International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(3): 1149-1153

Received: 13-03-2018
Accepted: 15-04-2018

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Studies on functional and textural quality of noodles incorporated with fenugreek leaves (*Trigonella foenum-graecum* L.) puree

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Abstract
Instant noodles are one of the breakfast and staple food item of East Asian countries, whose consumption is gradually increasing day by day worldwide. However, low dietary fibre content of noodles is becoming constraint for health conscious consumers. In present investigation, efforts were made to fortify noodles with fenugreek leaves puree and its effects on cooking quality, functional properties and textural characteristics were studied. The results revealed that increasing concentration of fenugreek leaves puree decreases cooking time, cooking losses, bulk density, water absorption capacity and solubility index, while cooked weight, water uptake, and swelling capacity increased with increasing concentration of fenugreek leaves puree. Fenugreek leaves puree found to negatively effects textural properties i.e. firmness, springiness, cohesiveness, gumminess and adhesiveness were found to decreases with increase in concentration of fenugreek leaves puree

Keywords: Fenugreek leaves, noodles, functional quality, textural quality

Introduction
Consumers all around the world, nowadays, are more at the risk of many diseases such as cardiovascular diseases and diabetes due to obesity, high cholesterol, high blood pressure and irregular blood sugar levels. These risk factors are because of the diet which is low in dietary fibre, phytochemicals and antioxidants. Functional foods provide health benefits and helps in the avoidance of diseases by incorporating nutraceutical ingredients. Foods that are excess in antioxidants and low in Glycemic Index (GI) can decrease the risk of increased postprandial oxidative stress, which is responsible for chronic diseases. The bioactive compounds that are responsible for providing health benefits in functional foods are phytochemicals, dietary fibre, and antioxidants (Yadav and Gupta, 2015) [17].

An increasing trend of improving dietary standards among the people in developing countries is taking place around the world. For a majority of people in developing and underdeveloped countries, eating a balanced diet is restricted by poverty and an insufficient supply of nutritious foods. Therefore, it is essential that locally available materials, which are inexpensive but highly nutritious, be used as a vehicle to improve the nutritional status of the masses. Leafy vegetables are rich source of vitamins, minerals and dietary fiber. Being an inexpensive source, these leaves can be used by a large population to meet their dietary requirements (Negi and Roy, 2004) [14].

Fenugreek (*Trigonella foenum-graecum L.*), is a highly respiring leafy vegetable enriched with many nutrients and other active ingredients such as protein, vitamin C, niacin, potassium, alkaloids, lysine and L-tryptophan as well as steroidal saponins which are beneficial for human health (Brar and Kaur, 2011) [3].

Fenugreek (*Trigonella foenum-graecum L.*) plant is effective on blood lipids and sugar and on some bacterial strains, antioxidant activity of fenugreek causing protective of organs and inhibition of entrance diseases to body, to decrease body fats and is effective on obesity. The plant contains active constituents such as alkaloids, flavonoids, steroids, Saponins etc. It is an old medicinal plant. It has been commonly used as a traditional food and medicine. Fenugreek is known to have hypoglycemic, and hypocholesterolaemic effects, Anti-inflammatory effects (Moradikor *et al*. 2013) [13].

Noodles are one of the staple foods consumed in many Asian countries. Instant noodles have become internationally recognized food and worldwide consumption is on the rise.

The properties of instant noodles like taste, nutrition, convenience, safety, longer shelf-life and reasonable price have made them popular. Quality factors important for instant noodles are colour, flavour, and texture, cooking quality, rehydration rates during final preparation and the presence or absence of rancid taste after extended storage (Gulia *et al.* 2013) [6].

Instant noodles are one of breakfast and staple food item of East Asian countries, whose consumption is gradually increasing day by day worldwide. Noodles, being a poor source of proteins due to use of refined flour in its production. Therefore, now it is an obligatory to fortify noodles with protein and fiber rich ingredients which will potentially enhance not only nutritional value but also functional characteristics (Pakhare *et al.* 2018) [15].

Materials and methods

Materials

The raw material such as fenugreek (*Trigonella foenum-graecum L.*) leaves, refined wheat flour (*Triticum aestivum L.*), egg, salt, etc. were purchased from local market of Parbhani.

