J. Phytol. Res. **23**(1) :23-28, 2010

NUTRITIONAL QUALITY OF AN INVASIVE WEED *STRUCHIUM SPARGANOPHORUM* (L.) KUNTZE

C. SALINI and I. MINI
Department of Botany, University College, Thiruvananthapuram-695 034, Kerala, India.
E- mail dr.mini08@gmail.com

Struchium sparganophorum (L.) Kuntze common in the wetlands of Kerala was analyzed for assessing nutritive potential of the plant such as moisture, fibre, energy nutrients (soluble carbohydrate, total protein, total lipid), vitamins (β carotene, ascorbic acid), pigments, antinutrients (tannin, phytic acid and phenol), macro and microelements (C, N, P, K, Ca, Na, Fe, Cu, Zn). The distribution of primary metabolites followed similar pattern of distribution in various bioparts (soluble protein > carbohydrate > lipids). The analysis of metabolites of *S. sparganophorum* indicated that the leaves of the plant are rich source of energy providing bioorganics such as soluble sugars (39.6 ± 1.2 mg g^{-1}), protein (75 ± 3.96 mg g^{-1}) and lipid (12.1 ± 0.57 mg g^{-1}) and store houses of antioxidants like ascorbic acid (0.139 ± 0.018 mg g^{-1}) and β carotene (0.03 ± 0.00 mg g^{-1}). Macronutrients viz., nitrogen (13.04 ± 0.79 mg g^{-1}), phosphorus (0.22 ± 0.02 mg g^{-1}), sodium, potassium and calcium (6.63 ± 0.25, 10.66 ± 0.1 and 3.56 ± 0.15 mg g^{-1}, respectively) content were high in the leaf. The micro nutrients revealed a distribution pattern with Fe>Zn>Cu in all the bioparts. The concentration of iron (939.5 ± 1.62 µg g^{-1}), copper (22.02 ± 0.89 µg g^{-1}), and zinc (60.85 ± 0.93 µg g^{-1}) also recorded high values in the leaves of *S. sparganophorum*. The values of bioorganics and macro and micronutrients remained higher than most of the conventional leafy vegetables.

Keywords: β carotene; Bioorganics; Elements; *Struchium sparganophorum*.

Introduction

Invasive/ noxious species may be any plant either native or introduced with a harmful or destructive influence on existing natural communities interfering with the objectives or requirements of people. The distribution, prevalence, competing ability, behaviour and survival of the weeds are determined by the climatic, edaphic and biotic factors of the environment [1]. Invasive weeds may destroy wildlife habitat, reduce opportunities for hunting, fishing, camping and other recreational activities, displace many threatened and endangered species, reduces plant and animal diversity because of weed monoculture. There exist beneficial weeds drawing away the attacks of crop destroying insects but act as breeding grounds for insects and pathogens that attack other plants or with nutritional and medicinal potentials. Weed species form a component of agrobiodiversity, playing a part in the ecology of natural enemies as in harbouring and supporting many beneficial arthropod species that suppress pest populations consequently improving crop yields[2].

Struchium sparganophorum (L.) Kuntze is a naturalized weed of wetlands and riparian zones, commonly known as Oreille–mouton in French and Yerba de Faja in Spanish and included under the family Asteraceae. The native range of the species is Tropical America, Indian Ocean Islands, South Eastern Asia and Indo Pacific[3].

Oboh[4] reported that *S. sparganophorum* is a leafy vegetable popularly used in soup preparations in processed and unprocessed forms in Nigeria. Systematic studies on the bioorganics and elemental characteristics of the *S. sparganophorum* remain few and fragmentary that prompted the present investigation. The present study envisaged a detailed analyses of moisture content, bioorganics viz., carbohydrates, proteins, lipids, phenol, phytic acid, tannin and plant pigments and mineral composition viz., carbon, nitrogen, phosphorous, potassium, calcium, sodium, copper, zinc and iron in various bioparts of *S. sparganophorum*.

