) and percent fat (using Soxhllet's apparatus) were estimated as per the procedures of AOAC (1995). The pH of the sample was determined by 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 was determined as per the Lerici *et al.* (1983). The 2–thiobarbituric acid reactive substance value of the samples was determined by the procedure of Tarladgis *et al.* (1960). Percent cooking yield was estimated by recording the difference between the pre and post cooking weights and expressed in percentages. Loss of weight of samples during storage was calculated by difference in initial and stored weight and expressed as shrinkage percentage. The total plate count per gram of samples were estimated as per the procedure recommended by Chestnut et *al.* (1977). For estimation of Yeast and Moulds

the procedure used for estimation of total plate count was adopted except that Sabourads Dextrose agar was used in place of Standard Plate Count agar. For estimation of *Coliforms* count Mac Conkey agar was used and for estimation of *Salmonella* count Brilliant green agar was prepared and used. 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

The effect of different starter cultures on semi-dry fermented mutton sausages during storage at ambient (29±1ºC) temperature were studied. The results indicated that the per cent moisture of semi-dry fermented mutton sausages as effected by different Lactic acid bacteria was significantly (P>0.01) lower whereas per cent protein and fat were higher than the control. Among treatments lower per cent moisture and higher protein and fat values were observed in sausages fermented with PP followed by LP and LC. Significantly higher mean per cent protein and fat values were observed in sausages fermented with LP than PP and LC among treatments than control. There was significant (P>0.01) reduction in moisture was observed during 5 days of storage in semi-dry fermented mutton sausages (Table 2). The results were in accordance with Wu *et al*. (1991) who made similar observation in vacuum packaged fermented sausages. Ahmad and Srivastava (2007) have also observed consistent decrease in moisture content in semi dry buffalo meat sausages. There was a significant (P>0.01) increase in per cent protein during 5 days of storage and significant (P>0.01) increase in per cent fat up to 3 days of storage of semi-dry fermented mutton sausages. Increase in protein and fat during storage may be due to corresponding moisture loss. The results were in accordance with the finding of Mukherjee

Table 2 : Mean ± SE of per cent moisture, protein and fat content of fermented semi-dry sausages using mutton as influenced by different starter cultures at ambient (29± 1ºC) temperature storage

Parameter	Storage periods	MUTTON			
		C	LC	LP	PP
Moisture %	0 DAY	59.11^{a1}±0.006	53.11^{b1}±0.005	50.71^{d1}±0.006	50.91^{c1}±0.006
	1 DAY	58.12^{a2}±0.009	52.73^{b2}±0.006	50.02^{c2}±0.005	49.14^{d2}±0.014
	2 DAY	Spoiled	51.73^{a3}±0.007	49.72^{b3}±0.007	48.74^{c3}±0.016
	3 DAY	Spoiled	50.73^{a4}±0.009	48.71^{b4}±0.004	47.43^{c4}±0.008
	4 DAY	Spoiled	50.11^{a5}±0.002	46.95^{b5}±0.010	46.63^{c5}±0.011
	5 DAY	Spoiled	50.06^{a6}±0.013	46.14^{b6}±0.006	45.53^{c6}±0.004
Protein %	0 DAY	22.11^{c2}±0.006	23.61^{a6}±0.007	23.62^{a5}±0.006	22.93^{b6}±0.017
	1 DAY	22.94^{c1}±0.009	23.62^{d5}±0.009	24.03^{a4}±0.008	23.63^{b5}±0.009
	2 DAY	Spoiled	23.83^{c4}±0.012	24.84^{a3}±0.013	24.01^{b4}±0.006
	3 DAY	Spoiled	24.04^{c3}±0.006	25.33^{a2}±0.007	24.94^{b3}±0.012
	4 DAY	Spoiled	24.74^{c2}±0.014	25.85^{a1}±0.010	25.14^{b2}±0.004
	5 DAY	Spoiled	25.11^{c1}±0.002	25.85^{a1}±0.007	25.75^{b1}±0.004
Fat%	0 DAY	19.71^{d1}±0.004	21.64^{c6}±0.009	21.95^{a6}±0.008	21.72^{b5}±0.006
	1 DAY	19.75^{d1}±0.009	21.95^{c5}±0.012	22.57^{a5}±0.006	22.12^{b4}±0.008
	2 DAY	Spoiled	22.13^{c4}±0.006	22.85^{a4}±0.011	22.75^{b3}±0.010
	3 DAY	Spoiled	22.96^{c3}±0.009	23.14^{a3}±0.010	23.01^{b2}±0.009
	4 DAY	Spoiled	23.03^{c2}±0.016	23.73^{a2}±0.006	23.42^{b1}±0.009
	5 DAY	Spoiled	23.03^{c1}±0.004	23.83^{a1}±0.003	23.45^{b1}±0.006

