Research Articles

Journal of Meat Science
Year 2024 (December), Volume-19, Issue-2

Optimization of Shatavari Powder Incorporation in Poultry Meat Nuggets

Silpa Sasi1, T. Sathu[2], Sunanda. C[3], Pavan.M[4], V.N. Vasudevan[2], Irshad. A[2]

Dept. of Livestock Products Technology and Meat Technology Unit, College of Veterinary and Animal Sciences, Mannuthy, Kerala-680 651
[1]PG Scholar, Department of Livestock Products Technology
[2]Assistant Professor, Department of Livestock Products Technology
[3]Assistant Professor, Department of Statistics
[4]Ph.D. scholar, Department of Livestock Products Technology

ARTICLE INFO

*Correspondingauthor:
E-mailaddress: silpa.s@kvasu.ac.in ,
Ph: 8075394869

doi10.48165/jms.2024.19.02.08

ABSTRACT

The present study was designed to determine the optimal concentration of Shatavari powder for integration into poultry meat nuggets. Various levels of Shatavari powder, at 0.5%, 1%, and 1.5%, were incorporated into the formulation of poultry meat nuggets, comprising 75% chicken and 25% duck meat, along with 2% jackfruit powder. Based on the sensory attributes, 0.5 percent shatavari powder was selected as the optimum level . Shatavari powder had a significant effect on the flavor, juiciness, texture, saltiness, and overall acceptability of the developed nuggets. The increase in levels of shatavari powder had an adverse effect on the sensory attributes due to the inherent bitter taste of the powder. The addition of shatavari powder at 0.5% in the nugget formulations was effective in sustaining the desired sensory attributes besides the nutritional benefits. Hence, acceptable functional nuggets can be made with the addition of shatavari powder up to two percent over and above the nuggets formulation containing 2 % jackfruit powder without affecting the sensory attributes.
Key words: nuggets, jackfruit powder, shatavari powder

INTRODUCTION

The relationship between food and human health has been a subject of research since ancient times. The dynamics of food production and consumption exhibit a profound connection to human health and overall well-being. In the era of advancing technologies, an escalating array of beneficial food products, fortified with functional ingredients, has gained importance in the global market. Functional foods, characterized by fortification, enrichment, or enhancement with bioactive components, hold the potential to mitigate disease risks and confer additional physiological benefits. These products assert claims of health improvement and disease prevention when integrated into a balanced diet and a healthy lifestyle.

The integration of jackfruit and *shatavari* (Asparagus racemosus) into functional meat products represents a novel approach to enhancing their nutritional and health-promoting properties. Jackfruit, with its abundant bioactive components such as flavonoids, carotenoids, and phenolic compounds, has been increasingly recognized for its potential to reduce the risk of chronic diseases and improve overall health. Its antioxidant, anti-inflammatory, and antimicrobial properties make it a suitable candidate for functional food development. However, its application in meat products has been largely unexplored, which presents an opportunity to leverage its benefits while diversifying its utilization.

Shatavari, a renowned medicinal plant, is rich in bioactive compounds such as saponins, flavonoids, and polyphenols, which contribute to its potent antioxidant properties. Traditionally used for its rejuvenating and health-promoting effects, *shatavari* has gained attention for its role in enhancing immunity, managing oxidative stress, and potentially prolonging the shelf life of perishable foods like meat products. Its incorporation into meat formulations not only provides a natural antioxidant source but also aligns with consumer demands for clean-label, health-oriented

food products.

The combination of jackfruit and *shatavari* in meat products offers a synergistic potential to:

Enhance the nutritional profile by introducing dietary fibers, vitamins, and phytonutrients.

Act as a natural preservative, extending the shelf life through their antioxidant and antimicrobial properties.

Develop functional foods that cater to health-conscious consumers, addressing modern dietary needs and lifestyle-related health issues.

By integrating these two bioactive-rich ingredients, the study aims to bridge the gap between nutrition and functional meat product development, paving the way for innovative solutions in the food industry.

MATERIALS AND METHOD

Chicken and duck meat: Broiler chicken and duck each of 2.5 to 3 kg live body weight procured from the local market were humanely slaughtered and dressed under hygienic conditions at Meat Technology Unit, Mannuthy. The dressed carcasses were immediately chilled for around 24 hours and deboned. Deboned meat was aerobically packed in high density polyethylene (HDPE) bags, kept frozen and thawed at 4±1°C before the preparation of nuggets.

Vegetable Oil: Refined sunflower oil (sunrich) was used throughout the study.

