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Effect of Clove Oil on the Storage Quality of Aerobically Packaged Fiber-Enriched Chevon Cutlets

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ABSTRACT

A study was conducted to evaluate the potential of clove oil as a natural preservative in muscle foods by assessing its effect on the storage quality of fiber-enriched chevon cutlets. Chevon cutlets containing optimum level of the barley flour (4 percent) treated with and without clove oil (100 ppm) were aerobically packaged in low density polyethylene pouches along with control (chevon cutlets without barley flour and without clove oil - T_1, chevon cutlets with barley flour and without clove oil -T_2, chevon cutlets without barley flour and with clove oil - T_3 and chevon cutlets with barley flour and with clove oil - T_4) and evaluated for storage quality for 15 days under refrigerated conditions (4±1°C). The products were analyzed for various physico-chemical, microbiological and sensory parameters. TBARS value (mg malonaldehyde/kg), total plate count (log CFU/gm), psychrophillic count (log CFU/gm) and yeast and mould count (log CFU/gm) showed significant ($P<0.05$) increasing trend whereas pH and all the sensory parameters decreased significantly ($P<0.05$) with increasing days of storage. Coliforms (log CFU/gm) were not detected throughout the period of storage. The products containing clove oil showed significantly ($P<0.05$) lower values than control samples for various parameters like TBARS value, total plate count, psychrophillic count and yeast and mould count.

Keywords : *Cutlets, Chevon, Barley, Clove oil, Refrigerated storage*

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INTRODUCTION

Viewed as potential competitor to beef and mutton (Simela *et*

2008), chevon is red meat that is almost universally acceptable and free from cultural, traditional, social and economic conditions (Webb *et al*. 2005;Xazela *et al*. 2011). Although, chevon has been reported to have higher collagen and lower solubility than mutton and its intramuscular connective tissues remain unchanged during post-mortem ageing (Kannan *et al.* 2005), the problems of toughness and odour can be overcome by the processing (Hedrick *et al.* 1994; Lawrie 1995). Chevonis considered as one of the most favoured meats by the consumers and chevon products have been considered as high quality products on sensory analysis by the trained panellists (Simela *et al.* 2008) and have been considered for cultural activities (Mahanjana and Cronje 2000). Furthermore, as the health benefits of goat meat are becoming more widely known among the general population, the demand for this alternative low-fat red meat continue to increase. Thus, prospects of further developing certain chevon products like cutlets by extending with certain fiber rich ingredients, like barley, could find increasing popularity in food service industry particularly at fast food outlets.

Obtained from the flowers, stems and leaves of the clove tree (*Eugenia aromatica*), clove oil is a natural and a safe preservative that has been listed as a GRAS substance by the United States Food and Drug Administration at a level not exceeding 1500 ppm in all food categories (Kildeaa *et al.* 2004). Inhibitory activity of clove oil has been proven against important spoilage microorganisms of intermediate moisture foods (Matan *et al.* 2006). Keeping in view all the above facts the present study was envisaged to attempt the still inconclusive studies on utilization of clove oil as a natural preservative in the fiber-fortified chevon cutlets.

MATERIALS AND METHODS

Source of meat

The round part of adult *Bhakarwal* goat carcass was purchased from the market of Jammu. The body fat was trimmed and deboning was done manually by removing all the tendons and separable connective tissue. The lean meat was packed in polythene bags and stored under frozen conditions at -18 ± 2°C until use.

Fat

Refined cotton seed oil of brand name '*Sheerji*' was purchased from local market and used in emulsion preparation. It approximately contained 900 k.cal of energy, 0gm of carbohydrate, 0 gm of proteins, 0 gm of cholesterol, 16 gm of saturated fatty acids, 23.5 gm of mono-unsaturated fatty acids,

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60.5 poly-unsaturated fatty acids and 0gm of trans-fatty acids per 100 gm.

Condiment mixture

Condiments used were fresh onion, garlic and ginger. The external covering of all were peeled off and cut into pieces. The cut pieces were weighed in a ratio of 3:2:1 and ground in a mixer to the consistency of fine paste.