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)

et al. (2006) in fermented goat meat sausage and Kirupasankar (2006) in fermented chicken meat sausages.

Significantly (P>0.01) lower pH, water activity, TBA values and cooking yield were observed in sausages fermented with LP than PP and LC than control. There was significant (P>0.01) decrease in pH and water activity upto 3rd and 2nd day of storage, respectively and the decrease in pH, water activity, cooking yield and increase in TBA values during storage of semi-dry fermented mutton 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 were in accordance with Christiansen *et al*. (1975) who observed pH decline in summer style sausage during storage, Subsoontorn (1985) in Thuringer sausages, Kalalou *et al*. (2004) in ground camel meat sausages. The lower a_w in treatment groups might be due to their shelf stability at room temperature (Campbell-Platt and Cook, 1995). The results were in accordance with Chacon *et al*., (2006) in sausage batters of pork. Increase in TBARS value during storage could be attributed to oxidation of polyunsaturated fatty acids of phospholipids fraction (Igene *et al*., 1980; Brewer *et al*., 1992). The rapid increase in TBARS value under aerobic packaging may be related to oxygen concentration (Fu *et al*., 1992) and oxygen permeability of packaging material (Brewer *et al*., 1992). Reduction in cooking yield during storage may be attributed to decline in pH, which reduced the water holding capacity of meat products (Lawrie, 1998).

Table 3 : Mean ± SE of pH, water activity, TBARS value and cooking yield% of fermented semi-dry sausages using mutton as influenced by different starter cultures at ambient (29± 1ºC) temperature storage

Parameter	Storage periods	MUTTON			
		C	LC	LP	PP
pH	0 DAY	4.52^{a6}±0.006	4.24^{b1}±0.009	3.86^{d1}±0.013	3.95^{c1}±0.014
	1 DAY	5.82^{a5}±0.006	4.14^{b2}±0.012	3.81^{d2}±0.006	3.94^{c1}±0.012
	2 DAY	Spoiled	4.13^{a2}±0.006	3.75^{c3}±0.010	3.93^{b1}±0.008
	3 DAY	Spoiled	4.09^{a3}±0.004	3.72^{c3}±0.006	3.86^{b3}±0.013
	4 DAY	Spoiled	4.04^{a4}±0.010	3.73^{c3}±0.009	3.82^{b4}±0.007
	5 DAY	Spoiled	4.05^{a4}±0.004	3.73^{c3}±0.003	3.83^{b3}±0.002
Water activity	0 DAY	0.940^{a1}±0.0006	0.932^{b1}±0.0004	0.893^{d1}±0.0003	0.923^{c1}±0.0007
	1 DAY	0.940^{a1}±0.0006	0.931^{b1}±0.0006	0.891^{d1}±0.0005	0.921^{c1}±0.0006
	2 DAY	Spoiled	0.930^{a1}±0.0003	0.892^{c1}±0.0008	0.922^{b1}±0.0007
	3 DAY	Spoiled	0.931^{a1}±0.0010	0.891^{c1}±0.0006	0.921^{b1}±0.0008
	4 DAY	Spoiled	0.931^{a1}±0.0007	0.891^{c1}±0.0005	0.921^{b1}±0.0008
	5 DAY	Spoiled	0.932^{a1}±0.0004	0.891^{c1}±0.0004	0.921^{b1}±0.0004
TBARS value	0 DAY	0.083^{a2}±0.0007	0.083^{a6}±0.0006	0.082^{a6}±0.0005	0.083^{a6}±0.0007
	1 DAY	0.865^{a1}±0.0006	0.184^{b5}±0.0006	0.155^{d5}±0.0008	0.165^{c5}±0.0013
	2 DAY	Spoiled	0.502^{a4}±0.0009	0.402^{c4}±0.0009	0.494^{b4}±0.0010
	3 DAY	Spoiled	0.885^{a3}0.0007	0.636^{c3}±0.0009	0.820^{b3}±0.0004
	4 DAY	Spoiled	1.895^{a2}±0.0010	1.812^{c2}±0.0007	1.835^{b2}±0.0009
	5 DAY	Spoiled	2.011^{c1}±0.0002	2.895^{b1}±0.0002	2.985^{a1}±0.0004
Cooking yield %	0 DAY	92.72^{a1}±0.005	89.63^{b1}±0.011	87.64^{d1}±0.009	88.74^{c1}±0.008
	1 DAY	92.63^{a2}±0.006	88.43^{b2}±0.008	86.53^{d2}±0.008	87.72^{c2}±0.004
	2 DAY	Spoiled	87.43^{a3}±0.009	85.43^{c3}±0.005	86.92^{b3}±0.006
	3 DAY	Spoiled	86.64^{a5}±0.011	84.46^{c4}±0.014	85.71^{b5}±0.003
	4 DAY	Spoiled	86.65^{a4}±0.007	84.42^{c5}±0.004	85.13^{b6}±0.006
	5 DAY	Spoiled	86.15^{a6}±0.004	84.23^{c6}±0.002	86.04^{b4}±0.005

