JOURNAL OF PURE AND APPLIED MICROBIOLOGY, Sept. 2016. Vol. **10**(3), p. 2135-2144

Microbiological, Physiochemical, Proximate and Sensory Attributes of Rabbit Meat Substituted Chevon Patties

P. Singh, Arvind Kumar, S. Dua, T. Tanwar, S.B. Kamal and F. Raja

Division of Livestock Products Technology, Faculty of Veterinary Sciences and Animal Husbandary, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Jammu - 181 102, India.

(Received: 10 April 2016; accepted: 14 May 2016)

The present study was undertaken to utilize and popularize rabbit meat quality nutritionally by substituting it in other popular meat products viz. rabbit meat substituted chevon patties. Chevon and rabbit meat in the ratio of 50:50 were found to be the most suitable for the preparation of rabbit meat substituted chevon patties on the basis of proximate and sensory analysis. Replacement of chevon with rabbit meat resulted in significantly ($p<0.05$) lower ash and fat percent however significantly ($p<0.05$) higher in dietary protein and moisture. During refrigerated storage (4 ± 1^0 C) of rabbit meat substituted at 50% in chevon patties were found acceptable up to 14 days on the basis of physico-chemical (TBA, FFA) and sensory parameters analysis. The total plate count, total psychrophillic count, total coliforms count, total yeast and mould count were also within acceptable limit till 14th day of refrigeration temperature in developed rabbit meat substituted chevon patties. Meat and meat products can be modified by substitution and are considered beneficial for health. The use of rabbit meat and chevon in meat products offers processors the opportunity to improve the nutritional and functional qualities of their meat products.

Keywords: Microbiological quality, Rabbit meat, Rabbit meat substituted chevon patties, proximate analysis, sensory evaluation, Storage quality attributes.

Consumer attitudes toward meat have changed dramatically in the past decade, and today consumers are demanding meat products that are convenient and healthful. Health conscious consumers associated diet with the probability of occurrence of health problems such as hypertension, cancer and cardiac disease. Increased health concerns have resulted in a shift away from high-fat, high-protein diets to low fat, low protein and high mineral diets (Furnols and Guerrero, 2014). Overall, per capita consumption of red meat and poultry has not changed significantly, but when beef, pork, mutton, chevon and chicken are examined separately, red meat appears to be losing market share to white meat (Resurreccion, 2003). The development of low-fat products is another strategy to increase the consumption of red meat. Continued interest and demand exists for low and reduced fat meat products which are being developed in response to health concerns of consumers. The red meat industry is now at a mature stage where product development and innovation are necessary to bring about significant demand growth. As a result of these changes, interest in new red meat products, particularly convenience oriented products has dramatically increased in recent years **(**Yang, *et al*., 2011). Goat meat viz. chevon is used for preparation of comminuted meat products. Since the cost of chevon is high and there is high fat and

* To whom all correspondence should be addressed.
Mob.: +91-9419794846;
E-mail: drarvindlpt@gmail.com

cholesterol level with respect to rabbit meat which can be matter of worry for cardiac patients and other health conscious people. The goaty flavour of chevon is also a hurdle in disposal of chevon made product in the market. So rabbit meat substitution can be a better option for producing an economic, low calorie, low cholesterol and stable product. The nutritive value of rabbit meat has an increasing importance in determining meat quality and consumer acceptability. Rabbit meat is a major source of animal proteins, essential amino-acids, B complex vitamins, minerals, and other bioactive compounds. However, meat is also a major source of saturated fatty acids and cholesterol and its consumption can lead to lifestyle and degenerative diseases (Valsta, *et al*., 2005). Therefore, different strategies can be effectively used bioactive compounds in order to produce nutraceutical grade functional meat and meat products using rabbit meat **(**Jimenez-colmenero, *et al*., 2006**)**. Rabbit meat is a lean meat rich in proteins of high biological values, with poly unsaturated lipids and low cholesterol content. Also, it has low content of sodium and a high content of phosphorus, and good source of B complex vitamins (Petracci, *et al*., 2009). Rabbit meat consumption could become best way to provide high levels of ù3 PUFA in human diet and thereby reducing the occurrence of lifestyle and other degenerative diseases, CLA and Vitamin E (Nuchi, *et al*., 2007). In addition, both selenium and iron are also responsive to dietary supplementation. Preparation of mixed-meat sausages resulted in a low-fat product, better water-holding capacity, nutritional and textural profiles (Corino, *et al*., 2002). So, Keeping in view of all nutritional and physico-chemical qualities of both chevon and rabbit meat, the objective of this study is to develop a designer rabbit meat substituted chevon meat product. The present study is to evaluate the changes in physico-chemical, proximate, sensory and storage profiles of chevon patties substituted with rabbit meat.

