

Antioxidant and nutritional evaluation of *Bhu Udumbara* (*Ficus semicordata* Buch.-Ham. ex Sm.) leaves and fruits: An extra pharmacopoeial drug of Ayurveda

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Abstract

Background: *Ficus semicordata* Buch.-Ham. ex Sm. (*Moraceae*) has been attributed with copious therapeutic claims in Indian traditional medical systems, especially for its ethnomedicinal and economical uses. **Aims:** The present study was carried out to evaluate the heavy metal, pesticide, aflatoxin content, antioxidant and nutritional value of leaves and fruits of *F. semicordata*. **Materials and Methods:** Heavy metal content; pesticide residues; aflatoxin content; antioxidant potential; and different nutritional parameters such as total carbohydrate, true protein, protein, total fat, energy, Vitamin C, Vitamin A, iron, zinc, manganese, phosphorus, calcium of the leaves, and fruits were evaluated following the standard guidelines. **Results:** Fruit powder shows the presence of 72.94 ppm Pb while <0.01 ppm Pb in leaf powder whereas Cd, Hg, and as were <0.01 ppm in both leaf and fruit powders. Pesticide residue and aflatoxin content in both leaves and fruit were below the limit of quantification. Antioxidant activities of both leaves and fruits increased with increasing concentrations in the dose-dependent manner by Diphenylpicrylhydrazyl (DPPH) assay, ferric-reducing antioxidant power assay and phosphomolybdenum assay. Fruits are found more nutritious with highest content of true protein, total fat, energy, Vitamin A, iron, zinc and phosphorus whereas the leaves are having highest content of total carbohydrate, protein, Vitamin C, manganese and calcium. **Conclusion:** The results of this study shows that in the leaves and fruits of *F. semicordata* mercury, cadmium, arsenic, pesticides residues and aflatoxin content are below the limit of quantification and possess mild antioxidant properties. Fruits are found more nutritious with the highest content of true protein, total fat, energy, Vitamin A, iron, zinc and phosphorus. Being wild, it is easily accessible and cheaper source of nutrition.

Keywords: Aflatoxin, antioxidant, *Bhu Udumbara*, *Ficus semicordata*, heavy metal, nutritional value, pesticide

Introduction

The use of wild plants, either as a source of food or for medicinal purposes, still persists in many tribal communities. Fruits and vegetables contain different antioxidant compounds, such as Vitamin C, Vitamin E and carotenoids.^[1] Epidemiologic studies have also revealed an inverse relation between the consumption of fruits and vegetables and morbidity and mortality from degenerative diseases.^[2] Natural antioxidants present in food and other biological materials have engrossed considerable interest because of their apparent safety and potential nutritional and therapeutic effects.^[3]

Ficus semicordata Buch.-Ham. ex Sm. of family *Moraceae* is a small- or medium-sized evergreen tree, having oblong or semi-saggitate leaves, hispid above, petioles-scabrid,

receptacles in pairs or clusters on leaflets, drooping branches and ripened fruits are reddish-brown.^[4] Young fruit juice is applied externally on forehead to relieve headache, raw fruits are eaten in diarrhea, leaf decoction in combination with other plant extract is taken orally to get relief from jaundice, the juice of leaves is applied externally for curing scabies, etc.^[5] In Nepal, it is known as khanyu (meaning edible fruit) and is used locally as a forage tree.^[6] Leaves are used as fodder^[7] and are also used as vegetable with pork.^[8] Ripen fruits are edible^[9]

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How to cite this article: Gupta S, Acharya R. Antioxidant and nutritional evaluation of *Bhu Udumbara* (*Ficus semicordata* Buch.-Ham. ex Sm.) leaves and fruits: An extra pharmacopoeial drug of Ayurveda. AYU 2019;40:120-6.

Submitted: 28-Nov-2018

Revised: 27-Apr-2019

Accepted: 23-Aug-2019

Published: 20-Mar-2020

Access this article online

Quick Response Code:



Website:
www.ayujournal.org

DOI:
10.4103/ayu.AYU_289_18

and are also reported to be used in the preparation of jam.^[10] The tree is also recorded as hosts of the Indian lac insect.^[11]

Recent researches

It is also found that *F. semicordata* has also been reported for its antidiabetic potential, antioxidant activity, antibacterial, anticancer, carbohydrate specificity and agglutinin activity for recognition of bacteria.^[5] Although leaves and fruits of *F. semicordata* are edible, their nutritional content and heavy metal distribution has not been reported. The present paper reports the nutritional value of leaves and fruits of *F. semicordata*.

