



Nutritional value assessment of *Cissus woodrowii* (Stapf ex Cooke) Santapau plant parts: An underutilized endemic plant of Western Ghats of India

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Malnutrition in developing countries can be reduced up to a certain extent by using various underutilized wild plants in the diet. *Cissus woodrowii* (Stapf ex Cooke) Santapau is an underutilized plant species of the Vitaceae family that is endemic to Maharashtra and Karnataka state of India. In this study, the nutritional value of *C. woodrowii* leaf, stem, and root is reported. The leaves have higher proximate value, energy, minerals, and vitamins than that of the stem and roots of *C. woodrowii*. In addition, two antinutritional factors (oxalate and phytate) were also recorded from plant parts of *C. woodrowii*. This study revealed that the leaves of *C. woodrowii* are rich in nutrients and energy, and can be utilized to overcome malnutrition.

Keywords: Antinutrients, Calories, *Cissus woodrowii*, Malnutrition, Proximate analysis, Vitamins.

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Introduction

Malnutrition is a socioeconomic problem leading to morbidity and mortality around the world with a higher intensity in developing countries^{1,2}. Malnutrition in these countries is related to the insufficient intake of either the macronutrients or micronutrients or both^{1,2}. Different scientific studies have proved that numerous underutilized wild plants (UWPs) can contribute to fulfil the nutritional demands of native populations to overcome malnutrition²⁻⁵. Furthermore, UWPs are not only useful in reducing malnutrition but are also essential in providing food security⁶.

The genus *Cissus* L. belongs to the Vitaceae family commonly found growing in the tropical and subtropical regions around the world^{7,8}. About 22 species of *Cissus* have been reported from India, of which *C. quadrangularis* is rich in nutrients and bioactive principles. Hence the annual demand for *C. quadrangularis* is about 200-500 metric tons⁹. However, congeneric species like *Cissus woodrowii* (Stapf ex Cooke) Santapau is not well utilized for its nutritional potential. Recently leaf, stem, and root of *C. woodrowii* were explored for their phytochemicals

and antioxidant activity⁹. In addition to this, the nutritional values and antioxidant potential of fruits were also explored¹⁰. However, data on the nutritional status of leaf, stem, and root are sparse.

Based on the previous studies, here an attempt was made to explore the nutritional values of *C. woodrowii* which may motivate the utilization of this plant to fulfilment of nutritional demand of the local population. To the best of the authors' knowledge, no comprehensive study has been documented on the proximate analysis, mineral composition, vitamins, and antinutrients of *C. woodrowii* plant parts.

Materials and Methods

Plant material

Plant parts of *C. woodrowii* were collected from the Pasarni ghat area (17°56'14" N and 73°48'54"), Wai – Panchgani road, Satara district, India from July to August 2020. The collected plant was identified using the Flora of the Presidency of Bombay¹¹ and the herbarium specimen (Voucher number NGCPR – 003000) was deposited at Naoroji Godrej Centre for Plant Research (NGCPR), Shirwal.

Proximate analysis

The analysis of moisture, ash, and crude fibre content was determined by the standard protocols of the Association of Official Agricultural Chemists

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(AOAC)^{12,13}. Fat, protein and carbohydrate contents of plant parts were determined as per Kumari *et al.*¹⁴, Lowry *et al.*¹⁵, and Idris *et al.*¹⁶ respectively. The value of energy was estimated by the addition of carbohydrates, lipids, and protein. The factor for carbohydrate and protein was 16.736 kJ and for lipid, it was 37.656 kJ. The energy value was expressed as kJ and kcal per 100 g of dried plant material. The mineral contents of *C. woodrowii* plant parts were determined by atomic absorption spectrophotometer (AA-7000, Shimadzu, Japan).

Determination of vitamins and anti-nutrients

Vitamins (carotenoids and ascorbic acid) in plant parts of *C. woodrowii* were determined as per Kumari *et al.*¹⁴ and the anti-nutrients (oxalates and phytic acid) were measured as per Idris *et al.*¹⁶.

