Development and quality assessment of carrageenan incorporated low fat chevon patties

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Abstract The present study was conducted to develop and assess the quality of carrageenan incorporated chevon patties with the objective of reducing fat content. Efficacy of carrageenan as fat replacers (0.3, 0.6 & 0.9 %) was assessed for development of low fat chevon patties. Emulsion stability and cooking yield increased with the increase in levels of carrageenan. Significantly ($P < 0.05$) lower fat and cholesterol contents and higher moisture and fat retention were observed in formulation with carrageenan. No significant difference in the mineral content in either of the treatment was recorded. Incorporation of fat replacer in chevon patties demonstrated significant effect on all the textural parameters except adhesiveness. Results of color value illustrated that lightness (L^*) value differ significantly. Sensory scores were higher or comparable for patties containing 0.6 % carrageenan as compared to control. Hence, carrageenan was observed to be suitable as fat replacer for producing low fat chevon meat patties.

Keywords Low fat · Functional meat · Chevron patties · Carrageenan

Introduction

India is the second largest goat meat producer against the 5.22 MT of world goat meat production (FAO 2013). It is estimated that 98 % of the goat population is in developing countries where more than 30 improved or indigenous breeds exist that are under-utilized (Devendra 2010). Globally, goat meat consumption increased during the past 20 years (Madruga and Bressan 2011). Goat meat is one of the most consumed red meats worldwide. The demand for goat meat is on the rise. The increase was mainly due to the growth of ethnic populations and also the awareness of health conscious consumers of lower fat in chevon compared to other red meats.

Some studies have shown the benefits of meat consumption as it is nutrients dense food. However, a sector of the population perceives meat as a food that is detrimental to their health because it contains high levels of sodium and fat and little or no fiber or calcium (Oliveira et al. 2011).

Growing understanding of the relationship between diet and health is leading to new insights into the effect of food ingredients on physiological function and health, inducing increased consumers demand for healthy, nutritious foods with additional health promoting functions, such as functional foods.

Reduction of fat in comminuted meat products results in rubbery and dry textured products and poses difficulties in terms of flavor and texture. Hence, there is a need for using suitable ingredient which is able to replace fat without affecting quality. Gums are polysaccharides and they are tasteless to bland and odorless. Seaweeds are excellent sources of food gums such as carrageenan. Carrageenan is extracted from red seaweeds (*Chondrus crispus*). They have been used by the food industry for their gelling, thickening, and stabilizing properties. Incorporated into

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low-fat meat formulations, carrageenans improve the textural characteristics of the product by decreasing toughness and increasing juiciness. Therefore, meat-based functional foods are being seen as an opportunity to improve the “image” of meat and address consumers needs and also to update the nutritional and dietary goals (Jimenez-Colmenero 2007). Most researches into meat-based functional foods are confined to animal production or technological strategies for increasing the presence of healthy compounds. The objective of present study was to develop and assess the quality of carrageenan incorporated low fat chevon patties.

Materials and methods

Meat and additives

Goat meat for the experiments was procured from authorized retail meat shop. The meat was obtained from hind legs of carcasses of good conformation of non-descript adult male goats (9–11 months of age group) slaughtered according to traditional halal method. The required quantity was purchased within 2–3 h of slaughter, packed in low-density polyethylene (LDPE) bags and brought to the laboratory within 20 min. The meat was deboned, trimmed-off separable fat and connective tissue. The samples were kept for conditioning in a refrigerator at 4 ± 1 °C for 6–8 h and then frozen at -18 °C till further use. The samples were used after partial thawing for 15 h at 4 °C. Various spices, Flours, condiments (onion, ginger, and garlic), refined oil and salt were purchased from standard shop of local market of Mathura. All the chemicals and media used in the study were of analytical grade and obtained from standard firm. Sago was procured from (Golden Harvest) Future Agrovets Limited, Mumbai to prepare sago flour.

