Journal of Scientific & Industrial Research
Vol. 69, January 2010, pp. 48-54

Quality evaluation of noodles from millet flour blend incorporated composite flour

T Poongodi Vijayakumar[1]*, Jemima Beryl Mohankumar[2] and T Srinivasan[1]

[1]Department of Food Science, Periyar University, Salem-636011, India

[2]Reader, Department of Nutrition and Dietetics, P.S.G. College of Arts and Science, Coimbatore, India

Received 21 July 2009; revised 20 November 2009; accepted 07 December 2009

This study presents influence of millet flour blend on physical, functional, nutritional, cooking and organoleptic characteristics of noodles prepared from composite flour of millet flour blend, whole wheat flour and soy flour. Fiber and amylose/amylopectin ratio increased significantly ($p<0.05$) with increase in level of millet flour blend incorporation. Cooking time of developed noodles from composite flour (15-18 min) was significantly ($p<0.01$) higher than cooking time of branded noodles (9.3 min). Mean overall organoleptic score of developed noodle from composite flour was in the range of highly acceptable criteria (20-25). By all means, 20% level of millet flour blend incorporation was found to be acceptable. Mean glycemic index and load of developed noodle was significantly ($p<0.01$) lower than branded noodle.

Keywords: Composite flour, Defatted soy flour, Glycemic response, Millet flour blend, Noodle

Introduction

In India, different kinds of traditional foods, made from small millet grains, form staple diet for many rural and urban households[1]. Number of technologies has been developed to enhance utility and commercial value of these grains[2]. Quality of protein in such products could be substantially improved through blending of cereal component with legumes, isolated proteins or defatted soy flour[3]. Since people are becoming health conscious by having high fiber low fat content in their diet, noodles from millets can provide such nutritional value[2]. This study presents millet flour blend incorporated composite flour, preparation of noodles and its characterization.

Materials and Methods

Among cultivated varieties, popular varieties of CO3 of kodo millet *(Paspalum scrobiculatum*) and CO1 of barnyard millet (*Echinochloa colona)* were procured from local market in Salem District, Tamil Nadu, India. Raw grains of kodo and barnyard millet were cleaned, winnowed and soaked in cold water for 24 h. After steaming for 20 min, grains were dried (moisture content, 10-12%) and milled into flour. Kodo and barnyard millet were mixed in equal proportion and sieved through 40 mesh sieve.

*Author for correspondence
E-mail: poonvija@yahoo.co.in / poonvija@gmail.com

Development of Composite Flour (CF)

Prepared millet flour blend was mixed with branded whole wheat flour and defatted soya flour, available in the market, in following combinations (millet flour blend %, whole wheat flour %, defatted soya flour %): (-, 90, 10), (10, 80, 10), (20, 70, 10).

Noodle Preparation

Noodle was prepared by mixing composite flour of different combinations with guar gum (25 g/kg), salt (5 g/kg) and sunflower oil (50 ml/kg). Flour was moistened in an electrical mixer to desired crumbly consistency similar to that of moist breads. Sheeting of dough was made by a process of folding and passing through rollers of noodle making machine several times. Sheeted doughwas extruded through a suitable die (width, 1.6 mm; height, 1.8 mm) and cut to have desired size of extrudates. Extruded noodle was steamed in steamer for 10 min at 102-105° C and distributed over wire mesh tray for drying. Dried noodle was packed in LDPE pack.

Table 1—Physical characteristics of noodles

Properties	BN	SN	10% MBN	20% MBN	CD
Height, cm (0.18)	0.20±0.0	0.14±0.0	0.14±0.0	0.13±0.009	0.004[c]
Width, cm (0.16)	0.16±0.0	0.122±0.004	0.12±0.0	0.12±0.005	0.003[c]
Height/width ratio	1.25±0.0	1.148±0.04	1.17±0.0	1.12±0.08	0.040[c]
Geometric mean diam, cm	0.312±0.008	0.313±0.007	0.30±0.006	0.307±0.01	0.007[c]
Expansion ratio	1.43±0.0	0.76±0.03	0.75±0.09	0.71±0.07	0.030[c]
Bulk density, g/ml	0.395±0.03	0.504±0.008	0.490±0.008	0.395±0.008	0.014[c]
Specific length of extrudates, mm/g	11.76±0.28	10.28±0.18	6.72±0.15	6.49±0.07	0.160[c]

