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Studies on Production of Functional Noodles with Incorporation of Spinach Puree

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ABSTRACT

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The objective of this study was to explore the possibility of adding spinach puree in preparation of vegetable noodles. The vegetable noodles were studied for its sensorial qualities, cooking qualities and proximate composition. The spinach puree was added at 10, 20, 30, 40 and 50 gm per 100gm of wheat flour. The results showed that spinach puree can be added successfully in wheat flour up to 40 gm /100gm of wheat flour. The sensorial qualities with respect to colour, flavour and texture were greatly improved with addition of spinach puree. The cooking time was found to be decreased with increase in level of spinach puree in noodles. The cooking weight and water absorption were also found to be increased with increase in level of spinach puree. The studies on color estimation revealed that green color of the product was slightly reduced during cooking of noodles, color loss in cooking water was negligible. The proximate composition results showed that with increase in level of spinach puree in noodle, there was progressive increase in moisture, fiber and ash content, fat and protein content increased non-significantly whereas carbohydrate content was decreased significantly as compared to control noodles.

Introduction

Noodles are very thin form mostly made of wheat flour, water, egg and salt. Noodles have been increasingly important food commodity worldwide. 97.5 billion servings of instant noodles were eaten in 2016, by simple arithmetic as many as 270 millions servings are eaten every day (World Instant Noodle Association, 2016). The consumption level of noodles has become one of the fastest growing sectors in Asian countries, due to their ease of cooking and long shelf life. Traditional noodles are claimed to lack dietary fiber,

vitamins and minerals. Over the last decades consumer food demands have changed considerably. For these reason foods today are not only intended to satisfy the hunger and necessary nutrients, but also to prevent nutritional related diseases and enhance physical and mental well-being of consumer Betoret *et al.*, (2011). In this regard functional foods offer an outstanding opportunity to improve the quality of the product. Noodles in particular are an important basic food widely consumed across the world and is among first food to be authorized by food and drug administration as a good vehicle for addition

of bioactive compounds, However, noodles enriched with bioactive compounds of vegetable origin is still limited Rekha *et al.*, (2013) and Deep *et al.*, (2014). Worldwide, people's lifestyle is continuously changing and with respect to eating habits, it is changing in an unhealthy direction Caballero, (2007). Both developed and developing countries are experiencing a nutrition transition.

This phenomenon is characterized by a decrease in physical activity and a too low consumption of vegetables and grains. Eating habits are now characterized by an increase in the consumption of high energy-dense foods, i.e. foods with a high amount of calories per gram of food. This lifestyle is one of the factors for the development of diseases such as obesity, which is now acknowledged as a global epidemic. In turn, obesity has been linked to the development of other chronic diseases such as type II diabetes, hypertension, coronary heart disease and several types of cancer. When it comes to childhood obesity, concerns increase, since there are strong indications that it will persist into adulthood Wang *et al.*, (2010).

One of the most effective strategies to fight this problem involves the combination of physical activity and the consumption of low energy-dense foods, such as vegetables, at an early age. A hurdle for implementing this strategy is the fact that children often dislike vegetables. Vegetables are known to have health benefits but are often non-appealing to children/adolescents due to their bitterness, undesired texture, and their low satiating capacity Zeinstra *et al.*, (2010). One of the possible solutions to increase vegetable intake by children is to incorporate vegetables in a food matrix that they do like. Several studies have shown that noodles are very much appreciated by children, making it an ideal candidate for the development of vegetable-

enriched foods. Spinach is one of the important vegetable rich in vitamins, minerals and antioxidants, Enriching noodles with ingredients, like spinach vegetables paste, represents challenges since the incorporation of fresh purees rather than dried powder as other researches used elsewhere will enhance the color intensity and distribution of pigments in the dough. Thus improving the quality of noodles. This also avoids drying of vegetable purees prior to their addition to the flour. The major purpose of this research is to develop a functional herbal noodles with incorporation of spinach puree in preparation of instant noodles.

Materials and Methods

Preparation of instant noodles

Preparation of spinach puree

Fresh spinach leaves were procured from local market. Leaves were washed, sorted, stalks were removed and leaves were cut into pieces, steam cooked and ground in grinder. The mass was passed through muslin cloth to get the homogenous spinach puree.

Noodle preparation

Noodles were prepared according to a method described by Collado and Corke (1996) with some modifications. The noodles were prepared in a automatic laboratory Kent noodle maker. Dry ingredients were first mixed for about 5 minutes, followed by addition of whole egg, oil, spinach puree and water to form a crumbly mass and then extruded through a die with 12 outlets of 0.8 mm in diameter. The noodles were cut and cooked in steam for 5 minutes and dried at 50⁰C for 5 hours and packed in polyethylene pouches. The noodles produced from different blends of spinach and carrot with wheat flour are shown in table 1.

