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Fiber Enrichment in Noodles using Banana Pseudo-stem (*Musa paradaisiaca*)

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ABSTRACT

Background: Despite the fondness for noodles, consumers in India hold the notion that noodles are being made from maida which is seen as product with low fiber. Hence an attempt was made to develop fiber enriched noodles by incorporating banana pseudo-stem tender core powder (BPP) as a fiber source.

Methods: BPP was incorporated at different levels *viz*., 5, 10 and 15% in which 5% was found to be the best based on cooking characteristics and sensory evaluation. The noodles thus prepared were packed in flexible polyethylene pouches and stored at room temperature and were further analyzed for physicochemical, cooking, sensory and colour characteristics at regular intervals of 60 days till 180 days of storage.

Result: All the analysis showed the non-significant difference during the storage period stating that the product is good till 180 days of storage. The dietary fiber was found to increase from 3.35 to 4.74% and *in vitro* method of glycemic index (GI) analysis showed that the fiber noodle was a low GI food when compared to the medium GI of control. The MUFA and PUFA content of BPP noodles were increased when compared to control.

Key words: Banana pseudo-stem, Dietary fiber, Fiber, Glycemic index, Noodles, Total fiber.

INTRODUCTION

Over the years, change in consumer preferences, eating habits, global exposure and along with an increasing younger population has given a boost to the convenience food segment. Being a quick meal requiring minimal cooking time with its advantage in availability, affordability, anytime-anywhere consumption and convenience, noodles have also emerged from being a snack food or an occasional chat to an alternate eating option for mainstream food featuring regularly in consumer's grocery baskets. As a result, world's noodles market has charted a high growth trajectory from production of 90,230 million tonnes in 2006 to 1, 12,148 million tonnes in 2016 (https://www.noodle.com/colleges/statistics subjects).

Noodles are generally prepared from unleavened dough of wheat flour, refined wheat flour or buckwheat flour. About three parts of flour are usually mixed with one part of salt solution to form crumble dough which is compressed between the rolls to form a dough sheet. The gluten network developed during the sheeting process contributes to the noodle texture. The sheeted dough is then slit to produce noodles which are then steamed, dried and packed.

Usually noodles are enriched with various food flours like grains, vegetables, tubers, egg, meat, fish *etc.* to improve its nutritive value. In grain flours rice, soya, cassava, pulses *etc*., are used: vegetables like tomato, palak greens, carrot, beetroot, *etc*., are used; powders of egg, meat of emu, fish, poultry *etc*. are incorporated in noodles as a nutrient and flavor enhancers. Xiaoyan *et al.,* (2013) described the possibility to produce fiber-rich noodles by incorporating 2.0 to 6.0% ultrafine food fibers of wheat bran, wheat fiber and fruit fibers *etc*., so, these studies offer opportunities for the noodle industry to use various fibers as an ingredient for enhancing the dietary fiber content of noodles.

In the present study, fiber enriched noodles were prepared by incorporating banana pseudo-stem. It was evident that the cost of production was lowered; profit increased as well as adding value to banana pseudo-stem when used as meat filler in scrapple preparation by Marichu *et al.*, (2014). The chemical and functional properties of the native banana pseudo-stem tender core flours indicate good fiber supplementation for oats and sorghum in the development of new food products. (Noor *et al*. 2011).

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MATERIALS AND METHODS

The raw materials like banana pseudo-stem tender core, refined wheat flour, salt were procured from the local vegetable market. The utensils and accessories made of food grade stainless steel (SS 304) were used for the noodle preparation. The compatible noodle making machine: Make: M/s Atlas Pvt Ltd (completely made of food-grade stainless

steel SS 304) consists of a set of plain rollers and two sets of cutting rollers (cutting width 4 mm and 7 mm). Removable arm handle is provided for easy rotation of rollers. An adjustable screw was provided for plain rollers for adjusting the clearance between the rollers.

