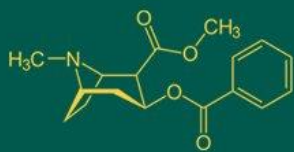


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Effect of unripe plantain and banana peel powder incorporation on the quality of functional chicken nuggets

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Abstract

An attempt was made to prepare functional chicken nuggets formulations with pre-standardized cooked shredded unripe plantain with peel (5%) and ripened banana peel powder (RBPP) and to evaluate its combined effect on the physico-chemical, proximate composition and sensory quality of functional chicken nuggets by replacing chicken meat in the formulation. In this experiment, 5% cooked unripe plantain with peel was further fiber enriched with 0, 1, 1.5 and 2% of ripened banana peel powder. All cooked unripe plantain with peel and ripened banana peel powder incorporated chicken nuggets had significantly ($p < 0.01$) higher emulsion stability, cooking yield, fat retention, ash and fiber content values increased with increasing levels of incorporation. Emulsion pH, product pH, protein and fat content were decreased significantly ($p < 0.01$) with increasing levels of cooked unripe plantain with peel and ripened banana peel powder in chicken nuggets. However, chicken nuggets incorporated with cooked unripe plantain with peel had higher moisture retention values as compared to combination of cooked unripe plantain with peel and ripened banana peel powder. Protein and fat content was significantly ($p < 0.01$) reduced in treated samples than control whereas total ash and fibre content significantly ($p < 0.01$) increased in treated samples than control respectively. Chicken nuggets incorporated with 5% cooked shredded unripe plantain with peel plus 1% ripened banana peel powder were rated better for all sensory attributes, except appearance and colour. Therefore, functional chicken nuggets can be prepared by incorporating 5% cooked shredded unripe plantain with peel plus 1% ripened banana peel powder without affecting the physico-chemical and sensory characteristics of the product.

Keywords: Functional chicken nuggets, ripened banana peel powder, plantain

Introduction

At present in our country, poultry is likely to be the individual major contributor of animal protein next to milk proteins. Chicken meat has low cholesterol with essential fatty acids and has good source of minerals and essential vitamins, particularly vitamin E, vitamin A, equivalents and also delivers a significant amount of niacin equivalent, which is nutrient for energy metabolism (Charlton *et al.*, 2008) [9]. Chicken meat is considered relatively leaner and there are no social taboo attached to its consumption, making it the most preferred meat in India Zargar *et al.*, (2014) [32]. Diet is one of the most important factor determining well-being and health and therefore there is increasing demand for safer and healthier foods. A promising approach to improve health care would be to produce a healthier food as a preventive health care strategy (Decker and Park 2010) [10].

Natural food can be made functional by means of different technological interventions. The term functional food refers to processed foods containing ingredients that aid specific bodily functions in addition to its nutritive value. The Institute of Medicines Food and Nutrition Board defined functional food as "any food or food ingredient that may provide a health benefit beyond the traditional nutrients it contains" (IOM/FNB, 1994) [15]. Foods can be made functional either by adding certain functional components *viz.*, antioxidants, dietary fibres, probiotics or by replacing components with more desirable ones (Colmenero *et al.*, 2001) [8]. One such health promoting functional food substance is Plantain (raw banana). Bananas are the world's most widespread fruit crop, grown primarily in tropical and subtropical regions, and are one of the most widely consumed fruits in the world.

Bananas are considered to be the main source of sugar, vitamins, bioactive compounds and fiber which helps to minimize the risk of various chronic diseases (Vishala and Singh, 2021) [28]. Zaini *et al.* (2022) [31] mentioned that banana peel is an agricultural by-product, which is often discarded despite its potential to serve as a source of functional food ingredients and it is valued for its bioactive constituents, particularly its phenolic compounds. These phenolic compounds encompass flavanols, hydroxycinnamic acids, flavan-3-ols and catecholamines. The inclusion of banana peel in food products results in increased nutritional value, particularly in terms of dietary fibre and phenolic content. It has been demonstrated that banana peel can effectively reduce lipid oxidation, especially in meat-based products. However, use of unripe cooked banana and ripened banana products as a source of dietary fiber in meat products is yet to be fully explored. Keeping these in view, the present study was designed to analyze the physico-chemical, proximate composition and sensory qualities of functional chicken nuggets.

