Research Article

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Development and Quality Evaluation of Fiber-enriched Chicken Nuggets Incorporated with Ripened Banana Peel Powder and Cooked Unripe Plantain

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ABSTRACT

An attempt was made to prepare fiber-enriched chicken nuggets formulations with pre-standardized cooked shredded unripe plantain (CSUP) without peel (10%) and ripened banana peel powder (RBPP) and evaluate its combined effect of on the physico-chemical, proximate composition and sensory quality of fiber-enriched chicken nuggets by replacing chicken meat in the formulation. In this experiment, 10% CSUP without peel was further fiber enriched with 0, 1, 1.5 and 2% of RBPP. The emulsion stability, cooking yield, fat retention, ash and fiber content of CSUP without peel and RBPP incorporated chicken nuggets had significantly ($P<0.01$) increased with increasing levels of incorporation. Emulsion pH, product pH, protein and fat content were decreased significantly ($P<0.01$) with increasing levels of CSUP without peel and RBPP in chicken nuggets. However, chicken nuggets incorporated with CSUP without peel had higher moisture retention values as compared to combination of CSUP without peel and RBPP. Chicken nuggets incorporated with 10% CSUP without peel plus 1% RBPP were rated better for all sensory attributes, except appearance and colour. Therefore, fiber-enriched chicken nuggets can be prepared by incorporating 10% CSUP without peel plus 1% RBPP, without affecting the physico-chemical and sensory characteristics of the product.

Keywords: Fiber-enriched chicken nuggets; ripened banana peel powder; Plantain

INTRODUCTION

Chicken has the distinction of the most liked meat in Indian subcontinent and is considered as white meat having many unique desirable properties compared to other red meats, some of these merits are excellent flavor, easy to digest, low fat content, high ratio of polyunsaturated fatty acids to saturated fatty acids, excellent source of protein and fair source of vitamins and minerals, more tender due to less connective tissue and shorter muscle fibers, requires less cooking and retains more nutrients. It is considered nutrient-dense food which is desirable in planning health diets. It contains higher proportion of protein per unit of calories as compared to red meat. 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).

Functional foods have been defined as foods that may provide health benefits beyond basic nutrition and are similar in appearance to conventional foods that are intended to be consumed as part of a normal diet, but have been modified to sub serve physiological roles beyond the provision of simple nutrient requirements (Bech- arsen and Grunert, 2003). 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). 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). 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. Banana peel are considered to be the main source of bioactive compounds (Xylitol) and fiber which helps to minimize the risk of various chronic diseases (Vishala and Singh, 2021). 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. Hence, a scientific approach was made to develop fiber-enriched chicken nuggets with CSUP without peel and RBPP.

MATERIALS AND METHODS

Procurement of materials for the preparation of Functional chicken nuggets:

Raw materials

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, Germamy) for further processing.

PLANTAIN COMPONENTS

Preparation of cooked shredded unripe plantain

The mature unripe Monthan variety plantain of uniform size and shape were purchased from the local market. The adhering extraneous materials on the surface of plantain were removed by using knife and washed in the running water. Then the plantain was steam cooked for 30 min to an internal temperature of 80°C. The cooked plantain without peel was shredded by vegetable shredder to a required quantity and used in the chicken nuggets preparation.

FORMULATION OF CHICKEN NUGGETS

Based on preliminary studies formulation for chicken nuggets was developed. Control chicken nuggets were prepared by using 73% of chicken meat along with following ingredients, Salt 1.5%, Sodium tri polyphosphate 0.5%, Dry spice mix 1.5%, Condiments mix 3.0%, Vegetable oil 7.5%, Refined wheat flour 3.0% and Ice flakes 10%.

PREPARATION OF FIBER-ENRICHED 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 (Model: Primus MEW 713, Mado GmbH, Germamy) 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, Schaefen, 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 and fat were 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 in to 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 till it reaches internal temperature of 80 ±2°C. The internal temperature of the cooked blocks was measured by using a probe type thermometer (Aceteq, 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 CSUP without peel and RBPP in the chicken nuggets.

Table 1: Fiber-enriched chicken nuggets formulations with CSUP without peel and RBPP

Ingredients (%)	Control	Level of CSUP without peel and RBPP			
		T_1	T_2	T_3	T_4
Chicken meat	73.0	63.0	62.0	61.5	61.0
CSUP without peel	-	10.0	10.0	10.0	10.0
RBPP	-	-	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 suspension was recorded by immersing the combined glass electrode of digital pH meter (Model LMPH 9Labman, India). The method was based on the emulsion stability test reported by Baliga and Madaiah (1971) 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). The moisture retention value represents the amount of moisture retained in the cooked product per 100 gm of sample and was determined (El-Magoli et al. (1996) according to the equation below:

Moisture retention (%) = % yield X % moisture in chicken nuggets X 100

100

Fat retention was calculated according to Murphy *et al.* (1975) by using formula.

