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RESEARCH ARTICLE

Effect of incorporation of apple pomace on the physico-chemical, sensory and textural properties of mutton nuggets.

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Abstract

Mutton nuggets produced with the addition of apple pomace at the levels of 0% (Control), 5% (Treatment 1), 10% (Treatment 2) and 15% (Treatment 3) were evaluated for emulsion stability, cooking yield, pH, proximate composition, texture analysis and sensory properties. Apple pomace addition resulted in significantly higher ($p \leq 0.05$) emulsion stability and cooking yield of treatments in comparison to control and pH values were significantly higher ($p \leq 0.05$) for the control as compared to treatments. Among the treatments, the product with 15% apple pomace had significantly ($p \leq 0.05$) highest moisture content, and protein, ash and fat contents were significantly ($p \leq 0.05$) higher in control than treatment groups. Crude fiber content of control was found significantly ($p \leq 0.05$) lower in comparison to nuggets formulated with 5%, 10% and 15% apple pomace and was found to increase significantly ($p \leq 0.05$) with the increasing levels of apple pomace. Hardness of the products significantly ($p \leq 0.05$) decreased with addition of apple pomace, whereas springiness, cohesiveness, chewiness and gumminess showed a non-significant ($p \geq 0.05$) decrease with the levels of apple pomace. Sensory evaluation showed significant ($p \leq 0.05$) reduction in texture, flavour and overall acceptability scores of treatment products; however the scores were in the range of acceptability and T-1 showed better acceptability among apple pomace incorporated treatments.

1 Introduction

Meat is a highly nutritious and versatile food. Its principal components, besides water, are proteins and fats, with a substantial contribution of vitamins and minerals of a high degree of bioavailability. It is a good source of phosphorous, zinc and iron, but low in calcium. Raw meat is prepared in many ways, as steaks, dried meat, patties, loaves, sausages, etc. A simple technology has been developed to produce meat nuggets from different meats and their combination by forming a block using a mould and cutting the cooked meat block into nuggets of different sizes and shapes. This technology is of low cost as compared to modern technology using forming machines and emulsion of any desired consistency could be used. Fried, smoked, pickled typed variety meat nuggets could be produced (Kondaiah, 2004).

Negative campaign about muscle foods, and their possible health hazard effects, shows that consumers are increasingly interested about health oriented functional meat products that are low in salt, fat, cholesterol, nitrites and calories in general and in addition contain health-promoting bioactive components such as carotenoids, unsaturated fatty acids, sterols, and fibers. Changes in consumer demand of meat products as well as increased global competition, powerful influence of diet on health and well-being, increasing scientific evidence has revitalized the interests not only in consumer, but also among researchers and meat food product processors to develop formulated products, which are “natural, functional and nutritional” as well. At the same time, competition is forcing the meat processing industry to use the increasingly expensive raw material "meat" more efficiently and produce products at lower costs. One of the food ingredients greatly used when developing nutritionally designed foods that promote health is the dietary fiber (DF) (Puupponen-pimia et al., 2002). Functional modification in meat and meat products, modification of fatty acid and cholesterol levels in the meat, addition of natural extracts with antioxidant properties, limiting sodium chloride, incorporation of dietary fibers, inulins, gums, starch, proteins and reduction of nitrite are some of the approaches to make meat and meat products as functional foods (Fernandez-Gines et al., 2005). Fiber is suitable in meat products and has previously been used in meat emulsion products (Cofrades et al., 1995, Grigelmo-Miguel et al., 1999) because it has diverse functional properties such as moisture holding capacity, gel forming ability, viscosity, solubility, provide structural integrity, volume, adhesiveness and shelf stability in reduced-fat products and has a neutral flavour with no or fewer changes in textural parameters by enhancing water binding capabilities and carries great economical advantages for both the consumers and processors.

