Journal of Animal Research: v.8 n.3, p. 487-495. June 2018

DOI: 10.30954/2277-940X.06.2018.25

Quality and Sensory Attributes of Noni Incorporated Low Fat Low Sodium Functional Chevon Patties

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Received: 19 Dec., 2017 **Revised:** 02 May, 2018 **Accepted:** 07 May, 2018

ABSTRACT

Three different levels (1%, 3% and 5%) of noni juice were attempted in the formulation of low sodium reduced fat meat emulsion to explore the possibility of its utilization as antioxidants in functional chevon patties. The product was evaluated for various quality characteristics and sensory attributes. The pH, thiobarbituric acid (TBA), free fatty acid (FFA) and peroxide value were significantly (P<0.05) lower and cooking yield was higher in treatment compared to control. Mineral contents did not differ significantly (P>0.05) in either of the treatment. Springiness increased and cohesiveness decreased gradually and become significant (P<0.05) at treatment NJ_3 (patties added with 5% noni juice). Lightness ($L*$) value decreased with addition of noni juice and differ significantly (P<0.05) at treatment NJ_2 (patties added with 3% noni juice) and NJ_3 compared to control. Sensory scores for NJ_2 were either comparable or higher as compared to control. Therefore noni juice at 3% may suitably be used for the development of functional chevon patties without affecting its quality and sensory attributes.

Keywords: Chevon patties, functional, noni juice, quality, sensory attributes

Goat meat is one of the most consumed red meats worldwide. The popularity of goat meat is subject to the common culture of communities and the forces of civilization (Webb *et al*., 2005). Globally, goat meat consumption increased during the past 20 years (Madruga and Bressan, 2011). 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. 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.

Lipid oxidation is of great concern to the consumer because it causes physical and chemical deterioration of food quality, such as undesirable changes in taste, texture, appearance and development of rancidity, losses of important nutritional values and formation of potentially harmful components including free radicals and reactive aldehydes (Alamed *et al.,* 2009; Conde *et al.,* 2011). Especially, this process is favored in oil-in-water emulsions because of the large contact surface between the oxidizable lipid hydroperoxides in emulsion droplets and water-soluble prooxidants resulting in the propagation of oxidation reactions (Waraho *et al.,* 2012).

Although there are many compounds that have been proposed to possess antioxidant properties to inhibit oxidative deterioration, only a few can be used in food products. These may be either synthetic or natural. However, synthetic antioxidants have now fallen under scrutiny due to potential toxicological effects. The meat industry is actively seeking natural solutions to minimize oxidative rancidity and increase products' shelf-life (Naveena *et al*., 2008). In response to recent demand for natural products and consumers' willingness to pay significant premiums for natural foods, because "natural" additives are perceived as beneficial for both quality and safety aspects and also possible beneficial effects on human health (Viuda-Martos *et al.,* 2010).

Natural antioxidants constitute a broad range of compounds including phenolic or nitrogen species and carotenoids (Aehle *et al.*, 2004). They suppress the levels of reactive oxygen intermediates and thus play an important role in the defense mechanisms (Gulcin *et al.*, 2003; Aehle *et al.*, 2004). Natural antioxidants can also protect the human body from free radicals and retard the progress of many chronic diseases as well as lipid oxidation in foods. Noni (*Morinda citrifolia*) is an evergreen plant found in tropical regions of the world. Recently, juices from noni have become popular in nutraceutical drinks for their immune-stimulating and antioxidant properties. Tapp *et al.* (2010) have reported beneficial effects of noni puree when added to ground beef. Patties containing noni puree also reported higher shelf life in ground beef. Thus, the objective of this study was to determine if the inclusion of different levels of noni could improve quality, retain color, texture and sensory attributes.

MATERIALS AND METHODS

Goat meat for the experiments 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^{o}C for 6–8 hours and then frozen at -18^{o}C till further use. The samples were used after partial thawing for 15 hours at 4^{o}C. Various spices, flours, condiments (onion, ginger, and garlic: 3:1:1), refined soya oil and salt were purchased from standard shop of local market of Mathura, UP, India. All the chemicals and media used in the study were of analytical grade and obtained from standard firm.

Original divine noni juice was procured from World Noni Research Foundation, Chennai. It was diluted five times with distilled water at the time of incorporation.

