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Physico-chemical and sensory properties of chicken nuggets supplemented with green gram paste at varied levels

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Abstract
A study was carried out to look into the effect of green gram on the physicochemical and sensory properties of chicken meat nuggets. Chicken nuggets were made by incorporating corticated and decorticated green gram paste at 5%, 10%, and 15% levels of incorporation. Different formulations had no effect on the mean pH values of chicken meat nuggets (p>0.05). When the percentage of green gram was increased, there was a significant increase in cooking yield, antioxidant activity, and a significant decrease in cholesterol content when compared to the control. As the amount of green gram paste increased, the percentage of moisture, protein, and fat content decreased significantly, while the percentage of crude fibre increased significantly compared to control. The sensory properties of green gram treated samples shows slight declining trend when compared to control.

Keywords: Green gram**,** chicken nuggets, anti-oxidant activity, cholesterol content, sensory properties

Introduction
Meat and meat products are essential components of the modern diet. Food of animal origin, including meat, is required to keep a human body healthy. Aside from water, their main components are proteins and fats, with a significant contribution of highly bioavailable vitamins and minerals (Gaudichon and Calvez, 2021) [5]. In recent years, the consumption of poultry meat has increased dramatically. Poultry meat is preferred over meat from other species not only because it is less expensive, but also because it is an excellent source of animal protein. It is more acceptable to non-vegetarians due to its flavour, ease of digestion, and lower fat content, and thus can play an important role in the introduction of innovative value-added processed meat products (Adegbeye *et al*., 2020) [3].
Growing consumer demand for healthier products is driving new product development. This is more sustainable because the incorporation of vegetal sources improves yield, texture, palatability, protein and fibre content, and lowers the product production costs. Legumes have high levels of starch, fibre, and protein when compared to other plant foods. The type of legume used in meat products must be carefully selected in order to obtain a stable matrix that reduces water and fat losses while increasing protein interactions (Kyriakopoulou *et al*., 2021) [4].
Green gram (*Vigna radiata*) is a member of the Fabaceae family and is also known as golden gram, mung bean, moong, and mag. Starch causes granules in the protein gel matrix to swell, increasing water holding capacity and resulting in a stronger heat-induced structure. Further, fiber improves water and fat binding capacity (Johansson *et al*., 2022) [1]. Protein influences functional properties such as solubility, emulsification, foaming ability, gelling characteristics, and oil absorption (Cabra *et al*., 2008) [2]. Antioxidants prevent the formation of off-odors and flavours, as well as reducing oxidative rancidity and extending the shelf life of meat products.
Chicken nuggets are a popular processed meat product all over the world. Some of the reasons for their widespread popularity include their low cost, availability in a variety of flavours, and longer shelf life. Raw material, processing, and ingredient factors have a significant impact on the nutritional value and overall acceptability of nuggets. This study was conducted with an aim to know the effect of inclusion of different levels of corticated and decorticated green gram on technological and sensory characteristics of chicken nuggets and evaluate the physico-chemical and sensory characteristics of the product.

Materials and Methods

Hygienically reared broiler birds were dressed and deboned manually in wet market to obtain deboned chicken meat. Meat emulsion was prepared by mincing the deboned meat with fat, ice flakes, condiment mix, spice mix thoroughly. Both corticated and decorticated green gram paste is prepared by soaking the green gram for one hour, then drain the water and minced with little amount of water. To the above meat emulsion, green gram paste is added at different levels (5%, 10%, 15%) to select the optimum level for the development of green gram supplemented chicken meat nuggets.

Weighed quantity of emulsion was taken and filled in stainless steel mould. Mould was covered with lid and tied with thread and steam cooked for 35 mins. Chicken meat blocks so obtained were sliced and cut into pieces to get nuggets. Quality of nuggets with the following parameter was evaluated.

Physico-Chemical Properties

Mean pH

Mean pH of the preparation was determined by following the method of Trout *et al*. (1992) [6] using deluxe digital pH meter (model 101E).

Antioxidant activity

The antioxidant activity was determined by N, N-dimethyl-1, 4-diaminobenzene (DMPD) free radical scavenging assay as described by Fogliano *et al*. (1999) [7].