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)

Significantly (P>0.01) higher total plate count, Yeast and Mould count and lower *Coliform* count and *Salmonella* 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 (by 2 log) and *Yeast and Mould* count and decrease in *Coliform* count and *Salmonella* count during 5 days of storage in fermented semi-dry mutton sausages treated with LC, LP and PP (Table 4). The increase in TPC might be due to the storage temperature, which is favorable for the growth of microorganisms. Increase in TPC of fermented sausages during ambient storage is in agreement with Salahuddin (1992) in fermented mutton sausages and Kirupasankar (2006) and Ahmad and Srivastava (2007) in buffalo meat semi-dry sausages. The decrease in *coliform* and *Salmonella* counts 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). The results were in agreement with Drosinos *et al.* (2005) in fermented sausages, Hwang *et al.* (2009) in soudjouk-style fermented sausage. The increase in yeast and mould count might be due to acid environment by production of lactic acid. The results were in agreement with Bacus (1984) and Kirupasankar (2006) who had similar opinion regarding the growth of yeast and mould in fermented sausages and Ahmad and Srivastava (2007) in semi-dry buffalo meat sausages.

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

Table 4: Mean ± SE of Total plate count, *Coliforms, Salmonella* count and *Yeast* and *Mould* count (log CFU/g) of fermented semi-dry sausages using mutton as influenced by different starter cultures at ambient (29± 1ºC) temperature storage