Fruit fibers have better quality due to higher total and soluble fiber content, water and oil holding capacity and colonic fermentability, as well as lower phytic acid and caloric value (Figuerola et al., 2005). Apart from dietary fiber, these health benefits are mainly attributed to organic micronutrients such as carotenoids, polyphenolics, tocopherols, vitamin C, and others (Schieber et al., 2002). There are many fruits, for example orange, apple, peach, sugar beet and olive, which are used for extraction of their juices. They all contain a by-product from which can be recovered different high-added value compounds; among those, it is the fiber fraction that has a great potential in the preparation of functional foods. Traditional fruits have many health benefits and especially apple (Malus domestica) is a typical source of dietary fiber (Goni et al., 1989). Apple pomace is the solid phase resulting from pressing apples for juice, containing the pulp, peels and cores. It accounts for 25-35 per cent of the dry weight of the apple processed (Joshi et al., 2009). In India, total production of apple pomace is about 1.3 million tonnes per annum and only approximately 10,000 tonnes of apple pomace is being utilized (Manimehalai, 2007). Apple pomace contains large amount of water and is in wet and easily fermentable form therefore causes serious disposable problems. Processing waste utilization is the necessity and a challenge to the food industry and needs first and foremost consideration to make the units economically viable through the recovery of the value added by-products (Joshi and Pandey, 1999). Apple pomace is considered as a rich source of nutrition and typically contains 66.4–78.2% (wb) moisture and 9.5–22.0% carbohydrates (Glucose and fructose). It also contains 26.4% dry matter, 4% proteins, 3.6% sugars, 6.8% cellulose, 4.30-10.5% crude fibre, 1.50-2.50% pectin, 0.38% ash, 0.42% acid and 8.7 mg calcium, per 100 g of wet apple pomace (Vasil’ev et al., 1976). Great improvements have been reported in water absorption capacity of wheat flour by addition of apple pomace (Masoodi *et al.,* 1988).Being a rich source of several nutrients, apple pomace has therefore been included in the formulations of several meat products such as nuggets, sausages, etc. Keeping in view the above facts the present study was undertaken to develop high fiber functional mutton nuggets, incorporated with apple pomace and to evaluate the influence of apple pomace on the physico-chemical, textural and sensory properties of the mutton nuggets.

2. Materials and methods

2.1 Materials

Mutton from the leg portions (Shank and foreshank) of freshly dressed carcass was procured from a local meat shop in district Budgam, and brought to the FPTC laboratory of Islamic university of Science and Technology Awantipora. After deboning, the external fat and visible connective tissue on the surface were removed by knife and lean meat was cut into cubes. Apples (*Malus domestica*) were purchased from local fruit market at Srinagar and were brought to the Food Processing laboratory, Islamic University, Awantipora. Fresh visceral fat preferably obtained from carcasses as well as all the visible fat trimmed off from the hot boned mutton was pooled and utilized for experiments. Condiments were prepared by making a fine paste of onion, garlic and ginger to optimize a final level of 10% in the standardized product. The various ingredients used in the spice mix in the preparation of mutton nuggets are shown in Table-1. Salt was purchased from local market.

2.2 Method

2.2.1 Apple pomace preparation

After washing and coring, apples were cut into small sized pieces and ground in an electric crusher (Vindhawashani Engineering, India). The crushed pulp was then pressed in hydraulic press (Vindhawashani, Engineering, India) and ground to the consistency of paste to obtain apple pomace.

2.2.2 Product preparation

Four types of formulations were prepared in which the meat percentage varied from 83% - 68% and 0.0% - 15% of apple pomace (Table-2). The nuggets were manufactured using the method as described by (Verma et al., 2010). Deboned lean meat was cut into pieces and minced properly in a grinder. Salt was added to the minced mutton with ice flakes and chopped again for 2-3 minutes. At this stage fat was incorporated slowly and meat was again chopped for 2-3 minutes, till it was completely dispersed in the batter. Whole egg, condiments, spice mix and apple pomace weighed according to the formulations shown in Table-2 were then added and chopping continued thoroughly till uniform dispersion of all the ingredients and desired consistency of the emulsion was achieved. Weighed quantity (1000 g) of four types of emulsions (control, T-1, T-2 and T-3) were taken and filled in to four moulds. Moulds were covered with lid and tied with thread and then cooked in a water bath (Memmert, Germany) for pre-standardised 35 minutes to achieve an internal temperature of about 85 ºC. After cooking, cooling was done to ambient temperature. Meat blocks thus obtained were sliced and cut into pieces to get nuggets (15 mm^3) and subjected to analysis.