Noodle preparation and storage

The ingredients for the preparation of fiber-enriched noodles were refined wheat flour, water, salt and fiber source (banana pseudo-stem tender core). Banana pseudo-stem tender core were cut into uniform size of 5 mm cubes and dried in solar drier for 24-48 hours. It was then powdered in a mixer grinder to form banana pseudo-stem tender core powder (BPP). Salt was first dissolved in water and the solution was added to the refined wheat flour along with BPP at the rate of 5, 10 and 15% and mixed well. The resultant dough had a crumbly consistency similar to that of moist breadcrumbs. Conditioning of noodle dough is carried out for about half an hour to make the dough to be good for sheeting. The dough was first formed into a sheet by process of folding and passing through the plain rollers of the noodle machine several times. The thickness of the sheet was reduced stepwise by minimizing the roller spacing before cutting into strands of 4 mm thick. Steaming of freshly prepared noodles is done for about 15-20 minutes until noodles were partially cooked. The steam cooked noodles were arranged upon trays and were kept for sun drying for about 6-8 hours for effective drying and thereafter kept in a hot air oven at 60°C for 6-8 hours till the product has reached about 12% moisture content. The product was then allowed to cool for 30 minutes in the ambient conditions at room temperature thereafter packed in polyethylene bags, sealed and stored at ambient temperature. The flowchart for the preparation of fiber-enriched noodles is shown in Fig 1.

Analysis of samples

The cooking characteristics considered for optimization of fiber level in noodles includes the cooking time, gruel solid loss and water uptake which was calculated respectively by the methods given by Omeire *et al.,* (2015), Poongodi *et al.,* (2010) and Taneya *et al*., (2014). The fiber-enriched noodle samples were analyzed for physicochemical parameters *viz*.,

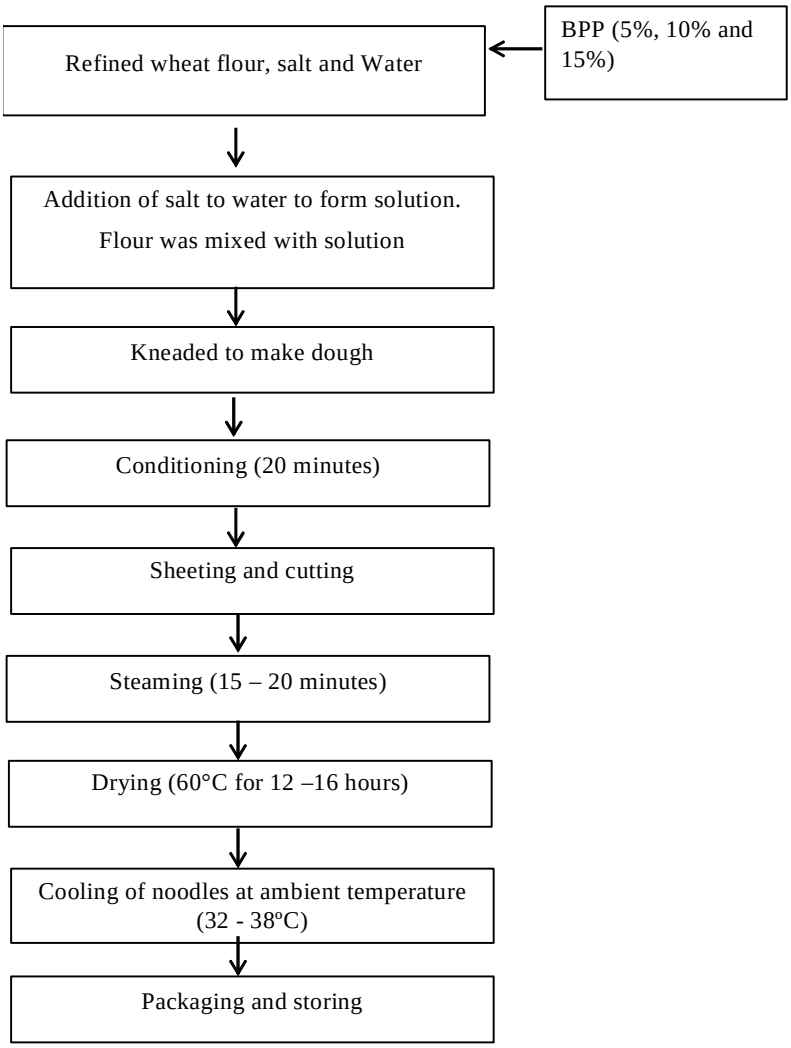


Fig 1: Flow chart for the preparation of noodles.

moisture (wet basis) and total ash as per the standard procedures described in AOAC, 2006. Crude fiber was analyzed as per the standard procedure of AOAC, 2000.