Per cent cooking yield

Cooking yield per cent was determined by calculating the difference in weight of chicken meat nuggets before and after cooking in a water bath for 20 min.

Cholesterol content

Cholesterol content was determined according to the procedures described by Turhan *et al*. (2007) [8].

Proximate Composition

Proximate composition of product was determined following the standard procedure of AOAC (2016) [10].

Sensory evaluation

The sensory quality of samples was evaluated using 8 point hedonic scale where in 1 indicates dislike extremely and 8 indicate like extremely. At least seven sensory panelists drawn from staff and students of this university were utilized for sensory evaluation.

Statistical analysis

The data obtained from various trials under each experiment was subjected to statistical analysis (Snedecor and Cochran, 1994) for Analysis of Variance (ANOVA) and Duncan's multiple range test (DMRT) to compare the means by using SPSS16 software package.

Results and Discussion

Physico-Chemical Properties

Mean pH

The mean pH values of chicken meat nuggets were non significantly (p>0.05) affected by different formulations (table 1). The results obtained were similar to Para *et al*. (2015) [15] reported non-significant (p>0.05) difference was observed in the pH of the products enrobed with two different levels of green gram flour. This could be due to neutral nature of extenders.

Table 1: Effect of different levels of green gram paste on the physico-chemical properties of chicken meat nuggets

Samples	Cooking yield%	Cholesterol (%mg)	Antioxidant activity (µg/ml)	pH
Control	77.15 ± 0.01^{g}	19.83 ± 0.10^{a}	99.58 ± 0.22^{g}	5.73 ± 0.05^{a}
5% corticated	82.74 ± 0.01^{e}	13.73 ± 0.05^{d}	117.75 ± 0.01^{c}	5.73 ± 0.07^{a}
10% corticated	89.85 ± 0.01^{c}	11.53 ± 0.08^{f}	119.85 ± 0.01^{b}	5.75 ± 0.03^{a}
15% corticated	94.92 ± 0.01^{a}	10.46 ± 0.06^{g}	121.64 ± 0.10^{a}	5.76 ± 0.02^{a}
5% decorticated	78.94 ± 0.10^{f}	17.45 ± 0.01^{b}	108.13 ± 0.17^{f}	5.71 ± 0.06^{a}
10% decorticated	84.95 ± 0.01^{d}	14.90 ± 0.10^{c}	110.65 ± 0.01^{e}	5.74 ± 0.05^{a}
15% decorticated	93.43 ± 0.01^{b}	11.94 ± 0.01^{e}	113.96 ± 0.01^{d}	5.78 ± 0.03^{a}

(p<0.05) Means bearing at least one common superscript in the same column do not differ significantly

Antioxidant activity

The mean antioxidant activity of chicken meat nuggets prepared with corticated green gram paste at 15 per cent level recorded significantly (p<0.05) higher antioxidant activity than other treatments and control (table1). This might be due to green gram had good antioxidant properties due to presence of phenolic acids and flavonoids. The results obtained were similar to Sattar *et al*. (2017) [12] observed that the antioxidant activity increases with increase in the level of germinated green gram, black gram and lentils.

Per cent cooking yield

The mean per cent cooking yield of chicken meat nuggets was significantly (p<0.05) affected by different formulations. Chicken meat nuggets prepared with corticated green gram paste at 15 per cent level recorded significantly (p<0.05) higher cooking yield than other treatments and control (table1). As increase in the per cent green gram there was a significant increase in the per cent cooking yield it might be due to higher moisture and fat retention of chicken meat nuggets extended with green gram paste. The results obtained were similar to Para *et al*. (2015) [15] in papaya pulp enriched chicken nuggets where green gram flour is used as an enrobing material. Similar result was reported by Kenawi *et al*. (2009) [13] in buffalo meat patties where low-fat soy flour and mung bean powder used as meat extenders.