Methods

Cooking qualities of noodles incorporated with fenugreek leaves puree

The qualities of the cooked noodles, cooking time and cooking loss were determined according to Chillo *et al.* (2008) [4]. Optimal cooking time was evaluated by observing the time of disappearance of the core of the noodle strand during cooking (every 30s) by squeezing the noodles between two transparent glass slides. The cooking loss was determined by measuring the amount of solid substance lost to cooking water. A 10 g sample of noodles was placed into 300 ml of boiling distilled water in a 500 ml beaker. Cooking water was collected in an aluminum dish which was placed in hot air oven at 105°C and evaporated to dryness. The residue was weighed and reported as a percentage of the starting material. For each optimal cooking time and cooking loss value, three determinations were performed to obtain the mean values.

$$Cooking\ loss(\%) = \frac{Dried\ residue\ in\ cooking\ water}{Noodle\ weight\ before\ cooking} \times 100$$

Water uptake

The water uptake of noodles incorporated with fenugreek leaves puree was carried out according to the method of Gull *et al.* (2016) [7].

$$Water\ uptake(\%) = \frac{Weight\ of\ cooked\ noodles - Weight\ of\ raw\ noodle}{Weight\ of\ raw\ noodles} \times 100$$

Functional quality of noodles incorporated with fenugreek leaves puree

Determination of bulk density

Bulk density was determined by adopting the method of Akinoso *et al.* (2016) [2]. 3g of each sample was weighed into 10 ml graduated cylinder and tapping ten times against the palm of hand. The volume of sample was recorded after tapping and bulk density was expressed as g/ml.

Determination of water absorption capacity

Water absorption capacity of noodles was determined according to the method of A.A.C.C. (1999) [1]. Aqueous suspension of noodles was made by dissolving 2 g (dry weight) of noodle in 40 ml of distilled water. The suspension was agitated for 1 hour on a Griffin flask shaker and centrifuged at 2200 rpm for 10 minutes. The free water (supernatant) was decanted from the wet sample, drained for 10 minutes and the wet sample was then weighed.

$$Water\ absorption\ capacity(\%) = \frac{Weight\ of\ wet\ sample}{Weight\ of\ raw\ sample} \times 100$$

Oil absorption capacity

The oil absorption capacity of noodles incorporated with fenugreek leaves puree was determined by adopting the method of Kinsella and Melachouris (1976) [10]. 1 g of meal was mixed with 10 ml refined vegetable oil in a weighted 25 ml centrifuge tube was thoroughly stirred for 2 min and then centrifuged at 4000 rpm for 20 min. the supernatant was discarded, the adhering free oil was removed and the tube and content was re-weighed. Oil absorption capacity expressed as weight of oil bound by 1g of meal.

Determination of solubility index and swelling capacity

Solubility index and Swelling capacity determinations were carried out based on a modification of the method of Iwuoha (2004) [9]. 1 g of noodle was dissolved with distilled water to a total volume of 40 ml using a weighed 50 ml graduated centrifuge tube. The suspension was stirred just sufficiently and uniformly avoiding excessive speed since it might cause fragmentation of the starch granules. The slurry in the tube was heated at 85°C in a water bath for 30 minutes with constant gentle stirring. The tube was then removed, wiped dry on the outside and cooled to room temperature. It was then centrifuged at 2200 rpm for 15 minutes. The supernatant was decanted into a pre-weighed aluminium dish. The solubility index was determined by evaporating the supernatant in drying oven at 105°C and weighing the residue. The sediment paste was weighed and swelling capacity was calculated as the weight of sediment paste per gram of noodle used.

$$Solubility\ index(\%) = \frac{Weight\ of\ soluble}{Weight\ of\ sample} \times 100$$

$$Swelling\ capacity = \frac{Weight\ of\ sediment}{Sample\ weight - Weight\ of\ soluble}$$

Evaluation of textural quality of noodles incorporated with fenugreek leaves puree

For the evaluation of textural quality of noodles, 30 g noodles were cooked in 300 g of water for 8 min. The cooked noodles were then cooled in a sieve for 30 s and left for 2 min to remove the remaining water. Noodles of 2.0 mm thickness and 50 mm length were prepared for the analysis of texture profile analysis using a texture analyzer (TA-XT plus, Stable Micro Systems Ltd., Godalming, UK). A cylindrical probe with a diameter of 36 mm was used. The test conditions were as follows: 1 mm/s pre-test speed, 1 mm/s test speed, 5 mm/s post-test speed, 80 per cent strain, and 20g trigger force. The parameters calculated were firmness, springiness, cohesiveness, gumminess and adhesiveness. Measurements were replicated 3 times for each treatment.

Results and Discussion

Cooking quality of noodles incorporated with fenugreek leaves puree

The cooking quality of pasta and noodles is the most important feature that encompasses the following

characteristics: (a) the weight of cooked pasta and noodles indicating the water uptake during cooking; (b) the cooking loss, related to solid leaching during cooking and considered as an indicator of the overall cooking performance; (c) the texture of the cooked product, which indicates firmness and resilience (Doxastakis *et al*, 2007) [5].