Material and Methods

Struchium sparganophorum (L.) Kuntze (synonym: *Ethulia sparganophora* (L.) basionym, *Sparganophorus spanganophora* (L.) C. Jeffery) of the family Asteraceae is an invasive and naturalized weed which possess an erect pubescent stem, simple, alternate leaves with serrate

Table 1. Proximate composition of *Struchium sparganophorum* (L.) Kuntze.

SI.No.	Parameter (mg g^{-1})	Stem	Leaf	Root
1	Soluble Carbohydrates	20.5±0.8	39.6±1.2	5.3±0.09
2	Total Protein	64±2.05	75±3.96	8.02±0.7
3	Lipid	8.9± 0.15	12.1± 0.57	2.95± 0.07
4	Phenol	19.94± 2.77	29.15 ± 5.07	21.96± 4.46
5	Ascorbic acid	0.08± 0.029	0.139± 0.018	0.06 ± 0.007
6	β carotene	0.006 ± 0.004	0.03 ± 0.00	0.0008± 0.0002
7	Phytic acid	0.04±0.001	0.02±0.001	0.001±0.0
8	Tannin	0.5±0.01	0.3±0.004	0.4±0.001

Table 2. Comparison of *Struchium sparganophorum* (L.) Kuntze leaf with Leafy vegetables.

	Parameters	*Struchium sparganophorum*	*Amaranthus hybridus* [17]	*Sauropus androgynus* [16]	*Boerhavia diffusa* [18]	*Amaranthus spinosus* [16]	*Cassia tora* [16]	*Moringa oleifera* [19]	*Brassica oleracea* [20]
%	Moisture	84.83±1.04	83.48	88	82.22	84	85	76.53	-
mg g^{-1}	Protein	75±3.96	179.2	34	22.6	36	7	275	14.4
	Lipid	12.1±0.57	46.5	-	-	-	-	-	1.2
	Carbohydrate	39.6±1.2	521.8	5	105.6	87	14	438.8	55.8
	Sodium	6.63±0.2	0.07	-	1.625	-	-	-	0.18
	Potassium	10.66±0.1	0.542	-	0.009	-	-	-	2.46
	Calcium	3.56±0.15	0.44	3.13	1.74	2.48	1.44	20.09	0.47
µg g^{-1}	Iron	939.5±1.62	135.8	100.9	0.12	131.2	201.8	282.9	5900
	Zinc	60.85± 0.93	38	-	-	-	-	34.1	18
mg g^{-1}	Phosphrus	0.22±0.03	0.34	-	-	-	-	-	0.23
µg g^{-1}	VitaminC	0.139±0.018	0.25	-	-	-	-	-	0.32
	β carotene	0.03±0.00	0.03	-	-	-	-	-	-
µg g^{-1}	Copper	22.02 ± 0.89	-	-	-	-	-	11.2	0.23

margin, arranged oppositely on the stem. Flowering heads are homogamous, small, sessile and clustered in leaf axils. Flowers are white tubular, 3 to 4 lobed, perfect, the anther base sagittate with accuminate lobes. The style is branched and pale blue in colour. Fruit is an achene, 3 or 4 angled and propagation is through seed.

Whole plant was collected from its natural habitat washed thoroughly to remove adhering particles and the bioparts viz., leaves, stem, root and flowers were separated, dried under shade followed by oven drying. The dried samples were powdered kept in polythene bags and stored in a desiccator until analyses. Fresh samples were used for the analysis of moisture[5], total soluble sugars[6], pigments[7], vitamins[8], phenols[9] , phytic acid and tannin[5] while dried samples were used for the analysis of total lipids[10], total proteins[11], elements (carbon[12], total nitrogen[11], total phosphorous[14], macro/micro nutrients[15]).

Results and Discussion

The analysis of moisture, biochemical and elemental constituents in the invasive weed *S. sparganophorum* revealed significant variation among different bioparts such as root, stem, leaves and flower. The plant exhibited

Table 3. Pigment analysis in of *Struchium sparganophorum* (L.) Kuntze.