Materials and Methods

Collection and preservation of the sample

F. semicordata Buch.-Ham. ex Sm. (*Moraceae*) known as *Bhui Dumri* was identified from its natural habitat Paikmal, Odisha, during November 2017; leaves and fruits were collected and authenticated by local taxonomist with the help of botanical flora^[12] and also authenticated by the Botanical Survey of India (Certificate no. CNH/Tech. II/2018/11) [Figure 1a-c]. A sample specimen was preserved in Pharmacognosy Laboratory in a solution prepared from 70% ethyl alcohol: glacial acetic acid: formalin in the ratio of 90:5:5.^[13] The collected materials were washed under running water, shade-dried, powdered through mechanical grinder and stored in airtight container.

Dried leaf and fruits powder were used to assess heavy metal, aflatoxin, pesticide, antioxidant activity and nutritional status by following standard guidelines mentioned below.

Pb, Cd, Hg and As were estimated by inductively coupled plasma-atomic emission spectrometry (AES) method.^[14,15] Pesticide residues were estimated by Association of Analytical Communities (AOAC) Official Method 2007.01.^[16] Aflatoxin content was estimated by AOAC Official Method 991.31.^[17] The antioxidant activity was assessed by three methods, DPPH assay;^[18] ferric reducing antioxidant power (FRAP) assay^[21] and by phosphomolybdenum assay^[19] methods. Total carbohydrates were estimated by phenol-sulfuric acid method.^[20] Total soluble protein content present in the samples

were estimated by the Folin–Lowry method.^[21] The crude protein was determined by the Kjeldahl method.^[22] Total fat estimation was performed using the Soxhlet extraction method.^[23]

The caloric value of leaves and fruits were determined based on the Atwater factor.^[24] Vitamin C was estimated by DNPH (dinitrophenylhydrazine) method.^[25] Vitamin A was estimated by high-performance liquid chromatography method.^[26] Iron, zinc, manganese and calcium were estimated by microwave plasma-AES method^[27] and vanadomolybdophosphoric acid method^[28] was used to determine phosphorus content of acid extractions of leaves and fruits.

Results and Discussion

Heavy metal

The details of the observed data on heavy metal analysis are presented in Table 1. The levels of mercury, cadmium and arsenic in leaf and fruit of *F. semicordata* were <0.01 ppm; in leaf, lead was <0.01 ppm, whereas in fruit, it was 72.94 ppm. Permissible limits of lead, mercury, cadmium and arsenic are 10 ppm, 1 ppm, 0.3 ppm and 3 ppm, respectively.^[29] Heavy metals are present in the soil with large variations due to mining, fossil fuels, etc.^[30]

Fig trees have a unique form of fertilization, female flower collect pollen from the male flowers, and fly off in search of figs whose female flowers are receptive; thus, accumulation of excreta of wasps inside the fig^[31], *F. semicordata* cultivation occurs in valleys, ravines and on the banks of streams^[32] may have lead to contamination by heavy metals.

Pesticide residue

Pesticide residue in the leaves and fruits of *F. semicordata* are found to be below the prescribed recommended limit of quantification [Table 2]. The term pesticide covers a wide range of compounds including insecticides, fungicides, etc., in which organochlorine insecticides, used efficaciously in controlling a number of diseases, such as malaria and typhus, were banned or restricted.^[33] Acquaintance of the population to pesticide residues can be minimized by washing the foodstuffs thoroughly in running water or by peeling.^[34]

Aflatoxin content

Aflatoxin contents in the leaf and fruit of *F. semicordata* are below the limit of quantification [Table 3]. Aflatoxins