Lean meat was cut into smaller chunks and minced in a Sirmen mincer (MOD- TC 32 R10 U.P. INOX, Marsango, Italy) with 6mm plate followed the 4mm plate. Common salt, vegetable oil, refined wheat flour (maida), sodium tripolyphosphate, spice mixture and condiment mix were added to weighed meat according to formulation (Table 1) 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 salt and sodium tripolyphosphate for 1.5 minute. Water in the form of crushed ice was added and blending continued for 1 minute. This was followed by addition of refined vegetable oil and blended for another 1 to 2 minutes. This was followed by addition of spice mixture, condiments and other ingredients and again mixed for 1.5 to 2 minutes to get 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.

Table 1: Formulation of noni juice incorporated functional chevon patties

Ingredient	Treatments (%)			
	C	NJ_1	NJ_2	NJ_3
Lean goat meat	70.0	70.0	70.0	70.0
Vegetable oil	5.0	5.0	5.0	5.0
Carrageenan	0.6	0.6	0.6	0.6
Ice flakes	14.4	13.4	11.4	9.4
Dry spices mix	2.0	2.0	2.0	2.0
Condiments	3.0	3.0	3.0	3.0
Refined wheat flour	3.0	3.0	3.0	3.0
STTP	0.4	0.4	0.4	0.4
Nacl	1.0	1.0	1.0	1.0
Kcl	0.4	0.4	0.4	0.4
$Cacl_2$	0.2	0.2	0.2	0.2
Noni juice	0.0	1.0	3.0	5.0

C (Control) - low fat, low sodium chevon patties without natural antioxidant, **NJ_1**- low fat, low sodium chevon patties with 1% noni juice; **NJ_2**- low fat, low sodium chevon patties with 3% noni juice and **NJ_3**- low fat, low sodium chevon patties with 5% noni juice.

To prepare patties about 50 g of emulsion was molded on steel plate with circular ring (55 mm diameter and 20 mm height). 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 minutes after which they were turned and allowed to cook for 4 more minutes to reach internal temperature of 75°C (Probe thermometer, Labware Scientific, Inc, USA). Developed patties were packed in low-density polyethylene pouches and stored at refrigerated temperature (4±1ºC). Each experiment was replicated thrice and the samples were analyzed in duplicate leading to total observation 6 (n = 6), whereas the sensory attributes were evaluated by a seven member (trained panel) in three sittings (n = 21) for each replicate.

pH was determined by using digital pH meter (WTW, Germany, model pH 330i) by immersing the spear type combination electrode (Sentix®, Germany) directly into minced meat sample. 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. Percentage of cooked mass was expressed as emulsion stability. Cooking yield was calculated as under and expressed as percentage (Murphy *et al.,* 1975).

$$\text{Cooking yield \%} = \frac{\text{Weight of cooked chevon patties}}{\text{Weight of raw chevon patties}} \times 100$$

Moisture, protein, fat and ash contents were determined as per AOAC (1995) method. 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). Fat retention was calculated based on a modified method of Murphy *et al.* (1975).

Total cholesterol was determined as per Zlatkis *et al.* (1953) with slight modifications. Lipid extract was prepared by mixing one gram 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 percent was recorded as follows:

Cholesterol (mg/100g) =

$$\frac{\text{O.D.of sample}}{\text{O.D.of standard}} \times \frac{\text{Vol.of choloform (ml)}}{\text{Weight of the sample taken (gm)}} \times \text{Conc.of standard}$$

Thiobarbituric Acid Value (TBA) value was estimated as per procedure given by Tarladgis *et al.* (1960). Ten grams of sample was taken and added to 49 ml of distilled water and 1 ml of sulphanilamide reagent (1 gram of sulphanilamide dissolved in solution containing 40 ml of concentrated HCl and 160 ml of distilled water) and blended with the help of pestle and mortar. After this 48 ml of distilled water was used for washing the mortar and to it 2 ml HCl solution (diluted 1:2 with distilled water) was added. The contents were transferred to Kjeldhal flask after adding several glass beads. The blank prepared consisted 5 ml distilled water and 5 ml TBA reagent. The flasks were then cooled under tap water for 10 minutes and the optical density (O.D.) was recorded at 538 nm against blank. The TBA value as mg of malonaldehyde per 1000 gram of sample was calculated using following formula:

$$\textit{TBA value (mg of malonaldehyde/1000 g of sample)} = \textit{O.D. of sample} \times 7.8$$