Chemical analysis

All the chemicals used in the present research work were of analytical grade. The proximate composition (Moisture, crude fat, crude protein, total ash and fiber) were analyzed using AOAC (2000). The total carbohydrates were determined by difference method.

Sensory evaluation

All dried noodles samples were prepared for sensory evaluation by cooking in soup solution before testing. The cooking was carried for optimum cooking time and served the hot for the panel members to evaluate for its colour, flavour texture and overall acceptability using 10 semi trained panel members with 9- point hedonic rating where 9= like extremely and 1= dislike extremely.

Cooking characteristics

Optimum cooking time

To determine optimum cooking time, 250 gm of noodles were dispersed in 250ml boiling water. For every 30 seconds, a piece of noodle was held between a plastic paper and pressed gently until the white color of noodle at central portion of strand disappears. Optimum cooking time was achieved when the centre of noodles become transparent.

Cooking loss

Cooking loss was determined by measuring the amount of solid substance lost to cooking water. A 10 gm sample of noodles was placed into 300 ml boiling distilled water in a 500 ml beaker. Cooking water was collected in an aluminum dish and placed in oven at 105 °C and evaporated to dryness.

The residue was weighed and reported as a percentage of starting material.

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

Water absorption

The water absorption was determined by the ratio of the weight of cooked noodles to the weight of noodles before cooking as described by AACC method AACC (2005).

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

Swelling index

The swelling index of cooked noodles was determined according to the procedure described by Cleary and Brennan (2006). The Swelling index was expressed as weight of cooked noodle,

$$\text{Swelling Index} = \frac{\text{Weight of cooked noodles} - \text{Weight of noodles after drying}}{\text{Weight of noodles after drying}}$$

Colour measurement

The colour values of cooked and uncooked noodles were measured using Hunter lab colour measurement system using method of Jyotsna *et al.*, (2004). (Colour measuring lab scan XE system, USA). A standard white tile of barium sulphate (100 % reflectance) was used as a perfect white surface for calibration of instrument with the illuminant.

Noodles samples were placed in the sample holder and reflectance was auto recorded for the wave length from 360 – 800nm. The values were recorded in terms of lightness L (Lightness: 0 = black, 100= white) and colour (+a: red; -a: green; +b: yellow and -b: blue).

Statistical analysis

The data obtained from the laboratory experiment was analyzed using completely randomized design and appropriately interpreted as per the methods described in "Statistical methods for agricultural workers" by Panse and Sukhatme (1985). Appropriate standard error (S.E) and critical differences (C.D.) at 5% level were worked out as and when necessary and used for data interpretation.

Results and Discussion

The proximate composition of refined wheat flour, spinach puree and egg is shown in table.1.

The wheat flour contained 10.86% moisture, 1.56% crude fat, 11.6% protein, 1.67% fibre and 0.59% ash. Spinach was rich in moisture (90.70%) ash (1.40%), fibre (1.67%) and fat (0.28%). Egg was also rich in fat, protein and ash. The results are in agreement with several workers.

Sensory evaluation of spinach puree added noodles

Results pertaining to the sensory qualities of noodles added with spinach puree are presented in table.2.

Spinach puree was added in refined wheat flour at 10,20,30,40 and 50 gm per 100gm flour and noodles were prepared and sensory evaluation was carried out. The significance differences were found in various parameters. The colour of the product greatly improved with the addition of spinach puree. The colour is the first quality parameter customer identification in food. It is the most important attribute used by customer to evaluate the quality of the product and it is the only test carried out without touching to the product.

The maximum score was allotted to the sample Sp 30 and Sp 40 as compared to control. Flavour, texture and overall acceptability were also significantly improved with addition spinach puree in noodles. Overall acceptability was greatly improved in Sp 30 and Sp 40 samples. However, the results pertaining to taste were not encouraging as the spinach imparts its vegetable taste to the product therefore, taste parameter obtained fewer score. The similar results with respect to colour were obtained Rekha *et al.*, (2013). Similar results of increasing parameters with respect to appearance were reported by Keyimu (2013) with addition of sea weed puree in noodles up to 3% level. Yadav *et al.*, (2014) also reported that the spinach incorporated pasta was most acceptable than other pastas.

Cooking qualities

Cooking qualities affected by addition of spinach puree are presented in table 3.