Materials and Methods

Raw materials

Chicken meat: The live broiler chicken birds were purchased from the local market and slaughtered at Department of Livestock Products Technology, VCRI, Orathanadu. The chicken carcasses were washed, deboned and placed in deep freezer at a temperature of -20 °C for overnight. Next day, meat was minced with the help of a meat mincer (Model: Prims MEW 713, Mado GmbH, Germany) for further processing.

Preparation of cooked shredded unripe plantain: The mature unripe *Monthan* variety plantain were purchased from the local market. The plantain was cooked, the adhering extraneous materials on the surface were removed by using knife and washed in the running water. Then the plantain was steamed for 30 min to an internal temperature of 80 °C. The cooked plantain with peel then shredded by vegetable shredder then required quantity of shredded cooked plantain with peel and shredded plantain with peel was used in the chicken nuggets preparation.

Preparation of ripened banana peel powder: The ripened bananas were purchased from local fruit and vegetable market. A cluster of bananas was randomly picked from a banana bunch and the stalks were removed. Then, the banana was rinsed several times with tap water and last rinsed with distilled water and separated into peels. To avoid a browning reaction, peels were dipped in 0.5% w/v citric acid solution for 20 min and drained (Eshak, 2016) [12]. Then, banana peels were dried in hot air oven (Lab Tech, India) at 60 °C for 24 hrs until no more sap can be seen. Dried peels were ground in the mixer and passed through 60 mesh screen to obtain banana peel flour and were stored in air tight container until further use.

Preparation of functional chicken nuggets

Chicken meat was partially thawed at refrigerator (4±1 °C) and the thawed meat was cut into small cubes and minced in the meat mincer using 8 mm plate. Pre weighed quantities of salt and sodium tri poly phosphate were added to the minced chicken meat and chopped for 2 min with a food cutter (Model TC 11, Schaefer, Germany). After addition of ice flakes, it was chopped again for 1 to 2 min. Refined vegetable oil was incorporated slowly and chopping was continued till the oil was completely dispersed in the batter. Condiments mix, spice mix and refined wheat flour as binder were added and chopping continued for 2 min to give a fine viscous emulsion. The temperature of the emulsion varied from 10 to 12 °C. The emulsion was then filled uniformly into aluminium moulds, packed compactly and covered. The moulds were then clipped tied; the meat blocks were cooked in a steam oven without pressure for 40 min. The internal temperature of the cooked blocks was 80±2 °C measured using a probe type thermometer (Acetec, India). The meat blocks were cooled to room temperature, chilled overnight at 4±1 °C and cut into slices of 15 mm thickness using a meat slicer (ALS, India). The slices were manually cut into nuggets (1 cm x 1 cm). The chicken nuggets were aerobically packed in LDPE pouches using a packaging machine. The chicken nuggets samples were subjected to physico-chemical analysis and sensory evaluation to select the optimum level of replacement of cooked unripe plantain with peel and ripened banana peel powder in the functional chicken nuggets (Table-1).

Table 1: Functional chicken nuggets formulations with cooked unripe plantain with peel and ripened banana peel powder

Ingredients (%)	Control	Level of cooked unripe plantain with peel and ripened banana peel powder			
		T ₁	T ₂	T ₃	T ₄
Chicken meat	73.0	68.0	67.0	66.5	66.0
Cooked unripe plantain with peel	-	5.0	5.0	5.0	5.0
Ripened banana peel powder	-	-	1.0	1.5	2.0
Salt	1.5	1.5	1.5	1.5	1.5
Sodium tri poly phosphate	0.5	0.5	0.5	0.5	0.5
Dry spice mix	1.5	1.5	1.5	1.5	1.5
Condiments mix	3.0	3.0	3.0	3.0	3.0
Vegetable oil	7.5	7.5	7.5	7.5	7.5
Refined wheat flour	3.0	3.0	3.0	3.0	3.0
Ice flakes	10.0	10.0	10.0	10.0	10.0

