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Quality Characteristics of Functional Spent Hen Meat Nuggets Incorporated with Amla (*Emblica officinalis*) Fruit Juice Powder

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ABSTRACT

The present study was conducted to develop functional fibre enriched spent hen meat nuggets (SMN) with incorporation of amla fruit juice powder. Four different products with amla fruit juice powder with the replacement of lean meat viz. 0% (Control), 0.5% (T_1), 1.0% (T_2) and 1.5% (T_3) were prepared and optimum level of amla fruit juice powder was selected on the basis of physico-chemical, proximate analysis, instrumental texture and color profile, and sensory analysis. The pH decreased whereas water activity (a_w) and moisture content followed an increasing trend with the increase in the level of incorporation of amla fruit juice powder in the SMN. The cooking yield and emulsion stability significantly ($P<0.05$) increased with the incorporation of amla fruit juice powder. The fat percentage was comparable in T_1 and T_2 and was significantly ($P<0.05$) higher than T_3. Protein content decreased whereas crude fiber and ash increased with the increase in level of incorporation of amla fruit juice powder. Color profile did not vary significantly ($P<0.05$) among the different treatments with the incorporation of amla fruit juice powder. Hardness, chewiness and gumminess significantly decreased whereas springiness, resilience showed an increase with in treatments and control. The overall acceptability in treated products was higher than control. Sensory panelists awarded highest overall acceptability scores to T_2. Results concluded that functional fibre enriched spent hen meat nuggets can be successfully manufactured with the incorporation of 1.0% amla fruit juice powder.

Keywords: Amla powder, antioxidant, functional, spent hen meat nuggets

Poultry industry in India is growing at a very fast pace and India is placed at 3rd position in egg production and 5th position in broiler production globally (Chatli *et al.,* 2015). Mammoth egg production resulted in 1.4 lakh tons of layer hens after completion of productivity and their disposal at suitable price remains a big challenge to poultry industry. The meat obtained from spent hen is tough, chewy and has poor juiciness, so fetches low price in the market and cost of transportation, handling of this meat exceeds their value for meat (Aho, 1999). However, toughness of spent hen meat is no obstacle for the production of a variety of comminuted products and utilization of various processing technologies. The proper utilization of spent hen meat can resolve the problem of protein deficiency and may generate additional revenues for the farmers.

In the last decades, India has experienced a rapid rise in urbanization and globalization which has contributed largely to changes in lifestyle and food habits of people leading to more inclination towards fast/ready-to-eat products. These fast foods are rich in saturated fats and sugars (Aleson-Carbonell *et al*., 2005) and lack minimum amount of dietary fibre to fulfill the recommended dietary intake (Verma and Banerjee, 2010). Meat and meat products are inherently low in dietary fibre and antioxidants.

Dietary fibre (DF) is the remnant of edible part of plants and are resistant to digestion and absorption in small intestine of humans (Prosky, 1999). DF acts as bulking agent, normalize the intestinal motility and act as protective agent against heart diseases, constipation, colon cancer, irritable colon and diabetes (Rodriguez *et al*., 2006; Jenkins *et al.,* 1998). Rani *et al.* (2015) developed fiber enriched functional chicken meat bullets from spent hen meat with the incorporation of different levels of maltodextrin as source of fiber.

Antioxidants are very important in maintaining normal health and well-being and provide protection against damage caused by free radicals. Oxidative damage of genetic material, proteins and other macromolecules has been concerned in the pathogenesis of variety of diseases such as heart diseases, cancer and ageing (Halliwell, 1994). The addition of antioxidant in meat plays a major role in prevention of oxidative deterioration during processing and storage. Utilization of synthetic antioxidants may cause potential health problems (Raghavan and Richards, 2007), thus enhancing the research for addition of natural antioxidants to protect the consumers and food from the harmful effects resulting from oxidation.

Amla (Emblica officinalis) is one of the natural source of nutraceuticals and functional components and is second richest in terms of vitamin C content having approximately 600 to 700 mg of vitamin C per fruit (Goraya *et al.,* 2015). Amla is a rich source of ascorbic acid, phenols and tannins that are responsible for its antioxidant activity. Amla is a good source of pectin that regulates bowel action, treats pulmonary tuberculosis, and has anti-diabetic effect (Yokozawa *et al.,* 2007). Amla fruits are reported to have hypolipidemic (Anila and Vijayalakshmi, 2000) and hypoglycemic activities (Abesundara *et al.,* 2004). Giriprasad *et al.* (2015) successfully developed functional restructured buffalo meat steaks with the incorporation of optimum level of *mousambi* peel and amla powder with lowering of oxidative deteriorative changes during storage.

