Full Length Article

ANTIOXIDANT EFFECT OF FUNCTIONAL CHICKEN NUGGETS UTILIZING KODO MILLET (*PASPALUM SCROBICULATUM*) - AN INDIAN NUTRICEREAL

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ABSTRACT

Antioxidant effect of Kodo millet (Paspalum scrobiculatum) was exploited in the preparation of functional chicken nuggets replacing refined wheat flour at 5% (T1), 6% (T2), 7% (T3) and 10% (T4) levels while control nuggets were prepared using Refined Wheat Flour. Antioxidant potential was assessed by DPPH radical scavenging activity, ABTS radical cation decolourization assay and Ferric Reducing Antioxidant Power. Hunters colour analysis reflected the antioxidant effect of kodo millet in chicken nugget due to the presence of phytochemicals. Incorporation of kodo millet in chicken nuggets had enriched the antioxidant capacity by 8.26% for DPPH radical scavenging activity, 11.43% for ABTS activity, and 36.29% for FRAP activity over control.

Keywords: DPPH, ABTS, FRAP, Chicken nuggets, Kodo millet

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INTRODUCTION

Processed meat products like patties, balls, kebabs, sausages and nuggets attract meat loving consumers of all ages. Despite its nutritional value, myths of meat as a cause of lifestyle disorders have created a negative image in the minds of consumers. Incorporation of millet as a functional ingredient in meat product is a recent trend to cater the requirements of both taste and health in cost effective manner. However, meat and meat products are prone to oxidative deterioration even under cold storage. Use of natural antioxidants from plant sources are preferred in meat products and have replaced the synthetic antioxidants to avoid toxicity and carcinogenic impacts. Thus, incorporation of non meat ingredient sources rich in antioxidants in meat enhances the functional benefits to the comminuted

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meat products and caters the dietary and health requirements of the consumers. Millets being rich source of phyto chemicals are now receiving specific attention for utilization as food. Kodo millet (Paspalum scrobiculatum), commonly known as "Varagu" in tamil, is rich in antioxidants (Deshpande *et al.,* 2015). Kodo millet has higher free radical scavenging activity (70%) compared to other millets (Hegde and Chandra, 2005). Hence, this experimental study was conducted to develop functional chicken nuggets incorporating kodo millet to attain the benefits of antioxidant in the meat product.

MATERIALS AND METHODS

Preparation of functional chicken nuggets

Frozen deboned chicken meat was tempered (4±1ºC) and minced in meat mincer (Model No.TS 12, Omas Food machinery, Italy). Minced chicken meat is mixed with other ingredients like salt, sodium tripolyphosphate, sodium nitrite, spice mix, green condiments and different replacement levels of refined wheat flour like 0% (Control) 5% (T1), 6% (T2), 7% (T3) and 10% (T4) with kodo millet flour to form 100% of formulation (Table.1). The temperature of the emulsion was maintained between 12-16◦C using slushed ice flakes during the process of mixing. The mix was stuffed in aluminium boxes (25 cm x 10 cm x 10 cm) without air pockets, cooked at 121º C for 30 min and the cooked loaves were cooled and cut into nuggets of 1" cubes. Antioxidant activity of the product incorporated with kodo millet was studied to identify the optimum level of incorporation of kodo millet in the functional chicken meat nuggets.

Colour

Antioxidant effect of kodo millet was visualized in the product through colour analysis using Hunter lab Mini scan XE plus Spectro- colorimeter (Model No. 45/O-L, Reston Virginia, USA) with geometry of diffuse/80 (sphere – 8 mm view) and an illuminant of D65/10◦ (Bindu *et al.,* 2007). The colour was expressed as L* (brightness), a*(redness) and b* (yellowness).The hue and chroma was calculated as follows.