Free fatty acid value was determined by modified AOCS method (Koniecko, 1979). Five gram of sample of different treatments was blended with the help of pestle and mortar in 30ml chloroform in presence of anhydrous sodium sulphate. Then it was filtered through Whatman's filter paper no.1 in to 150 ml conical flask. About 2-3 drops of phenolphthalein indicator (0.2%) was added to the filtrate, which was titrated against 0.1N alcoholic potassium hydroxide to get the pink color end point. The free fatty acid content of the sample was calculated as:

% FFA as Oleic acid =

$$\frac{0.1\ \textit{Xml of}\ 0.1\ \textit{alcahalic KOH used in titration} \times 0.282}{\textit{sample. weight(g)}} \times 100$$

The peroxide value was measured as per procedure described by AOCS (1992) with suitable modifications. Five gram of sample was blended with 30 ml acetic acid and chloroform solution (3:2) in 250 ml glass stoppered Erlenmeyer flask. Slurry obtained was gently swirled to extract lipid and then 0.5 ml saturated potassium iodide solution was added and allowed to stand for 1 min with occasional shaking (swirling), 30 ml of distilled water and 0.5 ml of freshly prepared 0.5 percent starch solution were added. Flask contents were titrated immediately against 0.01N sodium thiosulphate until intense blue colour disappeared. The peroxide value (meq/kg of the meat) was calculated as per the following formula;

PV (meq/kg sample) =

$$\frac{\textit{N of sodium thiosulphate} \times \textit{ml sodium thiosulphate used}}{\textit{Wt. of sample (g)}} \times 100$$

Mineral contents were estimated as per method described by Horowitz (1965). 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 (TPA) was performed as per Bourne (1978) using homogeneous sample (1.5mm × 1.5mm X 1.5mm) in Texturometer (stable micro system TA.XT-2i-25) for each treatment which was compressed to 10 mm (1cm) of original height through miniature Ottowa 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/cm^2) = 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/cm^2 or g/mm^2) = 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).

Colour 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 colour parameters were selected. The instrument was directly put on the surface of functional chevon patties (Hunter and Harold, 1987). This replicated thrice and the samples were analyzed in duplicate leading to total observation 6 (n = 6).

Sensory evaluation was carried out by an experienced seven member trained panel in the morning session at 11.00 A.M. Three sittings (n = 21) were conducted for each treatment. Panel members were either faculty or post graduate students of the Deen Dayal Upadhyaya Veterinary and Animal Science 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. Chevon 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) were served to each panelist to compare the products.

Data were subjected to one way analysis of variance using homogeneity and Duncan's Multiple Range Test (DMRT) for comparing the effects between samples using the SPSS software of windows (version 16.0). Each experiment was replicated thrice and the samples were analyzed in duplicate leading to total observation 6 (n = 6), whereas for sensory attributes, evaluation were done by 7 members and replicated thrice for each experiment leading to total observation 21(n = 21). The statistical significance was expressed at ($P<0.05$).

RESULTS AND DISCUSSION

Moisture, protein, fat and ash contents did not differ significantly ($P>0.05$) with the incorporation of noni juice in low fat low sodium functional chevon patties (Table 2). This might be due minuscule alteration in formulation that was not able to modify the composition of chevon patties.

Table 2 : Physico-chemical properties (Mean±SE) of noni juice incorporated functional chevon patties

