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Development and nutritional characterization of noodles enriched with *Centella asiatica* powder

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Abstract
Centella asiatica is a medicinal herb consumed widely as green leafy vegetables in many countries. It has anti-bacterial; anti-viral and anti-inflammatory properties with the ability to aid wound healing, detoxification, improve appetite and are rich in micronutrients. Considering its health promoting effects, the present study aims at value addition of noodles by incorporation of *Centella asiatica* powder. Fresh *Centella asiatica* procured from market were cleaned, dehydrated and ground to powder. The developed *Centella asiatia* powder was rich in crude fibre (17.55 ± 0.31 g/100g), ash (12.98 ± 0.40 g/100g), iron (25.76 ± 1.32 mg/100g) and magnesium (278.00 ± 4.69 mg/100g). The nutrient rich powder was incorporated into noodles in different proportions, of which noodles treated with 5 per cent *Centella asiatica* powder (T_0) had highest acceptability in terms of sensory attributes and therefore was analysed for its nutritional compositions. The treated noodles had higher protein, fibre, ash, iron and magnesium content of 9.57 g/100g, 3.30 g/100g, 1.31 g/100g, 2.83 mg/100g and 42.67 mg/100g respectively which was higher than control. Thus, owing to its nutritional properties, the noodles developed with incorporation of *Centella asiatica* powder could be beneficial to meet the nutrient security which is an important issue that needs to be addressed in developing countries.

Keywords: *Centella asiatica,* noodles, value addition, medicinal, nutritional

1. Introduction

Centella asiatica is a therapeutic potential medicinal herb belonging from the family *Apiaceae*, which has wide range of therapeutic potential. *Centella asiatica* is also known as *Gotu Kola* (from traditional Chinese medicine), Indian Pennywort, *Jal Brahmi*, *Manimuni* (in Assamese) and *Mandookapami* (Gohil *et al*., 2010) [1]. *Centella asiatica* have been in used for traditional Indian Ayurvedic and Chinese medicine for decades and now it has found wide usage in pharmaceutical industries because of its chemical composition, nutritive value and health benefits. It is consumed as green leafy vegetables in many countries and also as salad, juice, soup and as other food products (Udumagala, 2010). *In vitro* and vivo studies have shown the multifunctional health benefits of *Centella asiatica* as anti-diabetic herb because of its hypoglycaemic effect, immune-modulating activity due to its antioxidant potentialities, anti-microbial, anti-inflammatory, neuroprotective activities and as memory enhancer. It comprises of several important bioactive compounds such as Meidecassic acid, Asiatic aid, ∝-copaene, ∝-teropinene, β-caryphyllene which are responsible for its antioxidant and antiviral activities (Zahara *et al.,* 2014) [5].

With increase in food processing industries and consumers demand for easy to prepare foods, a wide range of extruded products such as noodles, pasta, snack foods, baby foods and other cereals-based blend are highly demanded (Semaska *et al*., 2010) [3], however they are lack in essential nutrients. Therefore, successful value addition could be beneficial to deliver the nutrients lacking in it. Noodle in particular is one such widely consumed extruded food product across the world and is authorized by Food and Drug administration as a good vehicle for addition of bioactive compounds. However, there are limited studies on noodles enriched with bioactive compounds (Deep *et al.,* 2014) [4].

Therefore, owing to the advantages of *Centella asiatica* and increased demand of extruded food product as such noodles, the present study was carried out to develop value added extruded food product by the incorporation of *Centella asiatica* in powdered form to noodles and to assess the nutritive value of the developed product.

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2. Materials and methodology
2.1. Preparation of *Centella asiatica* powder
Fresh *Centella asiatica* procured from local vegetable market of Allahabad was cleaned by removing undesirable parts like stem and other foreign materials and washed thoroughly under running water. Cleaned *Centella asiatica* leaves were spread onto blotting paper to remove excess water. After removal of excess water, leaves were dried in a cabinet drier at a temperature of 45 degree Celsius for 8 hours. Dried leaves were ground to powder and stored in airtight container for further analysis.

1.2. Preparation of noodles
For the preparation of noodles refined wheat flour and *Centella asiatica* powder were mixed in definite proportion as given in Table 1. The different formulations were processed into noodles using a Kent noodles and pasta maker. The extruded noodles were steamed for 5 minutes and then dried at a temperature of 55°C for 5 hours in a tray drier.