Processing

Lean meat was cut into smaller chunks and minced in a Sirmen mincer (MOD-TC 32 R10 U.P. INOX, Marsango, Italy) with 6 mm plate followed by common grind size, the 4 mm plate. Sodium chloride, vegetable oil, refined wheat flour (maida), sodium tripolyphosphate, spice mixture and condiment mix were added to weighed meat according to formulation separately for each treatment group. Meat emulsion for patties was prepared in Bowl Chopper (MOD C 15 2.8G 4.0 HP, Marsango, Italy). Minced meat was blended with sodium chloride and sodium tripolyphosphate for 1.5 min. Water in the form of crushed ice was added and blending continued for 1 min. This was followed by addition of refined vegetable oil and blended for another

1–2 min. This was followed by addition of spice mixture, condiments and other ingredients and again mixed for 1.5–2 min to get the desired emulsion. Adequate care was taken to keep the end point temperature below 18 °C by preparing the emulsion in cool hours of morning, by addition of meat and other ingredients in chilled/partially thawed form and by addition of crushed ice or ice water. The emulsion was prepared in four different formulations (Table 1).

About 50 g of emulsion was moulded on steel plate with circular ring (55 mm diameter and 20 mm height). The height and diameter of the patty was determined by Vernier Callipers. Patties were cooked in a pre-heated convection oven at 180 °C for 14 min after which they were turned and allowed to get cooked for 4 more minutes to get internal temperature about 75 °C (Probe thermometer, Labware Scientific, Inc, USA). The patties were packed in low-density polyethylene pouches and stored at refrigerated temperature (4 ± 1 °C).

Physicochemical analysis

Estimation of pH was done by using digital pH meter (WTW, Germany, model pH 330i) by immersing the spear type combination electrode (Sentix®, Germany) directly into minced meat sample. Reading was taken twice for each sample and average of reading was taken as pH of sample. The emulsion stability was determined by the method of Baliga and Madaiah (1970) with minor modifications. Twenty five grams of meat emulsion was taken in polyethylene bag and heated in thermostatically controlled water bath at 80 °C for 20 min. after cooling and draining the exudates, the cooked mass was weighed. The

Table 1 Formulations of low fat chevon patties incorporated with different levels of carrageenan

S.N.	Ingredient	% of mix			
		Control	CG ₁	CG ₂	CG ₃
1	Lean goat meat	70.0	70.0	70.0	70.0
2	Refined vegetable oil	10.0	5.0	5.0	5.0
3	Ice flakes	10.0	10.0	10.0	10.0
4	Salt	1.6	1.6	1.6	1.6
5	Dry spices mix	2.0	2.0	2.0	2.0
6	Condiments	3.0	3.0	3.0	3.0
7	Refined wheat flour	3.0	3.0	3.0	3.0
8	STTP	0.4	0.4	0.4	0.4
9	Carrageenan	0.0	0.3	0.6	0.9
10.	Compensatory water	0.0	4.7	4.4	4.1

Control (C) Chevon patties without carrageenan, CG₁ Chevon patties with 0.3 % carrageenan, CG₂ Chevon patties with 0.6 % carrageenan, CG₃ Chevon patties with 0.9 % carrageenan

percentage of cooked mass was expressed as emulsion stability. The cooking yield was expressed as percentage (Murphy et al. 1975). Moisture, protein, fat and ash contents were determined as per AOAC (1995) method. Moisture Protein ratio was calculated by ratio of the moisture and protein content in the sample. Fat retention was calculated based on a modified method of Murphy et al. (1975). Moisture retention value represents the amount of moisture retained in the cooked product per 100 g of sample and was determined according to equation by El-Magoli et al. (1996).

Moisture retention (%)

$$= (\% \text{ cooking yield} \times \text{moisture in cooked Patties})/100$$

Total cholesterol was determined as per Zlatkis et al. (1953) with slight modifications. Lipid extract was prepared by mixing 1 g of sample with 10 ml of freshly prepared 2:1 Chloroform: Methanol solution and homogenizing it in a blender. Homogenate was filtered using Whatman filter paper No. 42 and 5 ml of filtrate was added with equal quantity of distilled water, mixed and centrifuged at 3000 rpm for 7 min. Top layer (methanol) was removed by suction. Volume of bottom layer (Chloroform) having cholesterol was recorded. The O.D. of standard and sample against blank was taken at 560 nm. Total cholesterol (mg /100 g of sample) was recorded as follows:

$$\begin{aligned} \text{Cholesterol in (mg/100 g)} &= \frac{\text{O.D. of sample}}{\text{O.D. of standard}} \\ &\times \frac{\text{Vol. of choloform (ml)}}{\text{Weight of the sample taken(g)}} \\ &\times \text{Conc. of standard} \end{aligned}$$

Mineral profile analysis

The mineral contents were estimated as per method described by Horowitz (1965). The digested samples were then analyzed on Atomic Absorption Spectrophotometer (AAS 400 Perkin Elmer, USA) for Calcium (Ca), Iron (Fe), and Zinc (Zn) estimation, while Sodium (Na) and Potassium (K) were estimated by a Flame Photometer for which the volume was made up to 1000 ml.