2.2.3 Emulsion stability

Emulsion stability was determined as per the method described by Townsend et al. (1968) with some modifications. About 25 g emulsion samples were placed in polyethylene bags and heated at 80ºC in a thermostatically controlled water bath for 20 minutes. After draining out the exudates, the cooked mass was cooled, weighed and the yield was expressed as per cent emulsion stability.

2.2.4 Cooking yield

Cooking yield was determined by measuring weight of mutton nugget blocks before and after cooking for each treatment using electronic weighing balance (Plate-17) and calculating the ratio of cooked weight to raw weight and expressed as percentage.

pH determination

The pH of mutton nugget samples soon after their preparation was determined by the method of Trout et al. (1992) using a digital pH meter (Labindia). Ten gram of sample was blended with 50 ml of distilled water. The pH of the suspension was recorded by dipping combined glass electrode of digital pH meter.

2.2.5 Proximate composition

The percent moisture, protein, fat, ash, and crude fiber content of meat product samples were evaluated as per standard procedure of Association of Official Analytical Chemists (AOAC, 2005).

2.2.6 Texture profile analysis

Texture profile analysis (TPA) of nuggets was conducted by the procedure described earlier **(**Bourne, 1978) using Texture Analyser (TA.HD. Plus, Stable Micro Systems, Godalming, Surrey, UK) (Plate-22) attached to a software, texture expert. Chilled samples were tempered to bring to room temperature (27 ºC). Uniform- sized pieces (1.5×1.5×1.5 cm) were used as the test samples. They were placed on platform on a fixture and compressed to 50% of their original height at a cross head speed of 5 mm/s through a two cycle sequence, using a 25 kg load cell. The parameters determined were: Hardness (kg); Adhesiveness (kg×s); Cohesivenes (mm/mm); Springiness (mm); Gumminess (mm): (hardness × cohesiveness) and Chewiness (kg): (springiness × gumminess).

2.2.7 Sensory evaluation

The sensory attributes, namely appearance and colour, flavour, juiciness, texture and overall acceptability, were evaluated using an 8-point descriptive scale (Keeton, 1984) where 8 = extremely desirable as a sensory attribute and 1 = extremely undesirable. The nuggets were shallow pan fried in refined mustard oil until golden brown and served warm to a seven member panel of faculty members and post-graduate students in Food Science and Technology department, Islamic University of Science and Technology, Awantipora, to determine their sensory characteristics. Three digit coded samples were served to the panellists in random order. The nature of experiment was explained to the panellists without disclosing the identity of samples. Water was provided to rinse the mouth between the samples. The panellists judged the samples for appearance, flavour, texture, juiciness and overall acceptability.

2.3 Statistical analysis

The statistical design was 4 (treatments) × 3 (replications) randomised block design. Data generated were compiled and analysed following the standard procedure (Snedecor and Cochran, 1995), for the analysis of variance (ANOVA) and Tukey's test (at 5% significance level) using Minitab 16 for comparing the mean values to find the effect of treatments and their interactions for various parameters in different experiments.

3. Results and discussion

3.1 Emulsion stability

Emulsion stability of nugget samples are presented in Table 3. Emulsion stability of T-3 was highest with a mean percentage of 98.35% and emulsion stability of control was significantly ($p \leq 0.05$) lower as compared to treatments. Emulsion stability showed a significant ($p \leq 0.05$) increasing trend with the increasing levels of apple pomace. This significant increase could be due to the water holding capacity and high moisture absorption ability of the dietary fiber in apple pomace. This is in agreement with the results obtained by Turhan et al. (2005) who reported that the addition of various types of dietary fiber to meat products helps to improve emulsion stability and rheological properties. Same results were also obtained by Fernandez-Gines et al. (2003) in bologna sausage with different concentrations of orange fiber. Lanttoa et al. (2006) observed that apple pomace powder contained suitable enzyme activities which improved gel formation during heating in battered pork meat and thus increased emulsion stability.

