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Quality and Shelf-Life of Smoked Chevon Sausages Packed under Vacuum and Stored at 4±1°C

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Abstract: Smoked chevon sausage was prepared using four-year-old Barbari bucks to study their shelf-life under refrigeration. Smoked sausages were packed in HDPE bags under vacuum (VP) and aerobically (AP). Packed sausages were evaluated for proximate, physico-chemical, microbiological and sensory changes on day 0, 7, 14 and 21 due to storage. The cooking yield (%) and cholesterol (mg per 100 g of sausages) content of fresh smoked chevon sausages were 73.50 and 98.74. Overall mean moisture, fat, protein and ash contents were 55.48, 17.05, 18.36 and 3.00 percent, respectively. Overall mean water activity (a_w), pH and W-B shear force values (kg/5 cm length sausages) were 0.972, 6.41 and 3.20, respectively. In microbial analysis overall SPC, PBC and LAB were log 5.86, 5.00 and 4.24 CFU g^{-1} respectively. Coliform, yeast and mould were also detected. To identify day of spoilage SPC values were plotted in graph. Over all spoilage based on storage period mean was day 12 but yeast and mold growth was visible on the surface of sausage on day 14. Smoking and vacuum packaging of spent goat chevon sausages has some beneficial effect on pH, protein, SPC and sensory scores but did not extend the shelf -life. In light of the observations, it can be concluded that vacuum packaging has no definite advantage in preserving quality and sensory attributes. Product can be stored under refrigeration up to seven days irrespective of packaging condition.

Key words : Goat meat, smoked sausages, shelf-life, quality, refrigeration

INTRODUCTION

Sausages are getting popularity in Indian market especially as a fast food in big cities. Sausages prepared after smoking is less popular due to non availability. In India processing of goat meat was often ignored with the argument that there is potential market for fresh meat. This misconception needs to be changed for development of goatery on strong footing. In this connection, the National Food Processing Policy vision document is developed to encourage value added food products for domestic and export markets with a strong emphasis on food quality and safety enabling farmers to realize direct benefits of new technology and marketing network and to ensure adequate availability of quality food products for consumers at economic prices. Meat trade is concerned with changing consumer demand, which may influence economics of buying animals and selling of meat and meat products that are independent and unpredictable. This is also applicable to Goat meat trade in India. Goat meat production in India is 0.47 MT from 123 million goats. Goat meat is the most preferred and mostly consumed domestically.

Goat meat sausages can be prepared replacing beef in a beef/pork frankfurter formulation (Eggen *et al*., 1973). Padda and Sharma (1988) reported that chevon sausages were organoleptically better than pork sausages although pork fat was added in both type of sausages. Sausages prepared using spent buck meat and cooked under pressure (1.1 kg cm^{-2}) had a product yield of

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77.0% (Prasad and Agnihotri, 1991) and had a shelf-life of seven days during refrigerated storage (Agnihotri and Pal, 2000). Effect of vegetable oil on the quality of fresh chevon sausages (Pal and Agnihotri, 1996) was studied but not on vacuum packaging. Rajkumar *et al*. (2004) investigated the shelf-life and keeping quality of emulsion based goat meat patties by vacuum packaging. Lee (2001) reported that vacuum packaging increased keeping quality of meat product and retarded the microbial count during storage period. Apple *et al*. (2003) reported that meat product during refrigerated storage in vacuum packaging decreased drip loss, increased color moisture retention affect the pH. Byun *et al*. (2001) reported that the properties of vacuum packed sausage stored in refrigerated condition had lower microbial load. Sureshkumar *et al*. (2006) reported effect of water activity and pH on the shelf life of buffalo meat sausage. Effect of smoking on quality of chevon sausages was rarely reported and also the combination of vacuum packaging and smoking.

The tropical environmental conditions in India favor the microbial spoilage of fresh meat and reduce its shelf life. Microbial growth is mainly associated with quality deterioration and economic loss. There is needed to improve quality and shelf-life. Of the several methods available, vacuum packaging can check microbial growth and another method is smoking or combinations of both. The purpose of the study was, to asses the quality of sausages packed under vacuum. An evaluation on physico-chemical, microbiological and sensory properties of sausages was carried.