$$\text{Hue} = \tan^{-1}(b^*/a^*)$$

$$\text{Chroma} = \sqrt{(a*)^2 + (b*)^2}$$

Antioxidant capacity

DPPH radical scavenging activity

The ability to scavenge the 1, 1 diphenyl 2picryl hydrazyl (DPPH) radical by added antioxidants in the functional chicken meat nuggets was estimated following the modified method of Jung *et al.* (2010). Ten gram of the sample was mixed with 20 ml of ethanol for 2 min and filtered through Whatman filter paper No 42. A 200 µL sample aliquot was added to 800 µL distilled water and 1 ml methanolic DPPH solution (0.2 mM) and the sample mixture was vortexed and left to stand at room temperature (20–22°C) for 30 min. Ethanol was used as blank and the solution containing 1 ml of distilled water and 1 ml of methanolic

DPPH solution (0.2 mM) was used as control. The absorbance of the solution was measured at 517 nm using a UV-VIS spectrophotometer (Agilent Technologies, Model. Cary 60) and DPPH scavenging activity was calculated using the formula.

DPPH Scavenging activity (%) =
$(Ab_{control} - Ab_{sample} / Ab_{control}) \times 100$

$Ab_{control}$ - Absorbance of the control (DPPH solution without sample)

Ab_{SAMPLE} - Absorbance of the test sample (DPPH solution plus test sample)

ABTS.+ radical cation decolourization assay

Sample extraction process is similar to that done for DPPH assay. ABTS radical cation decolourization assay was conducted as per the method outlined by Re *et al.* (1999). The ABTS (2,2-azino bis-3 ethyl benzo thiazoline-6-sulfonic acid) radical cation, ABTS.+ was produced by incubating the mixture of 14 mM ABTS and 4.9 mM potassium per sulfate in distilled water in equal proportion (final concentration of 7 mM ABTS and 2.45 mM potassium per sulfate) and incubated in the dark at room temperature, 12–16 hrs prior to usage. The prepared ABTS.+ solution was adjusted to an absorbance of 0.70 (± 0.02) at 734 nm using ethanol. Three ml of this diluted ABTS.+ solution was reacted with 30 µl of the sample extracts, and the absorbance was recorded after 6 min of initial mixing. Ethanol was used as blank and the mixture of diluted ABTS.+ solution with ethanol serves as control. The reduction of the ABTS.+ radical was calculated as:

$ABTS\ (\%) = ((Abs_{control} - Abs_{sample}) / Abs_{control}) \times 100$

where $Abs_{control}$ is the absorbance of ABTS with ethanol and Abs sample is the absorbance of the ABTS radical solution of the sample.

Ferric reducing antioxidant power

Sample extraction process is similar to that done for DPPH assay. FRAP was estimated to measure endogenous FeII that could react with TPTZ and determined using a TPTZ/HCl solution without the addition of FeCl3 to the mixture. Ferric antioxidant capacity of the samples was estimated as per the modified method described by Descalzo et al. (2007). FRAP buffer is prepared freshly with 10 mM TPTZ (2,4,6-tris (2-pyridyl)-s-triazine) in 40 mM HCl and 20 mM FeCl3 added to 300 mM acetate buffer (pH 3.6) (1:1:10). Sample extract (83 µL) were added to 2.5 ml of the FRAP buffer and allowed to stand for 4 min at room temperature and the absorbance was measured at 593 nm using a spectrophotometer. The results were expressed as mmol of FeII equivalent per kilogram using 0–100 µM calibration curve for FeSO4•7H2O (final concentrations).

Statistical analysis

The data obtained on the assessment of colour, fat deteriorative products, antioxidant activities in chicken nuggets were analysed statistically by one way ANOVA and the significance by DUNCANS

test using the SPSS software as per the method outlined by Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

The results of Hunters colour analysis (Table 2) revealed improved colour characteristics like increased darkening (L*) and redness (a*) and decreased yellowness (b*) with increase in replacement levels which may be attributed to the innate colour of kodo millet due to high contents of tannins, poly phenols etc which turned dark on cooking. The addition of kodo millet in chicken nuggets significantly ($P<0.01$) decreased the hue values but did not differ significantly in saturation index (chroma) compared to control. Similar darkening (L*) and decreased yellowness (b*) was recorded in chevon patties incorporated with finger millet (Kumar *et al.,* 2015) but a contrast observations of increase in hue and chroma was recorded, the reason could be attributed to the meat and millet used in their research.

