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RESEARCH NOTE

Nutritional Composition and Polyphenol Content of Food Products Enriched with Millets and Drumstick Leaves

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Abstract

The present study was undertaken to formulate and analyze the nutritional composition of value added food products prepared by the incorporation of finger millet flour *(Eleusine coracana)*, pearl millet flour *(Pennisetum glaucum)* and drumstick leaves *(Moringa oleifera)*. Three value added food products were namely *'Idli', 'Dhokla'* and *'Uthapam'* were analyzed for proximate constituents and total phenolic content. *'Idli', 'Dhokla'* and *'Uthapam'* were prepared by the incorporation of finger millet flour, pearl millet flour and drumstick leaves in ratio of 20:20:10. Results showed that *'Idli', 'Dhokla'* and *'Uthapam'* were rich in calcium, vitamin C and total phenolic content (141.48mg/100g, 23.42mg/100g and 712.43mg/100g), (154.84mg/100g, 24.78mg/100g and 622.6mg/100g) and (142.91mg/100g, 25.23mg/100g and 687.03mg/100g) respectively. Incorporation of finger millet flour, peal millet flour and drum stick leaves improved the nutritional composition of the products. It can be concluded that these products prepared from millets and drumstick leaves have potential to in the prevention of ageing and various diseases associated with oxidative stress.

Keywords: Nutritional composition, Finger millet flour, Pearl millet flour, Drumstick leaves, *Eleusine coracana*, *Pennisetum glaucum*, *Moringa oleifera*

Plant foods are important due to their antioxidant activity (AOA) attributed to the phenolics which are known to protect organisms against harmful effects of free radicals. However, information on antioxidant activity of Indian plant foods is scanty (Sreeramulu *et al*. 2009). Millets were found to have high nutritive value and comparable to that of major cereals such as wheat and rice (Parameswaran *et al.* 1994). It has also been reported that millet proteins are good sources of essential amino acids except lysine and threonine but are relatively high in methionine. Millets are also rich sources of phytochemicals and micronutrients (Mal *et al.* 2012). Finger millet *(Eleusine coracana)*, one of the minor cereals, is known for several health benefits and some of its health benefits are attributed to its polyphenol and dietary fiber contents. Its importance is well recognized because of its high content of calcium (0.38 per cent), dietary fiber (18 percent) and phenolic compounds (0.3–3 per cent).

Pearl millet (*Pennisetum glaucum)*, is the most popular cereal crop grown in tropical semi-arid regions of the world. Pearl millet (*Bajra*) has been recommended for several therapeutic purposes. *Moringa oleifera*, an edible tree found worldwide in the dry tropics, is increasingly being used for nutritional supplementation. Its nutrient-dense leaves are high in protein quality, leading to its widespread use by doctors, healers, nutritionists and community leaders, to treat under-nutrition and a variety of illnesses. These leaves are good source of calcium, iron, folic acid, riboflavin, vitamin C and β-carotene

should be used in abundance in order to maintain the body against oxidative damage caused by everyday pollutants. The extract of *M. oleifera* may also have beneficial effect on serum cholesterol concentration and a stimulant to thyroid functions (Tabassum *et al.* 2013*).*

Phenolics are antioxidants with redox properties, which allow them to act as reducing agents, hydrogen donators and single oxygen quenchers. They also have metal chelation properties and their significance for the human diet and antimicrobial activity has been established. The antioxidant properties of these compounds are often claimed for the protective effects of plant-based beverages against cardiovascular disease, certain forms of cancer and photosensitive reactions (Chanda *et al.* 2013). Polyphenols are the most abundant antioxidants in the diet. Their total dietary intake could be as high as 1g/d, which is much higher than that of all other classes of phytochemicals and known dietary antioxidants (Chandrasekara and Shahidi, 2010*).*

No studies are available on the values of the total polyphenol content of Indian pearl millet (commonly known as *Bajra*), Finger millet (*Ragi*) and drumstick leaves based recipes. Hence, the present study has been undertaken for nutritional composition and polyphenol content of food products enriched with millets and drumstick leaves.

MATERIALS AND METHODS

The investigation was conducted in the Department of Foods and Nutrition, Ethelind School of Home Science, Sam Higginbottom Institute of Agriculture, Technology and Science (SHIATS), Allahabad.

Procurement of Raw Materials

Pearl millet and finger millet were purchased from the local market of Allahabad district and drumstick leaves were procured from the farm of the SHIATS, Allahabad.

Preparation of Value Added Food Products

Three food products namely (*'Idli'*, *'Dhokla'*, *'Uthapam'*) were prepared with the incorporation of finger millet flour, pearl millet flour and drumstick leaves. For each product, the basic recipe (control T_0) had three variations T_1, T_2 and T_3 respectively, where the amount of one or more ingredients was varied. A detail of control and treatment is given in Table 1.

