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Cooking characteristics and texture profile analysis of spice powders incorporated noodles

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Abstract
The aim of the present work was to study the effects of incorporation of different spice powders *viz*., fenugreek, coriander, black cumin and cinnamon in noodles preparation. The noodles were formulated with spice powders at different incorporation levels of 2%, 4% and 6% and compared with control. The developed products were investigated for their sensory attributes, cooking characteristics, textural parameters, shelf-life studies and microbial analysis. The water absorption capacity of spices incorporated noodles was significantly higher ($P<0.05$) compared to the control and found to be ranged from 112.06 to 162.55. The cooking time of the developed noodles increased with the addition of spice powders. The 4% incorporation levels of spice powders in noodles showed higher overall acceptability than others. The results suggested that the noodles made from whole wheat flour by incorporating different spices improved the flavor and overall acceptability.

Keywords: Noodles, fenugreek, black cumin, cinnamon, shelf-life

1. Introduction
Noodles are the most popular traditional food products, which are consumed all over the world because of its convenience, variety, versatility, nutrition, flavor, less cooking time, and palatability (Aydin and Gocmen, 2011) [2]. The major ingredients required for noodles preparation are wheat flour, water, and salt etc., which play an important role in dough quality and also to enhance textural properties *viz*., cohesiveness, gumminess, springiness and chewiness (Maberly, 2003; Day *et al.*, 2006; Kaur *et al.*, 2005; Prabhasankar *et al.*, 2007; Zawawi *et al.*, 2014) [8, 4, 6, 11, 14]. Nowadays, a wide variety of Asian noodles are available, varying in their ingredients, processes applied, and the form of the finished products (Crosbie and Ross, 2004) [3]. This diversity reflects differences in culture, climate, region, and several other factors (Hou, 2001) [5]. During the past two decades, the consumption of noodles has increased considerably due to the changes in customer preferences and nutritional awareness (Mahmoud *et al.*, 2012) [9]. Hence, the present study was undertaken to develop noodles by incorporating different spice powders and to study their sensory attributes, cooking characteristics and texture profile.

2. Materials and Methods
Spices *viz*., coriander, fenugreek, black cumin, cinnamon and salt used in the development of noodles was purchased from Sri MRV supermarket, Redhills, Chennai. Whole wheat flour used in the preparation of noodles was obtained from Chennai roller flour mills, Ponneri, Chennai. The present study was carried out in the College of Food and Dairy Technology, Alamathi, a constituent college of Tamil Nadu Veterinary and Animal Sciences University, Chennai.

2.1 Optimization of noodles incorporated with spices
Noodles were prepared from the whole wheat flour incorporated with selected spices *viz*., coriander, fenugreek, black cumin, and cinnamon. The whole wheat flour (1000g) was weighed and to it 20g of salt was added, then grounded spice powders in different equal proportions i.e., 2%, 4% and 6% were added and mixed well and then 300ml of water was added in order to form the dough. Conditioning of dough is carried out to make sheeting. The dough is placed in the rollers; the sheets are passed through the cutting rollers of 4mm and 2mm diameter and then folded. The steaming of folded noodles was done for 15-20 minutes. The steam-cooked noodles were folded and kept in stainless steel trays, dried in a tray drier at 60ºC for about 4-6 hrs.

The noodles were then allowed to cool for 30 minutes at ambient temperature are packed and stored.

2.2 Sensory evaluation
Sensory evaluation of spice powders incorporated noodles (SPIN) was carried out using the 9-point hedonic scale (Amerine *et al.*, 2013) [1] by a panel of 20 judges comprising of Post Graduate students and Faculty members of College of Food and Dairy Technology, Alamathi, Chennai - 600 052.

2.3 Cooking characteristics
The cooking characteristics considered for optimization of spices incorporated noodles include cooking time, cooking loss, and water uptake.

2.3.1 Cooking time
About 10g of the sample was cooked in 300ml of deionized water in a covered 500ml beaker. Cooking time was determined by the removal of a piece of noodle at a frequent interval of time (Omeire *et al*., 2015) [10]. Optimum cooking was achieved when the center of the noodles becomes transparent or fully hydrated.