MATERIALS AND METHODS

Location of the Study

The study was conducted at Central Institute for Research on Goats located in Makhdoom village of Mathura District, Utter Pradesh, India (27°10' N, 78°02' E and 169 m above MSL). Geologically the Institute land falls under Jamuna alluvial soil category. The climate is semi-arid. Temperature ranges between 6°C in winter to as high 45°C in summer. Annual average rainfall is 750 mm and spread over a period of 50-60 days. Monsoon arrives in mid July and remains active till mid - September. Deep tube wells provide saline water. The research was carried out during the month of March to May 2004.

Meat Source

Three Barbari male goats of about four years age, reared under semi intensive management system at the Barbari shed of Nutrition division, Central Institute for Research on Goats, were slaughtered after 18 h of off-feed with potable water. After stunning with electrical stunner (Model BTR 109, Freund, GmbH, Germany) bleeding, skinning and evisceration were done as per the standard commercial procedures. Warm carcasses were dressed immediately followed by hot deboning. Separated meat was packed in high-density polyethylene (High Density Polyethylene (HDPE), WVTR 5 g m^{-2} per 24 h at 38°C and 90% RH) bags, heat-sealed and kept under -20±2°C till use.

Mixture of Green and Dry Spices

Dry spices mixture was prepared (Table 1) and filled in stainless steel jars. It was stored in cool and dry place and used within two weeks. For preparation of green spices mixture, peeled and washed onion, ginger and garlic in ratio of 3:1:1 (Table 2) were finely chopped and ground. Mixture thus obtained was packed in HDPE and stored at -20±2°C and used within two weeks.

Recipe and Preparation of Smoked Chevon Sausages

The separated lean obtained from the carcasses three animals was packed in HDPE bags and stored at -20±2°C was used within 15 days for meat sausages preparation. Before use meat was

Table 1: Composition of dry spice mixture

Spices	Composition (%)
Clove	5
Cinnamon bark	5
Small cardamom seed	5
Black pepper	10
Shia zira (*Carum carvi*) seeds	10
Anise	10
Turmeric powder	10
Cumin seed	15
Red pepper	15
Coriander seed	15
Total	100

Table 2: Composition of green spices

Green spices	(%)
Onion	60
Ginger	20
Garlic	20

Table 3: Ingredient composition of smoked chevon sausages

Ingredients	Composition (g)	Composition (g %)
Minced goat meat	100.0	72.30
Maida	3.0	2.17
Refined oil	2.5	1.81
Goat fat	2.5	1.81
Salt	1.5	1.08
Dry spices	2.0	1.45
Green spices	6.0	4.34
Sugar	0.5	0.35
Tetra sodium pyrophosphate	0.3	0.22
Sodium nitrite	0.01	0.01
Chilled water	20.00	14.46
Total	138.31	100.00

Table 4: Stages of cooking in smoke oven

Time (min)	Oven temp. (°F)	Core temp. (°F)	Humidity (%)	Damper	Blower	Options
40	120	-	0	Closed	High	Heat
30	135	-	15	Half	High	Feed
30	145	-	35	Closed	High	Feed
40	165	-	38	Closed	High	-
00	170	158	38	Closed	High	-
00	-	90	38	-	-	Shower
01	-	00	-	-		Alarm

thawed overnight at 4±1°C. Chevon sausages were prepared using standard recipe (Agnihotri, 2002). Thawed meat was minced in automatic meat mincer (Tellers Ramon, make-p- 23, Barcelona) using a 5 mm plate. The ingredient composition of chevon sausage was presented in the Table 3.

