International Journal of Health Sciences and Research
Vol.13; Issue: 1; January 2023
Website: www.ijhsr.org
Original Research Article *ISSN: 2249-9571*

Nutritional and Phytochemical Analysis of Leafy Vegetables from Konkan Region, Maharashtra

Dr. Lubdha A. Kagale[1], Dr. Surekha P. Rode[2]

[1]Department of Botany, Vivekanand College, Kolhapur, Maharashtra
[2]Department of Botany, Rajarshi Chhatrapati Shahu College, Kolhapur, Maharashtra

Corresponding Author: Dr. Lubdha A. Kagale

DOI: https://doi.org/10.52403/ijhsr.20230116

ABSTRACT

The objective of present study is to identify the leafy vegetables traditionally utilized by local communities, in rainy season who reside at the rural areas of Ratnagiri district of Maharashtra region. The study conducted in this respect to analyze four leafy vegetables from study region at monsoon. Highest moisture content was recorded in *Chlorophytum tuberosum* followed by *Commelina benghalensis*. Ash content is a measure of the mineral elements present in food and ranged from 2.3-14.3%. A good amount of protein was seen in the vegetables, being maximum in *Colocasia esculenta* (11.1%). *Chlorophytum tuberosum* (10.48%) maximum amount of carbohydrates was recorded followed by *Colocasia esculenta* (8.19%). Crude fiber content ranged from 11.4 to 16.8% in different vegetables and was highest in *Chlorophytum tuberosum.* Lipid content ranged from 2. 53-5.9% in all four vegetables. Two vegetables namely *Chlorophytum tuberosum and Smithia sensitiva* had the maximum calcium content i.e. more than 1000mg/100g. Phosphorus content in the vegetables ranged between 62 to 117mg/100g Highest content of magnesium was noticed in *Chlorophytum tuberosum* (216mg/100g). Total antioxidant capacity was found to be highest in methanolic and ethanolic extracts of *Smithia sensitiva* (388.29 mg/g and 386.90 mg/g respectively).

Keywords: Wild vegetables, Nutritional content, Mineral content, Total antioxidant capacity, Phytochemical analysis

INTRODUCTION

Vegetables play an important role in human diet. A diet rich in vegetables and fruits is considered healthy and supposed to reduce the possible risk of various diseases. Vegetables contain vitamins, minerals and carbohydrates which are necessary for good health[(1)] . Vegetables represent a protective food and are highly beneficial for human health and also useful as a traditional medicine[(2)]. Leafy vegetables are mostly herbs but leaves of shrubs and trees are also used as vegetables and are generally a good source of nutrients. Green leaf contains maximum amount of vitamins and minerals but it is low in fats and calories[(3)] . Constituents present in leafy vegetables help to build teeth and protect the body, regulating its processes.

An abundant amount of phytochemicals are present in leafy vegetables which act in the defense mechanism. Some leafy vegetables are a rich source of essential oils, glycosides and pigments which help to stimulate appetite. Some of them contain important digestible and nondigestible carbohydrates[(4)]. Soluble and insoluble fibers in leafy vegetables help in digestion. Mineral constituents in vegetables like Ca, Mg, P, Fe, Cu etc. provide alkalizing effect and neutralize acidity produced by other foods[(5)]. All these factors are necessary to grow healthy and strong.

Wild plants have been used as a source of food and medicine since ancient time. Wild leafy vegetables are available luxuriantly in the monsoon and occupy a modest place as a source of macro and micro elements due to their high water content[6]. It is reported by several research workers that wild leafy vegetables have more valuable food ingredients than the cultivated common leafy vegetables. The most important point is that these wild leafy vegetables supply nutrients during the rainy season when there is a shortage of cultivated green leafy vegetables and other vegetable resources. They are less expensive and are also used in dry form during winter and spring season. These wild vegetables provide a cheap source of protein[7]. Wild leafy vegetables are cooked or eaten raw. They are also used in folklore medicine for the treatment of stomach, fever, piles, headache and many other disorders.

There are a great variety of seasonal leafy vegetables available during the post monsoon season in the coastal region of Maharashtra. In the present study phytochemical and nutritional composition of four wild leafy vegetables from the Ratnagiri district, namely, *Chlorophytum tuberosum, Colocasia esculenta, Commelina benghalensis* and *Smithia sensitive* has been reported and analyzed. The key emphasis of this article is to provide the useful side including its botanical aspects, ethnopharmacology and phytochemistry as well as nutritional value.