Table 1: Details of control and treatment combinations

Sl. No.	Ingredients	Treatments			
		T_0	T_1	T_2	T_3
1.	*Idli*				
	Semolina	90	45	40	35
	Finger millet flour	-	20	20	20
	Pearl millet flour	-	20	20	20
	Drumstick leaves	-	5	10	15
	Curd	10	10	10	10
2.	*Dhokla*				
	Besan	90	45	40	35
	Finger millet flour	-	20	20	20
	Pearl millet flour	-	20	20	20
	Drumstick leaves	-	5	10	15
	Curd	10	10	10	10
3.	*Uthapam*				
	Semolina	90	45	40	35
	Finger millet flour	-	20	20	20
	Pearl millet flour	-	20	20	20
	Drumstick leaves	-	5	10	15
	Curd	10	10	10	10

Nutritional composition and polyphenol content of prepared food products

Chemical analysis: Protein, ether extract, ash, moisture content, and fibre were determined according to the standard methods of AOAC (2005). The remaining percentage represented carbohydrates by difference. Energy was calculated from fat, carbohydrate and protein contents using Atwater's conversion factors. Ascorbic acid was determined following the AOAC (2005) official method 967.21 by titration with the 2-6 dichloro-phenol-indophenol reagents. Calcium and iron were estimated by standard procedures of AOAC, 2005.

Total Polyphenols content: Total phenolic content of the organic solvent extracts of different plants was determined with Folin-Ciocalteu reagent method (Mc Donald *et al.* 2001). 0.5mL sample (1mg/mL in distilled water) was taken in triplicates and 0.1mL Folin-Ciocalteu reagent (0.5 N) was mixed and then the incubated for 15 minutes at room temperature. Then 2.5mL of saturated sodium carbonate was added and mixture was again incubated for 30minutes at room temperature. The absorbance of the mixture was measured at 760nm. Gallic acid was used as a standard. Total phenol values were expressed in terms of Gallic acid equivalent (mg g-1of extracted compound).

Sensory Evaluation

Sensory evaluation of the food products for their acceptability was done by a panel of judges. The score card based on the 9 point Hedonic Scale was used for sensory evaluation on the basis of evaluation of attributes like Colour and Appearance, Texture, Taste & Flavour and Overall Acceptability (Srilakshmi, 2007).

RESULTS AND DISCUSSION

Sensory Evaluation of Developed Products

Table 2: Average sensory scores of different parameters in control and treated sample of '*Idli*'

Parameters	T_0	T_1	T_2	T_3
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Colour and appearance	7.4 ± 0.12	7.2 ± 0.08	8.4 ± 0.05	5.8 ± 0.05
Body and texture	7.6 ± 0.23	7.6 ± 0.14	8.5 ± 0.10	5.7 ± 0.10
Taste and flavour	7.5 ± 0.10	7.4 ± 0.21	8.7 ± 0.05	6.1 ± 0.25
Overall acceptability	7.5 ± 0.12	7.3 ± 0.13	8.5 ± 0.05	5.8 ± 0.08

The Table 2 shows the mean scores of *'Idli'* in relation to overall acceptability which indicates that T_2 (semolina + finger millet flour + pearl millet flour + drumstick leaves + curd 40:20:20:10:10) had the highest score followed by T_0 (semolina + curd 90:10), T_1 (semolina + finger millet flour + pearl millet flour + drumstick leaves + curd 45:20:20:5:10), and T_3 (semolina + finger millet flour + pearl millet flour + drumstick leaves + curd 35:20:20:15:10) respectively. Scoring shows that the treatment T_2 was liked very much while control and T_0, T_1, and T_3 were moderately liked by the panel of judges.

Table 3: Average sensory scores of different parameters in control and treated sample of '*Dhokla*'

Parameters	T_0	T_1	T_2	T_3
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Colour and appearance	7.1 ± 0.20	7.4 ± 0.23	8.4 ± 0.09	6.2 ± 0.20
Body and texture	7.1 ± 0.12	7.3 ± 0.22	8.4 ± 0.12	6.1 ± 0.17
Taste and flavour	7.1 ± 0.12	7.3 ± 0.20	8.5 ± 0.09	6.2 ± 0.28
Overall acceptability	7.1 ± 0.12	7.3 ± 0.10	8.4 ± 0.08	6.1 ± 0.19

The Table 3 shows the mean scores of *'Dhokla'* in relation to overall acceptability which indicates that T_2 (besan + finger millet flour + pearl millet flour + drumstick leaves + curd 40:20:20:10:10) had the highest score followed by T_1 (besan + finger millet flour + pearl millet flour + drumstick leaves + curd 45:20:20:5:10), T_0 (besan + curd 90:10), and T_3 (besan + finger millet flour + pearl millet flour + drumstick leaves + curd 35:20:20:15:10) respectively. Scoring shows that the treatment T_2 was liked very much while control and T_1, T_0, and T_3 were moderately liked by the panel of judges.