Fig 1: Different formulation of noodles

Table 1: Proportion of ingredients used for formulation of noodles

Ingredients	Formulations			
	T_0	T_1	T_2	T_3
Refined wheat flour	100g	95g	90g	85g
Gotu kola powder	0g	5g	10g	15g
Water	30 ml	30 ml	30 ml	30 ml

2.3. Sensory evaluation of noodles
Sensory evaluations of treated and untreated noodles as shown in Figure 1 were carried out by 10 semi-trained panellists in the Department of Food Nutrition and Public Health, Ethelind College of Home Science, SHUATS, Allahabad. All samples were assessed in terms of their appearance, colour, texture, taste, flavour and overall acceptability using a 9 point hedonic scale where 9 represents Like extremely, 8 represents like very much, 7 like moderately, 6 like slightly, 5 neither like nor dislike, 4 dislike slightly, 3 dislike moderately, 2 dislike very much and 1 represents dislike extremely.

2.4. Nutritional composition
All the samples were analysed for their nutritional composition. The moisture content was estimated by oven drying method (AOAC, 2007) [10], fat content was estimated by soxhlet method following the procedures of AOAC, 2007 [10], protein was analysed by Lowry's method (Lowry *et al.*, 1951) [6], ash content was estimated by (Maynard, 1970) [11] and fibre content by extraction method (AOAC, 2007) [10]. Carbohydrate content was determined by subtracting the sum of fat, protein, ash, fibre and moisture content from 100 and energy content was calculated as per formula given by James, 1995.
Among minerals only iron and magnesium contents were determined. Iron content was determined by Wong's method using colorimeter following the procedure of AOAC, 2007 [10] and magnesium content was determined by titration method following the method of AOAC, 2007 [10].

2.5. Statistical analysis
Data obtained were analysed statistically using Microsoft excel and SPSS software version 20. One way ANOVA followed by Duncan test and paired t test at $p<0.05$ was performed to determine significant differences among the different formulations of noodles.

3. Results and discussions
3.1. Nutritional composition of *Centella asiatica*
Table 2 represent nutritional compositions of both fresh and powdered samples. Fresh *Centella asiatica* had moisture, protein, fat, ash and fibre content of 86.05±0.55 g/100g, 2.36±0.19 g/100g, 0.33±0.08 g/100g, 2.04±0.25 g/100g and fibre 2.91±0.16 g/100g respectively. Several other studies (Hashim, 2011; Joshi and Chaturvedi (2013) [7, 8] have also reported similar results for nutrient composition of fresh *Centella asiatica*. The moisture, protein, ash, fat, fibre and carbohydrate content of powdered sample are 5.55±0.40, 12.26±0.29, 12.98±0.40, 1.35±0.05, 17.55±0.31 and 49.30±0.30 per cent respectively.
Both fresh and powdered samples had high magnesium content of 62.35±1.12 and 278.00±4.69 mg/100 g respectively which can aid in bone formation and can also required for processing ATP (Godswill, 2020) [9]. Samples were also rich in iron with iron content of 5.41±0.65 and 25.76±1.32 mg/100 for fresh and powdered sample respectively and therefore can be beneficial for people suffering from iron deficiency.

Table 2: Nutritional composition of *Centella asiatica (Gotu Kola)*

Parameters	*Centella asiatica (Gotu Kola)*	
	Fresh	Powdered
Moisture (g/100)	86.05±0.55	5.55±0.40
Protein (g/100)	2.36±0.19	12.26±0.29
Ash (g/100)	2.04±0.25	12.98±0.40
Fat (g/100)	0.33±0.08	1.35±0.05
Crude fiber (g/100)	2.91±0.16	17.55±0.31
Carbohydrate (g/100)	6.31±0.81	49.30±0.30
Energy (KCal/100)	37.65±2.60	273.10±1.39
Iron (mg/100g)	5.41±0.65	25.76±1.32
Magnesium (mg/100g)	62.35±1.12	278.00±4.69

3.2. Sensory evaluation of noodles
Sensory characteristic of a product is an important parameter affecting the consumer acceptability of a product in market. A product with superior sensory properties generally has greater demand. Table 3 elucidates sensory scores of noodles

prepared by incorporating C*entella asiatica* powder and control noodles in terms of their appearance, colour, taste, texture, flavour and overall acceptability. Highest sensory scores were bagged by control compared to other three formulations and among treated samples formulation T_1 was found superior. Statistical analysis showed no significant difference ($p>0.05$) between control and T_1 in terms of all the sensory attributes except flavour, while T_2 and T_3 differed significantly ($p<0.05$) from control. Results of sensory evaluation showed decrease in sensory scores on increased

incorporation of *Centella asiatica* powder. This was because of development of darker colour and bitter taste in the final product on incorporation of *Centella asiatica* powder at higher level. Similar results were obtained in the study of Tan and Rabeta, (2018) [13] in which there was decrease in sensory scores of noodles with substitution of wheat flower with *Vitex negundo* powder. Khojah *et al.,* 2017 [12] also observed decrease in overall acceptability of noodles with increased amount of broccoli powder in the formulation.