Fat retention (%) = (Product yield) x (Fat in cooked product) X 100

(Uncooked product weight) x (Fat in uncooked product)

Proximate composition viz., moisture, protein, fat and total ash contents of control and fiber-enriched chicken nuggets were determined by using standard methods as per (AOAC, 1995). Estimation of the dietary fiber content of fiber-enriched chicken meat nugget was done by using modified method prescribed by AOAC (2012).

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) 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).

RESULTS AND DISCUSSION

Physico-chemical Characteristics

Effect of incorporation of CSUP without peel and RBPP on the sensory attributes of fiber-enriched chicken nuggets is presented in Table 2. Results of physico-chemical parameters of fiber-enriched chicken nuggets for control (no treatment), T_1 (only 10% cooked plantain without peel), T_2 (10% cooked plantain without peel + 1% RBPP), T_3 (10% cooked plantain without peel + 1.5% RBPP) and T_4 (10% cooked plantain without peel + 2% RBPP) are presented in Table 2.

Table 2. Effect of incorporation of CSUP without peel and different levels of RBPP on physico-chemical properties and proximate composition of chicken nuggets

Parameters	Level of CSUP without peel and RBPP				
	Control (0%)	T_1	T_2	T_3	T_4
Physico-chemical parameters					
Emulsion pH	6.23±0.00^a	6.13±0.00^b	6.08±0.00^b	6.07±0.01^b	6.04±0.01^b
Emulsion stability (%)	94.75±0.53^a	95.84±0.33^a	96.48±0.53^b	97.05±0.24^b	97.70±0.41^c
Cooking yield (%)	94.62±0.47^a	95.75±0.56^b	96.63±0.38^c	96.94±0.49^c	97.26±0.31^c
Product pH	6.30±0.00^a	6.18±0.00^b	6.14±0.01^b	6.13±0.00^b	6.09±0.01^b
Moisture retention (%)	57.87±1.07^a	60.76±0.45^b	61.39±0.71^c	60.66±0.20^b	60.27±0.13^b
Fat retention (%)	90.69±1.29^a	92.58±1.08^b	92.61±1.10^b	93.36±1.41^{bc}	94.05±0.37^{bc}
Proximate composition					
Moisture (%)	61.16±0.86^a	63.45±0.14^b	63.53±0.59^b	62.57±0.31^c	61.86±0.18^{ad}
Protein (%)	16.61±0.38^a	15.39±0.09^b	14.71±0.15^b	14.04±0.24^c	13.39±0.10^c
Fat (%)	20.50±0.26^a	18.54±0.21^b	18.62±0.14^b	17.63±0.14c	16.59±0.08^d
Total ash (%)	2.87±0.09^a	2.91±0.03^a	3.00±0.03^b	3.06±0.06^b	3.16±0.60^c
Fiber content (%)	0.47±0.02^a	4.43±0.08^b	4.75±0.07^b	5.51±0.03^c	5.77±0.04^c

*Number of observations: = 6

Means bearing different superscripts row-wise differ significantly (P<0.01).

pH

The emulsion and product pH were significantly (P<0.01) lower in T 4 followed by T_3, T_2, T_1 and control. This could be attributed to incorporation of plantain components, which inherently exhibit lower pH (pH 5.1) than lean meat (Tribess et al. 2009). The mean pH values of the incorporated chicken nuggets were in agreement with the result of Alves et al. (2016), wherein they reported pH values of 6.01 to 6.11 in bologna type sausages formulated with green banana and pork skin gel.

Emulsion stability, Cooking yield, Moisture and Fat retention

The treatment T_4 (P<0.01) had higher emulsion stability, cooking yield and fat retention than the T_3, T_2, T_1 and

control. The higher product yield may be attributed to the improved water binding and fat absorption by the insoluble fibers (Backers and Noli, 1997), which would have favored in improved cooking yield and emulsion stability (Colmenero et al. 2005). Bastos et al. (2014) also reported that higher cooking yield and emulsion stability was observed by incorporating green banana flour in beef burgers. The moisture retention of T_2 was significantly higher and that of control and other treatment was significantly lower. The fat retention values were significantly ($P<0.01$) higher for T_4 **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. The observation above indicated that the resistant starch and fibers present in unripe banana by-products allow the retention of more water due to its absorption capacity (Zaini et al. 2020).

