Effect of normal/dehydrated greens on the rheological, microstructural, nutritional and quality characteristics of *paratha*—an Indian flat bread

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Abstract The leaves of dill (*Anethum graveolens*) and fenugreek (*Trigonella foenum-graecum* L. *Leguminosae*) were dehydrated using low temperature low humidity dryer, packed in polypropylene bags and stored at refrigerated conditions. Dehydration process marginally reduced the chlorophyll, carotenoid and ascorbic acid contents. Replacement of whole wheat flour with dehydrated leaves (dill-DDL, fenugreek leaves DFL) at 0, 5, 7.5 and 10 % increased the water absorption (68.5 to 70.2 %), dough development time (3.5 to 5.9 min) and mixing tolerance index values (78 to 98 BU). Pasting temperature increased (69 to 74.1 °C), whereas the hot paste viscosity (255 to 210 BU) and cold paste viscosity values (355 to 295 BU) decreased with increase in the DDL/DFL content in the blend. Sensory evaluation of *parathas* prepared with either normal dill/fenugreek leaves (NDL/NFL) at 0, 12.5, 25 and 37.5 % or dehydrated leaves at 0, 5, and 7.5 % showed that *parathas* with 25 % of normal leaves and 7.5 % of dehydrated leaves were acceptable. Microstructure of the fenugreek leaves had more porous

structure on dehydration. *Parathas* enriched with either of leaves were rich in dietary fiber, chlorophyll and carotenoid content.

Keywords *Paratha* · Farinograph · Microstructure · Dietary fiber · Chlorophyll · Carotenoids

Introduction

Since thousands of years plants have played a vital role in maintaining human health and improving the quality of human life (Craig 1999). Dill (*Anethum graveolens*) is an annual, tall, erect, glabrous herb with furrowed, hollow and branched stems and feathery leaves (Hemalatha et al. 2011). It is an aromatic herb, used as a condiment. Tea, pickles and confectionary are flavored by this herb. Proteins, minerals and fibres are abundantly found in dill leaves. In India, dill leaves are used as an edible vegetable (Jinesh et al. 2010). Studies have found that, the polyphenol content of the plant increases with increase in height of the plant (Rekha et al. 2010). In infants and children, dill leaves are used in the treatment of gastric disturbance. Potential cancer preventive agents like anethofenone, carvone and limonene were isolated from dill oil and carvone content of the oil increased with the maturity of the herb while phellandrene and d-limonene contents decreased. A number of diseases like, diabetes, parkinson's disease, atherosclerosis, liver disease etc are prevented by antioxidants (Jinesh et al. 2010). It is known that, dill is a galactagogue which increases the flow of milk in nursing mothers and helps to prevent colic when taken by the baby. Menstrual cycle can also be regulated by dill (Hemalatha et al. 2011).

Fenugreek (*Trigonella foenum-graecum* L. *Leguminosae*) belongs to the family of legumes. It is an annual crop, usually

Practical applications Flat bread is normally prepared from whole wheat flour. Greens are rich in carotenoids and are difficult to store. Processing the greens with higher shelf life would have increased consumer demands. The functional properties of the dehydrated form of greens would be better utilised and incorporating of the same would help in for flat bread with high nutritional value. Dill and fenugreek leaves when incorporated as such and in dehydrated form, gave the flat breads with acceptable sensory quality and with high amounts of carotenoids.

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used as potherbs and the seeds are used as herbal medicine or as spice. Fenugreek leaves are rich sources of iron, calcium, β -carotene and vitamin K (Annida and Venugopal 2010). It is reported that fenugreek has anti-diabetic, anti-cancer, anti-microbial, anti-fertility, and anti-parasitic and hypocholesterolaemic effects (Acharya et al. 2006). National Institute of Nutrition, India has carried out studies on fenugreek by incorporating them in the diets of human subjects. The serum cholesterol, LDL/VLDL cholesterol and triglycerides level were found to have significantly reduced and they are likely to provide a significant reduction in LDL/VLDL fractions without altering the HDL fractions (Anita et al. 2007). The hypoglycemic effect of fenugreek may be due to the soluble fibres present in high content. As a result gastric emptying is decreased resulting in delayed absorption of glucose in the small intestine.

