BIOSCIENCES BIOTECHNOLOGY RESEARCH ASIA, December 2015. Vol. **12**(3), 1923-1929

Chemical Composition of *Suaeda vermiculata* Seeds Grown in Hormozgan in the South of Iran

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DOI: http://dx.doi.org/10.13005/bbra/1858

(Received: 01 October 2015; accepted: 13 November 2015)

There are 26 families of halophytes species in Iran and more than 70% of them has belonged to the *Chenopodiaceae* family. The leaf of halophytes has been used as a medicine for hepatitis and antiviral activity. The young leaf of it often mixed with other vegetable to reduce their saltiness. Elemental food composition data are important for both consumers and health professionals. Literature survey revealed that no investigation has been done on *Suaeda Vermiculata* grown in the Hormozgan province by now. The aim of this study was determination of proximate composition, mineral elements contents in this endemic Iranian seed. *S.vermiculata* were collected in August 2014 from Bandar Abbas, Hormozgan Province, Iran and samples was identified by R. Asadpour and voucher was deposited in the Herbarium of Faculty of Pharmacy, Pharmaceutical Sciences Branch, Islamic Azad University (IAUPS).Concentrations of some elements containing Na, K, Li, Se, Cu, P, I, Mg, Ca, Al, B, Mn, Fe and Zn were analyzed in *S.Vermiculata* samples by atomic absorption spectroscopy by standardized international protocols in Research Laboratory in Pharmaceutical Sciences Branch, Islamic Azad University. Obviously in *S. vermiculata*, the amount of the mineral element contents are high in comparison by other seeds studied in other countries, even the value of potassium, iron and Manganese in *S. vermiculata* grown in Hormozghan were ten times higher than seeds grown in Bushehr as different region of South of Iran. In this study, the nutritive value of *S. vermiculata* seed native to Hormozghan province in the south of Iran was determined and results revealed that it is so rich in mineral elements especially Iron. Therefore it could be recommended as a raw material for various industries but also would serves as useful dietary supplements.

Key words: *Suaeda Vermiculata* Seeds, Mineral elements, Iran, Hormozghan

Trace elements in soils result from the weathering of rocks and minerals in the soil parent material. The concentration of trace elements in different parent rocks is especially important in soils of undeveloped arid and semi-arid zones[1-2]. Trace elements can be mobilized from arid soils through plant uptake and erosion/leaching processes, but these soils usually contain higher contents of trace elements than other soils[3]. Some elements are highly immobile in nature and do not degrade biologically and, therefore, are persistent in soils and sediments. Residence times depend on the climate and can range from few decades in tropical areas to thousands of years in arid regions[4]. Trace element problems in agricultural soil (both deficiencies and toxicities) are associated with soil

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properties such as pH, soil texture, cation exchange capacity (CEC), and Fe/Mn content, which are mostly inherited from the soil parent material. More siliceous parent material will result in sandier soils with lower fertility, while mafic rocks release the greatest quantity of basic cations and, therefore, influence soil fertility[3, 5-6]. Halophyte plant species vary considerably in their nutritive value. Information on forage quality of halophytes in each phenological stage could help range managers choose suitable plant species for cultivation and also determine suitable grazing time to achieve higher animal performance in saline rangelands[7]. Suaeda Vermiculata and Suaeda aegyptiaca are common species of the genus Chenopodia. There are 26 families of halophytes species in Iran and more than 70% of them has belonged to the Chenopodiaceae family. They grow during both high and low tides from April to October. Some halophytes are also able to live in regions immersed with saline water. Tides immerse some regions seasonally, monthly, or daily, with a certain period and depth that depends on height. In response, halophytes increase the uptake of Na and decrease the uptake of K to their shoots; in addition, the activity of their fermentative enzymes is particularly high. Some halophytes are also compatible to live in immersion regions with saline water, for example coastal salt swamps[8]. The growth rates of *S.vermiculata* and *S.aegyptiaca* decreased after July and then increased after August. The leaf of halophytes has been used as a medicine for hepatitis and antiviral activity. The young leaf of it often mixed with other vegetable to reduce their saltiness[8]. Elemental food composition data are important for both consumers and health professionals. They contain moderate amounts of protein of which high percentage is in the form of soluble proteins. They also contain high levels of ash and crude fiber. Plant secondary metabolites content of halophytes vary considerably from species to species and from season to another. All these factors have certain implications on the feeding and nutritional value of halophytes.