2.3.2 Cooking loss
About 10g of the sample was cooked with sufficient water. Cooking loss was measured by transferring the cooked water (10ml) to a pre-weighed beaker and evaporating the water in a conventional oven overnight at 100ºC, then re-weigh the beaker with left over solids (Omeire *et al.*, 2015) [10]. The cooking loss was calculated as follows given in the formula:

$$\text{Cooking loss (\%)} = \frac{\text{weight of dried gruel}}{\text{weight of sample taken}} \text{ X } 100$$

2.3.3 Water uptake
The water uptake or absorption is the weight of water consumed for cooking to the weight of the uncooked noodles (Taneya *et al.*, 2014) [13].

$$\text{water uptake (\%)} = \frac{\text{weight of cooked noodles} - \text{weight of uncooked noodles}}{\text{weight of uncooked noodles}} \text{X } 100$$

2.4 Texture profile analysis
The textural characteristics of noodles samples were evaluated instrumentally using TA-XT Plus texture analyzer (Stable Micro System Ltd, Surrey, UK) fitted with a 5mm diameter stainless steel probe, set up to record the force used to penetrate the depth of 25mm at a speed of 2mm/s. The hardness of noodles was measured with a penetration probe of 20mm diameter attached to a 25kg load cell.

2.5 Shelf-life studies
The spice powders incorporated noodles were stored at room temperature for six months. The control and samples were analyzed for shelf-life studies based on storage at different intervals *viz*., 0, 30, 60, 90, 120, 150, and 180 days by sensory evaluation (Larmond, 1977) [7].

2.6 Microbial analysis
The microbiological analysis *viz*., standard plate count, coliform count, yeast and mold count were carried out as per the standard procedure described in BIS: 1981, SP: 18 (Part XI).

2.7 Statistical analysis
Results are presented as Mean ± SE. Analysis of variance was performed using SPSS®20.0 software for windows to determine the significant differences (Snedecor and Cochran, 2004) [12].

3. Results and Discussion
3.1 Effect of spice powders incorporation on sensory attributes of noodles
The sensory scores of spice powders incorporated noodles and control were shown in Figure 1. The mean values of colour and appearance, taste, texture, chewability and overall acceptability at different incorporation levels *viz*., 2% (SPIN 1), 4% (SPIN 2) and 6% (SPIN 3) ranged from 7.35±0.254 to 7.05±0.223, 7.20±0.268 to 7.00±0.271, 7.05±0.135 to 6.80±0.225, 7.15±0.244 to 6.95±0.235, 7.20±0.213 to 6.90±0.216 respectively. The sensory results revealed that the incorporation of spice powders beyond optimum (4%) level decreased the sensory scores. The results also indicated that the colour of cooked noodles is not attractive as control, which attributed to the incorporation of different spice powders. The overall acceptability and quality of a product directly imparts with the colour characteristics.

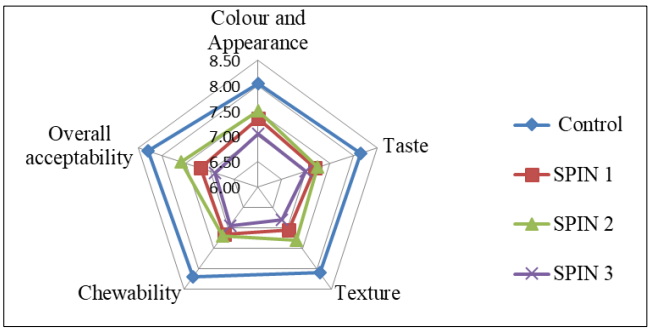

Fig 1: Sensory evaluation of spice powders incorporated noodles

3.2 Cooking characteristics of spice powders incorporated noodles
Cooking characteristics *viz*., cooking time, cooking loss and water uptake of spice powders incorporated noodles and control were presented in Table 1. The cooking time of the control and spice powders incorporated noodles at 2, 4 and 6 per cent was found to be 7.60±0.375, 8.52±0.165, 8.78±0.162 and 9.65±0.292 respectively. The cooking loss was found to be 5.71±0.318, 6.65±0.134, 7.32±0.168 and 8.29±0.225 respectively. The water uptake was found to be 112.06±0.438, 122.35±0.554, 142.38±0.545 and 162.55±0.521 respectively. Cooking time of the noodles increased with the addition of spice powders might be due to the presence of fibre, which implies that the cooking time of the noodles directly related to their composition of flour in their production. Cooking quality of spice powders incorporated noodles significantly increased but the cooking loss of the product is more compared to control.

