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Nutritional assessment of the plant, *Spergula arvensis* L.

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Spergula arvensis. var. *sativa*, commonly known as *Corn spurry* has been used as a green vegetable from prehistoric times by certain tribes. The composition and nutritional value of this plant, however, is not known. The nutritional assessment of the plant was, therefore, carried out. The components analyzed include moisture, carbohydrate, fat, protein, β-carotene, lycopene, micronutrients, macronutrients, vitamin A, vitamin C, energy, total antioxidants and amino acids. Antinutritional components such as tannins, total phenols and minerals were also analyzed. The study shows that the plant has low fat and sugar content but high potassium, calcium and sodium content. Mercury, nickel, lead and palladium are absent. Essential amino acids such as leucine, isoleucine and histidine are high when compared to FAO/WHO standard reference values. The plant can, therefore, be used as an alternative source of food to overcome malnutrition problems.

Keywords: Amino acids, Corn spurry, Food analysis, Minerals, Nutrition, *Spergula arvensis* L.

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Introduction

Plants, greens and seeds were important foods of the tribal population the world over. Traditional vegetables that grow wild and available readily are inexpensive and high quality nutrition sources for the poor segment of the world population. Extensive research in traditional vegetables show that it could boost agricultural output and food security since they are rich in nutrients and are easy to grow. The use of traditional and indigenous vegetables by the tribal people, however, has not yet been scientifically validated. Knowledge of indigenous plant use, therefore, needs urgent scientific investigation, validation and documentation before it is irretrievably lost. In recent years, several plant species such as dandelion (laxative, diuretic and appetite stimulant), garlic (blood purifier, antibacterial, antiparasitic) and tomato (anticancer, antidiabetic) have been identified that contain nutrients and display beneficial medicinal or therapeutic properties[1]. *Spergula arvensis* L. (Family Caryophyllaceae), grows as a weed in the potato and the carrot fields of the Nilgiri District of Tamil Nadu. The local people consume it as a green vegetable, which created an interest in us on its possible use elsewhere as human diet. A literature survey revealed that the seeds and fruits of *S. arvensis* have been used for consumption by humans even during prehistoric times[2]. This low growing species seems to have been harvested near the ground and used as early as the Celtic and Roman times. The macro remains from the gut of the Kayhausen and European bog bodies have revealed the presence of *S. arvensis* seeds. The plant seems to have close links with intentionally cultivated cereals and hence gained the status of a secondary cultivated plant. The plant is also believed to have been cultivated on its own in later years. The tender young plant is also used as an edible by the *Oraon* tribe in the Indian states of Jharkhand, Orissa and West Bengal[3]. Only a preliminary analytical study has been reported on this plant[4-6]. We report here for the first time a detailed study on the composition and nutritional assessment of the plant.

Plant description

S. arvensis (Plate 1), commonly known as *Corn spurry*, *Devil's gut*, *Field spurry*, *Pickpurse*, *Sandweed*, *Starwort* and *Stickwort* is an unusual weed associated with crops especially in corn and potato fields. Annual, tap rooted, several stemmed at base, ascending to erect, in range 10–40 cm tall; shoots

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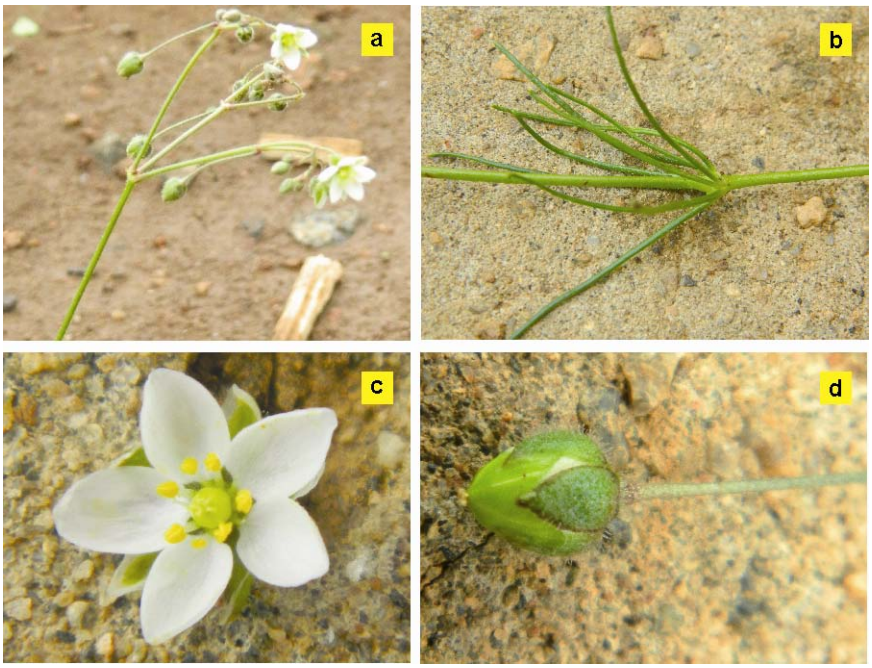

