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Physico-chemical, proximate, sensory and storage quality attributes analysis of *Papaver somniferum* (poppy) fortified chevon nuggets

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Abstract: *Papaver somniferum* (Poppy) seeds contain poly-phenols like tannic acid, ellagitannin that act as antioxidant, fat replacer, sedative, analgesic and anti-tussive properties, disease preventing and health promoting properties. Efficacy of ground *P. somniferum* poppy seed was used in chevon nuggets was analyzed. The use of ground poppy seed in chevon nuggets formulation had no effect on moisture as well as pH content of poppy seed incorporated chevon nuggets. However, ground poppy seed incorporation in chevon nuggets had significantly ($p<0.05$) lower fat content, higher protein content, higher emulsion stability and subsequently higher cooking yield. Chevon nuggets having 10% ground poppy seed were having significantly ($p<0.05$) higher sensory scores. The ground poppy seed treated chevon nuggets were having significantly ($p<0.05$) lower TBA and FFA value. The microbial load of developed product was significantly ($p<0.05$) lower during refrigeration storage. The chevon nuggets prepared with fortification of ground poppy seed was found to be suitable for consumption till 21st day during refrigeration storage based on TBA, FFA, microbiological and sensory profile. Thus, chevon nuggets with good to very good acceptability were developed with incorporation of ground poppy (*P-. somniferum*) seed in it. The chevon nuggets developed consisted of higher amount of antioxidants and polyunsaturated fatty acid with better sensory scores and longer shelf-life.

Keywords: Chevon nuggets, Fat replacer, *Papaver somniferum* (poppy), Storage quality

INTRODUCTION

Today's date consumer demands that food only which is health beneficial, especially, having lower saturated fat content and greater polyunsaturated fat content. Low fat meat product is in demand owing to beneficial human health and nutritional correlation. So, the food industry motivate themselves to develop meat product consists of less amount of animal fat consisting of lower saturated fat and grater polyunsaturated fat content (Delgado, 2003; Yildiz-Turp and Serdaroglu, 2008; Choi *et al.,* 2010; Gok *et al.*, 2011). Several diseases occurred are related to excessive dietary fat, made consumers to be more careful on the amount as well as quality of fat consumed everyday. High fat intake increases risk of obesity, diabetes, hypertension and other lifestyle diseases. The quality and amount of fat consumed is closely related to high blood cholesterol, arteriosclerosis and coronary heart disease (USDA and USDHHS, 1995). The meat and traditional meat products consist of high amount of fat which can be associated with cardiovascular health of consumers (Ozvural and Vural, 2008).

Papaver somniferum (poppy) is widely grown as an annual crop consists of approximately 73% of linoleic acid, 10% of Palmatic acid and 13% of oleic acid. These unsaturated fatty acids help in lowering serum cholesterol level (Bozan and Tameli, 2003). These also contain poly-phenols like tannic acid, ellagitannin that act as potential antioxidant. Poppy extract has traditionally been used to relax smooth muscle tone and can act as potent sedative analgesic and anti-tussive effect (Kim *et al*., 2013). It is used as a vehicle in chemotherapy and to cure insomnia. Poppy seeds contain many plant derived chemical compounds that are known to have anti-oxidant, disease prevention and health promoting properties (Imaizumi *et al*., 2000).

Addition of poppy seed paste in various chevon nuggets provides different delicacies and novelties. It may act as fat replacer in meat products. It may also increases unsaturated fatty acid concentration of developed meat nuggets. Sensorial properties of chevon nuggets may also be improved by ground poppy seed addition. Antioxidant property of poppy seed also enhances its shelf-life properties. Decreasing cholesterol may have significant application on consumer's health (Choi *et al.,* 2010). Therefore, the present study aims to use ground poppy seed paste in emulsion based chevon meat products viz. nuggets and to determine its effect on quality of meat nuggets.