Colour is one of the most important quality attributes of vegetable products. Chlorophyll is the most abundantly present plant pigment. The green colour is mainly due to the importance of chlorophyll a and b, which degrades during processing, storage; temperature; pH and light. Degradation of chlorophylls during heating followed a first-order reaction kinetic model (Canjura et al. 1991; Chen and Chen 1993; Schwartz et al. 1981; Schwartz and Von Elbe 1983; Steet and Tong 1996). Recently, different drying methods were investigated for efficient dehydration of fenugreek (*Trigonella foenum-graecum*) greens for optimal retention of color and its constituents (Naidu et al. 2012).

To a large population of the world, balanced diets are not accessible and this is particularly seen in developing countries. The health of vulnerable groups of population is severely affected by malnutrition and micronutrient deficiency. Locally available green leafy vegetables rich in micronutrients are highly perishable and are the cheapest source of raw materials. Dehydration is one of the most popular methods of preserving these leaves; there by increasing the storage life. Thus these leafy vegetables are available throughout the year even in off season and the nutrients are available in concentrated form (Singh et al. 2007). To incorporate these leaves in the diet, efforts are made to develop a nutritional supplement using these traditional medicinal plants (Anita et al. 2007).

Wheat based traditional products like *chapathi*, *roti*, *phulka*, *puri*, *nan* and *paratha* are prepared from wheat (Indrani et al. 2000). South India, which is predominantly the rice eating population, has increased its consumption of wheat substantially (Indrani and Venkateswara Rao 2003). *Paratha*, a triangular shaped product with 4–6 layers is prepared from whole wheat flour, salt, oil and water (Indrani et al. 2011). Several studies indicate the medicinal properties of fenugreek and dill, but the nutritional and quality characteristics when incorporated into *paratha* have not been examined. The objective of this study was to

dehydrate fresh/normal dill and fenugreek leaves, wherein losses of nutrients are minimized. Incorporate the dehydrated form of leaves to study the effect on the rheological characteristics of whole wheat flour dough and *paratha* preparation. The nutritional quality of the *paratha* and the retention of the bioactive components in *paratha* were evaluated.

Materials and methods

Chemical characteristics

The raw materials namely whole wheat flour (Pillsbury, India), normal dill leaves (NDL), normal fenugreek leaves (NFL), salt (food grade) and sunflower oil were procured from local market. After cutting the roots of the fresh leaves, it was washed and dried at 50 ± 2 °C in a low humidity (28–30 %) drier. The dehydrated leaves were ground in a lab mixer to pass through 40 mesh to obtain dehydrated dill (DDL) and dehydrated fenugreek leaves (DFL). The ground leaves were stored at 5 °C in a refrigerator.

Raw materials and *parathas* prepared using fresh and dehydrated leaves were analysed for moisture (method 44-16), ash (method 08-01), protein (method 46-10), fat (method 30-10) using the American Association of Cereal Chemists (AACC 2000). Dietary fiber was estimated according to AOAC (2000) method.

Rheology

Whole wheat flour-dehydrated leafy vegetable (dill/fenugreek) blends were prepared in the ratio of 0, 95:5, 92.5:7.5 and 90:10. The mixing properties of these blends was assessed based on the farinograph parameters like, farinograph water absorption, dough development time, dough stability and mixing tolerance index (method 54-21, AACC 2000). Amylograph characteristics were studied for the blends (method 22-10, AACC 2000) to know the peak viscosity, gelatinization temperature and cold paste viscosity.