Proximate Composition

Moisture content of T_1 was significantly higher and control was significantly lower. However, no significant difference was observed between T_1 and T_2. Moisture content of control was comparable with T_4. Moisture and total ash content values were significantly increased from control to treatments whereas protein and fat content values were significantly decreased from control to treatments. The moisture and total ash content values were significantly ($P<0.01$) higher for T_4 **and significantly lower for control**. However, reverse trends were observed in protein and fat content. The moisture content reduced as the ripened banana peel powder was increased. This could be due to moisture content of banana peel powder (11.11%) which is lesser than the moisture content in chicken meat (Zaini et al. 2019).

Protein content of control was significantly higher than all other treatments. However, no significant difference was observed between T_1 and T_2 and between T_3 and T_4. The fat content was significantly ($P<0.01$) higher in control and lower in T_4. The fat content of T_2 and T_3 did not differ significantly. Protein and fat present in the treated samples also reduced significantly ($P<0.05$) due to the lesser fat and protein content present plantain components. The present results are in agreement with studies made on oat flour added chicken nuggets (Santhi and Kalaikannan, 2014) and carrageenan flour added meat kofta (Modi et al. 2008). Control had significantly ($P<0.01$) lower and T_4 had significantly ($P<0.01$) higher ash content. The higher ash content of plantain components incorporated samples might be due to increasing concentration of total dietary fibers, minerals and resistant starch present in the banana peel powder (Pereira and Maraschin, 2015).

Fiber content of T_4 was significantly higher than all other treatments and control. However, no significant difference was observed between treatments $T_1$and T_2 and between T_3 and T_4. Fiber content values were significantly increased from control to treatments**.** The mean fiber content value was significantly ($P<0.05$) higher for T_4 **and significantly lower for control.** Significantly higher fiber content values were observed in ripened banana peel powder incorporated chicken nuggets as compared to control. Similar conclusions were also observed by Zaini et al. (2020) in chicken sausages, where the dietary fiber increased significantly upon the incorporation of 2% to 6% banana peel powder.

Sensory Evaluation

Effect of incorporation of CSUP without peel and RBPP on the sensory attributes of fiber-enriched chicken nuggets is presented in Table 3.

Table 3: Effect of incorporation of CSUP without peel and different levels of RBPP on sensory attributes of chicken nuggets

Parameters	Level of cooked shredded unripe plantain without peel and banana peel powder				
	Control	T_1	T_2	T_3	T_4
Sensory attributes					
Appearance and colour	8.30±0.34^a	7.97±0.30^a	7.60±0.57^a	6.92±0.43^b	6.55±0.23^b
Flavor	8.17±0.24^a	7.55±0.68^b	7.65±0.81^b	7.27±0.34^b	7.30±0.47^b
Juiciness	8.02±0.30^a	7.47±0.57^b	7.67±0.40^b	7.17±0.24^c	6.75±0.44^c
Tenderness	7.65±0.51^a	7.57±0.40^a	7.62±0.58^a	7.42±0.40^a	6.97±0.30^b
Texture	8.15±0.40^a	7.45±0.45^b	7.62±0.42^b	7.17±024^c	6.83±0.23^c
Overall acceptability	8.10±0.34^a	7.52±0.44^b	7.70±0.25^b	7.22±0.25^b	6.72±0.34^c

**Number of observations: = 42

Means bearing different superscripts row-wise differ significantly ($P<0.05$).

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, t**he mean score for flavor, juiciness, tenderness, texture and over all acceptability were higher for T_2 with 10% CSUP **without peel and 1% RBPP incorporated chicken nuggets** followed by T_1, T_3 and T_4**.** Mean score for overall acceptability was significantly higher for control. Akram et al. (2022) who found that sensory evolution of broiler nuggets made with banana peel powder decreased with increasing level in the formulation. These results are in agreement with Pereira et al. (2020), who reported that incorporation of unripe banana by products in frankfurters formulation improved

the sensory scores of the products. Based on the results of sensory attributes, chicken nuggets were prepared with 1% RBPP and 10% CSUP **without peel** was rated better for all sensory attributes except appearance and colour.

CONCLUSIONS

From the above results, it can be concluded that 10 % CSUP **without peel** plus 1 % RBPP was more acceptable than other treatments. Acceptable fiber-enriched chicken nuggets can be prepared by incorporating 10 % CSUP without peel plus 1% RBPP without affecting the physico-chemical and sensory characteristics of the product

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