Minced meat was mixed with common salt and chopped (Model type K 20, Seydelmann, Germany) using 6 cutters knives for 2 min. Sodium nitrite, Tetra Sodium Pyrophosphate (TSPP) were dissolved in 70 mL lukewarm water and added followed by addition of other ingredients and chopped for 3 min. In running condition already prepared ice flaxes were added intermittently to maintain the internal temperature of bowl chopper in the range of 9-10°C for better emulsion formation. Prepared emulsion was then filled in automatic sausage filler (Talleres Ramon Make P-22, Barcelona) and the sausage emulsion was stuffed into natural goat casings of 18-20 mm diameter with the help of sausage filler. Stuffed sausage emulsion was then interlinked and hanged in smoke sticks (Enviro Pak, USA). For smoking hard wood (Hickory) sawdust was used. Program for cooking and smoking in the automatic smoke oven (Enviro Pak- model CVU 150 HL, USA) is presented in the Table 4.

Packaging, Sampling and Storage of Smoked Chevon Sausages

Cooked, smoked chevon sausages were filled in HDPE bags and packed under vacuum (VP) (Model 19/S, Roscherwerke GmbH, Germany) and aerobically (AP). All the bags were stored under refrigerator (4±1°C) for further investigation. Values obtained on day 0 was considered common for both AP and VP sausages and presented. Stored chevon sausage in HDPE bags were examined after peeling the outer casings, for changes in physico-chemical, microbiological and sensory properties during day 0, 7, 14 and 21. Three similar studies, each time in duplicates were conducted. Samples from the packets for microbiological studies were taken first, then for pH, water activity, shear force, cholesterol and physico-chemical determination. The remaining part of samples was used for sensory evaluation.

Analyses of Chevon Smoked Sausages

The cooking yield, cholesterol content, water activity, pH, shear force values, moisture, fat, protein, ash, microbial analyses and sensory evaluation analyses were carried out as per the method described by Rajkumar *et al*. (2004).

Calculation of Day of Spoilage of Chevon Sausages

Day of spoilage of chevon sausages were calculated based on the counts obtained by Standard Plate Count (SPC) method. The day of spoilage was determined by plotting the storage period in X -axis and the SPC log values in the Y-axis. Based on the values obtained during different days of storage, a linear regression line was computed and drawn. The formula used for drawing a linear regression line is depicted at the right corner of each graph. The SPC count of log 6.00 CFU g^{-1} was taken as standard for spoilage and a perpendicular line from this point was dropped to X-axis to find the day of spoilage for any particular treatment and for overall storage period.

Statistical Analysis

Statistical analysis was carried out with the MSTATC (Version 2.10) statistical programme to find the effect of treatment, storage period and their interactions on quality traits of patties. Differences between means were tested by critical difference

RESULTS AND DISCUSSION

Cooking yield and Cholesterol Content

The cooking yield and cholesterol content of fresh smoked chevon sausages were presented in Table 5. Cooking yield (%) of chevon smoked sausages was 73.50. Agnihotri and Pal (2000) reported 78.55% yield of sausages, which was prepared without addition of binder such as phosphates. In the present study the low yield is attributed to smoking. Kumar and Sharma (2003) observed that low cooking yield in emulsion based meat products could be due to low fat incorporation in formulation. In the present investigation only 2.5% goat fat was used. Agnihotri and Pal (1997) reported sausage treated with 0.5% TSPP yielded 87.92%. Cooking yield of 80 to 87% for buffalo meat nuggets (Anjaneylu and Kondaiah, 1990) and 91% in chevon patties (Rajkumar *et al*., 2004) were reported. High yield in these reports may be because they were not smoked for preparing the product.

Total cholesterol content of smoked chevon sausage was 98.74 mg 100 g^{-1}, which is higher than values (75 mg 100 g^{-1}) reported for roasted goat meat (USDA, 1997). Rajkumar *et al*. (2004) reported 134.84 mg cholesterol per 100 g in goat patties. The cholesterol content of goat meat balls varied from

Table 5: Cooking yield and cholesterol content of fresh smoked sausages

Traits	Fresh cooked sausages
Cholesterol content, mg/100 g (n = 16)	98.74±9.07
Cooking yield (%)	73.50±0.5

Table 6: Effect of smoking and vacuum packaging on physico-chemical properties of chevon sausages stored at 4±1°C