Cooking time refers to the time in minutes to gelatinize the starch marked by disappearance of central white core in the noodles strand De pilli *et al.*, (2013). The results indicated that there were significant differences in time required to cook the control noodles and spinach noodles. Addition of spinach reduced the cooking time progressively from 6.24 (control) to 5.15 minutes (50gm spinach noodles). This might be due to dilution of gluten in dough. Gluten is primarily responsible for the development of starch/protein complex; which in term determines the noodles structure and cooking properties. The dilution of these constituents by addition of spinach puree might be reducing the cooking time Rekha *et al.*, (2013). The results are in agreement with those described by Petitot *et al.*, (2010) and Kuchtowa *et al.*, (2016) in supplementation of wheat flour in pasta with faba bean flour and

pumpkin powder. Reduction in cooking time was also observed by Padalino *et al.*, (2017) in fortification of tomato peel flour in pasta.

Cooking loss

Cooking loss is amount of solids that dissolve in water during cooking and may be an indicator of noodles structure integrity during cooking Li *et al.*, (2015). Cooking loss is commonly used as predictor of overall noodle cooking performance Tudorica *et al.*, (2002).

Type of ingredients added directly affect the loss of soluble solids during cooking and has been reported that a compact texture of noodles often results in less cooking loss than the loose textured noodle Krishnan *et al.*, (2012). From the results it can be clearly seen that cooking loss was maximum (14.33 %) in control. There was a progressive reduction in cooking loss with increasing level of spinach puree in formulation. This could be due to better binding of starch granules with added vegetable puree in gluten matrix Rekha *et al.*, (2013) also reported decrease in gruel loss for vegetable paste in incorporated pasta.

Water absorption

Water absorption is indication of quantity of water absorbed by the noodles during cooking, an important characteristics in deciding the cooking quality Li *et al.*, (2015). Results indicated that, there was slight increase in water absorption and consequently in cooking weight of noodles.

The water absorption for control was minimum and with increase in spinach puree water absorption was progressively increased from 150.27 (control) to 162.6 (Sp 50). The addition of vegetable puree enhances the interaction between starch granules and protein matrix resulting in better quality noodles. Since, vegetables have greater water

holding capacity therefore spinach puree added noodle samples had more water absorption as compared to control. Vegetable noodles had higher fiber content than control noodles, which resulted in higher water absorption due to strong water binding ability of fibers. Chen *et al.*, (1998). The present results are in accordance with the results of Rekha *et al.*, (2013).

Swelling index

Concerning swelling index the noodles samples with spinach puree recorded slightly lower values as compared with control samples. The results can be interpreted in terms of competition between fiber and starch for water absorption means starch components might have absorbed less water at optimum cooking time giving rise to lower swelling indices. Therefore increasing the amount of fiber thus generally resulted in lower swelling of starch and consequently lower swelling index. Padalino *et al.*, (2017) also reported lower swelling index in spaghetti incorporated with tomato peel flower.

Colour measurement

Colour is a major factor for assessing the visual quality and market value of a product. Colour values were measured for cooked and uncooked noodles and control sample with 100% flour was used to compare the colour.

The table 4 represents the colour characteristics of cooked and uncooked noodles. The control sample had the highest L value both in cooked and uncooked samples. During cooking lightness was slightly increased. In general lightness decreased continuously and progressively with increase in spinach level in the noodle. It was also observed that there was some loss of colour during cooking and therefore corresponding increase in L value.