The Table 4 shows the mean scores of *'Uthapam'* in relation to overall acceptability which indicates that T_2 (semolina + finger millet flour + pearl millet flour + drumstick leaves + curd 40:20:20:10:10) had the highest score followed by T_1 (semolina + finger millet flour + pearl millet flour + drumstick leaves + curd 45:20:20:5:10), T_0 (semolina + curd 90:10) and T_3 (semolina + finger millet flour + pearl millet flour +

drumstick leaves + curd 35:20:20:15:10) respectively. Scoring shows that the treatment T_2 was liked very much while control and T_1, T_0, and T_3 were moderately liked by the panel of judges.

Table 4: Average sensory scores of different parameters in control and treated sample of '*Uthapam*'

Parameters	T_0	T_1	T_2	T_3
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Colour and appearance	7.5 ± 0.05	7.9 ± 0.12	8.8 ± 0.08	6 ± 0.16
Body and texture	7.6 ± 0.21	7.5 ± 0.05	8.4 ± 0.05	6.05 ± 0.17
Taste and flavour	7.5 ± 0.12	7.6 ± 0.05	8.5 ± 0.17	6.3 ± 0.10
Overall acceptability	7.5 ± 0.11	7.6 ± 0.04	8.5 ± 0.05	6.1 ± 0.11

The result is also supported by the findings of Nazni and Shalini, (2010) who determined the physical properties of batter, physio-chemical properties and organoleptic evaluation of the developed '*Idli*'. '*Idli*' were prepared from Rice and Black gram dhal incorporating Pearl millet. The developed millet '*Idli*' were highly acceptable by the subjects and notable change in physical parameters of both millet incorporated batter and '*Idli*' was observed when compared to standard.

Nutritional Composition of Idli

Data from Table 5 unfold the nutritional contents of control and developed *idli*. Moisture content of control and developed samples were 37.82 percent and 40.28 per cent respectively. Protein content was observed lower (9.22 g) in control sample of *idli* whereas higher value (11.46 g) was recorded in developed *idli*. The increase in protein content may be attributed to addition of millets. Further, 0.94 g and 1.48 g crude fat found in the control and developed samples of *idli*, In contrast of that energy content of control and developed *idli* was 320.22 kcal and 292.09kcal respectively. While the respective ash content were 3.41 per cent and 4.27 per cent respectively.

In control *idli,* total carbohydrate was calculated as 72.5 g whereas in developed sample it was 81.6 g. Proteins, total carbohydrate and total energy content of developed *idli* were found to be higher than the control sample. In control sample, polyphenols, vitamin C, calcium and iron content were found as 575.84 mg/100g, 1.3 mg/100 g, 28.16 mg/100g and 1.25 mg/100 g respectively whereas in developed *idli,* values were recorded as 712.43 mg/100g, 23.58 mg/100g, 141.48 mg/100g and 3.75mg/100g respectively. Similar results were reported by Wijesiri *et.al,* 2014 that by incorporating *moringa* leaves, calcium content of rice noodles could be increased. On the basis of Sensory evaluation (finger millet flour, pearl millet flour, and drumstick leaves in the ratio of 20:20:10) T_2 was found best in *Idli, Dhokla*, and *Uthapam* with regards to colour and appearance, body and texture, taste and flavor, and overall acceptability.

Table 5: Average nutritional composition of control and best treatment samples of '*Idli*' per 100 g

Nutrients	*Idli*		Results
	Control	Treatment	
Moisture (%)	37.82 ± 0.29	40.28 ± 0.34	S
Ash (%)	3.41 ± 0.25	4.27 ± 0.08	NS
Energy (kcal)	320.22 ± 0.36	292.09 ± 0.32	S
Protein (g)	9.22 ± 0.21	11.46 ± 0.45	S
Fat (g)	0.94 ± 0.02	1.48 ± 0.27	NS
Carbohydrate(g)	72.5 ± 77	81.6 ± 0.57	S
Calcium (mg)	28.16 ± 0.56	141.48 ± 0.36	S
Iron (mg)	1.25 ± 0.04	3.75 ± 0.17	S
Vitamin C (mg)	1.3 ± 0.16	23.58 ± 0.13	S
Polyphenols (mg)	575.84 ± 1.9	712.43 ± 1.03	S