Traits	Treatment	Storage period in days 0	7	14	21	Treatment Mean±SE
Water activity	AP	0.975±0.003	0.975±0.002	0.975±0.002	0.967±0.006	0.973±0.002
	VP	0.975±0.003	0.972±0.002	0.970±0.002	0.965±0.001	0.971±0.002
	Storage period Mean±SE	0.975±0.000[a]	0.974±0.002[b]	0.972±0.003[c]	0.966±0.001[d]	0.972±0.001*
pH	AP	6.44±0.02	6.48±0.01	6.49±0.02	6.97±0.23	6.60±0.12[A]
	VP	6.44±0.02	6.30±0.10	6.07±0.17	6.08±0.21	6.22±0.09[B]
	Storage period Mean±SE	6.44±0.00	6.40±0.09	6.28±0.21	6.52±0.45	6.41±0.10
W-B shear force value, kg cm^{-1} dia sausage with casings	AP	3.31±0.24	3.44±0.17	3.38±0.16	2.64±0.10	3.19±0.19
	VP	3.31±0.24	3.45±0.20	3.47±0.12	2.59±0.11	3.21±0.21
	Storage period Mean±SE	3.31±0.00[a]	3.44±0.00[a]	3.43±0.05[a]	2.62±0.02[b]	3.20±0.13*

Each value under the head storage period in days is mean (±SE) of 8 observations; For WB shear force values are means of 34 observations;*Values are overall means (±SE) for each trait; Storage period means bearing uncommon superscripts (small letter) in each cell of a row differ ($p<0.01$); Treatment means bearing different superscripts (capital letter) for each trait differ ($p<0.01$)

75 to 89.6 mg/100 g (Agnihotri and Rajkumar, 2003). The cholesterol content of cooked goat meat leg slices was lower than cooked carcass composite (Jonson and McGowan, 1998). Variation in the total cholesterol content might be due to type of cooking method.

Physico-chemical Properties

Physico-chemical properties of smoked, vacuum packed and stored (4±1°C) chevon sausages are presented in Table 6. Sausages had overall a_w of 0.972. Sureshkumar *et al*. (2006) reported a_w of 0.932 for untreated buffalo meat sausage and fresh goat meat patties had a_w 0.983 (Rajkumar *et al*., 2004). Lower a_w of buffalo meat sausage might be due to difference in species and batter composition. In the present study AP sausages had similar (0.975) a_w but decreased on day 21 (0.967). This might be due to growth of microorganisms as revealed by the microbiological studies. The a_w of VP sausages decreased simultaneously from 0.975 on day 0 to 0.965 on day 21. Combination of smoking and vacuum packaging had no significance on a_w but storage period significantly ($p<0.01$) affected a_w. Similar trend was observed for goat meat patties (Rajkumar *et al*., 2004).

Over all pH of smoked and VP chevon sausage was 6.41. Treatment mean significantly ($p<0.01$) affected pH. Initial pH (6.44) of fresh sausage was decreased due to VP (6.02) on day 21 of storage. Decrease in pH in meat products are due to growth of dominating lactic acid bacteria and depends on the available carbohydrates in the meat product (Pexara *et al*., 2002). VP and storage (4°C) decrease the pH of sausage (Santos *et al*., 2005). Storage period did not affect the pH. Similar observation was recorded by Agnihotri and Pal (2000) in phosphate added goat meat sausage. In present study pH of AP sausages increased during storage period. Deva and Narayan (1988) reported that microbial load increased with the increase in final pH of the meat product. Results of the present study are in agreement with the above result.

Storage significantly ($p<0.01$) affected shear force values and treatment had no influence on smoked chevon sausage. Similar trend was observed in texture scores of sensory evaluation. Fernandez *et al*. (2005) reported higher hardness in a VP dry cured sausage. Similar values were reported by Anjaneylu and Kondaiah (1990) for buffalo nuggets. Smoking of goat meat sausages reduces the moisture content and increased the hardness.