Paratha making quality

Parathas were prepared from whole wheat flour and by incorporating finely chopped either NDL or NFL (0, 12.5, 25 and 37.5 %). *Parathas* were also prepared by adding either DDL or DFL (0, 5, 7.5, 10 %) according to Indrani et al. (2011) with slight modification. Ingredients (whole wheat flour, salt, oil and water) were mixed in a mixer for 4 min and rested for 10 min. Thirty grams dough was sheeted into a circular shape of 14.8 diameter and 2 mm thick, 1 g of oil was smeared, folded into half circle and then into a triangular shape. This was sheeted to a triangular shape of 2 mm thickness and baked on a preheated hotplate for 2 min

at 180 °C by applying oil on both sides. *Parathas* were cooled and packed in polypropylene bags till further evaluation. *Parathas* were evaluated for shearing strength using Warner-Bratzler probe of texture analyser (Model TAHdi, Stable Micro System, Surrey, UK). The load cell used was 10 kg and the plunger speed was 100 mm/min. Colour of the raw materials and *parathas* prepared using NDL, NFL, DDL and DFL, were evaluated for lightness (L^*), greenness ($-a^*$), yellowness ($-b^*$) and colour difference (ΔE). All estimations were done in triplicate.

Ten panelists who were capable of assessing the traditional products made from wheat were asked to evaluate the products on 9 point hedonic scale. The quality characteristics of *paratha* enriched with either dill or fenugreek leaves were assessed based on colour, appearance, pliability, layers and texture. A combined score of all the five quality attributes were taken as the overall quality score.

Statistical analysis was carried out using Duncan's new multiple range test (DMRT) according to Steel and Torrie (1980) with a significant level at $p \leq 0.05$.

Scanning electron microscopic studies

Normal leaves were freeze dried using Heto freeze-dryer model DW3 (Allerod, Denmark). The small *paratha* sheet immediately after preparing and the final baked *paratha* product was cut into pieces without damaging the structure. They were defatted with hexane and freeze dried using Heto freeze-dryer model DW3 (Allerod, Denmark). Leo scanning electron microscope Model 435VP (Leo Electronic Systems, Cambridge, UK) was used separately for normal and dehydrated leaves (NDL, NFL, DDL and DFL), *paratha* sheets- before and after baking containing optimum levels of greens. Double scotch tape was used to hold the sample and sputter-coated with gold (2 min, 2 mbar). Each sample was finally observed under the microscope at 15 kV and 9.75×10^{-5} Torr vacuum.

Estimation of bioactive compounds

Chlorophyll content in leaves and *paratha* were estimated according to the procedure of Raganna (1986). The absorbance was taken at wavelengths 642.5 and 660 nm and the chlorophyll content (mg/mL) was estimated in the solutions using the following equations.

Total chlorophyll = $7.12 \times \text{O.D. at } 660 \text{ nm} + 16.8 \times \text{O.D. at } 642.5 \text{ nm}$

Chlorophyll 'a' = $9.93 \times \text{O.D. at } 660 \text{ nm} - 0.777 \times \text{O.D. at } 642.5 \text{ nm}$

Chlorophyll 'b' = $17.60 \times \text{O.D. at } 642.5 \text{ nm} - 2.81 \times \text{O.D. at } 660 \text{ nm}$

The chlorophyll content was calculated taking the dilution factor into consideration and the results were expressed as mg% on dry basis.

Extraction of β -carotene was carried out according to the method of Raju et al. (2007). 20–30 g of sample was well ground along with 2–3 g of anhydrous sodium sulfate and α -tocopherol (0.5 mL, 2 mM), and pigments were extracted using ice-cold acetone. The extraction was repeated until the residue was colorless, indicating complete extraction of pigments. The solvent was removed at 40 °C under reduced pressure (40 milli bar) in a rotavapor. The dried sample was dissolved in methanol (50 mL). An aliquot of the sample (0.5 mL) was diluted to 10 mL and absorbance was recorded at 450 nm. β -carotene concentration was estimated as,

$$\text{mg \%} = (A/\Sigma) \times \text{Dilution factor},$$

where A = O.D. of the sample at 450 nm and Σ is the extinction coefficient of β -carotene

The ascorbic acid in leaves was determined by 2, 6-dichlorophenol-indophenol visual titration method (Raganna 1986). Vitamin C content was calculated as: Ascorbic acid (mg per 100 g) = $A \times B \times V \times 100/W \times \text{aliquot of the extract}$ taken where A is titre value of sample, B is dye factor, V is volume of sample and W is weight of sample in g.

