The Nutritional Value of some Desert plants in Kuwait, Arabian Pennisula

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The nutritional role of five desert plants in the diet of the inhabitants of Kuwait was investigated. Different organs of the five species (leaves, stems or the whole plants) were analyzed for mineral ion composition, amino acids, carbohydrates content, crude fat, crude fibres and crude protein: *Rumex vesicarius, Malva parviflora, Suaeda aegyptiaca, Sonchus oleraceus* and *Cynomorium coccineum.* The hydrolyzate of *Sonchus oleraceus* was found to contain 17 amino acids and thus representing the most valuable species, also it contains large amount of crude fibres. All five plants contained eight essential amino acids. The parasitic species (*Cynomorium coccineum)* contained the highest content of protein (28.67% dry weight) and large amounts of crude fat. High concentrations of Na were recorded in *Suaeda aegyptiaca* (105.4mg / g oven dry weight). The levels of trace minerals detected constitute no hazardous effect on human health. Results indicated that edible desert plants of Kuwait could contribute useful amounts of essential nutrients especially in poor countries.

Key wards: *Gynomorium*, *Malva*, Nutritional value, *Rumex*, *Sonchus*, *Suaeda*.

Introduction

Protein malnutrition is considered one of the most serious problems in undeveloped countries. Until food technology develops to solve this problem, proteins from many botanical sources (aquatic or terrestrial plants) could be made palatable to humanbeings by selecting certain plants, which possess high protein content, crude fat, crude protein, crude fibres and mineral ions. Several investigators have suggested the utilization of aquatic plants, weeds and desert plants as additional food sources. Abo-bakr *et al*. (1984), stated that the leaf protein of an isolate of *Eichhornia crassipes* contained a high percentage of proteins together with high levels of all the essential amino acids, with the exception of methionine and cystine, which were present in limited amounts. Becker (1986), reported that wild plants can theoretically supply only about 10% of the populations by energy needs. Their contribution to the concentration to the vitamins and mineral supply is considerable, vitamins A, B_2 and C.

In Kuwait, tribal people living in Kuwait are consuming several wild plants. Some wild plants are cooked, or eaten raw directly or eaten as salad. However, very little attention has been paid to the edible desert plants which are consumed by many tribal sects. Moreover, the available information regarding their nutritional evaluation is very scanty.

In the present investigation, attempts were done to investigate the protein value (amino acids) crude protein, crude fat, crude fibres and mineral composition of five edible desert plants.

Materials And Methods

The species investigated are usually collected and eaten directly as many vegetables or cooked like spinach and radish. They grow in the desert of Kuwait during or after the rainy season. The following species were the subject of the present study:

1. *Rumex vesicarius* L, (Fam. Polygonaceae) common desert annual which inhabits sandy soil, wadi beds and cliffs along the sea (Gulf) shores, and on

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sand dunes. The leaves are eaten raw or after being cooked, and have been used in medicine as a laxative. The local name of the species is "Hommad or Hommeid."

2. *Malva parviflora* L. (Fam. Malvaceae) common weed which inhabits course sandy soil, roadsides and waste places. In many countries, it is cultivated and sold as vegetable. The edible part is the blade of the leaves,which are separated and cooked as spinach. The local name of the species is "Khobbas."

3. *Sonchus Oleraceus* L. (Fam Compositae), weed in orchards, fields, moist ground and in sandy deserts. The edible part is the shoot system (leaves and steam) which eaten directly like radish. Its local name in celery is "Go'died, Hodeid, and Hawwa."

4. *Suaeda aegyptiaca* (Hasseql.) Zohary (Fam. Chenopodiaceae). It is an annual herb, 20-25 cm long, glabrous, green, very fleshy and juicy. The species inhabits saline soils and marshes. After the rainy season (from December to February) seedlings are left to grow for about a month, then they are collected and sold in markets under the local name "Gollman". It is eaten raw or added to salad for providing a salty taste.