Condiment: The condiment mixture was prepared as and when required by blending peeled and chopped onion and garlic (3:1 w/w) to the consistency of a fine paste.

Spice mixture: consists of coriander 22%, cumin seeds 16%, black pepper 20%, red chilli 7%, anise 5%, dry ginger 5%, turmeric 5%, cinnamon 5%, cardamom 5%, curry leaves 2%, clove 2%, nutmeg 3% and mace 3%.

Curing ingredients: Sodium chloride 1%, sugar0.3%, sodium-tri-polyphosphate 0.3%, sodium ascorbate 550 ppm and sodium nitrite 120ppm.

Functional ingredient: jackfruit powder (Jackfruit 365, Eastern Condiments Pvt Ltd) and shatavari powder purchased from the local market of Thrissur, Kerala was used throughout the study.

Product formulation

The formulation of emulsion based poultry meat nuggets was standardized by conducting several trials. The standardized formulation was used for the entire study (Table.1).

Table 1 Formulary for the preparation of control and functional nuggets

Ingredients	Control nuggets (%)	Functional nuggets (%)
Ground chicken	50.625	50.625
Ground duck meat	16.875	16.875
Ice flakes	10	10
Vegetable oil (sunflower oil)	12	12
Condiments	4.0	4.0
Spice mix	1.7	1.7
Soya powder	2.0	2.0
Corn flour	1.5	1.5
Refined Wheat flour	1.5	1.5
Salt	1.0	1.0
Sugar	0.3	0.3
SodiumTripolyphosphate	0.3	0.3
Sodium ascorbate	0.3	0.3
Sodium nitrite	120 ppm	120 ppm
Egg	3.33	3.33
Jackfruit powder	2	**2**
Shatavari powder	**0**	*

***shatavari powder** was added over and above the quantity of the formulation at three different levels.

Preparation of nuggets

Deboned broiler chicken and duck meat was minced through a 9 mm grinder plate in a meat mincer (MADO primus Model MEW 613, Germany). The ground chicken and duck meat were preblended with salt, sodium-tri-polyphosphate, sugar, sodium ascorbate, and sodium nitrite at the levels given in Table 1 and kept under refrigeration for about 12 hours. The emulsion was prepared in a bowl chopper (MADO GARANT, Germany) by chopping the pre-blended chicken for 3-5 min with the simultaneous addition of ice flakes. The beaten egg was added and chopped further for 1-2 min, followed by the addition of pre-chilled refined sunflower oil till it was evenly dispersed in the batter during chopping. Then binders of corn flour and refined wheat flour (1.5%) each, soya powder (2%), condiments (4%) and spices mix (1.7%) as per formulary were added. Jackfruit powder and shatavari powder were added to the mix and chopped till uniformly dispersed with desired consistency of the batter. The batter was taken and manually filled in a stainless-steel mold under hygienic conditions. The mold covered with a lid was steam-cooked for 40 minutes to get proper cooked blocks. Chicken and duck meat blocks obtained were cooled and kept under refrigeration for 12-15 hours. These blocks were sliced into nuggets of size 1.5cm x 1.5cm x 1.5cm. The product preparation procedure for different nuggets formulations was uniform throughout the study.

Analytical procedures

Physico-chemical characteristics

pH

The pH of the nuggets from all the treatments and control, before and after cooking was determined using a combined electrode digital pH meter (μ pH system 362, Systronics, India) as per procedure of Troutt *et al* (1992).

Water activity (a_w)

To determine a_w, the samples were cut into small pieces and filled in the sample cup up to the mark. The filled sample cup was kept in the measurement chamber of Lab swift a_w meter (Novasina, Switzerland). The readings were taken, when the stable a_w was on in the display.

Cooking yield percentage

The weights of meat loaves before and after cooking were recorded. Product yield was expressed in percentage.

$$\text{Product yield (\%)} = \frac{\text{weight of cooked meat block}}{\text{Weight of raw batter}} \times 100$$

Proximate analysis

The proximate composition of the nuggets batter and products was determined by the standard procedure of AOAC (2016). Analyses were conducted in duplicate.
Moisture was determined by weight loss after 16 hours of drying in hot air at 105°C. The fat content was determined in moisture-free samples by an ether extraction procedure in an Automatic Solvent Extraction System (SOX plus, Model SCS 6, Pelican Equipments, Chennai, India). Moisture and fat-free samples were used to estimate the protein and ash content. The protein content was determined by the Block Digestion Method (KEL plus, Model KES 6L, Pelican Equipments, Chennai, India). Ash was determined by weight loss after 2 hours of drying in a muffle furnace (HF-electric furnace, Hindustan Furnace, Thrissur, Kerala) at 600°C. The amount of carbohydrates was calculated as 100 minus the sum of the percentage of moisture, protein, fat, and ash. The proximate composition was expressed in as-is-basis.