Analytical Procedures

Physico-chemical quality: The pH of the emulsion and product was recorded by using a digital pH meter (Model LMPH 9Labman, India). Emulsion stability of meat emulsion was determined as per the method of Baliga and Madaiah (1971) [6] with slight modifications. Cooking yield

used to predict the yield of cooked product. The cooking yield was determined by the method outlined by Anna Anandh *et al.* (2008) [3]. The moisture retention value represents the amount of moisture retained in the cooked product per 100 gm of sample and was determined as per (El-Magoli *et al.* (1996) [11] according to the equation below:

Fat retention was calculated according to Murphy *et al.* (1975) [21]. The Proximate composition viz., moisture, protein, fat and total ash contents in both control and treatment samples was determined by standard (AOAC, 1995) [4]. Estimation of the dietary fibre content of functional chicken meat nugget was done by using modified method prescribed by AOAC (2012) [5].

Sensory quality: The organoleptic qualities of chicken nuggets were assessed by subjecting the nuggets samples to appearance, colour, flavour, juiciness, tenderness, texture and overall acceptability using 9-point hedonic scale (where in 9 = extremely desirable, 1 = extremely undesirable) (Keeton, 1983) [16] by a trained and semi trained panel consisted of faculties and post graduate students from Veterinary College and Research institute, Orathanadu.

Statistical analysis: The data generated from six trials of each experiment were analyzed in SPSS (version 20.0) software by following standard procedures (Snedecor and Cochran, 1994) [25] for Analysis of variance means were compared and the effects of treatments and their interactions for various parameters in different experiments were interpreted.

Results and Discussion

Physico-chemical Characteristics

Results of physico-chemical properties and proximate analysis of functional chicken nuggets prepared with different levels of ripened banana peel powder viz., 0, 1, 1.5 and 2%; and pre-standardized cooked plantain with peel (5%) are presented in Table 2. The emulsion and product pH were significantly ($p < 0.01$) lower in T₄ followed by T₃, T₂, T₁ and control. Significantly lower emulsion and product pH values were observed in ripened banana peel powder incorporated chicken nuggets as compared to control. The results of pH are in agreement with Abidin (2021) [1] who

reported that lower pH of fiber incorporated chicken nuggets. Kumar *et al.*, (2013) [18] also reported that the changes in pH values of meat products containing vegetable and fruit by-products rich in fiber content. The drop in pH by the addition of plantain components might be due to the fact that it is rich in phenolic acids and tartaric acid (Nair and Pullammanappallil, 2003) [22].

Emulsion stability, cooking yield and fat retention: The treatment T₄ had significantly ($p < 0.01$) higher emulsion stability, cooking yield and fat retention than the T₃, T₂, T₁ and control. Significantly higher emulsion stability and cooking yield values were observed in ripened banana peel powder incorporated chicken nuggets as compared to control. The present findings are in agreement with Kumar *et al.* (2010) [17] who found the similar increase in emulsion stability and cooking yield with inclusion of green banana flour. Pereira *et al.*, (2020) [24] also found the similar results in fat frankfurters incorporated with unripe banana by products.

Moisture retention and fat retention: Fat retention values were significantly increased from control to treatments. The fat retention values were significantly ($p < 0.01$) higher for T₄ and significantly lower for control. Significantly higher moisture retention and fat retention values were observed in ripened banana peel powder incorporated chicken nuggets as compared to control. This might be due to reduction of lean meat percentage by overall increase in bulk of batter by addition of dietary fibre which is low in protein and fat content and increase in the total product yield by increased moisture retention percentage with inclusion of dietary fibre. Similar results were reported by Trout *et al.* (1992) [27] in low fat beef patties and Huang *et al.* (2011) [14] in emulsified pork meat balls incorporated with dietary fibres at different levels.