5. *Cynomorium occineum* L. (Fam. Cynomoriaceae). It is a blackish-red fleshy parasitic plant, inhabiting salty maritime sandy plains. It has been observed growing frequently together with *Limoniastrum monopetalum* and *Limonium delicatulum*; which are believed to be among its host plants (Täckholm, 1974). It infects desert plants including *Zygophyllum coccineum* and *Haloxylon salicornicum*. It has a sweet taste and is appreciated by children and many adult people. Also, it has a delicious taste when grilled on firebrands. The dried powdered plant is usually used for biliary obstruction when mixed with butter. The powder could be added to meat dishes as a condiment, the vernacular name of the species is "Tarthos".

Species were identified after Migahid (1978), Daoud & El-Rawi (1985) and Boulos (1988).

1. Collection of samples

The plants were collected from different sites in the desert and local markets of Kuwait. The plants were then cleaned and washed many times with tap and distilled water. The edible parts of each plant species were separated, cleaned and washed again with distilled water. Some of the cleaned and washed edible parts were dried in open air till obtaining a constant weight. The residual parts were dried in an electric oven at 90°C for 48 hours or up to a constant weight. After drying, the edible parts were ground and stored in a dessicator at room temperature for analysis.

2. Proximate composition

The moisture content was determined by the method of Jackson (1967) and the pH of the juice of edible parts was determined using a pH meter. Total nitrogenous compounds were

estimated by the microkjeldahl method as described by Peach and Tracey (1956) and the crude protein content was calculated (N x 6.25). Crude fibres, crude fats and ash were determined according to AOAC methods (1980). Total soluble carbohydrates were also determined according to the method of Allen (1974).

3. Mineral analysis

All plant samples were acid-digested (hydrochloric acid and nitric acid) before the determination of Na, K, Ca, Mg, Cr, Co, Zn, Pb, and Ni concentrations using atomic absorption spectrophotometry, where AAS-Flame was used for the analysis of Cr, Co, Cu, Zn, Fe and Mn; AAS-Graphite Furnace for Pb and Ni; and ICP for Na, K, Ca and Mg.

4. Amino acid analysis:

The protein of 20 mg dry weight of each sample was extracted by 1M NaOH at 37°C for 2 hours, followed by neutralization with 1M HCl. The protein was hydrolyzed by an equal value of 12 M HCl at 105°C for one day in Teflon screw-capped tubes. The hydrolyzate was evaporated to dryness under vacuum, extracted with ethanol, evaporated to dryness, redissolved in 0.1 M lithium citrate buffer (pH 2) and analyzed with an Eppendorf amino acid analyzer (LC 3000) at the Regional Center for Mycology and Biotechnology, Al-Azhar University.

Results and Discussion

The concepts used in describing the macronutrient content of food have their origins in the so-called “proximate system” which was developed in the last century by agricultural chemists concerned with animal nutrition (Henneberg & Stahmann, 1860,1864). In the “proximate system” the major components of food fall into four major categories; moisture (or water content), ash (the mineral content), fat and carbohydrate (Heijden *et al.,* 1999).

The categories protein, fat and carbohydrate together with the energy or caloric content constitute the “big four” and still widely used as the basis for nutritional labeling.

Amino acids content

Table (1) shows that 12 amino acids were detected in the hydrolyzate of *Rumex vesicarius, Malva parviflora* and *Cynomorium coccineum*. The hydrolyzate of *Suaeda aegyptiaca* contained 13 amino acids, while that of *Sonchus oleraceus* was found to contain 17 amino acids and thus representing the most valuable species. Among the essential amino acids (EAA), eight were present in the five species investigated (lysine, histidine, arginine, valine, methionine, isoleucine and phenylalanine); *Malva parviflora* lacked valine and isoleucine. Phenylalanine content was very high in *Cynomorium coccineum* (20.94%) followed by *Suaeda aegyptiaca* (13.45%), *Malva parviflora* (13.11%), *Rumex vesicarius* (13.01%) and *Sonchus oleraceus* (8.2%). Glutamic acid, proline, alanine and cysteine were recorded only in *Sonchus oleraceus*. In the five species investigated, aspartic acid, glycine and threonine were completely absent, while the concentration of γ-aminobutyric acid, cystathionine and phosphoserine were found to vary from traces to small quantities. No marked changes were observed for the other amino acids.