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MATERIALS AND METHODS

Raw material: Deboned chevon was procured from local market of Jammu from male goat of 1.5 years to 2 years. It was packed in sterilized polythene bags and frozen at -18±2□C until use. Poppy seed was procured from local market of Jammu. It was washed and further dried properly followed by grinding to make into powder form. 35 gms of poppy powder was mixed in 100ml of water to obtain poppy paste.

Preparation of chevon nuggets: Chevon meat was further cut in smaller pieces and minced in a meat mincer (MOD-TC 23 R10 U.P. INOX, Marsango, Italy). Chevon meat emulsion for chevon nuggets was prepared in bowl chopper [MOD 25 2.8G 4.0, Marsango, Italy]. Crushed ice was added and blending continued for 1.5 minutes. Addition of refined vegetable oil, spice mixture, condiments and other ingredients and again mixed for 1.5 to 2 minutes to get the desired emulsion. The weighted quantity of the chevon meat emulsion was stuffed in rectangular stainless steel mould (17.5cm ×11.5cm ×5 cm) with parchment paper re-smeared with oil to avoid sticking. Mould was covered with lid and tied with thread. The mixture was subjected to steam cooking for 50±5 minutes in pressure cooker. The boxes were allowed to cool at room temperature after removal from pressure cooker. The brick shaped chevon nugget so obtained were sliced and cut into pieces to get smaller nuggets.

The formulation used in (%) was standardized, optimized and used for preparation of chevon nuggets was lean meat- 68.6, added water- 9.1, vegetable oil- 8.9, condiment mixture-4.9, refined wheat flour - 4.1, spice mixture-1.9, table salt-1.6, monosodium glutamate-0.4, sodium tripolyphosphate - 0.4, sodium nitrite -100 ppm. The fortification was done in the ratio of 5, 10, and 15% poppy with replacement in lean meat (wt./ wt.). The nuggets were cooled and then stored in low density polyethylene pouches (200 gauge). These were stored in refrigerator (4±1°C) for evaluation of physico -chemical, microbiological and sensory parameters 0^{th}, 7^{th}, 14^{th} and 21^{st} day.

Analytical techniques: The pH of cooked nuggets sample was measured by the method of (Keller *et al*.,1974). The pH was recorded by digital pH meter (Systronics Digital pH meter 802, Serial No. 603). Moisture, Crude protein, Crude fats, emulsion stability and cooking yield in both control and treated samples were done as per standard procedures (AOAC, 2000).

Thio Barbituric Acid (TBA) was determined using the method of (Witte *et al*., 1970). Free Fatty Acid (FFA) was determination of free fatty acids, the method described by (Koniecko, 1979) was followed.

Total plate count, Psychrotrophic count, Coliform count and Yeast and Mould count in the sample were determined by method described by (APHA, 1984). Readymade media (Hi-Media) were used for the analysis.

Sensory evaluation was carried for various attributes viz. color and appearance, flavor, juiciness, texture and overall acceptability by a panel of trained members composed of scientists based on a eight-point Hedonic scale, wherein 8 denoted "extremely desirable" and 1 denoted "extremely undesirable" (Seman *et al*., 1987). Seven members of the panel replicated the experiment thrice (n = 21). Panellists were comfortably seated in a room free of noise and odours and suitably illuminated. Coded samples for sensory evaluation were prepared.

The results were analyzed statistically for analysis of variance in one way as well as two way and least significant difference tests as per (Snedecor and Cochran, 1997). In significant effects, least significant differences were calculated for a pair wise comparison of treatment means.

Experimental design: The standardization and optimization of chevon nuggets was done by incorporating 0% (control), 5%, 10% and 15% level of ground poppy seed paste. The developed products were evaluated based on physico-chemical, proximate, sensory and storage quality on 0^{th}, 7^{th}, 14^{th} and 21^{st} day during refrigeration storage at (4±1°C).