It is proposed that the increased salt intake and, hence, the osmotic pressure of the rumen may affect the microorganism population and metabolism The high salt content is perhaps the major negative component in halophytic species and may be a factor which limits dry matter intake (DMI) and also reduces digestibility[9]. Halophytic plant species vary considerably in their chemical composition and nutritive value. There is a lack of information about trace element concentrations in soils of southern Iran. Information on the content and distribution of trace elements in soil and parent materials is important for several reasons, including characterization and assessment of soil quality and health, evaluation of soil for crop growth as well as forage and livestock production, providing baseline information required to determine the environmental impact from accidental chemical spills, as well as environmental contamination risk assessment. The objectives of this paper are (1) To determine the concentration ranges of selected elements in S.Vermiculata seed, growing in Hormozgan province in the south of Iran (2) To assess the chemical composition of S.Vermiculata seed according to the characteristics of the soil properties and soil quality, and (3) to investigate relationships among and between elements and other soil properties.

MATERIALS AND METHODS

Plant material

S.vermiculata seeds were collected in August 2014 from Sarkhun village, Bandar Abbas, Hormozgan Province, Iran: (27°23’34" N 56°23’59" E, 100m). Specimen was identified by R. Asadpour and voucher was deposited in the Herbarium of Faculty of Pharmacy, Pharmaceutical Sciences Branch, Islamic Azad University (IAUPS) Tehran. Hormozgan province district is situated in the southeast of Iran. More than 70% of the province is covered by mountains and hills thus it is a mountainous region[10-11]. This province is located between northern latitude 25p 24' to 28p 57' and eastern longitude 53p 41' to 59p 15'. It occupies an area of 70697 km2 [11-14].

The study area (BandarAbbas region in Hormozgan province) is located in northern costal zones of the Persian Gulf in south of Iran (Fig. 1). The extent of the study area was about 18,000 ha and was situated in mountain and hill area having elevation ranging from 860 m to 3,081 m. Annual rainfall is 214 mm, mean temperature is 24.33°C, average maximum temperature is 31.25°C, and average minimum is 17.35°C. The soils of the study area are mostly shallow and therefore are only suitable as rangeland for herd grazing. According to the American system of soil taxonomy[15], the soils of the region are classified in as Entisols.

Plain part of the region includes much of the southern, eastern and northern part of the strip consisted of alkaline and saline soils contain large amounts of soluble salts such as chloride, sulfate and carbonate of Ca, Mg, sodium, and potassium[14,15].

Sampling Method

The present study was carried out the common halophytes S. Vermiculata in early summer, 2014 *S.Vermiculata* is native to the south, southern-east and Persian Gulf coastal and are recognized as Tahma. After drying at (95 C °) for 1 h to a constant weight, the samples were separated and weighed individually. The dried samples were homogenized and grounded using a mortar.

Crude Fiber

Five grams of the grounded *S.Vermiculata* mature dry seeds samples were digested in 50 ml of 1.25% H_2SO_4. The solutions were boiled for 45 minutes and then were filtered and washed with hot distilled water. The filtrates were digested in 50 ml of 1.25% Sodium Hydroxide solutions. For 50 minutes these solutions were heated, filtered and washed with hot deionized water and over dried. The final oven-dried residues were ignited in a furnace at 550°C. The weights of the left after ignition were measured as the fiber contents and were expressed in term of the weights of the samples before ignition[14, 16].

Crude Protein

The protein nitrogen in one gram of the dried samples were converted to ammonium sulphate by digestion with concentrated H_2SO_4 (Merck 96.5%) and in the presence of $CuSO_4$ and K_2SO_4 (20-21). The solutions were heated and the ammonia evolved were steam distilled into Boric acid 2%. The nitrogen from ammonia were deduced from the titrations of the trapped ammonia with 0.1M HCl with Tashirus indicator (methyl red: methylene blue 2:1) until a purplish pink color were obtained. Crude proteins were calculated by multiplying the valve of the deduced nitrogen by the factor 6.25 mg[13, 14, 17-18].

Ash Content

One gram of the oven-dried samples in powder from was placed in acid washed crucible by known weight. They were ignited in a muffle furnace for 5 hours at 550°C. After cooling crucibles they were weighed and the ash contents were expressed in terms of the oven-dried weight of the sample[18].

Zinc, Manganese, Copper and Potassium Determination

All stock solutions and working standards were stored at 4°C and brought to room temperature (25 °C) before use. For Zinc, Manganese, Copper and Selenium concentration in *S.Vermiculata*, powered seed samples were dried in oven for 48 hours at a temperature of 85°C. The samples were then ground and sieved through 0.5 mm sieve. The powdered samples then subjected to the acid digestion using concentrated nitric acid (65% Merck), Sulfuric acid (96.5% Merck) and per chloric acid (70% sigma). Analar grade hydrogen peroxide (about 30%) also was used for the digestion. Application of concentrated HNO_3 along with thirty percent hydrogen peroxide H_2O_2 (Merck) for mineralization of samples to the complete digestion of samples[12-14] following Environmental Protection Agency (EPA) Method 3052 was done[19-21].