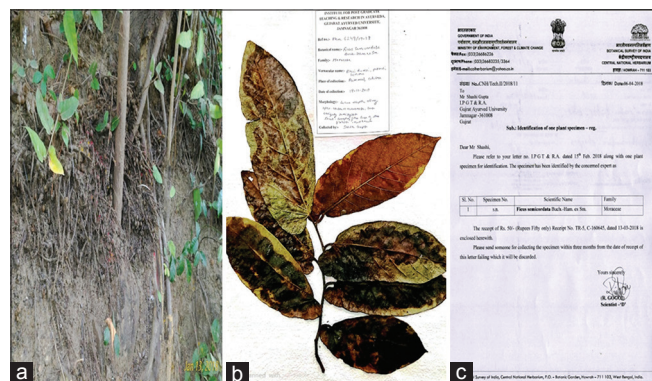


Figure 1: (a) Plant in natural habitat, (b) Herbarium Phm. 6249/17-18, (c) BSI Certificate no. CNH/Tech. II/2018/11

Table 1: Heavy metal in the leaf and fruit of *Ficus semicordata*

Heavy metal	Permissible limits (ppm)	In leaf	In fruit (ppm)
Lead (Pb)	10	ND	72.94
Mercury (Hg)	1	ND	ND
Cadmium (Cd)	0.3	ND	ND
Arsenic (As)	3	ND	ND

ND Not detected or <0.01 ppm.

Table 2: Pesticide residue in the leaf and fruit of *Ficus semicordata*

Test name (mg/kg)	Leaf	Fruit
Organochlorine pesticides residues		
Alachlor	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Butachlor	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Aldrin	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Chlorothalonil	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
DDT (all isomers)	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Dicofol	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Dieldrin	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Endosulphan	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Endrin	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
HCH (alpha and beta)	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Tetraclonazole	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Metalachlor	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Trichlorfon	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Heptachlor	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Lindane	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Organophosphorous pesticides residues		
4-bromo-2-chlorophenol	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Acephate	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Chlorfenvinphos	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Edifenphos	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Fenthion	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Chlorpyrifos	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Malaaxon	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Iprobenfos	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Chlorpyrifos methyl	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Diazinon	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Dichlorovos	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Ethion	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Etrimphos	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Fenitrathion	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Iprobenphos	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Parathion ethyl	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Parathion methyl	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Phorate	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Phorate sulfone	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Phorate sulfoxide	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Phosalone	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)

B.L.Q: Below limit of quantification, Q.L: 0.01 Quantification limit,
DDT: Dichloro diphenyl trichloroethane, HCH: Hexachlorocyclohexane

Table 3: Aflatoxin content in the leaf and fruit of *Ficus semicordata*

Test name (mcg/kg)	Leaf	Fruit
Aflatoxin B1	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Aflatoxin B2	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Aflatoxin G1	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)
Aflatoxin G2	B.L.Q (Q.L=0.01)	B.L.Q (Q.L=0.01)

B.L.Q: Below limit of quantification, Q.L: 0.01 Quantification limit

are poisonous carcinogens.^[35] Plants grown under warm and moist weather are especially more prone to aflatoxin

contamination.^[36] Both leaves and fruits of *F. semicordata* do not contain aflatoxin; this may be due to the natural availability of the drug.

Antioxidant potential

In the recent past, the role of vegetables and fruits, as sources of antioxidants, has been receiving considerable attention. Antioxidants restrict the damage that reactive oxygen-free radicals can cause to the cell and cellular components. They are of primary biological value in giving protection from certain diseases. Some of the diseases that have their origin in deleterious-free radical reactions are atherosclerosis, cancer, inflammatory joint diseases, asthma, diabetes, etc.^[34] Both leaf and fruit parts were assessed for their antioxidant activity by three different methods.