3.2 Cooking yield

The results of cooking determinants indicated that the control showed significantly ($p \leq 0.05$) lower cooking yield than T-1, T-2 and T-3 (Table 3). Among the treatment groups cooking yield increased significantly ($p \leq 0.05$) with the increasing levels of apple pomace. Increase in cooking yield might be attributed to the increase in emulsion stability and due to the high ability of apple pomace to retain moisture and fat in the matrix. This finding is supported by the previous work of Aleson-Carbonell et al. (2005) on the incorporation of lemon albedo fibers in beef patty formulation which showed that dietary fibers increased cooking yield, because of their ability to keep moisture and fat in the matrix. Also cooking loss was affected by dietary fiber which decreased as the amount of dietary fiber increased (Chin et al., 2004). Similar findings were documented by Turhan et al. (2005) who reported that addition of hazelnut pellicle fiber was found to be effective in improving cooking yield.

3.3 pH

Results revealed that pH of the treatments were significantly ($p \leq 0.05$) lower than control (Table 3). pH values decreased significantly ($p \leq 0.05$) with the increasing level of apple pomace and significant effect was observed in mutton nuggets containing 15% apple pomace. The apparent significant reduction in pH values, as a result of apple pomace addition could possibly be due to the mild sourness of apple pomace. Decrease in pH scores are consistent with the findings of Verma et al. (2010) who reported that incorporation of apple pulp in low fat chicken nuggets resulted in gradual decrease in emulsion and product pH as the level of apple pulp increased. Viuda-Martos et al. (2010) also reported that addition of orange dietary fiber in bologna sausages resulted in decreased pH of treatments compared with control.

3.4 Proximate composition

The proximate composition of mutton nuggets is presented in Table 4. Proximate analysis proved that control recorded significantly ($p \leq 0.05$) lower moisture content than treatment groups (T-1, T-2 and T-3). The moisture content of treatments increased concomitantly with the level of apple pulp. Among all apple pomace based treatments, nuggets which was replaced with 15% (T-3) of pomace, recorded significantly highest ($p \leq 0.05$) moisture retention (65.89%). Increase in the moisture per cent among treatment products with increasing level of apple pomace could be due to comparatively higher moisture content in apple pomace. This is in accordance with the results obtained by Verma et al. (2010) who reported that moisture content of low fat chicken nuggets increased with the increasing level of apple pulp. The protein content of control was found to be significantly ($p \leq 0.05$) higher than T-1, T-2 and T-3. Among the treatments protein content decreased significantly ($p \leq 0.05$) with the increasing levels of apple pomace. The lower protein content among the treatments could be due to the replacement of lean meat by apple pomace. Trout et al. (1992) observed similar results and reported that protein percent of low fat beef patties containing polydextrose and oat flour as texture modifying ingredients was significantly decreased. Similar results was also observed by Huang et al. (2005) in emulsified pork meatballs incorporated with rice bran at the level of 5% and above. Results indicated that the mean fat value of control was significantly ($p \leq 0.05$) higher than T-1, T-2 and T-3. Among the treatment groups fat content of T-3 (15%) was significantly ($p \leq 0.05$) lower than T-1 and T-2 respectively. This decrease in fat content could be attributed to the increase in the level of apple pomace. These results agree with those reported by Fernandez-Gines et al. (2004) in which the addition of raw and cooked albedo at any concentration and 2.5 or 5.0% decreased fat content in sausages. Similar results were also reported by Sanchez-Escalante et al. (2001). Ash content of all treatments was found to decrease significantly ($p \leq 0.05$) with the increasing levels of apple pomace. This was in agreement with the findings of Verma et al. (2010) who reported that the ash content of low fat chicken nuggets decreased with the increasing levels of apple pulp. Crude fiber content of control was found significantly ($p \leq 0.05$) lower in comparison to nuggets formulated with 5%, 10% and 15% apple pomace and was found to increase significantly ($p \leq 0.05$) with the increasing levels of apple pomace. This significant increase in crude fiber could be possibly due to the higher fiber content of apple pomace. Verma et al. (2010) observed similar increase in the crude fiber in low fat chicken nuggets incorporating apple pulp. Fernandez-Gines et al. (2004) reported the utilization of lemon albedo, a major component of lemon peel as a source of dietary fiber increased the fiber content in bologna sausages.