BN - Branded noodle, SN - Noodle from standard composite flour, 10% MBN - Noodle from 10% millet flour blend incorporated composite flour, 20% MBN - Noodle from 20% millet flour blend incorporated composite flour; CD - Critical difference; c - significant at $p<0.05$; Values in the table are average of 10 determinants; figure in parenthesis indicates size of die

Table 2—Functional properties of noodles

Functional properties	BN	SN	10% MBN	20% MBN	CD
Hydration capacity, g	4.62±0.07	5.82±0.05	5.10±0.04	4.61±0.03	0.07[c]
Hydration Index, g/g	1.54±0.02	1.94±0.02	1.70±0.01	1.54±0.01	0.024[c]
Swelling capacity, ml	2.50±0.12	3.80±0.07	3.48±0.04	2.32±0.04	0.108[c]
Swelling Index, ml/g	0.83±0.04	1.27±0.02	1.16±0.01	0.77±0.01	0.036[c]

BN - Branded noodle, SN - Noodle from standard composite flour, 10% MBN - Noodle from 10% millet flour blend incorporated composite flour, 20% MBN - Noodle from 20% millet flour blend incorporated composite flour; CD - Critical difference; c - significant at $p<0.05$; Values in table are average of five determinants

Characteristics of Noodles

Physical properties[4-7] (Table 1), functional properties[8] (Table 2), nutritional properties[9,10] (Table 3) and cooking characteristics[7,11,12] (Table 4) were assessed for characterizing developed noodles.

Sensory Evaluation

For sensory evaluation[13], samples were presented to a panel of 20 semi trained judges selected from Department of Food Science, Periyar University, Salem, Tamil Nadu, India. Organoleptic characteristics of cooked noodles were assessed by descriptive sensory profile on color, roughness, firmness, stickiness and starchy mouth coating using 5 point attribute scale as follows: (*Color*: Light cream – 1, Cream – 2, Creamish grey – 3, Light grey – 4, Grey – 5; *Roughness*: Very smooth – 1, Smooth – 2, Slightly rough – 3, Rough – 4, Very rough –5; *Firmness*: Very soft – 1, Soft – 2, Slightly firm – 3, Firm – 4, Very firm – 5; *Stickiness*: Non sticky – 1, Mildly sticky – 2, Moderately sticky – 3, Sticky – 4, Very sticky – 5; *Starchy mouth coating*: Non starchy – 1, Mildly starchy – 2, Moderately starchy – 3, Starchy – 4, Very starchy – 5.). Sensory acceptability level on appearance, flavour, color, texture and taste was described by a 5 point hedonic scale ranging from 1 indicating dislike very much to 5 indicating like very much with aneutral category of 3 indicating neither like nor dislike. Noodles were considered acceptable (overall) if mean total score was 11 and more out of 25.

Table 3—Nutritional composition of noodles

Nutrients(g %)	BN	SN	10%MBN	20%MBN	CD
Moisture	8.6±0.31	11.7±0.14	10.7±0.28	10.7±0.28	0.76^c
Total carbohydrate	67.5±0.56	62.0±1.41	54.0±1.41	48.0±1.41	3.48^c
Protein	10.6±0.42	12.2±0.28	13.4±0.14	14±0.14	2.10^c
Fiber	3.0±1.41	2.15±0.07	3.1±0.28	3.6±0.28	2.04^c
Ash	2.2±0.28	2.3±0.28	2.1±0.14	2.2±0.28	0.62^c
Fat	8.1±0.14	6.8±0.14	7.0±0.28	7.1±0.14	0.62^c
Total sugar	6.7±0.28	5.6±0.42	5.2±0.28	4.6±0.14	0.83^c
Reducing sugar	1.6±0.42	0.9±0.28	0.84±0.57	0.72±0.14	0.72^c
Non-Reducing sugar	5.1±0.14	4.7±0.14	4.36±0.34	3.88±0.0	0.61^c
Starch	54.6±0.42	54.58±0.06	46.92±0.02	41.7±0.0.03	0.71^c
Amylose	21.4±0.57	22.08±0.07	19.72±0.04	17.9±0.06	0.82^c
Amylopectin	33.2±0.28	32.5±0.28	27.2±0.03	23.8±0.14	0.59^c
Amylose/Amylo pectin ratio	0.645±0.022	0.679±0.003	0.725±0.000	0.752±0.001	0.03^c

BN - Branded noodle, SN - Noodle from standard composite flour, 10% MBN - Noodle from 10% millet flour blend incorporated composite flour, 20% MBN - Noodle from 20% millet flour blend incorporated composite flour; CD - Critical difference; c - significant at $p<0.05$; Values in the table are the average of two determinants.