Two gram of air-dried of each homogeneously *S.Vermiculata* samples accurately weighed and 30.0 mL of the digestion mixture (2 parts by weight of nitric acid: 1 parts of Sulfuric acid & 4 parts by weight perchloric acid) and heated slowly by an oven and then rise the temperature. The remaining dry inorganic residues were dissolved in 30.0 mL of concentrated nitric acid and the solution used for the determination of trace and essential mineral elements. Blanks and samples were also processed and analyzed simultaneously. All the chemicals used were of analytical grade (AR). Standardized international protocols were followed for the preparation of material and analysis of heavy metals contents[22-24]. The samples were analyzed by Flame Emission Spectrophotometer Model AA-6200 (Shimadzu, Japan) using an air-acetylene, flame temperature: 2800°C, acetylene pressure: 0.9–1.0 bar, air pressure: 4.5–5 bar, reading time: 1–10 sec (max 60 sec), flow time: 3-4 sec (max 10 sec), using at least five standard solutions for each metal and determination of potassium content was followed by FDA Elemental analysis[25]. In order to verify of reliability of the measuring apparatus, periodic testing of standard solutions was performed. The accuracy was checked using quality control test for fungi and their substrate samples to show the degree of agreement between the standard values and measured values; the difference was less than 5%.

Iron Determination

The aliquot was passed through the atomic absorption spectrophotometer to read the iron concentration. Standards were prepared with a standard stock of 10 mg/L using ferrous ammonium sulphate where 3 - 60 ml of iron standard solution (10 mg /L) were placed in stepwise volumes in 100 ml volumetric flasks. 2 ml of hydrochloric acid were added and then brought to the volume with distilled water. The concentration of iron in the aliquot was measured using the atomic absorption spectrophotometer in mg/L. The whole procedure was replicated three times[11-13].

Calcium, Sodium and Magnesium Determination

5 ml of the aliquot were placed in a titration flask using a pipette and diluted to 100 ml with distilled water and subsequently 15 ml of buffer solution, ten drops of Eriochrome black T indicator and 2 ml of triethanolamine were added. The mixture was titrated with Ethylene-Diamine-Tetra-Acetate (EDTA) solution from red to clear blue[12-13].

Selenium Determination

Stock standard solutions for selenium were 1000 g /mL solution. All reagents and standards were of analytical grade (Merck, Germany) .The palladium matrix modifier solution was prepared by the dilution (10 g/ L) $Pd(NO_3)_2$ and iridium AA standard solution, 1000 g/ mL in 20% HCl , 0.1 % V/V nitric acid prepared by dilution trace pure 65 % nitric acid and 0.1 % Triton X-100 were used. Doubly distilled water was used in all operations. The samples were analyzed by Flame Emission Spectrophotometer Model AA-6200 (Shimadzu, Japan). The analyze performed according by Analytical Method ATSRD[11-13, 26-27].

Crude Protein - Nitrogen Crude Protein (CP)

Nitrogen content was measured by modified Kjeldahl method (involving sulphuric acid digestion). It was assumed all N present in the feed was derived from protein and that all protein contains 16%N. Thus CP = N x 100/16 = N x 6.25[28].

Ether soluble Extract

An ether soluble extract was prepared by mixing the feed using petroleum ether for a defined period. The mixture was then filtered. The filtrate was allowed to evaporate and the remaining residue was weighed to determine the mass of the ether soluble extract (EE)[28].

Crude Fiber

Crude Fiber (CF) was measured by taking the residual food following ether extraction, and then boiling it with acid and then alkali for defined periods. The residue was then dried, weighed, ashed and weighed again. CF was weight of residue less weight of ash. CF equates to the indigestible part of ration (for non-ruminants) and consists of cellulose, hemicellulose, lignin, i.e. plant cell walls[28].

Nitrogen free extractive

This is an indirect determination of the non-fiber carbohydrate content of the feed. Nitrogen free extractive (N-FE) as a percentage is 100% minus the rest. This will include sugars, starches, and water soluble vitamins (will also measure some cellulose, hemicellulose, resins, pigments, tannins, pectin)[28].

RESULTS AND DISCUSSION

The mean content of trace and essential mineral elements (mg/kg DW) in the mature dry seed of *S.Vermiculata* samples is shown in table 1. The samples were analyzed by wet digestion method and standardized international protocols were followed for the preparation of material and analysis of mineral contents and analyzed by Atomic Absorption Spectrophotometer in Research Laboratory in Pharmaceutical Sciences Branch, Islamic Azad University.

Proximate composition and physicochemical characteristics of the samples has shown in table 2 , based on the fresh weight.