Parameter	Treatment			
	C	NJ_1	NJ_2	NJ_3
Emulsion Stability (%)	91.8 ± 0.60	92.12 ± 1.09	93.41±1.11	93.88±0.98
Cooking Yield (%)	91.88 ^{a}±0.61	92.20 ^{ab}±0.89	93.54 ^{ab}±1.03	94.61 ± 0.64
Moisture (%)	62.98 ± 0.32	63.16 ± 0.61	63.31 ± 0.62	63.43 ± 0.55
Protein (%)	16.42 ± 0.32	16.39 ± 0.55	16.34 ± 0.40	16.30 ± 0.47
Fat (%)	9.00 ± 0.28	9.05 ± 0.31	9.09 ± 0.25	9.09 ± 0.26
Ash (%)	2.89 ± 0.11	2.91 ± 0.10	2.93 ± 0.09	2.94 ± 0.10
Moisture retention %	57.87 ± 0.50	58.23 ± 0.80	59.20 ± 0.69	60.01 ± 0.72
Fat retention (%)	93.52 ± 0.56	93.89 ± 0.70	93.98 ± 0.74	94.00 ± 0.72
Cholesterol (mg/100gm)	106.08 ± 0.81	106.00 ± 1.09	105.82 ± 0.75	105.71 ± 0.91
Emulsion pH	6.03 ^{b} ± 0.02	6.00 ^{ab} ± 0.02	5.94 ^{ab} ± 0.03	5.89 ^{a} ± 0.02
Product pH	6.12 ^{b} ± 0.01	6.00 ^{a} ± 0.02	5.97 ^{a} ± 0.04	5.94 ^{a} ± 0.03
TBA (mg malonaldehyde/kg)	0.51 ^{d} ± 0.007	0.44 ^{c} ± 0.009	0.38 ^{b} ± 0.018	0.32 ^{a} ± 0.007
FFA (% oleic acid)	0.35 ^{c} ± 0.010	0.32 ^{bc} ± 0.007	0.29 ^{b} ± 0.012	0.25 ^{a} ± 0.013
PV (meq/kg)	1.72 ^{b} ± 0.027	1.68 ^{b} ± 0.016	1.62 ^{a} ± 0.018	1.60 ^{a} ± 0.016

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

C = Control **-** low fat, low sodium chevon patties without natural antioxidant, **NJ_1-** low fat, low sodium chevon patties with 1% noni juice; **NJ_2-** low fat, low sodium chevon patties with 3% noni juice and **NJ_3-** low fat, low sodium chevon patties with 5% noni juice.

However, moisture and fat contents were marginally increased with the addition of noni juice because of higher moisture and fat retention capacity of noni juice. Moisture protein ratio was also marginally increased with addition of noni juice due to difference in the moisture contents of the products. Yıldız-Turp and Serdaroglu (2010) in beef patties ; Lee and Ahn (2005) in turkey breast rolls had also observed non significant (P>0.05) effect of incorporation of plum puree plum extract on moisture, fat, protein and ash contents of compared products. Moisture retention in meat products is an important cooking parameter, since retained moisture in the product affects eating quality. Keeping fat within the matrix of meat products during cooking and storage is necessary to ensure sensory quality and acceptability (Anderson and Berry, 2001). Moisture and fat retention were marginally increased in chevon patties with the incorporation of noni juice. However, no significant (P>0.05) difference in between treatments and control were recorded. Cholesterol content was also not influenced by incorporation of noni juice.

Emulsion pH was decreased with the addition of noni juice in low fat, low sodium functional chevon patties (Table 2). There was a significant (P<0.05) difference between NJ_3 and control. However, in between treatments no significant (P>0.05) difference was noticed. This might be due acidic nature of noni juice. Yıldız-Turp and Serdaroglu (2010) also observed decreasing pH value with increasing levels of plum puree in uncooked meat samples. Decrease in pH values were also observed by García *et al.* (2009) when 6% dried tomato puree was added to a hamburger formulation. Mean values of emulsion stability of noni incorporated chevon patties were higher as compared to control and increased with the increasing level of noni juice. Cooking yield of noni juice incorporated chevon patties were marginally higher as compared to control and differed significantly (P<0.05) at treatment NJ_3. All Noni-treated patties were similar (P > 0.01) in cooking loss to control patties (Ahrens *et al.,* 2011). The pH values of cooked chevon patties incorporated with noni juice were significantly (P<0.05) lower compared to control. However, in between treatments no significant (P>0.05) difference was estimated. This might be due to acidic nature of noni juice. Nayak and Pathak (2017) also reported lower pH value in plum puree added chevon patties. Similar results were also recorded by Candogan (2002) in meatballs formulated with tomato puree.

The TBA value of chevon patties were decreased significantly ($P<0.05$) with the increasing level of noni juice compared to control. Ulu (2004) reported that heating of samples during distillation promotes further oxidation leading to additional malonaldehyde and other TBA reacting substances. It is indicated that noni juice may be heat stable and withstands meat processing temperatures. The FFA and peroxide value also decreased with the increasing level of noni juice, but the difference was non significant. Pandey *et al.* (2016) also recorded lower TBARS value in treated samples than control while using BHA in pork sandwich. Das *et al.* (2011) also reported addition of curry leaf powder, into minced goat meat at a concentration of 0.2% resulted in a significant ($P<0.05$) reduction of TBARS, FFA and PV values compared to the control.