SI. No.	Parameter (mg g^{-1})	Leaf	Stem
1	Total Chlorophyll	0.248 ± 0.09	0.159 ± 0.09
2	Chlorophyll a	0.106 ± 0.03	0.068 ± 0.042
3	Chlorophyll b	0.142 ± 0.05	0.091 ± 0.06
4	Carotenoids	0.365 ± 0.002	0.265 ± 0.17

Table 4. Analysis of elements in *Struchium sparganophorum* (L.) Kuntze.

	Element	Stem	Leaf	Root	Flower
	Carbon	705 ± 7.53	679.78 ± 4.79	579.52 ± 4.99	106.38± .25
	Nitrogen	9.31±0.50	13.04 ±0.79	7.23 ± 0.25	5.08 ±0.3
mg g^{-1}	Phosphorus	0.22 ±0.02	0.22 ± 0.03	0.19 ± 0.007	0.22 ±0.04
	Sodium	6.38 ±0.25	6.63 ± 0.25	3.51 ± 0.15	3.58 ±0.15
	Potassium	6.38 ±0.25	10.66 ±0.1	0.93 ± 0.1	10.54 ±0.15
	Calcium	19.07 ±0.32	3.56 ± 0.15	4.23 ± 0.22	5.35 ±0.15
	Iron	1667 ± 2.52	939.5 ±1.62	4055.5 ± 1.80	1087.5 ±1.5
µg g^{-1}	Copper	35.82±1.5	22.02 ± 0.89	42.04 ±1.3	3.2 ± 0.87
	Zinc	100.2±1.9	60.85 ± 0.93	150.89 ± 1.2	8.9 ± 0.16

comparatively high moisture content among the bioparts which varied from 84% to 88% in leaf and stem, respectively. The high values noticed in the plant irrespective of the bioparts may be attributed to the ecological condition of wetlands with high saturation of water in the soil.

The distribution of primary metabolites is given in Table 1 .The nutritional potentials of *S. sparganophorum* is compared with other leafy vegetables[16-20] (Table 2). Bioorganics viz., carbohydrates, proteins, lipids and plant pigments help assess the nutritive potential and photosynthetic efficiency of the plant. The total protein in *S. sparganophorum* remained comparatively high in leaf (75±3.96 mg g^{-1}) and a progressive increase was noticed from root to leaf. The leaf proteins have several roles in plants and function as a major storage sink of nitrogen. More over storage protein of leaves has an important role in maturation, reproduction and final seed yield of the plant[21]. The soluble carbohydrate content in *S. sparganophorum* recorded high values in leaf (39.6±1.2 mg g^{-1}) and stem (20.5±0.8 mg g^{-1}) while comparatively low in root (5.3±0.09 mg g^{-1}). Concentration of carbohydrates, the basic energy storing compounds, could be a good pointer to physiological processes in plants[22]. Leaves of *S. sparganophorum* showed high lipid content (12.1± 0.57 mg g^{-1}) and recorded a gradual decrease from leaf to root.

β carotene, a precursor of vitamin A is needed for maintenance of skin, mucous membranes, bones, teeth, hair, vision and reproduction. Ascorbic acid (Vitamin C) is necessary for healthy teeth, gums and bones and is essential for proper functioning of adrenal and thyroid glands. It is an antioxidant and as such act as a general detoxicant. The leaves showed high amount of β carotene (0.03 ± 0.00 mg g^{-1}) and ascorbic acid (0.139± 0.018 mg g^{-1}) as compared to stem and root which remained in unison with reported values in various leafy vegetables[23]. The plant could be a valuable source of dietary vitamins in human nutrition and remained within the range of the reported values in various conventional leafy vegetables[24] while slightly higher values were reported by Yadav[25], Shingde *et al.*[26] and Yadav and Sehgal[27].

The concentration of phenol in *S. sparganophorum* followed a distribution pattern with leaf

> root >stem. Antinutrients such as tannin (<6%) and phytic acid content were low in the bioparts of the plant. Phytic acid is considered as an antinutrient since it chelates some essential minerals like calcium and iron contributing to mineral deficiency in man. It is the storage form of phosphorus in many plant tissues. Phenol, phytic acid and tannin in the leaves were 29.15 ± 5.07, 0.02±0.001 and 0.3±0.004 mg g^{-1}, respectively. Plants with >6% tannin content were of little nutritive value since high tannin interferes with protein digestibility. Tannins are astringent, bitter plant polyphenols that either bind or precipitate proteins. They are mainly located in the vacuoles or surface wax of plants and do not normally interferes with plant metabolism.