Results and discussion

Chemical characteristics of raw material

Data on composition of raw materials presented in Table 1 show that the dill and fenugreek leaves are rich in ash, protein and fiber content and thus are nutritious than whole wheat flour. The dehydrated dill and fenugreek leaves had moisture content in the range of 6.4 and 8.0 % respectively when compared to normal dill (78.5 %) and fenugreek leaves (84.7 %). This is evident since dehydration removes all the moisture content in the sample. Studies of George (2003) have reported that an important contribution for the texture of the leaves is the moisture content. It helps in maintaining the protoplasmic content of the cell and also causes microbial spoilage during storage. The mineral content of the food which is measured by the ash value was found to be 9.93 % and 10.5 % in normal and dehydrated dill leaves respectively. It was found to be slightly higher in fenugreek leaves of about 12.2 and 13 % percent in normal and dehydrated fenugreek leaves respectively. In whole wheat flour, the ash content was found to be comparatively less of about 1.5 %. Protein content of whole wheat flour was 12.6 % and was about 21.5 to 24.4 % in fenugreek leaves, whereas dill leaves had a lesser protein content of about 16.9 to 17.9 %. Singh et al. (2007) suggested that proteins behave as antioxidant additive in food because they can inhibit lipid peroxidation. They also inactivate reactive oxygen species by scavenging free radical and chelation of pro-oxidative transition metals. Dietary fiber was 12.1 % in whole wheat flour with 53.5–55.9 % in dill leaves and 25.2–28.8 % in fenugreek

Table 1 Chemical characteristics of raw materials

Sample	Ash (%) ^a	Protein (%) ^a	Fat (%) ^a	Dietary fiber (%) ^a	Colour			
					L*	a*	b*	ΔE
Whole wheat flour	1.50±0.01	12.6±0.01	1.9±0.01	12.1±0.01	83.9±0.01	1.23±0.01	14.4±0.01	16.0±0.01
Normal dill leaves (NDL)	9.93±0.01	17.9±0.01	1.0±0.01	53.5±0.01	30.4±0.01	−8.9±0.01	11.9±0.01	61.9±0.01
Dehydrated dill leaves (DDL)	10.59±0.01	16.9±0.01	0.92±0.01	55.9±0.01	33.9±0.01	−3.9±0.01	17.2±0.01	63.0±0.01
Normal fenugreek leaves (NFL)	13.0±0.01	24.4±0.01	0.8±0.01	25.2±0.01	31.6±0.01	−8.3±0.01	14.3±0.01	61.0±0.01
Dehydrated fenugreek leaves (DFL)	12.2±0.01	21.5±0.01	0.9±0.01	28.8±0.01	44.5±0.01	−8.2±0.01	15.9±0.01	49.2±0.01

NDL normal dill leaves; DDL dehydrated dill leaves; NFL normal fenugreek leaves; DFL dehydrated fenugreek leaves

^a On dry basis

leaves. Whole wheat flour having 12.1 % of dietary fiber, when incorporated with these leafy vegetables would be a healthy food rich in fibers.

Colour measurement of the raw materials (Table 1) indicate that whole wheat flour had higher lightness value (83.9) when compared to normal or dehydrated dill or fenugreek leaves (30.4–44.5). The *a** values which indicate either redness or greenness value show that the greenness of NDL and NFL was higher (−8.3 to −8.9). However dill leaves on dehydration lost its greenness with a negative *a** value of −3.9, whereas DFL had greenness value similar to NFL. Thus the DDL were less greenish than DFL.