Moreover, a big difference in the total content of amino acids in the five species was observed. In *Rumex vesicarius* the total content was found to decrease to reach a value of 53.35% while in *Sonchus* the percentage was found to increase reaching a value of 92.81%.

Table 1: Amino acid content (gm/100gm) in the hydrolysates of the five investigated species.

Species / Amino acids	*Rumex vesicarius*	*Malva parviflora*	*Sonchus oleraraceus*	*Suaeda aegyptiaca*	*Cynomorium coccineum*
Lysine	4.67	9.97	4.77	7.34	5.59
Histidine	2.48	4.14	1.30	2.46	2.13
Arginine	4.39	6.84	2.46	6.75	7.57
Aspartic acid	-	-	-	-	-
Threnine	-	-	-	-	-
Serine	4.36	8.09	4.20	4.82	4.47
Phosphoserine	1.37	2.20	1.78	2.18	1.70
Phosphoethanolamine	3.13	3.96	4.26	2.33	3.65
Glutamic acid	-	-	11.14	-	-
Proline	-	-	9.72	-	-
Glycine	-	-	-	-	-
Alanine	-	-	5.79	-	-
Cysteine	-	-	5.45	-	-
Valine	5.17	-	5.38	7.00	4.73
Methionine	4.08	8.44	4.59	6.36	3.81
Isoleucine	7.05	-	8.41	10.73	6.29
Leucine	2.56	4.21	2.00	2.89	3.69
Tyrosine	-	13.32	6.29	8.56	4.37
Phenylalanine	13.01	13.11	8.20	13.45	20.94
Gamma-Amino Butyric acid	1.02	0.96	1.07	-	-
Cystathionine	-	0.10	-	0.54	-
Total amino acids	53.35	75.34	92.81	75.41	68.94

It is worth noting that leucine, isoleucine, valine, phenylalanine and methionine are essential to maintain the nitrogen balance in mankind (Harper, 1963). Most of these amino acids were detected in the investigated species except for *Malva parviflora* in which valine was not detected. Cystine which is responsible for strengthening the root of human hair and its growth (Harper, 1963) was present only in *Sonchus oleraceus*, thus cystine is an amino acid moiety in protein synthesis rather than acting as a stimulant for hair growth.

Regarding the crude protein content (Table 2), it has been found to vary from one species to another. The parasitic *Cynomorium coccineum* contained the highest amount of

crude protein (28.67%) followed by *Malva parviflora* (20.96%), *Sonchus oleraceus* (18.56%) *Suaeda aegyptiaca* (13.24%) and *Rumex vesicarius* (10.79%).

From a nutritional point of view, no distinction should be made between animal or plant protein (Pirie,1957). The most important factor determining the biological value of a protein is the relative concentration of its amino acids, particularly of the essential ones.

Akeson and Stahman (1965), studied the amino acid content of several animal and plant proteins and suggested that neither the biological value (BV) nor the amino acid content of the leaf protein from Chenopodium, turnip, Sonfion, ryegrass, Nasturtium, clover or alfalfa was in any way inferior to that of wheat or corn.

Moisture content and pH

The moisture content in the investigated five plant species was very high (Table 2); it ranged between 93.23% for *Rumex vesicarius* and 78.67% for *Cynomorium coccineum*. The pH value of juice of five plants ranged from 3.27 (*Rumex vesicarius*) to 8.13 (*Suaeda aegyptiaca*) (Table 2).

Table 2: Different types of analysis (Proximate system), on the five investigated species.