Table 4—Cooking quality of noodles

Cooking characteristics	BN	SN	10% MBN	20% MBN	CD
Water uptake ratio, g/g	2.87±0.03	3.25±0.04	2.79±0.02	2.09±0.08	0.04^c
Cooking volume expansion, ml/g	1.62±0.11	2.60±0.05	2.56±0.03	2.44±0.05	0.096^c
Bulk density of cooked noodles, g/ml	0.647±0.03a	0.790±0.03 a	0.601±0.01 a	0.457±0.02a	0.02^c
Cooking time, min	9.30±0.05	15.21±0.27	16.02±0.04	16.23±0.26	0.26^c
Gruel solid loss (wet basis), g%	23.2±0.91	15.12±0.67	11.6±0.69	11.08±0.27	0.94^c
Gruel solid loss (dry basis), g%	8.68±0.11	6.76±0.26	6.2±0.2	5.76±0.38	0.36^c
Cooking Geometric mean diam, cm	0.379a±0.01	0.443a±0.01	0.439a±0.01	0.433a±0.01	0.009^c
Height/width ratio of cooked noodles	1.04 a±0.07	1.11a±0.05	1.10a±0.05	1.19c±0.04	0.05^c
Elongation Index	0.828±0.06	0.964±0.06	0.935±0.04	1.069±0.08	0.05^c

BN - Branded noodle, SN - Noodle from standard composite flour, 10% MBN - Noodle from 10% millet flour blend incorporated composite flour, 20% MBN - Noodle from 20% millet flour blend incorporated composite flour; CD - Critical difference; c - significant at $p<0.05$; Values in table are the average of five determinants

Glycemic Response

Ten normal healthy adult women [age, 35-50 y; Body Mass Index BMI, 20-25; and fasting blood sugar level (FBSL), 70-110 g/dl], and ten confirmed type 2 diabetic women (age, 40-55 y, BMI, 20-30; and FBSL, 140-180 g/dl) were selected for testing glycemic responses of developed noodle.

On first visit, selected women were subjected to an oral glucose tolerance test using glucose load (50g). On subsequent visits, selected women were given a test noodle and one on each day containing 50g (available) carbohydrate, which was consumed over 10-15 min time period. Just 12 h before test, selected type 2 diabetic women were instructed to withdraw consumption of oral hypoglycemic drugs to avoid influence of drugs on blood glucose. Blood glucose response from capillary blood sample at 0 h, 1 h, 2 h and 3 h were obtained after administering standard and test noodle. Blood glucose

level was measured using Accuchek glucometer. Throughout the collection of blood samples, subjects were not allowed to eat/drink any calorie containing foods[14].

Glycemic index and load was calculated as

$$\text{Glycemic index} = \frac{\text{IAUC of test food}}{\text{IAUC of glucose}} \text{ X } 100$$

$$\text{Glycemic load} = \frac{\text{Grams of carbohydrate per serving} * \text{GI}}{100}$$

Statistical Analysis

Data were fitted to a ANOVA based critical difference to determine influence of incorporation of millet flour blend on quality characteristics of noodles. Tukey HSD (Honestly Significant Difference) test was performed to determine significant difference in descriptive sensory scores of noodles from composite flour of different combinations and with branded noodle.

Results and Discussion

Physical Characteristics of Noodles

Physical characteristics (Table 1) show that height/width ratio of noodles from 20% millet flour blend incorporated composite flour (20%MBCF) was significantly less than branded noodles and noodles from 10 % MBCF. Geometric mean diameter, and expansion ratio of noodles from MBCF decreased significantly ($p<0.05$) when compared to branded and noodle from standard composite flour (SCF). Expansion ratio of noodles from SCF was also significantly ($p<0.05$) less than branded noodles. Decrease in expansion ratio with increase in level of millet flour blend and as well as addition of defatted soy flour may be attributed to increase in protein content. Bulk density of noodles from composite flour was significantly ($p<0.05$) high as compared to bulk density of branded noodles. Specific length of noodles decreased significantly ($p<0.01$) with increase in the level of incorporation of millet flour blend.