RESULTS AND DISCUSSION

Physico-chemical parameters: Table 1 depicts the effect of poppy seed paste on physico-chemical properties of chevon nuggets. It was evident that there was no significant ($p<0.05$) change in pH and moisture after fortification of poppy seed paste in chevon nuggets as compared to control. However, the fat content of treated chevon nuggets had significant ($p<0.05$) decrease with increase in the level of poppy seed. The

Table 1. Effect of *P. somniferum* (poppy) on physico-chemical properties of chevon nuggets. (Mean ±SE)*

Parameters	0% (control)	5%	10%	15%
pH	6.36±0.07	6.40±0.12	6.42±0.06	6.49±0.14
Moisture	57.59±1.18	57.73±1.13	56.09±1.21	56.89±1.20
Protein	16.31 ± 0.45^{a}	16.57 ± 0.39^{a}	17.10 ± 0.28^{b}	17.57 ± 0.34^{b}
Fat	14.18 ± 0.21^{b}	14.66 ± 0.31^{b}	13.70 ± 0.46^{a}	13.05 ± 0.27^{a}
Emulsion stability	81.68 ± 0.27^{a}	83.80 ± 0.20^{b}	83.89 ± 0.27^{b}	85.36 ± 0.14^{c}
Cooking yield	82.73 ± 0.28^{a}	83.99 ± 0.24^{b}	84.74 ± 0.25^{c}	85.01 ± 0.22^{d}

*Mean± SE with different superscripts in a row wise (lower case alphabet) and column wise (upper case alphabet) differ significantly ($P<0.05$).n=6 for each treatment.

Table 2. Effect of *P. somniferum* (poppy) on sensory attributes of cooked chevron nuggets. (Mean ±SE)*

Attributes	0% (control)	5%	10%	15%
Colour and Appearance	6.19 ± 0.17^{b}	6.51 ± 0.13^{c}	7.44 ± 0.12^{d}	4.08 ± 0.13^{a}
Flavour	6.28 ± 0.18^{b}	6.66 ± 0.19^{c}	7.13 ± 0.11^{d}	4.45 ± 0.11^{a}
Juiciness	6.23 ± 0.19^{b}	6.43 ± 0.16^{c}	7.35 ± 0.10^{d}	4.27 ± 0.13^{a}
Texture	7.39 ± 0.15^{c}	7.44 ± 0.15^{d}	6.88 ± 0.10^{b}	4.38 ± 0.16^{a}
Overall Acceptability	7.27 ± 0.14^{b}	7.42 ± 0.12^{c}	7.77 ± 0.18^{d}	4.57 ± 0.18^{a}

*Mean± SE with different superscripts in a row wise (lower case alphabet) and column wise (upper case alphabet) differ significantly (P<0.05).n=6 for each treatment.

Table 3. Storage quality of *P. somniferum* (poppy) treated chevon nugget in terms of physico-chemical properties during refrigeration storage (4 ± 1^{0}C). (Mean ±SE)*

Treatments	Storage days			
	0^{th} day	7^{th} day	14^{th} day	21^{st} day
TBA(mg malonaldehyde/kg)				
Control	0.298 ± 0.0131^{Ad}	0.430 ± 0.0005^{Ac}	1.052 ± 0.0008^{Ab}	1.310 ± 0.0007^{Aa}
(5%) *Papaver somniferum*	0.296 ± 0.0179^{ABd}	0.395 ± 0.0007^{Bc}	0.675 ± 0.0006^{Bb}	0.838 ± 0.0009^{Ba}
(10%) *Papaver somniferum*	0.290 ± 0.0277^{BCd}	0.363 ± 0.0004^{Cc}	0.626 ± 0.0007^{Cb}	0.794 ± 0.0008^{Ca}
(15%) *Papaver somniferum*	0.287 ± 0.0143^{Ca}	0.326 ± 0.0004^{Dc}	0.564 ± 0.0008^{Db}	0.773 ± 0.009^{Dd}
pH				
Control	5.85 ± 0.121^{Ad}	6.08 ± 0.008^{Ac}	6.27 ± 0.013^{Ab}	6.74 ± 0.003^{Aa}
(5%) *Papaver somniferum*	5.84 ± 0.154^{Ad}	5.86 ± 0.008^{Bc}	6.12 ± 0.012^{Bb}	6.48 ± 0.007^{Ba}
(10%) *Papaver somniferum*	5.83 ± 0.125^{Ad}	5.84 ± 0.011^{Bc}	6.03 ± 0.008^{Cb}	6.34 ± 0.008^{Ca}
(15%) *Papaver somniferum*	5.87 ± 0.169^{Ad}	5.90 ± 0.008^{Bc}	5.60 ± 0.006^{Db}	6.32 ± 0.006^{Da}
FFA				
Control	0.091 ± 0.0013^{Ad}	0.135 ± 0.0008^{Ac}	0.225 ± 0.0007^{Ab}	0.362 ± 0.0010^{Aa}
(5%) *Papaver somniferum*	0.090 ± 0.0061^{Ad}	0.115 ± 0.0006^{Bc}	0.206 ± 0.0008^{Bb}	0.318 ± 0.0009^{Ba}
(10%) *Papaver somniferum*	0.089 ± 0.0138^{Bd}	0.095 ± 0.0008^{Cc}	0.178 ± 0.0007^{Cb}	0.235 ± 0.0012^{Ca}
(15%) *Papaver somniferum*	0.087 ± 0.0215^{Cd}	0.076 ± 0.0007^{Cc}	0.133 ± 0.0009^{Cb}	0.216 ± 0.0045^{Ca}