DPPH assay

The percentage of inhibition of standard, leaf and fruit drugs are given in Figure 2a-c. Leaf and fruit showed good radical scavenging power in different concentrations. Inhibitory concentration (IC₅₀) value of standard (ascorbic acid) is 178.88 µg/ml, IC₅₀ value of leaf is 8690.93 µg/ml whereas IC₅₀ value of fruit is 364.44 µg/ml. Percentage scavenging of DPPH radical was found to rise with increasing concentration of the crude extract. The use of the DPPH assay provides an informal and speedy way to assess antioxidants by spectrophotometry, so it can be useful to assess various products at a time.^[37]

FRAP assay

FRAP of the standard (FeSO₄ and acetic acid) leaf and fruit are given in Figure 3a-d. FRAP of leaf is 41.27 µmol and FRAP of fruit is 36.14 µmol. FRAP is a modest, automated test measuring the ferric-reducing ability of plasma and is presented as a unique method for assessing antioxidant power in which ferric to ferrous ion reduction at low pH causes a colored ferrous-tripyridyltriazine complex to be formed.^[38]

Phosphomolybdenum assay

Phosphomolybdenum assay of the standard ascorbic acid, leaf and fruit is given in Figure 4a-c. Phosphomolybdenum assay of leaf is 156 and fruit is 158.48 mg equivalent to ascorbic acid per gram dry weight. The presence of steroids, terpenoids, flavonoids, glycosides, tannins, carbohydrates, and saponins are reported which may play an important role in the antioxidant activities.^[39] Phosphomolybdenum assay is based on the reduction of Phosphate-Mo (VI) to Phosphate Mo (V) by the sample and subsequent formation of a bluish green-colored phosphate/Mo (V) complex at acidic pH. The phosphomolybdenum method is characteristically applied in the laboratory to appraise the total antioxidant capacity of plant extracts.^[19]

Nutritional value

Essential nutrients are not limited to vitamins and minerals. The major macronutrients – protein, carbohydrate, and fat – are also essential to nutritional health and well-being.

The results of nutritional analysis of *F. semicordata* leaf and fruit are provided in Table 4.

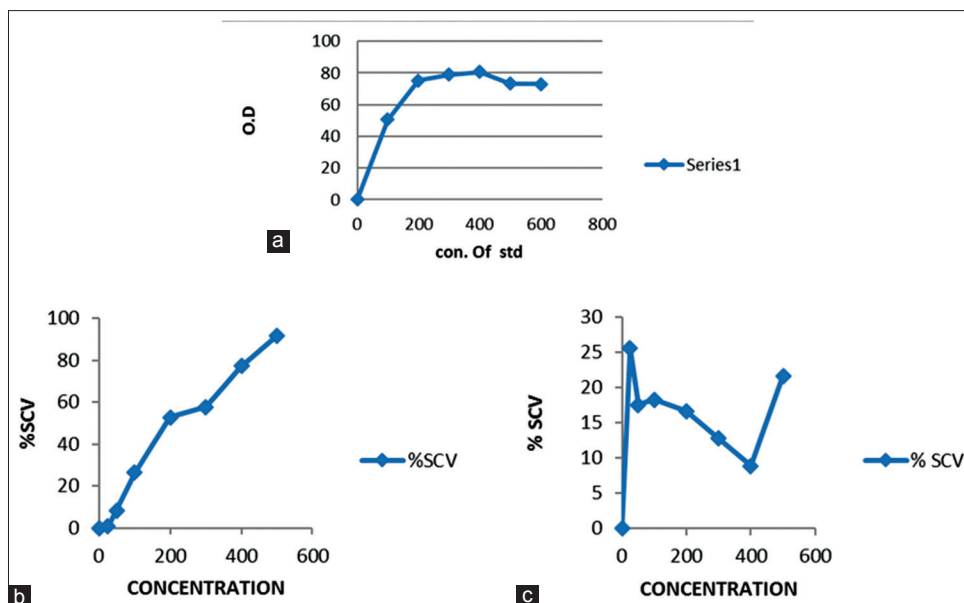


Figure 2: (a-c) Antioxidant potential by DPPH assay of leaf and fruit of *Ficus semicordata*. (a) Standard. (b) Leaf. (c) Fruit