Spice mixture

The spice mix formula used for preparation of the chevon cutlets was standardized in the laboratory and contained aniseed (*Pimpinalla anisum*) 10%, coriander (*Coriandrum sativum*) 15%, cumin seed (*Cuminum cyminum*) 15%, black pepper (*Piper nigrum*) 10%, red chilli (*Capsicum frutescens*) 7%,caraway seed (*Trachyspermum copticum*) 5%, green cardamom (*Elettaria cardamomum*) 5%, white pepper (*Piper nigrum*) 5%, cardamom (*Amomum subulatum*) 5%, cinnamon (*Cinnamomum zeylanicum*) 5%, degimirch (*Capsicum annum*) 5%, turmeric (*Curcuma longa*) 5%, bay leaves (*Laurusnobilis*) 2%, cloves (*Syzygium aromaticum*) 2%, mace (*Myristica fragrans*) 2% and nutmeg (*Myristica fragrans*) 2%.

Barley flour of a commercial brand was purchased from the local market and used in the preparation of chevon cutlets at various levels viz. 0, 2, 4 and 6 percent replacing lean meat in the formulation. Based on the various physico-chemical and sensory parameters, 4 percent incorporation was optimized as best. The chevon cutlets containing 4 percent barley were further treated with clove oil and packaged aerobically within low density polyethylene pouches along with control samples and evaluated for storage quality for 15 days under refrigerated conditions.

Method of preparation of chevon cutlets

Several preliminary trials were conducted to optimize the basic formulation and processing conditions for the preparation of chevon cutlets. The standardized formulation contained lean meat 74%, added water 3%, shredded potato 5%, condiment mixture 10%, gram flour 2%, whole egg liquid 2%, spice mixture 2%, common salt 1.75%, sugar 0.25% and sodium nitrite 120 ppm.

Lean meat from round part of goat carcass was cut into smaller chunks and minced in a Sirman mincer (MOD-TC 32 R10 U.P. INOX, Marsango, Italy) with 6 mm plate twice. The common salt, sugar, sodium nitrite and added water in the form of crushed ice was added to weighed meat according to above formulation and was kept at refrigeration temperature (4 ± 1^0C)for 15-20 min. The mixture was shallow fat fried in 2.5 percent w/w refined oil for 8 min. The condiment and spice mixture was fried separately till golden brown colour. The fried meat, condiment and spice mixture, gram flour, shredded potato and whole egg liquid were mixed in a domestic mixer. The batter so formed was used in the preparation of raw cutlets by using moulds. The raw cutlets were kept at refrigeration temperature for 15-20 min and dipped in whole egg liquid and then rolled in rusk powder till uniform coating was formed on the surface and were deep fat fried in refined oil till golden brown colour. The internal core temperature was measured with the help of a thermometer (80 ± 2^0C) and the excess fat was removed from the fried cutlets by using tissue paper.

Analytical procedures

pH

The pH of chevon cutlets was determined by the method of Keller *et al.* (1974) using a digital pH meter (Systronics Digital pH Meter 803, serial No. 603).

Thiobarbituric acid reacting substances (TBARS) value

Thiobarbituric acid reacting substances (TBARS) value of cooked products during storage was determined using the method described by Witte *et al.* (1970).

Microbiological profile

Total plate count, psychrophilic count, coliform count and yeast and mold count were determined by methods described by APHA (1984). Readymade media (Hi-Media) were used for the analysis.

Sensory Evaluation

The sensory evaluation of the products was carried for various attributes namely colour and appearance, flavour, juiciness, texture and overall acceptability by a panel of seven trained members composed of scientists and research scholars of the division based on a 8-point hedonic scale, wherein 8 denoted "extremely desirable" and 1 denoted "extremely undesirable" (Seman *et al.* 1987).

Statistical analysis

Means and standard errors were calculated for different parameters. Data obtained in the study was analyzed statistically on 'SPSS-16.0' software package as per standard methods (Snedecor and Cochran 1994). Duplicate samples were drawn for each parameter and the experiment was replicated thrice (n=6). Sensory evaluation was performed by a panel of seven member judges three times, so total observations being 21 (n=21). Data was subjected to two way analysis of variance.

RESULTS AND DISCUSSION

The chevon cutlets incorporated with 4 per cent barley flour treated with and without clove oil were aerobically packed in low density polyethylene (LDPE) pouches along with control samples {chevon cutlets without barley flour and without clove oil (T_1), chevon cutlets with barley flour and without

clove oil (T_2), chevon cutlets without barley flour and with clove oil (T_3) and chevon cutlets with barley flour and with clove oil (T_4)}and evaluated for storage quality for 15 days at refrigeration temperature (4±1^{0}C).