Cholesterol content

The mean cholesterol content of chicken meat nuggets was significantly (p<0.05) affected by different formulations. chicken meat nuggets prepared with corticated green gram paste at 15 per cent level recorded significantly (p<0.05) lower cholesterol levels than other treatments and control (table1). As the level of green gram paste increases there was a significant decrease in the cholesterol content. This might be due to replacement of lean meat and ultimately meat fat by green gram, similar results were reported by Verma *et al*. (2012) [14] observed that as increase in the level of chick bean

hull four there was a decrease in the cholesterol content in the low-fat chicken nuggets. Verma *et al*. (2015) [15] observed that addition of pea hull flour in low salt, low fat chicken nuggets significantly decreased the total cholesterols at 8 % and 12 % levels, respectively.

Proximate Analysis

As increase in the level of green gram paste there was a significant decrease of per cent moisture content (table 2). This decreasing trend of moisture value might be due to increase in the levels of green gram paste in treated formulations that contained less moisture than that of chicken meat. Significant (p<0.05) gradual decrease in moisture content in oven roasted chicken seekh kababs with 10,15 and 20 percent extension level of black bean paste by Bhat *et al*. (2011) [17, 20].

As increase in the level of green gram paste there was a significant decrease of per cent protein content. The control product had the highest per cent crude protein content (table2). The possible reason of this declining trend in protein content might be due to the lower protein content of green gram paste than that of chicken meat, replaced in treated formulations. The results obtained are similar with green gram paste in chicken seekh kababs by Bhat and Pathak (2009) [16].

Table 2: Effect of different levels of green gram paste on the proximate composition of chicken meat nuggets

Parameter %	control	5% corticated	10% corticated	15% corticated	5% decorticated	10% decorticated	15% decorticated
Moisture	49.88 ± 0.02^{a}	48.74 ± 0.01^{b}	43.65 ± 0.01^{d}	39.20 ± 0.02^{f}	47.89 ± 0.01^{c}	41.86 ± 0.01^{e}	36.60 ± 0.01^{g}
Protein	23.53 ± 0.01^{a}	21.92 ± 0.01^{b}	19.76 ± 0.01^{d}	19.45 ± 0.01^{f}	21.69 ± 0.01^{c}	19.50 ± 0.01^{e}	19.25 ± 0.01^{g}
Crude fat	22.62 ± 0.03^{a}	21.08 ± 0.04^{b}	20.90 ± 0.04^{c}	13.21 ± 0.03^{d}	21.70 ± 0.04^{e}	21.40 ± 0.03^{f}	15.19 ± 0.04^{g}
Crude fiber	0.80 ± 0.03^{g}	1.18 ± 0.03^{e}	1.78 ± 0.02^{c}	1.90 ± 0.03^{a}	1.10 ± 0.02^{f}	1.70 ± 0.03^{d}	1.88 ± 0.02^{b}

(p<0.05) Means bearing atleast one common superscript in the same column do not differ significantly.

As increase in the level of green gram paste there was a significant (p<0.05) decrease of per cent fat content (table 2). This might be because the fat content of chicken meat nuggets was replaced by increasing levels of green gram paste in different treatment groups. Dzudie *et al*. (2002) [18] reported similar finding in the study on common bean flour in beef sausages. Kumar *et al*. (2013) [19] added green banana-and soybean hulls flours in the chicken nuggets.

As increase in the level of green gram paste there was a significant (p<0.05) increase of per cent crude fiber content (table 2). This might be due to crude fiber content in the green gram. Para *et al*. (2015) [15] reported that per cent crude fiber content in papaya pulp enriched chicken nuggets increases with increase in green gram flour incorporation.

Sensory Evaluation

There was significant decrease of colour, crispiness, hardness, flavour, overall acceptability scores for chicken meat nuggets with increased levels of incorporation of green gram paste. The higher scores were recorded in 5 and 10% of both corticated and decorticated green gram paste supplemented chicken meat nuggets. But naturally highest colour scores was recorded in control.

The colour scores of chicken meat nuggets decreased significantly (p<0.05) with the increasing levels of green gram paste in the treatments (table 3). This might be due to increased level of green gram in the treated products which reduced the dark colour of chicken meat by diluting the meat pigment. The findings of the present study collaborate well with the reports of Kenawi *et al*. (2009) [13] as they reported that the buffalo meat patties containing 5% of both low fat soy flour and mung bean powder had the highest values for colour than patties with 10% soy flour and mung bean powder.