Total fiber

The pre-weighed sample (W) of about 1g is taken in crucible and is subjected to acid wash and alkali wash in the automated fiber estimating apparatus (Fibrotron). Frequent distilled water wash was done after both the acid and alkali washes. The washed samples were then dried in hot air oven at 110°C and weighed (W_1). The same crucible with the sample is kept in muffle furnace at 550°C for 5-6 hours and weighed as W_2. The percentage of crude fiber present was estimated from the formula given below, equation 1.

$$\% \text{ of Total fiber} = (W_1 - W_2)/W \times 100 \ldots\ldots\ldots (1)$$

Dietary fiber

The noodle samples were taken for sequential enzymatic digestion by heat stable α -amylase, protease and amylo-glycosidase to remove starch and protein. For determining insoluble dietary fiber (IDF), enzyme digestase is mixed with samples, filtered and residue is washed with warm water and then dried and weighed. For Soluble dietary fiber (SDF), combined filterate and washes are precipitated with alcohol, which was then filtered, dried and weighed. The sum of IDF and SDF will give Total dietary fiber (TDF).

The fatty acid profile was analyzed by gas chromatography (Jana *et al.,* 2015). Glycemic index (GI) measurement is carried out based on *in vitro* technique on carbohydrate-containing foods. GI is a relatively new way of counting the total amount of carbohydrates in foods in their unconsumed state (Crosbie and Ross, 2004). Texture for uncooked noodles is measured in terms of gradient force which acts opposite to the gravitational force and is calculated negatively on mathematical expression. To determine the gradient force using texture analyzer, probe PS 06 was used. For cooked noodles, the stickiness was calculated using Texture profile analysis with the compression batten probe (Fu, 2008). Noodle color was measured with a hunter colorimeter (spectrophotometry). L* denotes the lightness, a*denotes redness or greenness and b*values represents yellowness. The sensory analysis was assessed by subjecting the cooked noodles samples to the sensory scores for color and appearance, taste, texture, chewability and overall acceptability from six untrained panelists from College of Food and Dairy Technology, the scores were obtained on a 9 point hedonic scale.

Storage studies

The packed samples were analyzed at an interval of 60 days until 180 days of storage. Physicochemical properties like moisture content, crude fiber and total ash determined during the storage study during 0th, 60th, 120th and 180th day of storage. The color and texture of the noodle samples were analyzed at the 0th and 180th day of storage whereas the glycemic index and fatty acid profile were analyzed at the initial stage (Hou *et al.*, 2010). The data obtained were analyzed statistically using IBM SPSS® 20.0 for Windows® software as per the standard procedure of Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

The preliminary trials were conducted with three different levels of fiber incorporation for noodle preparation. The level of incorporation of the selected fiber was optimized based on the results of cooking characteristics *viz*., minimum cooking time, lowest gruel solid loss and highest water uptake ratio (Fig 2) and sensory parameters (Fig 3). From Fig 2 and Fig 3, it is obvious that 5% incorporation was chosen as the best level and further studies were carried out for noodles prepared using 5% level of incorporation.

The physicochemical characteristics like moisture, total ash, crude fiber, SDF, IDF and TDF were analyzed at an interval of 60 days and the results are denoted in Table 1. From the table, it is obvious that there is a decrease in moisture and total ash content whereas the crude and dietary fiber content increased when compared to control. Also non-significant changes in the physiochemical parameters were observed for the BPP noodles during storage period. The result is in accordance with Dhingra *et al*., (2012) which

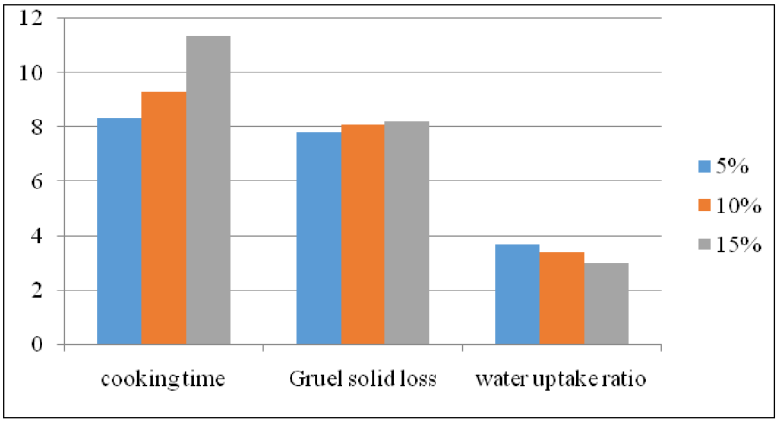


Fig 2: Optimization of BPF enriched noodles by sensory analysis (Mean ± SE)#.

showed no significant difference of fiber content during the storage period.