Physico-chemical parameters

The mean values of various physico-chemical parameters of cooked chevon cutlets incorporated with 0 and 4 per cent level of barley flour with and without clove oil (100 ppm) during refrigerated storage (4±1^{0}C) are presented in Table 1.

pH

pH value followed a significant (P<0.05) decreasing trend with the advancement of storage period with lowest value on day 15th of the storage although, the decrease was non-significant (P>0.05) up to 5th day of the storage in all products. The probable reason may be due to presence of some fermentable carbohydrates in the product. Garcia *et al.*(2002) also observed a similar decrease in pH of low fat dry fermented sausages prepared with cereals and fruit fibers. Chang *et al.* (2010) reported a similar decrease in pH during storage in sausages treated with carrot and onion. Decrease in pH of meat products during storage due to fermentable carbohydrates was also reported by Borch *et al.* (1996). Incze (1992) reported that decrease in the pH values might be due to significant (P<0.05) increase in psychrophilic and lactobacillus count during storage period producing lactic acid by breakdown of carbohydrates.

Thiobarbituric acid reacting substances (TBARS) value (mg malonaldehyde/kg)

TBARS value followed a significant (P<0.05) increasing trend from day 0 to 15 for all treatments as well as control. The increase in TBARS value on storage might be attributed to oxygen permeability of packaging material that led to lipid oxidation (Brewer *et al.* 1992). Similar findings were reported by Reddy *et al.*(2014) in chicken meat sausages, Kumar and Tanwar (2011) in chicken nuggets, Sudheer *et al.* (2010) in restructured chicken block, Chidanandaiah *et al.* (2009) in meat patties, Ruban *et al.* (2008) in pork sausages, Reddy *et al.* (2008) in chicken nuggets, and Modi *et al.*(2003) in buffalo meat burger during refrigerated storage. TBARS value of products containing clove oil increased significantly (P<0.05) throughout the period of storage. However, the values of TBARS for clove oil enriched cutlets (T_3 and T_4) were significantly (P<0.05) lower than control nuggets (T_1 and T_2) on day 10 and onwards. A comparatively slow increase in TBARS values of cutlets incorporated with clove oil might be attributed to the antioxidant and antimicrobial effects of clove oil. Similar findings were reported by Das *et al.* (2013) in chicken nuggets containing fermented bamboo shoot and Banerjee *et al.* (2012) in goat meat nuggets containing broccoli powder extract.

Table-1 : Effect of clove oil (100 ppm) on the quality attributes of aerobically packaged chevon cutlets incorporated with barley flour at refrigerated storage (4±1^{0}C) (Mean± SE)*

Treatments	Storage period (Days)			
	0	5	10	15
		PH		
T_1	6.09±0.01^{C}	6.07±0.01^{C}	6.01±0.02^{B}	5.92±0.01^{A}
T_2	6.12±0.02^{C}	6.10±0.01^{C}	5.96±0.02^{B}	5.84±0.02^{A}
T_3	6.08±0.02^{C}	6.04±0.02^{BC}	5.97±0.02^{B}	5.96±0.02^{A}
T_4	6.11±0.02^{C}	6.08±0.01^{C}	5.92±0.02^{B}	5.88±0.01^{A}
		TBARS value (mg malonaldehyde/Kg)		
T_1	0.34±0.02^{A}	0.44±0.01^{B}	0.76±0.02^{Cb}	1.05±0.03^{Db}
T_2	0.28±0.01^{A}	0.37±0.02^{B}	0.67±0.01^{Cab}	0.98±0.02^{Db}
T_3	0.27±0.02^{A}	0.39±0.02^{B}	0.61±0.03^{Cab}	0.89±0.03^{Da}
T_4	0.22±0.02^{A}	0.32±0.02^{B}	0.56±0.03^{Ca}	0.80±0.02^{Da}

*Mean±SE with different superscripts in row (upper case alphabets) and column (lower case alphabets) differ significantly (P<0.05), n = 6 for each treatment;T1= Chevon cutlets without barley flour, without clove oil;T2 = Chevon cutlets with 4% barley flour, without clove oil;T3 = Chevon cutlets without barley flour, with clove oil;T4 = Chevon cutlets with 4% barley flour, with clove oil

Microbiological characteristics

The mean values of various microbiological characteristics of cooked chevon cutlets incorporated with 0 and 4 percent level of barley flour with and without clove oil (100 ppm) during refrigerated storage (4±1^{0}C) are presented in Table 2.