Analysis / Species	Moisture content (%)	pH	Crude protein (%)	Crude fat (%)	Crude fibres (%)	Ash (%)	Total soluble Carsbohydrates (%)
Rumex vesicarius	93.229 ± 0.30	3.27 ± 0.11	10.79 ± 0.74	1.801 ± 0.46	1.821 ± 0.45	24.470 ± 1.9	1.876 ± 0.33
Malva parviflora	82.003 ± 1.85	6.42 ± 0.11	20.964 ± 1.99	0.866 ± 0.13	11.080 ± 1.33	13.883 ± 2.145	0.933 ± 0.05
Sonchus oleraceus	86.734 ± 0.80	5.67 ± 0.12	18.558 ± 0.48	1.477 ± 0.32	28.243 ± 3.05	21.43 ± 1.02	1.667 ± 1.3
Suaeda aegyptiaca	93.739 ± 1.15	8.13 ± 0.34	13.236 ± 1.93	2.219 ± 0.91	4.348 ± 1.32	33.34 ± 1.45	2.067 ± 0.981
Cynomrium coccineum	78.667 ± 1.50	5.40 ± 0.13	28.671 ± 2.55	9.359 ± 1.24	2.163 ± 0.88	14.191 ± 2.25	10.933 ± 1.88

The cell sap of *Rumex vesicarius* leaves has a pH of 3.2, due to accumulation of organic acids. In this respect, it approaches the pressed sap of lemon fruits which has a pH of 2.5, due to the presence of as much as 58 mg citric acid per ml. Leaves of many plants also have this ability (accumulation of organic acids) and members of Crassulaceae, are notable for the diurnal variation in the amount of leaf acids, mainly citric, malic and isocitric acids (Ranson,1965).

Carbohydrates content

Carbohydrate is the most important fuel for high-intensity exercise and performance. Since the human body has limited stores of carbohydrates as glycogen in muscle and liver, it is clear that oral supplementation will definitely affect performance, especially when the endogenous carbohydrate stores are consumed, which normally occurs after 60-90 minutes of moderately intense exercise (Heijden *et al.,* 1999).

Recent studies have shown that although the oxidative capacity of the muscle for carbohydrate coming from circulation is up to 2 gm/min; the liver will not allow an increase in glucose output and hence the muscle uptake greater than 1 gm/min (Rehrer *et al.,* 1992).

The percentage of total soluble carbohydrates percentage has been estimated to be 1.876±0.33,0.933± 0.05, 1.667 ± 1.3, 2.067± 0.981 and 10.933 ± 1.88 for *Rumex vesicarius, Malva parviflora, Sonchus oleraceus, Suaeda aegyptiaca* and *Cynomorium coccineum* respectively. Thus *Cynomorium coccineum* is the plant species with the highest carbohydrate content (Table 2).

Fats

Depending on age and sex, fat intake should not represent more than 25% of the available energy consisting of one third mono-unsaturated and one third poly-unsaturated fatty acids. This recommendation regarding fat intake is valid not only for individuals genetically at risk for premature ischemic heart disease, but for the whole population (Heijden *et al.,* 1999).

Cynomorium coccineum represent the species with the highest percentage of crude fat (9.359 ± 1.24%) while *Malva parviflora* has been found to contain the lowest percentage of 0.866 ± 0.13 (Table 2).

Crude fibres

Dietary fibre was a term developed as “shorthand” for the plant cell wall material in the diet (Asp *et al.,* 1992). This plant cell wall material is not digested in the human small intestine and the indigestibility of these components by the small intestine enzymes was used as the basis for developing the total dietary fibre of the AOAC (1980), which is the official method for fibre in nutritional labeling in the USA and several other countries (Lee *et al*., 1992).

Sonchus oleraceus (Table 2), represents the species with the maximum crude fiber content (28.243±3.05%) followed by *Malva parviflora* (11.080± 1.33), *Suaeda aegyptiaca* (4.348±1.32), *Cynomorium coccineum* (2.163±0.88) and *Rumex vesicarius* (1.801±0.46). The cell walls from tissues of edible plants, some polysaccharides food additives and dietary fiber (DF) are very important in the human colon (Selvendran, 1984).

It is also worth noting that fibres are of value in decreasing serum cholesterol level (Anderson *et al.,* 1990).

