Study on Development of Fiber-enriched Noodles using Moringa Leaves (*Moringa olifera*)

M Udhaya Ganga¹, A Karthiayani²*, G Vasanthi³, D Baskaran⁴

**Abstract**

Though noodles are popular, it holds a notion of ‘low fiber food’ as they are generally prepared from refined wheat flour, which by its nature lacks fiber. Hence an attempt was made to develop fiber enriched noodles by incorporating leaves of moringa (*Moringa olifera*) as a fiber source at different levels viz., 3, 4.5 and 6 % in which 3% 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, and sensory characteristics at regular intervals of 60 days till 180 days of storage. 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 3.3 to 4.1 %, and in vitro method of glycemic index (GI) analysis showed that the moringa fiber noodle was a low GI food when compared to the medium GI of control. The MUFA and PUFA content of moringa fiber noodles were increased to 3.4 and 2.2 % respectively when compared to control.

**Keywords:** Fiber, Glycemic index, Moringa, Noodles, Total fiber and dietary fiber.

**Asian Journal of Dairy and Food Research** (2019)

**Introduction**

The consumption rate of noodles has been steadily increasing not only in Asia but in other parts of the world making noodles a popular food product mainly due to its easy cooking procedure, lower cooking time and yummy taste (Hou *et al*., 2010). There is a drastic increase in market size of noodles in India during the last decade, wherein the size has increased from 0.31 to 1.87 billion US dollars from 2009 to 2019 (Anon, 2019). Noodles have been categorized into white salted noodles and yellow alkaline noodles based on the type of salt used that affects the color, flavor, and texture of the final noodle product. Noodles made with regular salt (NaCl) are called as white salted noodles and with alkaline salts (Na₂CO₃ or K₂CO₃) are yellow alkaline noodles (Fu, 2008 and Xiaoting *et al*., 2016). Common steps in noodle production involve dough kneading, conditioning, sheeting and compounding, cutting, steaming, and drying (Xiaoyan *et al*., 2013). These methods were common for all machine made noodles with minor adjustments being made by processors. Commercially noodles are made with refined wheat flour, which by its nature lacks the dietary fiber (Guoquan, *et al*. 1998). Many research works have been conducted to incorporate various fiber content in food like., carrot pomace (Prashant Sahini and Shere, 2017), wheat fiber, banana fiber, etc., the present study involves the development of fiber enriched noodles using leaves of moringa (*Moringa olifera*).

Moringa (*Moringa olifera* Lam.) is native to the Indian subcontinent and has become naturalized in the tropical and subtropical areas around the world. This plant can grow well in the humid tropics or hot dry lands and can survive even in less fertile soils and are also less affected by drought (Anwar *et al*., 2007). The tree is known by various regional names like benzolive, drumstick tree, horseradish tree, kelor, marango, mlonge, mulangay, sahijan, and sajna (Fahey, 2005). The tree is very important for its medicinal value because its various parts possess antitumor, antipyretic, anti-inflammatory, antulcer, anti-diabetic, diuretic, antioxidant, antibacterial, and antifungal properties. Apart from these properties, the leaves are also rich in dietary fiber content (Sodamade *et al*., 2013). Hence a study was carried out to develop fiber enriched noodles by incorporating the moringa leaves as a fiber source and to assess its shelf life during the storage period.

**Materials and methods**

**Materials**

The raw materials like moringa leaves, 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 (Plate 1).

Methods

Noodle Preparation and Storage
The ingredients for the preparation of fiber-enriched noodles were refined wheat flour, water, salt, and fiber source. Salt was first dissolved in water, and the solution was added to the refined wheat flour along with moringa leaves powder at the rate of 3, 4.5 and 6% 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 60ºC 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 Flow chart 1.

The fiber-enriched noodle samples were analyzed for physicochemical parameters viz., moisture (at 110ºC) and total ash as per the standard procedures described in AOAC, 2006 and the total and dietary fiber were analyzed as per the standard procedure AOAC, 2000.

Fatty Acid Profile
Gas chromatography is a technique applied for carrying out the separation and measurement of mixtures of materials that can be volatilized. The fatty acid profile was analyzed by gas chromatography (Jana et al., 2015).

Glycemic Index
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
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 is calculated using Texture profile analysis with the compression batten probe (Fu, 2008).

Colour
Noodle color was measured with a hunter colorimeter (spectrophotometry). L* denotes the lightness, a* denotes redness or greenness and b* values represents yellowness.

Cooking Characteristics
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 (2015), Poongodi et al., (2010) and Taneya et al., (2014).
Sensory Evaluation
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.

Shelf Life Study
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).