MATERIALS AND METHODS

Source of materials

Chevon meat is obtained of (Bhakerwal) and rabbit meat is obtained of (New Zealand White) breeds. The chevon and rabbit meat was bought and deboned manually after trimming the fat. The lean meat was packed in polythene bags and frozen at -18±2°C until use. The body fat was trimmed and deboning of dressed chevon and rabbit meat was done and packed in LDPE bags, kept in frozen condition at (-18±2°C) until use. All the chemicals incorporated in developed product were of food grade and those used in analysis were of analytical grade. Low-density polyethylene films (2 mm gauge) were used for aerobic packaging during refrigeration storage. Lean meat was cut into smaller chunks and minced in mincer with 6mm plate. The common salt, vegetable oil, refined wheat flour, nitrite, sodium tripolyphosphate, spice mixture and condiment mixture were added. Meat emulsion for patties was prepared in Sirman Bowl Chopper. Minced meat was blended with salt, sodium tripolyphosphate, sodium nitrite, ice flakes, refined vegetable oil, spice mixture, condiments and mixed to get the desired emulsion. Formulation of patties (%) were as lean meat- 68.7, Added water in form ice flakes-10.0, Vegetable oil-8.0, Condiment mixture-5.0, refined wheat flour-4.0, spice mixture-2.0, table salt-1.5, monosodium glutamate-0.5, sodium tripolyphosphate-0.3, sodium nitrite-120 ppm. Weighed quantity (65 g) of meat mix/emulsion in the form of a ball was taken, roughly made circular with hand and then gently spread evenly into a circular shaped patty of 3.5 cm in diameter with 12mm thickness**.** The molded raw patties were smeared with vegetable oil and cooked hot air oven at 180±2°C for a total time of about 16 minutes. The internal temperature of patties was monitored by a thermometer and cooked to an internal temperature of 80±2^{0}C for chevon and 78±2^{0}C for rabbit meat patties. The patties were removed from the plates, cooled to room temperature and weighed. Pooled sample of each treatment was assigned for analysis.

Analytical procedures

The pH of raw emulsion soon after its preparation and cooked patties was determined by the method of Keller *et al*., (1974) using digital pH meter. The weight of each patty was recorded before and after cooking to obtain cooking yield. Emulsion stability of meat emulsion was determined as per procedure described by Townsend *et al*., (1968).Proximate Composition viz. moisture, fat, ash and protein content of patties were determined by standard methods using hot air oven, soxhlet extraction apparatus, muffle furnace and Kjeldahl

assembly respectively (AOAC, 1995).Thio barbituric acid (TBA) of patties, during storage was determined using the method of Witte *et al.*, (1970).Free Fatty Acid (FFA) was determined by method of US Army laboratories (Natick) described by Koniecko (1979). Microbiological profile viz. total plate count, psychrotropic count, coliform , yeast and mold count in the sample were determined by method described by APHA (1984).Sensory attributes viz: appearance, flavour, juiciness, texture and the overall acceptability of fresh and stored samples using 8 point descriptive scale (Seman *et al*., 1987). Statistical Analysis viz. Mean and standard errors were calculated for different parameters. Factorial design of experiment was fallowed. Analysis of variance was performed as per Snedecor and Cochran (1980). In significant effects, least significant differences were calculated at appropriate level of significance for a pair wise comparison of treatment means.

Experimental Design

The patties made of chevon and rabbit meat were standardized and optimized for its preparation. The chevon meat was substituted with rabbit meat at the rate of 5, 10, 15% for the preparation of rabbit meat substituted chevon patties. The prepared product was analyzed for physic-chemical, sensory and microbiological profile. Further the product was studied for its storage quality parameters viz. TBARS, FFA, physicochemical, sensory and microbiological profile at refrigeration temperature of (4 ± 1^0C).

