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**K Santhi Sirisha**

PhD Scholar, Department of  
Foods and Nutrition, Post  
Graduate and Research Centre,  
Professor Jayashankar  
Telangana State Agricultural  
University, Rajendranagar,  
Hyderabad, Telangana, India

**Dr. TV Hymavathi**

Professor and Head, Department  
of Foods and Nutrition, Post  
Graduate and Research Centre,  
Professor Jayashankar  
Telangana State Agricultural  
University, Rajendranagar,  
Hyderabad, Telangana, India

**K Shreeja**

PhD Scholar, Department of  
Foods and Nutrition, Post  
Graduate and Research Centre,  
Professor Jayashankar  
Telangana State Agricultural  
University, Rajendranagar,  
Hyderabad, Telangana, India

**Correspondence****K Santhi Sirisha**

PhD Scholar, Department of  
Foods and Nutrition, Post  
Graduate and Research Centre,  
Professor Jayashankar  
Telangana State Agricultural  
University, Rajendranagar,  
Hyderabad, Telangana, India

## Development of spinach (*Spinacia oleracea* L.) incorporated foxtail millet (*Setaria Italica*) based biscuits

**K Santhi Sirisha, Dr. TV Hymavathi and K Shreeja**

**Abstract**

The present study aimed at the development of foxtail millet based biscuits incorporated with spinach (*Spinacia oleracea* L.) at different proportions viz. 10%, 15% and 20% using traditional creamery method. These developed biscuits were analysed for physical properties and sensorial qualities using 9 point hedonic scale. Physical characteristics of the analysed biscuits viz. diameter, thickness, spread ratio did not vary significantly due to spinach addition ( $p>0.05$ ). As per the results of sensory evaluation after the control, SIFB<sub>20</sub> had the highest overall acceptability. It was observed a decreased trend in the bulk density of the spinach puree incorporated foxtail millet biscuits except for biscuit with 20% incorporation. Water activity of the analysed samples was in the range of 0.23 to 0.36. Results suggested that spinach puree could be incorporated in the Foxtail millet biscuits at 20% level with good physical and sensorial qualities.

**Keywords:** Spinach, foxtail millet, biscuit, physical parameters, sensory evaluation

**Introduction**

Transition in consumer demand for health-promoting foods than hunger-satisfying foods is taking place. Hence there is a need to develop health-promoting foods especially bakery products having high market potential. Biscuits, basic snack consumed widely worldwide usually prepared with refined wheat flour which is devoid of essential nutrients, could be used as a vehicle for the addition of various nutrients. There are many ways to improve the quality of biscuits one of which is replacement or blending of refined wheat flour with another nutrient-rich millet flour, pulse and vegetable or fruit. Development of various food products by blending different health-promoting foods has increased and attracting much attention. Foxtail millet with its dietary fibre, divalent minerals i.e. zinc, magnesium, calcium and low glycemic index makes it suitable to enrich the eatables (Kim *et al.*, 2001; Anju and Sarita 2010) [10, 4]. High polyphenolics in foxtail millet help to boost the immune system and cardio protective in nature (Awika and Rooney, 2004) [5]. Similarly, spinach loaded with minerals, fibre and antioxidants exert hypocholesterolemic, hypolipidemic effects. Soybean is an excellent health food and it contains 40% good quality protein, 23% carbohydrates, 20% cholesterol-free oil and sufficient amounts of minerals and vitamins. Several studies were conducted for exploring the incorporation of dehydrated spinach powder in the different food products. Through the present study an attempt was made develop foxtail millet based biscuits with spinach puree incorporation at different levels.

**Materials and Methods****Materials**

Foxtail millet flour, refined wheat flour, soy flour, icing sugar, shortening, spinach, green chillies, cumin seeds and curry leaves were procured from the local market of Hyderabad.

**Preparation of spinach puree**

Fresh spinach leaves were washed, sorted, stalks were removed and leaves were cut into pieces, ground in the mixer grinder (Philips, HL1632) to fine mass in the grinder and was passed through muslin cloth to get homogenous puree.

**Formulation of spinach incorporated foxtail millet biscuits with spices**

Formulations used for biscuits are given in Table 1. Biscuits were prepared by following the creaming method in the Millet Processing Incubation Centre, Rajendranagar, Hyderabad.

