Original Research Article

Sensory and Nutritional Analysis of Spinach Powder Fortified Biscuits

Abstract

The present study was conducted to see the effect of supplementation of spinach leaves powder in commonly consumed baked products**.** Spinach leaves were dried in the shade for 6 to 8 hrs.; to remove excess moisture followed by oven drying at 40-45 ^{0}C till complete drying. The dried leaves were ground in an electric grinder to obtain a fine powder. The powder was rich in essential minerals like calcium, iron, zinc and phosphorous. Biscuits were prepared using 4%, 6%, 8%, 10% and 12% spinach leaves powder and evaluated for their sensory and nutritional quality. Spinach biscuits were found nutritionally rich in crude protein, dietary crude fibre, minerals, β-carotene and anti-oxidant activity in comparison to their respective control biscuitsproducts. organoleptic properties Sensory studies of biscuits showed that 10% supplementation of spinach powder were more acceptable.

Comment [Ma1]: where? Not evaluated in research

Keywords: Supplementation, **Biscuits,** Nutritional composition, Antioxidant activity, Sensory quality

Introduction

Micronutrient deficiencies are more common than single nutrient deficiency in developing countries and the cause for their high prevalence is inadequate dietary intake and poor availability of micronutrients from vegetarian diets (Gupta *et al.* 2015; Galla *et al.* 2017). Among them vitamin A and iron deficiencies are two major nutritional public health problems affecting the vulnerable groups of population in India. The food based approach for combating micronutrient malnutrition, is difficult and of a long duration, although its effect is predicted to be long lasting (Singh *et al.* 2014; Gupta *et al.* 2015; Singh *et al*. 2018).
For value addition nutrient rich foods like chickpea flour and green leafy vegetables can be used along with wheat for enhancing the nutritional quality of wheat based traditional recipes (Pant et al. 2012; Lohekar 2014).

Green leafy vegetables serve as good sources of water soluble vitamins and vitamin A as well as minerals such as calcium, phosphorus and iron. They contain sufficient amounts of β-carotene and other carotenoids which precursor to vitamin A that can be enhanced the absorption of vitamin A in the human body other provitamin A carotenoids that can be absorbed and converted to vitamin A in the human body (Van den berg *et al*. 2000). They contain a variety of powerful natural antioxidants such as vitamin C and β-carotene (Umma Khair *et al*. 2012; Kavitha & Ramadas 2013; Longvah *et al.* 2017).

Spinacia oleracea L. popularly known as spinach in India, its production worldwide has reached 20.79 million tons in 2011. Spinach leaves are very good source of β-carotene, calcium, iron, phosphorus, dietary fibre, antioxidants and phytochemicals (Premavalli *et al*. 2001; Gupta *et al*. 2015). Antioxidants, vitamins like vitamin C and phenols are important in human food since they act as an anticancer agent (Nnamani *et al.* 2007). Dietary fibre from

spinach helps in lowering the plasma total cholesterol and triglyceride levels and increase HDL the good cholesterol (Vadhera *et al*. 2003; Dachana *et al.* 2010; Umma Khair *et al.* 2012).

Dehydration is one of the traditional methods of preservation, which converts the food into light weight, easily transportable and storable products. Dehydrated vegetables can be easily converted into fresh like form by rehydration and can be used throughout the year (Karva *et al.* 2010).

The nutritive value of staple food can be enhanced through a mutual complementation of their restrictive micronutrients with value added ingredients. Green leafy vegetables and legumes are among the value added ingredients and multi-cultural components used ubiquitously in Indian cuisine. Green leafy vegetables and legumes are rich source of protein, micronutrients and dietary fibre (Galla *et al*. 2017; Longvah *et al*. 2017; Singh *et al*. 2018). The dehydrated spinach leaves powder was supplemented in wheat biscuits and their organoleptic and nutritional value were investigated.

Materials and Methods:

The present study was conducted in the Department of Foods and Nutrition, COHS, CCS Haryana Agricultural University, Hisar.

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Procurement of materials

Grain samples of a wheat variety (WH-1105) and a bengal gram variety (HC-1) were procured from the Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar. The grain samples were cleaned, bengal gram seeds were dehulled and ground into flour. The ground samples were stored in plastic container till further use.