RESULTS AND DISCUSSION

Effect rabbit meat substitution on the physiochemical properties and sensory attributes in raw and cooked chevon patties

The mean values of various physico-chemical parameters and mean sensory scores of oven roasted chevon patties incorporated with varying levels of rabbit meat are presented in Table-1 and Table-2. There was a significant ($P<0.05$) gradual decrease in pH with increase in level of substitution of rabbit meat in chevon patties. Cooking yield was also significantly ($P<0.05$) increased with increase in rabbit meat substitution. This was found in agreement with Arun *et al*., (2010) who observed that there was decrease in pH of rabbit meat nuggets by sodium alginate replacement. There was significantly higher ($p<0.05$) cooking yield of control than treated products, however, among treated products cooking yield did not differ ($p>0.05$). Lower emulsion stability among treated products might have attributed to reduced cooking yield. This was found in agreement with Ruiz-Capillas *et al*., (2012) who observed that there was decrease in cooking yield while working on konjac gel as pork backfat replacer in dry fermented sausages. However this was in contrast to Pinero *et al*., (2008) who observed significant improvement in cooking yield in low fat beef patties by incorporating oat. A gradual increase in moisture was recorded and was significantly higher ($p<0.05$) at all substituted levels as compared to control. Protein content of developed patties was decreased significantly ($P<0.05$) with the substitution, however reduction was significant ($p<0.05$) between the variants prepared by incorporation of rabbit meat at all levels. A gradual decrease in fat was recorded and was significantly low ($p<0.05$) at all substituted levels as compared to control. Ash percentage was significantly lower ($p<0.05$) at all incorporation levels as compared to control. There was significant difference ($p<0.05$) in the moisture percent between control and other prepared patties that were substituted by rabbit meat. The moisture percent of the treated products increased concomitantly with the increase in the levels of rabbit meat substitution and significant effect ($p<0.05$) was observed upto 75% substitution. Rabbit meat is a lean meat rich in proteins of a high biological value and it is characterized by high levels of essential amino acids (Dalle Zotte, 2004).So, this increase in substituted patties may be attributed due to the high content of protein in rabbit meat then the chevon. Fat percent showed a significant decline ($p<0.05$) with the increase in the percentage of substitution. This was found in agreement with Yilmaz (2004) who observed that rye bran addition at the level of 20% resulted in reduction of fat content of meatballs. The amount of linolenic acid is also remarkably abundant in rabbit meat (3%), (Hernández and Gondret, 2006) in comparison with those reported in other meats (1.37 in lamb, 0.70 in beef and 0.95 in pork (Enser *et al*., 1996). Ash percent showed a significant decline ($p<0.05$) at all incorporation levels as compared to control. This was in agreement with the findings

of (Mendoza *et al*., 2001) in low fat dry fermented sausages incorporated with inulin as fat substitute in low fat, dry fermented sausages.

Sensory attributes of cooked chevon Patties substituted with Rabbit meat

Table 2 revealed a significant ($p<0.05$) influence on flavour, texture and overall acceptability of developed patties as a result of substitution with rabbit meat. Appearance score showed a gradual decline but were comparable to control at 25% level. Flavour and juiciness scores showed a gradual decline but 25% and 50% levels are comparable. The texture scores showed decreasing trend when compared to control. Overall acceptability of product was significantly lower($p<0.05$) at control and 25% levels of rabbit meat substitution, while at 50% level of substitution the developed patties are more acceptable whereas the 75% level of substitution is least acceptable. It also revealed a significant ($p<0.05$) influence on flavour, texture and overall acceptability of patties as a result of substitution with rabbit meat. This relationship was also observed by other authors in various meat and meat products. Such a decline in texture was also supported by findings of Huang *et al*., (2005). Olusegun *et al*., (2007) and Gadiyaram *et al*., (2004) studied the rheological properties of low fat or fat replaced chevon meat sausages and concluded that there is enhancement in all sensory scores including all textural properties with incorporation of chevon meat in mixed meat sausage.