**Table 1:** Formulations of Spinach incorporated Foxtail millet based biscuits with spices

Samples	Foxtail millet flour %	Refined wheat flour %	Soy flour %	Sugar %	Fat %	Spinach puree %	Salt %	Spices		
								Green Chilly (%)	Cumin seeds (%)	Curry leaf (%)
CB	35	25	15	3	20	---	2	---	---	---
SIFB <sub>10</sub>	30	15	12	3	20	10	2	3	3	2
SIFB <sub>15</sub>	28	15	10	3	20	15	2	3	3	1
SIFB <sub>20</sub>	27	15	8	3	20	20	2	1	2	2

CB: 0% Spinach incorporated foxtail millet biscuit

SIFB<sub>10</sub>: 10% Spinach incorporated foxtail millet biscuit with spices

SIFB<sub>15</sub>: 15% Spinach incorporated foxtail millet biscuit with spices

SIFB<sub>20</sub>: 20% Spinach incorporated foxtail millet biscuit with spices

### Physical characteristics of biscuits

Physical parameters of experimental and control biscuits such as weight (g), diameter (mm), thickness (mm), spread ratio (Bala *et al.*, 2015) [6], colour intensity of the biscuit samples was measured using hunter lab color measurement system, bulk density and water activity were determined by following standard protocols.

### Sensory evaluation

A semi-trained panel of 15 judges has evaluated the four biscuit formulations. The products were evaluated for colour, appearance, texture, taste, flavour and overall acceptability on a 9-point hedonic scale (1 = Dislike extremely to 9 = Like extremely) (Amerine *et al.*, 1965) [3]. Samples were coded using random three-digit numbers. Panelists were provided with a glass of water and instructed to rinse and swallow water between samples.

### Statistical analysis

All data were presented as means  $\pm$  the standard deviation of the mean. As for multiple group comparison, the significance of the differences among the treatment groups and their respective control groups were analysed using Window stat 9.1 software. Statistical significance was assessed by one-way analysis of variance (ANOVA). Differences between means were considered statistically significant at 5% level.

## Results and discussion

### Physical parameters

The data regarding physical properties such as weight, diameter, thickness, spread ratio, bulk density is presented in Table 2 along with water activity. Weight of the biscuits ranged from 4.98 to 5.93 g. It was observed that the weight of the biscuits decreased with an increasing proportion of

spinach puree. The decrease in the weight was due to the replacement of the other ingredients by spinach puree. Among all the biscuits, CB had the highest weight (5.93 $\pm$ 0.521) and lowest for SIFB<sub>20</sub> (4.98 $\pm$ 0.14). Statistically, a significant difference was not found in the thickness of samples. The decrease in the thickness was observed which is from 5.92 to 5.56 mm. CB had the highest thickness followed by SIFB<sub>20</sub>, SIFB<sub>15</sub> and SIFB<sub>10</sub> with the values 5.92 $\pm$ 0.02, 5.91 $\pm$ 0.18, 5.66 $\pm$ 0.33 and 5.56 $\pm$ 0.28 mm respectively.

Spread ratio or diameter is used to determine the quality of flour used to prepare the biscuits and the ability of the biscuits to rise (Bala *et al.*, 2015) [6]. The higher the spread ratio of the biscuit the more desirable it is (Chauhan *et al.*, 2016) [7]. Decreasing order of spread ratio was as follows SIFB<sub>10</sub>>SIFB<sub>15</sub>>CB > SIFB<sub>20</sub>. Among all the variations SIFB<sub>10</sub> recorded the highest spread ratio (6.84) as compared to the control and other samples. Reduced spread ratio of the biscuits is due to the fact that composite flours of wheat, foxtail millet and soy formation of aggregates with increasing number of hydrophilic sites competing for limited available water in dough (Mc Watters, 1978) [11, 12]. Bulk density is generally affected by the particle size and the density of flour or flour blends and it is very important in determining the packaging requirement, raw material handling and application in wet processing in the food industry (Adebowale *et al.*, 2012) [1]. The bulk density of the biscuit samples ranged from 0.53 to 0.62 (g/cm<sup>3</sup>). Bulk density values for control, SIFB<sub>10</sub>, SIFB<sub>15</sub> and SIFB<sub>20</sub> were 0.57 g/cm<sup>3</sup>, 0.54 g/cm<sup>3</sup>, 0.53 g/cm<sup>3</sup> and 0.62 g/cm<sup>3</sup> respectively. It was observed a decreased trend in the bulk density of the spinach puree incorporated foxtail millet biscuits except for biscuits with 20% incorporation this implies that a denser packaging material requirement for SIFB<sub>20</sub>.