Chlorophyll and carotenoid content (Table 3) was high in leaf (0.248 ± 0.09 and 0.365 ± 0.002 mg g^{-1}) than in stem. Dietary consumption of green vegetables was found to be associated with protection against mutagenic and clastogenic activity of genotoxicants and chlorophyll, present in all green plants has been suggested to be the principal factor involved. Yang *et al.*[28] and Kotake *et al.*[29] emphasized the ingestion of green leafy vegetables rich in carotenoids possessed the potential to lower the risk of cancer.

The distribution pattern of macro elements (Table 4) revealed fluctuation among various bioparts of the plant may be due to the structural and physiological differences. Several elements have predominant nutritive role[30] and are highly significant components of a balanced diet. The macro elements showed a distribution pattern with C> Ca> N> Na = K >P in stem, C>N > K >Na>Ca >P in leaf, C >N >Ca >Na >K >P in root and C >K >Ca >N >Na >P in flower. Carbon was found to be the most abundant element in the plant and high concentration was noticed in stem as compared to the rest of the bioparts.

Nitrogen content remained high in the leaf (13.04 ±0.79 mg g^{-1}) and is an important constituent of proteins, nucleic acids, porphyrins, alkaloids, vitamins and coenzymes as well as possesses a crucial role in metabolism, growth, reproduction. Phosphorus content was almost same in stem, leaf and flower (0.22 ±0.02 mg g^{-1}) compared with root. Sodium and potassium content was high in leaf (6.63 ± 0.25 and 10.66 ±0.1 mg g^{-1}) as compared to stem, root and flower. The calcium content was high in stem (19.07 ±0.32 mg g^{-1}) compared to flower, root and leaf. The values of calcium in the present study corroborated with the reports of Reddy and Bhatt[31]. The optimal calcium content ensures proper assimilation of fats, fibre, reduce formation of green house gas methane in animal and organisms [32]. Calcium and phosphorus are associated with each other for growth and maintenance of bones, teeth and muscles[33].

The Na/K ratio in the body is of great concern for prevention of high blood pressure and Na/K ratio less than one is recommended [34]. Ca/P ratio help assess the nutritive quality and the ratio greater than 1 is recommended. The ratio of Na/K and Ca/P revealed the nutritive potential of *S. sparganophorum*. The values of potassium and sodium obtained in the present study remained higher than conventional leafy vegetables [35] while calcium levels were lower than *M. oleifera*.

Micronutrients are required in traces and exert a positive or negative influence on metabolism. The concentration of iron was greater in root (4055.5 ± 1.80) as compared to stem, flower and leaf. The higher concentration at the root surface as compared to the rest of the bioparts is in unison with the reports of Vesk *et al*[36]. The iron content in the leaves of *S. sparganophorum* (939.5±1.62 µg g^{-1}) remained higher than *S. androgynus*, *A. hybridus*, *C. tora* and *M. oleifera*. Iron content in the leaves depends on the phenology, application of fertilizers and agronomic characters[37]. The copper content was greater in root compared with stem, leaf and flower. It is an essential micronutrient which can act as an antioxidant that neutralise free radicals lowering the risk to cardiovascular diseases and cancer. Copper is required for the synthesis of iron porphyrin, the precursor of chlorophyll and affects the accumulation and metabolism of iron[22]. The copper content in *S. sparganophorum* leaves (22.02 ± 0.89 µg g^{-1}) was higher than the values in *M. oleifera* and *B. oleraceae*. The analysis of zinc displayed high values in root compared with stem, leaf and flower. Zinc is an essential micronutrient for life since it is required either as a structural component or as reaction site in numerous proteins[38] and plays positive correlation with the foliage yield[39]. Lack of zinc in the diet may reduce the appetite and sense of taste in humans and interfere with normal functioning of the immune system. The concentration of zinc in the leaves of *S. sparganophorum* (60.85 ± 0.93 µg g^{-1}) remained higher than *M. oleifera*, *B. oleraceae* and *A. hybridus*.