The cooking characteristics of fiber enriched noodles stated no significant increase in the gruel loss, cooking time and the water uptake ratio during the storage period. The cooking time was from 6 to 8 min, whereas gruel solid loss is at range from 6 to 8.5 and water uptake ratio was 3.8 to 3.5. The cooking characteristics are studied during period of 0th, 60th, 120th and 180th days and shown in Fig 4. The results obtained was in coincidence with the study of Taneya *et al.,* 2014, where the study shows that the incorporation level of various supplement sources should never change the product originality but the supplementation should be effect positively on both quality and nutrition concept of the product. The study was correlated with the water uptake, where when a product absorbs about 1.5 and greater the

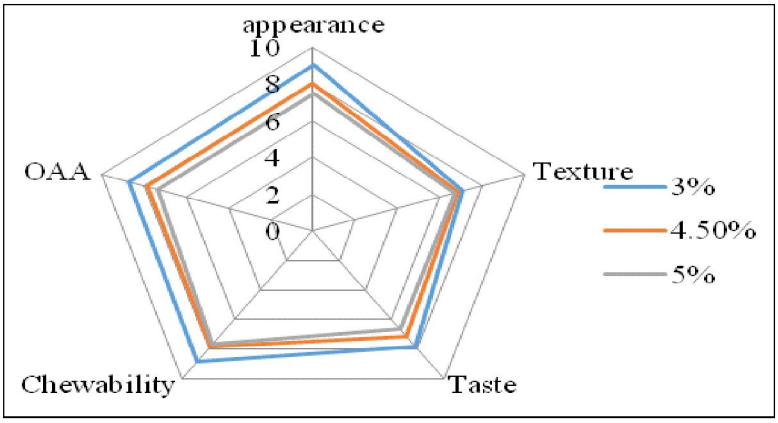


Fig 3: Optimization of BPN by sensory characteristics.

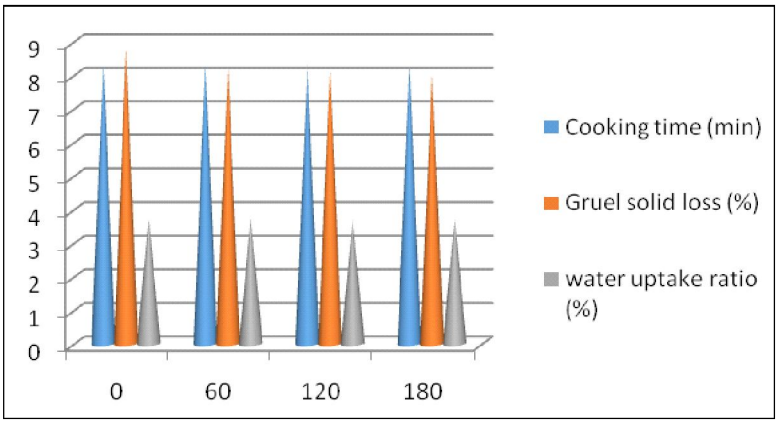


Fig 4: Changes in cooking characteristics of BPN during storage period.

Table 1: Changes in physicochemical characteristics during storage period.

Samples	Storage period (in days)	Physico-chemical characteristics (uncooked noodles)					
		Moisture %	Total ash %	Crude fibre %	SDF %	IDF %	TDF %
Control	0	8.14±0.008	3.60±0.011	0.70±0.012	0.05±0.013	3.3± 0.013	3.35±0.016
	0	7.52±0.008	2.38±0.021	1.20±0.014	0.12±0.307	4.67±0.224	4.79±0.307
BPN	60	7.50±0.013	2.37±0.016	1.19±0.013	0.11±0.307	4.66±0.333	4.77±0.167
	120	7.49±0.013	2.35±0.013	1.19±0.015	0.11±0.211	4.65±0.333	4.76±0.211
	180	7.49±0.009	2.33±0.030	1.17±0.012	0.9±0.091	4.63±0.258	4.74±0.258
F value		1.38^{NS}	0.87^{NS}	1.19^{NS}	1.93^{NS}	2.43^{NS}	2.43^{NS}

Table 2: Fatty acid profile and glycemic index of BPP noodles.

Noodle type	Saturated fatty acid	MUFA (%)	PUFA (%)	Glycemic index (%)
Control	0.84±0.15	0.53±0.12	0.74±0.19	59
BPN	1.87±0.19	2.78±0.03	2.28±0.02	45

Table 3: Colour and texture of fiber enriched noodles during storage period (Mean ± SE)[#].