Parameter	Storage periods	MUTTON			
		C	LC	LP	PP
TotalPlate Count	0 DAY	5.885^{a2}±0.0009	4.485^{b6}±0.0007	4.432^{c6}±0.0006	4.362^{d6}±0.0005
	1 DAY	6.234^{a1}±0.0010	5.254^{d5}±0.0010	5.463^{b5}±0.0007	5.343^{c5}±0.0008
	2 DAY	Spoiled	6.142^{c4}±0.0009	6.353^{a4}±0.0010	6.230^{bc4}±0.0010
	3 DAY	Spoiled	6.234^{c3}±0.0007	6.432^{a3}±0.0010	6.332^{b3}±0.0009
	4 DAY	Spoiled	6.645^{b2}±0.0004	6.731^{a2}±0.0002	6.624^{c2}±0.0009
	5 DAY	Spoiled	6.738^{c1}±0.0002	6.843^{a1}±0.0005	6.753^{b1}±0.0002
Coliform count	0 DAY	3.834^{a2}±0.0006	1.563^{b1}±0.0008	1.373^{d1}±0.001	1.433^{c1}±0.0008
	1 DAY	4.147^{a1}±0.0013	1.544^{b2}±0.001	1.365^{d2}±0.0009	1.416^{c2}±0.001
	2 DAY	Spoiled	1.357^{a3}±0.001	1.165^{c3}±0.0013	1.253^{b3}±0.0009
	3 DAY	Spoiled	1.154^{a4}±0.001	0.935^{c4}±0.001	1.034^{b4}±0.001
	4 DAY	Spoiled	0.985^{a5}±0.0013	0.763^{c5}±0.001	0.964^{b5}±0.0008
	5 DAY	Spoiled	0.866^{a6}±0.0006	0.646^{c6}±0.0006	0.853^{b6}±0.0004
Salmonellacount	0 DAY	0.983^{b2}±0.0008	1.186^{a1}±0.001	0.974^{c1}±0.0007	1.184^{a1}±0.0012
	1 DAY	2.956^{a1}±0.0007	0.982^{b2}±0.0008	0.863^{c2}±0.0011	0.983^{b2}±0.0008
	2 DAY	Spoiled	0.883^{a3}±0.0013	0.726^{c3}±0.0006	0.832^{b3}±0.0013
	3 DAY	Spoiled	0.764^{a4}±0.0012	0.632^{c4}±0.0009	0.726^{b4}±0.0008
	4 DAY	Spoiled	0.673^{a6}±0.0012	0.544^{c6}±0.001	0.635^{b6}±0.0012
	5 DAY	Spoiled	0.683^{a5}±0.0002	0.573^{c5}±0.0004	0.643^{b5}±0.0004
Yeast and Mould count	0 DAY	3.284^{a2}±0.001	2.152^{d6}±0.0006	2.585^{b6}±0.001	2.172^{c6}±0.0008
	1 DAY	4.294^{a1}±0.0007	2.224^{d5}±0.0004	2.245^{b5}±0.001	2.234^{c5}±0.001
	2 DAY	Spoiled	2.346^{c4}±0.001	2.373^{a4}±0.001	2.357^{b4}±0.001
	3 DAY	Spoiled	2.453^{c3}±0.001	2.472^{a3}±0.0004	2.462^{b3}±0.001
	4 DAY	Spoiled	2.685^{b2}±0.001	2.695^{a2}±0.0012	2.693^{a2}±0.001
	5 DAY	Spoiled	2.784^{b1}±0.0003	2.793^{a1}±0.0005	2.785^{b1}±0.0005

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)

juiciness scores were observed for semi-dry fermented mutton sausages treated with LC, LP and PP than control (Table 5). Improvement of colour scores might be due to increased fat and moisture retention upon cooking. Among treatments significantly higher colour, flavour and overall acceptability scores and lower tenderness and juiciness scores were noticed in sausages fermented with LP followed by PP and LC. There was a significant (P>0.01) decrease in colour, flavour, juiciness, tenderness and overall acceptability scores during 5 days of storage in fermented semi-dry mutton sausages. This might be due to oxidative fading of pigment and lipid oxidation resulting in non-enzymatic browning of the product. (Kirupasankar, 2006). The decreased flavour scores may be due to fat oxidation during storage, which can be noticed by increasing Thiobarbituric Acid Reactive Substance. These were in association with Hu *et al.* (2007) who observed highest scores for flavour and overall acceptability in silver carp sausages.The reduction of mean tenderness scores during storage might be due to the relative reduction in moisture content

Table 5 : Mean ± SE of Colour, flavour, juiciness, tenderness and overall acceptability scores of fermented semi-dry sausages using mutton as influenced by different starter cultures at ambient (29± 1ºC) temperature during storage