Therefore, the present study was undertaken to develop fiber enriched functional spent hen meat nuggets with the optimum level of amla fruit juice powder in the formulation.

MATERIALS AND METHODS

Sources of materials

White leghorn layers of age 70 weeks were procured from poultry farm of GADVASU, Ludhiana. All the formulation additives were procured from local market, Ludhiana. Amla fruit juice powder was procured from Biomax Life Sciences Limited, Hyderabad, India. Low density polyethylene (LDPE) bags of 140 gauze and double layered polyester; 100/100µ) laminated pouches were procured from reputed firms.

Preparation of spent hen meat nuggets

Spent hen meat nuggets were developed using pre-standardized formulation and process protocol in the laboratory. Frozen deboned spent hen meat chunks were thawed overnight in a refrigerator (4±1ºC) and the meat was double minced in a mincer through plates of size 4mm. Meat was chopped for 3 min in bowl chopper while adding additives as per formulation (Table 1) to obtain emulsion of desired consistency. Remaining ingredients were then incorporated and chopped to obtain emulsion of desired characteristics.

Table 1: Formulation of Spent Hen Meat Nuggets

Ingredients %	Control	T_1	T_2	T_3
Lean meat	69.5	69.0	68.5	68
Refined Oil	7.5	7.5	7.5	7.5
Spices	2.5	2.5	2.5	2.5
Salt	1.5	1.5	1.5	1.5
Condiments	3.0	3.0	3.0	3.0
Chilled water	7.5	7.5	7.5	7.5
Refined Wheat flour (Maida)	3.0	3.0	3.0	3.0
TSPP	0.3	0.3	0.3	0.3
Sugar	0.2	0.2	0.2	0.2
Egg Albumen	5.0	5.0	5.0	5.0
Sodium Nitrite (ppm)	120	120	120	120
Amla fruit juice powder	—	0.5	1.0	1.5

The emulsion was placed into moulds and steam cooked in autoclave at 121ºC at 15psi for 15 min. The cooked product was taken out and cut into rectangular or cubical meat nuggets. Three treatments of spent hen meat nuggets having varying levels of amla fruit juice powder as source of antioxidant; control (0%), T_1 (0.5%), T_2 (1%), T_3 (1.5%) were formulated. The cooked products were analyzed for various physico-chemical properties, proximate composition and sensory attributes.

Analytical procedure

pH

The pH of spent hen meat nuggets was determined as per the method of Trout *et al.*(1992) using digital pH meter equipped with a combined glass electrode.

Emulsion stability and cooking yield

Twenty gram of meat emulsion was taken in low density polyethylene (LDPE) bags of 150 gauge (11cm x10 cm) and were placed in a thermostatically controlled water bath (Equitron, Model: 8414, Medica Instrument Mfg. Co., Mumbai, India) at 80±1ºC for 20 min. Thereafter, fluid was drained off and cooked mass was measured, and emulsion stability was expressed as percentage. Cooking yield was estimated by measuring the weight of spent hen meat emulsion and cooked nuggets and yield was expressed as percentage with the following formula.

Cooking yield % =

$$\frac{\text{Wt. of cooked spent hen meat nuggets}}{\text{Wt. of spent hen meat emulsion}} \times 100$$

Proximate analysis

The moisture content of spent hen meat nuggets was determined by standard procedure of (AOAC, 1995). Fat content in spent hen meat nuggets was estimated by ether extraction (AOAC, 1995) using Socs Plus (SCS-6-AS, Pelican Industries, Chennai). The protein content of spent hen meat nuggets was estimated as per method described in AOAC (1995) with suitable modifications using automatic digestion and distillation unit (Kel Plus-KES 12L, Pelican Industries, Chennai). Crude fibre content of spent hen meat nuggets was estimated as per AOAC (1995) method using Fibra Plus, automatic unit, (FES-6, F-09014, Pelican Industries, Chennai). The ash content in the spent hen meat nuggets was estimated as per (AOAC, 1995) method using muffle furnace.

Texture profile analysis

Texture profile analysis (TPA) was conducted using texture analyzer (TMS- PRO, Food Technology Corporation, USA) following the method of Bourne (1978). Samples of size 1.0 cm × 1.0 cm × 1.0 cm were cut from cooked spent hen meat nugget and subjected to pre-test speed (30mm/sec), post test speed (100 mm/sec) to a double compression cycle with a load cell of 100 N. Parameters like hardness, gumminess, stringiness, springiness, resilience, chewiness, and cohesiveness were calculated automatically by the preloaded software in the equipment from the force time plot.