Table 1: Cooking characteristics of spice powders incorporated noodles

Samples	Cooking characteristics		
	Cooking time (minutes)	Cooking loss (%)	Water uptake (%)
Control	7.60±0.375^{a}	5.71±0.318^{a}	112.06±0.438^{a}
SPIN 1	8.52±0.165^{ab}	6.65±0.134^{b}	122.35±0.554^{b}
SPIN 2	8.78±0.162^{bc}	7.32±0.168^{b}	142.38±0.545^{c}
SPIN 3	9.65±0.292^{c}	8.29±0.225^{c}	162.55±0.521^{d}
F-value	10.156**	23.818**	916.976**

Data are expressed as Mean ± SE; n=6**;** ** - Highly significant difference (P≤0.01);
Different superscripts in the same column indicate that treatments significantly differ.

3.3 Texture analysis of spice powders incorporated noodles

The textural parameters *viz*., hardness, adhesiveness, springiness, cohesiveness, gumminess, chewiness and resilience of spice powders incorporated noodles and control were presented in Table 2. The hardness values of control and spice powders incorporated noodles at 2, 4 and 6 per cent were found to be 1825.06±4.707, 1841.17±6.550, 1920.15±5.165 and 1985.20±3.634g respectively. The springiness values of control and spice powders incorporated noodles at 2, 4 and 6 per cent were found to be 0.764±0.008, 0.571±0.011, 0.467±0.009 and 0.380±0.010 mm respectively. The cohesiveness values of control and spice powders incorporated noodles at 2, 4 and 6 per cent were found to be 0.559±0.060, 0.461±0.010b, 0.374±0.006 and 0.255±0.007 respectively.

Table 2: Texture analysis of spice powders incorporated noodles

Samples	Texture profile analysis						
	Hardness (g)	Adhesiveness (g s)	Springiness (mm)	Cohesiveness	Gumminess (g)	Chewiness (g mm)	Resilience
Control	1825.06±4.707^{a}	-350.68±3.961^{a}	0.764±0.008^{d}	0.559±0.060^{c}	274.19±3.108^{d}	484.36±1.835^{a}	0.645±0.038^{c}
SPIN 1	1841.17±6.550^{a}	-176.74±2.263^{d}	0.571±0.011^{c}	0.461±0.010b^{c}	262.54±3.074^{c}	586.05±1.251^{b}	0.427±0.017^{b}
SPIN 2	1920.15±5.165^{b}	-193.57±1.539^{c}	0.467±0.009^{b}	0.374±0.006^{ab}	249.17±2.387^{b}	631.14±3.136^{c}	0.373±0.005^{b}
SPIN 3	1985.20±3.634^{c}	-224.03±2.586^{b}	0.380±0.010^{a}	0.255±0.007^{a}	219.20±2.419^{a}	684.37±2.670^{d}	0.241±0.014^{a}
F-value	210.169**	830.700**	302.248**	17.496**	73.290**	1315.741**	57.024**

Data are expressed as Mean ± SE; n=6**;** ** - Highly significant difference (P≤0.01)
Different superscripts in the same column indicate that treatments significantly differ

3.4 Shelf-life studies

The shelf-life studies were carried out by sensory evaluation during storage intervals of 0, 30, 60, 90, 120, and 150 and 180 days for the control and spice powders incorporated noodles were presented in Table 3. No notable variations were observed in all the sensory parameters during 30th day of storage at room temperature. On 120th day, the mean scores for texture, taste and overall acceptability was liked slightly, whereas further storage i.e., up to 180th day, all the sensory parameter scores slightly declined. The sensory parameters were observed during storage period from initial to 180th day and the scores were declined for colour and appearance (8.24±0.012 to 6.89±0.010), texture (8.47±0.014 to 6.96±0.165). The overall acceptability was accepted by the panellists during the prolonged storage. Shelf-life study is a major deliberation in new product development, production and marketing of a food, which is referred to the consumer acceptance during the time of sale and consumption. The shelf-life studies indicated that the noodles prepared by incorporating different spice powders have retained good flavor.