Effect of dehydration on bioactive compounds

The data on chlorophyll, carotenoid and ascorbic acid content in normal and dehydrated leaves are presented in Table 2. The ascorbic acid content and β-carotene in dill leaves were higher than fenugreek leaves. The ascorbic acid which was 180.9 and 161.5 in normal dill and fenugreek leaves reduced to 166.7 and 152.4 mg% upon dehydration respectively. The β-carotene content changed marginally upon dehydration. Naidu et al. (2012) developed and optimized a drying method of choice for fenugreek leaves with higher content of bioactive compounds. The content of β-carotene normally in green leafy vegetables and medicinal plants is 1.5–120 and 0.4 to 34.7 mg/100 g, respectively (Raju et al. 2007). In the present study, higher contents of

β-carotene 22.5 mg/100 g, 34.7 mg/100 g in dehydrated fenugreek and dill leaves respectively was observed. Both the chlorophyll a and b contents decreased in both the leaves on dehydration indicating that there was loss of green colour. This is due to the liability of chlorophyll to oxidation during processing (Heaton and Marangoni 1996; Schwartz and Lorenzo 1991).

Rheological characteristics

Farinograph and amylographic studies were done for whole wheat flour and dehydrated dill/fenugreek leaf blends (Fig. 1). Farinograph water absorption increased marginally from 68.5 to 69.9 % and to 70.2 with increasing levels of DDL or DFL respectively. Dough development time increased to a greater extent when DDL concentration increased in the blends when compared to addition of DFL. Dough stability marginally increased for DDL blends, where as it decreased for DFL blends. Mixing tolerance index increased in both dill and fenugreek blends. This indicates that whole wheat flour dough strength reduced due to disruption and dilution of gluten by either DDL or DFL. Similar weakening of gluten strength by addition of dehydrated moringa leaves was reported by Dachana et al. (2010).

Amylographic studies were carried out to study the pasting profile of whole wheat flour and DDL or DFL blends (Fig. 1). The gelatinization temperature increased with increasing amounts of either DDL or DFL from 69 to 79.8 and

Table 2 Effect of dehydration on the bioactive compounds in leaves

Sample	Ascorbic acid (mg %) ^a	β-carotene (mg %) ^a	Chlorophyll a (mg %) ^a	Chlorophyll b (mg %) ^a	Total chlorophyll (mg %) ^a
Normal dill leaves (NDL)	180.9±0.01	38.9±0.01	6.8±0.01	2.1±0.01	8.9±0.01
Dehydrated dill leaves (DDL)	166.7±0.01	34.7±0.01	4.2±0.01	1.7±0.01	5.9±0.01
Normal fenugreek leaves (NFL)	161.5±0.01	35.3±0.01	9.89±0.01	6.31±0.01	15.2±0.01
Dehydrated fenugreek leaves (DFL)	152.4±0.01	22.5±0.01	3.8±0.01	1.4±0.01	5.2±0.01

NDL normal dill leaves; DDL dehydrated dill leaves; NFL normal fenugreek leaves; DFL dehydrated fenugreek leaves

^a On dry basis; values are means ± standard deviation (*n*=3)

Fig. 1 Farinograph (a) and amylograph (b) characteristics of whole wheat flour–dehydrated dill/fenugreek leaf blends. CON—Whole wheat flour, FWA (%)—Farinograph water absorption, MTI (BU)—Mixing tolerance index, DDT (min)—Dough development time, DS (min)—Dough stability, GT (°C)—Gelatinization temperature, PV (BU)—Peak viscosity, HPV (BU)—Hot paste viscosity, CPV (BU)—Cold paste viscosity

Fig. 2 Scanning electron micrographs of dill and fenugreek leaves. (Magnification 500×) **a** normal dill leaves; **b** dehydrated dill leaves; **c** normal fenugreek leaves; **d**–dehydrated fenugreek leaves

74.1 °C respectively. The peak viscosity and cold paste viscosity values decreased with increasing level of either DDL or DFL in the blend. High content of starch in wheat flour contributed to high peak viscosity. A low amount of total carbohydrate and high amount of dietary fiber resulted in lowering of peak viscosity. Substituting the wheat flour with dehydrated moringa leaves also resulted in lowering of peak viscosity and cold paste viscosity (Dachana et al. 2010).