Plate 1—*Spergula arvensis*. a) Whole plant, b) Leaves and stem, c) Flower and d) Fruit

with fleshy unequal leaves in axillary clusters of 8−20, glandular-pubescent, somewhat viscid.

This plant *S. arvensis* is distributed in all of Western Europe, Northern Africa, Northern America, China, India, Japan, Northern and Central regions of the European part of the former USSR, the Caucasus, Western and Eastern Siberia and the Far East.

S. arvensis is an endangered species[7] and there are three varieties found, a wild one (*S. arvensis* var. *vulgaris*) and two cultivated forms (*S. arvensis* var. *sativa*, '*Corn spurry*' and *S. arvensis* var. *maxima*, '*Giant spurry*')[8]. The plant, *S. arvensis* var. *sativa*, (Plate 1a) is sticky and glandular. It grows to a height of 15-60 cm. Leaves are in false whorls, slender, rather fleshy and half cylindrical (Plate 1b). Flowers are white, in sub-umbellate clusters and self pollinating (Plate 1c). Fruits are round capsules with many dull, black flattened seeds (Plate 1d). Capsules are subglobose and shining. Seeds are black, keeled or narrowly winged. The seeds contain 10 % of yellow fatty oil. The plant is cultivated as a fodder crop in Europe and South Africa. It is recommended as a soil renovator for sandy soils and also as a green manure[4]. The dried seeds are ground and used with flour for making bread. The weed forms a potential source of organic matter in the soil and significantly increases the available nitrogen, phosphorus and potassium[5]. When interplanted in rows, it attracts beneficial insect–predators and parasites of cabbage pests. It repels harmful insects–caterpillars, aphids and root worms.

Plants belonging to Caryophyllaceae family are reported to cure intermittent fever, eye troubles, urinary bladder diseases, inflammations of digestive and respiratory tracts. In addition, the plant is also reported to possess diuretic, antioxidant, antimicrobial, wound healing properties and employed against pulmonary tuberculosis[4,9-12]. In the present study, amino acids, minerals, micro and macronutrients of *S. arvensis* were analyzed. These data could be a starting point for better food selection and consequent improvement in the nutritional status of people who consume this plant.

Materials and Methods

Collection and authentication of the plant

The plant, *S. arvensis* var. *sativa*, was collected from in and around Udhagamandalam town in August 2009 and was authenticated by Dr. N Selvaraj, Professor and Head, Horticulture Research Station, Tamil Nadu Agricultural University, Udhagamandalam, The Nilgiris. A voucher specimen (TIFAC 05) was deposited in the herbarium of JSS College of Pharmacy, Udhagamandalam.

Processing of sample

Approximately 5 kg of the whole plant (root, stem, leaves and flowers) was collected and dried. Healthy plants were removed and washed thoroughly with

distilled water until no foreign material remained. Some plants were also dried using tray drier for 3 h. The dried samples were stored in capped bottles in a desiccator till further analysis. Minerals were analyzed using the dried plant samples. Vitamin A, vitamin C and antinutritional factors were analyzed using fresh plant samples. All the analyses were conducted in duplicate.