Calorific Value

The total calorie content of the nuggets was arrived at as per FAO (2002) on a wet matter basis.

Calories from fat= fat per cent × 9
Calories from protein= protein per cent × 4
Calories form carbohydrate = carbohydrate per cent × 4.

Total calories (kcal/100g) = (fat% x 9) + (protein% x 4) + (carbohydrate % x 4).

Organoleptic evaluation

Sensory attributes of the poultry meat nuggets were assessed organoleptically using an 8-point Hedonic scale scorecard. (AMSA, 1983) with the help of seven semi-trained taste panellists drawn from the Department of Livestock Products Technology, Mannuthy, Thrissur. The nuggets were shallow fried in sunflower oil and served warm to the panellists with code numbers to the samples. The average of the individual scores was taken as the score for the particular attribute.

Statistical analysis

The experiment was replicated four times and the data obtained for physico-chemical and sensory evaluation of different products were statistically analyzed as per Snedecor and Cochran (1994) by one-way ANOVA and Kruskal-Walli's test using SPSS software version 24.

RESULTS AND DISCUSSION

Shatavari powder was added at different levels *viz.*, 0.5, 1, and 1.5 percent, over and above the selected formulary of poultry meat nuggets enriched with 2% jackfruit powder. The best level was assessed based on the physio chemical and sensory attributes.

Physio-chemical characteristics

The results of the physio-chemical characteristics of the poultry meat nuggets incorporated with different levels of Shatavari powder (0.5, 1, and 1.5 percent) are given in Table 2. The mean emulsion pH of S_1 was significantly ($p< 0.001$) higher than that of other treatments and without any significant difference when compared to S_2. The product pH was found to be significantly ($p< 0.001$) higher for S_1 in comparison with S_2 and S_3. The lowest product pH was noticed for S_3. Statistically, no significant difference was noted for the water activity and cooking yield between the treatments (S_1, S_2, and S_3). The reduction in the pH of kabab containing shatavari may be attributed to the presence of acidic constituents, such as ascorbic acid, present in the herbal extract, as noted by (Veena et al., 2015).This finding aligns with findings of (Ibrahim et al., 2012), where a decrease in pH was observed in cooked nuggets that incorporated pomegranate rind powder.

Proximate composition and calorie content

The average proximate composition and calorie content of the nuggets enriched with different levels of Shatavari powder are presented in Table 2. No significant difference ($p< 0.001$) was noticed for moisture, protein, fat, ash, carbohydrate, and calorie content among treatments incorporated with shatavari at different levels (S_1, S_2, and S_3). Contarary to this, (Hussain et al., 2020) reported significant effect in proximate

composition of chicken meat kabab when incorporated with shatavari root powder.

Table 2. The physicochemical characteristics, proximate composition, and calorie content of nuggets

Parameters	S_1	S_2	S_3	F value (P value)
Emulsion pH	6.76 ± 0.01[a]	6.74 ± 0.01[a, b]	6.71 ± 0.01[b]	4.255[*] (0.034)
Product pH	6.80 ± 0.01[a]	6.76 ± 0.00[b]	6.72 ± 0.01[c]	32.872[**] (<0.001)
Water activity	0.92 ± 0.00	0.92 ± 0.00	0.92 ± 0.00	0.317[ns] (0.733)
Cooking yield (%)	97.83 ± 0.32	97.65 ± 0.14	97.56 ± 0.31	0.257[ns] (0.776)
Moisture (%)	61.89 ± 0.50	61.09 ± 0.45	61.81 ± 0.52	0.807[ns] (0.465)
Protein (%)	15.81 ± 1.14	16.81 ± 0.98	16.67 ± 0.79	1.862[ns] (0.190)
Fat (%)	12.62 ± 0.30	12.27 ± 0.33	11.88 ± 0.52	0.876[ns] (0.437)
Carbohydrate (%)	8.22 ± 0.67	8.02 ± 0.75	8.95 ± 0.92	0.388[ns] (0.685)
Ash (%)	1.80 ± 0.06	1.82 ± 0.03	1.84 ± 0.05	0.201[ns] (0.820)
Calorie (kcal/100 g)	209.70 ± 2.91	209.74 ± 3.10	209.39± 4.36	0.003[ns] (0.997)

** Significant at 0.01 level; * significant at 0.05 level;ns - non-significant at 0.05 level

S_1–nuggets with 75% chicken, 25% duck meat, 2% jackfruit powder, 0.5% Shatavari powder

S_2–nuggets with 75% chicken, 25% duck meat, 2% jackfruit powder, 1% Shatavari powder

S_3–nuggets with 75% chicken, 25% duck meat, 2% jackfruit powder, 1.5% Shatavari powder.