In general, *S. sparganophorum* leaves are rich source of energy providing bioorganics (soluble sugars, protein and lipid) and store houses of antioxidants like ascorbic acid and β carotene. Oboh[4] reported that the leaf extract of *S. sparganophorum* has high antioxidant activity. The mineral composition is higher in *S. sparganophorum* as compared to some ethnic and conventional leafy vegetables except calcium and phosphorus.

Acknowledgement

The authors are highly indebted to The Principal, University College, Thiruvananthapuram for the facilities provided.

References

1. Rao V S 1983, Principles of weed science. Oxford and IBH Publishing Co.Pvt.Ltd. New Delhi, Bombay, Culcutta. pp. 9.
2. Richardson D. M, Macdonald I, Holmes P M and Cowling R M 1992, Plants and animal invasions. In Cowling (Ed). *The ecology of Fynbols- Nutrient, Fire and Diversity.* Oxford University Press. South Africa, Cape Town.
3. Smith and Albert C 1991, Flora Vitiensis nova: a new flora of Fiji. National Tropical Botanical Garden, Lawai, Kauai, Hawaii, volume 5. pp. 626.
4. Oboh G 2006, Nutritive Value, Antioxidant and Antimicrobial Properties of *Struchium sparganophora* Leaves *J. Med. Food* **9**(2) 276-280.
5. IUPAC, 1987, Standard methods for the analysis of oils, fats and derivatives. Blackwell Scientific Publication, Oxford.
6. Roe J H 1955, *J. Bio.Chem*: 212.
7. Arnon D I 1949, *Plant Physiol;* Lancaster. **24** 1-5.
8. Sadasivam S and Balasubramanian T 1987, In: *Practical manual in Biochemistry.* Tamil Nadu Agricultural University, Coimbatore. pp. 14.
9. Mayr V, Treutter D, Santos Buelga C, Bauer H and Feucht W 1995, *J. Phytochem.* **38**(5) 1151-1155.
10. Bligh E G and Dyer W J 1959, Rapid method of total lipid extraction and purification. *Can. J. Biochem. Physiol.* **37** 911-917
11. Belcher R and Godbert A L 1954, Semi-micro quantitative organic analysis. 2nd edition. Longman, Green and Co., London: 102 –107
12. El Wakeel S K and Riley J P 1957, The Determination of organic carbon in marine mud. *J. Cons. Intern. Explor. mer.* **22** 180-183.
14. Murphy J and Riley J P 1962, A modified single solution method for the determination of phosphate in natural waters. *Anal. Chem. Acta* **27** 31–36.
15. APHA 1992, Standard methods for the examination of water and waste water. 18th edn. APHA-AWWA-WPCF. pp. 1134.
16. Sheela K, Nath K G, Vijayalakshmi D, Geeta M, Yankanchi and Patil R B 2004, Proximate composition of under utilized green leafy vegetables in Southern Karnataka. *J. Hum. Ecol.* **15**(3) 227-229.
17. Akubogwo I E, Obasi N A, Chinyere G C and Ugbogu A E 2007, Nutritional and Chemical value of *Amaranthus hydridus* L. leaves from Afikpo, Nigeria. *fr. J. Biochem.* **96**(24) 2833-2839.
18. Ujowundu C O, Igwe C U, Enemor V H, Nwaogu L A and Okafor O E 2008, Nutritive and Antinutritive Properties of *Boerhaavia diffusa* and *Commelina nudiflora* leaves. *Pakistan J. Nutrition* **7**(1) 90-92.
19. Ibok O, Ellis W O and Deborach O 2008, Nutritional potential of two Leafy Vegetables: *Moringa oleifera* and *Ipomea batatas* leaves. *Scient. Res. Essay* **3**(2) 057-060.
20. Luciane M, Kawashima and Valenta L M 2003, Mineral profile of raw and cooked leafy vegetables consumed in Southern Brazil. *J. Food Comp. and Annal.* **6**(5) 605-611.
21. Hoffaker R C 1982, Biochemistry and physiology of leaf protein. Encyclopedia of Plant Physiology. New Series **14A** 374.
22. Mehmooduzzafar Nighat and Iqbal M 2004, Carbon assimilation, partitioning and bioaccumulation in *Ruellia tuberosa* plants under coal smoke pollution. *Int. J. Ecol. and Environ. Sci.* **30** 215-223.
23. Rajyalekshmi P K, Venkatalekshmi K and Venkatalakshmamma 2001, Effect of boiling on β carotene content of green leafy vegetables consumed by tribals of South India. *J. Food Sci. Technol.* **30** 56-58.
24. Nambiar V S and Seshadri S 2001, Retention of total and carotenes from fresh radish leaves in shallow fried steamed/sauted and baked products of western India. *J. Food Sci. Technol.* **39** 458-461.
25. Yadav S K 1992, Nutritional evaluation of some nonconventional green leafy vegetables. M.Sc. Thesis CCS Haryana University, Hisar.
26. Shingde M Y, Chavan K M and Gupta D N 1995, Proximate composition of unconventional leafy vegetables from Konkan region of Maharashtra. *J. Food Sci. Technol.* **32** 424-437.
27. Yadav S K and Sehgal S 1995, Effect of home processing on ascorbic acid content of spinach and *amaranthus* leaves. *Plant Food Hum. Nutr.* **47** 125-131.
28. Yang Y, Huang C Y, Peng S S and Li J 1996, Carotenoid analysis of several dark green vegetables associated with a lower risk of cancer. *Bio. Med. Environ. Sci.* **9**(4) 386-92.
29. Kotake N E, Kushiro M, Zhang H, Sugawara T, Miyashita and Nagao A 2001, Carotenoids affect the proliferation of human prostrate cancer cells. *J. Nutr.* **131**(12) 3303-6.
30. Jain V K 2006, Plant physiology, Ninth edition, S. Chand & Co. pp. 594.
31. Reddy N S and Bhatt G 2001, Contents of minerals in leafy vegetables cultivated in soil fertilized with