Results and Discussion

Proximate composition

The analysis of proximate composition is the fundamental prerequisite for regulatory purposes, quality control, and product development in any food industry. In the present investigation, the proximate chemical composition of *C. woodrowii* was studied to understand its role in future drug development and health improvement. The moisture content of leaf, stem, and root showed a significant difference whereas dried leaf showed the least moisture content (7.81%). Plant material with moisture content higher than 8% supports the invasion of insects, and higher than 15% aid in the contamination of the dried powder due to bacteria and fungi¹⁷ making the food or food product unfit for human consumption causing illness or in the worst case, death¹⁸. The moisture content in *C. woodrowii* leaf revealed that it can be preserved with less risk of any microorganism invasion or contamination, thus increasing its shelf life. The moisture content in *C. woodrowii* leaf was less as compared to *C. quadrangularis* (18.4%)¹⁹ and *C. rotundifolia* (81.49%)²⁰ and could be preserved with little risk of insect and microorganism invasion, hence increasing its shelf life. The ash content in the leaf (21.45%) was higher as compared to the root and stem (Table 1) which signified a higher mineral concentration in the leaf. This result correlated with the mineral analysis performed which showed significantly higher mineral levels in leaves as compared to other studied plant parts (Table 2). Crude fibre gauges the amount of indigestible cellulose, pentosans, lignins, and other similar

components present in foods²¹. The crude fibre content of *C. woodrowii* leaves (19.23 g/100 g DW) was higher than stem and root. Consumption of fibre decelerates the mastication time along with increased saliva production making the fibre to inhibit absorption of nutrients and energy from the food. This promotes faster satiation as a result of more gastric emptying time, thus beneficial for digestion-related or gastric disorders, and in preventing and treating obesity and diabetes mellitus²². The people who consumed high fibre diets are healthy than the individuals consuming low fibre diets, constipation being one of the conditions associated with it²³. Leaves of *C. woodrowii* showed significant values of fat, protein, and carbohydrate as compared to the root and stem (Table 1). The oxidizable energy of the leaf (349.00 kcal/100 g DW) was significantly higher than that of the root and stem which could be due to the higher carbohydrate content in the leaves (Table 1). Carbohydrates, protein and fats are the dietary macro-components and are the basic source of energy in the diet²⁴.

Table 1 — Proximate composition and energy contents of *C. woodrowii* plant parts

		Leaves	Stem	Root
Proximate composition	Moisture (%)	7.81±1.16	29.86±2.77	20.56±1.91
	Ash (%)	21.45±0.47	16.12±0.74	19.23±0.39
	Fiber (g/100g DW)	19.23±1.32	7.41±1.78	11.33±1.02
	Fat (g/100g DW)	13.21±1.21	10.12±1.45	10.23±1.01
	Protein (g/100g DW)	17.88±0.78	11.91±0.48	15.71±0.71
	Carbohydrate (g/100g DW)	39.65±1.29	29.99±2.33	34.27±1.14
Energy	(kJ/100 g DW)	1460.25	1082.31	1221.68
	(kcal/100 g DW)	349.00	258.68	291.99

*The data represents the Mean±standard deviation.

Table 2 — Minerals (macro and micro) contents of *C. woodrowii* plant parts

		Leaves	Stem	Root
Macro minerals (mg/100g DW)	Na	27.8±3.42	11.2±1.78	22.3±1.98
	K	77.8±3.78	26.9±4.22	44.91±3.78
	Ca	65.3±2.21	34.13±1.55	48.21±3.12
	Mg	102±7.45	74.65±2.45	98.40±5.44
	P	28.21±3.99	11.35±2.14	21.47±3.31
Micro minerals (µg/100g DW)	Fe	10650±27.06	3781±16.84	8457±24.01
	Mn	1712.7±36.89	1321.7±33.45	1532.1±29.74
	Zn	732±11.78	417±23.03	614±17.45
	Cu	569±09.23	319±14.56	412±22.45

*The data represents the Mean ± standard deviation.