Storage quality and shelf life of rabbit meat substituted chevon patties, chevon patties and rabbit meat Patties at refrigeration temperature (4±1^{0}C)

The different physico-chemical, proximate, microbiological and sensory properties of patties from chevon, rabbit meat and chevon (50%) substituted with rabbit meat were aerobically

Table 1. Effect of Rabbit meat substitution on pH, emulsion stability, cooking yield and proximate composition of cooked chevon Patties substituted with rabbit meat. (Mean ± SE)*

Parameters	Levels of rabbit meat (%)			
	0	25	50	75
pH	6.78^{d} ±0.18	6.57^{c} ±0.22	6.47^{b} ±0.31	6.40^{a} ±0.21
Emulsion Stability (%)	85.67^{a}±19.04	86.84^{b} ±17.05	88.68^{c} ±11.05	88.01^{d} ±14.03
Cooking Yield (%)	85.15^{a}±21.06	85.27^{b} ±18.07	86.12^{c} ±15.05	86.85^{d} ±19.09
Moisture (%)	59.72^{a}±9.02	61.53^{b} ±8.10	62.31^{c}±9.07	63.05^{d} ±7.02
Protein (%)	20.49^{a}±3.02	21.37^{b} ±5.05	22.24^{c}±4.03	22.95^{d} ±6.05
Fat (%)	12.50^{a}±0.21	12.07^{b} ±0.33	11.78^{c}±0.26	11.25^{d} ±0.37
Ash (%)	2.49^{d}±0.02	2.14^{c} ±0.03	2.05^{b} ±0.02	1.99^{a} ±0.04

*Mean SE with different superscripts in a row differs significantly ($P<0.05$). n = 6 for each treatment

Table 2. Effect of Rabbit meat substitution on sensory attributes of cooked chevon Patties (Mean ± SE)*

Sensory attributes	Levels of rabbit meat (%)			
	0	25	50	75
Appearance	7.42^{b}±0.08	7.41^{b}±0.18	7.45^{c}±0.14	7.11^{a}±0.11
Flavour	7.42^{c}±0.16	7.35^{b}±0.35	7.38^{b}±0.26	7.01^{a}±0.15
Juiciness	7.31^{b}±0.08	7.35^{c}±0.16	7.37^{c}±0.11	7.16^{a}±0.18
Texture	7.35^{d}±0.17	7.43^{c}±0.06	7.39^{b}±0.07	7.18^{a}±0.10
Overall acceptability	7.41^{b}±0.06	7.39^{b}±0.15	7.49^{c}±0.16	7.21^{a}±0.28

*Mean SE with different superscripts in a row differs significantly ($p<0.05$). Mean values are scores on 8 point descriptive scale where 1- extremely poor and 8- extremely desirable. n = 21 for each treatment

packaged in low density polyethylene (LDPE) pouches and were analyzed at a regular interval of 0, 7, 14 and 21 days during refrigerated storage at 4±1^{0}C as presented in Table-3.Substitution with rabbit meat had a significant ($p<0.05$) effect on the pH values in all treated samples. The effect of

Table 3. Effect of refrigerated storage on proximate composition, storage quality and microbiological profile of aerobically packaged cooked rabbit meat substituted chevon patties, chevon patties and rabbit meat Patties.(Mean ± SE)*