MATERIALS AND METHODS

Vegetable samples were collected from natural habitat at different places from Ratnagiri District during monsoon (June to September 2012). The leaves and young shoots were washed to remove soil debris and dust, blotted to dry and used for moisture determination. Edible portion of vegetables were dried in hot air oven at 45^0C. Dried material was powdered in a grinder and then stored in air tight containers, protected from moisture and light, for further use.

Qualitative analysis of vegetable samples was carried out to detect the presence of phytochemical constituents using standard procedures described by[8]. Ethanol and acetone extracted samples were used for this study. The extracts were prepared by suspending 1g of dry powder in 10ml of respective solvent in a conical flask. These samples were shaken for 12h on a rotary shaker. The extracts were filtered, centrifuged and the supernatants were saved for analysis. Fluorescence analysis was carried out by following the method given by[9]. Powdered vegetable samples were treated with different reagents and color change was recorded on exposure to UV and visible light.

Proximate composition included determination of moisture, ash, crude fiber, total lipid, total protein, carbohydrates and minerals. Moisture content was determined using a moisture balance. Ash content was recorded by following the procedure given in[10]. Crude fiber and total protein were evaluated by the methods described in[11].Total lipid content was estimated by the method of[12] and carbohydrates were analyzed using[13]. For mineral analysis sample were digested using conc. HNO_3 and perchloric acid[14]. The acid digest was used for mineral analysis employing atomic absorption spectrophotometer (Perkin Elmer, USA). Antioxidant capacity of ethanol, methanol and aqueous extracts of vegetables was determined according to [15].

RESULT

Preliminary phytochemical screening indicated presence of a wide array of phytochemicals including phenols, alkaloids, flavonoids, tannins, saponins, glycosides, coumarins and quinines in all the vegetables (Table 2). Most of the constituents were present in both the extracts of vegetables. Quinines was present in *Smithia sensitiva* and *Chlorophytum tuberosum* in ethanol and methanol extracts. All vegetable gave evidence of tannins in aqueous extract and three vegetables revealed tannins in ethanol extract

Glycosides, alkaloids, steroids, and tannins have been reported to be present in *Bidens biternata* from Western Ghats[16].

Fluorescence is the phenomenon exhibited by various chemical constituents present in the plant material. Some Constituents show fluorescence in the visible range in day light. The ultraviolet light produces fluorescence in many natural products (e.g. Alkaloids like Berberine) which do not visibly fluoresce in day light. The color changes observed under visible and ultraviolet light in different vegetable samples in the present study are reported in Table 4. Most of the samples appeared dark colored under UV light.

Proximate Analysis

Proximate analysis includes determination of major ingredients that are nutritionally important like moisture, ash, crude fiber, lipids, proteins and carbohydrates from the edible parts of vegetables was represented in Table 1. Moisture content is a major factor as it determines the shelf life and storage of the commodity. Moisture content of leafy vegetables ranged between 83.27-91.42% Highest value was recorded in *Chlorophytum tuberosum* followed by *Commelina benghalensis*. Ash content is a measure of the mineral elements present in food and ranged from 2.3-14.3% in different vegetables. Lowest value of ash was observed in *Smithia sensitiva* (2.3%) and highest value was seen in *Commelina benghalensis*. Proteins are considered as the structural constituent as they are the major component of a living cell. A good amount of protein was seen in the vegetables, being maximum in *Colocasia esculenta* (11.1%), and minimum in the *Commelina benghalensis* (2.19%).

Carbohydrates are important source of energy and indigestible carbohydrates are counted as fibers. In *Chlorophytum tuberosum* (10.48%) maximum amount of carbohydrates was recorded followed by *Colocasia esculenta* (8.19%). Fibers in leafy vegetables are useful for digestion in human diet. Crude fiber content ranged from 11.4 to 16.8% in different vegetables and was highest in *Chlorophytum tuberosum.* Lipid content ranged from 2. 53-5.9% in all four vegetables.