Statistical Analysis
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 and superior sensory scores of cooked noodles (Table 1 and 2). From Tables 1 and 2, it is obvious that 3% incorporation was chosen as the best level, and further studies were carried out for noodles prepared

Flow chart 1: Flowchart for the preparation of noodles

- Refined wheat flour (100 g), salt (3 g) and water (about 30 mL)
- Addition of salt to water to form solution. Flour was mixed with solution
- Kneaded to make dough
- Conditioning (20 minutes)
- Sheeting and cutting
- Steaming (15–20 minutes)
- Drying (60°C for 12–16 hours)
- Cooling of noodles at ambient temperature (38°C)
- Packaging and storing
- Moringa leaves (3%, 4.5% and 6%)
using 3% level of incorporation. The physicochemical characteristics like moisture, crude fiber, total ash, and dietary fiber were analyzed at an interval of 60 days, and the results are denoted in Table 3. From the table, it is seen that there is an increase in moisture, crude, and dietary fiber whereas a reduction in total ash were found for moringa fiber noodles when compared to control. The in vitro method of the glycemic index was measured and fatty acid profile was estimated by chromatographic technique. The color (L*, a* and b*) and texture (gradient force) for both cooked and uncooked noodles were analyzed by the above-mentioned method of analysis. The results were tabulated in Tables 1 to 5.

### Conclusion
The study on fiber enrichment in noodles resulted that the noodles prepared by incorporating moringa leaves show 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 moringa leaves. The developed noodles can also be categorized into low glycemic food as it possesses a lower glycemic index. The ambient shelf life storage study was conducted for the moringa leaves incorporated noodles, and the storage studies for 180 days showed no significant difference in characteristics of fiber noodles. Therefore, the shelf life of fiber-enriched noodles was found to be 180 days.

### Table 1: Optimization based on cooking characteristics

| S. no | Selected level of fiber for optimization | Cooking characteristics |
|-------|----------------------------------------|------------------------|
|       |                                        | Cooking time (min) | Gruel solid loss (%) | Water uptake ratio (%) |
| 1     | 3                                      | 9.33 ± 0.018         | 3.93 ± 0.167         | 3.58 ± 0.021 |
| 2     | 4.5                                    | 11.33 ± 0.167        | 4.87 ± 0.224         | 3.45 ± 0.033 |
| 3     | 6                                      | 12.33 ± 0.211        | 4.98 ± 0.258         | 3.34 ± 0.022 |

# average of six trials; *, significant (p ≤ 0.05); NS, not significant (p > 0.05)

### Table 2: Optimization based on sensory characteristics

| S. no | Selected level of fibre for optimization | Sensory characteristics |
|-------|-----------------------------------------|-------------------------|
|       |                                        | Colour and appearance | Texture | Taste | Chewability | Overall acceptance |
| 1     | 3                                      | 7.67 ± 0.211           | 9.07 ± 0.010       | 7.83 ± 0.307       | 7.01 ± 0.011       | 8.05 ± 0.258 |
| 2     | 4.5                                    | 7.33 ± 0.221           | 8.08 ± 0.258       | 7.17 ± 0.311       | 6.67 ± 0.211       | 9.09 ± 0.015 |
| 3     | 6                                      | 6.67 ± 0.231           | 7.06 ± 0.254       | 7.50 ± 0.342       | 5.67 ± 0.251       | 7.50 ± 0.342 |

# average of six trials; *, significant (p ≤ 0.05); NS, not significant (p > 0.05)

### Table 3: Changes in physicochemical characteristics during storage period

| Days of storage | Moisture (%) | Crude fiber (%) | Total ash (%) | Dietary fiber (%) |
|-----------------|--------------|-----------------|---------------|-------------------|
| Control         | 8.14 ± 0.008 | 0.70 ± 0.012    | 3.60 ± 0.011  | 3.35 ± 0.016      |
| 0               | 11.31 ± 0.012| 1.05 ± 0.013    | 3.48 ± 0.012  | 4.14 ± 0.016      |
| 60              | 11.30 ± 0.006| 1.05 ± 0.015    | 3.47 ± 0.014  | 4.13 ± 0.018      |
| 120             | 11.29 ± 0.012| 1.04 ± 0.013    | 3.45 ± 0.021  | 4.12 ± 0.009      |
| 180             | 11.28 ± 0.021| 1.03 ± 0.014    | 3.43 ± 0.006  | 4.11 ± 0.017      |
| F value         | 1.77<sup>NS</sup> | 1.72<sup>NS</sup> | 1.50<sup>NS</sup> | 1.38<sup>NS</sup> |

# average of six trials; NS, not significant (p > 0.05)

### Table 4: Glycemic index and fatty acid profile of optimized fiber level incorporated noodles

| S. no | Glycemic index (GI) | MUFA | PUFA | Saturated fatty acid |
|-------|---------------------|------|------|----------------------|
| 1     | 47                  | 1.55 ± 0.15<sup>NS</sup> | 2.35 ± 0.24<sup>NS</sup> | 2.38 ± 0.24<sup>NS</sup> |