Proximate analysis

Fresh plant material was used for the determination of its nutritive value. Moisture, ash, crude protein, fat and dietary fibre were analyzed by the methods described in Association of Official Analytical Chemists, Washington, DC, USA[13]. Moisture was determined using the oven dry method. A sample of 5 g was dried in an oven with air circulation for overnight at 100–110 °C. The ash content was determined by weighing 10 g of sample in a silica crucible and heating over a low flame till the material was completely charred, followed by heating in a muffle furnace for 3–5 h at 600 °C. It was cooled in a desiccator and weighed to ensure completion of ashing. The crude fat was determined using petroleum ether in a soxhlet apparatus with a boiling point 40–60 °C[14]. Protein analysis was performed according to the Kjeldahl method[14]. The energy value was calculated by multiplying the mean values of the crude fat, protein and total carbohydrates by 37, 17 and 17, respectively[15]. The total energy was calculated by taking the sum of the energy value of the crude fat, protein and total carbohydrates.

Mineral analysis

Ultrapure water collected from milliQ system was used. Analytical grade (Merck) nitric acid was used. Metal standard solutions (Sigma Aldrich) were prepared by appropriate dilutions of 1000 mg/L stock solutions. Analysis was carried out with Shimadzu AA 6300 Flame Atomic Absorption Spectrometer (Tokyo, Japan) equipped with deuterium background corrector. Hollow cathode lamps of specific metals were used as a radiation source.

Calcium, iron, sodium, cadmium, chromium, copper, palladium, magnesium, manganese, nickel, zinc and potassium were determined in the dried and powdered sample. One gram of the sample was weighed and taken in a clean silica crucible. This was ignited until the sample was completely ashed and then digested with 0.5 mL of concentrated nitric acid. The digested contents from the crucible were filtered using Whatmann filter paper No. 42 impregnated with HNO_3 and the volume of the clear solution was made up to 100 mL using double deionized water. The required blanks were also prepared. The solutions were appropriately diluted prior to analysis for the estimation of minerals and heavy metals. Samples of the respective mineral solutions were quantified against standard solutions of known concentration that were analyzed concurrently[16].

β–Carotene and lycopene were measured by the spectrophotometric method. Vitamin A was estimated by the spectrometry conversion method. Vitamin C was estimated by the 2, 4- dinitrophenylhydrazine method in conjunction with spectrophotometric measurement[17]. Tannins, total phenols and total antioxidants were also estimated. Tannins were calculated by the Folin-Dennis method and total phenol content was estimated by the Folin-Ciocalteau method[18]. Total antioxidant content of the fresh plant was measured by Ferric reducing antioxidant (FRAP) method[19]. The sample (2 g) was powdered using liquid nitrogen and transferred to a small beaker, to which 2 mL of water was added. The pH of this solution was then recorded using a pH meter.

Amino acid composition

The standard and sample solutions were analyzed by reverse phase high pressure liquid chromatography (RP-HPLC) using fluorescence detector for the quantification of amino acids. A Shimadzu LC20AT system, equipped with a quarternary pump and a fluorescence detector was used. An isocratic elution was performed for 70 min using a stationary phase of Hibar C_{18} column (250 x 4.6 mm i.d., 5 µ) and a mobile phase consisting of (a) 0.1 M sodium citrate, buffer of pH 3.2, adjusted with perchloric acid along with 30:70 % v/v ethanol, (b) 0.1 M sodium citrate, buffer of pH 10, adjusted with 4 M sodium hydroxide and (c) 0.2 M sodium hydroxide, in the ratio 60:20:20 % v/v. The mobile phase was pumped at a flow rate of 0.5 mL/min. Precolumn derivatisation of the sample and standard solutions were performed using o-phthalaldehyde reagent. The retention times of the various amino acids were determined using an amino acid calibration mixture. Quantitation of individual amino acids was achieved by monitoring the absorption of the column eluate at 348 and 450 nm and comparing the areas under the individual peaks with those of the corresponding amino acid standards. The essential amino acids were then calculated using the following formula[20],

Essential amino acid score = g of essential amino acid in 100 g of test protein/g of essential amino acid in 100 g of FAO/WHO (1991) reference pattern x 100