Samples	Storage period	Colour and texture of fiber enriched noodles							
		Colour						Texture	
		Uncooked noodles			Cooked noodles			Uncooked noodles	Cooked noodles
		L*(HU)	a*(HU)	b*(HU)	L*(HU)	a*(HU)	b*(HU)	Gradient force (kg/sec)	Stickiness (g)
BPP	0	67.68±0.023	1.55±0.013	12.95±0.012	71.01±0.019	1.56±0.041	19.31±0.224	-25.741±0.03	26.139±0.008
Noodles	120	67.12±0.021	1.44±0.14	12.91±0.014	70.84±0.016	1.55±0.054	19.30±0.191	-25.225±0.04	26.131±0.013
F value		1.01 ^{NS}	1.73 ^{NS}	1.031 ^{NS}	1.93 ^{NS}	0.79 ^{NS}	1.19 ^{NS}	21.01^{NS}	1.38 ^{NS}

[#]-Average of six trials; (p >0.05).

Table 4: Sensory attributes of fiber enriched noodles during storage period (Mean ± SE)[#].

Sensory attribute	Storage period (in days)	Sensory attributes of fiber enriched noodles				
		Colour	Texture	Taste	Chewability	Overall acceptance
Control	0	8.83±0.258	8.50±0.307	8.50±0.224	8.50±0.333	8.67±0.167
	60	7.67±0.211	8.17±0.167	8.33±0.307	8.33±0.167	8.50±0.211
	120	7.83±0.307	7.83±0.211	8.17±0.224	8.00±0.224	8.33±0.307
	180	8.17±0.333	7.83±0.224	7.83±0.167	7.67±0.167	8.17±0.211
F value		1.07 ^{NS}	2.17 ^{NS}	2.19 ^{NS}	2.07 ^{NS}	6.17 ^{NS}
BPP Noodles	0	8.67±0.211	8.50±0.224	8.67±0.211	8.50±0.342	8.67±0.211
	60	8.50±0.224	8.17±0.307	8.00±0.258	8.33±0.333	8.17±0.307
	120	8.33±0.211	7.83±0.307	7.83±0.307	8.00±0.258	8.50±0.224
	180	8.17±0.307	7.67±0.211	7.67±0.333	8.00±0.258	8.00±0.258
F value		0.79^{NS}	1.93^{NS}	2.43^{NS}	0.69^{NS}	1.45^{NS}

level of water, the product swells and makes the greater hydration index.

Food with lower than glycemic index of 50 are considered as low glycemic food whereas at range of 50-75 are medium glycemic food (Jorge *et al.,* 1997). The *in-vitro* method of glycemic index brings out the result that control sample is a food with medium glycemic index of 59 whereas BPP noodles as food with lower glycemic index of 45 (Table 2).

The fatty acid profile was analyzed during the 0th day of storage for both control and BPP noodles and the quantification for saturated fats and unsaturated fats like MUFA and PUFA was estimated and tabulated in the Table 2. From the table it is inferred that both saturated and unsaturated fats were found to increase in BPP noodles and this may be due to the presence of fatty acid in the banana pseudo-stem tender core powder.

The colour characteristics of uncooked and cooked noodles were studied during initial and final days of storage (Table 3). The values of L*, a* and b* were evaluated and are found to be with non-significant difference within treatments. The lightness L* characteristics was observed representing slight decrease in lightness (Xiayoan *et al.,* 2013).

No significant (P ≥0.05) difference was observed in the scores of colour and appearance, flavour, taste, consistency and overall acceptance during storage period but significant difference (P ≤ 0.05) was observed in the texture of BPP noodles during storage. The results were in coincidence with the study of Deshpande and Poshadri (2011), where the slight variation on parameters like, chewability doesn't change the overall acceptability of the product stored. (Table 4).

CONCLUSION

The study on fiber enrichment in noodles resulted that the noodles prepared by incorporating banana pseudo-stem tender core powder increased fiber content than the control sample. The presence of MUFA and PUFA was also found at the increased range on developed noodles by incorporating banana pseudo-stem tender core powder. The developed noodles can also be categorized into low glycemic food as compared to medium glycemic food of control noodles. The ambient shelf life storage study was 180 days for developed noodles with no significant difference in characteristics of fiber noodles. Therefore, the shelf life of fiber-enriched noodles was found to be 180 days.

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