Mineral composition

Table (3) shows that sodium (Na) represents the main cation, accounting for about 10% of the dry weight. *Suaeda aegyptiaca* was found to have the highest sodium concentration which accounts for the salty taste of this species. However, *Malva parviflora* was observed to be of the least sodium concentration (4.02 mg/gm oven dry weight). The potassium (K) content in

the five species ranged from 37.27mg/g in *Rumex vesicarius* to 19.54 mg/g in *Cynomorium coccineum.*. Similar trend was observed regarding calcium (Ca). On the other hand, low concentrations of magnesium (Mg) have been detected in all species examined; ranging from 1.2 mg/gm in *Malva parviflora* to 3.22 mg/gm in *Sonchus oleraceus*.

Leaves and stems were found to accumulate high concentrations of most of the minerals than the other plant organs. The halophyte *Suaeda aegyptiaca*, accumulates high concentrations of sodium which act as a regulator for the osmotic potential (Yagodin, 1982., Wiebe and Walter,1972)

In this respect the magnesium (Mg) concentration in cow's milk is approximately 130 mg/Lt. The least magnesium concentration is the 1240 mg/kg in *Malva parviflora* while the highest concentration is 3220 mg/kg in *Sonchus oleraceus* (Table 3).

Table 3: Mineral ion composition (mg/gm oven dry weight) of the five investigated species.

Species	Na	K	Ca	Mg
Rumex vesicarius	11.672	37.268	23.080	3.156
Malva parviflora	4.016	26.776	26.324	1.240
Sonchus oleraceus	21.924	33.32	20.404	3.22
Suaeda aegyptiaca	105.468	28.740	15.212	2.992
Cynomorium coccineum	23.716	19.540	01.540	3.064

Heavy metals

Many researches have shown that heavy metals, when deposited onto soils (sandy soils are exceptions) are quite immobile. Unless removed by physical processes, they tend to accumulate in surface soil at or near the depth at which they are incorporated (Page *et al.*, 1995) representing contaminants of essential elements (Ahmed, 1999).

Zinc

The recommended dietary allowance (RDA) for zinc is 125 mg/day for people aged 11 years old (NRC, 1980), but zinc available in the US food supply is only ~12.3mg per capita (NRC,1989). The RDA for zinc is very high when compared to the zinc content of the five plant species examined. *Malva parviflora* represent the species with the highest Zn content (90.204 mg/g), while *Cynomorium coccineum* is the species with the lowest Zn content (0.004 mg/g), (Table 4).

Table 4: Heavy metal content (mg/gm oven dry weight) of the five investigated species.

Species	Fe	Cu	Zn	Mn	Cr	Co	Pb	Ni
Rumex vesicarius	0.168	0.012	0.196	0.060	0.016	0.028	0.001072	0.0012
Malva parviflora	0.244	0.002	0.204	0.080	0.004	0.016	0.002680	0.0040
Sonchus oleraceus	0.448	0.004	0.044	0.036	0.012	0.012	0.000048	0.0028
Suaeda aegyptiaca	0.124	0.004	0.056	0.016	0.004	0.020	0.000960	0.0016

Cynomorium coccineum	0.068	0.004	0.004	0.004	0.008	0.012	0.000760	0.0084

Iron

Iron is an essential element present in all body cells, as a component of haemoglobin and myoglobin and as a constituent of certain oxidative enzymes such as cytochrome and xanthine oxidases (Moffat &Whittle, 1999).

Dietary intakes for 15-years old boys and girls from two different regions in Sweden ranged from 7-35 mg/day and from 6-27 mg/day, with daily median intakes of 18.7 and 14.2 mg, respectively (Samuelson *et al*., 1996). Higher dietary iron intake among 299 urban pre-school children in Maryland (ages 9 months to 15 years) was associated with lower lead blood levels (Hammad *et al*. 1996).

It is worth mentioning that the investigated plants are good sources of iron (Table 4) with *Sonchus oleraceus* being the richest source (0.448 mg/g).

