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Mineral and Anti- Nutrient Content of Common and Uncommon Green Leafy Vegetables Before and After Drying

Aruna Narayanan , Keerthana.G and Varsha Ravikumar

Department of Nutrition and Dietetics, PSG College of Arts and Science, Coimbatore, India.

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ABSTRACT

Green leafy vegetables play an important place in a well-balanced and healthy diet. To determine the mineral and anti-nutrient content of fresh GLV, quantify the change on drying. Two common (*Moringa oleifera* and *Trigonella foenum graecum*) and two uncommon (*Boerhaavia diffusa* and *Trianthema portulacastrum*) greens were selected. Their ash content ranged from 1.75±0.19 (*T. foenum graecum*) to 3.63±0.16 g/100g (*B.diffusa*) in fresh leaves. In dried leaves the ash was between 10.57±0.19 (*M. oleifera*) and 18.98±0.26 g/100g. (*T.portulacastrum*).*T.foenum graecum* had the least iron (3.79±0.2mg), *M.oleifera* had the highest (4.43±0.16 mg/100g) iron. Phytate content was 2.46±0.13 (T.portulacastrum) to 5.24±0.20 (B.*diffusa*) mg in fresh leaves.Drying concentrates the nutrients and antinutrient content.

Introduction

Green leafy vegetables are rightly called as "treasure-trove of micronutrients" and these are termed as "poor men's diet" as they are abundantly available all-round the year. The greens are inexpensive. They are recognized for their wide variation in color, taste, texture, therapeutic value[1] and give an interesting additional touch to the meals. They are rich sources of vitamins such as beta carotene, ascorbic acid, riboflavin, folic acid as well as minerals like iron, calcium, phosphorous etc. The lack of knowledge especially on the nutritive value of these GLV and elaborate cleaning cooking procedure in general are the main drawback in their lower consumption [2]. If GLV are available in powder form it is easy to incorporate in all preparations and consuming GLV either in the fresh or dry form will help to improve of the nutritional status. Drying enhances the shelf life, reduces the volume, makes the product easy to store and handle. This study aimed to determine the mineral and anti-nutrient content of fresh GLV, quantify the change of the same on drying.

Methods

Totally four green leafy vegetables (GLV) were selected (Figure1). Two commonly consumed greens; Murungai keerai (Drumstick leaves- Moringa oleifera) and Venthaya keerai (Fenugreek leaves–Trigonella foenum graecum) and uncommon greens; Mukarattai keerai (Boerhaiva diffusa) and Saravalli (Trianthema protulacastrum) were chosen based on usage and availability.

The selected uncommon GLV were identified, authenticated and certified by the taxonomist at the Botanical Survey of India of Tamilnadu Agricultural University Coimbatore.

The drumstick leaves and fenugreek leaves were procured from the local vegetable market, Coimbatore, India and the uncommon GLV namely *Boerhaiva diffusa* and *Trianthema protulacastrum* were procured from the Agricultural farm in *Somanur*, Tamilnadu, India.

The cleaned edible portion was washed thoroughly under running tap water to remove the mud, dirt and any other non-edible adhering particles. One portion of the cleaned vegetables were designated as fresh sample and used for analysis. The other portion was used for drying, storing and further analysis. The following analysis were carried out for the fresh as well as the dried *Moringa oleifera, Trigonella foenum graecum, Boerhaiva diffusa* and *Trianthema portulacastrum* Moisture affects the quality of foods on storage[3].The moisture of the sample was analyzed as per the procedure of Raghuramulu et al., (2003)[4]. The ash content of the sample was analyzed as per the AOAC (1990)[5] procedure. High level of acid insoluble ash indicates the presence of sand or dirt in the samples. This determination is of value in showing the presence of dirt or sand. It may be applied either to the water-insoluble residue of the total ash or the total ash itself[6]. Calcium was precipitated as calcium oxalate; the precipitation was dissolved in hot dilute sulphuric acid and titrated with standard potassium permanganate solution. The iron content of the samples was estimated by Wong's method (1928)[7] by ashing the sample through ignition and wet digestion. Zinc is an essential micronutrient performing a range of functions in the body as it is a co-factor for a number of enzymes. Zinc content was analyzed in Atomic Absorption Spectrophotometer as per the procedure of Murthy *et al*., 1971[8].The complexion of Phytic acid with iron, zinc, calcium and magnesium and the possibilities of interference with proteolytic digestion have been suggested as responsible for anti-nutritional activity [1].Phytate content of all samples was determined according to the method AOAC 2007[9]. Mean, standard deviation and ANOVA were used for statistical analysis.