Table 3: Effect of different levels of green gram paste on the sensory properties of chicken meat nuggets

Parameter	Control	5% corticated	10% corticated	15% corticated	5% decorticated	10% decorticated	15% decorticated
Colour	7.80 ± 0.02^{a}	7.70 ± 0.03^{c}	7.60 ± 0.04^{d}	7.0 ± 0.02^{f}	7.72 ± 0.03^{b}	7.56 ± 0.02^{e}	7.40 ± 0.03^{g}
Crispiness	8.19 ± 0.03^{a}	8.16 ± 0.01^{a}	8.15 ± 0.02^{a}	8.13 ± 0.01^{a}	8.14 ± 0.03^{a}	8.09 ± 0.02^{a}	8.05 ± 0.01^{a}
Hardness	8.15 ± 0.02^{a}	8.14 ± 0.03^{a}	8.10 ± 0.04^{a}	8.08 ± 0.02^{a}	8.12 ± 0.02^{a}	8.09 ± 0.03^{a}	8.06 ± 0.01^{a}
Mouth coating	8.27 ± 0.01^{a}	8.25 ± 0.04^{a}	8.23 ± 0.03^{a}	8.21 ± 0.02^{a}	8.19 ± 0.01^{a}	8.13 ± 0.02^{a}	8.09 ± 0.03^{a}
Flavour	7.90 ± 0.02^{a}	7.62 ± 0.03^{b}	7.40 ± 0.01^{c}	7.28 ± 0.03^{d}	6.70 ± 0.02^{e}	6.60 ± 0.03^{f}	6.50 ± 0.03^{g}
Overall acceptability	8.20 ± 0.02^{a}	8.15 ± 0.01^{c}	8.06 ± 0.03^{e}	7.92 ± 0.01^{g}	8.19 ± 0.03^{b}	8.08 ± 0.02^{d}	7.96 ± 0.01^{f}

(p<0.05) Means bearing atleast one common superscript in the same column do not differ significantly.

The hardness scores of chicken meat nuggets decreased non-significantly (p>0.05) along with the increasing levels of green gram paste in the treated formulations (table 3). Such slight decrease might be due to absorption and retain moisture by green gram paste. Similar findings were reported by Trout *et al*. (1992) [6] suggested that a decrease in the hardness of sausage by the addition of texture-modifying ingredients, such as soy protein, oat bran, and starch.

There was a significant decrease in flavour scores (table 3) might be due to lowering of fat content replaced by green gram paste and also might be due to dilution of meaty flavour with increase in the level of extender (Bhat *et al*. 2012, Malav *et al*. 2013) [21, 23] . The findings of the present study were well in agreement with the reports of Bhat and Pathak (2011) [17, 20] who observed decreasing values in flavour score in oven roasted chicken seekh kababs extended with black bean paste.

The crispiness of the chicken meat nuggets decreased non-significantly (table 3), due to reduced volume and the lack of cellular structure in these when compared to the control. Singh *et al*. (2014) [22] reported decrease in crispiness with increase in the level of rice flour in chicken meat caruncles.

The overall acceptability of chicken nuggets decreased significantly (table 3), due to the lower scores recorded for colour, flavour, crispines and hardness qualities due to the addition of green gram paste. The results are similar with Malav *et al*. (2013) [23] reported that the overall acceptability scores were significantly lower as compared to control for products with 9% and 12% incorporation of lentil flour in chicken meat blocks.

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Conclusion
The chicken nuggets among different treatments, 5 and 10 per cent corticated and decorticated green gram paste incorporated chicken nuggets showed higher physical (percent moisture, per cent crude protein, per cent crude fiber and per cent fat), Physico-chemical (cooking yield, cholesterol and antioxidant activity) and sensory scores than control, whereas 15% corticated and decorticated green gram paste incorporated chicken nuggets exhibited inferior sensory scores.

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