*Mean± SE with different superscripts in a row wise (lower case alphabet) and column wise (upper case alphabet) differ significantly (P<0.05). n=6 for each treatment.

protein content was significantly ($p<0.05$) increased with increase level of ground poppy paste addition in chevon nuggets. This may be attributed to the lower fat content and higher protein content in poppy seed as compared to chevon. Therefore it can act as fat replacer too. The protein content was determined to be highest in meat nuggets samples treated with 15% ground poppy seed paste. This can be attributed to high protein content of poppy seed (18.9%). Poppy seed paste treated chevon nuggets were recorded significant ($p<0.05$) higher emulsion stability and cooking yield than control. Similarly, Turhan *et al*. (2005) reported that addition of hazelnut pellicle increased emulsion stability and cooking yield of meat burgers. Similarly, ground poppy seed paste contains 21.1% of protein (Bozan and Temilli, 2003). Similar results were reported in meat balls with addition of oat bran (Yilmaz and Daglioglu, 2003; Rababah, *et al*., 2004) and about production in fatty acid content of meat product with addition of rice bran (Yilmaz 2004), oat bran (Pinero *et al*., 2008) where other developed products was enhanced by ~18% proteins.

Table 2 depicts the effect of poppy seed paste on sensory attributes of chevon nuggets. The chevon nuggets

Table 4. Changes in microbiological profile of *P. somniferum* (poppy) treated chevon nugget at refrigeration temperature (4 ± 1^0C). (Mean ±SE)*.

Treatments	0th day	7th day	14th day	21st day
Total Plate Count (log_{10}cfu/g)				
Control	2.92 ± 0.0075^{Ad}	3.73 ± 0.0089^{Ac}	4.17 ± 0.0111^{Ab}	5.15 ± 0.0081^{Aa}
(5%) *Papaver somniferum*	2.57 ± 0.0072^{Bd}	3.36 ± 0.0112^{Bc}	3.86 ± 0.0073^{Bb}	4.38 ± 0.0096^{Ba}
(10%) *Papaver somniferum*	2.02 ± 0.0065^{Cd}	3.17 ± 0.0077^{Cc}	3.52 ± 0.0100^{Cb}	3.81 ± 0.0078^{Ca}
(15%) *Papaver somniferum*	1.91 ± 0.0056^{Dd}	2.96 ± 0.0081^{Dc}	3.16 ± 0.0060^{Db}	3.68 ± 0.0069^{Da}
Psychrophillic count (log_{10}cfu/g)				
Control	ND	ND	1.69 ± 0.019^{Ab}	2.80 ± 0.0158^{Aa}
(5%) *Papaver somniferum*	ND	ND	ND	1.95 ± 0.0129^{Ba}
(10%) *Papaver somniferum*	ND	ND	ND	1.28 ± 0.0123^{Ca}
(15%) *Papaver somniferum*	ND	ND	ND	0.89 ± 0.0131^{Da}
Coliform Count (log_{10}cfu/g)				
Control	ND	ND	ND	ND
(5%) *Papaver somniferum*	ND	ND	ND	ND
(10%) *Papaver somniferum*	ND	ND	ND	ND
(15%) *Papaver somniferum*	ND	ND	ND	ND
Yeast and Mold Count (log_{10}cfu/g)				
Control	ND	ND	2.09 ± 0.0093^{Ab}	3.23 ± 0.0117^{Aa}
(5%) *Papaver somniferum*	ND	ND	ND	2.79 ± 0.0105^{Ba}
(10%) *Papaver somniferum*	ND	ND	ND	1.98 ± 0.0116^{Ca}
(15%) *Papaver somniferum*	ND	ND	ND	1.83 ± 0.0119^{Da}