Texture profile analysis

Texture profile analysis (TPA) was performed as per Bourne (1978) using homogeneous sample (1.5 mm × 1.5 mm × 1.5 mm) in texturometer (stable micro system TA.XT-2i-25) for each treatment which was compressed to 10 mm (1 cm) of original height through miniature Ottawa and Kramer shear cell platen probe. Cross head speed of

2.00 mm per second, post test speed 10.00 mm per sec. target mode distance 10.00 mm was used. The following parameters were determined viz; Hardness(N/cm²) = - maximum force required to compress the sample (H); Adhesiveness (Ns/g sec) = work necessary to pull the compressing plunger away from the sample; Springiness (cm/mm) = ability of sample to recover its original form after a deforming force was removed (S); Cohesiveness (Ratio) = Extent to which samples could be deformed prior to rupture (A2/A1, A1 being the total energy required for first compression and A2 total energy required for second compression); Gumminess (N/cm² or g/mm²) = - force necessary to disintegrate a semi solid sample for swallowing (H × Cohesiveness); and Chewiness (N/cm or g/mm) = work required to the sample for swallowing (S × Gumminess).

Instrumental color analysis

Color profile was measured using Lovibond Tintometer (Model: RT-300, UK) set at 2 of cool white light (D65) and known as L*, a*, and b* values. L* value denotes (brightness 100) or lightness (0), a* (redness/greenness), b* (yellowness/blueness) values. The instrument was calibrated using a light trap (black hole) and white tile provided with the instrument. Then the above color parameters were selected. The instrument was directly put on the surface of functional chevron patties at three different points (Hunter and Harold 1987).

Sensory evaluation

Sensory evaluation was carried out by an experienced seven member trained panel. Panel members were either faculty or post graduate students of the DUVASU, University. Four training sessions were held to familiarize the panelists with the developed product characteristics to be evaluated and the scale to be used. Panelists were asked to evaluate the samples for general appearance, flavor, texture, saltiness, juiciness, mouth coating and express their overall acceptability using 8-point hedonic scale (Keeton 1983), where 8 denoted extremely desirable and 1 denoted extremely undesirable. Chevron meat patty samples were internally cooked to 75 °C and were served in random order at a temperature of approximately 60 °C. At a time total of four samples (one from each treatment group) were served to compare the products.

Statistical analysis

Three replications of the study were performed and measurements of all parameters were made in duplicate. Mean values for various parameters were calculated and

compared by analysis of variance using the SPSS software for windows (version 16.0). Means of all the parameters were subjected to one way analysis of variance using homogeneity and Duncan's Multiple Range Test (DMRT) for comparing the means to find the effects between samples. Statistical significance was identified at the 95 % confidence level ($P < 0.05$). The average values were reported along with standard error.

Results and discussion

Physico-chemical properties

The mean values for various physicochemical parameters of low fat chevon patties incorporated with different levels of carrageenan are presented in Table 2. Emulsion stability

Table 2 Physico-chemical properties (Mean $\pm$ SE) of chevon patties incorporated with different levels of carrageenan