different chemical fertilizers. *J. food Sci. Technol.* **56** 1-2.

32 Machmuller A and Krefzer M 2005, Influence of Myristic acid supplementation on energy, fatty acid and calcium metabolism of sheep as affected by dietary calcium and forage concentration ratio. *J. Ani. Physiol. Ani. Nutr.* **89** 284-290.

33 Turan M, Kordali S, Zengin H, Dursum A and Sezem Y 2003, Macro and micro mineral content of wild edible leaves consumed in Eastern Anatolia. *Acta Agric. Scand. Sect. B, Plant and Soil Sci.* **53** 129-137.

34 FND 2002, Food and Nutrition board Institute of Medicine. National Academy of Sciences. Dietary, reference intake for energy, carbohydrate, Fibre, Fat, Fatty acids, Cholesterol, Protein and Amino acid (Micronutrients) www.nap.edu.

35. Singh G, Asha K and Sehgal S 2001, Nutritional composition of selected green leafy vegetables, herbs and carrots. *Plant Food Hum. Nutr.* **56** 351-364.

36. Vesk P A, Nockoldis C E and Allaway W G 1999, Metal localization in water hyacinth roots from an urban wet land. *Plant, Cell and Env.* **22**(2) 149-158.

37. Bawa S F and Yadav S P 1986, Protein and mineral content of green leafy vegetables consumed by Sokota populations. *J. Sci. Food Agric.* **37** 505-506.

38. Neill P O 1993, Environmental chemistry. 2 nd Edition. Chapman and Hall, London. pp. 268.

39. Achinewhu S C, Oqbonna C and Hart A D 1995, Chemical composition of indigenous wild herbs, spices, nuts, fruits and leafy vegetables. *Plant Food Hum. Nutr.* **48**(4) 341-348.