3.5 Texture Profile Analysis

Results of the Texture profile analysis of control and treatments are shown in Table -6. The hardness value of control was significantly ($p \geq 0.05$) higher as compared to treatments with different levels of apple pomace. Among the treatments, the hardness values decreased significantly ($p \leq 0.05$) as the level of apple pomace increased and T-3 had significantly lower ($p \leq 0.05$) mean values than other treatments and control. This hardness reduction might be attributed to the incorporation of apple pomace in meat which resulted in the decreased protein binding and hence decreased hardness. High moisture retention might also be responsible for this hardness reduction among the treatments. Similar results were also obtained by Garcia et al. (2002) and Lin and Lin (2004) in low fat dry fermented sausages and Chinese style meatballs, respectively. Verma et al. (2010) also reported a similar decrease in the hardness values of low fat chicken nuggets with the increasing levels of apple pomace. The adhesiveness values show no significant difference ($p \geq 0.05$) in control as well as treatment products. The adhesiveness values for control and treatments were almost similar. This was in consonance with the findings of Huang et al. (2005) in emulsified pork meat balls incorporated with rice bean which showed a decrease in adhesiveness values. The springiness values of T-3 was significantly ($p \leq 0.05$) higher than control. However, a non-significant ($p \geq 0.05$) difference was observed between control, T-1 and T-2. The treatments were less hard and springier than the control. The cooking process of nuggets with added apple pomace could lead to some modifications in their structure, which could cause an increase in the springiness of treatment products as compared to control. Similar result was observed in low fat dry fermented sausages incorporated with fruit dietary fiber which had higher springiness value as compared to control (Garcia et al., 2002). The cohesiveness values show that Control group had significantly ($p \leq 0.05$) higher cohesiveness value in comparison to treatment groups. Non-significant difference ($p \leq 0.05$) in cohesiveness values was observed among the treatment products. According to Ho et al. (1997) frankfurters incorporated with soybean tofu powder through texture profile analysis showed non-significant differences between cohesiveness values. Lin and Lin (2004) reported a decrease in cohesiveness value with the increasing level of bacterial cellulose (Nata) in Chinese style meatballs. Gumminess values for control were significantly higher ($p \leq 0.05$) when compared to treatment products. Among the treatments, gumminess values decreased with the increasing levels of apple pomace although the difference was non-significant ($p \geq 0.05$). Mendoza et al. (2001) observed a similar decreasing trend in the gumminess values of low fat dry fermented sausages incorporated with inulin as a fat substitute and source of soluble dietary fiber. Verma et al. (2010) also reported that the gumminess values of low fat chicken nuggets decreased with the increasing levels of apple pomace. Among treatments, chewiness values showed non-significant ($p \geq 0.05$) difference. Lin and Lin (2004) also reported decrease in chewiness values of Chinese style meatballs containing bacterial cellulose (Nata). Das et al. (2006) studied the effect of textured soy granules and reduced beany flavour full-fat soy paste (FFSP) in a comminuted meat system and reported that chewiness values decreased in soy paste incorporated nuggets.