**Table 2:** Physical parameters of Spinach incorporated Foxtail millet based biscuits

Parameter	Weight (g)	Diameter (mm)	Thickness (mm)	Spread ratio	Bulk density (g/cm <sup>3</sup> )	Water activity
CB	5.93 $\pm$ 0.521a	38.13 $\pm$ 0.58a	5.92 $\pm$ 0.02a	6.43 $\pm$ 0.11a	0.57 $\pm$ 0.39a	0.23 $\pm$ 0.12b
SIFB <sub>10</sub>	5.56 $\pm$ 0.29a	37.97 $\pm$ 0.66a	5.56 $\pm$ 0.28a	6.84 $\pm$ 0.24a	0.54 $\pm$ 0.26b	0.34 $\pm$ 0.12a
SIFB <sub>15</sub>	5.27 $\pm$ 0.43a	37.21 $\pm$ 0.72a	5.66 $\pm$ 0.33a	6.62 $\pm$ 0.55a	0.53 $\pm$ 0.33c	0.36 $\pm$ 0.15a
SIFB <sub>20</sub>	4.98 $\pm$ 0.14a	37.28 $\pm$ 1.44a	5.91 $\pm$ 0.18a	6.60 $\pm$ 0.39a	0.62 $\pm$ 0.10a	0.35 $\pm$ 0.21a
CD	1.28	2.74	0.87	1.23	0.07	0.06

**Note:** Values are expressed as mean  $\pm$  standard deviation of three determinations

There is a significant difference ( $p < 0.05$ ) among the samples for water activity. Water activity of the analysed samples was in the range of 0.23 to 0.36. The water activity of the control biscuits was found to be lower than spinach incorporated biscuits. The mean value of water activity was 0.34 for SIFB<sub>10</sub>, 0.36 for SIFB<sub>15</sub>, 0.35 for SIFB<sub>20</sub> 0.23 for CB. The water activity of below 0.61 is desirable for baked products

while fresh biscuits should have water activity about 0.3 (Stellamaris *et al.*, 2018) [14].

### Colour attribute of the biscuit

Colour is an important attribute of the baked products to attract consumer acceptability. The colour of the biscuits, which was represented by L\*, a\* and b\* values are shown in

Table 3. 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). The control sample had the highest L value. Lightness decreased continuously as the level of spinach incorporation increased. It was observed a negative value for a\* which indicates the green colour of the spinach incorporated biscuits. Positive a\* value for the control sample was recorded. These results were in accordance with the results reported by Galla *et al.*, 2017 [8]. CB had the highest b\* value followed by SIFB<sub>20</sub>, SIFB<sub>15</sub> and SIFB<sub>10</sub>. Redness of the cookies decreased from 32.3 to 25.22 as the level of spinach incorporation had increased.

**Table 3:** Colour values of Spinach incorporated Foxtail millet based biscuits

Sample	L*	a*	b*
CB	46.94±0.19	14.01±0.45	32.31±0.87
SIFB <sub>10</sub>	42.60±2.47	- 3.30±0.26	25.22±2.38
SIFB <sub>15</sub>	43.18±0.44	-3.68±0.30	25.74±1.12
SIFB <sub>20</sub>	42.62±0.65	-4.43±0.29	26.45±0.23

**Note:** Values are expressed as mean ± standard deviation of three determinations

### Sensory evaluation

Results of sensory evaluation of spinach incorporated foxtail millet based biscuits were presented in the Table 4. Spinach puree was added to other ingredients *i.e.* foxtail millet, refined wheat and soy along with spices at 10, 15 and 20% and biscuits were prepared which were further subjected for sensory evaluation. The mean sensory scores for the appearance of spinach incorporated foxtail millet biscuits ranged from 6.47±0.30 to 7.14±0.37 (Table 3) among which

SIFB<sub>20</sub> had been rated with the highest score (7.61±0.25). The highest score for appearance was given for control biscuit (7.66±0.25).