Proximate Composition

Proximate composition of smoked and packed chevon sausages stored at 4±1°C was presented in Table 7. Fresh sausages had overall moisture percentage of 55.48. Agnihotri (2002) and Anjaneyulu *et al*. (1989) reported higher moisture and lower fat in goat meat patties. Agnihotri and Pal

Table 7: Effect of smoking and vacuum packaging on proximate composition (%) of chevon sausages stored at 4±1°C

Traits	Treatment	Storage period in days 0	7	14	21	Treatment Means±SE
Moisture	AP	55.66±0.71	55.93±0.54	56.42±1.58	49.90±1.09	55.48±2.08
	VP	55.66±0.71	59.24±1.47	56.22±1.66	50.81±0.84	55.48±1.75
	Storage period Mean±SE	55.66±0.00^{a}	59.58±0.34^{b}	56.32±0.10^{c,a}	50.35±0.45^{d}	55.48±1.26*
Fat	AP	16.82±0.78	13.72±0.07	17.59±1.24	20.77±0.93	17.22±1.45
	VP	16.82±0.78	14.45±0.16	16.66±0.93	19.60±0.78	16.88±1.05
	Storage period Mean±.SE	16.82±0.00^{a}	14.09±0.37^{b}	17.12±0.46^{a}	20.18±0.59^{c}	17.05±0.83*
Protein	AP	18.01±0.43	16.94±0.68	17.83±0.87	18.80±0.12	17.89±0.38^{A}
	VP	18.01±0.43	18.89±0.34	19.90±0.62	18.51±0.48	18.82±0.40^{B}
	Storage period Mean±SE	18.01±0.00	17.91±0.97	18.87±1.03	18.66±0.15	18.36±0.31*
Ash	AP	2.68±0.19	2.66±0.20	2.94±0.11	3.47±0.06	2.94±0.19
	VP	2.68±0.19	2.99±0.14	3.02±0.16	3.57±0.20	3.06±0.15
	Storage period Mean±SE	2.68±0.00^{a,b}	2.82±0.16^{a,b}	2.98±0.04^{b}	3.52±0.05^{c}	3.00±0.12*

Each value under the head storage period in days is mean (±SE) of 16 observations; For protein and ash, values are means of 4 and 8 observations, respectively; *Values are overall means (±SE) for each trait; Storage period meansbearing uncommon superscripts (small letter) in each cell of a row differ ($p<0.01$); Treatment means bearing differentsuperscripts (capital letter) for each trait differ ($p<0.05$)

(2000) also reported 66.71% moisture in chevon sausages. Smoking and VP had no significant effect on moisture content. Summo *et al.* (2006) reported that VP ripened sausages retained moisture for 40 days of storage. In the present study, VP sausages retained moisture for 14 days. Moisture content significantly differ ($p<0.01$) due to storage. Same trend was observed for goat meat patties (Rajkumar *et al.*, 2004) and for ripened sausages (Summo *et al.*, 2006).

Overall fat content of smoked and VP sausage was 17.05. The fat content of fresh sausages was 16.82. Fat content of stored sausages was significantly ($p<0.01$) differed. Packaging method had no influence. Fat increased due to decreasing of moisture in on day 7. Rajkumar *et al.* (2004) reported that moisture loss was responsible for higher fat content during storage. In the present study treatment means fat not significantly differ but in aerobic pack fat is higher comparatively vacuumed packed, also same in storage period means at day 14 and 21. Agnihotri and Pal (1997) reported that phosphate treated sausages had lower fat.

Over all protein content of sausages was 18.36%. Treatment significantly ($p<0.05$) differed in AP (17.89) and VP (18.82), respectively but storage period mean had no significantly difference on day 7 (17.91). VP sausages had more protein than AP. Jindal and Bawa (1988) reported 22.10% protein in poultry sausage. They reported that soy flour in formulation increased protein in sausages. Anjaneylu and Kondaiah (1990) reported 22.96% protein in buffalo meat nuggets Agnihotri and Pal (1997) reported that addition of TSPP resulted in decreased protein content and increased fat content.