Total plate count (log cfu/gm)

A significant (P<0.05) effect of clove oil and storage period was observed on the total plate count of the products. A significant (P<0.05) increasing trend was observed with

advancement of storage in all the treatments as well as control. Similar observation was reported by Bhat *et al.* (2013a) in chicken *seekhkababs*, Bhat *et al.* (2013b) in chicken meat balls, Kumar and Tanwar (2011) in chicken nuggets, Chidanandaiah *et al.* (2009) in meat patties and Kumar *et al.* (2007) in chicken meat patties. Total plate count of clove oil enriched cutlets (T_3 and T_4) increased significantly ($P<0.05$) throughout the period of storage, however, the values were significantly ($P<0.05$) lower than control cutlets (T_1 and T_2) on all days of storage. A comparatively slow increase in total plate count of clove oil enriched cutlets might be attributed to the terpenoids in clove which are thought to exert inhibitory action against microorganisms through membrane disruption (Lambert *et al.* 2001). Inhibitory action of clove oil against various Gram-positive as well as Gram-negative bacteria in meat and meat products is reported (Mannie 1999).

Psychrophilic count (log cfu/gm)

Psychrophillic counts were not detected on day 0 of storage in all the products. Psychrophillic counts were observed from day 5 and followed a significant ($P<0.05$) increasing trend in clove oil enriched (T_3 and T_4) as well as control cutlets (T_1 and). However, the counts were significantly ($P<0.05$) lower in clove oil enriched products as compared to control. A detectable count on day 5 while no counts in preceding observations might be attributed to the fact that bacteria generally need some lag phase before active multiplication is initiated. Similar results were reported by Bhat *et al.* (2013a) and Bhat *et al.*(2011) in chicken *seekh kebabs* and Kumar *et al.* (2007) in chicken meat patties.

Coliform count (log cfu/gm)

The coliforms were not detected throughout the period of storage in all types of cutlets. It could be due to the destruction of these bacteria during cooking at high temperature, much above their death point of 57^0C. Further, hygienic practices followed during the preparation and packaging of products could also be one of the reasons for the absence of coliforms. Similar results were reported by Bhat *et al.* (2013a); Bhat *et al.* (2013b); Singh *et al.*(2011); Kandeepan *et al.* (2010) and Kumar and Sharma (2004) who also reported zero count of coliforms for different meat products heated to such a high temperature.

Yeast and mould count (log cfu/gm)

No yeast and moulds were detected up to 10^{th} day of storage both in the control (T_1 and T_2) as well as clove oil incorporated

Table-2: Effect of clove oil (100 ppm) on the microbiological quality of aerobically packaged chevon cutlets incorporated with barley flour at refrigerated storage (4±1^{0}C) (Mean±SE)*

Treatments	Storage period (Days)			
	0	5	10	15
		Total plate count (log cfu/gm)		
$_1$	2.20±0.01^{bA}	3.08±0.02^{bB}	3.98±0.02^{bC}	5.10±0.02^{bD}
$_2$	2.16±0.02^{bA}	3.00±0.02^{bB}	3.90±0.02^{bC}	5.00±0.01^{bD}
$_3$	2.01±0.01^{bA}	2.60±0.03^{bB}	3.21±0.01^{bC}	4.16±0.02^{bD}
$_4$	1.94±0.01^{bA}	2.53±0.02^{bB}	3.12±0.02^{bC}	4.05±0.02^{bD}
		Psychrophilic count (log cfu/gm)		
T_1	ND	1.86±0.03^{bA}	2.47±0.01^{bB}	3.53±0.03^{bC}
T_2	ND	1.80±0.02^{bA}	2.37±0.02^{bB}	3.46±0.04^{bC}
T_3	ND	1.44±0.02^{bA}	2.25±0.03^{bB}	2.59±0.03^{bC}
T_4	ND	1.40±0.02^{bA}	2.13±0.03^{bB}	2.49±0.03^{bC}
		Coliform count (log cfu/gm)		
T_1	ND	ND	ND	ND
T_2	ND	ND	ND	ND
T_3	ND	ND	ND	ND
T_4	ND	ND	ND	ND
		Yeast and mould (log cfu/gm)		
T_1	ND	ND	ND	1.97±0.02^{b}
T_2	ND	ND	ND	1.75±0.02^{b}
T_3	ND	ND	ND	1.50±0.02^{b}
T_4	ND	ND	ND	1.35±0.01^{a}

*Mean ±SE with different superscripts in row (upper case alphabets) and column (lower case alphabets) differ significantly ($P<0.05$), n = 6 for each treatment ;T1 = Chevon cutlets without barley flour, without clove oil;T2 = Chevon cutlets with 4% barley flour, without clove oil;T3 = Chevon cutlets without barley flour, with clove oil;T4 = Chevon cutlets with 4% barley flour, with clove oil

cutlets (T_3 and T_4). The counts were significantly ($P<0.05$) lower in the clove oil incorporated cutlets as compared to control on 15th day, attributed to the antifungal properties of eugenol present in the clove oil. Das *et al.* (2013) and Singh *et al.* (2011) also reported similar results in chicken nuggets and chicken snacks, respectively.