Table 1. Proximate Analysis of Leafy Vegetable All values are expressed in g/100g

Name of the vegetables	Moisture	Ash	Total Proteins	Total Carbohydrates	Crude Fibers	Total Lipids
Chlorophytum tuberosum	90.53	10.2	3.65	10.48	16.8	5
Colocasia esculenta	83.27	12.7	11.1	8.19	11.4	3.5
Commelina benghalensis	90.14	14.3	2.19	3.49	15.5	5.9
Smithia sensitiva	88.7	2.3	4.2	1.27	14. 5	2. 53

DISCUSSION

Gupta *et al*.,[17] reported nutrient content of 13 locally available underutilized green leafy vegetables from Mysore, Karnataka. Moisture content of these vegetables ranged between 73-95% highest being in *Coleus aromaticus* (Doddipatre) and lowest in *Delonix alata* (Vayunarayani). *Delonix alata* and *Digera arvensis* (Gurchi) had a better protein content (7.1% and 4.3% respectively) but these vegetables were poor sources of fats which ranged between 0.2-0.9 %. In the present study a greater amount of lipid (1.73-5.9%) was reported in the vegetables.

An attempt was made by [18] to identify and analyze the various underutilized green leafy vegetables for their nutrient content from selected regions of south Karnataka. Among these vegetables *Amaranthus, Basella* and *Pimpivella species* had a high moisture content (93%). Protein content of these vegetables ranged from 0.7-3.6% highest being in *Alternanthera sessilis*. Vishwakarma and Dubey [19] carried out nutritional analysis of 18 wild leafy vegetables from eastern Chhattisgarh in India. They noticed a high moisture content (93.45%) in *Carthamus tinctorius* (barrel leaf) while highest value of crude fiber was seen in *Centella asiatica* (21.78%). Crude protein content in samples varied from 1.2-17.84% and it was maximum in *Ipomoea aquatica*.

Oxalis corniculata, used by tribals in central India, was analyzed by [20] for nutritional content. This species had a high level of moisture, lipid and crude protein, (82.42%, 23.75% and 28% respectively). Seal *et al*.,[21] studied six wild leafy vegetables from Meghalaya, in which fat content ranged between 0.57-2.84%. Misra and Misra [22] evaluated twenty seven leafy vegetables from South Odisha, which are less consumed. All these vegetables had more than 75% moisture content. Crude protein content was highest in *Moringa oleifera* (66.2mg/g) and lowest in *Tridax procumbens* (8.2mg/g). Total sugar content was maximum in *Murraya koenigii* (187.6mg/g) and minimum in *Tridax procumbens* (18.0mg/g). Fat content of all these vegetables was very poor.

Saha *et al*. [23] reported nutritional composition of underutilized green leafy vegetables in Assam. Moisture and ash content of these vegetables were in the range of 71.74- 98.20% and 8.23-26% respectively. Fiber was higher in *Basella rubra* (Malabar night shade 8.61%) and least in *Moringa oleifera* (0.25%). Protein content in these vegetables varied from 2.29-18.56% while carbohydrates ranged from 5.45 -11.16%. Singh *et al*.[24] studied six green leafy vegetables from Hisar in Haryana. Moisture content of the vegetables ranged between 75.1-93.4%. Protein content was higher in mint leaves (30.9%) and in it was more than 20% in *Coriandrum sativum, Cicer arietinum, Spinacea oleracea, Brassica oleracea* and *Amaranthus tricolor.* Proximate composition of five wild leafy vegetables from Sikkim was analyzed by [25]. These vegetables were nutritionally rich in terms of calorific value, fibers, proteins and had low fats.

Kayode *et al*. [26] studied uncommon leafy vegetables from Southern Nigeria. *Solanum nigrum* had the highest moisture content (88.47%) while *Vernonia amygdalina* (bitter leaf) had the minimum (78.6%). Protein content varied from 1.76 to 3.36%. Three leafy vegetables namely *Corchorus olitorius, Celosia argentea* and *Ocimum gratissimum* (scent leaf) were analyzed by [27] from Oyo state, Nigeria. Among the nutrients, percentage of carbohydrate and protein in the three vegetables were very high (31.42 -49.39% carbohydrates and 22.24 - 30.79% protein).