Colour

The change in colour characteristics by addition of different levels of shatavari powder were measured objectively in terms of L*, a* and b* values and the results are given in Table 3.

Table 3. Effect of different levels of shatavari powder on the colour of nuggets.

Parameters	S_1	S_2	S_3	F value (P value)
L* (lightness)	51.36 ± 0.10[b]	52.39 ± 0.12[a]	52.69 ± 0.07[a]	48.026[**] (<0.001)
a* (redness)	6.46 ± 0.02[c]	6.64 ± 0.02[b]	6.93 ± 0.03[a]	67.042[**] (<0.001)
b* (yellowness)	25.63 ± 0.17[a]	24.72 ± 0.04[b]	25.02 ± 0.05[b]	19.969[**] (<0.001)

** Significant at 0.01 level

S_1–nuggets with 75% chicken, 25% duck meat, 2% jackfruit powder, 0.5% Shatavari powder

S_2–nuggets with 75% chicken, 25% duck meat, 2% jackfruit powder, 1% Shatavari powder

S_3–nuggets with 75% chicken, 25% duck meat, 2% jackfruit powder, 1.5% Shatavari powder.

The lightness (L*) value was significantly ($p< 0.001$) higher recorded with S_3 and S_1 recorded significantly ($p< 0.001$) lower among all. Addition of shatavari powder significantly ($p< 0.05$) lowered the L* value.

The redness value was significantly ($p< 0.001$) higher for S_3 when compared to S_1 and S_2. The redness value significantly ($p< 0.001$) increased on increasing the level of shatavari powder in treatment samples. Similar results where obtained when pork patties were subjected to the addition of condensed black currant (Ribes nigrum L.) extract (BCE) at concentrations of 5, 10, or 20 g/kg under chilled conditions wherein the treated patties exhibited a notable increase in redness compared to the untreated samples (Jia et al., 2012). Cooked pork meat patties, subjected to treatment with a combination of Rosemary (*Rosmarinus officinalis L.*) and lemon balm (*Melissa officinalis L.*) under modified atmospheric conditions (70% N2 + 30% CO2) under refrigerated conditions, exhibited increased redness (a*) values (Trindade et al., 2009).

Yellowness value of S_1 was significantly ($p< 0.001$) higher than control S_2 and S_3. Incorporation of shatavari powder significantly ($p< 0.001$) increased the lightness, redness and significantly ($p< 0.001$) decreased yellowness value. (Naveena et al., 2008) observed significant reduction in the lightness and yellowness values of chicken patties with the addition of pomegranate rind powder as antioxidant.

Texture profile analysis

Quantitative textural parameters of nuggets incorporated with different levels of shatavari powder are given in Table 4. The various textural parameters hardness, gumminess, springiness, chewiness, adhesiveness and cohesiveness values did not differ significantly ($p< 0.05$) among treatment samples. Similar to this the inclusion of Shatavari root powder and its aqueous extract at concentrations of 1% and 2% in chicken meat kabab did not yield any statistically significant impact on the firmness and toughness of the product (Hussain *et al.*, 2020).

Table 4. Texture profile analysis of nuggets containing different levels of shatavari powder

Parameters	S_1	S_2	S_3	F value (P value)
Hardness (N)	136.10 ± 4.17	135.53 ± 4.71	138.13± 4.40	0.098^{ns} (0.907)
Gumminess (N)	44.20 ± 2.56	39.72 ± 3.18	41.09 ± 2.75	0.656^{ns} (0.533)
Springiness (cm)	0.49 ± 0.07	0.50 ± 0.05	0.49 ± 0.06	0.001^{ns} (0.999)
Chewiness (Ncm)	26.60 ± 2.41	28.65 ± 2.16	29.22 ± 2.27	0.365^{ns} (0.700)
Adhesiveness	-0.004 ± 0.00	-0.01 ±0.01	-0.01± 0.00	1.540^{ns} (0.246)
Cohesiveness ratio	0.33 ± 0.01	0.35 ± 0.01	0.35 ± 0.02	0.290^{ns} (0.752)

ns - non- significant at 0.05 level

S_1–nuggets with 75% chicken, 25% duck meat, 2% jackfruit powder, 0.5% Shatavari powder

S_2–nuggets with 75% chicken, 25% duck meat, 2% jackfruit powder, 1% Shatavari powder

S_3–nuggets with 75% chicken, 25% duck meat, 2% jackfruit powder, 1.5% Shatavari powder.