Sensory parameters

The mean values of various sensory parameters of cooked chevon cutlets incorporated with 0 and 4 per cent level of barley flour with and without clove oil (100 ppm) during refrigerated storage (4 ± 1^0C) are presented in Table 3. The sensory attributes were significantly affected during 15 days of refrigerated storage and all the sensory parameters followed a descending trend ($P<0.05$) with storage.

Appearance and colour

The appearance and colour scores showed a significant ($P<0.05$) decreasing trend throughout the period of storage. The scores were significantly ($P<0.05$) higher for clove oil enriched cutlets (T_3 and T_4) in comparison to control cutlets (T_1 and T_2) at 10th day of storage and onwards. The appearance and colour scores decreased gradually as the days of storage increased. The decrease in colour and appearance scores might be due to pigment and lipid oxidation resulting in non-enzymatic browning. A decrease in appearance and colour scores of meat products with increase in storage period was also reported by Bhat *et al.* (2013a); Bhat *et al.* (2013b); Singh *et al.*(2011);Kandeepan *et al.* (2010); Chidanandaiah *et al.* (2009) and Kilinc (2009). Similar observation was also reported by Wu *et al.* (2000) in precooked beef patties stored in natural antioxidant treated coatings.

Table-3: Effect of clove oil (100 ppm) on the sensory attributes of aerobically packaged chevon cutlets incorporated with barley flour at refrigerated storage (4 ± 1^0C) (Mean± SE)*

Treatments	Storage period (Days)			
	0	5	10	15
		Appearance and colour		
T_1	6.89 ± 0.04^{D}	6.15 ± 0.04^{C}	5.61 ± 0.02^{abB}	4.95 ± 0.03^{aA}
T_2	6.96 ± 0.04^{D}	6.10 ± 0.05^{C}	5.54 ± 0.03^{aB}	5.00 ± 0.02^{aA}
T_3	6.98 ± 0.05^{D}	6.18 ± 0.05^{C}	5.65 ± 0.02^{bB}	5.14 ± 0.05^{bA}
T_4	7.01 ± 0.05^{D}	6.22 ± 0.05^{C}	5.69 ± 0.04^{bB}	5.20 ± 0.05^{bA}
		Flavour		
T_1	7.18 ± 0.04^{D}	6.40 ± 0.04^{aC}	5.59 ± 0.06^{abB}	4.94 ± 0.04^{aA}
T_2	7.11 ± 0.05^{D}	6.37 ± 0.04^{bC}	5.51 ± 0.04^{aB}	4.85 ± 0.05^{aA}
T_3	7.23 ± 0.03^{D}	6.54 ± 0.03^{bC}	5.76 ± 0.04^{bB}	5.22 ± 0.06^{bA}
T_4	7.16 ± 0.04^{D}	$6.44\pm0.04a^{bC}$	5.69 ± 0.04^{bbC}	5.13 ± 0.04^{bA}
		Juiciness		
T_1	7.11 ± 0.04^{bC}	6.94 ± 0.05^{C}	6.08 ± 0.05^{B}	5.14 ± 0.03^{A}
T_2	7.00 ± 0.06^{abC}	6.88 ± 0.03^{C}	6.00 ± 0.04^{B}	5.08 ± 0.03^{A}
T_3	7.06 ± 0.04^{abC}	6.96 ± 0.02^{C}	6.04 ± 0.04^{B}	5.28 ± 0.03^{A}
T_4	6.97 ± 0.04^{aC}	6.90 ± 0.03^{C}	5.96 ± 0.04^{B}	5.16 ± 0.04^{A}
		Texture		
T_1	7.09 ± 0.04^{abD}	6.85 ± 0.04^{abC}	6.19 ± 0.04^{abB}	4.98 ± 0.04^{aA}
T_2	7.02 ± 0.05^{aD}	6.80 ± 0.04^{aC}	6.12 ± 0.03^{aB}	5.09 ± 0.04^{aA}
T_3	7.19 ± 0.04^{bD}	6.93 ± 0.05^{bC}	6.29 ± 0.04^{bB}	5.29 ± 0.05^{bA}
T_4	$7.13\pm0.05a^{bD}$	6.90 ± 0.04^{abC}	6.22 ± 0.05^{abB}	5.20 ± 0.04^{bA}
		Overall acceptability		
T_1	7.34 ± 0.04^{D}	6.87 ± 0.03^{abC}	6.20 ± 0.03^{abB}	5.04 ± 0.04^{aA}
T_2	7.22 ± 0.03^{D}	6.78 ± 0.02^{aC}	6.15 ± 0.04^{aB}	4.90 ± 0.04^{aA}
T_3	7.28 ± 0.05^{D}	6.90 ± 0.04^{bC}	6.35 ± 0.03^{cB}	5.25 ± 0.05^{bA}
T_4	7.24 ± 0.03^{D}	6.82 ± 0.03^{abC}	6.27 ± 0.04^{bcB}	5.19 ± 0.04^{bA}
	7.24 ± 0.03^{D}	6.82 ± 0.03^{abC}	6.27 ± 0.04^{bcB}	5.19 ± 0.04^{bA}