Table 2. Phytochemical Analysis

Name of the vegetable	Phenol		Alkaloid		Flavonoid		Saponin		Tannin		Quinine		Glycosides		Coumarin	
	E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	A
Chlorophytum Tuberosum	+	+	+	+	+	+	+	_	+	_	_	+	_	_	+	+
Colocasia esculenta	+	+	+	+	+	+	_	_	+	_	+	+	+	_	+	+
Commelina benghalensis	+	+	+	+	+	+	_	_	_	_	_	_	+	_	+	+
Smithia sensitiva	+	+	+	+	+	+	_	_	_	_	_	_	_	_	_	_

E- Ethanol, A- Acetone

Table 3. Mineral Content of Leafy Vegetables (mg/100g dry vegetables)

Name of the vegetable	Ca	Mg	P	Na	K	Fe	Zn	Cu	Co
Chlorophytum Tuberosum	2070	216	62	22	124	68.6	1.48	1.3	0.32
Colocasia esculenta	131	50	96	16	262	11.96	3.5	1.62	0.92
Commelina benghalensis	861	162	117	52	119	40.3	2	1.6	0.1
Smithia sensitiva	1320	113	69	72	102	13.11	6	1.78	0.5

Table 4. Fluorescence Analysis

Name of the vegetable	Powd. + 50%HCl		Powd. + 50%HNO_3		Powd. + Ethanol		Powd. + $FeCl_2$		Powd. + 10%NaOH		Powd. + 5%KOH		Powd. + Acetic acid	
	V	UV	V	UV	V	UV	V	UV	V	UV	V	UV	V	UV
Chlorophytum Tuberosum	Gr	Br	Y.Gr	O.Gr	Gr	Br	O.Gr	Gr	Y.Gr	Gr	O.Gr	Gr	D.O.Gr	Br
Colocasia esculenta	Gr	D.Gr	Y.Or	Gr	O.Gr	D.Br	O.Gr	D.O.Gr	O.Gr	Gr	Gr	D.Gr	D.Gr	Bl
Commelina benghalensis	D.Gr	Bl	Br	Bl	D.Gr	Bl	Gr	Br.Gr	D.Gr	D.Gr	D.Gr	Bl.Gr	Bl.Gr	Bl
Smithia sensitive	D.Gr.	D.Gr	Or	D.Gr	D.O.Gr	Bl.Br	D.Gr	Bl.Br	D.O.Gr	Bl.Br	D.Gr	BL.Gr	Bl.Gr	Bl

Bl-Black, Br-Brown, D-Dark, Gr-Green, O-Olive, Or-Orange, Y-Yellowish

Mineral composition

Mineral elements of the vegetables are presented in Table 3. Mineral elements are divided broadly into two groups. Macroelements are those which are required in a greater amount (upto 100mg/day) while microelements or trace elements are required in less amount (< 100mg/day) [28]. Calcium is an important dietary mineral for strong bones and muscle/neurological functions. The Na/K ratio in human body is very important to prevent high blood pressure. Calcium and phosphorous are one of the important constituents for growth and health of bones, teeth, muscles and blood [29,30]. Out of four vegetables, two vegetables namely *Chlorophytum tuberosum and Smithia sensitiva* had the maximum calcium content i.e. more than 1000mg/100g and it was less in the remaining two vegetables. The highest amount (2070mg/100g) was observed in *Chlorophytum tuberosum* followed by *Smithia sensitiva.* Phosphorus content in the vegetables ranged between 62 to 117mg/100g being highest in *Commelina benghalensis.* Magnesium is involved in bone development, protein synthesis, enzyme action, normal muscular contraction and nerve transmission [31]. Highest content of magnesium was noticed in *Chlorophytum tuberosum* (216mg/100g), followed by *Commelina benghalensis* (162mg/100g). In the present study sodium content of vegetable samples ranged between 16mg-72mg/100g.

Trace elements like iron, zinc, copper, cobalt and manganese are essential in enzyme metabolism. Iron is an essential trace element for hemoglobin formation, and normal functioning of the central nervous systems and in the oxidation of carbohydrate, proteins and fats[32]. Low dietary intake and poor bioavailability of iron from food are the major cause of anemia. Regular consumption of leafy vegetables can prevent iron deficiency.