*Mean± SE with different superscripts in a row wise (lower case alphabet) and column wise (upper case alphabet) differ significantly ($P<0.05$).n=6 for each treatment.

prepared with 10% incorporation of poppy seed paste was best among all as it was having greater sensory scores. Samples having 10% ground poppy seed paste had significantly ($p<0.05$) higher colour and appearance, flavour, juiciness, and overall acceptability scores as compared to other ground poppy seed paste treated chevon nuggets including control. Kaayadri and Gok, (2004) studied fat replacer in preparation of Turkish Sucuk. The olive oil at the level of forty percent as animal fat replacer was most liked by sensory panels. However, adverse effect of walnut fortification on sensory quality of Turkish Sucuk was reported by (Ercoskun and Demirch Ercoskun, 2010). Meat balls having added oat soluble fibre as a fat replacer had also higher sensory scores (Pinero *et al*., 2008).

Table 3 shows storage quality of chevon nugget in terms of physico-chemical properties during storage. The TBA value of ground poppy seed paste incorporated chevon nugget was significantly ($p<0.05$) lower as compared to control chevon nugget. The TBA value recorded stated that the control chevon nugget was deteriorated and not fit for human consumption till 21st day of refrigeration storage. However, the ground poppy seed paste incorporated chevon nugget was found to be suitable for human consumption even on 21st day of refrigeration storage. It may be attributed to the fact that poppy seed contains linoleic acid and other poly unsaturated fatty acids and mono unsaturated fatty acids which delayed lipid peroxidation and lipolysis in ground poppy seed paste incorporated chevon nuggets. Ayo *et al*., (2007) reported similar findings with addition of walnut as an animal fat replacer in frankfurters. Similar results were also reported by Ozcan and Cigdem (2006) and Ernic *et al*., (2009) that ground poppy seed paste fortification had lower TBA value as compared to control meat burgers.

The pH value of ground poppy seed paste treated chevon nuggets has significantly ($p<0.05$) lower value during 7th ,14th and 21st day of refrigeration storage as compared to control mutton nuggets. It may be attributed to the fact that poppy seed contains polyunsaturated fatty acids mainly oleic acid and linoleic acid that were not vulnerable towards lipid oxidation. Similar findings were reported in hazelnut fortified Turkish sucuk (Yildiz-turp and Sedraroglu, 2008) , where pH was found to be in the range of 6.0.

The FFA value of ground poppy seed paste chevon nuggets has significantly ($p<0.05$) lower value than controlled mutton nuggets on 0th, 7th, 14th and 21st day of refrigeration storage. It may be due to 23.9% of MUFA and 63.0% PUFA content in poppy seed which resisted lipolysis and lipid peroxidation in meat prod-

Table 5. Changes in the sensory attributes of aerobically packaged *P. somniferum* (poppy) treated chevon nugget during refrigerated storage at (4±1°C). (Mean ±SE)*