# Average of six trials; NS, not significant (p > 0.05)
Study on Development of Fiber-enriched Noodles using Moringa Leaves (Moringa oleifera)

Table 5: Colour and texture of cooked and uncooked noodles during initial and final stage of storage

| Days of storage | 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) |
| 0   | 56.51 ± 0.023 | -0.97 ± 0.09 | 17.51 ± 0.23 | 50.09 ± 0.023 | -0.97 ± 0.09 | 9.49 ± 0.019 | -1.887 ± 0.001 | 28.701 ± 0.013 |
| 180 | 56.17 ± 0.023 | -0.95 ± 0.021 | 17.41 ± 0.015 | 50.07 ± 0.09 | -0.96 ± 0.04 | 9.48 ± 0.091 | -1.587 ± 0.02 | 28.693 ± 0.03 |
| F value | 11.01NS | 13.01NS | 1.93NS | 1.12NS | 1.07NS | 2.31NS | 0.62NS | 1.93NS |

#, average of six trials; NS, not significant (p > 0.05)

REFERENCES

Anonymous, (2019). https://www.statista.com/statistics/613179/ noodle-market-size-india
Anwar, F., Latif, S., Ashraf, M., Gilani, A.H. (2007). Moringa oleifera: a food plant with multiple medicinal uses. Phytotherapy research, 21(1):17-25.
AOAC. 2000. Official Methods of Analysis.(17th Ed). Association of official Analytical Chemist. Washington D.C. AOAC.
AOAC.2006. Official Methods of Analysis.(18th Ed). Association of official Analytical Chemist. Washington D.C. AOAC.
Crosbie, G.B. and Ross, A.S. (2004) Asian wheat flour noodles. Encyclopedia of grain science G.G. Hou (Ed.), Oxford, U.K: Elsevier Ltd. pp. 304-312.
Fahey, W (2005). Moringa Oleifera: A review of the Medical Evidence for its nutritional, therapeutic and prophylactic properties. Part 1. Trees of Life journal. 1(5): www.TFL Journal.org.
Fu, B.X. (2008). Asian noodles: History, classification, raw materials, and processing. Food Research International, 41:888-902.
Guoquan, H., Kruk, M., Menter, W. (1998). Asian noodle technology. Technical Bulletin, 20(12):1-10.
Hou, G.G., Otsubo, S., Okusu, H., Shen, L. (2010). Noodle processing technology I. Asian Noodles. Science, Technology, and Processing. Hoboken, New Jersey: John Wiley & Sons Inc. pp. 99-140.
Jana, O.L., Misurcova, L., Ambrozova, J.V., Vicha, R., Mlcek, J. (2015). Fatty acids composition of vegetable oils and its contribution to dietary energy intake and dependence of cardiovascular mortality on dietary intake of fatty acids. International journal of molecular sciences, 16(6): 12871-12890.
Omeire, G. C., Nwosu, J.N., Kabuo, N.O., Nwosu, M.O., Obasi, N.E. (2015). Cooking properties and sensory evaluation of enriched cassava/wheat noodles. International Journal of Innovative Res. Technology Science, 3:46-50.

Poongodi Vijayakumar.T., Mohankumar, J.B., Srinivasan, T (2010). Quality evaluation of noodles from millet flour blend incorporated composite flour. Journal of Scientific and Industrial Research, 69(1):48-54
Prashant Sahini and Shere, D.M. (2017). Physico-chemical and sensory characteristics of carrot pomace powder incorporated fibre rich cookies. Asian journal of Dairy and Food Research: 36(4): 327-331.
Snedecor, G.W. and Cochran, W.G. (1994). Statistical methods applied to experiments in agriculture and biology. Citation classics, 5thed. Ames, Iowa: Iowa State University Press.
Sodamade, A., Bolaji, O.S., Adeboye, O. O. (2013). Proximate analysis, mineral contents and functional properties of Moringaoleifera leaf protein concentrate. IOSR Journal of Applied Chemistry (IOSR-JAC), 4(6):47-51.
Taneya, M. L. J., Biswas, M.M.H., Ud-Din, M.S. (2014). The studies on the preparation of instant noodles from wheat flour supplementing with sweet potato flour. Journal of the Bangladesh Agricultural University, 12(1):135-142.
Xiaoyan Song and Wei Zhu (2013). Effects of wheat bran with different colors on the qualities of dry noodles, Journal of Cereal Science, 58:400-407.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The images or other third party material in this article are included in the article’s Creative Commons license, unless indicated otherwise in a credit line to the material. If materials is not included in the article’s Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this license, visit http://creativecommons.org/licenses/by/4.0/© The Author(s) 2019

ISSN: 0976-0563 (Online), 0971-4456 (Print), Naas Rating: 4.20