Parameter	Treatments			
	C	CG ₁	CG ₂	CG ₃
Emulsion stability (%)	91.28 ^a ± 0.35	92.18 ^a ± 0.64	94.58 ^b ± 0.62	94.66 ^b ± 0.48
Cooking yield (%)	90.67 ^a ± 0.70	92.04 ^{ab} ± 0.62	93.23 ^b ± 0.47	93.30 ^b ± 0.46
Product pH	6.26 ± 0.02	6.29 ± 0.03	6.31 ± 0.02	6.32 ± 0.02
Moisture content (%)	58.09 ^a ± 0.66	62.90 ^b ± 0.80	63.36 ^b ± 0.58	63.25 ^b ± 0.63
Protein content (%)	16.41 ± 0.36	16.69 ± 0.37	16.61 ± 0.44	16.57 ± 0.43
Fat content (%)	13.88 ^b ± 0.36	8.76 ^a ± 0.21	8.86 ^a ± 0.20	8.92 ^a ± 0.18
Ash content (%)	2.85 ± 0.09	2.81 ± 0.11	2.81 ± 0.10	2.81 ± 0.13
Carbohydrate content (%)	8.78 ± 0.79	8.85 ± 0.73	8.37 ± 0.66	8.45 ± 0.68
Moisture protein ratio	3.55 ^a ± 0.06	3.78 ^b ± 0.04	3.83 ^b ± 0.04	3.83 ^b ± 0.05
Moisture retention %	52.65 ^a ± 0.43	57.38 ^b ± 1.58	59.11 ^b ± 0.76	59.01 ^b ± 0.79
Fat retention (%)	87.33 ^a ± 0.56	90.22 ^b ± 0.40	93.33 ^c ± 0.74	93.39 ^c ± 0.74
Cholesterol (mg/100 g)	165.00 ^b ± 0.78	104.00 ^a ± 0.68	105.32 ^a ± 0.41	106.00 ^a ± 0.57

Means bearing different superscripts (a, b, c, d, ...) in a row differ significantly ($P < 0.05$) (n = 6)

Control (C) Chevon patties without carrageenan, CG₁ Chevon patties with 0.3 % carrageenan, CG₂ Chevon patties with 0.6 % carrageenan, CG₃ Chevon patties with 0.9 % carrageenan

increased with the addition of carrageenan. Initially it was increased non significantly ($P > 0.05$) and become significant at 0.6 % addition of carrageenan (CG₂). However, the further increase showed non significant effect ($P > 0.05$). This might be due to comparatively better binding and gelling properties of carrageenan at particular level. The evolution of the microstructure can explain not only textural properties, but also the change in the water holding capacity (WHC). The compactness of the protein gel network allowed more binding of water, therefore, with an increase in the carrageenan concentration, the water holding capacity increased (Ayadi et al. 2009; Panyathitpong and Puechkamut 2010).

There was a significant ($P < 0.05$) difference in the cooking yield of chevon patties between control and treatments. Cooking yield increased non significantly ($P > 0.05$) in carrageenan added chevon patties. However, it was significantly ($P < 0.05$) higher at CG₂ and CG₃ as compared to control. It could be due to ability of carrageenan to form complexes with water and protein (Egbert et al. 1991) which improve water retention and cooking yield. Carrageenan reduced cooking losses in meat products (Chatli 2001).

There was an increasing trend in the pH of cooked chevon patties from C to CG₃. However, difference was non significant ($P > 0.05$). Similar results were obtained in low fat pork patties containing carrageenan as fat replacer (Kumar and Sharma 2004).

There was a significant ($P < 0.05$) difference in the moisture content of chevon patties between control and treatments. However, a non significant ($P > 0.05$) difference was recorded in between treatments. This might be due to addition of compensatory water in the formulation of low fat chevon patties as well as the ability of carrageenan particles to retain more water. The results are in agreement with findings of Kumar and Sharma (2004) low fat carrageenan added pork patties. Results clearly indicated that no significant ($P > 0.05$) difference in the protein content of carrageenan added chevon patties was noticed between treatments. This might be due to approximately similar amount of lean meat used in all the formulation. Candogan and Kolsarici (2003a, b) reported that no difference in the protein content of low fat frankfurters containing fat replacers like carrageenan. Sharma et al. (2015) also observed no significant difference ($P > 0.05$) in any of the physicochemical parameters in restructured mutton chops incorporated with different levels of gum tragacanth except fat percent.