Organoleptic evaluation

The organoleptic qualities *viz*., appearance and colour, flavour, juiciness, texture, saltiness, mouth coating and overall acceptability of functional nuggets incorporated with different levels of shatavari powder are presented in the Table 5.

The comparative organoleptic scores for treatment samples S_1, S_2 and S_3 did not significantly differ for appearance. For flavour score, S_1 had significantly ($p<0.001$) higher and S_3 had significantly lower score among the samples. Addition of shatavari powder significantly reduced the flavour score. Juiciness was highest for S_1 and lowest for S_3. No significant difference was noticed for the juiciness score among S_2 and S_3. The highest score for texture and saltiness was observed in S_1 and lowest was observed in S_3. The results indicate no significant difference for texture and saltiness score among S_2 and S_3. The overall acceptability and mouth coating score for treatment S_1 was significantly ($p< 0.001$) higher and was significantly ($p< 0.001$) lower for S3 among treatments. The increase in the level of shatavari powder had adverse effect on the sensory scores due to the inherent bitter taste of the powder. Similar to this finding (Price et al., 2013) documented a notable impact on sensory attributes when green tea and grape seed extract were incorporated into pork meatballs.

Table 5. Sensory attributes of nuggets incorporated with different levels of shatavari powder

Attributes	S_1	S_2	S_3	χ^2 – value (p-value)
Appearance	7.26 ± 0.06	7.13 ± 0.09	7.08 ± 0.10	3.023^{ns} (0.221)
Flavor	7.14 ± 0.10^a	6.70 ± 0.11^b	6.23 ± 0.16^c	14.894**(0.001)
Juiciness	7.07 ± 0.12^a	6.73 ± 0.10^b	6.62 ± 0.09^b	9.198* (0.010)
Texture	7.19 ± 0.08^a	6.65 ± 0.14^b	6.51 ± 0.09^b	14.426**(0.001)
Saltiness	7.38 ± 0.06^a	6.92 ± 0.14^b	6.65 ± 0.13^b	13.115** (0.001)
Mouth coating	7.27 ± 0.06^a	6.86 ± 0.10^b	6.56 ± 0.07^c	19.451** (<0.001)
Overall acceptability	7.29 ± 0.06^a	6.67 ± 0.13^b	6.36 ± 0.08^c	18.515** (<0.001)

Based on 8-point Hedonic scale (1=extremely undesirable; 8 = extremely desirable)

** Significant at 0.01 level; * significant at 0.05 level;ns - non-significant at 0.05 level

S_1–nuggets with 75% chicken, 25% duck meat, 2% jackfruit powder, 0.5% Shatavari powder

S_2–nuggets with 75% chicken, 25% duck meat, 2% jackfruit powder, 1% Shatavari powder

S_3–nuggets with 75% chicken, 25% duck meat, 2% jackfruit powder, 1.5% Shatavari powder.

Result indicates that 0.5 per cent of shatavari powder incorporated nuggets scored significantly higher values for the flavour, juiciness, texture, saltiness, mouth coating and overall acceptability. The increase in the level of shatavari powder had adverse effect on the sensory scores due to the inherent bitter taste of the powder. Therefore 0.5 per cent of shatavari powder incorporated nuggets was selected as best and was used for final product preparation.

Effect of shatavari powder on the functional nuggets.

The selected level of shatavari powder (treatment T) was compared with three controls *viz*. C1-100 percent chicken nuggets, C_2 - with 75 per cent chicken and 25 per cent duck meat without jackfruit powder, C_3 - with 75 per cent chicken, 25 per cent duck meat and 2.0 percent jackfruit powder.

Physico-chemical characteristics

Effect of Shatavari Incorporation on pH,

Water Activity, and Cooking Yield of Chicken Cocktail Nuggets

The incorporation of shatavari powder in cocktail nuggets (T) resulted in a significantly lower pH (P<0.001) for both emulsion and product compared to the control (C3), likely due to the acidic nature of shatavari powder. This aligns with findings by Maheswara *et al.* (2014), who reported a significant pH reduction in functional chicken sausages containing rosemary extract at 0.2%. Conversely, Zargar *et al.* (2014) observed no significant pH difference in functional chicken nuggets with varying levels of pumpkin incorporation.