Tele:
E-mail address: arunarayanan_1959@yahoo.com

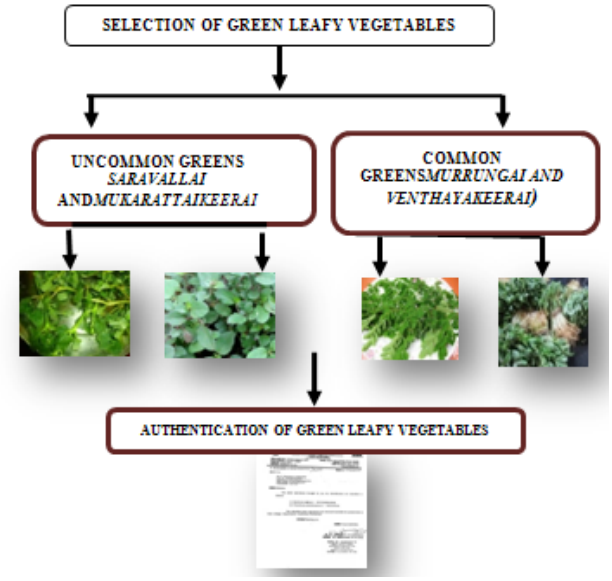

Figure 1. Researchdesign.

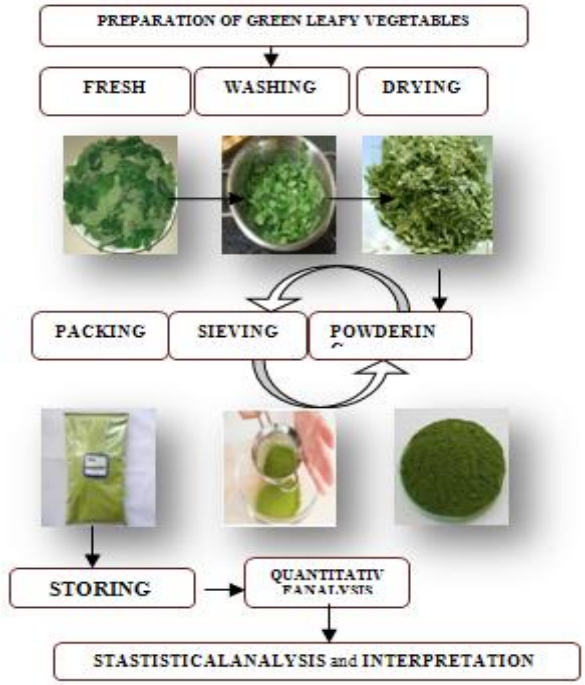

Figure 2. Process Chart

Results

Edible portion

The edible portion of the fresh green leafy vegetables chosen for the present study ranged widely from 34 (*Venthaya keerai)* to 72 g (*Mukarattai keerai*). This indicates that the non-edible portion was highest in *Venthaya keerai* and least in *Mukarattai keerai*. While the *Murungai keerai*'s edible portion was 46 g it was almost one and half times in *Saravallai* (63 g)

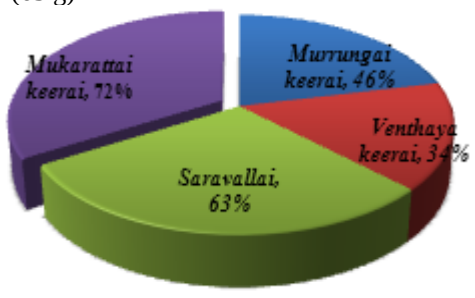

Figure 3. Edible portion of selected green leafy vegetables

The variation in the edible portion of the green leafy vegetable was due to the fact that in *Murungai keerai* and *Venthaya keerai* only leaves could be consumed as the stem or the stick is too fibrous and are not generally included in the preparation whereas *Saravallai* and *Mukarattai keerai* as they are creepers, the stems were more tender and less fibrous, hence could be included under edible portion.