Treatments	Storage period (Days)			
	0	7	14	21
Moisture (%)				
RMSCP	62.35^{dB} ± 4.04	61.15^{cB} ±5.16	60.22^{bB} ±4.36	59.79^{aB} ± 5.07
CP	59.20^{dA} ±4.02	58.03^{cA} ± 4.28	57.34^{bA} ± 5.02	56.79^{aA} ±4.87
RMP	63.05^{dC} ± 3.26	62.52^{cC} ±3.39	61.04^{bC} ±4.46	60.51^{aC} ±5.19
Protein (%)				
RMSCP	21.91^{aB} ± 2.13	22.84^{bB} ± 2.06	23.36^{cB} ± 2.10	23.95^{dB} ± 3.07
CP	20.28^{aA} ± 3.05	20.81^{bA} ±4.07	21.30^{cA} ±2.09	21.93^{dA} ± 2.18
RMP	23.09^{aC} ± 1.07	23.67^{bA} ± 6.09	24.05^{cC} ± 3.10	24.05^{dC} ± 3.11
Fat (%)				
RMSCP	11.55^{aB} ±1.14	11.86^{bB} ±2.18	11.14^{cB} ± 1.16	10.85^{dB} ± 1.19
CP	12.05^{aA} ± 1.09	12.42^{bA} ± 3.15	12.86^{cA} ±2.16	13.25^{dA} ±2.21
RMP	10.45^{aC} ± 2.14	10.81^{bC} ± 4.17	11.09^{cC} ± 1.08	11.39^{dC} ± 1.31
Ash (%)				
RMSCP	2.08^{aB} ± 0.05	2.40^{bB} ± 0.06	2.77^{cB} ±0.07	3.04^{dB} ± 0.09
CP	2.14^{aC} ± 0.05	2.56^{bC} ±0.04	2.80^{cB} ±0.15	3.08^{dB} ± 0.08
RMP	1.73^{aA} ± 0.05	2.01^{bA} ± 0.15	2.39^{cA} ± 0.06	2.79^{dA} ± 0.07
pH				
RMSCP	6.53 ± 0.52^{dB}	6.56 ± 0.53^{bB}	6.59 ± 0.74^{cB}	6.60 ± 0.63^{cC}
CP	6.48 ± 0.81^{dA}	6.31 ± 0.32^{cA}	6.28 ± 0.52^{bA}	6.25 ± 0.33^{aA}
RMP	6.78± 0.61^{dC}	6.71± 0.43^{cC}	6.64± 0.33^{bA}	6.57± 0.54^{aB}
FFA (% Oleic acid)				
RMSCP	0.093^{aB} ± 0.03^{a}	0.103^{bA} ± 0.03	0.116^{cA}±0.03	0.147^{dB} ± 0.04
CP	0.098^{aC} ± 0.04	0.106^{bB} ±0.02	0.121^{cB}± 0.02	0.168^{dC} ± 0.02
RMP	0.089^{aA} ± 0.05	0.102^{bA} ± 0.06	0.115^{cA} ± 0.05	0.141^{dA} ± 0.03
TBA (mg Malonaldehyde/Kg.)				
RMSCP	0.20± 0.01^{aA}	0.57 ± 0.01^{bA}	0.79± 0.01^{cA}	0.95 ± 0.02^{dA}
CP	0.29 ± 0.0 ^{aC}	0.68 ± 0.01^{bB}	0.89 ± 0.01^{cC}	1.07 ± 0.01^{dC}
RMP	0.24± 0.02^{aB}	0.59 ± 0.03^{bA}	0.83 ± 0.02^{cB}	0.99 ± 0.02^{dB}
Total plate count (log cfu/g)				
RMSCP	2.42^{aA} ±0.14	3.13^{bA} ±0.15	4.08^{cA} ± 0.14	4.93^{dA} ± 0.13
CP	2.59^{aB} ±0.17	3.49^{bC} ±0.15	4.35^{cC} ± 0.14	5.18^{dC} ± 0.14
RMP	2.40^{aA} ± 0.17	3.22^{bB} ±0.14	4.26^{cB} ± 0.13	5.06^{dB} ± 0.13
Psychrotrophic count (log cfu/g)				
RMSCP	Not detected	Not detected	1.96^{aA} ± 0.16	2.89^{aB} ± 0.15
CP	Not detected	Not detected	2.08^{bA} ± 0.17	3.07^{bB} ± 0.13
RMP	Not detected	Not detected	2.26^{cA} ± 0.16	3.24^{cB} ± 0.14
Yeast and Mould count (log cfu/g)				
RMSCP	Not detected	Not detected	Not detected	1.69^{aA} ± 0.15
CP	Not detected	Not detected	1.86^{aA} ± 0.16	2.91^{cB} ± 0.13
RMP	Not detected	Not detected	Not detected	2.14^{bA} ± 0.14