Noni juice incorporation up to the level of 5% in chevon patties did not show significant ($P>0.05$) difference in any of the estimated mineral in this experiment Table 3. However, marginal increment in sodium, potassium and iron contents was estimated with addition of noni juice. This might be due presence of these contents in noni juice (Sodium 25mg /100gm, calcium 46 mg/100gm and iron 1.0 mg/100gm). Vunchi *et al.* (2011) stated that moderate calcium value could be used for the management of oesteomalacia.

Texture profile of low fat low sodium chevon patties incorporated with different levels of noni juice (Table 4) indicated that hardness, gumminess and chewiness were decreased marginally with the addition of noni juice. This could be due to slight increase in the moisture and fat value with the noni juice addition. However, adhesiveness of chevon patties incorporated with noni juice was increased marginally compared to control. Ahrens *et al.* (2011) also observed lower Lee-Kramer shear force value in 5 % noni juice incorporated beef patties. Noni products may have extracted soluble proteins in the patties, tenderizing the beef as would happen in sausage manufacture. Springiness value was increased and cohesiveness value was decreased in noni juice incorporated chevon patties and significant ($P<0.05$) difference was estimated at 5% added level of noni juices. As a result of the research phase of examining the effect of the concentration of fruit syrup, it was shown that the firmness, gumminess and chewability of fruit concentrated lokum (value added Turkish delight) decreased with increasing amounts of black grape concentrate (Batu *et al.,* 2014). They also examined that springiness value was increased with black grape concentrate.

Mean values for instrumental color of low fat low sodium chevon patties incorporated with noni juice are presented in Table 4. Lightness (L^*) value decreased in noni juice incorporated chevon patties and significant ($P<0.05$) lower at NJ_2 and NJ_3 compared to control. However, lightness (L^*) value of NJ_1 was comparable to control. Redness *(a*)* and yellowness (b^*) values of chevon patties showed non significant ($P>0.05$) increasing trend with incorporation of noni juice. This might be due to slightly dark color of noni juice. Ahrens *et al.* (2011) also analyzed that patties with noni juice had higher yellow (b^*) color at 2.5% noni juice

Table 3: Mineral profile (Mean ± SE) of noni juice incorporated functional chevon patties

Minerals	**Treatments**			
(mg/100gm)	**C**	**NJ_1**	**NJ_2**	**NJ_3**
Sodium	445.54 ± 9.92	446.12 ± 12.45	446.58 ± 11.12	447.06 ± 10.23
Potassium	452.41 ± 18.76	452.91 ± 11.26	455.23 ± 10.23	457.34 ± 11.23
Calcium	61.26 ± 1.67	61.37 ± 1.32	62.18 ± 1.02	62.62 ± 1.17
Iron	2.96 ± 0.10	2.98 ± 0.12	3.02 ± 0.13	3.07 ± 0.11
Manganese	0.089 ± 0.003	0.089 ± 0.004	0.088 ± 0.003	0.089 ± 0.006
Zinc	2.41 ± 0.08	2.42 ± 0.09	2.41 ± 0.11	2.40 ± 0.14

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

C =Control - low fat, low sodium chevon patties without natural antioxidant, **NJ_1-** low fat, low sodium chevon patties with 1% noni juice; **NJ_2-** low fat, low sodium chevon patties with 3% noni juice and **NJ_3-** low fat, low sodium chevon patties with 5% noni juice.

Table 4: Texture and instrumental color profile (Mean±SE) of noni juice incorporated functional chevon patties

Parameter	Treatments			
	C	NJ_1	NJ_2	NJ_3
	Texture profile			
Hardness (N/cm^2)	40.72 ± 0.86	39.68 ± 0.46	39.21 ± 0.91	38.71 ± 0.67
Adhesiveness (Ns)	-4.09 ± 0.28	-4.18 ± 0.16	-4.30 ± 0.34	-4.42 ± 0.27
Springiness (cm)	0.873 ^{a} ± 0.007	0.901 ^{ab} ± 0.012	0.903 ^{ab} ± 0.015	0.921 ^{b} ± 0.011
Cohesiveness (Ratio)	0.703 ^{b} ± 0.009	0.683 ^{ab} ± 0.009	0.675 ^{ab} ± 0.010	0.643 ^{a} ± 0.017
Gumminess (N/cm^2)	33.97 ± 0.59	33.84 ± 0.73	33.62 ± 0.60	33.06 ± 1.18
Chewiness (N/cm)	27.63 ± 0.73	26.63 ± 0.80	26.24 ± 0.78	26.09 ± 0.53
	Instrumental color profile			
Lightness (*L**)	43.74^{c} ± **0.82**	42.46^{bc} ± **0.40**	41.60^{ab} ± **0.40**	39.65^{a} ± **0.51**
Redness (*a**)	3.26 ± 0.22	3.31 ± 0.19	3.59 ± 0.24	3.93 ± 0.27
Yellowness (*b**)	10.28 ± 0.44	10.99 ± 0.48	11.54 ± 0.58	12.10 ± 0.55