Copper

Rumex vesicarius, having a copper content of 12mg/kg could be cited among the food plants with the greatest natural amount of copper when compared with beef liver which contains 11mg/kg. The National Research Council (NRC) of USA has set an estimated safe and adequate dietary intake (ESADDI) level of copper at 0.5-1 mg/day for infants; 1- 2.5 mg/day for children and 2-3 mg/day for those over 11 years old (NRC, 1980). The consumption of 250 gm of *Rumex vesicarius* leaves could supply the human body with the daily copper requirements.

Manganese

The NRC ESADDI level of manganese is 1-3 mg/day for children up to 10 years old, and 2.5-5 mg for adolescents and adults (NRC, 1980). Hence the investiged species are considered rich sources of Mn with *Malva parviflora* being the richest source (80 mg/kg). It should be noted that dietary manganese appears to be non-toxic (NRC, 1989).

Lead

Fortunately, none of the plant species investigated in this work (Table 4), have a Pb level exceeding that of the permissible FDA (0.3 ppm), which reflects the safe use of these plants by human beings (Bahatia & Choudhri, 1996).

Chromium

It has been reported that the chromium content in food is low, and most intake of chromium is from food, estimated to be less than 100 mg/day (Moffat & Whittle, 1999).

Low levels chromium have been detected in the five species examined which ranged between 0.016 mg/kg in *Rumex vesicarius* and 0.008 mg/kg in *Cynomorium coccineum* (Table 4). Hence no fear of using such plants as food for human consumption regarding chromium toxicity.

Magnesium

Magnesium is an essential nutrient and a co-factor for many enzymes, particularly metallcoenzymes associated with phosphate. However, high magnesium concentrations are toxic and its toxicity is similar to that of zinc (Hammond & Beliles, 1980 and Goyer, 1995).

Trace elements are essential for leaf growth, cell wall bonding (Ca and Mg), chlorophyll synthesis (Fe, Mg and Ca) vitamins and coenzymes (Fe, Co and Zn) colour, smell and taste (Mn, Fe, Co, Ni, Cu, and Ag) and protein (Cu and Zn), (cf. Rashed & Awadallah, 1998)

The magnesium ash content of dry weight of the investigated species, varied from 1.24 mg in *M. parviflora* to 2.99 mg in *S. aegptiaca* (Table 3). High ash content of *Suaeda* may be due to mild accumulation of many salts as found in many other halophytes (Wiebe & Walter, 1972; Abd El- Rahman *et al*., 1975). The salty taste may be referred to accumulation of many salts in shoot system of *Suaeda aegyptiaca.*

The Folk Midicine:

In folk medicine, some of the studied species were used,viz., *Rumex vesicarius* which contains albuminoids, sugars and woody fibres. The plant is stomachic, diuretic and astringent. The juice allays toothache, checks nausea and promotes appetite. The plant is an antidote to scorpion-stings, (Mossa *et al*., 1987).

The seeds of *Malva parviflora* are used as a demulcent in coughs and ulcer in the bladder. In Europe, an infusion of the leaves is drunk as a nerve tonic. The leaves are also used as a hot poultice for wounds and swellings. In Africa, the leaf decoction is used as a remedy for tap worms and also as lotion for bruised limbs (Mossa *et al*., 1987). Flowering and fruiting branches are used as a gargle for their astringent properties, also bechic and emollient (Boulos and El-Hadidi, 1984). The entire plant of *Cynomorium. coccineum* is used as a plant aphrodisiac, spermatopoietic, tonic, astringent (Boulos, 1983).

In conclusion, the five plant species could be used as foods of good nutritional values where *Cynomorium coccineum* represent the species with the highest crude protein, fat and carbohydrate contents. Additionally its protein hydrolyzate contained eight essential amino acids. However, this species contain lower levels of minerals and fibres when compared to the other species investigated. Also the levels of the heavy metals detected constitute no hazardous effects on human health.

Consequently, owing to their good nutritional value, especially protein and amino acids, the five plant species investigated represent useful foods for human consumption. It might be encouraging to know that generally the health and diets of adult western vegetarian groups have been studied extensively and appear to be good, as the low content of saturated fat and the high fiber content offer advantages (Heijden *et al*., 1999).

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