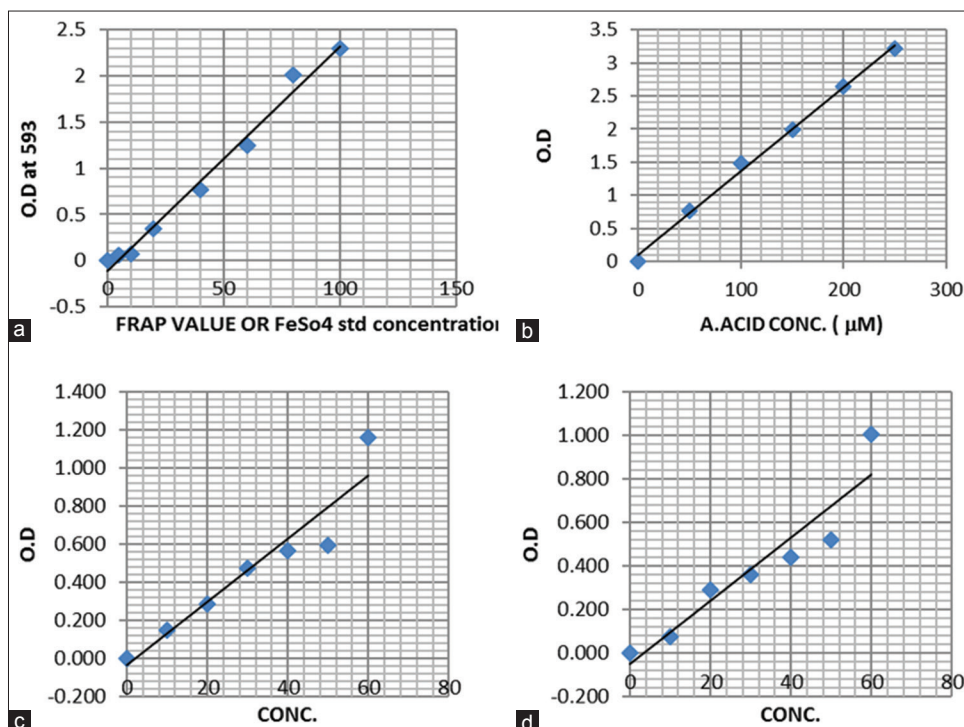


Figure 3: (a-d) Antioxidant potential by ferric-reducing antioxidant power (FRAP) assay of leaf and fruit of *Ficus semicordata*. (a) FeSO₄ (b) Acetic acid (c) Leaf (d) Fruit

Carbohydrate

In *F. semicordata*, carbohydrate is present in higher amount than the other chemical components in both leaf and fruit. Carbohydrates are either simple or complex and are foremost sources of energy in all human diets^[34]

True protein

True protein is present in higher concentration in fruit than the leaf. True protein measures merely the proteins.^[40]

Protein

In *F. semicordata*, the protein is present in second higher amount after carbohydrate than the other chemical components in both leaves and fruits.

Fat

Fruits are richer source of fat than the leaf.

Energy values

One hundred gram of *F. semicordata* leaves provide 4.74%–7.10% energy in female, 3.79%–5.68% in male;