Fig.1 Flow sheet for production of spinach puree

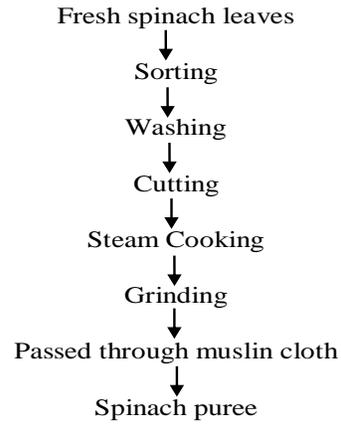


Plate.1 Spinach puree



Plate.2 Spinach Puree Added Noodles

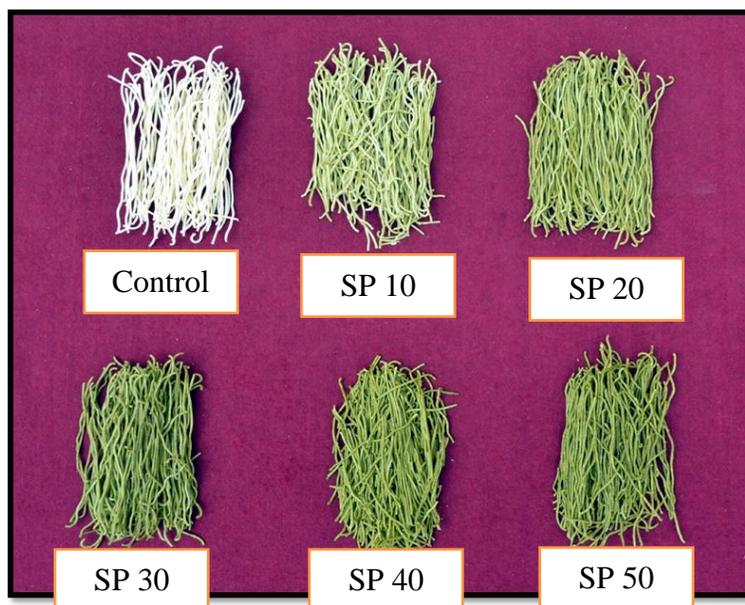


Table.1 Formulation of instant noodles with spinach puree and carrot puree

Ingredients	Sp ₀	Sp ₁₀	Sp ₂₀	Sp ₃₀	Sp ₄₀	Sp ₅₀
Wheat flour(g)	100	100	100	100	100	100
Spinach puree (g)	-	10	20	30	40	50
Whole egg (g)	8	8	8	8	8	8
Water (g)	30	30	30	30	25	20

SP₀= Control 100% wheat flour noodles

SP₁₀= 10g spinach puree in 100g flour

SP₂₀= 20 g spinach puree in 100g flour

SP₃₀= 30 g spinach puree in 100g flour

SP₄₀= 40 g spinach puree in 100g flour

SP₅₀= 50 g spinach puree in 100g flour

Table.2 Chemical composition of raw material

Sample	Moisture (%)	Fat (%)	Protein (%)	Carbohydrate (%)	Fibre (%)	Ash (%)
Refined wheat flour	10.86	1.56	11.6	71.38	1.67	0.59
Spinach puree	90.70	0.28	1.8	4.15	1.67	1.40
Egg	73.30	11.20	12.5	0.20	Trace	2.8
SE ±	0.5151	0.1056	0.5172	0.3865	0.1155	0.1007
CD at 5%	1.6798	0.3444	1.6867	1.2604	0.3997	0.3284

Table.3 Sensory evaluation of spinach puree noodles

Sample	Colour	Flavor	Taste	Texture	Overall acceptability
SP ₀	6.5	7.5	7.50	7.5	7.5
SP ₁₀	7.50	7.25	7.50	7.75	7.75
SP ₂₀	8.0	7.50	7.50	8.00	8.25
SP ₃₀	9.0	8.0	7.00	8.50	8.50
SP ₄₀	9.0	8.0	7.00	8.75	8.75
SP ₅₀	8.50	8.0	6.5	8.25	8.0
SE ±	0.1196	0.1394	0.1146	0.1222	0.1644
CD at 5%	0.3686	0.4296	0.3531	0.3766	0.5066

SP₀= Control 100% wheat flour noodles

SP₁₀= 10g spinach puree in 100g flour

SP₂₀= 20 g spinach puree in 100g flour

SP₃₀= 30 g spinach puree in 100g flour

SP₄₀= 40 g spinach puree in 100g flour

SP₅₀= 50 g spinach puree in 100g flour

Table.4 Cooking qualities of spinach puree added noodles

Sample	Cooking time (min)	Cooking weight (%)	Cooking loss (%)	Swelling index (ml/g)	Water absorption (%)
Control	6.24	250.31	14.33	1.85	150.27
SP ₁₀	5.45	252.29	8.5	1.82	152.2
SP ₂₀	5.25	254.45	7.65	1.82	154.4
SP ₃₀	5.20	255.65	7.60	1.84	155.6
SP ₄₀	5.18	260.75	7.40	1.89	160.7
SP ₅₀	5.15	262.26	6.8	1.91	162.6
SE ±	0.1426	1.9391	0.3278	0.1058	1.2085
CD at 5%	0.4394	5.9755	1.0101	0.3260	3.7241

SP₀ = Control 100% wheat flour noodles
 SP₁₀ = 10g spinach puree in 100g flour
 SP₂₀ = 20 g spinach puree in 100g flour
 SP₃₀ = 30 g spinach puree in 100g flour
 SP₄₀ = 40 g spinach puree in 100g flour
 SP₅₀ = 50 g spinach puree in 100g flour