Functional Properties of Noodles

All functional parameters were lowered significantly ($p<0.01$) with increase in level of millet flour blend (Table 2).

Nutritional Composition of Noodles

Total carbohydrate, starch, amylose and amylopectin content were reduced significantly ($p<0.01$) with increased level of incorporation of millet flour blend. Reduction in amylose and amylopectin content was in accordance with starch content of composite flour. Fiber and amylose/amylopectin ratio were increased significantly ($p<0.05$) with increase in level of millet flour blend incorporation, whereas increase in protein content was not at a significant level (Table 3). Whole wheat flour based vermicelli had total sugar level of 5.09 g%[15].

Cooking Characteristics of Noodles

Water uptake ratio and bulk density of cooked noodle (Table 4) decreased significantly ($p<0.05$) while increasing level of millet flour blend in composite flour. This was in accordance with hydration index of noodles. Cooking volume expansion was significantly ($p<0.001$) higher in noodles from composite flour than branded noodle, but this was decreased with increase in level of millet flour blend incorporation. Cooking loss (gruel solid loss) for noodles from composite flour on dry basis was < 8%. Gruel solid loss on both wet and dry basis decreased significantly ($p<0.01$) with increase in millet flour blend as well as in noodles from standard composite flour when compared to branded noodles. Elongation index calculated based on height/width ratio of cooked and uncooked noodles increased significantly ($p<0.001$) with increase in level of millet flour blend. Geometric mean diameter and bulk density of cooked noodles was significantly ($p<0.001$) higher than uncooked noodles, whereas height/width ratio of cooked noodles was significantly ($p<0.05$) lower than uncooked noodles.

Cooking time of developed noodles from composite flour varied (15-18 min), which was significantly ($p < 0.001$) higher than cooking time for branded noodles (9.3 min).

Sensory Characteristics of Noodles

Descriptive Sensory Attributes of Cooked Noodles

Color of noodles (Table 5) becomes darker (from light brown to brown) while increasing level of millet flour blend. Roughness of cooked noodles indicating amount of grainy particles and bumps on noodle surface was slightly increased with increase in level of millet flour blend. Firmness of cooked noodles from composite flour had a slightly less firm texture while increasing the level of millet flour blend, but significantly higher than branded noodles. Noodles from 20% MBCF was found to exhibit a mildly starchy mouth coating, unlike noodles from other composite flour and branded noodle.

Table 5—Mean descriptive sensory attributes score of noodles

Sensory Attributes	BN (a)	SN (b)	10% MBN (c)	20% MBN (d)	Tukey HSD Homogenous subsets P<0.05)
Color	1.0 ± 0.0^{bcd}	2.0 ± 0.0^{acd}	3.95 ± 0.2^{abd}	5.0 ± 0.0^{abc}	Nil
Roughness	1.75 ± 0.4^{cd}	2.0 ± 0.0^{cd}	3.0 ± 0.0^{abd}	3.30 ± 0.5^{abc}	a & b
Firmness	1.0 ± 0.0^{bcd}	3.25 ± 0.4^{ab}	3.0 ± 0.0^{a}	2.75 ± 0.4^{ad}	I- b & cII- c & d
Stickiness	1.0 ± 0.0^{d}	1.0 ± 0.0^{d}	1.10 ± 0.3^{d}	2.0 ± 0.0^{abc}	a, b & c
Starchy mouth coating	1.0 ± 0.0^{cd}	1.0 ± 0.0^{cd}	1.30 ± 0.5^{abd}	2.0 ± 0.0^{abc}	a & b

BN - Branded noodle, SN - Noodle from standard composite flour, 10% MBN - Noodle from 10% millet flour blend incorporated composite flour, 20% MBN - Noodle from 20% millet flour blend incorporated composite flour; Values in the table are the average of twenty determinants