Treatments	Storage period (Days)			
	0th day	7th day	14th day	21st day
Colour and appearance				
Control	6.67 ± 0.101^{Ca}	6.08 ± 0.106^{Cb}	5.59 ± 0.100^{Dc}	4.97 ± 0.141^{Cd}
(5%) *Papaver somniferum*	7.01 ± 0.099^{Ba}	6.49 ± 0.099^{Bb}	6.05 ± 0.093^{Bc}	5.44 ± 0.123^{Bd}
(10%) *Papaver somniferum*	7.43 ± 0.109^{Aa}	6.84 ± 0.101^{Ab}	6.42 ± 0.101^{Ac}	5.97 ± 0.092^{Ad}
(15%) *Papaver somniferum*	6.31 ± 0.089^{Da}	5.91 ± 0.116^{Db}	5.47 ± 0.102^{Cc}	4.54 ± 0.123^{Dd}
Flavour				
Control	6.53 ± 0.096^{Ba}	5.94 ± 0.130^{Bb}	5.59 ± 0.079^{Bc}	3.96 ± 0.109^{Bd}
(5%) *Papaver somniferum*	6.74 ± 0.131^{Ba}	6.13 ± 0.118^{Bb}	5.78 ± 0.110^{Bc}	4.08 ± 0.106^{Bd}
(10%) *Papaver somniferum*	6.77 ± 0.083^{Ba}	6.23 ± 0.075^{Bb}	5.89 ± 0.111^{Bc}	4.16 ± 0.071^{Bd}
(15%) *Papaver somniferum*	7.17 ± 0.098^{Aa}	6.75 ± 0.088^{Ab}	6.36 ± 0.082^{Ac}	4.85 ± 0.077^{Ad}
Texture				
Control	7.41 ± 0.096^{Aa}	6.84 ± 0.106^{Ab}	5.59 ± 0.089^{Ac}	4.64 ± 0.115^{Ad}
(5%) *Papaver somniferum*	7.42 ± 0.110^{Aa}	6.89 ± 0.135^{Ab}	5.66 ± 0.095^{Ac}	4.65 ± 0.143^{Ad}
(10%) *Papaver somniferum*	7.51 ± 0.912^{Aa}	6.98 ± 0.126^{Ab}	5.73 ± 0.118^{Ac}	4.77 ± 0.145^{Ac}
(15%) *Papaver somniferum*	7.34 ± 0.076^{Aa}	6.75 ± 0.101^{Ab}	5.55 ± 0.087^{Ac}	4.63 ± 0.055^{Ac}
Juiciness				
Control	6.83 ± 0.103^{Ca}	6.36 ± 0.101^{Cb}	5.61 ± 0.127^{Cc}	4.90 ± 0.098^{Cd}
(5%) *Papaver somniferum*	7.07 ± 0.087^{BCa}	6.75 ± 0.106^{BCb}	5.87 ± 0.115^{BCc}	5.13 ± 0.079^{BCd}
(10%) *Papaver somniferum*	7.46 ± 0.083^{Aa}	6.99 ± 0.093^{Ab}	6.47 ± 0.103^{Ac}	5.53 ± 0.050^{Ad}
(15%) *Papaver somniferum*	7.19 ± 0.112^{Ba}	6.69 ± 0.097^{Bb}	5.99 ± 0.097^{Bc}	5.25 ± 0.101^{Bd}
Overall acceptability				
Control	6.77 ± 0.097^{Ca}	6.25 ± 0.087^{Cb}	5.44 ± 0.137^{Cc}	4.03 ± 0.101^{Cd}
(5%) *Papaver somniferum*	6.88 ± 0.096^{Ca}	6.37 ± 0.095^{Cb}	5.59 ± 0.127^{Cc}	4.17 ± 0.087^{Cd}
(10%) *Papaver somniferum*	7.49 ± 0.098^{Aa}	7.19 ± 0.085^{Ab}	6.38 ± 0.087^{Ac}	5.01 ± 0.097^{Ad}
(15%) *Papaver somniferum*	7.19 ± 0.078^{Ba}	6.74 ± 0.111^{Bb}	5.98 ± 0.099^{Bc}	4.58 ± 0.110^{Bd}

*Mean± SE with different superscripts in a row wise (lower case alphabet) and column wise (upper case alphabet) differ 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.

uct (Gok *et al*., 2011). Kayaadri and Gok (2004) also reported lower FFA value in olive oil fortified meat burgers.