Values of iron in the vegetables ranged from 13.11-68.6mg/100g. However maximum amount was found in *Chlorophytum tuberosum.* Regulatory role of zinc in the body is its involvement in proper functioning of brain[33]. Zinc also plays an important role in various biological functions, including DNA synthesis, gene expression, hormone control, enzymatic reactions, and cell proliferation [34.35]. The level of zinc in different vegetables ranged between 1.48 to 6 mg/100g. Maximum amount of zinc was observed in *Smithia sensitiva.* Amount of copper was highest in *Smithia sensitiva* (1.78/100g) followed by *Colocasia esculenta* (1. 62/100g). In the present study different vegetables had less than 1mg of cobalt content and values ranged between 0.1mg-0.92mg/100g being highest in *Colocasia esculenta.*

Jain *et al.* [20] recorded mineral content of *Oxalis corniculata* from Gwalior. The vegetable was rich in sodium (1.12%), potassium (2.71%), calcium (2.5%) and magnesium (0.25%). Khader and Rama, [36] reported mineral content of common leafy vegetables from Hyderabad. They noticed that iron and manganese content were maximum whereas zinc and copper content were less. Saikia and Deka [37] while working on composition of some wild leafy vegetables from Assam found that calcium was the most abundant macroelement with values ranging from 125.7-543.2 mg/100g. They further stated that potassium, magnesium and phosphorus were in appreciable amount. Iron was the most abundant microelement in the examined vegetables ranging from 6.97-22.73mg/100g. Eight green leafy vegetables were analyzed by [23] from Assam which contained 70mg/100g potassium. Calcium content was maximum in *Moringa oleifera* while sodium content was highest in *Basella rubra*. They also reported the highest zinc and iron content in *Brassica juncea.*

Gogoi and Kalita, [38] analyzed mineral content of leafy vegetables from Assam. Potassium was the most abundant macroelement ranging from 6240-14570 mg/Kg followed by sodium, calcium and magnesium. Among the trace elements iron was highest (252.8-712.9 mg/Kg) followed

by zinc, manganese and copper. Based on reported values of leafy vegetables from Assam they concluded that all the vegetables were a rich source of minerals.

Total Antioxidant Activity

Total antioxidant capacity was found to be highest in methanolic and ethanolic extracts of *Smithia sensitiva* (388.29 mg/g and 386.90 mg/g respectively). In the present study *Colocasia esculenta* showed the highest activity in ethanolic extract (241.95mg/g). In methanolic and aqueous extract remaining vegetables showed significant activity (> 100mg/g).

Table 5. Total Antioxidant Capacity of Wild Leafy Vegetables (mg/g dry vegetables)

Name of the vegetable	Methanol	Ethanol	Water
Chlorophytum tuberosum	252.92	26.41	118.03
Colocasia esculenta	110.83	241.95	148.46
Commelina benghalensis	132.4	77.46	122.21
Smithia sensitiva	388.29	77.04	386.9

Sasi Priya *et al*. [39] evaluated two vegetables viz. *Mukia maderaspatana* and *Solanum trilobatum* that had good total antioxidant activity in methanolic extract (127.1mg/g and 63.5mg/g respectively). Dasgupta and De [40] analyzed eleven leafy vegetables from Kolkata. The highest TAC was recorded in *Centella asiatica* (224µg/mg) and lowest in *Nyctanthes arbortristis* (30.3 µg /mg).

Table. 6 Average status of nutritional composition of wild leafy vegetables

Parameters Vegetables	Moisture	Ash	Proteins	Carbohydrates	Crude Fibers
Chlorophytum tuberosum	+	++	+	++	+++
Colocasia esculenta	+	+++	+++	++	++
Commelina benghalensis	++	+++	+	+	+++
Smithia sensitive	+++	+	+	+	+++

Table. 7 Status of total antioxidant capacity of wild leafy vegetables

Name of Vegetables	TAC
Chlorophytum tuberosum	+++
Colocasia esculenta	++
Commelina benghalensis	++
Smithia sensitive	+++

Average status of nutritional composition of wild leafy vegetables

Overall nutritional composition of leafy vegetables is presented in Fig. 1,2,3 and 4. The vegetables possessed a high moisture content (>60%) and were a rich source of macroelements (100mg/100g). However better amount of microelements were present in all studied vegetables. So they can fulfil the necessity of macro as well as microelements.