*Mean SE with different superscripts in a row wise (Upper case alphabet) and column wise (Lower case) differ significantly ($p<0.05$).n = 6. RMSCP-Rabbit meat substituted chevon patties, CP-Chevon patties, RMP- Rabbit meat patties

storage was obvious as the pH of patties followed an increasing trend at progressive storage intervals. The mean pH values differs significantly ($p<0.05$) with each other on all days of storage except on 21st day whereas, these values were comparable between chevon and rabbit meat after 14 days of storage. The mean pH values of chevon, mutton and chevon patties substituted with rabbit meat varied significantly ($p<0.05$) on all days of storage. The increase in pH might be attributed to the increase in the microbial load that leads to formation of metabolites. The increase in pH was also reported by Sangtam *et al*., (2006). The decrease in pH in meat products also depended on the presence of fermentable carbohydrates. Gracia *et al*., (2002) also observed a similar decrease in pH of low-fat dry fermented sausages. Further, Fernandez-Gines *et al*., (2003) reported a similar trend in pH in bologna sausages. FFA followed a significant ($p<0.05$) linear increasing trend from day 0 to 21 in rabbit meat substituted patties. However a significant difference ($p<0.05$) in FFA values was observed between both treated as well as individual meat patties on 21st day of storage. Free fatty acids were the products of enzymatic or microbial degradation of lipids. Determination of FFA gives information about stability of fat during storage. These results are in good agreement with those reported by Marco *et al*., (2006) and Zanardi *et al*., (2004) in dry fermented sausages. Similar trend was observed by Nayak and Tanwar (2004) and Nagamallika *et al*., (2006) in rabbit meat patties. Similarly, Valeria *et al*., (2008) reported an increase in free fatty acids of dry fermented sausages (sobrassada). However lower values in present study was compared to those reported by above researches may be attributed to the presence of lower level of fat in all the products. TBA followed a significant ($p<0.05$) linear increasing trend from day 0 to 21. There was a significant difference ($p<0.05$) in the TBA values of rabbit meat substituted chevon, chevon and rabbit meat on most of the days of storage. TBA followed a significant ($p<0.05$) linear increasing trend from day

Table 4. Effect of refrigerated storage on sensory attributes of aerobically packaged cooked rabbit meat substituted chevon patties, chevon patties and rabbit meat Patties (Mean SE)*

Treatments	Storage period (Days)			
	0	7	14	21
Appearance				
RMSCP	$7.23^{aC} \pm 0.12$	$6.82^{bB} \pm 0.13$	$5.94^{cB} \pm 0.08$	$5.43^{dB} \pm 0.15$
CP	$7.15^{aB} \pm 0.08$	$6.81^{bB} \pm 0.08$	$5.82^{cA} \pm 0.07$	$5.31^{dA} \pm 0.06$
RMP	$7.08^{aA} \pm 0.12$	$6.74^{bA} \pm 0.11$	$6.09^{cC} \pm 0.04$	$5.50^{dC} \pm 0.16$
Flavour				
RMSCP	$7.16^{aB} \pm 0.10$	$6.72^{bB} \pm 0.10$	$6.39^{cC} \pm 0.08$	Not Tasted
CP	$7.19^{aC} \pm 0.13$	$6.71^{bB} \pm 0.12$	$6.33^{cB} \pm 0.08$	Not Tasted
RMP	$7.10^{aA} \pm 0.11$	$6.63^{bA} \pm 0.11$	$6.21^{cA} \pm 0.09$	Not Tasted
Texture				
RMSCP	$7.15^{aC} \pm 0.11$	$6.70^{bB} \pm 0.11$	$6.26^{cB} \pm 0.07$	$5.89^{dC} \pm 0.08$
CP	$7.08^{aA} \pm 0.10$	$6.61^{bA} \pm 0.10$	$6.21^{cA} \pm 0.09$	$5.62^{dA} \pm 0.15$
RMP	$7.11^{aB} \pm 0.10$	$6.63^{bA} \pm 0.12$	$6.27^{cB} \pm 0.06$	$5.69^{dB} \pm 0.15$
Juiciness				
RMSCP	$6.98^{aA} \pm 0.03$	$6.35^{bA} \pm 0.07$	$5.94^{cA} \pm 0.07$	Not Tasted
CP	$6.97^{aA} \pm 0.01$	$6.38^{bA} \pm 0.06$	$6.11^{cB} \pm 0.08$	Not Tasted
RMP	$7.08^{aB} \pm 0.04$	$6.54^{bB} \pm 0.05$	$6.43^{cC} \pm 0.06$	Not Tasted
Overall acceptability				
RMSCP	$7.09^{aC} \pm 0.14$	$6.27^{bB} \pm 0.10$	$5.92^{cC} \pm 0.12$	$5.59^{dC} \pm 0.11$
CP	$7.01^{aB} \pm 0.10$	$6.25^{bB} \pm 0.06$	$5.80^{cB} \pm 0.10$	$5.28^{dB} \pm 0.14$
RMP	$6.98^{aB} \pm 0.11$	$6.14^{bA} \pm 0.09$	$5.72^{cA} \pm 0.09$	$5.07^{dA} \pm 0.14$