Parameter	Storage periods	MUTTON			
		C	LC	LP	PP
Colour	0 DAY	8.424^{c1}±0.0006	8.444^{b1}±0.001	8.523^{a1}±0.0008	8.444^{b1}±0.001
	1 DAY	5.436^{d2}±0.0006	7.355^{c2}±0.001	7.523^{a2}±0.0013	7.472^{b2}±0.001
	2 DAY	Spoiled	7.273^{c3}±0.0008	7.453^{a3}±0.001	7.384^{b3}±0.001
	3 DAY	Spoiled	7.275^{c3}±0.0009	7.453^{a3}±0.0007	7.383^{b3}±0.001
	4 DAY	Spoiled	6.587^{c4}±0.0008	6.725^{a4}±0.0011	6.624^{b4}±0.001
	5 DAY	Spoiled	5.4^{b5}.0004	5.424^{c5}±0.0005	5.773^{a5}±0.0006
Flavour	0 DAY	6.826^{b1}±0.001	6.824^{b1}±0.001	6.825^{b1}±0.0007	6.833^{a1}±0.001
	1 DAY	5.482^{b2}±0.0009	6.645^{a2}±0.0009	6.644^{a2}±0.001	6.643^{a2}±0.0003
	2 DAY	Spoiled	6.544^{a3}±0.001	6.544^{a3}±0.0008	6.544^{a3}±0.0004
	3 DAY	Spoiled	6.345^{a4}±0.0007	6.344^{a4}±0.0008	6.345^{a4}±0.0007
	4 DAY	Spoiled	5.983^{a5}±0.0006	5.894^{b5}±0.001	5.984^{a5}±0.0009
	5 DAY	Spoiled	5.883^{a6}±0.0003	5.884^{a6}±0.0004	5.884^{a6}±0.0004
Juiciness	0 DAY	7.762^{a1}±0.001	5.763^{b1}±0.001	5.654^{c1}±0.001	5.763^{b1}±0.002
	1 DAY	6.955^{a2}±0.001	5.683^{b2}±0.001	5.584^{c2}±0.001	5.682^{b2}±0.001
	2 DAY	Spoiled	5.572^{a3}±0.0008	5.464^{b3}±0.001	5.573^{a3}±0.0009
	3 DAY	Spoiled	5.562^{a4}±0.001	5.465^{b3}±0.001	5.563^{a4}±0.001
	4 DAY	Spoiled	5.475^{b5}±0.001	5.353^{c4}±0.001	5.424^{b5}±0.001
	5 DAY	Spoiled	5.386^{a6}±0.0005	5.272^{b5}±0.0001	5.385^{a6}±0.0004
Tenderness	0 DAY	7.853^{a1}±0.0008	6.973^{b1}±0.001	6.934^{d1}±0.001	6.952^{c1}±0.0008
	1 DAY	7.734^{a2}±0.001	6.744^{b2}±0.0009	6.716^{d2}±0.0013	6.734^{c2}±0.0009
	2 DAY	Spoiled	6.623^{a3}±0.001	6.615^{a3}±0.001	6.625^{a3}±0.001
	3 DAY	Spoiled	6.532^{a4}±0.0007	6.514^{b4}±0.0008	$6.525^{a,b4}$±0.0007
	4 DAY	Spoiled	6.322^{a5}±0.0007	6.325^{a5}±0.005	6.306^{a5}±0.001
	5 DAY	Spoiled	6.316^{a5}±0.002	6.303^{a6}±0.001	6.306^{b5}±0.0005
Overall acceptability	0 DAY	7.782^{d1}±0.0009	7.834^{c1}±0.0008	7.876^{a1}±0.0005	7.845^{b1}±0.001
	1 DAY	6.164^{d2}±0.0009	6.553^{c2}±0.001	6.574^{a2}±0.0006	6.564^{b2}±0.001
	2 DAY	Spoiled	6.443^{c3}±0.001	6.463^{a3}±0.0008	6.456^{b3}±0.0004
	3 DAY	Spoiled	6.323^{c4}±0.0007	6.354^{a4}±0.001	6.333^{b4}±0.0007
	4 DAY	Spoiled	6.222^{c5}±0.0009	6.244^{a5}±0.001	6.234^{b5}±0.002
	5 DAY	Spoiled	5.984^{c6}±0.0002	6.122^{a6}±0.0004	6.113^{b6}±0.0005

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)

and juiciness of the product and gradual loss of moisture that led to hardening of the product. These results were in agreement with Prabhakar Reddy and Vijayalakshmi (1998) in chicken meat sausages. The decrease in overall acceptability might be due to decrease in colour, flavour, juiciness and tenderness scores of the samples during the storage period. The results were also in accordance with Mukherjee *et al*. (2006) in fermented goat meat sausage.

CONCLUSION

The fermented semi-dry mutton sausages were acceptable physico-chimically, microbilogically and organoleptically upto 5 days during storage at ambient (29+1^{0}C) temperature. However, mutton sausages fermented and LP considered to be superior in respect to its quality characteristics that have low pH,water activity,TBARS values and microbial counts and high organoleptic quality followed by PP and LP.

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