Scanning electron microscopy

The electron micrographs of normal and dehydrated dill and fenugreek leaves are presented in Fig. 2. The SEM shows that drying process has changed the micrograph of leaves. The stomata which was clearly visible in normal leaves was not observed in either of the dehydrated leaves. Greater changes were observed in dill leaves when compared to fenugreek leaves. Structure of the dried fenugreek greens was more porous in nature than dehydrated dill leaves, which seem to be slightly flaky. This would explain the better rehydration properties of the dehydrated leaves. Microwave drying helped the mint leaves to have porous structure, whereas high temperature drying made the mint leaves look to be more packed (Therdthai and Zhou 2009)

The Fig. 3 shows the scanning electron micrographs of *paratha* dough and baked *paratha* prepared with optimized levels of normal and dehydrated dill or fenugreek leaves. Figure 3a is the control *paratha* dough, the small and large starch granules are embedded in the protein matrix. The starch granules were disturbed due to gelatinization during baking of *paratha*, which is clearly observed in Fig. 3b. Figure 3c has some fibrous material due to the presence of normal dill leaves

Fig. 3 Scanning electron micrographs of *paratha* dough and *paratha* enriched with dill leaves/fenugreek leaves (magnification 1,000×). **A** Control *paratha* sheet; **b** control baked *paratha*; **c** normal dill leaves *paratha* sheet (25 %); **d** normal dill leaves baked *paratha* (25 %); **e** dehydrated dill leaves *paratha* sheet (7.5 %); **f** dehydrated dill leaves

baked *paratha* (7.5 %); **g** normal fenugreek leaves *paratha* sheet (25 %); **h** normal fenugreek leaves baked *paratha* (25 %); **i** dehydrated fenugreek leaves *paratha* sheet (7.5 %); **j** dehydrated fenugreek leaves baked *paratha* (7.5 %)

which are again seen with small and large starch granules in the protein network. The protein matrix was disrupted due to the presence of chopped dill leaves and pits were observed in the disrupted protein matrix. Upon baking the fibrous structure was disturbed (Fig. 3d). SEM of *paratha* dough, with dehydrated dill leaves (Fig. 3e) has similar structure as the control dough, which may be due to addition of dehydrated dill leaves in powder form and on making of *paratha* dough, the DDL powder was entrapped in protein matrix. Incorporating normal fenugreek leaves into the *paratha* dough (Fig. 3g) also showed disrupted protein matrix, with small and large starch granules entrapped in the protein matrix which got disturbed in Fig. 3h similar SEM's were observed in Fig. 3i and Fig. 3j. Indrani et al. (2011) studied the north Indian *parotta* dough with different levels of multigrain mix and reported that coated starch granules with adhering protein bodies and pits were observed in the disrupted protein matrix.

Paratha making quality

Paratha quality characteristics incorporated with different leaves of NDL, DDL, NFL and DFL are presented in Table 3. With increasing levels of NDL from 0 to 37.5, the lightness value decreased, and the *parathas* had increasing green colour as seen in the increasing values of greenness (negative a^* value) to -4.4 , which is due to the high green colouration of normal dill leaves as observed in Table 1. The colour difference thus deviated from white with increase in NDL. Addition of DDL also showed lower lightness value, higher green value than the control *paratha*, but due to the lower greenness value of DDL than NDL, also gave the *paratha* with comparatively lower greenness value. Addition of increasing levels of NFL had the similar effect as observed when NDL was added, whereas addition of DFL gave *paratha* with higher greenness value as observed in the colour values of the leaves. Addition of NFL or

Table 3 Quality characteristics of *paratha* enriched with either dill or fenugreek leaves