Table 6—Mean sensory acceptability score of cooked noodles

Sensory Criteria	BN	SN	10% MBN	20% MBN	Tukey HSD Homogenous subsets(p< 0.05)
Appearance	5.0±0.0	4.0±0.0	3.9±0.32	4.8±0.42	nil
Texture	4.5±0.48	3.9±0.32	3.8±0.42	4.0±0.0	nil
Taste	3.5±0.71	4.4±0.52	4.0±0.0	3.2±0.42	nil
Color	4.1±0.32	4.6±0.52	4.4±0.67	4.8±0.42	nil
Flavour	4.5±0.53	4.0±0.0	4.3±0.52	4.5±0.53	nil
Total	21.6±1.7	20.9 ± 0.57^{NS}	20.5 ± 1.17^{NS}	21.3 ± 0.95^{NS}	BN,SN,10% MBN& 20%MBN

Overall acceptability range: 5-10-Unacceptable; 11-15-partially acceptable; 16-20-acceptable; 21-25-Highly acceptable. BN - Branded noodle, SN - Noodle from standard composite flour, 10% MBN - Noodle from 10% millet flour blend incorporated composite flour, 20% MBN - Noodle from 20% millet flour blend incorporated composite flour; NS - Not significant; Values in the table are the average of twenty determinants.

As per Tukey HSD test, color scores of noodles from composite flour was significantly ($p<0.001$) darker than branded noodles. Firmness score of noodles (10% and 20% MBCF) was significantly higher than that of branded noodles. Stickiness score of noodle from 20% MBCF was significantly ($p<0.01$) higher than noodle from SCF, 10% MBCF and branded noodle.

Sensory Acceptability Level of Cooked Noodles

Mean overall score of branded noodles and developed noodles from composite flour was in the range of highly acceptable criteria (20-25) (Table 6).

Glycemic Index and Load of Noodles

Overall glycemic response at each time interval, mean glycemic index and load (Table 7) was significantly ($p<0.01$) higher for branded noodle than noodle from composite flour.

Correlation between Characteristics of Developed Noodles

Bivariate correlation analysis (Pearson correlation coefficients) of noodles reveals that expansion ratio was positively significantly ($p<0.05$) correlated with gruel solid loss, fat and reducing sugar and negativelysignificantly correlated ($p<0.05$) with cooking volume expansion and

Table 7—Mean glycemic response, glycemic index and load of developed noodle

Meals	Mean blood glucose concentration mg/d l				Area under curve	Glycemic index	Glycemic load
	0 h	1 h	2 h	3 h			
			Normal subjects (n=10)				
Glucose	93.4±6.11	159.4±5.77	123.5±4.5	96.5±5.8	377.8±13.05	100.0±0.0	50.0±0.0
branded noodle (a_1)	92.2±5.73	143.9±4.20	120.9±4.38	95±6.19	358.4±10.28	94.91±2.40 1 b_1 c_1	64.1±1.6 b_1 c_1
Standard noodle (b_1)	93.1±7.12	132.3±5.16	112.3±6.39	95.4±5.87	338.8±14.68	89.70±3.24 a_1 c_1	55.6±2.01 a_1 c_1
20% Noodle (c_1)	91.2±6.51	125.2±2.89	106.3±6.76	93.8±4.70	324±12.18	85.8±3.95 a_1 b_1	41.2±1.9 a_1 b_1
			Type 2 diabetic subjects (n=10)				
Glucose	160.8±12.4	286.2±29.2	255.4±24.0	231.4±18.4	737.7±62.3	100.0±0.0	50.0±0.0
branded noodle (a_1)	162.9±11.1	263.3±29.2	236.6±24.4	213.1±12.6	687.9±59.0	93.3±4.0 b_1 c_1	63.0±2.7 b_1 c_1
Standard noodle (b_1)	157.9±8.94	243.8±20.8	216.6±12.1	199.8±7.0	639.2±32.5	86.9±5. a_1 c_1	53.9±3.2 a_1 c_1
20% Noodle (c_1)	160.6±5.7	231.3±16.3	210.5±9.65	199.2±7.2	621.7±28.9	84.6±5.8 a_1 b_1	40.6±2.8 a_1 b_1