Instrumental color profile

Color profile was measured using CR-400, Konica Minolta, Chroma Meter (Japan) set at 2º of cool white light (D65) and known as L^*, a^*, b^* values. L^* value denotes (brightness 100), or lightness (0), a^* (0+ redness/- greenness), b^* (+ yellowness/-blueness) values were recorded on spent hen meat nugget sample. The instrument was calibrated using white tile provided with the instrument. Then the above color parameters were selected. The instrument was directly put on the surface of spent hen meat nugget sample and values were recorded.

Sensory analysis

Seven experienced panelists were selected from the scientific staff and postgraduate students of GADVASU, Ludhiana, India. Protocol for sensory analysis was approved by the departmental research committee. Panelists were selected on the basis of previous experience in consuming meat products, availability and willingness. Furthermore, the panel members were detailed about the quality attributes of nuggets. Sensory evaluation was initiated after the panelists agreed with the descriptors. An 8-point descriptive scale was used for different sensory quality attributes viz. appearance and color, flavor, tenderness, juiciness and overall acceptability (Keeton, 1983) where 8-extremely desirable, 7-very desirable, 6-moderately desirable, 5-slightly desirable, 4-slightly undesirable, 3-moderately undesirable, 2-very undesirable and 1-extremely undesirable. Sensory evaluation for all the batches was carried out in the laboratory, according to the international standards (ASTM, 1986). Rectangular pieces (approx. 2×3cm) of nuggets were served at room temperature. The samples were coded with randomized numbers and presented to each panelist for evaluation.

Drinking water was provided between samples to cleanse the palate.

Statistical analysis

The data obtained from different set of each experiment were subjected to statistical analysis (Snedecor and Cochran, 1954) for one way Analysis of Variance (ANOVA) on Completely Randomized design (CRD) and Duncans multiple range test (DMRT) to compare the means with standard error (SE) by using SPSS-20 (SPSS Inc. Chicago IL, USA). The whole set of experiments were repeated three times for the consistency of the results. Samples for each parameter were drawn in duplicate leading to observation 6 (n=6) whereas in instrumental texture and color profile, 4 samples were drawn for analysis (n=12) and similarly seven panelist analyzed the samples for sensory attributes (n=21). The statistical difference was expressed at 5% level of experiment.

RESULTS AND DISCUSSION

Physico-chemical characteristics

Table 2 depicted the effect of different levels of amla fruit juice powder on physico-chemical characteristics of SMN. The pH of the product decreased with increasing level of amla powder in the formulation. This is attributable to the innate pH of the amla powder, which was estimated as 2.42. Water activity (a_w) and moisture content followed an increasing trend with the increase in the level of incorporation of amla fruit juice powder in the SMN. The highest a_w was estimated for T_3, which was significantly ($P<0.05$) higher than T_1 and control. The percent moisture content followed an increasing trend in treated products. It might be due to the water binding property of the dried amla fruit juice powder. Verma *et al.* (2013) also observed increase in moisture content with the incorporation of guava powder in sheep meat nuggets. Similar results were documented by Soncu *et al*. (2015) in beef hamburger with incorporation of dried carrot and lemon powder. This could be due to absorption and retention of added water by fruit juice powder during emulsion preparation. Emulsion stability was significantly ($P<0.05$) higher in all the treated products than control. The lower expressible fluids were attributable to improved emulsion stability. The cooking yield improved with the incorporation of amla fruit juice powder. It was recorded highest in T_3 (91.42 ± 0.10) and the lowest is T_1 (89.53±0.08) amongst the treatment. The cooking yield was significantly ($P<0.05$) lower in control than all the treated products. This could be due to the lower cooking losses with improved water binding ability of the formulation.

Table 2: Effect of different levels of incorporation of amla fruit juice powder on physico-chemical characteristics of the spent hen meat nuggets (Mean ±S..E)*