3.6 Sensory evaluation

The results obtained in the sensory analysis are presented in Table 5. The mean values of the appearance, flavor texture and juiciness were evaluated to determine overall acceptability. Mutton nuggets incorporating with 5% apple pomace indicated no significant difference from the control group ($p \leq 0.05$). However, appearance scores of control group was significantly higher ($p \leq 0.05$) than T-2 and T-3. Appearance showed a significant ($p \leq 0.05$) decreasing trend with the increasing levels of apple pomace. A comparable general appearance score between the treatments and control could be attributed to attractive pinkish colour in apple pulp. Similar results was found by Verma et al. (2010) who reported that the appearance scores of control were significantly higher than the low fat chicken nuggets containing apple pulp. The mean flavor scores revealed significant difference ($p \leq 0.05$) between control and treatment products. Flavour scores for control were significantly higher ($p \leq 0.05$) than treatment products. Among treatments, flavour scores decreased significantly ($p \leq 0.05$) with the increasing levels of apple pomace. The lower flavour scores among treatments could be due to the mild sweet fruity flavour attributed by the apple pomace at higher levels. Verma et al. (2010) reported that the flavour scores of control were significantly higher than the low fat chicken nuggets containing apple pulp. Texture scores of control were significantly higher ($p \leq 0.05$) than treatment products. Among treatments, texture scores decreased significantly ($p \leq 0.05$) with the increasing levels of apple pomace. However, the texture scores of control and 5% apple pomace incorporated mutton nuggets were comparable. Apple pomace incorporation might have contributed to lower texture scores for treatment product because it might have resulted in the decreased protein binding in matrix. The dilution effect of non-meat ingredients in meat protein systems has been primarily accounted for soft texture (Comer and Dempster, 1981). This was also in agreement with the findings of Verma et al. (2010) who reported a similar decrease in the texture scores of low fat chicken nuggets incorporated with apple pomace. No significant difference ($p \leq 0.05$) was observed in the juiciness scores of control and apple pomace incorporated nuggets. This comparable juiciness score between control and treatments could be attributed to higher moisture content in apple pomace. Verma et al. (2010) reported no significant difference in juiciness scores of control and apple pulp incorporated low fat chicken nuggets. Overall acceptability scores of control were significantly higher ($p \leq 0.05$) than T-2 and T-3, but non-significantly higher ($p \geq 0.05$) than T-1. Among treatments, overall acceptability scores decreased significantly ($p \leq 0.05$) with the increasing levels of apple pomace. The comparatively lower flavour and texture scores of treatments could be the factors that resulted in lower rating by the sensory panelists. Similar results was observed by Verma et al. (2010) who found that the overall acceptability scores of control were higher than treatments. However among the treatments, the differences were marginal.

Table-1 Composition of spices used in preparation of mutton nuggets.

Spices	**Percentage (%)**
Black cardamom (Badi elaichi)	5
Cinnamon (Dalchini)	20
Turmeric (Haldi)	10
Clove (Loang)	5
Red chilli	10
Coriander (Dhania)	20
Cumin (zeera)	10
Black pepper (Kalimirch)	10
Aniseed (Soanf)	10
Total	100

Table 2 Product formulation (g/1000 g) for control & pomace treated mutton- nuggets.

Ingredients	Treatments[a]			
	Control	**T-1**	**T-2**	**T-3**
Lean meat (g)	830	780	730	680

Fat (g)	100	100	100	100
Salt (g)	5	5	5	5
Water (g)	15	15	15	15
Egg (g)	10	10	10	10
Condiment mix (g)	20	20	20	20
Apple pomace (g)	0	50	100	150
Spice mix (g)	20	20	20	20

[a]Control: containing apple pomace (0%); T-1: containing apple pomace (5%); T-2: containing apple pomace (10%); T-3: containing apple pomace (15%).

Table-3 Effect of incorporation of apple pomace on the physico-chemical properties of mutton nuggets.

Parameters	**Control**	**T-1**	**T-2**	**T-3**
pH	5.80^{a} ±0.03	5.67^{b}±0.04	5.55^{c}±0.04	5.41^{d} ±0.04
Cooking yield (%)	95.01^{a}±0.10	96.25^{b}±0.05	97.21^{c}±0.05	97.90^{d}±0.05
Emulsion stability (%)	95.57^{a}±0.02	96.43^{b}±0.07	97.32^{c} ±0.24	98.35^{d} ±0.06

All values are average of three determinations. Row-wise mean values bearing different superscripts (Small) differ significantly ($p \leq 0.05$). Control: containing apple pomace (0%); T-1: containing apple pomace (5%); T-2: containing apple pomace (10%); T-3: containing apple pomace (15%).

Table-4 Effect of incorporation of apple pomace on the proximate composition of mutton nuggets.

Parameters	**Control**	**T-1**	**T-2**	**T-3**
Moisture (%)	63.71^{a} ±0.07	64.48^{b}±0.07	65.15^{c} ±0.07	65.89^{d} ±0.06
Fat (%)	13.00^{a} ±0.05	12.07^{b}±0.02	11.15^{c} ±0.04	10.15^{d} ±0.04
Ash (%)	3.54^{a} ±0.06	3.09^{b}±0.06	2.89^{c} ±0.05	2.70^{d} ±0.05
Crude fiber (%)	0.67^{a}±0.02	1.91^{b} ±0.05	2.52^{c} ±0.02	3.29^{d} ±0.05
Protein (%)	16.89^{a} ±0.04	14.85^{b} ±0.13	14.20^{c} ±0.06	13.90^{d} ±0.06

All values are average of three determinations. Row-wise mean values bearing different superscripts (Small) differ significantly ($p \leq 0.05$). Control: containing apple pomace (0%); T-1: containing apple pomace (5%); T-2: containing apple pomace (10%); T-3: containing apple pomace (15%).