Effect of drying on the weight of the selected green leafy vegetables

Every 100 gram edible portion of green leafy vegetables when dried; showed a drastic reduction in the weight. (Table-1)

Table 1.Percentage reduction in weight of the green leafy vegetables.

Name of greens	Weight (g)		
	Fresh	Dried	Percentage reduction
	% Edible portion		
Moringa oleifera (Murungaikeerai)	100	21.34	78.66
Trigonella foenum graecum (Venthayakeerai)	100	14.49	85.51
Trianthema protulacastrum (Saravallai)	100	14.27	85.73
Boerhaiva diffusa (Mukarattaikeerai)	100	15.89	84.11

The decrease in weight ranged from 78.66 (*Murungai keerai)* to

85.73 percent (*Saravallai*). This result indicates that on an average; more than three fourths of the greens are made up of water/moisture and the GLV have high water holding capacity. Of all the four greens selected *Murrungai keerai* had the least weight reduction compared to the other three greens namely *Venthayakeerai*, *Saravallai* and *Mukarattai keerai*. The decrease in weight of *Venthayakeerai* and *Saravallai* was almost the same at 85/86 percent.

Quality parameter of the selected green leafy vegetables

(i) Moisture

It is quite obvious from the below Figure – 4 that, the moisture content of all the four greens (fresh) selected was above 74 percent but below 91 percent. Of the selected greens; the *Murrungai keerai* contained the lowest (74.62±0.16g) moisture, whereas *Saravallai* had the highest moisture (90.81±0.41 g). It is also clear from the figure that the process of drying, decreased the moisture content to a maximum of 97.3 percent (*Saravallai*). One hundred grams of edible portion of the above greens, on drying could give only two to six grams of dried powder. The proximate analysis of *Moringa oleifera* by Offor, Ehiri and Njoku (2014)[10], Sodamade, Bolaji and Adeboye (2013)[11] and Sengev, Abu and Gernah (2013)[12] revealed the moisture content to be 14.8 percent (dry leaves), 9.00mg/100g (leaf protein concentrate) and 6.46 ± 0.01g percent (dry *Moringa oleifera* powder) respectively, whereas the value (5.93 ±0.26g percent) obtained in the present study for dry *Moringa oleifera* was lower than the above reported values. Misra and Malaya (2014)[13] analyzed twenty one green leafy vegetables and divulged that the moisture content ranged from 69.6 (*Tridax procumbens*) to 87.3 percent (*Celosia argentea*). According to Misra and Malaya (2014)[13]*B. diffusa* contained 83 percent moisture however the present study's finding is a little higher at 84.78 ±0.2 g percent. *Kasuri methi* and fenugreek leaves had 6.07 and 5.22 percent (dry leaves) moisture as communicated by Pasricha and Gupta (2014)[14], but in the current study; the dried fenugreek leaves' moisture was slightly higher at 5.72 ±0.13 g percent.

The moisture content of dry *Saravallai* greens in the present study was 2.44 ±0.23, whereas Madukwe, Ugwuoke and Ezeugwu[15] 's (2013) value of 7.05 ± 0.17 g percent (dry *Saravallai* greens) and [16] value of 4.92 ±0.05 g/100g (*Saravallai* dhal powder) are two to three times higher than the present finding

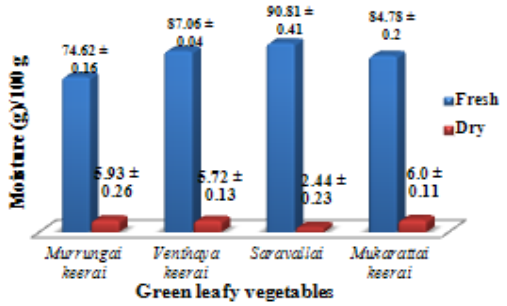

Figure 4 .Moisture content of the selected green leafy vegetables

Statistical analysis did not indicate any significant difference in fresh (p=3.94) and dry (p=3.56) green leafy vegetables' moisture content.