Parameters	Treatments			
	Control	T_1	T_2	T_3
pH	6.25 ± 0.02^d	6.21 ± 0.01^c	6.18 ± 0.03^b	6.11 ± 0.01^a
Water activity (a_w)	0.87 ± 0.01^a	0.91 ± 0.02^b	0.94 ± 0.01^c	0.95 ± 0.02^c
Cooking yield (%)	88.54 ± 0.11^a	89.53 ± 0.08^b	90.55 ± 0.13^c	91.42 ± 0.10^d
Emulsion stability (%)	88.60 ± 0.16^a	89.40 ± 0.12^b	90.58 ± 0.13^c	91.45 ± 0.10^d
Moisture (%)	55.15 ± 0.04^a	56.71 ± 0.08^b	57.92 ± $.07^c$	58.48 ± 0.06^d
Fat (%)	15.77 ± 0.11^c	14.96 ± 0.20^b	14.91 ± $.01^b$	14.47 ± 0.12^a
Protein(%)	17.5 ± 0.11^b	16.51 ± 0.09^{ab}	16.14 ± 0.14^a	15.81 ± 0.20^a
Crude fibre (%)	0.58 ± 0.03^a	0.7 ± 0.04^b	1.2 ± 0.07^c	1.34 ± 0.05^c
Ash(%)	4.33 ± 0.09^a	5.61 ± 0.07^b	5.93 ± $.08^b$	6.00 ± 0.06^c
Calories (Kcal/100g)	224.48 ± 1.10^b	211.72 ± 0.64^a	210.16 ± 0.76^a	208.54 ± 0.81^a

n=6, Control; T_1-0.5%; T_2-1%; T_3-1.5% amla fruit juice powder

*Mean ±S.E. with different superscripts row-wise (a-d) differ significantly ($P<0.05$)

Proximate composition

Proximate composition of SMN is presented in Table 2. The fat percentage was comparable in T_1 and T_2 and was significantly ($P<0.05$) higher than T_3. It might be due to the incorporation of the amla fruit juice powder with the replacement of meat in the formulation. Fat percentage was significantly ($P<0.05$) higher in control then all the treated products. Protein content also followed a decreasing trend with increase in level of incorporation of amla fruit juice powder. It was significantly (P<0.05) lower in T_3 and T_2 than control. The crude fiber content followed an increasing trend with an increase in the level of incorporation of amla fruit juice powder. The crude fiber content was significantly (P<0.05) higher in all the treated products. Verma *et al.* (2013) also reported increase in fiber content of sheep meat nuggets with incorporation of guava juice powder. In the present study, the fiber content in developed products increased more than 200% than control, which identifies the developed product as functional meat product. Addition of amla fruit juice powder significantly (P<0.05) increased the ash content in the product. This could be due to higher ash content in amla fruit juice powder, which represents mineral content in amla fruit. Calorie content was comparable in all the treated products and was significantly (P<0.05) lower than control. This could be due to variation in proximate composition of the treated and control products. Calorie content was recorded 6-7% lower in treated products as compared to control.

Instrumental texture profile

Textural profile characteristics (Table 3) varied significantly (P< 0.05) within treatments and with control. Hardness and chewiness were being lowest in T_3 amongst the treatment. However, these were significantly (P<0.05) higher in control than all the treated products. These observations can be correlated with the results of higher moisture content and low fat content in treatments than control. Similar observations were recorded by Soncu *et al.* (2015), in low fat beef burger, with incorporation of the dried carrot and lemon powders. The springiness was found to be higher in the treatments in comparison to the control. It was recorded highest in T_3 and lowest in T_1 among the treatments. However, Soncu *et al.* (2015) and Verma *et al.* (2013) reported significant decrease in springiness of the respective product with incorporation of fruit juice powders. Trout *et al*. (1992) reported the springiness follow an irregular behavior with the addition of different fiber sources in meat products. Cohesiveness was comparable in all the products irrespective of level of incorporation of additive in the formulation. The gumminess significantly (P<0.05) decreased in the treated products than control. This could be correlated with the changes in the fat content and other prominent variables in the developed product. The literature in this regard exhibited varied views. Crehana *et al.* (2000) and Rani *et al.* (2015) reported decrease, Soncu *et al.* (2015) reported increase and Verma *et al.* (2013) reported that there is no effect of incorporation of fibre on gumminess of meat products. It might be due to the difference in source of fibre, amount of fibre added and type of meat product.

Table 3: Effect of different levels of amla fruit juice powder on instrumental textural profile of spent hen meat nuggets (Mean ±S.E)*