Dill/Fenugreek (%)	Colour				Colour and appearance (9)	Pliability (9)	Layers (9)	Texture		Overall quality (9)
	L	a*	b*	ΔE				O (g force)	S (9)	
CON-0	56.4	7.1	30.1	45.5	8.0a	8.0a	8.5a	829	8.0a	8.0a
Dill leaves-normal										
12.5	50.2	2.9	25.7	49.8	7.5b	7.5b	7.0b	742	7.5b	7.0c
25.0	47.2	-1.1	22.6	52.1	6.5d	6.0e	6.0c	632	7.0c	6.5d
37.5	40.7	-4.4	16.3	58.9	6.0e	6.0e	5.0e	520	6.0e	6.0e
Dill leaves-dehydrated										
5.0	49.9	3.2	26.9	50.7	7.0c	7.0c	7.0b	894	7.5b	7.0c
7.5	45.2	-0.9	20.5	51.9	6.5d	6.0e	6.0c	995	6.5d	6.5d
10.0	38.4	-2.1	14.2	55.1	5.0e	5.5f	5.0e	1,154	5.0e	5.0e
Fenugreek leaves-normal										
12.5	52.1	3.1	27.4	48.4	7.5b	7.5b	7.0b	720	8.0a	7.5b
25.0	48.6	-1.6	23.9	53.1	6.5d	7.0c	6.0c	601	7.0c	7.0c
37.5	43.1	-4.1	18.7	57.4	6.0e	6.5d	5.5d	497	6.5d	6.5d
Fenugreek leaves-dehydrated										
5.0	51.1	3.0	25.4	49.7	7.5b	7.5b	7.0b	892	8.0a	7.5b
7.5	50.0	-1.7	23.8	52.6	7.0c	7.0c	6.0c	969	6.5d	7.0c
10.0	40.4	-4.9	17.2	56.8	6.0e	6.0e	5.5d	1,027	6.0e	6.0e
SEM	—	—	—	—	0.12	0.18	0.14	—	0.19	0.7
df	—	—	—	—	65	65	65	—	65	65

Values in the parenthesis indicate maximum score; values for a particular column followed by different letters differ significantly ($p < 0.05$); SEM standard error of mean; DF degrees of freedom, CON whole wheat flour; O objective; S subjective

DFL at varying levels also decreased the lightness value, increased the greenness value, but the extent in variation due to addition of either NFL or DFL was not observed. The sensory scores of *paratha* presented in Table 3 show that an addition of either NDL or NFL significantly scored higher values for colour and appearance than *parathas* where either DDL or DFL were added ($p \leq 0.5$). This is due to the uniform green colour of *paratha* obtained when powdered form of either DDL or DFL was added. The pliability which indicates the handfeel in terms of softness significantly reduced on addition of either of the form of leaves. Addition of increasing levels of either

NDL or NFL significantly reduced the pliability scores ($p \leq 0.5$) to a lower extent than addition of either DDL or DFL. The increasing levels of leaves also destroyed the distinct layers in *paratha* as compared to control *paratha* ($p \leq 0.5$). The shear force as measured using texture analyser significantly decreased from 829 g for control to 520 and 497 g force on addition of increasing levels of either NDL or NFL respectively. Lowering in shear force showed improvement in the *paratha* quality, whereas addition of increasing levels of either DDL or DFL increased the shear force gradually from 829 to 1,154 and 1,027 respectively. This indicates that addition of leaves in dehydrated form made