(ii) Acid insoluble ash

The acid insoluble ash **(**AIA-Figure 5), an indicator of extraneous non edible matter, was quite low in the fresh leaves of all the four greens namely *Murungai keerai* (0.01), *Venthaya keerai* (0.058), *Saravallai* (0.061) and *Mukarattai keerai*(0.045 g/100g). The acid insoluble ash of all the four fresh greens was lower than the FSSAI (2014) standards of one g/ 100g.

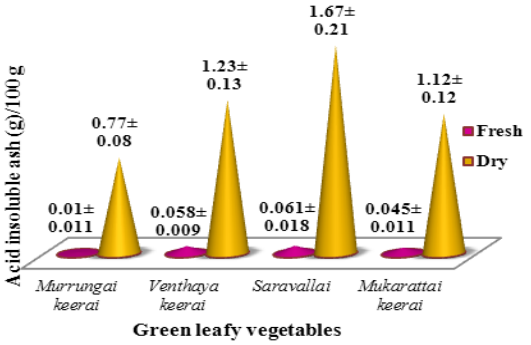

Figure 5.Acid insoluble ash of the selected green Leaf vegetables.

This indicates that the selected greens were free from non-edible matter but on drying, the acid insoluble ash had increased considerably in all the four greens; however only the *Murungai keerai's* AIA was within the above indicated standard whereas the other three greens' (*Venthaya keerai, Saravallai and Mukarattai keerai*) AIA was higher than the aforementioned FSSAI value.

This indicates that the greens could have got contaminated during drying and that should be controlled with covering the greens with muslin cloth during drying. Gobi and Narayanan (2015)[16] in Saravallai dhal powder had reported an AIA of 0.05 ±0.02 g/100g.

The present study's finding of 0.01±0.111 (*Murrungai keerai*) and 0.045±0.011 (*Mukarattai keerai*) are below the above reported value but the dried greens' AIA were very high compared to the quoted value.

Among the fresh samples of four green leafy vegetables there was a significant difference (p=0.011) in the acid insoluble ash content.

Similarly the AIA of the dry samples of the same green leafy vegetables also differed significantly (p=0.0004) at five percent level.

(iii)Total minerals content

The ash (Total minerals) may be defined as the inorganic residue from the incineration of organic matter, but its composition will vary depending on the nature of the food ignited and the method of incineration [6]. Table – 2 indicates that *Mukarattai keerai* contained relatively higher ash (3.63±0.16 g/100g) than the other three green leafy vegetables analyzed but *Venthaya keerai* had the lowest ash and it was one and a half times lower than that of Mukarattai keerai's ash content. The total mineral content of Saravallai and Murrungai keerai was more or less the same at 2.48 ±0.27 and 2.87±0.09 g percent. Drying of green leafy vegetables had enhanced the ash content tremendously and it was 268.29 (Murrungai keerai) to 665.32 (Saravallai) percent. Offor, Ehiri and Njoku (2014)[10], Sodamade, Bolaji and Adeboye (2013)[11], Sengev, Abu and Gernah (2013)[12]and Gopalan et al (2007)[1]recorded an ash content of 3.8 percent (dry leaves) and 6.00mg/100g (leaf protein concentrate) and 5.36 ± 0.01 g percent (dry powder) and 2.3 g percent (fresh) in Moringa oleifera.

Table 2.Ash content of the selected green leafy vegetables

Criteria	*Moringa oleifera*	*Trigonela foenum graecum*	*Trianthema portula castrum*	*Boerhaaiva diffusa*
	Mean ± SD g / 100 g			
Fresh	2.87±0.09	1.75±0.19	2.48±0.27	3.63±0.16
Dry	10.57±0.19	12.30±0.30	18.98±0.26	16.28±0.14
Percent increase	268.29	602.85	665.32	348.48

On the other hand in the current study the ash content of the fresh and dry *Moringa oleifera* was 2.87±0.09 and 10.57±0.19 g percent only. Pasricha and Gupta (2014)[14] and Gopalan *et al* (2007)[1]documented the ash content of fenugreek leaves as 13.36 g percent (dry leaves) and 1.5 (fresh) g percent however in this study; 1.75±0.19 (fresh) and 12.30±0.30g percent (dry) of ash was obtained for fenugreek leaves.