Table 1: Cooking quality of noodles incorporated with fenugreek leaves puree.

Sample	Cooking time (min)	Cooking loss (%)	Cooked weight (%)	Water uptake (%)
F_0	6.28	10.68	252.17	152.17
F_{10}	5.43	9.40	254.20	154.20
F_{20}	5.35	8.75	258.18	158.10
F_{30}	5.26	8.12	260.65	160.60
F_{40}	5.19	7.65	262.25	162.20
F_{50}	5.14	6.98	262.86	162.86
SE ±	0.00351	0.00351	0.00423	0.00423
CD at 5%	0.01058	0.01058	0.01274	0.01274

* Each value is average of three determinations

The data presented in (Table 1) depicted that the incorporation of fenugreek leaves puree in noodles influenced the cooking properties of noodles. The cooking time of control noodles was (6.28 min.) and cooking time was decreased with increased proportion of fenugreek leaves puree from F_{10} to F_{50}. Similar trend was observed with cooking loss. The cooking loss is the amount of dry matter in the cooking water of optimally cooked noodles. The decrease in the cooking loss with noodles incorporated with fenugreek leaves puree from F_0 to F_{50} (10.68 per cent) to (6.98 per cent) respectively. The cooked weight and water uptake were observed to decrease due to increased proportion of fenugreek leaves puree. The cooked weight found to be lowest in F_0 (252.17 per cent) and it increased from F_{10} to F_{50}. The water uptake of noodles increased with increase in level of fenugreek leaves puree and ranged from (152.17 per cent to 162.86 per cent). The similar results were found in close agreement of Rekha *et al.* (2013) [16].

Table 2: Functional quality of noodles incorporated with fenugreek leaves puree.

Sample	Bulk density (g/ml)	Water absorption capacity (%)	Oil absorption capacity (ml/g)	Swelling capacity (g)	Solubility index (%)
F_0	1.92	151.20	0.462	4.13	8.18
F_{10}	1.90	164.25	0.485	4.15	7.43
F_{20}	1.87	179.60	0.502	4.18	7.12
F_{30}	1.86	186.30	0.512	4.20	6.87
F_{40}	1.84	199.25	0.543	4.24	6.14
F_{50}	1.81	202.55	0.586	4.36	5.69
SE ±	0.00423	0.01826	0.00351	0.00351	0.00351
CD at 5%	0.01274	0.05496	0.01058	0.01058	0.01058

* Each value is average of three determinations

The results of functional quality of noodles incorporated with fenugreek leaves puree were presented in (Table 2). Control sample F_0 had the highest degree of bulkiness (1.92 g/ml) and bulkiness ranged between (1.92 to 1.81 g/ml). Bulk density was decreased with addition of fenugreek leaves puree to noodles. The water absorption capacity increased with increased level of fenugreek leaves puree and ranged between (151.20 to 202.55 per cent). Similar trend was observed on oil absorption capacity with F_{50} being the highest (0.586 g) and control noodle, the least (0.462 g). Swelling capacity of noodles increased with increased proportion of fenugreek leaves puree and ranged between (4.13 g to 4.36 g). F_0 had the least value (4.13 g) and F_{50} the highest (6.14 g). Solubility indices of noodles decreased with the increased proportion of fenugreek leaves puree and ranged (8.18 to 5.69 per cent). The similar results were found in close agreement of Akinoso *et al.* (2016) [2].

Textural quality of noodles incorporated with fenugreek leaves puree

Texture Profile Analysis (TPA) can simulate masticatory movement of human, so it can be used to test physical properties of food. The instrumental measurement of cooked noodles texture can be a reliable and convenient alternative evaluation to the sensory method (Lee *et al*, 1987) [11]. Due to the above reasons, instrumental method is widely used for the measurement of noodle texture (Hatcher *et al*, 1999) [8]. Hardness, gumminess and chewiness have negative correlation with noodle quality, i.e. the higher of these values, the worse of noodle quality is. Springiness and cohesiveness have positive correlation with noodle quality. For shearing experiment, there is a remarkable positive correlation between maximum shear stress and chewiness, hardness and elasticity of noodle (Gull *et al*, 2016) [7].