Smoked and vacuum-packed chevon sausages, stored at 4±1°C had an ash content of 3.00. Packaging method had no influence but storage period significantly affected the ash content. Treatment was not significantly differed in AP (2.94) and VP (3.06) ash content of sausages. Storage period was significantly ($p<0.01$) differed, which was simultaneously increased from 2.68 (day 0) to 3.52 (day 21). Pal and Agnihotri (1996) reported 2.06 to 2.21% ash in chevon sausages. Ash increased with increased in protein content. Similar trend was observed for ripened and stored sausages (Summo *et al.*, 2006).

Microbiological Properties of Smoked Chevon Sausages

Effect of smoking and vacuum packaging on microbial counts (log CFU g^{-1}) of chevon sausages stored at 4±1°C, were presented in Table 8. Overall SPC, psychrotrophic bacteria count (PBC) and lactic acid bacteria (LAB) counts were log 5.86, 5.00 and 4.24 CFU g^{-1}, respectively. On day 0,

Table 8: Effect of smoking and vacuum packaging on microbial counts (log CFUg^{-1}) of chevon sausages stored at 4±1°C

		Storage period in days				
Traits	Treatment	0	7	14	21	Treatment Means±SE
Standard plate	AP	4.83±0.09	5.35±0.24	6.13±0.31	6.27±0.23	5.64±0.34^{A}
Count	VP	4.83±0.09	6.07±0.23	6.52±0.24	6.80±0.22	6.07±0.44^{B}
	Storage period Mean±SE	4.83±0.00^{a}	5.71±0.36^{b}	6.33±0.20^{c}	6.56±0.27^{c,d}	5.86±0.27*
Psychrotrophic	AP	4.54±0.21	4.96±0.26	5.20±0.30	5.09±0.05	4.94±0.15
bacteria counts	VP	4.54±0.21	5.00±0.38	5.45±0.20	5.24±0.08	5.06±0.20
	Storage period Mean±SE	4.54±0.00^{a,b}	4.98±0.02^{b,c}	5.32±0.12^{c}	5.16±0.08^{b,c}	5.00±0.11*
Lctic acid	AP	3.76±0.20	3.43±0.33	5.12±0.29	5.20±0.24	4.38±0.46
bacteria counts	VP	3.76±0.20	2.73±0.49	4.42±0.56	5.32±0.21	4.10±0.55
	Storage period Mean±SE	3.76±0.00^{a}	3.08±0.35^{a}	4.77±0.35^{b,c}	5.35±0.06^{C}	4.24±0.34*
Coliforms	AP	Nil	0.48±0.31	1.64±0.63	Nil	ND
	VP	Nil	1.02±0.50	2.25±.53	2.41±0.38	ND
Yeast and	AP	1.3±0.11	<1	<1	1.25±0.43	ND
mould counts	VP	1.3±0.11	Nil	1.05±0.33	<1	ND

Each value under the head storage period in days is mean (±SE) of 8 observations; For SPC values are means of 12 observations; *Values are overall means (±SE) for each trait; ^{a}ANOVA was not done because the counts were <10 on different storage days; ND = Not Done; Storage period means bearing uncommon superscripts (small letter) in each cell of a row differ ($p<0.01$);Treatment means bearing different superscripts (capital letter) for each trait differ ($p<0.01$)

coliforms were not detected. As the storage period advanced their counts increased. On day 21, coliforms were not detected. Consistent pattern for yeast and mould counts were not observed. On day 14 of storage visible growth of moulds were detected in AP packed sausages.