Table 3: Mean sensory scores of control and treated samples of *Noodles*

Formulations	Appearance	Color	Taste	Texture	Flavor	Overall acceptability
T_0 (Control)	8.50 ± 0.53^a	8.20 ± 0.42^a	8.60 ± 0.52^a	8.30 ± 0.48^a	8.20 ± 0.42^a	8.30 ± 0.48^a
T_1	8.10 ± 0.57^a	7.80 ± 0.79^a	8.40 ± 0.51^a	7.80 ± 0.63^a	7.80 ± 0.42^b	8.00 ± 0.47^a
T_2	7.20 ± 0.52^b	7.00 ± 0.67^b	7.70 ± 0.67^b	7.00 ± 0.67^b	$7.50\pm0.52^{b,c}$	7.10 ± 0.74^b
T_3	6.70 ± 0.48^c	6.60 ± 0.52^b	7.10 ± 0.74^b	6.60 ± 0.52^b	6.90 ± 0.57^c	6.70 ± 0.48^b

T_0=100% refined wheat flour; T_1= 95% refined wheat flour and 5% *Centella asiatica* powder; T_2= 90% refined wheat flour and 10% *Centella asiatica* powder; T_3= 85% refined wheat flour and 15% *Centella asiatica* powder
Note. Values are mean ± standard deviation. Column with different superscript are statistically different ($p<0.05$)

3.3. Nutritional composition of noodles
Among all the *Centella asiatica* powder incorporated noodles, formulation T_0 got highest acceptability in terms of their sensory evaluation, therefore was further analysed for its nutritional compositions. The nutritional composition of noodle is presented in Table 4.

The moisture, protein ash, fat, fibre, carbohydrate and energy content of control noodles were 10.48 ± 0.35 g/100g, 9.35 ± 0.44 g/100g, 0.43 ± 0.05 g/100g, 0.68 ± 0.04 g/100g, 1.96 ± 0.20 g/100g, 77.09 ± 0.48 g/100g and 351.92 ± 2.14 Kcal.100g respectively. It can be observed from the table that there is significant increase ($p<0.05$) in moisture (10.13 ± 0.29 g/100g), ash (1.31 ± 0.21 g.100g) and fibre (3.30 ± 0.22 g/100g)

content of the noodles prepared by incorporating 5 per cent *Centella asiatica* powder (T_1). The study of Khojah *et al.,* 2017 [12] also revealed increase in crude fiber and ash content of noodles prepared by incorporating *Brassica oleracea* powder. The increase in crude fiber and ash content may be due to higher ash and fibre content of *Centella asiatica* powder.

The table also shows a significant increase ($p<0.05$) in iron (2.83 ± 0.06 mg/100g) and magnesium (42.67 ± 0.50 mg/100g) content of noodles treated with 5 per cent *Centella asiatica* powder compared to iron and magnesium content of control noodles. This increment was due to high iron and magnesium content of *Centella asiatica* powder added to noodles.

Table 4: Nutritional composition of noodles

Parameters	Formulations		T value	P value
	T_0 (Control)	T_1		
Moisture (g/100)	10.48 ± 0.35	10.13 ± 0.29	10.10	0.01
Protein (g/100)	9.35 ± 0.44	9.57 ± 0.60	-0.99	0.43
Ash (g/100)	0.43 ± 0.05	1.31 ± 0.21	-8.69	0.01
Fat (g/100)	0.68 ± 0.04	0.69 ± 0.04	-0.22	0.84
Crude fiber (g/100)	1.96 ± 0.20	3.30 ± 0.22	-13.85	0.00
Carbohydrate (g/100)	77.09 ± 0.48	74.99 ± 0.21	7.95	0.01
Energy (Kcal/100)	351.92 ± 2.14	344.46 ± 1.41	13.42	0.00
Iron (mg/100g)	1.85 ± 0.32	2.83 ± 0.06	-5.89	0.02
Magnesium (mg/100g)	27.63 ± 2.76	42.67 ± 0.50	-8.26	0.01

T_0=100% refined wheat flour and T_1= 95% refined wheat flour and 5% *Centella asiatica* powder
Note. Values are mean ± standard deviation.

Conclusion
The study concludes that developed *Centella asiatica* powder was nutritionally rich and incorporation of powder into noodles resulted an increase in fibre and mineral content of the noodles. Thus, could act as a potential ingredient in preparation of various nutritious food products, thereby contributing to nutrition security.

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