Table 2: Effect of incorporation of cooked shredded unripe plantain with peel and different levels of ripened banana peel powder on physico-chemical properties and proximate composition (%) of chicken nuggets

Parameters	Level of cooked shredded unripe plantain with peel and banana peel powder				
	Control	T ₁	T ₂	T ₃	T ₄
Physico-chemical parameters					
Emulsion pH	6.22±0.00 ^a	6.11±0.00 ^b	6.08±0.00 ^b	6.06±0.00 ^b	6.03±0.01 ^b
Emulsion stability (%)	94.75±0.53 ^a	95.84±0.33 ^b	96.48±0.53 ^b	97.05±0.24 ^b	97.70±0.41 ^b
Cooking yield (%)	94.60±0.50 ^a	96.64±0.26 ^b	96.78±0.21 ^b	97.02±0.34 ^b	97.68±0.70 ^b
Product pH	6.30±0.01 ^a	6.17±0.00 ^b	6.14±0.00 ^b	6.13±0.01 ^b	6.08±0.01 ^b
Moisture retention (%)	58.01±0.94 ^a	63.27±0.12 ^b	62.87±0.20 ^b	62.13±0.59 ^{bc}	61.69±0.75 ^{bc}
Fat retention (%)	90.78±1.07 ^a	92.43±1.09 ^b	92.54±0.97 ^b	93.34±0.63 ^c	94.13±0.98 ^c
Proximate Composition					
Moisture (%)	61.32±0.82 ^a	65.47±0.15 ^b	64.96±0.19 ^b	64.04±0.48 ^b	63.16±0.61 ^c
Protein (%)	16.59±0.47 ^a	15.42±0.09 ^b	15.31±0.19 ^b	14.43±0.33 ^c	13.85±0.04 ^c
Fat (%)	20.55±0.16 ^a	18.67±0.07 ^b	18.59±0.09 ^b	17.63±0.08 ^c	16.64±0.13 ^d
Total ash (%)	2.67±0.03 ^a	2.90±0.03 ^b	2.95±0.02 ^b	3.00±0.05 ^b	3.13±0.43 ^c
Fiber content (%)	0.48±0.02 ^a	4.54±0.04 ^b	4.92±0.05 ^b	5.71±0.02 ^b	5.99±0.42 ^c

Means bearing different superscripts in a row differ ($p < 0.01$) significantly.

Proximate Composition: Moisture content of T₁ was significantly higher and control was significantly lower. The moisture content was significantly ($p < 0.01$) higher for T₂ with 5% cooked shredded unripe plantain with peel and 1% ripened banana peel powder incorporated chicken nuggets and significantly lower for control. Incorporation of dietary fiber in its dry form causes a reduction of moisture in the treated samples (Yadav *et al.* 2018) [29]. The result was also

consistent with the finding of Grigelmo-Miguel *et al.* (1999) [13] in low fat, high dietary fibre incorporated frankfurter. Similar observations were reported by Talukder and Sharma (2010) [26] who found that the inclusion of wheat bran to chicken patty led to a decrease in moisture content. The protein content of control was significantly ($p < 0.01$) higher and T₄ was significantly ($p < 0.01$) lower among all. The fat content was significantly ($p < 0.01$) higher for control

and T₄ had significantly ($p<0.01$) lower fat content than that of treatments. Protein and fat present in the treated samples also reduced significantly ($p<0.01$) because of the lesser fat and protein present in plantain components. The present results are in agreement with earlier studies made on banana peel powder incorporated chicken sausages (Zaini *et al.*, 2020)^[30].

Total ash and fiber content of treatment T₄ was significantly higher and control was significantly lower. No significant difference was observed between T₁, T₂ and T₃. Total ash content was significantly increased from control to treatments whereas protein and fat content were significantly decreased from control to treatments. The moisture and total ash content were significantly ($p<0.05$) higher for T₄ and significantly lower for control. However, reverse trends were observed in protein and fat content. The present results are in agreement with earlier studies made on fruit albedo (2.3 to 5%) incorporated pork burgers (Lopez-Vargas *et al.* 2014)^[19] and banana peel powder (2 to 6%)

incorporated chicken sausage (Modi *et al.*, 2008)^[20]. Akram *et al.* (2022)^[2] observed that significantly lower protein, fat and higher ash content in banana peel incorporated chicken nuggets than control.