Results and Discussion

Survey and interview with the local rural population of Nilgiris, India, revealed that the plant leaves are usually cooked and consumed. It was felt that a nutritional analysis was necessary and the data obtained on nutritional analysis is shown in Table 1. The protein content in the leaves was 2.30 %, whereas moisture content was very high (85.89 %). Sugar and carbohydrate contents were low. The total antioxidant content was found to be 294.23 µg/mL. β-Carotene and lycopene contents were 21.95 and 3.93 mg/100 g, respectively. Antioxidants are known to be useful to control the oxidative stress including certain cancers, heart disease, etc. The plant was slightly acidic in nature with a pH of 6.46. Vitamin A and C contents were 36.58 IU and 1.19 mg/100 g, respectively. The amounts of antinutritional contents are shown in Table 2. Total phenols and tannins content were 105.83 mg/mL and 165.79 mg/100 g, respectively. Tannins may also be effective in protecting the kidneys and have been shown to have potential as antiviral[21], antibacterial[22] and antiparasitic agents[23]. Data on the mineral composition is given in Table 3. The leaves contained high concentration of potassium (7200.22 mg/100 g), calcium (647.89 mg/100 g) and sodium (429.7 mg/100 g). Sodium plays an important role in the transport of metabolites and potassium is important as a diuretic. Calcium plays an important part in nerve-impulse transmission and in the mechanism of neuromuscular system. Silicon content was also high. Silicon is known to improve plant cell wall strength and structural integrity. It also improves drought and frost resistance of the plant. It decreases lodging potential and boosts the plants natural pest and disease fighting systems. Zinc, cadmium and iron were present in moderate amounts, namely 259.15, 322.39 and 154.15 mg/100 g, respectively. Zinc is known to speed up the healing process after injury. It also plays ubiquitous biological roles as it interacts with a wide range of organic ligands and has a role in the metabolism of RNA, DNA signal transduction and gene expression. Small amounts of magnesium (38.48 mg/100 g), manganese (33.72 mg/100 g) and chromium (67.89 mg/100 g) were also present. Magnesium is an important signaling ion useful in enzyme activation and catalysis. Manganese functions as cofactors for a large variety of enzymes. A small amount of copper was present (1.573 mg/100 g). Copper is known to help in biological electron and oxygen transportation. The essential amino acids contents are shown in Table 4. The amounts of

Table 1—Nutritional analysis based on fresh weight basis

Nutrient	Quantity present
Carbohydrates	7.03 %
Sugars	0.17 %
Starch	1.8 %
Total Ash	2.52 %
Cellulose	4.30 %
Fibre	1.96 %
Free fatty acids	28.2 %
Crude protein	2.30 %
Nitrogen	369.03 mg/mL
Total antioxidants	294.23 µg/mL
Moisture	85.89 %
Fat	0.30 %
Vitamin C	1.19 mg/100 g
Vitamin A	36.58 IU
pH in 2 % solution	6.46
β – carotene	21.95 mg/100 g
Lycopene	3.93 mg/100 g
Total energy	169.7 kJ/100 g

Table 2—Antinutritional analysis based on fresh weight basis

Antinutrients	Quantity present
Tannins	165.79 mg/100 g
Total phenols	105.83 mg/mL

Table 3—Mineral analysis based on oven dry basis

Mineral/ Element	Quantity present (mg/100 g)
Sodium	429.7
Potassium	7200.22
Magnesium	38.48
Manganese	33.72
Calcium	647.88
Copper	1.573
Zinc	259.15
Silicon	689.34
Lead	ND
Arsenic	ND
Mercury	ND
Cadmium	322.39
Nickel	ND
Chromium	67.89
Aluminium	ND
Paladium	ND
Iron	154.15

ND - Not detected

Table 4—Amino acid content

Amino acids	Quantity present g/100 g	Essential amino acid score	FAO/WHO (1991) Requirement pattern
Lysine	1.12	19.31	5.8
Proline	5.47	-	-
Isoleucine	6.28	224.2	2.8
Histidine	8.47	445.7	1.9
Leucine	9.43	142.8	6.6
Glycine	3.87	-	-

leucine, isoleucine and histidine were high when compared to the data of FAO/WHO reference standards[24]. Further work on anticancer potential of the plant is in progress.

Conclusion

The present study shows that the plant, *S. arvensis* var. *sativa*, has all the properties required as an alternate source of food to overcome the malnutrition problems. It has low carbohydrate and starch content and hence it can be consumed by diabetic patients also.

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