Spinach leaves (*Spinacia oleracea L.*) were procured in a single lot from local market of Hisar. Healthy mature and disease-free leaves were selected and washed under running tap water followed by distilled water. Excess water was wiped off with muslin cloth. Then the leaves were dried in the shade for 6 to 8 h to remove excess moisture followed by oven drying at 40-45^{0}C till complete drying. The dried leaves were ground in an electric grinder to obtain a fine powder. The ground powder was stored in low density polyethylene (LDPE) bags for further use.

Flow chart 1: Preparation of spinach leaves powder

Fresh spinach leaves

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Wash under tap water

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Rinse with distilled water

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Whip off excess water

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Dry in the shade for 6 to 8 h

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Dry in oven at 40- 45°C till complete drying

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Fine powder in grinder

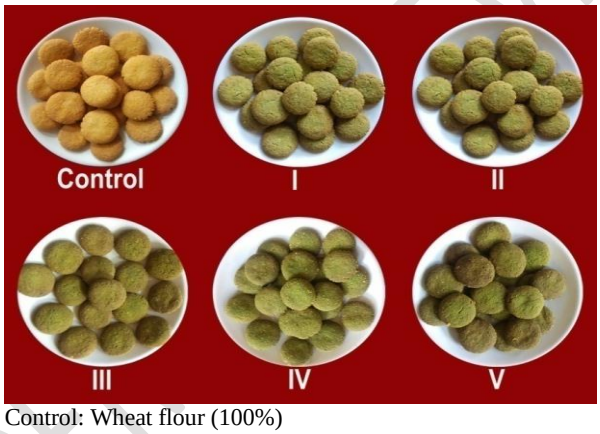
↓

Stored in low density polyethylene (LDPE) bags

Preparation of biscuits: The spinach, chickpea and wheat flour incorporated biscuits were prepared by replacing the main cereal used in basic recipe by spinach and chickpea flour. Five combinations were used for preparation of biscuits. The standard recipe of biscuits was taken as control. Biscuits were organoleptically evaluated by a panel of semi trained judges using 9 point hedonic scale. It was observed that biscuits were found acceptable up to 10 per cent level of incorporation of spinach leaves powder. The acceptable biscuits were selected for further nutritional analysis. These spinach and chickpea incorporated biscuits were oven dried at 60°C and ground to fine powder and stored in air tight container for nutritional evaluation.

Comment [Ma2]: What is the difference between chickpea flour and gram flour?; It should be clarified which one was used?

Fig 1: Nutritional evaluation



Control: Wheat flour (100%)
Type-I: Wheat flour:Bengal gram flour: Spinach leaves powder (48:48:4)
Type-II: Wheat flour:Bengal gram flour: Spinach leaves powder (47:47:6)
Type-III: Wheat flour:Bengal gram flour: Spinach leaves powder (46:46:8)
Type-IV: Wheat flour:Bengal gram flour: Spinach leaves powder (45:45:10)
Type-V: Wheat flour:Bengal gram flour: Spinach leaves powder (44:44:12)

Nutritional evaluation: The samples of biscuits were evaluated for proximate composition (AOAC, 2000); ~~total m~~Minerals such as Iron, calcium, zinc and phosphorus were estimated by the method of Lindsey and Norwell, 1969, antioxidant activity Prieto *et al*., 1999; AOAC 2000.

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RESULTS AND DISCUSSION

Sensory evaluation: Mean scores of sensory characteristics (colour, appearance, aroma, texture, taste and overall acceptability) of micronutrient rich biscuits are presented in the Table 1.

The prepared biscuits were subjected to sensory evaluation with respect to colour, appearance, flavour, taste, texture and over all acceptability by a semi trained panel of ten judges using 9-point hedonics scale. Overall acceptability scores of biscuits made from wheat flour (control) was 8.00 whereas biscuits made from Type-I, Type-II, Type-III and Type-IV

composite flours obtained mean scores as 7.74, 7.71, 7.36 and 7.20, respectively. But biscuits made from Type-V composite flour got lowest overall acceptability scores i.e. 5.88 which was 'neither liked nor disliked' by the panelists. However, up to 10 per cent level of incorporation of spinach leaves powder in wheat- bengal gram blend produced acceptable biscuits.