Freshly prepared sausages had SPC counts of log 4.83 CFU g^{-1}. Agnihotri and Pal (2000) reported log 4.52 CFU g^{-1} in steam-cooked chevon sausages. Fresh chevon patties had a SPC of log 5.98 CFU g^{-1} (Rajkumar *et al*., 2004). Lower values in the present study were due to smoking. Smoking and packaging significantly ($p<0.01$) influenced SPC. VP packed sausages had higher (log 6.07) SPC than AP (log 5.64) packed sausages. To identify day of spoilage, SPC values were plotted in a graph. Trend line was drawn and SPC of log 6.00 is taken as standard and a perpendicular line was dropped from this point of X-axis on the trend line to Y-axis to find the day of spoilage. Calculation revealed that AP nuggets were spoiled on Day 15 and VP spoiled on day 10. Overall spoilage based on storage period mean was day 12. In contrast visible yeast and mould growth on the surface of the sausage was observed on day 14. In case of VP sausages minimum standard for spoilage (log 6.00) crossed on day 7 (log 6.07). As per the trend line it was on day 10. As the storage period advanced significant ($p<0.01$) increase in SPC counts were noticed. On day 0 it log 4.83, which increased on day 21 to log 6.56 CFU g^{-1}. Mandal *et al*. (2002) reported that restructured cured chicken stored at refrigeration was remained acceptable up to day 10 of storage. Rajkumar *et al*. (2004) reported that chevon patties stored at refrigeration temperature had a shelf-life of 15 days. They reported that SPC was initially log 5.98 CFU g^{-1} and significantly declined on day 25 of storage. This trend was due to oven cooking as against simmering (moist heat) adopted for cooking of sausage. Biswas *et al*. (2003) reported significantly ($p<0.05$) increasing trends of SPC up to day 28. Shelf-life was more due to low (log 2.19) initial SPC.

Packaging method had no influence on psychotropic bacterial counts (PBC). VP sausages had non-significantly higher (log 5.06) PBC than AP sausages (log 4.94). As storage period advances significant increase ($p<0.01$) in PBC were recorded. On day 0 PBC was log 4.54, which gradually increased to log 5.16 CFU g^{-1} on day 21. Results are in accordance with the results obtained by Biswas *et al*. (2003) for enrobed pork patties stored under refrigeration. Agnihotri and Pal (2000) stated that psychotropic count increased from log 3.99±to 4.32±0.21 CFUg^{-1} due to phosphate treatment in steam-cooked sausages. Lower values in the latter study may be due to better hygiene. Kumar and Sharma (2003) reported that ground pork patties had significant linear increasing trend from day 0 to 21 for psychrotrophs and was due to improper handling during experiment. Rajkumar *et al*. (2004) reported that fresh patties had initial count of log 4.13, which increased to log 4.35 on day 25.

Treatment had no influence on Lactic Acid Bacteria (LAB) counts. VP sausages had lower (log 4.10) LAB than AP sausages (log 4.38). As the storage advances LAB counts were increased significantly ($p<0.01$). On day 0 it was log 3.76, which steadily increased to log 5.35 on day 21 except on day 7 (log 3.08). Babji *et al*. (2000) reported that LAB count significantly decline from 7 to 28 days in vacuum-packed goat meat at refrigerator storage. This may be due to fresh meat used in the latter study. Decline in LAB counts was observed in chevon patties as storage period advanced under refrigeration (Rajkumar *et al*., 2004). The difference might be due to the method of cooking followed. In the latter study smoke oven cooking was done.

Coliforms and yeast and mould counts were either not detected by the method used or when detected were very low in numbers indicating uniform and better sanitary measures adopted during processing of patties. The low coliform and yeast and mould counts were in accordance with Sutherland *et al*. (1975) on vacuum-packed beef and with Babji *et al*. (2000) on vacuum-packed minced goat meat. Rajkumar *et al*. (2004) reported low coliform count in chevon patties during storage under refrigeration due to better sanitary measures. Biswas *et al*. (2003) reported that coliform was not detected at experimental time due to good hygienic condition during preparation of pork patties. Rajkumar *et al*. (2004) and Biswas *et al*. (2003) reported yeast and mould in meat product. Overall counts were less than 10. Spores present in the spices and other non-meat ingredients added counts to the final product.