Table 3: Effect of storage period on sensory evaluation of spice powders incorporated noodles at ambient temperature

Attributes	Noodle variants	Storage days							
		0day	30th day	60th day	90th day	120th day	150thday	180thday	F-value
Colour and Appearance	Control	8.24±0.012^{cF}	8.18±0.022^{cF}	8.10±0.039^{dE}	8.01±0.011^{dD}	7.95±0.008^{cC}	7.80±0.017^{cB}	7.67±0.013^{dA}	106.178**
	SPIN 1	7.88±0.173^{bC}	7.66±0.009^{bB}	7.62±0.007^{bB}	7.59±0.013^{bB}	7.53±0.020^{bB}	7.29±0.024^{bA}	7.20±0.036^{bA}	11.218**
	SPIN 2	8.13±0.012^{bcE}	8.09±0.010^{cE}	8.02±0.011^{cD}	7.96±0.009^{cC}	7.90±0.025^{cB}	7.86±0.015^{cB}	7.58±0.014^{cA}	155.398**
	SPIN 3	7.34±0.019^{aB}	7.28±0.044^{aB}	7.21±0.014^{aB}	7.20±0.012^{aB}	7.18±0.015^{aB}	6.93±0.158^{aA}	6.89±0.010^{aA}	7.245**
	F-value	21.055**	263.521**	353.532**	1091.479**	392.211**	29.768**	291.318**	-
Texture	Control	8.47±0.014^{dE}	8.24±0.031^{dD}	8.14±0.022^{cC}	8.10±0.011^{dC}	8.01±0.013^{cB}	7.92±0.019^{cA}	7.87±0.017^{bA}	114.746**
	SPIN 1	7.75±0.023^{bF}	7.62±0.012^{bE}	7.59±0.015^{bE}	7.48±0.016^{bD}	7.41±0.020^{bC}	7.29±0.010^{bB}	7.11±0.018^{aA}	167.295**
	SPIN 2	8.14±0.026^{cF}	8.10±0.010^{cEF}	8.08±0.011^{cE}	7.99±0.012^{cD}	7.93±0.015^{cC}	7.88±0.014^{cB}	7.63±0.020^{bA}	114.012**
	SPIN 3	7.32±0.034^{aD}	7.27±0.016^{aCD}	7.18±0.014^{aBCD}	7.13±0.008^{aABCD}	7.07±0.042^{aABC}	6.99±0.037^{aAB}	6.96±0.165^{aA}	3.909**
	F-value	384.410**	570.573**	820.821**	1352.361**	316.862**	402.957**	25.728**	-
Taste	Control	8.74±0.015^{dG}	8.43±0.012^{dF}	8.30±0.011^{dE}	8.19±0.022^{dD}	8.08±0.014^{dC}	7.97±0.017^{dB}	7.82±0.010^{dA}	412.952**
	SPIN 1	7.74±0.017^{bG}	7.63±0.010^{bF}	7.56±0.019^{bE}	7.49±0.015^{bD}	7.39±0.009^{bC}	7.25±0.007^{bB}	7.09±0.014^{bA}	281.452**
	SPIN 2	8.16±0.009^{cF}	8.12±0.022^{cEF}	8.08±0.014^{cE}	8.01±0.013^{cD}	7.95±0.011^{cC}	7.89±0.016^{cB}	7.58±0.013^{cA}	180.708**
	SPIN 3	7.31±0.008^{aE}	7.30±0.014^{aE}	7.28±0.012^{aE}	7.19±0.032^{aD}	7.14±0.017^{aC}	7.08±0.018^{aB}	6.78±0.016^{aA}	103.682**
	F-value	2305.200**	1073.230**	1042.987**	447.802**	1146.440**	861.784**	1226.476**	-
Chewability	Control	8.66±0.017^{dG}	8.41±0.008^{dF}	8.29±0.011^{dE}	8.14±0.012^{dD}	8.06±0.014^{dC}	7.96±0.010^{dB}	7.79±0.009^{dA}	597.521**
	SPIN 1	7.68±0.019^{bE}	7.61±0.011^{bD}	7.57±0.005^{bD}	7.49±0.013^{bC}	7.30±0.029^{bB}	7.26±0.026^{bB}	7.02±0.016^{bA}	159.674**
	SPIN 2	8.09±0.012^{cE}	8.06±0.008^{cE}	8.05±0.012^{cE}	7.94±0.014^{cD}	7.86±0.009^{cC}	7.81±0.028^{cB}	7.48±0.015^{cA}	196.700**