The functional benefit on incorporating kodo millet in chicken nuggets through enrichment of antioxidant capacities were reflected by the increased activity of 8.26% for DPPH radical scavenging activity, 11.43% for ABTS activity, and 36.29% for FRAP activity in the kodo millet incorporated nuggets over that of control (Table 3). Enrichment of antioxidants in millet incorporated meat products also increases the shelf life of the products many fold by scavenging the oxidizing free radical molecules (Chandrasekara and Shahidi, 2011).

CONCLUSION

Kodo millet replacement for refined wheat flour is an effective means of development of functional chicken meat nuggets with economic advantage for both consumers and the processors. Statistical analysis of the results of this study drives to a conclusion that functional chicken meat nuggets could be developed by replacement of refined wheat flour with kodo millet up to 7% level to achieve the acceptable product development with the functional benefit of increased antioxidant capacity.

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Table 1. Formulation of functional chicken nuggets

S. No	Ingredients	Percentage (w/w)				
		Control	Treatments			
			T1	T2	T3	T4
1.	Lean chicken meat	69.52	69.52	69.52	69.52	69.52
2.	Salt	1.45	1.45	1.45	1.45	1.45
3.	Sodium tri polyphos-phate	0.22	0.22	0.22	0.22	0.22
4.	Sodium nitrite	0.01	0.01	0.01	0.01	0.01
5.	Oil	7.23	7.23	7.23	7.23	7.23
6.	Spice mix	1.45	1.45	1.45	1.45	1.45
7.	Condiment mix (Onion: Garlic-3:1)	2.89	2.89	2.89	2.89	2.89
8.	Ice flakes	7.23	7.23	7.23	7.23	7.23
9.	Refined wheat flour	10.00	5.00	4.00	3.00	-
10.	Kodo millet flour	-	5.00	6.00	7.00	10.00

Table 2. Mean±SD of colour values of kodo millet incorporated functional chicken nuggets

Groups	L*	a*	b*	Hue	Chroma
Control	71.64c±0.41	7.33a±0.18	26.75±0.70	0.998b±0.00	28.18±3.07
T1-5%	68.93bc±0.78	7.76b±0.40	26.17±0.55	0.997a±0.00	27.29±0.51
T2 -6%	67.94ab±0.76	7.86b±0.41	26.10±0.82	0.997a±0.00	27.25±0.87
T3-7%	67.53ab±0.79	7.86b±0.31	25.81±0.91	0.997a±0.00	26.98±0.93
T4-10%	65.14a±5.19	7.91b±0.26	25 .04±3.14	0.998a±0.00	27.74±0.69
'F' value	5.74**	3.16*	0.64	4.86**	0.57

Means bearing different superscripts between rows (a,b,c,d) differ significantly ($P < 0.05$)

Table 3. Antioxidant activities of kodo millet incorporated functional chicken nuggets

Groups	DPPH (%)	ABTS (%)	FRAP (mmol/kg)
Control	69.42a± 2.29	56.40a±1.83	1.24a± 0.08
T1-5%	70.64a± 3.17	58.79b±1.11	1.42b± 0.06
T2 -6%	71.25a± 1.19	60.26b±0.58	1.54c±0.07
T3-7%	75.16b± 1.92	62.85c±1.33	1.69d± 0.06
T4-10%	77.32b± 2.49	68.15d±3.20	1.77e± 0.07
'F' Value	12.55**	35.76**	58.61**

Means bearing different superscripts between rows (a,b,c,d) differ significantly (P < 0.05)

CONFLICT OF INTEREST

We certify that there is no conflict of interest among the authors and the financial organization with respect to the materials discussed in the manuscript.

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