No significant differences were noted in water activity or cooking yield between the treatment and control samples, which may be attributed to their similar moisture content. Comparable results were reported by Banerjee *et al.* (2012), who found no significant change in the cooking yield of functional chevon nuggets containing broccoli powder extract. However, Das *et al.* (2013) observed increased cooking yield in functional chicken nuggets with fermented bamboo shoots compared to controls.

Proximate composition and calorie content

The incorporation of shatavari powder had no significant effect on the moisture, fat, or carbohydrate content of cocktail nuggets. Similar findings were reported by Nayak *et al.* (2015), who noted higher moisture with carrageenan incorporation in chicken nuggets.

Protein content was lowest in the treatment sample (T6) compared to controls, likely due to the reduced lean meat percentage caused by adding functional ingredients like jackfruit and shatavari powder. Sathu (2014) similarly reported reduced protein content in antioxidant-fortified chicken nuggets.

Significantly higher ash content (P<0.001) was observed in T5 compared to C1 and C2, with no significant difference between T6 and C3. This increase may be attributed to the higher mineral content of jackfruit and shatavari. Verma *et al.* (2012) observed increased ash in guava powder-enriched mutton nuggets, while Rajkumar *et al.* (2016) reported no significant variation in ash content for aloe vera-fortified chevon nuggets.

Table 6. Effect of shatavari powder on the physico-chemical characteristics, proximate composition and calorie content of the functional nuggets

Parameters	C_1	C_2	C_3	T	F value (P value)
Emulsion pH	6.66 ± 0.02^{c}	6.72 ± 0.02^{b,c}	6.79 ± 0.02^{a}	6.76 ± 0.01^{a,b}	6.562* (0.003)
Product pH	6.72 ± 0.01^{c}	6.74 ± 0.02^{c}	6.84 ± 0.02^{a}	6.80 ± 0.01^{b}	20.033**(<0.001)
Water activity	0.92 ± 0.00	0.92 ± 0.00	0.92 ± 0.00	0.92 ± 0.00	1.223^{ns} (0.327)
Cooking yield (%)	97.65 ± 0.19	97.15 ± 0.68	97.31 ± 0.55	97.83 ± 0.32	0.427^{ns} (0.736)
Moisture (%)	61.36 ± 0.65	61.25 ± 0.44	60.54 ± 0.64	61.89 ± 0.50	0.959^{ns} (0.431)
Protein (%)	17.25 ± 1.00^{a}	17.46 ± 0.61^{a}	16.72 ± 1.45^{a,b}	15.81 ± 1.14^{b}	2.731** (0.001)
Fat (%)	13.10 ± 0.37	12.87 ± 0.31	12.36 ± 0.37	12.62 ± 0.30	0.695^{ns} (0.566)
Carbohydrate (%)	7.07 ± 0.84	7.36 ± 0.47	8.50 ± 0.10	8.22 ± 0.67	0.782^{ns} (0.518)
Ash (%)	1.64 ± 0.03^{b}	1.66 ± 0.05^{b}	1.88 ± 0.04^{a}	1.80 ± 0.06^{a}	6.104* (0.004)
Calorie (kcal/100 g)	214.29 ± 4.54	215.08 ± 1.43	212.11 ± 2.81	209.70 ± 2.91	0.598^{ns} (0.624)

** Significant at 0.01 level; * significant at 0.05 level;ns - non- significant at 0.05 levelC_1 – Control 1 (nuggets with 100% chicken), C_2 – Control 2 (nuggets with 25% duck meat,75% chicken meat) C_3 – Control 3 (C2 +2 % jackfruit powder) T – Treatment 6 (C3 +0.5 % Shatavari powder).

Color

The incorporation of shatavari powder significantly (p<0.001) increased redness and yellowness while reducing lightness compared to controls, likely due to the natural color of shatavari. Naveena *et al.* (2008) reported reduced lightness and yellowness in chicken patties with pomegranate rind powder, while Devatkal *et al.* (2008) observed significant changes in redness and yellowness in chicken nuggets with carrot as a functional ingredient.

Table 7. Colour of control nuggets and shatavari powder incorporated nuggets.