	SPIN 3	7.37±0.023^{aE}	7.30±0.010^{aD}	7.27±0.024^{aD}	7.19±0.035^{aC}	7.16±0.014^{aBC}	7.11±0.010^{aB}	6.68±0.009^{aA}	126.741**
	F-value	943.178**	2854.470**	969.970**	427.419**	576.359**	407.122**	1509.394**	-
Overall acceptability	Control	8.54±0.019^{dG}	8.30±0.005^{dF}	8.19±0.008^{dE}	8.12±0.020^{dD}	8.05±0.025^{dC}	7.90±0.017^{cB}	7.75±0.032^{dA}	170.587**
	SPIN 1	7.74±0.026^{bG}	7.64±0.010^{bF}	7.58±0.013^{bE}	7.49±0.015^{bD}	7.39±0.018^{bC}	7.29±0.020^{bB}	7.08±0.008^{bA}	184.043**
	SPIN 2	8.17±0.030^{cF}	8.10±0.006^{cE}	8.06±0.008^{cE}	7.97±0.009^{cD}	7.90±0.016^{cC}	7.84±0.017^{cB}	7.54±0.024^{cA}	143.928**
	SPIN 3	7.31±0.010^{aE}	7.28±0.008^{aE}	7.23±0.005^{aD}	7.21±0.026^{aD}	7.15±0.007^{aC}	7.08±0.011^{aB}	6.78±0.015^{aA}	182.045**
	F-value	556.364**	3879.673**	2460.391**	508.885**	574.527**	601.080**	414.285**	-

Data are expressed as Mean ± SE; n=6**;** ** - Highly significant difference (P≤0.01);
Different superscripts in the same column and row indicate that treatments significantly differ

3.5 Microbial analysis of spice powders incorporated noodles

The microbial evaluation by standard plate, coliform, yeast and mold count during storage intervals of 0, 30, 60, 90, 120, 150 and 180 days for the control and spice powders incorporated noodles at 2, 4 and 6% were presented in Figure 2. The standard plate count during 0 to 180 days was found to be ranged from 1.54±0.012 to 1.67±0.008, 1.34±0.036 to 1.18±0.008, 1.09±0.012 to 0.97±0.014, 0.90±0.018 to 0.74±0.011 respectively. The coliform, yeast and mold were not found in both the control and spice powders incorporated noodles during different storage intervals of 0, 30, 60, 90, 120, 150 and 180 days at room temperature, which indicates that the hygienic practices followed during production and storage.

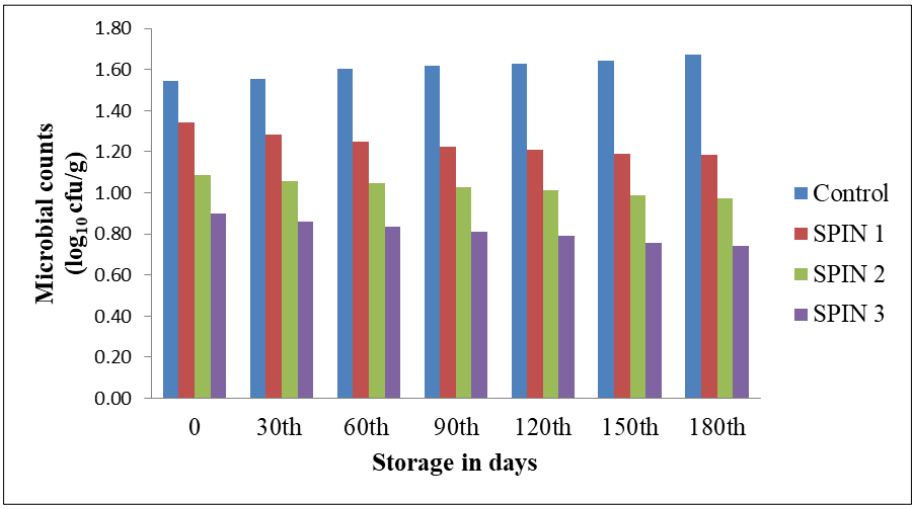

Fig 2: Microbial analysis of spice powders incorporated noodles

4. Conclusion

The noodles were prepared by incorporating spice powders at varying levels of substitution at 2%, 4% and 6% and studied for their sensory attributes, cooking characteristics and textural parameters. The spice powders incorporated noodles had higher influence in sensory characteristics as the incorporation levels increased the acceptance of the developed noodles decreased. The increased incorporation level of spice powders was the major factor affecting the colour and appearance of the noodles. Further, evaluation is carried out to understand the nutritional composition and health benefits of spices incorporated noodles, which will be helpful for manufacturers involved in the production of noodles.

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