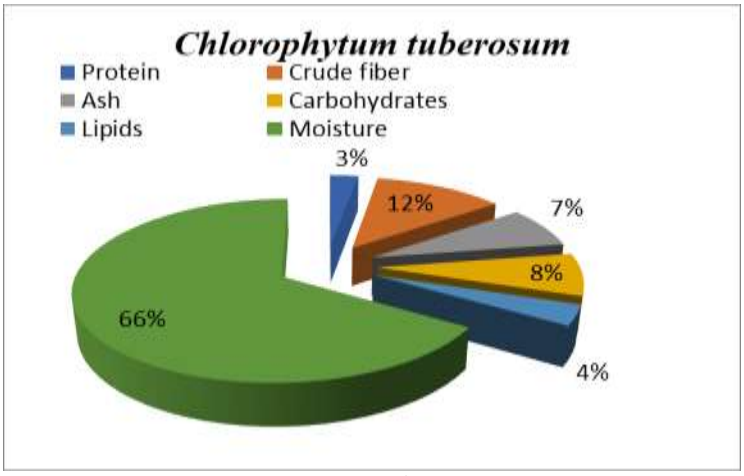

Fig. 1 Nutritional Composition of *Chlorophytum tuberosum*

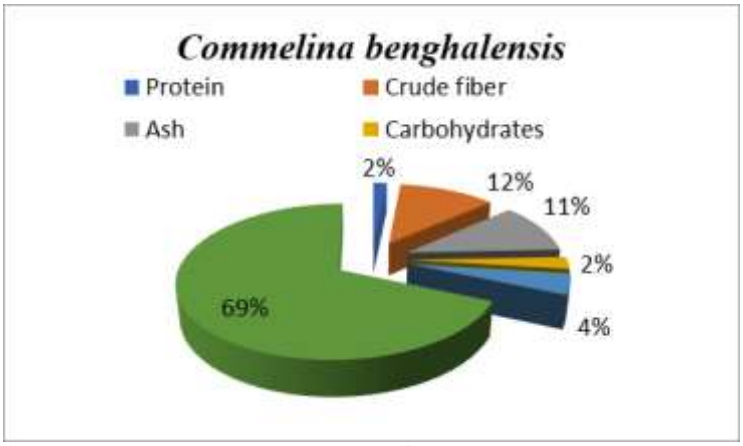

Fig. 2 Nutritional Composition of *Commelina benghalensis*

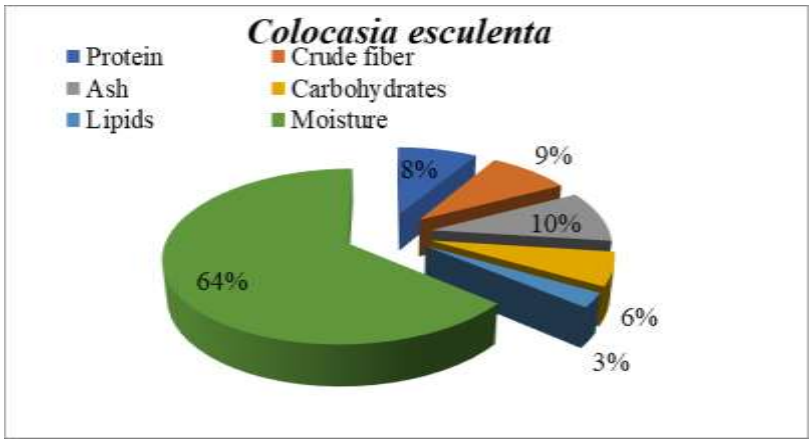

Fig. 3 Nutritional Composition of *Colocasia esculenta*

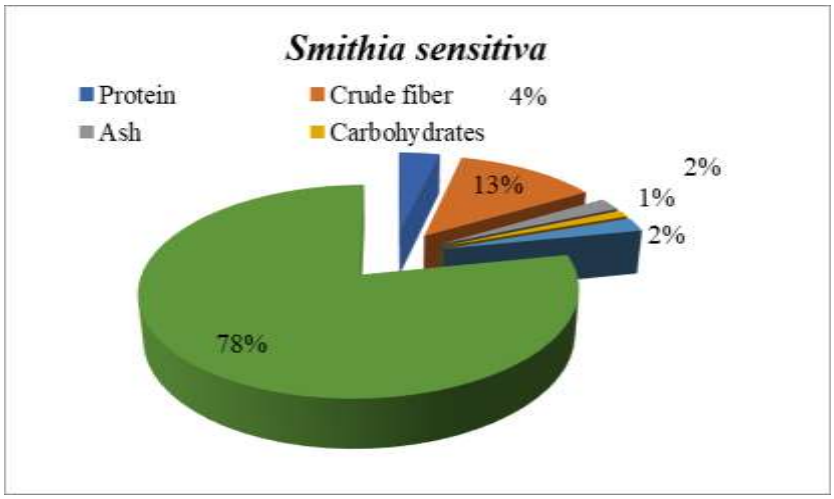

Fig. 4 Nutritional Composition of *Smithia sensitive*

CONCLUSIONS

All vegetables are a good source of proteins and fibers. Along with proteins these vegetables possess a high amount of minerals which are very beneficial for health. Total antioxidant capacity was found to be highest in methanolic and ethanolic extracts of all the vegetables.