Carrageenan added low fat chevon patties had significantly ($P < 0.05$) lower fat as well as cholesterol content as compared to control. This was because of obvious difference in the formulation of low fat chevon patties since they contained only 5 % added fat as compared to 10 % added

fat as in control. Naruka (2005) in low fat carrageenan added pork nuggets; Pietrasik and Duda (1999) in low fat sausages also reported significant decrease in fat percent. There was non significant ($P > 0.05$) increase in the fat and cholesterol content with increase level of carrageenan from CG₁ to CG₃ because of fat binding ability of carrageenan. Kumar and Sharma (2004) also reported similar results in pork patties. Verma et al. (2012) also observed significant reduction in cholesterol content of low fat chicken nuggets. A reduction of 50–59 % in cholesterol was also reported in carrageenan added low fat beef frankfurters as compared to control by Candogan and Kolsarici (2003b).

Ash and carbohydrate content of carrageenan added chevon patties did not differ significantly ($P > 0.05$) between variants. However, lower value of ash and carbohydrate content was observed in treatments as compared to that of control. Moisture protein ratio was found to be significantly ($P < 0.05$) higher in carrageenan incorporated chevon patties as compared to control. This might be due to obvious higher water content in the formulation of low fat chevon patties. Chatli (2001) also reported the higher moisture protein ratio in carrageenan incorporated pork patties.

Moisture retention as well as fat retention was significantly ($P < 0.05$) lower in control patties as compared to low fat carrageenan incorporated chevon patties. The marginal improvement in between treatments was also noticed which may be due to water binding nature of carrageenan. Pork patties added with carrageenan had higher fat and moisture retention (Chatli 2001).

Mineral profile analysis

Data presented in Table 3 indicated that there was no significant ($P > 0.05$) difference in the estimated mineral contents of chevon patties. However, all the minerals i.e. sodium, potassium, calcium, iron, manganese and zinc contents increased marginally up to CG₂ and this marginal improvement could be attributed to better water binding of carrageenan. Chatli (2001) also reported higher mineral contents in carrageenan added low fat pork patties.

Texture profile analysis

Texture profile analysis of low fat chevon patties incorporated with carrageenan are presented in Table 4 indicated that hardness value was significantly ($P < 0.05$) increased from control to CG₃. However, in CG₁ non significant ($P > 0.05$) improvement compared to control was noticed. Garcia and Totosaus (2008) in Low-fat sodium-reduced sausages and Cierach and Szacilo (2003) in low-fat breakfast sausages also reported increase in hardness value with the use of carrageenan as fat replacer.

Table 3 Mineral profile (Mean $\pm$ SE) of chevon patties incorporated with different levels of carrageenan

Mineral (mg/100 g)	Treatments			
	C	CG ₁	CG ₂	CG ₃
Sodium	715.26 ± 11.11	716.28 ± 13.26	718.87 ± 12.67	717.57 ± 16.23
Potassium	242.32 ± 9.23	243.12 ± 14.26	243.82 ± 13.82	242.98 ± 11.73
Calcium	6.97 ± 0.22	7.00 ± 0.22	7.01 ± 0.21	7.01 ± 0.21
Iron	2.95 ± 0.08	2.97 ± 0.08	2.97 ± 0.10	2.95 ± 0.11
Manganese	0.084 ± 0.004	0.084 ± 0.003	0.089 ± 0.003	0.089 ± 0.004
Zinc	2.40 ± 0.07	2.41 ± 0.08	2.41 ± 0.10	2.40 ± 0.17

Means bearing different superscripts (a, b, c, d, ...) in a row differ significantly ($P < 0.05$) (n = 6)

Control (C) Chevon patties without carrageenan, CG₁ Chevon patties with 0.3 % carrageenan, CG₂ Chevon patties with 0.6 % carrageenan; CG₃ Chevon patties with 0.9 % carrageenan

Table 4 Texture profile analysis (Mean $\pm$ SE) of chevon patties incorporated with different levels of carrageenan

Parameter	Treatments			
	C	CG ₁	CG ₂	CG ₃
Hardness (N/cm ²)	43.92 ^a ± 1.04	46.25 ^a ± 0.93	50.14 ^b ± 0.54	53.43 ^c ± 1.39
Adhesiveness (Ns)	−3.32 ± 0.22	−3.44 ± 0.18	−3.58 ± 0.23	−3.73 ± 0.57
Springiness (cm)	0.940 ^c ± 0.006	0.870 ^b ± 0.005	0.857 ^b ± 0.004	0.830 ^a ± 0.006
Cohesiveness (Ratio)	0.740 ^c ± 0.007	0.710 ^b ± 0.003	0.703 ^b ± 0.004	0.690 ^a ± 0.003
Gumminess (N/cm ²)	27.24 ^a ± 0.83	25.46 ^a ± 0.67	35.13 ^b ± 0.57	36.10 ^b ± 0.85
Chewiness (N/cm)	22.50 ^a ± 0.62	25.83 ^b ± 1.62	28.50 ^{bc} ± 0.81	29.92 ^c ± 0.35