Table 3 — Vitamins and antinutritive contents of *C. woodrowii* plant parts

		Leaves	Stem	Root
Vitamins	Carotenoids ($\mu\text{g}/100\text{g DW}$)	13.23 \pm 1.74	9.14 \pm 1.24	10.77 \pm 1.09
	Ascorbic acid ($\text{mg}/100\text{g DW}$)	41.23 \pm 2.23	23.17 \pm 1.95	29.32 \pm 2.04
Antinutritive factors	Oxalate ($\text{mg}/100\text{g DW}$)	12.09 \pm 0.032	13.71 \pm 0.011	11.14 \pm 0.02
	Phytic Acid ($\text{mg}/100\text{g DW}$)	1.01 \pm 0.31	1.23 \pm 0.45	1.98 \pm 0.23

*The data represents the Mean \pm standard deviation

Nutritional and antinutritional factors

In recent decades, micronutrients (essential trace elements) and dietary vitamins and their role in optimizing health and preventing or treating diseases have gained significant attention. It has been validated that a healthy diet has the potential to decrease the possible threat of certain non-communicable diseases, such as cardiovascular diseases and cancer²⁵. Thus, demanding the need to explore new avenues in plant research to overcome the problem of micronutrients deficiency. In the present investigation, five major macro-minerals were evaluated. It was observed that calcium (65.3 mg/100 g DW), sodium (27.8 mg/100 g DW), magnesium (102 mg/100 g DW), phosphorus (28.21 mg/100 g DW), and potassium (77.8 mg/100 g DW) were significantly high in leaves as compared to root and stem, and Na, K, Ca, and P were approximately two-fold higher than that of the stem (Table 2). Further, the leaves of *C. woodrowii* showed a significantly higher amount of iron, manganese, zinc, and copper in comparison with the root and stem powder of *C. woodrowii* (Table 2). According to the WHO database, iron, zinc, and iodine show the highest trace element deficiencies and have affected nearly two billion people worldwide²⁶. Iron deficiency is the most predominant nutritional disorder in the world. It is the only micronutrient deficiency that has not only affected the developing nations, but has impacted the developed nations as well. It has been projected that approximately one-third of the world's population suffers from anaemia²⁷. Comprehensive information regarding the essential micronutrients, their role in the function of the human body, the consequences of their deficiencies, biochemical effects and sources for their supplements to overcome deficiency has been described²⁸. Inclusion of minerals and vitamins in sufficient quantity is important to avoid various diseases and to improve health conditions. Calcium, sodium, magnesium, and potassium work as electrolytes and are essential for various biological processes²⁸. The studied plant parts of *C. woodrowii*

revealed the presence of vitamins where leaf powder showed higher content of carotenoids and ascorbic acid when compared with other studied plant parts (Table 3). Carotenoids and ascorbic acid are antioxidants²⁹ and important in the treatment of cardiovascular diseases, pulmonary diseases, chronic kidney diseases, neurodegenerative diseases, and cancer⁹. Antinutritive factors such as oxalate were higher (13.71 mg/100 g DW) in the dried stem powder of *C. woodrowii* while the phytic acid content was higher (1.98 mg/100 g DW) in the dried root powder of *C. woodrowii* (Table 3). While dried leaves of *C. woodrowii* had a lower content of oxalate (12.09 mg/100g DW) and phytic acid (1.01 mg/100g DW). Oxalic and phytic acid are mainly found as oxalates and phytates bound to minerals like calcium and potassium which makes it anti-nutritional³⁰. Over-consumption of oxalate is correlated with hyperoxaluria (increased urinary excretion of oxalate) and formation of calcium oxalate kidney stone, while over-consumption of phytate associated with decreased utilization of dietary proteins, and reduced bio-accessibility and bioavailability of some minerals³¹.

Conclusion

C. woodrowii is an underutilized shrub species of the Vitaceae family. The plant parts of *C. woodrowii* are a good source of different nutrients and minerals which can suffice the nutritional demand of the local population. Considering its availability in Indian states like Maharashtra and Karnataka and its shrub-like habit it is recommended for the commercial exploitation of *C. woodrowii*.

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Conflict of interest

The authors have no conflicts of interest.

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