Declaration by Authors

Acknowledgement: None

Source of Funding: None

Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

1. Robinson DS, Food biochemistry and Nutritional Value. Longman Scientific and Technical Publisher, New York, USA; 1990, 369p.
2. Kubmarawa D, Andenyang IFH. Magomya AM, Proximate composition and amino acid profile of two non-conventional leafy vegetables (*Hibiscus cannabinus and Haematostaphis barteri*). Afr. J. Food Sci 2009;3(9): 233-236.
3. Anon P, Opabode JI, Adegboye OC, Application of Biotechnology for the improvement of Nigerian Indigenous leafy vegetables. Afr. J. Biotech. 2005; 4 (3): 138-142.
4. Butnariu M, Noţiuni TS, Practice DB, Vegetală. Editura Mirton, Timişoara; 95p.
5. Genders, R. Scented Flora of The World Robert Hale London, (2007) 1994; 560p.
6. Sundriyal M, Sundriyal RC. wild edible plants of the Sikkim Himalaya: Nutritive value of selected species. Econ. Bot. 2004; 58: 286-299.
7. Chauhan D, Shrivastava AK, Patra S. Diversity of leafy vegetables used by tribal peoples of Chhattisgarh, India. Int. J. Curr. Microbiol. App. Sci. 2014; 3(4): 611-622.
8. Harborne JB. Phytochemical Methods. A guide to modern techniques of plant analysis, 3rd Eds. Springer (India) Private Limited, New Delhi, 1998;302p.
9. Chase CR, Pratt RJ. Fluorescence of powdered vegetables drugs Ind. J. Exp. Bio. 1949; 33(6): 428-432.
10. AOAC, Official Methods of Analysis, Association of the Analytical Chemists, 1995, 15th Eds. Washington DC, USA
11. Sadasivam S, Manickam A. Biochemical methods 2nd Eds. New Age International, 1996;256 p.
12. Folch J, Lees M. Sloane-Stanley GHA. Simple method for the isolation and purification of total Lipids from animal tissues. J. Bio. Chem. 1957; 266(1): 497-509.
13. Toth SJ, Prince AL, Wallace A, Mikkenlsen DS. Rapid quantitative determination of eight mineral elements in plant tissue. Systematic procedure involving use of a flame photometer. Soil Sci. 1948; 66:459-466.
14. Prieto P, Pineda M, Aguilar M. Spectrophotometric quantification of antioxidant capacity through the formation of a phosphomolybdenum complex: Specific application to the determination of vitamin. Anal. Biochem. 1999; 269: 337-341
15. Ozcan M. Mineral contents of some plants used as condiments in Turkey. Food Chem. 2004;84: 437-440
16. Adedapo A, Jimoh F, Afolayan A. Comparison of the nutritive value and biological activities of the acetone, methanol and water extracts of the leaves of *Bidens pilosa* and *Chenopodium album.* Acta Poloniae Pharma Drug Research. 2011;68(1): 83-92.
17. Gupta S, Lakshmi AJ, Manjunath MN, Prakash J. Analysis of nutrient and antinutrient content of underutilized green leafy vegetables. Food Sci. Technol. 2005;38(4): 339–345.
18. Sheela K, Kamal G, Nath D, Vijayalakshmi G, Yankanchi M, Patil RB. Proximate composition of underutilized green leafy vegetables in southern Karnataka. J. Hum. Ecol. 2004; 15(3): 227-229
19. Vishwakarma KL, Dubey V. Nutritional analysis of indigenous wild edible herbs used in eastern Chhattisgarh. India. Emir. J. Food Agric. 2011; 23(6): 554-560.
20. Jain AK, Tiwari P, Bashi BM. Nutritive aspects of *Oxalis corniculata* L. Used by tribals of central India during scarcity of food. J. Amer. Sci. 2010; 6: 435-437.
21. Seal T, Pillai B, Chaudhuri K. Effect of solvent extraction system on the antioxidant activity of some selected wild leafy vegetables of Meghalaya state in India. Int.J.Phar.Sur.R. 2013; 4(3): 1046-1051.
22. Misra S, Misra MK. Leafy vegetable plants of South Odisha, India. Int. J. Agric. Food Sci. 2014;3(4): 131-137.
23. Saha J, Biswal AK, Deka SC. Chemical composition of some underutilized green leafy vegetables of Sonitpur district of Assam, Indi\. Int. Food Res. J. 2015;22(4):1466-1473.
24. Singh G, Kawatra A, Sehgal S. Nutritional composition of selected green leafy vegetables, herbs and carrots. Plant Foods Hum. Nutr, 2001; 56(4): 359-364.
25. Pradhan S, Manivannan S, Tamang JP. Proximate, Mineral composition and antioxidant properties of some wild leafy vegetables. J. Scientific Indus. Res. 2015;74: 155-159.