Means bearing different superscripts (a, b, c, d, ...) in a row differ significantly ($P < 0.05$) (n = 6)

Control (C) Chevon patties without carrageenan, CG₁ Chevon patties with 0.3 % carrageenan, CG₂ Chevon patties with 0.6 % carrageenan; CG₃ Chevon patties with 0.9 % carrageenan

Improvement in the hardness value of carrageenan incorporated low fat frankfurters was also recorded by Mittal and Barbut (1994). Panyathitipong and Puechkamut (2010) also concluded that increasing the carrageenan concentration resulted in greater WHC and hardness value in surimi

emulsion gel. A progressive increment in the adhesiveness value of carrageenan incorporated chevon patties from control to CG₃ was recorded but difference was non significant ($P > 0.05$). A significantly ($P < 0.05$) higher adhesiveness value was observed by Cierach and Szacilo (2003) in low-fat breakfast sausages. Springiness and cohesiveness value of carrageenan incorporated chevon patties was decreased significantly ($P < 0.05$) as compared to control. Increasing the carrageenan levels resulted in a smoother gel matrix and increased the compactness of the protein gel network, which had a less aerated structure that might cause a reduction in springiness. Moreover, the significant increase ($P < 0.05$) in the gel hardness that was observed at high levels of carrageenan could have been the result of the formation of an additional carrageenan gel network (Ayadi et al. 2009). A considerable decrease in elasticity was noted in sausages with 0.5 and 0.7 % of carrageenan G-MR and A-MR, compared with the control sample by Cierach and Szacilo (2003). A gradual increase in gumminess and chewiness value of carrageenan incorporated chevon patties was observed with significant ($P < 0.05$) difference at higher level. Cierach and Szacilo (2003) also reported that sausages containing carrageenan were characterized by higher values of gumminess and chewiness than the control sample. The chewiness value was increased with addition of carrageenan in low fat frankfurters and beef gel respectively (Mittal and Barbut 1994; Pietrasik and Li-Chan 2002).

Instrumental color analysis

Instrumental color values (Table 5) illustrated that lightness value of carrageenan incorporated chevon patties was significantly ($P < 0.05$) higher from control. However, among treatments no significant ($P > 0.05$) difference was

Table 5 Instrumental color (Mean $\pm$ SE) of chevon patties incorporated with different levels of carrageenan

Parameter	Treatments			
	C	CG ₁	CG ₂	CG ₃
Lightness (L*)	40.97 ^a ± 0.71	42.57 ^{ab} ± 0.35	43.25 ^b ± 0.41	43.29 ^b ± 0.70
Redness (a*)	3.40 ± 0.22	3.34 ± 0.20	3.27 ± 0.13	3.25 ± 0.12
Yellowness (b*)	11.28 ± 0.65	10.71 ± 0.35	10.45 ± 0.35	10.37 ± 0.57

Means bearing different superscripts (a, b, c, d, ...) in a row differ significantly ($P < 0.05$) ($n = 6$)

Control (C) Chevon patties without carrageenan, CG₁ Chevon patties with 0.3 % carrageenan, CG₂ Chevon patties with 0.6 % carrageenan, CG₃ Chevon patties with 0.9 % carrageenan

observed. It might be due to higher moisture content in the treated chevon patties. On the contrary the redness and yellowness value was gradually decreased but the difference was non significant ($P > 0.05$). It could be attributed to dilution of color pigment due to addition of compensatory water in the formulation of low fat chevon patties. Fat reduction results in darker sausages with less red color, but has no effect on yellowness (Hughes et al. 1998). Addition of water in low-fat meat products resulted in a higher dilution of color and consequently less red color (Morin et al. 2002).