Table 4 depicted changes in microbiological profile of aerobically packaged ground poppy seed paste incorporated chevon nuggets during refrigeration storage. The total plate count was found to be significantly ($p<0.05$) lower during refrigeration storage on all successive days in ground poppy seed paste incorporated chevon nuggets as compared to control chevon nuggets. The fatty acid composition of poppy seeds mainly linoleic acid, oleic acid and palmetic acid had antimicrobial effect. The total plate count was recorded lower with addition of linseed oil, fish oil and natural antioxidant in pork sausages (Valenica *et al*., 2008). Addition of walnut as animal fat replacer had also showed lower microbial load in meat product (Ayo *et al*., 2007).

The Psychrophillic count was also found significantly ($p<0.05$) lower in ground poppy seed paste incorporated chevon nuggets as compared to control chevon nugget. Although, Psychrophillic count was not detected till 7th day of refrigeration storage in any of product. The late appearance of Psychrophillic may be attributed to more than week days of incubation period. This was further supported by (Ozcan and Cigdem 2006; Erinic, *et al*., 2009), who stated the presence of alpha-tocopherol and gama-tocopherol in poppy seed paste

which were having antioxidant and antimicrobial property. The coliforms count was not at all detected throughout storage period in all types of chevon nuggets. It may be due to strict hygienic condition maintained during processing of meat product. No coliform was detected in Turkish fermented sausages treated with hazelnut oil (Illikan *et al*., 2009). This was further supported by Valencia *et al.* (2008) who studied on fortification of linseed as well as fish oil in pork sausages.

The yeast and mould count was found to be significantly ($p<0.05$) lower in ground poppy seed paste treated chevon nuggets as compared to control chevon nuggets. Although, yeast and mould were not detected till 14th day of refrigeration storage in any type of chevon nuggets. It may be attributed to fact that yeast and mould required more than 5 days of incubation. Antifungal effect was also reported by Illikkan *et al*. (2009) in hazelnut oil treated Turkish fermented sausages. Similar reports were found in Turkish Pastirma during refrigeration storage (Gok *et al*., 2008).

Table 5 presented changes in sensory attributes of ground poppy seed paste fortified aerobically packed mutton nuggets during refrigeration storage.

All the sensory scores among all types of chevon nuggets had significantly ($p<0.05$) lower during refrigeration storage. However, the rate and extent of decline was significantly ($p<0.05$) lower in ground poppy seed paste fortified chevon nuggets as compared to control chevon nuggets. The antioxidant and antimicrobial property of poppy seed was due to higher MUFA, PUFA, alpha-tocopherol and gama-tocopherol content. Higher sensory scores were also reported in ground poppy seed paste incorporated in meat burgers (Gok *et al*., 2011). Luruena-Martinez *et al*., (2004) also analyzed higher sensory scores in olive oil treated low fat frankfurters. Higher sensory scores were also concluded in walnut incorporated restructured beef steaks (Serano *et al.,* 2005).The poppy seed incorporated developed chevon nuggets were having higher sensory scores as compared to control.

Conclusion

Ground poppy seed replacement was found effective in lowering fat (13.05±0.27) content, elevating protein (17.57±0.34) content, increasing emulsion stability (85.36±0.14) and cooking yield (85.01±0.22) of chevon nuggets. It was also evident that sensory scores (7.77±0.18) were also higher in ground poppy seed treated chevon nuggets. The storage quality was also improved with incorporation of ground poppy seed as it acts against lipid peroxidation and lipolysis (0.773±0.009). Moreover, addition of ground poppy seed declined the microbial load (3.68±0.006). The product developed with 10% ground poppy seed incorporation in chevon nuggets were higher sensory scores and found suitable for consumption even on 21st day of refrigeration storage at (4±1°C).

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