Table.5 Color values of raw and cooked spinach noodles

Sample	L		a		b	
	Raw	Cooked	Raw	Cooked	Raw	Cooked
Control	69.29	69.44	2.43	0.87	24.63	13.58
SP ₁₀	51.49	55.21	- 0.35	-1.76	29.57	20.83
SP ₂₀	43.73	50.37	-.95	-1.78	27.39	19.03
SP ₃₀	35.30	49.62	-1.00	-1.86	26.34	21.42
SP ₄₀	37.52	46.11	-1.36	-1.98	26.63	24.79
SP ₅₀	36.39	43.92	-1.41	-1.98	26.74	23.28

SP₀ = Control 100% wheat flour noodles; SP₁₀ = 10g spinach puree in 100g flour
 SP₂₀ = 20 g spinach puree in 100g flour; SP₃₀ = 30 g spinach puree in 100g flour
 SP₄₀ = 40 g spinach puree in 100g flour; SP₅₀ = 50 g spinach puree in 100g flour

Table.6 Proximate composition of spinach puree noodles

Sample	Moisture (%)	Fat (%)	Protein (%)	Carbohydrate (%)	Fiber (%)	Ash (%)
SP ₀	6.83	4.30	13.85	69.93	1.85	1.57
SP ₁₀	8.50	4.28	13.65	67.62	3.10	2.85
SP ₂₀	8.70	4.26	13.55	67.08	3.20	3.21
SP ₃₀	8.75	4.27	13.40	66.86	3.40	3.32
SP ₄₀	8.98	4.26	13.20	66.51	3.60	3.45
SP ₅₀	9.50	4.25	13.05	65.80	3.80	3.60
SE ±	0.4255	0.237	0.5424	0.7781	0.2422	0.2739
CD at 5%	1.3407	NS	NS	2.3978	0.7464	0.8444

SP₀ = Control 100% wheat flour noodles; SP₁₀ = 10g spinach puree in 100g flour
 SP₂₀ = 20 g spinach puree in 100g flour; SP₃₀ = 30 g spinach puree in 100g flour
 SP₄₀ = 40 g spinach puree in 100g flour; SP₅₀ = 50 g spinach puree in 100g flour

Uncooked and cooked spinach pasta had green colour as seen from negative “a” that indicates green shade. It also had some yellowness as indicated by its “b” value. These values indicated that the noodles had green natural colour of spinach used. The colour of cooked sample was slightly less green than corresponding uncooked sample. Leaching of colour during cooking was almost negligible and all noodles had attractive green colour after cooking also. The results of present investigation were in accordance with the finding of Rekha *et al.*, (2013).

Chemical Characteristics

Chemical characteristics of spinach noodle are presented in table 5.

The moisture content of different noodles significantly affected with addition of spinach puree. Addition of spinach puree increased moisture content progressively and it was significantly different ($P < 0.05$) to the control. Moisture content of control noodle was lower as compared to other noodles. There was a progressive increase in moisture content of noodles with increase in proportion of spinach puree in wheat flour from 6.83 % (Control) to 9.50 (Sp 50). The higher moisture content in spinach noodles may be due to higher water holding capacity of fibers in spinach puree during dough formation. Spinach puree was comprised of small fine particles of cellulosic matters and hence when it was mixed with wheat flour to form dough it resulted in unhomogenous dough and which caused in increased moisture adsorption Lahaye (2001). The increase in moisture content with addition of seaweed puree in noodles was also reported by Eko Nurcahya (2011).

The results pertaining to fat and protein content were found to be non-significant with that of control. The fat and protein content

was in the range of 4.30(control) to 4.25 (Sp50) and protein content was 13.85 (control) to 13.05 (Sp50). In general fat and protein content slightly decreased with increase in level of spinach puree in noodles. This might be due to lower percentage of fat and protein in spinach puree.

There was a significant difference in carbohydrate content of noodles and control. In general carbohydrate content decreased progressively with addition of spinach puree in noodles. Fiber and ash content was found to be increased significantly in spinach noodles than control noodles.

There was a progressive increase in both the constituent with increase in level of spinach puree in noodle formulation. Fiber and ash content were almost double in Sp40 and Sp50 as compared to control noodles. Increase in fiber and ash content was also noted by Eko Nurcahya (2011) in substitution of seaweed puree in noodles.

The spinach puree can be added up to 40gm per 100gm of wheat flour. The sensorial parameters were improved with addition of spinach puree. The cooking time and cooking loss was reduced with increase in level of spinach puree in formulation. Whereas cooking weight, swelling index and water absorption was increased with increase in level of spinach puree in the noodle formulation.

The green colour in cooked and uncooked sample was progressively increased with increase in level of spinach. Moisture was significantly increased with increase in level of spinach puree. Fiber percent and ash content was also progressively increased with increase in level of spinach puree in formulation. The carbohydrate content was significantly decreased as compared to control noodles.

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