Standard noodle - Noodle from SCF; 20% MB Noodle -Noodle from 20% MBCF; Letter a_1 b_1c_1, a_2 b_2c_2, a_3 b_3c_3, a_4 b_4c_4 in superscript indicate significant difference of mean with mean of other columns at $p<0.05$.

firmness of noodles. Gruel solid loss was negatively significantly ($p<0.05$) correlated with protein content. There was a high degree significant negative correlation ($p<0.01$) between water uptake ratio and fiber content. Firmness of noodles was positively significantly correlated with moisture content ($p<0.05$), and negatively significantly correlated with fat content ($p<0.01$). Hydration index and swelling index of noodles were positively correlated with firmness and negatively correlated with fiber and fat content but these correlations were not significant. Roughness of noodles increased with protein and amylase/amylopectin ratio. Glycemic index and load of noodles was significantly ($p<0.05$) correlated with total sugar, reducing sugar, non-reducing sugar, amylose / amylopectin ratio and an inverse significant ($p<0.05$) correlation with protein content.

Conclusions

Incorporation of millet flour blend and soy flour improved quality of noodle in terms of nutrient density, glycemic response, gruel solid loss and taste. But cooking time was more. Though noodle from 20% MBCF was acceptable, 10% MBCF based noodle was highly acceptable next to noodle prepared with standard composite flour. Hence, millet flour blend and defatted soy flour incorporation has potential as an ingredient in healthy noodle products.

References

1 Vidyavati H G, Begum J M, Vijayakumari J, Gakavi S S & Begum S, Utilization of finger millet in the preparation of Papad, *J Food Sci Technol*, **41** (2004) 379-382.

2 Sowbhagya C M & Ali S Z, Vermicelli noodles and their quality assessment, *Journal of Food Science and Technology*, **38 (5)** (2001) 423-432.

3 Prasad N N, Swamy S M, Sha S T & Semwal A D, Protein quality of sorghum-soy based extruded snack food, *J Food Sci Technol*, **44** (2007) 165-167.

4 Devaraju B, Begum M J, Begum S & Vidhya K, Effect of temperature on physical properties of pasta from finger millet composite flour, *J Food Sci Technol*, **43** (2006) 341-343.

5 Singh D S, Garg S K, Singh M & Goyal N, Effect of major processing parameters on the quality of extrudates made out of soy-kodo blends, *J Food Sci Technol*, **43** (2006) 434-437.

6 Mohesenin N N, *Physical properties of Plant and Animal Materials* (Gordan and Breach Science publication, New York) 1970.

7 Balandran-Quintana R R, Barbosa-Canovas G V, Zazueta-Morales J J, Anzaldua-Morales A & Quintero-Ramos A, Functional and Nutritional properties of extruded whole pinto bean meal (*Phaseolus vulgaris* L.), *J Food Sci*, **63** (1998) 113-116.

8 Williams C P, Hanni Nakoul & Singh K B, Relationship between cooking time and some physical characteristics in chick pea (*Cicer arietinum* L,), *J Agric Food Chem*, **34** (1983) 492-496.

9 Ranganna S, *Handbook of Analysis and Quality Control for Fruit and Vegetable Products* (Tata McGraw Hill Publishing co.Ltd., New Delhi) 2004.

10 Sadasivam S & Manickam A, *Biochemical Methods,* **2nd edn** (New Age International Private Ltd, New Delhi) 2005, 8-9, 20-21, 56-57.

11 Hundal M, Bakhshi A K & Kaur A, Studies on the preparation of instant fresh spaghetti flavoured with various spices (Ginger, Garlic and Onion), *Beverage & Food World*, **Jan** (2007) 45-48.

12 Juliano B O & Perez C M, Results of a collaborative test on the measurement of grain elongation of milled rice during cooking, *J Cereal Sci*, **2** (1984) 281-292.

13 Bhat G T C M & Sharma K, Organoleptic evaluation of nutritious dhal vadas, *J Agric Res*, **26** (1989) 334-338.

14 Urooj A, Rupashri K & Puttaraj S, Glycemic responses to finger millet based Indian preparations in non-insulin dependent diabetic and healthy subjects, *J Food Sci Technol*, **43** (2006) 620-625.

15 Midha S & Mogra R, Quality evaluation of value added vermicelli, *J Food Sci Technol*, **44** (2007) 220-223.