Table-5 Effect of incorporation of apple pomace on the sensory properties of mutton nuggets.

Parameters	Control	T-1	T-2	T-3
Appearance/colour	7.55^{a} ±0.05	7.45^{a} ±0.05	7.21^{b} ±0.02	7.08^{c} ±0.02
Flavour	7.41^{a} ±0.06	7.23^{b} ±0.02	7.09^{c} ±0.01	6.95^{d} ±0.01
Texture	7.46^{a} ±0.02	7.38^{a} ±0.02	7.25^{b} ±0.05	7.08^{c} ±0.02
Juiciness	7.27^{a} ±0.02	7.23^{a} ±0.02	7.28^{a} ±0.02	7.27^{a} ±0.02
Overall acceptability	7.51^{a} ±0.07	7.41^{a}±0.02	7.13^{b}±0.02	6.85^{c} ±0.04

All values are average of three determinations. Row-wise mean values bearing different superscripts (Small) differ significantly ($p \leq 0.05$). Control: containing apple pomace (0%); T-1: containing apple pomace (5%); T-2: containing apple pomace (10%); T-3: containing apple pomace (15%).

Table-6 Effect of incorporation of apple pomace on the sensory properties of mutton nuggets.

Parameters	Control	T-1	T-2	T-3
Hardness (kg)	75.16^{a} ±0.12	55.29^{b} ±0.04	50.75^{c} ±0.05	46.24^{d} ±0.06
Adhesiveness (kg×s)	-0.08^{a} ±0.02	-0.09^{a} ±0.03	-0.04^{a} ±0.03	-0.05^{a} ±0.03
Springiness (mm/mm)	0.78^{a} ±0.07	0.81^{ab} ±0.03	0.83^{ab} ±0.05	0.86^{b} ±0.05
Cohesiveness(mm/mm)	0.46^{a} ±0.02	0.31^{b} ±0.02	0.35^{b} ±0.04	0.35^{b} ±0.05
Gumminess (kg)	33.81^{a} ±0.03	23.03^{b} ±0.04	20.63^{b} ±0.02	19.42^{b}±0.04
Chewiness (kg)	26.53^{a} ±0.02	18.70^{b} ±0.02	17.13^{b} ±0.03	16.77^{b} ±0.03

All values are average of three determinations. Row-wise mean values bearing different superscripts (Small) differ significantly ($p \leq 0.05$) Control: containing apple pomace (0%); T-1: containing apple pomace (5%); T-2: containing apple pomace (10%); T-3: containing apple pomace (15%).

Conclusion

The results of this investigation indicate that, mutton nuggets containing apple pomace had improved emulsion stability and cooking yield than the control sample. Incorporation of apple pomace at 5% (T-1) level in mutton nuggets for increasing fiber content while maintaining physico-chemical and sensory properties were possible. Crude fiber content of control was found significantly ($p \leq 0.05$) lower in comparison to nuggets formulated with 5%, 10% and 15% apple pomace and was found to increase significantly ($p \leq 0.05$) with the increasing levels of apple pomace. The textural properties show that hardness of the products significantly ($p \leq 0.05$) decreased with addition of apple pomace, whereas springiness, cohesiveness, chewiness and gumminess showed a non-significant ($p \geq 0.05$) decrease with the levels of apple pomace. Since control had higher overall acceptability, however the scores for treatments were also in the range of acceptability and T-1 showed better acceptability among apple pomace incorporated treatments. Apple pomace being a rich source of carbohydrate, pectin, crude fibre and minerals; has potential for use in restructured meat products. The incorporation of apple pomace in meat products could help to overcome the fiber deficit in actual human diet.

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