Sensory Evaluation Scores of Smoked Chevon Sausages

Sensory evaluation scores of smoked chevon sausages are presented in Table 9. On day 14 sensory evaluations was not done because the product showed symptoms of spoilage. Overall scores for general appearance, colour, flavor, texture, juiciness and overall acceptability were 7.6, 7.6, 7.5, 6.7, 7.1 and 7.5, respectively. Storage period mean significantly ($p<0.01$) effected colour, juiciness and overall acceptability but texture was significantly ($p<0.01$) effected on 0 and 7th day in vacuum packed. Kondaiah and Panda (1991) reported that addition of phosphates in chicken sausages result better scores for appearance, flavor, juiciness and overall acceptability. Agnihotri (2002) reported that

Table 9: Sensory scores of smoked and vacuum-packed chevon sausages stored at 4±1°C

		Storage period in days				
Traits	Treatment	0	7	14	21	Treatment Means±SE
General	AP	7.6±0.2	7.6±0.2	ND	ND	7.6±0.0
appearance	VP	7.6±0.2	7.7±0.2	ND	ND	7.6±0.1
	Storage period Mean±SE	7.6±0.0	7.7±0.0	ND	ND	7.6±0.0*
Colour	AP	7.4±0.2	7.8±0.2	ND	ND	7.6±0.2
	VP	7.4±0.2	7.8±0.2	ND	ND	7.6±0.2
	Storage period Mean±SE	7.4±0.0[a]	7.8±0.0[b]	ND	ND	7.6±0.1*
Flavor	AP	7.5±0.2	7.5±0.2	ND	ND	7.5±0.0
	VP	7.5±0.2	7.2±0.2	ND	ND	7.4±0.2
	Storage period Mean±SE	7.6±0.0	7.4±0.2	ND	ND	7.5±0.1*
Texture	AP	6.2±0.3	7.1±0.1	ND	ND	6.7±0.4
	VP	6.2±0.3[a]	7.1±0.2[b]	ND	ND	6.7±0.4
	Storage period Mean±SE	6.2±0.0	7.1±0.0	ND	ND	6.7±0.3*
Juiciness	AP	6.7±0.2	7.5±0.2	ND	ND	7.1±0.4
	VP	6.7±0.2	7.5±0.3	ND	ND	7.1±0.4
	Storage period Mean±SE	6.7±0.0[a]	7.5±0.0[b]	ND	ND	7.1±0.2*
	VP	7.3±0.2	7.7±0.2	ND	ND	7.5±0.2
	Storage period Mean±SE	7.3±0.0[a]	7.7±0.0[b]	ND	ND	7.5±0.1*

Each value under the head storage period in days is mean (±SE) of 20 observations; *Values are overall means (±SE) for each trait; Storage period means bearing uncommon superscripts (small letter) in each cell of a row differ ($p<0.01$) and for colour ($p<0.05$); # Sensory evaluation was not done because on day 14, the product showed symptoms of spoilage

flavor increased in croquettes due to egg yolk malange with phosphate. General appearance and flavor was not significantly effected neither storage period means nor treatment means. Expect general appearance and flavor all were significantly affected ($p<0.01$) by storage period means. The results are in agreement with the results obtained by Agnihotri and Pal (2000) for steam-cooked sausages.

CONCLUSIONS

The research was undertaken with the key objective to evaluate the physico-chemical, proximate composition and shelf-life of smoked chevon sausages during storage at 4±1°C. Cooked sausages were filled in HDPE bags and stored at 4±1°C. The cooking yield (%) and cholesterol (mg per 100 g of sausages) content of fresh smoked chevon sausages was 73.50 and 98.74, respectively. Physico-chemical and microbiological properties were analysed on day 0, 7, 14 and 21. Overall water activity, pH and shear force values were 0.972, 6.41 and 3.20, respectively. Overall moisture, fat, protein and ash contents were 55.48, 17.05, 18.36 and 3.00%, respectively. In microbial analysis overall SPC, PBC and LAB were log 5.86, 5.00 and 4.24 CFU g^{-1}, respectively. Over all spoilage based on storage period mean was day 12 but yeast and mold growth visible on the surface of sausage on day 14. Smoking and vacuum packaging of spent goat chevon sausages has some beneficial effect on pH, protein, SPC and sensory scores but did not extend the shelf -life. In light of the observations, it can be concluded that vacuum packaging has no definite advantage in preserving quality and sensory attributes. Product can be stored under refrigeration up to seven days irrespective of packaging condition.

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