Nutritional evaluation of biscuits:

Proximate composition: The data in respect of proximate composition of biscuits are presented in Table 2.

Moisture, crude protein, crude fat, crude fibre and ash contents of biscuits made from wheat flour (control) were found to be significantly increased on addition of spinach leaves powder and bengal gram flour in wheat flour. While increase in crude protein content up to 10 per cent level i.e Type-IV biscuits was 16.84 per cent, respectively. It might be due to fortification of wheat flour with bengal gram flour and spinach leaves powder. Crude fat and crude fibre content were also found higher in all supplemented biscuits. The increase in fat content with incorporation of spinach leaves powder may be due to the increased absorption of fat because of high fibre content in composite flour.

Total minerals: The results of total calcium, iron, zinc and phosphorus contents of biscuits are presented in Table 3.

Total iron, calcium, zinc and phosphorus contents of biscuits supplemented with spinach leaves powder were in the range of 4.67 to 7.65, 77.84 to 89.04, 2.12 to 3.12 and 309.89 to 337.71 mg/100g, respectively. Total iron, calcium, zinc and phosphorus content were found to be improved significantly with increase in the level of incorporation of spinach leaves powder in wheat-bengal gram flour blends. As spinach is rich source of all minerals (Singh & Kawatra 2006; Khan *et al*. 2015; Galla *et al*. 2017). These results are also supported by the earlier reports (Pant *et al.* 2012; Singh & Grover 2014; Alijoba *et al.* 2015; Singh *et al*. 2018). Pant *et al.* (2012) reported iron content of control *matthi* was 2.1 mg/100g which increased to 2.3 and 2.5 mg/100g on supplemented with 25 per cent spinach leaves powder and drumstick leaves powder, respectively. Brar (2009) reported high iron and calcium content in colocasia supplemented *matthi*, Verma & Jain (2012) reported 14.7 mg/100g total iron in 7.5 per cent level of bengal gram leaves supplemented *chapatti* while Srinivasamurthy *et al.*, (2017) reported 55.06 mg/100g calcium, 3.55 mg/100g iron, 275.0 mg/100g phosphorus in muffin incorporated with 10 per cent level of moringa leaves powder.

Anti-oxidant activity: The result of anti-oxidant activity of biscuits is presented in Table 4.

Anti-oxidant activity of control biscuits was in the range of 13.82 per cent which found to be significantly increased in all the spinach leaves powder supplemented biscuits i.e Type-I, Type-II, Type-III and Type-IV biscuits. This increase might be due to addition of spinach powder (4, 6, 8, 10 and 12 % levels) which has high anti-oxidant activity (Ajibola *et al.* 2015). Umma Khair *et al*. (2012) also reported higher anti-oxidant activity in spinach leaves powder supplemented products in comparison to control products.

Table: 1 Mean scores of organoleptic characteristics of biscuits

Types of Biscuits	Colour	Appearance	Aroma	Texture	Taste	Overall Acceptability
Control	8.20±0.06	8.10±0.04	7.90±0.09	7.70±0.07	8.10±0.19	8.00±0.21

Type- I	7.60±0.09	7.45±0.17	7.85±0.05	7.90±0.00	7.90±0.17	7.74±0.01
Type –II	7.60±0.05	7.73±0.19	7.84±0.11	7.70±0.12	7.70±0.19	7.71±0.10
Type- III	7.40±0.04	7.40±0.17	7.30±0.08	7.40±0.16	7.30±0.05	7.36±0.11
Type –IV	7.20±0.17	7.18±0.03	7.26±0.09	7.39±0.18	6.95±0.14	7.20±0.08
Type-V	5.30±0.15	5.87±0.25	5.80±0.01	5.86±0.10	5.50±0.14	5.88±0.03
CD(P=0.05)	0.36	0.50	0.23	0.33	0.53	0.38