*Mean SE with different superscripts in a row wise (Upper case alphabet) and column wise (lower case alphabet) differ significantly ($p<0.05$).n= 21.RMSCP- Rabbit meat substituted chevon patties, CP- Chevon patties, RMP- Rabbit meat patties

0 to 21 in all types of patties. The values of TBA are comparable among chevon and rabbit meat on 7 th day difference among mutton and chevon and rabbit meat exists throughout the storage period. The increase in TBA values on storage might be attributed to oxygen permeability of packaging material that led to lipid oxidation. Kumar and Sharma (2004) have also reported an increase in TBA values with increasing storage period while working on low fat ground pork patties and in dry fermented sausages Valeria *et al*., (2008).

Proximate composition

The mean moisture values showed significant difference ($p<0.05$) and the moisture content decreased with increasing storage days. The difference ($p<0.05$) was significant among the different types of developed patties also. The mean protein values showed significant difference ($p<0.05$) and the protein content increased with increasing storage days. The mean fat values of patties significant difference ($p<0.05$) and the fat content increased with increasing storage days. The difference ($p<0.05$) was significant among the different types of developed patties. The mean ash values of treatment products as well as control showed a significant increasing trend throughout the period of storage. Rao and Reddy (2000) has also reported an increase in moisture values with decreasing storage period. Kumar and Sharma (2004) have also reported similar trend in proximate values during storage period while working on low fat ground pork patties.

Microbiological Characters

Total plate count increased from day 0 to 21 in treated products and control. TPC count of rabbit meat substituted patties showed significance difference ($p<0.05$). The TPC significantly ($p<0.05$) differed with the increase in storage period. Total plate count followed a significant ($p<0.05$) linear increasing trend from day 0 to 21 in all types of patties. A difference among them also existed. The TPC is comparable among the chevon and rabbit meat patties substituted with 50% rabbit meat only in the starting (0 and 7) days of storage days but differed significantly ($p<0.05$) with the increase in storage period. The increase in TPC with increase in storage period was also reported in incorporation of rabbit meat, rabbit meat offal's and extenders in the preparation of mutton nuggets by (Sangtam *et al*., 2006). Similar findings were reported by (Kumar *et al*., 2007) in rabbit meat patties and according to them total plate count (TPC) increased at each storage interval both in control and extended patties.

Psychrotrophic counts were not detected till 7 days of storage in all products. But, it was observed on day 14 of storage in all types of patties. The counts for various patties were comparable with each other on day 14 of storage and the counts showed a significant increase on day 21 of storage. The counts of patties differed significantly ($p<0.05$) with each other on day 21 of storage. It might be due to increased possibility of ingress of microbes through extenders. The psychrotropic count always remained well below the maximum permissible limits in cooked meat products. A detectable count on day 14 while nil on preceding observations might be attributed to the fact that bacteria generally need some lag phase before active multiplication is initiated. A gradual increase in psychrotrophic counts during storage of rabbit meat products had also been reported by Kalaikanan, (1998).

The coliforms were not detected throughout the period of storage in both control and treated patties. The coliforms were not detected throughout the period of storage in both control and treated products. It could be due to the destruction of these bacteria during cooking at 78^0C, much above their death point of 57^0C. Further, hygienic practices followed during the preparation and packaging of patties could also be one of the reasons for the absence of coliforms. Kumar (2001) also reported zero count of coliform for the product heated to such a high temperature.