Parameters	C_1	C_2	C_3	T	F value (P value)
L* (lightness)	53.98 ± 0.51[a]	53.97 ± 0.26[a]	52.49 ± 0.10[b]	51.36 ± 0.10[c]	18.309** (<0.001)
a* (redness)	5.43 ± 0.09[b]	5.52 ± 0.12[b]	4.65 ± 0.06[c]	6.46 ± 0.02[a]	80.258** (<0.001)
b* (yellowness)	24.48 ± 0.29[b]	24.67 ± 0.13[b]	24.55 ± 0.43[b]	25.63 ± 0.17[a]	3.677* (0.029)

** Significant at 0.01 level; * significant at 0.05 level

C_1 – Control 1 (nuggets with 100% chicken), C_2 – Control 2 (nuggets with 75% chicken meat, 25% duck meat) C_3 – Control 3 (C2 +2 % jackfruit powder) T – Treatment 6 (C3 +0.5 % Shatavari powder).

Texture profile analysis

Table 8. Texture profile analysis of control chicken nuggets and nuggets incorporated with shatavari powder

Parameters	C_1	C_2	C_3	T	F value (P value)
Hardness (N)	195.08± 5.30[a]	173.89 ± 6.07[b]	135.47 ± 4.24[c]	136.10 ± 4.17[c]	34.609** (<0.001)
Gumminess (N)	46.58 ± 5.98	45.28 ± 3.86	43.60 ± 3.11	44.20 ± 2.56	0.102[ns] (0.958)
Springiness (cm)	0.60 ± 0.04	0.59 ± 0.04	0.51 ± 0.06	0.49 ± 0.07	1.121[ns] (0.364)
Chewiness (Ncm)	29.41 ± 2.00	26.50 ± 2.17	29.76 ± 2.96	26.60 ± 2.41	0.532[ns] (0.366)
Adhesiveness	-0.01 ± 0.01	-0.004± 0.00	-0.004 ± 0.00	-0.004 ± 0.00	3.384[ns] (0.038)
Cohesiveness ratio	0.31 ± 0.01	0.30 ± 0.01	0.34 ± 0.02	0.33 ± 0.01	0.627[ns] (0.606)

** Significant at 0.01 level, ns non- significant at 0.05 level

C_1 – Control 1 (nuggets with 100% chicken), C_2 – Control 2 (nuggets with 75% chicken meat, 25% duck meat) C_3 – Control 3 (C2 +2 % jackfruit powder) T – Treatment 6 (C3 +0.5 % Shatavari powder).

The findings indicate that the hardness values of treatment T were significantly lower (p<0.001) compared to the control samples C1 and C2. This reduction in hardness is attributed to the dilution of meat proteins by the addition of jackfruit and shatavari powder. Moreover, no significant differences were observed in the gumminess, springiness, chewiness, adhesiveness, and cohesiveness values between treatment T6 and the control samples. These results align with findings of Rosli et al. (2011) who reported significantly lower values for hardness, cohesiveness, gumminess, and chewiness in chicken patties incorporated with oyster mushrooms compared to control samples. Similarly, Rajkumar et al. (2016) documented a significant reduction in hardness, gumminess, and chewiness in chevon nuggets containing aloe vera gel when compared to control chevon nuggets.

Organoleptic evaluation

The panel scores revealed that there was no significant difference for appearance and colour between control and the treatment containing selected level of shatavari powder (T). There was no significant difference (p<0.05) in appearance and color between the control nuggets and the treatment containing shatavari powder (T). Although the scores for flavor, juiciness, texture, saltiness, mouth coating, and overall acceptability were higher for C1, they were not significantly different (p<0.001) from T. These findings are consistent with findings of Maheswara et al. (2014) who reported a significant improvement in the flavor and juiciness scores of chicken sausages incorporated with rosemary extract compared to control samples. Similarly, Bhat et al. (2015) observed significantly higher appearance and flavor scores in aloe vera-incorporated nuggets compared to controls, with a notable increase in juiciness scores corresponding to higher concentrations of aloe vera.