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

C =Control - low fat, low sodium chevon patties without natural antioxidant, **NJ_1**- low fat, low sodium chevon patties with 1% noni juice; **NJ_2**- low fat, low sodium chevon patties with 3% noni juice and **NJ_3**- low fat, low sodium chevon patties with 5% noni juice.

Table 5: Sensory attributes (Mean±SE) of noni juice incorporated functional chevon patties

Attributes	Treatments			
	C	NJ_1	NJ_2	NJ_3
General appearance	6.72 ^{a} ± 0.08	6.84 ^{ab} ± 0.07	6.94 ^{b} ± 0.07	6.92 ^{b} ± 0.06
Flavour	7.06 ± 0.07	7.07 ± 0.07	7.13 ± 0.08	7.12 ± 0.07
Texture	6.75 ^{a} ± 0.06	6.87 ^{a} ± 0.06	7.05 ^{b} ± 0.07	7.07 ^{b} ± 0.08
Saltiness	7.11 ^{b} ± 0.08	7.10 ^{b} ± 0.06	7.08 ^{b} ± 0.07	6.75 ^{a} ± 0.06
Juiciness	7.08 ± 0.07	7.14 ± 0.08	7.16 ± 0.07	7.18 ± 0.07
Mouth coating	6.89 ± 0.07	6.90 ± 0.06	6.96 ± 0.06	6.95 ± 0.06
Overall acceptability	7.08 ± 0.08	7.08 ± 0.09	7.12 ± 0.07	7.10 ± 0.06

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

C =Control - low fat, low sodium chevon patties without natural antioxidant, **NJ_1**- low fat, low sodium chevon patties with 1% noni juice; **NJ_2**- low fat, low sodium chevon patties with 3% noni juice and **NJ_3**- low fat, low sodium chevon patties with 5% noni juice.

in beef patties. Moreover, patties containing 2% noni were redder than those containing 6%, but that difference was small and irrelevant. Similarly, Batu *et al.* (2014) studied that that the lightness (*L**) value decreased in parallel with the increase in added red grape juice concentrate and redness (*a**) as well as yellowness (*b**) values increased in lokum mass.

Scores for sensory attributes of low fat low sodium chevon patties incorporated with different levels of noni juice are presented in Table 5. General appearance and texture scores were increased in chevon patties with the addition of noni juice. The marginal difference at NJ_1 and significant (P<0.05) difference at NJ_2 and NJ_3 were evaluated compared to control. This might be due to better binding of noni, providing good shape and color to the products. Batu *et al.* (2014) reported non significant difference in appearance between control and red grape juice concentrate added lokum mas. Yıldız-Turp and Serdaroglu (2010) in beef patties and Nunez de *et al.*

(2008) in beef roast also reported that addition of 5% plum had minimal effect on sensory color and appearance. A significant (P<0.05) difference in saltiness value of chevon patties at higher level ie 5 % noni juice incorporation were reported. This might be due to slightly salty taste of noni juice. However, for treatment NJ_1 and NJ_2 the saltiness value was comparable to control.

Flavor, juiciness, and mouth coating scores were also increased with the addition of noni juice in chevon patties. But difference was non significant (P>0.05). This might be due to 7% compositional sugar in added noni juice. Ahrens *et al.* (2011) and Tapp *et al.* (2010) also reported higher juiciness score in beef patties mixed with noni puree. However, they observed decreasing trend in flavor and mouth coating noni added beef patties. Likewise Candogan (2002) reported an increase in juiciness of patties with the addition of 10% and 15% tomato puree.

Overall acceptability did not differ significantly (P>0.05). However, sensory panelists rated highest score for overall acceptability in formulation of 3% noni juice and further addition of noni juice resulted in marginal reduction in acceptability. This is in agreement with sensory findings of Ahrens *et al.* (2011) who suggested that consumer panelists did not rate higher score for patties with 5% noni and scores for overall acceptance of 2.5% noni products were similar (P > 0.05) to control patties.