Fiber content values were significantly increased from control to treatments. The mean fiber content value was significantly ($p<0.01$) higher for T₄ and significantly lower for control. Significantly higher fiber values were observed in ripened banana peel powder incorporated chicken nuggets as compared to control. Zaini *et al.* (2020)^[30] also observed that the incorporation of banana peel powder in chicken sausages caused an increase in the dietary fiber content in the sausages.

Sensory Evaluation

Results of sensory evaluation of functional chicken nuggets prepared by incorporation cooked plantain with peel and ripened banana peel powder for control, T₁, T₂, T₃ and T₄ are presented in Table 3.

Table 3: Effect of incorporation of cooked shredded unripe plantain with peel and different levels of ripened banana peel powder on sensory attributes of chicken nuggets

Parameters	Level of cooked shredded unripe plantain with peel and banana peel powder				
	Control	T ₁	T ₂	T ₃	T ₄
Sensory attributes					
Appearance and colour	8.22±0.30 ^a	8.10±0.30 ^a	7.57±0.51 ^b	6.72±0.41 ^c	6.42±0.43 ^c
Flavor	8.10±0.26 ^a	7.92±0.43 ^a	7.50±0.51 ^b	7.10±0.20 ^{bc}	6.95±0.32 ^{bc}
Juiciness	8.05±0.27 ^a	7.15±0.23 ^b	7.55±0.35 ^b	7.05±0.22 ^c	6.67±0.24 ^c
Tenderness	7.60±0.61 ^a	7.47±0.47 ^a	7.52±0.49 ^a	7.30±0.47 ^a	6.87±0.35 ^b
Texture	8.07±0.33 ^a	7.42±0.29 ^b	7.55±0.39 ^b	7.17±0.29 ^{bc}	6.75±0.25 ^{bc}
Overall acceptability	8.12±0.39 ^a	7.30±0.34 ^b	7.67±0.29 ^b	7.15±0.28 ^{bc}	6.80±0.37 ^{bc}

Means bearing different superscripts in a row differ ($p<0.01$) significantly.

The result revealed that significant ($p<0.01$) difference in appearance and color, flavor, juiciness, tenderness, texture and overall acceptability scores between control and three levels cooked shredded unripe plantain with peel in chicken nuggets. Appearance and colour scores were significantly decreased from control to treatments. The mean scores for flavor, juiciness, tenderness and texture were significantly ($p<0.01$) higher for control as compared to treatments. Among treatments, the mean score for flavor, juiciness, tenderness and texture were higher for T₂ with 5% cooked shredded unripe plantain with peel and 1% ripened banana peel powder incorporated chicken nuggets followed by T₁, T₃ and T₄. Mean score for overall acceptability was significantly higher for control. Among treatments, T₂ with 5% cooked shredded unripe plantain with peel and 1% ripened banana peel powder incorporated chicken nuggets had higher overall acceptability scores as compared to control. Zaini *et al.* (2020)^[30] reported that banana peel powder in concentrations of more than 2% decreased the organoleptic perception of sausage. Prakash *et al.* (2016)^[23] also reported that decrease sensory scores of fiber incorporated meat products might be due to increased perception of fiber components, flavor and masking of meaty flavor. Based on the results of sensory attributes, the chicken nuggets were prepared with 1% ripped banana peel powder and 5% cooked shredded unripe plantain with peel was rated better for all sensory attributes except appearance and color.

Conclusion

Findings of this study reveals that 5% cooked shredded unripe plantain with peel with 1% ripened banana powder

was the optimum level for preparation of fiber enriched functional chicken nuggets. From the above results, it can be concluded that T₂ with 5% cooked shredded unripe plantain with peel plus 1% ripened banana peel powder was more acceptable than other treatments. Acceptable functional chicken nuggets can be prepared by incorporating 5% cooked shredded unripe plantain with peel plus 1% ripened banana peel powder without affecting the physico-chemical and sensory characteristics of the product.

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