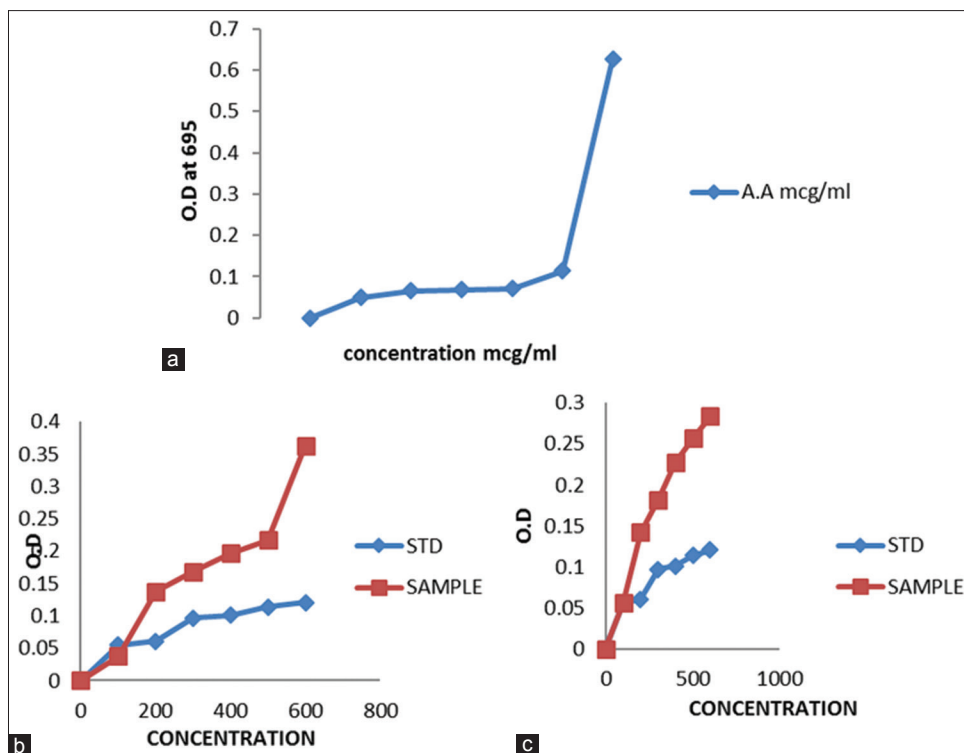


Figure 4: (a-c) Antioxidant potential by phosphomolybdenum assay of leaf and fruit of *Ficus semicordata*. (a) Standard. (b) Leaf. (c) Fruit

Table 4: Nutritional value of leaf and fruit of *Ficus semicordata*

Parameters	Leaf	Fruit
Total carbohydrate	22.29 g/100 g	19.51 g/100 g
True protein	2.95 g/100 g	7.50 g/100 g
Protein	12.20 g/100 g	9.78 g/100 g
Total fat	1.41 g/100 g	2.96 g/100 g
Energy value	113.65 Kcal/100g	138.86 Kcal/100 g
Vitamin C	8.5 mg/g	5.3 mg/g
Vitamin A	0.091 mg/g	0.979 mg/g
Iron	145.33 ppm	264.62 ppm
Zinc	6.46 ppm	10.24 ppm
Manganese	29.5 ppm	11.36 ppm
Phosphorus	0.16 ppm	0.17 ppm
Calcium	22048.33 ppm	2623.09 ppm

whereas 100 g fruit provides 5.79%–8.68% energy in female and 4.63%–6.94% energy in male per day. The chief food sources of energy to the human body are fat, carbohydrate, and protein. The heat released by oxidation of food in the bomb calorimeter is its heat of combustion and is a measure of its gross energy value.^[41,42]

Vitamin C

Leaves are richer source of Vitamin C than the fruits.

Vitamin A

Fruits are richer source of Vitamin A than the leaves.

Iron

Fruits are rich source of iron than leaves.

Zinc

Fruits are rich source of zinc than leaves. Zinc, which is defined as an essential trace element, or a micronutrient is essential for the normal growth and the reproduction of all higher plants and animals and of humans.^[44]

Manganese

Leaves are rich source of manganese than fruits.

Phosphorus

Fruits are rich source of phosphorus than leaves.

Calcium

Leaves' powder of *F. semicordata* is rich source of calcium.

vitamins,^[34] vitamin C,^[43,44] vitamin A,^[44-46] mineral,^[34] iron,^[44,47] zinc,^[48] manganese,^[49] phosphorus^[50] and calcium^[44,51] are essential ingredients with several health implication and pathological significance.

Conclusion

Leaves and fruits of *F. semicordata* are found to be innocuous as heavy metal; pesticide residues and aflatoxin content were found to be below the recommended limit of quantification, except the lead content, in the fruits, which was more than the prescribed limit. Antioxidant activities of both leaves and fruits increased with increasing concentrations in dose dependent manner by DPPH as say, FRAP assay and phosphomolybdenum assay. Fruits of *F. semicordata* are found to be more nutritious than the leaves. Being wild, it is easily accessible and cheaper source of nutrition. Further studies

should be undertaken to explore the cause of high lead content in the fruits. Clinical and experimental study of the plant is indispensable to evaluate its effectiveness in the management of ethnomedicinal uses.

Acknowledgment

The author would like to thank Director, Institute for Postgraduate Teaching and Research in Ayurveda, Gujarat Ayurved University, Jamanagar.

Financial support and sponsorship

This study was financially supported by Institute for Postgraduate Teaching and Research in Ayurveda, Gujarat Ayurved University, Jamnagar, Gujarat and Ministry of AYUSH, Govt. of India.

Conflicts of interest

There are no conflicts of interest.

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