CONCLUSION

Based on the results obtained for various physico-chemicals, mineral profile, textural properties, color analysis and sensory attributes and discussion made in light of finding of other workers, formulation containing 3% Noni juice (NJ_2) may suitably be used in low sodium reduced fat functional chevon patties without affecting quality and sensory attributes of the product.

REFERENCES

AOAC. 1995. Official Methods of Analysis, 16th edn. Washington, DC, Association of Official Analytical Chemists, Pp. 1–23.

AOCS. 1992. Peroxide value acetic acid chloroform method. In: Official methods and recommended practices, firestone D. (Ed.). America Oil chemist Soci, Champaign, IL.

Aehle, E., Grandic S., Ralainirina, R., Baltora, R., Mesnard, S. and Prouillet, C. 2004. Development and evaluation of an enriched natural antioxidant preparation obtained from aqueous spinach (*Spinacia oleracea*) extracts by an adsorption procedure. *Food Chem*., **86**: 579-585.

Ahrens C.R., Yancey, J.W.S., Apple, J.K., Johnson, T.M. and Browne N.A. 2011. Effects of Noni puree vs. clarified Noni juice on quality characteristics of cooked ground beef patties. Arkansas animal science department report, pp. 93-96.

Alamed, J., Chaiyasit, W., McClements, D.J. and Decker, E.A. 2009. Relationships between free radical scavenging and antioxidant activity in foods. *J. Agric. Food Chem*., **57(7):** 2969–2976.

Anderson, E.T. and Berry, B.W. 2001. Effects of inner pea fiber on fat retention and cooking yield in high fat ground beef. *Food Res. Int.,* **34(8):** 689–694.

Babiker, S.A., El-Khider, I.A. and Shafie, S.A. 1990. Chemical composition and quality attributes of goat meat and lamb. *Meat Sci.,* **28**: 273–277.

Baliga, B.R. and Madaiah, N. 1970. Quality of sausage emulsion prepared from mutton. *J. Food Sci*., **35**: 383–385.

Batu, A., Arslan, A. and Eroğlu, A. 2014. Effects of Black Grape Syrup on Texture, Colour and Sensory Qualities of Value Added Turkish Delight (Lokum*). J. Nutri. Food Sci*., **S8**: 005

Bourne, M.C. 1978. Texture profile analysis. *Food Technol*., **32**: 62–66.

Candogan, K. 2002. The effects of tomato puree on some quality characteristics of beef patties during refrigerated storage. *European Food Res. Technol*., **215**: 305−309.

Conde, E., Gordon, M.H., Moure, A. and Dominguez, H. 2011. Effects of caffeic acid and bovine serum albumin in reducing the rate of development of rancidity in oil-inwater and water-in-oil emulsions. *Food Chem.,* **129(4)** : 1652–1659.

Das, A.K., Rajkumar, V. and Dwivedi, D.K. 2011. Antioxidant effect of curry leaf (*Murraya koenigii*) powder on quality of ground and cooked goat meat. *Int. Food Res. J.,* **18**: 563-569.

Devendra, C. 2010. Concluding synthesis and the future for sustainable goat production. *Small Rum. Res*., **89**: 125-130.

El-Magoli, S.B., Laroria, S. and Hansen, P.M.T. 1996. Flavour and texture characteristics of low-fat ground beef patties formulated with whey protein concentrate. *Meat Sci.,* **42**: 179–193.

García, L.M., Calvo, M.M. and Selgas, M.D. 2009. Beef hamburgers enriched in lycopene using dry tomato peel as an ingredient. *Meat Sci.,* **83**: 45−49.

Gulcin, I., Buyukokuroglu, M., Oktay, M. and Kufreviolu, I. 2003. Antioxidant and analgesic activities of turpentine of *Pinus nigra Arn*. subsp. *pallsiana* (Lamb.) *Holmboe. J. Ethnopharmacol.,* **86**: 51–58.

Horowitz, W. 1965. Official methods of analysis of the Association of Official Agricultural Chemists. Association of Official Agricultural Chemists, Washington, D.C. p. 193.

Hunter, R.S. and Harold, R. 1987. The measurement of appearance. 2nd ed. Wiley, New York. Little, A.C. 1975. Off on a tangent. *J. Food Sci*., **40**: 410-411.