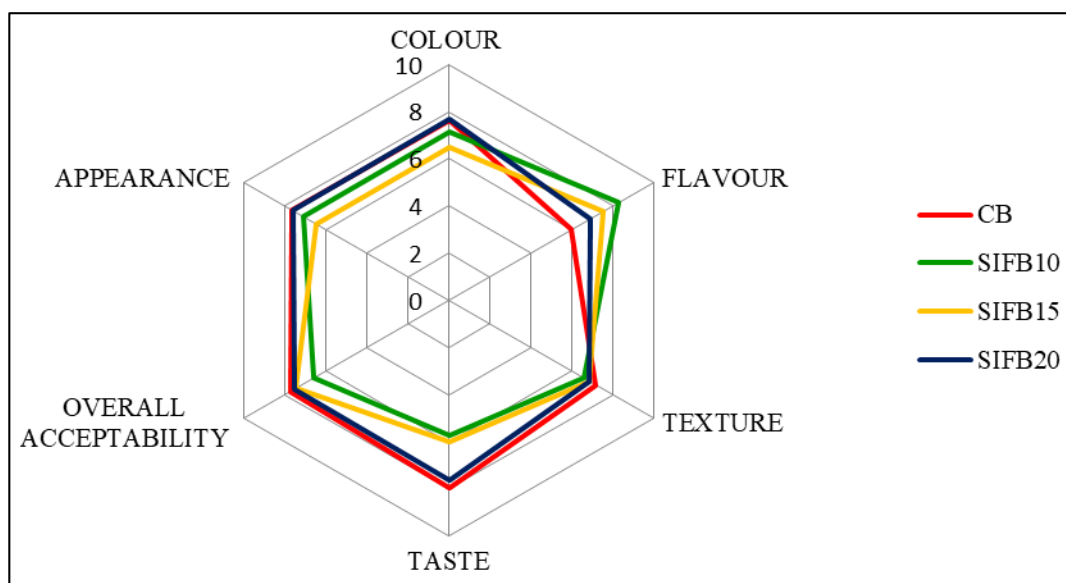
The highest score for colour was given for CB followed by SIFB<sub>20</sub>, SIFB<sub>15</sub> and SIFB<sub>10</sub> with mean sensory scores 8.06±0.24, 7.20±0.29, 6.66±0.48, 5.13±1.08 respectively. The mean sensory score for texture ranged from 6.86±0.36 to 7.20±0.45. CB was rated with the highest score for texture whereas SIFB<sub>20</sub> was given a mean score of 6.86±0.41 making it superior to the other two experimental samples. SIFB<sub>10</sub> had been given a highest mean score for flavour which is about 8.33±0.15 followed by SIFB<sub>15</sub>, SIFB<sub>20</sub> and CB with mean scores 7.53±0.47, 6.93±0.35, 6.00±0.35 respectively. This may be due to the characteristic flavour of the spices added to the experimental biscuits. Highest mean score to taste was observed for CB (7.93±0.30) and the least was given for SIFB<sub>10</sub> (5.73±0.20).

The scores for overall acceptability were in the range of 6.61±0.29 to 7.76±0.19. The mean sensory score for overall acceptability of SIFB<sub>20</sub> was on par with the CB compared to the other experimental biscuits. Based on the sensory evaluation and physical properties SIFB<sub>20</sub> which is on par with the CB in most of the analyzed parameters. Similar results were reported by Ramu *et al.*, 2018 [13] that increment in spinach puree in wheat noodles from 0-30% resulted in enhancement of flavour and colour value. Alka *et al.*, 2015 [2] reported that spinach powder incorporated *paratha* and *kichadi* were awarded with highest scores for all the sensorial qualities at 10% level of incorporation whereas Galla *et al.*, 2017 [8]; Khan *et al.*, 2015 [9] reported that dehydrated spinach powder incorporation in biscuits was acceptable at 5% level compared to 10 and 15%.

**Table 4:** Mean sensory scores of Spinach incorporated Foxtail millet based biscuits

	Appearance	Colour	Texture	Taste	Flavour	Overall acceptability
CB	7.66±0.25 <sup>a</sup>	8.06±0.24 <sup>a</sup>	7.20±0.45 <sup>a</sup>	7.93±0.30 <sup>a</sup>	6.00±0.35 <sup>bc</sup>	7.76±0.19 <sup>a</sup>
SIFB <sub>10</sub>	7.14±0.37 <sup>a</sup>	5.13±1.08 <sup>c</sup>	6.60±0.52 <sup>a</sup>	5.73±0.20 <sup>cb</sup>	8.33±0.15 <sup>a</sup>	6.61±0.29 <sup>b</sup>
SIFB <sub>15</sub>	6.47±0.30 <sup>b</sup>	6.66±0.48 <sup>b</sup>	6.86±0.36 <sup>a</sup>	6.00±0.37 <sup>b</sup>	7.53±0.47 <sup>a</sup>	7.47±0.22 <sup>a</sup>
SIFB <sub>20</sub>	7.61±0.25 <sup>a</sup>	7.20±0.29 <sup>a</sup>	6.86±0.41 <sup>a</sup>	7.60±0.25 <sup>a</sup>	6.93±0.35 <sup>b</sup>	7.57±0.23 <sup>a</sup>
CD	0.82	1.77	1.17	0.87	1.04	0.67

**Note:** Values are mean ± standard deviation of three determinations



**Fig 1:** Mean sensory scores of Spinach incorporated Foxtail millet based biscuits

## Conclusion

Present study assessed the feasibility of incorporating spinach into foxtail millet based biscuits at 10, 15 and 20% level of incorporation. From the present study, it can be concluded that spinach can be incorporated in the bakery products like biscuit at a 20% level with desirable physical and sensory properties to enhance the intake of green leafy vegetables.

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