Table 3: Textural quality of noodles incorporated with fenugreek leaves puree

Sample	Firmness (kg)	Springiness	Cohesiveness	Gumminess (kg)	Adhesiveness (-kg.sec)
F_0	10.320	2.304	1.181	12.187	-0.079
F_{10}	8.070	1.112	1.055	8.513	-0.074
F_{20}	7.792	1.097	0.812	6.327	-0.069
F_{30}	6.209	1.029	0.674	5.228	-0.063
F_{40}	5.091	1.027	0.622	4.184	-0.057
F_{50}	3.854	0.961	0.567	2.185	-0.036
SE ±	0.00351	0.00588	0.00451	0.00503	0.00045
CD at 5%	0.01058	0.0177	0.01359	0.01514	0.00136

* Each value is average of three determinations

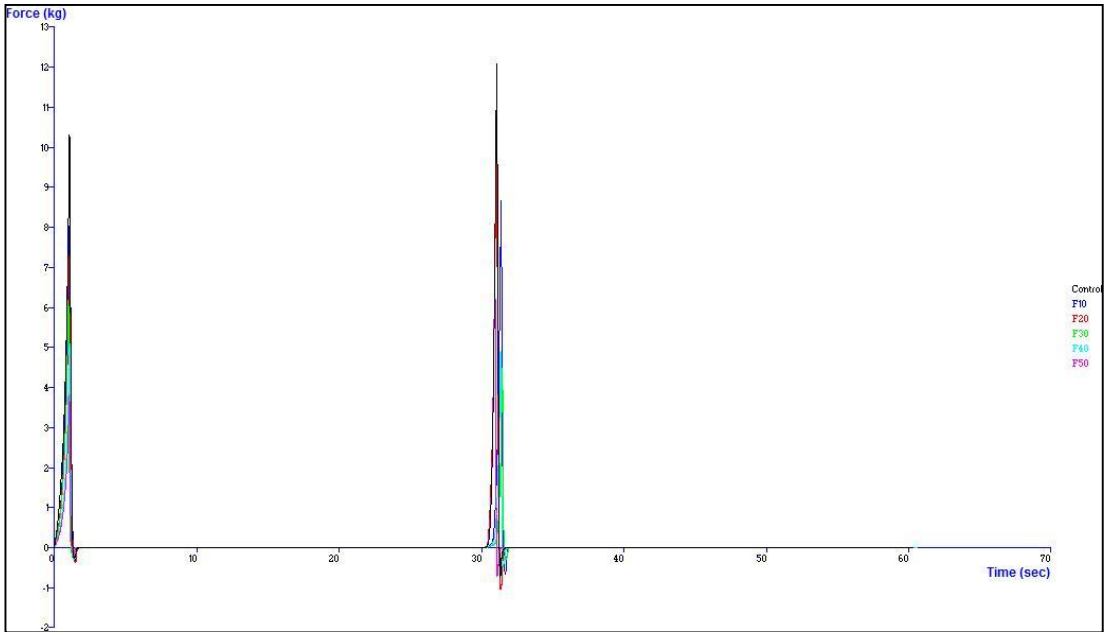

Fig 1: Graph representing textural quality profile of fenugreek leaves puree incorporated noodles.

Textural quality of noodles affected by the composition of fenugreek leaves puree blends as shown in (Table 3). The incorporation of fenugreek leaves puree at the level of 10, 20, 30, 40 and 50 per cent in refined wheat flour for noodle making caused decrease in hardness (firmness) of noodles from (8.07 to 3.854 Kg) as compared to control (10.320 Kg.). The springiness found highest in control sample (2.304) and lowest in F_{50} (0.961). The cohesiveness was found highest in F_0 (1.181) and gradually decreased as the proportion of fenugreek leaves puree increases and lowest was found in sample F_{50} (0.567). The similar trend was observed in gumminess, it was observed that the control sample F_0 showed highest gumminess (12.187) and decreased gradually from F_{10} to F_{50} (8.513 to 2.185 kg).The highest adhesiveness observed in control sample F_0 (-0.079 -kg.sec) and it was decreased from F_{10} to F_{50} (-0.074 to -0.036 -kg.sec) respectively. Similar results were found with the research finding of Lu *et al.* (2013) [12].

Conclusion

On the basis of obtained results, it could be concluded that increasing concentration of fenugreek leaves puree decreases cooking time, cooking losses, bulk density, water absorption capacity and solubility index, while cooked weight, water uptake, and swelling capacity increased with increasing concentration of fenugreek leaves puree. Fenugreek leaves puree found to negatively effects textural properties i.e. firmness, springiness, cohesiveness, gumminess and adhesiveness were found to decreases with increase in concentration of fenugreek leaves puree. Therefore, incorporation of fenugreek leaves puree results in enhanced cooking, functional and textural quality characteristics of noodles.

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