26. Kayode O, Idowu A, Micheal A, Adegbite AA. Chemical and phytochemical profile of some uncommon green leafy vegetables consumed in South West, Nigeria. J. Envir. Sci. Toxic food Tech. 2012; 1(3): 22-26.
27. Yekeen TA, Akintaro OI, Akinboro A, Azeez MA. Evaluation of cytogenotoxic and nutrient composition of three commonly consumed vegetables in south-western Nigeria. Afr. J. food Agri. Nutri. Dev. 2013; 13(2):5452-5466.
28. Akubugwo IE, Obasi NA, Chinyere GC, Ugbogu AE. Nutritional and chemical value of *Amaranthus hybridus* L. leaves from Afikpo, Nigeria. Afr. J. of Biotech. 2007; 6(24): 2833-2839.
29. Naidu GRK, Denschlag HO, Mauerhofer E, Porte N, Balaji T. Determination of macro, micro nutrient and trace element concentrations in Indian medicinal and vegetable leaves using instrumental neutron activation analysis. Appl. Radiat. Iso. 1999;50: 947–953.
30. Barminas JT, Charles M, Emmanuel D. Mineral composition of non-conventional leafy vegetables. Plant Foods Hum Nut. 1998; 53(1): 29–36.
31. Adeyeye EI, Otokiti MKO. Proximate composition of some nutritionally valuable minerals of two varieties of *Capsicum annum* (Bell and Cherry peppers). Discovry Innovation. 1999;11: 75-81.
32. Madhavan KN, Iyengar V. Iron content, bioavailability & factors affecting iron status of Indians. Ind. J. Med. Res. 2009;130: 634-645.
33. Brown CE, Dyck RH. Distribution of zincergic neurons in the mouse forebrain. J. Comp. Neurol. 2004;479: 156–167.
34. Beyersmann D, Haase H. Functions of zinc in signaling, proliferation and differentiation of mammalian cells. Biometals. 2001; 14: 331–341.
35. Colvin RA, Fontain CP, Laskowsk M, Thomas D. Zn^{2+} transporters and Zn^{2+} homeostasis in neuron. Eur. J. Pharmacol, 2003; 479: 171–185.
36. Khader V, Rama S. Selected mineral content of common leafy vegetables consumed in India at different stages of maturity. Plant Foods Hum. Nutr. 1998;53:71-81.
37. Saikia P, Deka DC. Mineral content of some wild green leafy vegetables of North-East India,. J. Chem. Pharma. Res. 2013;5(3): 117-121.
38. Gogoi P, Kalita JC. Proximate analysis and mineral components of some edible medicinally important leafy vegetables of Kamrup district of Assam, India. Int. J. Pharma. Bio. Sci. 2014; 5(4): 451 – 457.
39. Sasi Priya G, Radhika R Siddhuraju, P. Antioxidant and antimicrobial activity of traditional Indian leafy vegetables: *Mukia maderaspatana* and *Solanum trilobatum.* Int. J. Pharm. Pharma. Sci. 2012; 4(2): 513-521.
40. Dasgupta N, De B. Antioxidant activity of some leafy vegetables of India: A comparative study. Food chem. 2007; 101: 471-474.

How to cite this article: Lubdha A. Kagale, Surekha P. Rode. Nutritional and phytochemical analysis of leafy vegetables from Konkan Region, Maharashtra. *Int J Health Sci Res.* 2023; 13(1):111-119.
DOI: *https://doi.org/10.52403/ijhsr.20230116*

******