Keeton, J.T. 1983. Effect of fat and sodium chloride phosphate levels on the chemical and sensory properties of pork patties. *J. Food Sci.,* **48**: 878–881.

Koniecko, E.K. 1979. Handbook for Meat Chemists, (Chapter 6). Pp. 68–69. New Jersey, NJ: Avery Publishing Group Inc.

Lee, E.J. and Ahn, D.U. 2005. Quality characteristics of irradiated turkey breast rolls formulated with plum extract. *Meat Sci.,* **71**: 300–305.

Madruga, M.S. and Bressan, M.C. 2011. Goat meats' Description, rational use, certification, processing and technical developments. *Small Rum. Res*., **98**: 39–45.

Murphy, E.W., Criner, P.E. and Grey, B.C. 1975. Comparison of methods for calculating retention of nutrients in cooked foods. *J. Agric. Food Chem.,* **23**: 1153-1157.

Nayak, N. and Pathak, V. 2017. Effect of plum puree on quality characteristics and sensory attributes of functional chevon patties. *J. Anim. Res.,* **7(1):** 1-4.

Naveena, B. M., Sen, A. R., Vaithiyanathan, S., Babji, Y. and Kondaiah N 2008. Comparative efficacy of pomegranate juice, pomegranate rind powder extract and BHT as antioxidants in cooked chicken patties. *Meat Sci.,* **80(4):** 1304-1308.

Nunez de Gonzalez, M.T., Hafley, B.S., Boleman, R.M., Miller, R.K., Rhee, K.S. and Keeton, J.T. 2008. Antioxidant properties of plum concentrates and powder in precooked roast beef to reduce lipid oxidation. *Meat Sci.,* **80**: 997-1004.

Pandey, A., Keshari, R.C. and Kumar, R.R. 2016. Effect of antioxidants mixture on the quality characteristics of pork sandwich spread stored under refrigeration (4±1ºC). *J. Anim. Res*., **6(3)**: 423-430.

Shahidi, F. and Zhong, Y. 2010. Novel antioxidants in food quality preservation and health promotion. *European J. Lipid Sci. Tech.*, **112:** 930–940.

Tapp, W., Nathan, J.W.S., Yanceya Jason, K,. Applea, Michael E., Dikemanb and Richard G. Godbee 2010. Noni puree (*Morinda citrifolia*) mixed in beef patties enhanced color stability. *Meat Sci*., **91**: 131–136.

Tarladgis, B.G., Watts, B.M., Younathan, M.T. and Dugan, L.R. 1960. A distillation method for the quantitative determination of malonaldehyde in rancid foods. *J. Am. Oil Chem. Soc*., **37**: 403–406.

Ulu, H. 2004. Evaluation of three 2-thiobarbituric acid method for the measurement of lipid oxidation in various meats and meat products. *Meat Sci*., **6**: 683-687.

Viuda-Martos, M., Ruiz Navajas, Y., Sanchez Zapata, E., Fernandez-Lopez, J. and PerezAlvarez, J.A. 2010.

Antioxidant activity of essential oils of five spice plants widely used in a Mediterranean diet. *Flavour and Fragrance J*., **25(1)**: 13–19.

Vunchi, M.A., Umar, A.N., King, M.A., Liman, A.A., Jeremiah, G. and Aigbe, C.O. 2011. Proximate, Vitamins and Mineral Composition of *Vitex doniana* (black plum) Fruit Pulp. *Nigerian J. Basic Appl. Sci.,* **19(1)**: 97- 101.

Waraho, T., Cardenia, V., Nishino, Y., Seneviratne, K.N., Rodriguez-Estrada, M.T., McClements, D.J. and Decker, E.A. 2012. Antioxidant effects of mono- and diacylglycerols in non-stripped and stripped soybean oil-in-water emulsions. *Food Res. Int.,* **48(2):** 353–358.

Webb, E.C., Casey, N.H. and Simela, L. 2005. Goat meat quality. *Small Rum. Res*., **60** : 153–166.

Yıldız-Turp , G. and Serdaroglu , M. 2010. Effects of using plum puree on some properties of low fat beef patties. *Meat Sci*., **86** : 896–900.

Zlatkis, A., Zak, B., Boyle, H.J. and Mich, D. 1953. A new method for direct determination of serum cholesterol. *J. Lab Clinic. Med*., **41**: 486-489.