Sensory evaluation

Sensory analysis of low fat carrageenan added chevon patties (Table 6) revealed that general appearance differed significantly ($P < 0.05$) between control and CG₁. A comparative scores were evaluated for CG₂ and CG₃ with that of control. Flavor scores at treatment CG₁ and CG₂ were comparable to control although scores were significantly ($P < 0.05$) lower for CG₃. It might be due to pronouncement of off flavor at higher level of carrageenan. Pannin et al. (1974) also reported bitter off flavor in the meat products incorporated with higher concentration of carrageenan. Naruka (2005) also observed similar findings in pork nuggets.

Table 6 Sensory attributes (Mean $\pm$ SE) of chevon patties incorporated with different levels of carrageenan

Attributes	Treatments			
	C	CG ₁	CG ₂	CG ₃
General appearance	6.96 ^b ± 0.04	6.84 ^a ± 0.03	6.94 ^{ab} ± 0.04	6.92 ^{ab} ± 0.04
Flavour	7.14 ^b ± 0.03	7.04 ^b ± 0.03	7.13 ^b ± 0.03	6.76 ^a ± 0.03
Texture	7.07 ^b ± 0.04	6.97 ^b ± 0.04	7.05 ^b ± 0.03	6.68 ^a ± 0.03
Saltiness	7.00 ± 0.08	7.07 ± 0.09	7.13 ± 0.06	6.95 ± 0.05
Juiciness	6.88 ^a ± 0.04	7.14 ^b ± 0.04	7.16 ^b ± 0.03	7.18 ^b ± 0.03
Mouth coating	6.72 ^b ± 0.04	6.81 ^b ± 0.04	6.96 ^c ± 0.04	6.53 ^a ± 0.04
Overall acceptability	7.09 ^b ± 0.04	6.88 ^a ± 0.04	7.12 ^b ± 0.04	6.77 ^a ± 0.05

Means bearing different superscripts (a, b, c, d, ...) in a row differ significantly ($P < 0.05$) ($n = 21$)

Control (C) Chevon patties without carrageenan, CG₁ Chevon patties with 0.3 % carrageenan, CG₂ Chevon patties with 0.6 % carrageenan, CG₃ Chevon patties with 0.9 % carrageenan

Texture score decreased marginally for CG₁ and CG₂ compared to that of control. However, all textural parameters decreased significantly on addition of 0.9 % carrageenan. Sensory panelists rated CG₂ similar to control for texture attributes. It could be due to maximum fat mimicking property of carrageenan at particular level. Bradford et al. (1993) reported higher tenderness scores when Iota carrageenan was incorporated in low fat pork sausages. Saltiness scores of chevon patties were increased gradually and became significant ($P < 0.05$) at CG₂. However, further addition of carrageenan in chevon patties, saltiness score was reduced significantly ($P < 0.05$). It might be due to off flavor at higher level of carrageenan. Pannin et al. (1974) also reported bitter off flavor in the meat products incorporated with higher concentration of carrageenan.

There was a significant ($P < 0.05$) difference between control and low fat chevon patties for juiciness scores. This might be due to higher moisture content in the low fat carrageenan incorporated chevon patties. Carrageenan was reported to improve juiciness in low fat beef patties (Egbert et al. 1991). Naruka (2005) also observed the highest score for juiciness at 0.75 % incorporation in pork nuggets. The mean mouth coating scores increased marginally at CG₁ and became significant ($P < 0.05$) at CG₂. However, score reduced significantly ($P < 0.05$) for CG₃.

Overall acceptability scores revealed that there was significant ($P < 0.05$) variation among different carrageenan incorporated chevon patties. A significantly ($P < 0.05$) lower scores were observed for treatment CG₁ and CG₃. However, score for CG₂ was the highest and comparable to control. This might be due to additive effect of other sensory attributes. These findings are in agreements with observation recorded by Naruka (2005) and Chatli (2001) in pork products.

Conclusion

This study clearly demonstrated the fat replacer efficacy of carrageenan. Carrageenan significantly reduced fat and cholesterol content in the developed products. This can be used in the development of low fat chevon patties without affecting quality and sensory attributes simultaneously improving the functionality of the developed products. Therefore it was concluded that carrageenan could be successfully added to meat as fat replacer. The food industry can make use of the carrageenan as a fat replacer in processed food products.

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