Obviously in *S.vermiculata* the order of amount of the some mineral element contents such as zinc copper, iron, and calcium are different in comparison by other *S.vermiculata* studied in Iran in recent study in Bushehr. Chamkouri et al. in 2015, studied the minerals of halophytes and *S.Vermiculata* in Bushehr area and concluded that the accumulation of Na was higher than those of K, Ca and Mg[29] . Our data revealed that sodium content was higher than other metallic ions but not as much as in this seed growing in Busher. Asri *et al.* in 1997 studied the minerals of halophytes and concluded that the accumulation of Na was higher than those of K, Ca and Mg [30]. The results

Table 1. The Mean content (mg/kg DW) composition of the mature dry seeds of *S.vermiculata* from Hormozgan Province, Iran

Minerals	Mean content ± SD* (mg/Kg DW)	Minerals	Mean content ± SD* (mg/Kg DW)
Sodium	103.44± 2.103	Boron	0.066 ± 0.003
Potassium	24.732± 1.036	Phosphor	2.005 ± 0.002
Calcium	0.882± 0.012	Iodine	0.582 ± 0.001
Magnesium	22.07 ± 0.023	Manganese	0.030 ± 0.002
Iron	11.42 ± 0.006	Sulphur	1.002 ± 0.002
Copper	0.102 ± 0.001	Fluorine	0.005± 0.001
Selenium	0.005 ± 0.001	Lithium	0.001 ± 0.0002
Zinc	0.052 ± 0.004	Molybdenum	0.001± 0.0001

*SD = Standard Deviation

Table 2. Proximate analysis of *S.Vermiculata* samples from Hormozgan Province, Iran

Nutrient	Percentage (%)
Dry Matter(DM)	36.16
Crude Protein (CP)	15.79
Crude Fiber (CF)	3.14
Ash	8.78
Fats / lipids (EE)	5.59
Nitrogen Free Extractives (NFE)	30.54

showed that CP, CF, DMD and EE were 15.79, 3.4, 36.16% and 5.59 MJ/Kg, respectively in the mature seed of *S.Vermiculata.*

As the amount of structural tissues in the stem of plants increases with increasing plant age, the amount of DMD becomes reduced[31]. (There is a close relationship between digestibility and cell wall characteristics: cell contents can be 100% digestible for animals and will not become reduced even when the plant matures . In contrast, the

Fig. 1. Location of *S.vermiculata* samples collection

chemical composition of the cell wall changes as the plant grows, and fiber content increases and digestibility decreases, as was also reported by Asaadi and Yazdi[31]. Halophytes can play a significant role in the wellbeing of different peoples. The way in which halophytes are assessed will very much depend on which system dominates. Any evaluation must depend on viewing performance in the context (biological/ economic) in which it occurs. However, the shortage of animal feeds is the main constraint to increase indigenous animal production. It is a common characteristic in arid and semi-arid regions which is considered the main constraints to improve livestock productivity. In these areas, the animals often have to consume the only available feed resource which is halophytic plants[32]. Most of countries in these regions import large amounts of feed materials to cover the nutritional gap of animal and poultry which puts a heavy burden on the local governments and the farmers as well. It consequently decreases the net profits of animal investments operations due to the high costs of such feed materials. Improving nutritional status of desert grazing livestock (sheep, camels and goats) particularly during the prolonged dry seasons would increase the average annual animal production by approximately 27% [9,32]. Therefore, intensive efforts have been directed to find alternative feed resources from halophytes. Unfortunately, unpalatable halophytes are widely dominant. The development of salt tolerant fodder crops may help address the scarcity of good quality water in many arid agricultural regions of the world[9] mentioned that naturally occurring inland and coastal salt tolerant grasses have considerable potential as low cost non-conventional fodder crop. A number of saltbush species provide adequate nutrition with considerably preferred browse for domestic livestock. Halophytic plants such as *S.Vermiculata*, is generally considered extremely valuable as a fodder reserve during drought.

It has been long recognized that environmental conditions play a major role in determining the quantity and quality of nutrients produced by halophytes. It is reported that proteins level decreased under salinity is due to low uptake of nitrate ions[33] and due to other factors. It is proposed that the increased salt intake and, hence, the osmotic pressure of the rumen may affect the microorganism population and metabolism[9]. Increasing osmotic pressure in the rumen is believed to be unfavorable to the growth of protozoa. Also, the increased rates of outflow are believed to contribute to decreased protozoal population.

The mineral elements in the halophytes were significantly different depending on the weather conditions during growth. Halophytes such as *S. vermiculata* have mechanisms that can adapt and select the critical ions from the soil. The mineral elements in halophytes are significantly changed during growth in different weather conditions. The achieved data from this study suggests the strong potential of *S. vermiculata* as an halophyte could be a strong source of mineral and trace elements and compounds with beneficial proprieties, and a promising source of health products for food and pharmaceutical industry.

ACKNOWLEDGEMENT

Authors are thankful to Mrs Mahtab Alimardan for technical assistance. Supports from Pharmaceutical Sciences Branch, Islamic Azad University (IAUPS) is gratefully acknowledged.

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