Table 9. Sensory attributes of control chicken nuggets and nuggets incorporated with shatavari powder

Attributes	C_1	C_2	C_3	T	$\square^2$ - value (p-value)
Appearance	7.34 ± 0.07	7.23 ± 0.09	7.25 ± 0.07	7.33± 0.07	1.770[ns] (0.622)
Flavour	7.26 ± 0.09[a]	6.92 ± 0.11[b]	6.99± 0.08[b]	7.19± 0.10[a,b]	8.844* (0.031)

Juiciness	7.17 ± 0.08[a]	6.83 ± 0.10[b]	6.99 ± 0.07[a,b]	7.15 ± 0.07[a]	8.130[*](0.043)
Texture	7.31 ± 0.08[a]	6.93 ± 0.08[b]	6.95 ± 0.09[b]	7.25 ± 0.08[a]	15.951[**](0.001)
Saltiness	7.32 ± 0.10[a,b]	6.98 ± 0.11[c,b]	7.13 ± 0.97[b]	7.46 ± 0.07[a]	13.294[*](0.004)
Mouth coating	7.37 ± 0.07[a]	7.07 ± 0.07[b]	7.04 ± 0.07[b]	7.34 ± 0.06[a]	16.802[**](0.001)
Overall acceptability	7.32± 0.07[a]	7.02 ± 0.07[b]	7.02 ± 0.07[b]	7.32 ± 0.06[a]	16.327[**](0.001)

* Significant at 0.05 level, ns non- significant at 0.05 level

C_1 – Control 1 (nuggets with 100% chicken), C_2 – Control 2 (nuggets with 25% duck meat, 75% chicken meat) C_3 – Control 3 (C2 +2 % jackfruit powder) T – Treatment 6 (C3 +0.5 % Shatavari powder).

The product containing shatavari powder at 0.5 per cent was comparable to control nuggets. Thus considering the beneficial antioxidant properties, mineral content and cost of production, treatment sample T containing nuggets75 per cent chicken, 25 per cent duck meat, 2 per cent jackfruit powder and 0.5 percent shatavari powder was selected as the standardised product.

CONCLUSION

Results of the experiment indicated that shatavari powder at 1.5% percent level imparted a significant bitter taste which had a considerable adverse effect on the flavor, juiciness, texture, and also overall acceptability. Among all the treatments, 0.5 percent shatavari powder incorporated nuggets had acceptable sensory scores. Thus, functional poultry meat nuggets with high acceptability and nutritive value could be prepared by incorporating shatavari powder up to 0.5 percent in the formulation without affecting the sensory attributes. The incorporation of jackfruit powder and shatavari powder which is endowed with numerous nutritional and health values, in the emulsion-based poultry meat nuggets would enrich the functional value of the product.

REFERENCES

Hussain, S., Malik, A., Sharma, P., & Yadav, S. (2020).Study on development of chicken meat kebab by using shatavari roots powder and its aqueous extract. *Haryana Veterinarian ,59*(1), 63–66.

Ibrahim, H. M., Moawad, R. K., & Emam, W. H. (2012). Antioxidant effect of pomegranate rind, seed extracts and pomegranate juice on lipid oxidation and some quality properties of cooked beef patties. *Journal of Applied Sciences Research*, *8*(8), 4023–4032.

Jia, N., Kong, B., Liu, Q., Diao, X., & Xia, X. (2012). Antioxidant activity of black currant (Ribes nigrum L.) extract and its inhibitory effect on lipid and protein oxidation of pork patties during chilled storage. *Meat Science*, *91*(4), 533–539. https://doi.org/10.1016/j.meatsci.2012.03.010

Naveena, B. M., Sen, A. R., Vaithiyanathan, S., Babji, Y., & Kondaiah, N. (2008). Comparative efficacy of pomegranate juice, pomegranate rind powder extract and BHT as antioxidants in cooked chicken patties. *Meat Science*, *80*(4), 1304–1308. https://doi.org/10.1016/j.meatsci.2008.06.005

Price, A., Díaz, P., Bañón, S., & Garrido, M. D. (2013). Natural extracts versus sodium ascorbate to extend the shelf life of meat-based ready-to-eat meals. *Food Science and Technology International*, *19*(5), 427–438. https://doi.org/10.1177/1082013212455345

Trindade, R. A., Lima, A., Andrade-Wartha, E. R., Oliveira e Silva, A. M., Mancini-Filho, J., & Villavicencio, A. L. C. H. (2009). Consumer's evaluation of the effects of gamma irradiation and natural antioxidants on general acceptance of frozen beef burger. *Radiation Physics and Chemistry*, *78*(4), 293–300. https://doi.org/10.1016/j.radphyschem.2008.12.003

Veena, N., Arora, S., Singh, R. R. B., Katara, A., Rastogi, S., & Rawat, A. K. S. (2015). Effect of Asparagus racemosus (shatavari) extract on physicochemical and functional properties of milk and its interaction with milk proteins. *Journal of Food Science and Technology*, *52*(2), 1176–1181. https://doi.org/10.1007/s13197-013-1073-0