Parameters	Treatments			
	Control	**T_1**	**T_2**	**T_3**
Hardness (N)	14.88 ± 0.12^d	13.55 ± 0.14^c	12.69 ± 0.19^b	11.59 ± 0.16^a
Springiness (mm)	13.66 ± 0.12^a	15.51 ± 0.14^b	17.35 ± 0.07^c	19.75 ± 0.12^d
Stringiness (mm)	17.57 ± 0.20^a	19.66 ± 0.13^b	20.52 ± 0.11^c	21.40 ± 0.14^d
Cohesiveness	0.57 ± 0.05^a	0.54 ± 0.02^a	0.53 ± 0.03^a	0.51 ± 0.01^a
Gumminess (N)	9.57 ± 0.09^d	8.48 ± 0.07^c	7.65 ± 0.05^b	6.85 ± 0.03^a
Chewiness (J)	112.60 ± 0.12^b	111.98 ± 0.26^{ab}	111.4 ± 0.1^b	110.95 ± 0.29^a
Resilience	1.55 ± 0.08^a	2.17 ± 0.4^b	2.37 ± 0.18^{bc}	2.62 ± 0.03^c

n=18, Control; T_1-0.5%; T_2-1%; T_3-1.5% amla fruit juice powder

*Mean ±S.E. with different superscripts row-wise (a-d) differ significantly (P<0.05)

Instrumental color profile

Color is first criteria for acceptability and marketing of meat products. In the present study the instrumental color profile *(L*, a*, b*)* did not vary with the varying level of amla fruit juice powder. The treated products were comparable to control. Hence the use of amla fruit juice powder as an additive for the development of functional spent hen meat nuggets can be easily acceptable by the consumer without any discrete views.

Table 4: Effect of different levels of amla fruit juice powder on Instrumental Color Profile of spent hen meat nuggets (Mean ±S.E)*

	Control	**T_1**	**T_2**	**T_3**
Lightness (*L**)	59.37±0.28	59.81±0.22	59.85±0.31	59.66±0.47
Redness (*a**)	11.34±0.18	11.39±0.30	11.48±0.26	11.40±0.34
Yellowness (*b**)	24.15±0.44	23.19±0.57	23.76±0.32	23.77±0.54

n=18, Control; T_1-0.5%; T_2-1%; T_3-1.5% amla fruit juice powder

*Mean ±S.E. with different superscripts row-wise (a-d) differ significantly (P<0.05)

Sensory quality attributes

Mean sensory scores of SMN are presented in Fig. 1. Sensory score of color and appearance were comparable in all the treatments and control. These results are in consonance with finding of instrumental color profile. It can be attributable to the fact that very small quantity was added in the formulation.

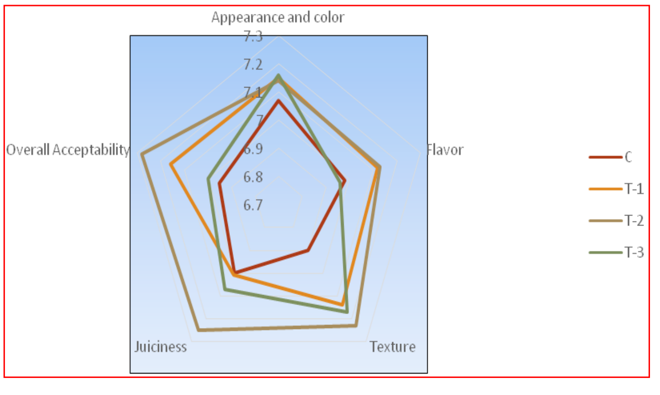

Fig. 1: Effect of Amla fruit juice powder on sensory attributes of Spent Hen Meat Nuggets

n=21, Control; T1-0.5%; T2-1%; T3-1.5% amla fruit juice powder

Mean flavor score were comparable among all treated and control products. However, the numeric value of mean flavor scores was recorded lowest in T_3. Soncu *et al.* (2015) reported lowering of the flavor scores with incorporation of fruit powders. However, Verma *et al.* (2013) documented that the flavor scores remain unaffected with incorporation of guava powder in the meat product. Texture and juiciness scores were significantly (P<0.05) improved in treated products than control. The sensory panelists awarded highest score to T_2 among the treated products for texture and juiciness. The improved score of texture and juiciness are in accordance with our results for moisture content and instrumental texture profile presented in Table 2 and 3. The optimum increase in moisture content improves the mouth feel and body of the product. Similar finding were reported by (Rani *et al.,* 2015; Chatli *et al.,* 2015). The overall acceptability in treated products was higher than control. Sensory panelists have awarded highest overall acceptability scores to T_2. Although, these were not significantly (P<0.05) higher than T_1 and T_3. Hence, T_2 was selected due to its better compositional texture profile and sensory attributes for further study. The selected product was further subjected to experimentation for extension of storage life.

CONCLUSION

Results concluded that functional fibre rich spent hen meat nuggets can be successfully developed with the incorporation of 1% amla fruit juice powder with the increase of fibre content by 200% and better cooking yield, textural and sensory characteristics.

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