The ash content of dry *Saravallai* greens (7.69 ± 0.13 g/100 g) and *Saravallai* dhal powder (12.3 ±0.2 g/100g) as reported by Madukwe, Ugwuoke and Ezeugwu (2013)[15] and Gobi and Narayanan (2015) [16]are one and a half to two and a half times lower than the present finding of 18.98±0.26 g percent.

(iv)Calcium content

Calcium is the most abundant divalent cation. The fresh *Murrungai keerai* and *Mukarattaikeerai* (Figure-6) had 633.43±0.18 and 577.72±0.14 mg of calcium, whereas the *Venthaya keerai (*161.60±0.22*)* and *Saravallai's (*156.20±0.24*)* calcium content was 3.5 to 4 times lower than the above values.

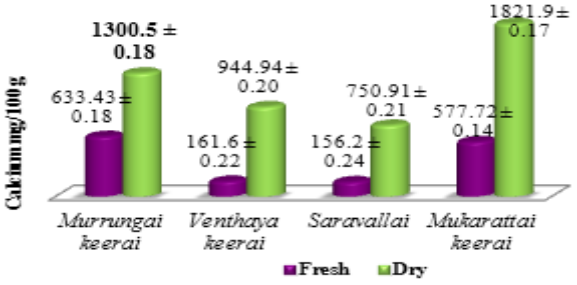

Figure 6.Calcium content of the selected green leafy vegetables.

The process of desiccation had enhanced the calcium content enormously and it ranged from 105.31 (Murrungaikeerai) to 484.74 (Venthayakeerai) percent. Although the fresh Venthaya keerai and Saravallai contained less calcium compared to fresh Murrungaikeerai and Mukarattaikeerai, the level of calcium increase was high in the former two greens than the latter two on dehydration. Navale et al., (2014) [18] had investigated and recorded the quantity of calcium as 395, 1063 and 1753 mg/100g in fresh, cabinet and solar dried fenugreek leaves The present research's finding of 161.60± 0.22 mg percent in fresh and 944.94± 0.20 mg percent in dried fenugreek leaves is two and a half and two times lower. Pasricha and Gupta (2014)[14] had found the Calcium content as 10988 µg/g in Methi leaves.

By moisture analyzer drying method the Calcium content of Drumstick, Moringa oleifera was found to be increased [17, 12] observed that Moringa oleifera dry powder contained 442.20 ± 0.03mg/100g calcium. According to Ujowundu et al (2008) the calcium content of B. diffusa was 174.09 mg/100g (fresh), whereas the present finding of 577.72 ±0.14 mg/100g is more than two times the above quoted value. Madukwe, Ugwuoke and Ezeugwu (2013) [15]and Gobi and Narayanan (2015)[16] had reported a very low (171.6 ±5.66 mg/100g) and low (589.33 ±8.14 mg/100g) calcium content in dry Saravallai greens and Saravallai dhal powder compared to the present finding of 750.91±0.21 mg/100g..No significant difference was present in the calcium content of the selected green leafy vegetables either in the fresh form (p=1.78) or in the dry form (p=9.55) at five percent level.

(v)Iron content

The amount of iron that was present in the selected green leafy vegetables before and after desiccation is disclosed in the Table 3. It is quite evident from the above table that there is no wide variation in the iron content of the four fresh green leafy vegetables. It was between 3.79 ±0.2 (Venthayakeerai) to 4.43 ±0.16mg/100 g (Murrungaikeerai) Venthaya keerai and Mukarattai keerai's iron content were within 3.5 to 4mg/100g. Likewise Murrungai keerai and Saravallai's iron content was between 4 to 4.5mg/100g. Parching of the green leafy vegetables had facilitated complete removal of moisture and increase in iron content and the increment was up to 88.12 percent (Venthayakeerai).