*Mean±SE with different superscripts in row (upper case alphabets) and column (lower case alphabets) differ significantly ($P<0.05$), n = 21 for each treatment;T_1= Chevon cutlets without barley flour, without clove oil;T_2 = Chevon cutlets with 4% barley flour, without clove oil;T_3 = Chevon cutlets without barley flour, with clove oil;T_4 = Chevon cutlets with 4% barley flour, with clove oil

Flavour

The scores for the flavour of the chevon cutlets decreased significantly ($P<0.05$) as the days of storage advanced. This decline was observed in all the products for all intervals of storage. The scores were significantly ($P<0.05$) higher for clove oil enriched cutlets (T_3 and T_4) in comparison to control cutlets (T_1 and T_2) at 5th day of storage and onwards. 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. Decline in flavour scores of meat products during storage was reported by Malav *et al.* (2013); Bhat *et al.* (2013a); Bhat *et al.* (2013b); Bhat *et al.* (2011) and Thomas *et al.* (2006) in different meat products.

Juiciness

The juiciness scores decreased significantly ($P<0.05$) as the days of storage progressed, however, scores were comparable on day 0 and day 5 for all the products and thereafter showed a significant ($P<0.05$) decline in all the products. The juiciness scores for all the products were comparable ($P>0.05$) to each other on 5th, 10th and 15th day of storage. Decrease in the juiciness scores with advancement of storage days may be attributed to the gradual loss of moisture from cutlets. The results were in accordance with findings of Bhat *et al. (*2013a); *et al.* (2013b);Chidanandaiah *et al.* (2009) and Thomas *et* (2006) who also reported a decline in the juiciness scores of different meat products during refrigerated storage.

The scores for texture showed a significant ($P<0.05$) declining trend with advancement of storage period. The probable reasons may be due to increased loss of water from cutlets; subsequent reduction of pH which leads to denaturation of proteins; and degradation of muscle fiber proteins by bacterial action (Jay 1996) resulting in decreased water binding. Similar results were presented by Bhat *et al.* (2013a); Bhat *et al.* (2013b); Bhat *et al.* (2011); Kilinc (2009) and Thomas *et al.* (2006) for different meat products. Among the treatments, T_3 and T_4 showed significantly ($P<0.05$) higher scores than T_1 and T_2 on almost all day of storage. This could be attributed to the antimicrobial activity of clove oil that may have resulted into lower degradation of proteins in clove oil treated samples.

Overall acceptability

Scores for overall acceptability showed significant ($P<0.05$) decreasing trend with increasing days of storage. The scores were significantly ($P<0.05$) higher for treatment T_3 and T_4 as compared to T_1 and T_2 on almost all days of storage. Continuous decrease in overall acceptability scores might be reflective of the decline in scores of appearance and colour, flavour, juiciness and texture. Similar observations were also reported by Bhat *et al.* (2013a); Bhat *et al.* (2013b); Bhat and Pathak (2009) and Kumar and Sharma (2004) for different meat products.

CONCLUSIONS

The products incorporated with clove oil had almost similar sensory attributes and acceptability as control cutlets up to 10th day of refrigerated storage and showed significantly ($P<0.05$) lower values for many storage and quality parameters indicating the antioxidant and antimicrobial nature of clove oil. Thus, the present study concludes the potential of clove oil as a source of natural preservative and antioxidant in muscle foods and assessed the effect of clove oil on the storage quality of the fiber enriched chevon cutlets.

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