Table 4 Nutritional characteristics of dill/fenugreek leaf enriched *paratha*

<i>Paratha</i>	Ash (%) ^a	Protein (%) ^a	Fat (%) ^a	Dietary fiber (%) ^a	β -carotene ($\mu\text{g } \%$) ^a	Chlorophyll a ($\mu\text{g } \%$) ^a	Chlorophyll b ($\mu\text{g } \%$) ^a	Total chlorophyll ($\mu\text{g } \%$) ^a
CON	1.61 $\pm$ 0.01	8.3 $\pm$ 0.01	8.9 $\pm$ 0.01	16.4 $\pm$ 0.01	—	—	—	—
25 % NDL	1.85 $\pm$ 0.01	9.3 $\pm$ 0.01	9.1 $\pm$ 0.01	21.8 $\pm$ 0.01	174 $\pm$ 0.01	54.3 $\pm$ 0.01	38.6 $\pm$ 0.01	92.9 $\pm$ 0.01
7.5 % DDL	2.14 $\pm$ 0.01	9.5 $\pm$ 0.01	9.6 $\pm$ 0.01	31.9 $\pm$ 0.01	170 $\pm$ 0.01	108.7 $\pm$ 0.01	98.5 $\pm$ 0.01	207.2 $\pm$ 0.01
25 % NFL	1.99 $\pm$ 0.01	8.9 $\pm$ 0.01	8.9 $\pm$ 0.01	20.4 $\pm$ 0.01	198 $\pm$ 0.01	73.0 $\pm$ 0.01	35.1 $\pm$ 0.01	108.1 $\pm$ 0.01
7.5 % DFL	2.21 $\pm$ 0.01	9.5 $\pm$ 0.01	9.2 $\pm$ 0.01	33.7 $\pm$ 0.01	181 $\pm$ 0.01	72.5 $\pm$ 0.01	51.6 $\pm$ 0.01	124.1 $\pm$ 0.01

NDL normal dill leaves; DDL dehydrated dill leaves; NFL normal fenugreek leaves; DFL dehydrated fenugreek leaves

^a On dry weight basis; values are means $\pm$ standard deviation ($n=3$)

the *paratha* slightly harder. *Parathas* prepared with multigrain mix improved the quality by reducing the shear force (Indrani et al. 2011). The reduction in shear force may be due to the presence of dietary fiber coming from, leaves, thereby diluting the gluten protein which makes the product more extensible and chewy. *Parathas* enriched with either normal or dehydrated leaves had the typical flavour of the respective leaves. Addition of leaves in dehydrated form also had acceptable quality. Based on the above results it can be concluded that normal leaves at 25 % and dehydrated leaves at 7.5 % was found to be acceptable.

Nutritional composition of greens enriched *paratha*

Control *paratha* and *parathas* with optimum levels of greens, i.e. either 25 % of normal dill/fenugreek leaves or 7.5 % of dehydrated dill/fenugreek leaves were evaluated for proximate composition and bioactive compounds (Table 4). The ash content of *parathas* incorporated with either of the leaves was higher than the control *paratha*. Protein and fat content of the *parathas* were in the similar range (8.3–9.5 % and 8.9–9.2 %). However the dietary fiber content of the *parathas* enriched with either of the leaves and also in either of the form was higher when compared to the control *paratha*. None of the bioactive components were detected in control *paratha*. The chlorophyll content was higher (207.2 µg/100 g) in *parathas* prepared with dehydrated dill leaves when compared to *parathas* prepared with dehydrated fenugreek leaves (124.1 µg/100 g). The β-carotene content was similar in *paratha* when either normal or dehydrated dill leaves was incorporated. However when 25 % of normal fenugreek leaves were incorporated, the *parathas* had slightly higher β-carotene content. Proximate composition of cookies with increasing levels of dried moringa leaves had higher ash, protein, dietary fiber, minerals and β-carotene content (Dachana et al. 2010). Thus, an opportunity exists to utilize green leafy vegetables in dehydration form to add value to traditional foods like *paratha*. Dill or fenugreek leaves which have been used in this study shows that they can be a potential source of bioactive compounds.

Conclusion

Paratha, a commonly consumed Indian traditional product from whole wheat flour was chosen as a product to enrich the *paratha* with leafy vegetables. Addition of normal or dehydrated leaves diluted the gluten quality. *Parathas* prepared with either of the leaves indicated that product quality improved with respect to texture; whereas the colour of the *parathas* got affected to a greater extent. Sensory evaluation of the *parathas* indicated that 25 % of normal leaves and 7.5 % of dehydrated leaves were acceptable with respect to colour, flavour and texture. The chlorophyll content and

carotenoid content of the *parathas* increased. Thus greens enriched *parathas* can serve as valuable source of protein, dietary fiber, chlorophyll and carotenoid content in the diets usually consumed. These results clearly demonstrated the usefulness of dehydrated fenugreek and dill leaves as a valuable food additive to enhance human nutrition through their higher contents of fibre and bioactive compounds.

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