Table 3.Iron content of the selected greens

Criteria	*Moringa Oleifera*	*Trigonella Foenum graecum*	*Trianthema protulacastrum*	*Boerhaaiva diffusa*
	Mean ± SD mg / 100 g			
Fresh	4.43±0.16	3.79±0.2	4.34±0.09	3.99±0.23
Dry	7.50±0.18	7.13±0.09	7.87±0.2	7.16±0.11
Percent increase	69.30	88.12	81.33	79.44

The iron content of dry Moringa oleifera powder (8.30 ± 0.01 g percent)as presented by [12], dry Saravallai powder (19.42 ±0.13mg/100g) as given by [15] and Saravallai dhal powder (30.13 ±2.4 mg/100g) as stated by Gobi and Narayanan (2015)[16] are comparatively higher than the current finding.

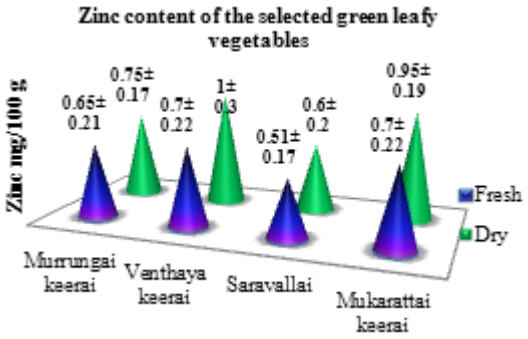

Figure 7. Zinc content of the selected green leafy vegetables.

The fresh Venthaya keerai and Mukarattai keerai had the same amount 0.7±0.22 mg of zinc, while the Murrungai keerai had 0.65±0.21 mg, Saravallai had still a lower (0.51±0.13) zinc content. The process of desiccation had enhanced the amount of zinc up to 42.85 percent (Venthayakeerai). Mukarattai keerai can be ranked next with 35.71 percent increase in zinc content. Improvement in the quantity of zinc was more are less similar in Murrungai keerai and Saravallai (15.38 and 17.64). The least increase was observed in Murrungaikeerai. Pasricha and Gupta's (2014)[14] finding of 49.6 µg/g zinc in dry fenugreek leaves is four times higher than the current study's finding. Gobi and Narayanan (2015)[16] report of 0.90 ±0.10 mg/100g (Saravallai dhal powder) zinc similar to the present result. Statistical analysis (ANOVA) did not show any significant difference among the fresh (p=7.86) and dry (p=5.22) samples of Murrungai keerai, Venthayakeerai, Saravallai and Mukarattai keerai at five percent level.

(vii) Phytate content

Phytic acid is the major phosphorus storage compound in leafy vegetables and this compound chelates multivalent metal ions such as zinc, calcium and iron, reducing their bioavailability (Champ (2005)[20] and Schlemmer et al (2009)[21]. The anti-nutrient inositol (phytate) content was between 2.46±0.13 and 5.24±0.20 m g/100 g. Murrungai keerai and Venthaya keerai's phytate content was nearer to each other with 4.61±0.20 and 3.88±0.19 mg/100 g. Udousore et al (2013)[22] study on four different green leafy vegetables of Nigeria found that the phytate content of fresh green leafy vegetables ranged from 33 to 43 mg/100g. Dried powders of the green leafy vegetables of the current research contained 12.0±0.19 to 132.0±0.10 mg/100g, whereas 17.25 ±0.00 to 86.45 ± 0.10 mg/100 g of phytate. (Amaranthus hybridus, Andasonia digitata, Ceiba patendra, Hibiscus sabdariffa and Vigna unguiculata) was reported by Patricia et al (2014)[23]

Conclusion

Green leafy vegetables could be sun dried for later use and sun drying concentrates the nutrient as well as the anti-nutrient content of green leafy vegetables.

Table 4.Phytate content of the selected greens.

Criteria	*Moringa oleifera*	*Trigonella foenum graecum*	*Trianthema protulacastrum*	*Boerhaaiva diffusa*
	Mean ± SD mg / 100 g			
Fresh	4.61±0.20	3.88±0.19	2.46±0.13	5.24±0.20
Dry	66.0±0.09	39.0±0.16	12.0±0.19	132.0±0.10
Percent increase	1331.67	905.15	387.80	2419.08

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