Values are mean ±SE of ten panelists
Control: WF (100%) Type-I: WF: BGF: SP (48:48:4)
Type-II: WF: BGF: SP (47:47:6) Type-III: WF: BGF: SP (46:46:8)
Type-IV: WF: BGF: SP (45:45:10) Type-V: WF:BGF:SP (44:44:12)
WF: Wheat flour BGF: Bengal gram flour SP: Spinach powder

Table: 2 Proximate composition of biscuits supplemented with spinach powder (%, on dry matter basis)

Biscuits	**Moisture***	**Crude protein**	**Crude fat**	**Crude fibre**	**Ash**
Control (WF100 %)	2.07±0.04	11.86±0.30	20.79±0.38	1.55±0.02	2.06±0.05
Type-I	3.68±0.03	14.54±0.20	22.23±0.13	2.15±0.01	3.45±0.04
Type-II	4.03±0.10	15.64±0.24	23.33±0.09	2.96±0.02	4.24±0.07
Type-III	4.63±0.11	16.16±0.32	24.42±0.23	3.75±0.08	4.78±0.06
Type-IV	5.02±0.10	16.84±0.01	25.51±0.59	3.94±0.02	5.16±0.13
CD (P=0.05)	0.29	0.76	1.09	0.13	0.23

*On wet matter basis Values are mean ± SE of three independent determinations
Type-I: WF: BGF: SP (48:48:4) Type-II: WF: BGF: SP (47:47:6)
Type-III: WF: BGF: SP (46:46:8) Type-IV: WF: BGF: SP (45:45:10)
WF: Wheat flour BGF: Bengal gram flour SP: Spinach powder

Table: 3 Total mineral content of biscuits supplemented with spinach powder (mg/100g, on dry matter basis)

Biscuits	**Iron**	**Calcium**	**Zinc**	**Phosphorus**
Control (WF 100%)	3.23±0.06	36.94±0.87	1.76±0.04	304.20±0.15
Type-I	4.67±0.10	77.84±1.78	2.12±0.04	309.89±0.97
Type-II	5.54±0.07	80.12±0.03	2.65±0.05	318.05±0.83
Type-III	6.65±0.04	85.32±0.35	2.99±0.03	332.14±0.91
Type-IV	7.65±0.01	89.04±1.62	3.12±0.03	337.71±0.17
C.D (P=0.05)	0.21	3.80	0.13	2.44

Values are mean ± SE of three independent determinations
Type-I: WF: BGF: SP (48:48:4) Type-II: WF: BGF: SP (47:47:6)
Type-III: WF: BGF: SP (46:46:8) Type-IV: WF: BGF: SP (45:45:10)

WF: Wheat flour BGF: Bengal gram flour SP: Spinach powder

Table: 4 Anti-oxidant activity of biscuits supplemented with spinach powder (on dry matter basis)

Biscuits	**Anti-oxidant activity (%)**
Control (WF 100%)	13.82±0.21
Type-I	15.32±0.01
Type-II	19.23±0.25
Type-III	22.21±0.05
Type-IV	24.16±0.60
CD (P=0.05)	1.04

Values are mean ± SE of three independent determinations
Type-I: WF: BGF: SP (48:48:4) Type-II: WF: BGF: SP (47:47:6)
Type-III: WF: BGF: SP (46:46:8) Type-IV: WF: BGF: SP (45:45:10)
WF: Wheat flour BGF: Bengal gram flour SP: Spinach powder

Conclusion

It was concluded that spinach biscuits was found organoleptically and nutritionally superior in terms of protein, fibre, ash, mineral and antioxidant activity contents. Spinach leaves powder has better functional characteristic and potentially the sources of value added products like biscuit, *matar*, *matthi* and *burfi*. Development and consumption of such value added products can go a long way in improving the nutritional status of the population especially for those suffering from micro nutrient deficiency.

Consent to participate- The consent of Panelists was taken for doing organoleptic evaluation of the developed products. All panel members filled the consent form to analyze the products.

Consent for publication – Yes

Ethics approval – Synopsis was approved by the Advisory committee of the researcher and Dean Post Graduate Studies, CCS HAU, Hisar.

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