Yeast counts were not detected on day 0 and 7 of storage of chevon, mutton and rabbit meat patties substituted with rabbit meat. But, it was observed on day 14 of storage in all types of patties except developed mutton patties. The counts showed a significant increase on day 21 of storage. The counts of patties differed significantly ($p<0.05$) with each other on day 21 of storage. Kumar and Sharma (2004) have also reported similar trend in microbiological profile of low fat ground pork patties during storage period.

Sensory Parameters

It was observed that the substitution with rabbit meat significantly ($p<0.05$) affect the sensory attributes. All the sensory parameters showed

significant difference on all days of storage. However some of these attributes were comparable throughout the storage period. The overall acceptability was decreasing with increasing in storage periods. A progressive and significant decline for all sensory attributes was observed during the period of storage. The sensory attributes were significantly affected during 21 days of storage. All the sensory parameters viz., appearance, flavour, juiciness, texture and overall acceptability of patties followed a significant ($p<0.05$) descending trend with increase in storage days. The decrease in appearance scores might be due to pigment and lipid oxidation resulting in non-enzymatic browning. A decrease in appearance or colour score of rabbit meat products with increase in storage period was also reported by (Kalaikannan, 1998) and many others. A gradual decline of flavour might be due to the expected loss of volatile flavour components from spices and condiments on storage of meat products. The progressive decrease in flavour could be correlated to increase in TBA value of meat product stored under aerobic conditions. Decline in flavour scores of meat products during storage was reported in buffalo meat nuggets (Thomas *et al*., 2006). Juiciness scores followed a decreasing trend in patties substituted with rabbit meat during the period of storage. It could be due to some loss of moisture from the products during storage. The results were in accordance with findings of (Kaliakannnan, 1998) and many others. The lower textural scores found in control and treated products might be due to increased loss of water in them and subsequent reduction of pH and denaturation of proteins at low pH and degradation of muscle fiber protein by bacterial action, which resulted in decreased water binding capacity. The findings were similar to those of (Kumar, 2001).The flavor and juiciness parameters were not taken on 21st day due to high TBA and TPC value of the stored patties. The overall acceptability of substituted patties decreased significantly ($p<0.05$) after 7th day of storage. A significant ($p<0.05$) decrease in scores during last phase of study might be reflective of the decline in scores of flavour, juiciness and texture attributes. A significant ($p<0.05$) decrease in scores during last phase of study might be reflective of the decline in sensory scores. The microbiological profile was in the congruence with reports on development of low-fat and low-calorie beef sausage at refrigeration storage (Mohammadi and Oghabi 2012).

CONCLUSIONS

Incorporation of 9% refined vegetable oil, 4% refined wheat flour and an internal cooking temperature of 80±2^{0}C for chevon and rabbit substituted chevon patties and 78±2^{0}C for rabbit meat patties was found to be optimum for the formulation of the meat patties. Replacement of chevon with rabbit meat resulted in lower ash and fat percent, however higher in dietary protein and moisture.50:50 of both chevon and rabbit meat replacement was found to be the most suitable. During refrigerated storage of patties with substitution rabbit meat at 50% in chevon were found acceptable upto 14 days on sensory as well as microbiological parameters. Meat and meat products can be modified by rabbit meat substitution are considered beneficial for health. The use of rabbit meat in meat products offers processors the opportunity to improve the nutritional and health qualities of their products. Besides being prolific breeder and source of high quality protein; rabbit is known for their rapid growth rate, high fecundity, efficient feed conversion and desirable meat to bone ratio. The rabbit meat is having high percentage of digestible proteins. It contains least percentage of fat among all the available meat. It contains high amount of polyunsaturated fatty acids, which are not detrimental to heart. Rabbit meat is almost cholesterol free so heart patient can eat this meat instead of other meat available in the market. Chevon is having high myoglobin content provides a high level of bioavailable iron, cholesterol level. So it is forbidden in case of hypertensive and cardiac disorder patient. Hence a right combination of rabbit and chevon meat product is a solution to this problem and substitution of different meat can be important feature in meat processing.

ACKNOWLEDGEMENTS

All authors are very grateful to Dean, Directors and Vice-Chancellor of the University for providing funds and facilities for proper execution of present research work.

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