Nutritional Composition of Dhokla

In Table 6, the nutritional contents of control and developed *Dhokla.* Moisture contents of control and developed sample were analyzed as 52.29 per cent and 50.13 pe rcent respectively. Protein content

was recorded as 14.43g in control sample of *dhokla* whereas 18.08 g was observed in developed *idli* in 100g. 2.1 g and 3.29 g crude fat was found in control and developed samples of *dhokla*, whereas the energy content of control and developed *dhokla* was 340.78 kcal and 301.8 kcal respectively. On the other hand, ash content was 4.99 per cent and 5.45 percent respectively. In control *dhokla,* total carbohydrate was calculated as 55.04g/100g whereas in developed sample it was 59.51g.In control sample of *dhokla*, polyphenols, vitamin C, calcium and iron content were recorded as 507.23 mg/100g, 1.12 mg/100g, 61.80 mg/100g and 3.25 mg/100 g respectively whereas in developed *dhokla,* values were seen as 622.6 mg/100g, 24.78 mg/100g, 154.86mg/100g and 4.22 mg/100g respectively. Significant changes in calcium, iron and vitamin C may be attributed to addition of finger millet, pearl millet and moringa leaves respectively.

Table 6: Average nutritional composition of control and best treatment samples of '*Dhokla*' per 100 g

Nutrients	*Dhokla*		Results
	Control	Treatment	
Moisture (%)	50.13 ± 0.17	52.29 ± 0.34	S
Ash (%)	4.99 ± 0.07	5.45 ± 0.21	NS
Energy (kcal)	340.78 ± 0.17	301.8 ± 0.15	S
Protein (g)	14.43 ± 0.77	18.08 ± 0.56	NS
Fat (g)	2.1 ± 0.14	3.29 ± 0.13	S
Carbohydrate(g)	55.04 ± 1.10	59.51 ± 0.39	S
Calcium (mg)	61.80 ± 0.92	154.86 ± 1.04	S
Iron (mg)	3.25 ± 0.23	4.22 ± 0.11	S
Vitamin C (mg)	1.12 ± 0.04	24.78 ± 1.14	S
Polyphenols (mg)	507.23 ± 2.3	622.6 ± 1.3	S

Nutritional Composition of *Uthapam*

Nutritional contents of control and developed *Uthapam,* presented in Table 4 shows that the moisture contents of control and developed sample were found to be as 47.49 per cent and 50.74 per cent, respectively. Protein content was found as 9.79 g in control sample of *uthapam* whereas 11.91 g was observed in developed *uthapam*. Fat content was found as 1.12 g and 1.43 g in control and developed samples of *uthapam* respectively, whereas the energy content of control and developed *uthapam* was 323.72 kcal and 295.47kcal respectively. Ash content of control and the developed samples was 4.34 per cent and 5.26 per cent respectively. In control *uthapam,* total carbohydrate was calculated as 69 g whereas in developed sample it was 74.26 g. Polyphenols, vitamin C, calcium and iron content of control *uthapam* were recorded as 561.75 mg/100g, 2.47 mg/100g, 25.59 mg/100g and 1.3mg/100 g respectively whereas in developed *uthapam,* values were found as 687.03 mg/100g, 25.23 mg/100g, 142.91 mg/100g and 4.04 mg/100g respectively. Increase in protein, fibre, calcium and iron content in pearl millet *idli* were also reported by Nazni and Shalini, 2010.

Table 7: Average nutritional composition of control and best treatment samples of '*Uthapam*' per 100 g

Nutrients	*Utthapam*		Results
	Control	Treatment	
Moisture (%)	47.49 ± 0.79	50.74 ± 0.32	S
Ash (%)	4.34 ± 0.31	5.26 ± 0.07	NS
Energy (kcal)	323.72 ± 0.25	295.47 ± 0.31	S
Protein (g)	9.79 ± 0.16	11.91 ± 0.55	S
Fat (g)	1.12 ± 0.07	1.43 ± 0.09	NS
Carbohydrate (g)	69 ± 0.32	74.26 ± 0.74	S
Calcium (mg)	25.59 ± 0.40	142.91 ± 0.52	S
Iron (mg)	1.3 ± 0.08	4.04 ± 0.06	S
Vitamin C (mg)	2.47 ± 0.19	25.23 ± 0.67	S
Polyphenols (mg)	561.75 ± 1.6	687.03 ± 2.3	S

CONCLUSION

Finger millet flour, pearl millet flour and drumstick leaves were found to be good source of calcium, iron, vitamin C and total phenolic content. The developed products have improved nutrient contents and could be helpful for providing variety in the daily dietaries in addition to their nutritional benefits.

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