Pak. J. Bot., 50(1): 287-300, 2018.

NUTRITIONAL POTENTIAL OF PAKISTANI MEDICINAL PLANTS AND THEIR CONTRIBUTION TO HUMAN HEALTH IN TIMES OF CLIMATE CHANGE AND FOOD INSECURITY

ALI REHMAN[1†] AND MUHAMMAD ADNAN[1†*]

[1]Department of Botany, Kohat University of Science and Technology, Kohat, Khyber Pakhtunkhwa (KP), Pakistan
[†]Equally contributed principal authors
[*]Corresponding author's email: ghurzang@hotmail.com

Abstract

Proteins, carbohydrates, fats, vitamins, minerals and water are the nutrients that are essential for life and contribute to the caloric content of the body. Due to rapid population growth and climate change, the demand on conventional plants based food would increase in future. It is therefore, necessary to search for the alternatives in order to meet the growing demand for food. As an example, many medicinal plants are being used as vegetables and fruits in Pakistan. These medicinal plants are low in protein and fat, however rich in carbohydrates. Moreover, they are energy's high source, as 100 g of plants can give approximately 258 kcal energy. In addition, 100 g plants consumption provide over 10-12% of the daily allowance recommended. Similarly, medicinal plants are a valuable source of insoluble dietary fiber and micronutrients. The amount of iron ranges from 0.043 to 422.5 mg/g while the zinc value ranges from 0.04 to 14.8 mg/g. The ascorbic acid ranges from 0.31 to 2035.7 mg/g. Most of these plants are good source of antioxidant and showing high medicinal value against different ailments. However, certain non-nutritional and anti-nutritional compounds are also being part of such medicinal plants. Hence, detailed information on the nutritional status and traditional uses of the documented medicinal plants is of utmost importance in upcoming era of climate change and food insecurities because it will play a significant role in the overall benefits to the health of people.

Key words: Traditional medicinal plants, Carbohydrates, Proteins, Micronutrients, Non-nutritional compounds, Anti-nutritional compounds.

Introduction

Plants are important source of proteins, carbohydrates, fats, vitamins, minerals and water. These are the nutrients that are necessary for sustaining the life and contribute to the caloric content of the body. The basic factor vital in the selection of plants for systematic classification, nutritive value and plant improvement programs is the quality and quantity of proteins in the seed (Siddique, 1998). However, other components such as carbohydrates, fats and vitamins are equally important. An important fact today is that a considerable population around the world is suffering from malnutrition. Moreover, due to rapid population growth, the demand on conventional plants based food would increase further. It is therefore, necessary to search for the alternatives in order to meet the growing demand for food. In developing countries, medicinal plants' usage is increasing day by day because herbal medicines have less or no side effects compared to allopathic drugs. About 80% people of the marginal communities around the world are using medicinal plants for their primary health care due to long age practices and reliability (Motley, 1994).To enable a healthy life every human required a daily supply of different types of food. It is from the time immemorial that the medicinal plants are also used as food and hence, could be used as an alternative to the conventional food.

Due to its unique climatic and edaphic factors, Pakistan has greater potential for medicinal plants. In total 6000 plant species reported in Pakistan, 600 being used for medicinal purposes (Shinwari, 2010, Shinwari & Qaiser). Despite their therapeutic uses, many medicinal plants are used as food supplements in remote areas of the country due to their easy availability in wild form. These plants are substitute of the common and costly plants' based food. People having low income mostly depend on medicinal plants both for cash and subsistence; however, exploitation is also there due to their rich nutritional and therapeutic values. So far many studies have been conducted on the proximate composition of Pakistani medicinal plants, however, most of the data is fragmented and no attempt has yet been made to compile all these information. This review is focused on the importance of medicinal and other edible plants from nutritional point of view in times of climate change and food insecurity.

Methodology: Articles documented in the present study were selected by using the online databases of bibliography. In total, 116 potential articles and other relevant literature were reviewed in this study. Data was then tabulated using Microsoft Excel and Microsoft Word. Plants with their families, localities, nutritional values were put in the Table. Plants were divided into four distinct geographical zones of the country on the basis of precipitation-evaporation index (PE index). First geographical zone was designated as "wet" where PE index values ranged between 50-148; second was "humid" where index values ranged between 10-49; third was "less humid" with index values ranging from 20-33 and fourth one was "Arid " having PE values less than 20. In the literature, different analytical procedures were being used for the determination of proximate composition, micronutrients and other important components of medicinal plants. Most proximate composition of plant species in the reported studies were found out by using the methodology of Association of Official Analytical Chemists (AOAC). These include total crude protein determined by Kjeldahl method, fiber content analyzed as crude fiber; carbohydrate determined by difference method for the total available carbohydrates; fats determination were carried out using soxhlet method; vitamins by HPLC, and minerals were determined by using atomic absorption spectrophotometry. Units used in different research work were unified.

Results and Discussion

Climate change and food insecurity: The Himalayan glaciers are melting at an alarming rate which may result in the increased amount and flow of water in rivers and streams. Floods will result in human casualties, harm to agriculture, forestry and power sector. Agriculture is more susceptible to changes in weather patterns. Majority of Pakistan's population is dependent on agriculture sector. The total population of Pakistan is 180 million, of which 70% is dependent on agriculture. Agriculture is the backbone of the country's economy because it contributes 21% of GDP. Hence, climate change may have great consequences for the county's agriculture, which may leads towards food insecurities (Ali *et al*., 2017).

In the present world, the human food is mainly based on 12 crops that contribute 85–90% caloric intake of the whole world. However, in many countries, the utilization of wild plants as food is not insignificant (Pieroni *et al*., 2007). Therefore, such wild plants may play an important role as substitute in times of climate change and food insecurities.

Family wise and geographical distribution of species: Pakistan is situated between 23° 45' to 36° 50' N latitude and 60° 55' to 75° 30' E longitude with 796096 km^2 geographical areas, and distributed along 0 to 8611 m above the sea level. The country has diversity of plant resources distributed along four precipitation based climatic zones. In total, 123 plant species (including the 9 varieties) belong to 48 families have been reviewed for their nutritional and medicinal values. Highest number of 11 plant species have been recorded for family Lamiaceae followed by 10 each recorded for Asteraceae and Faboideae-Fabaceae. These plants have different geographical distribution ranging from wet to dry (arid). Based on the four climatic zones, 49 plants belong to less humid region, 35 to humid region, 25 to dry region and 14 to wet region (Table 1). The members of family Lamiaceae were mostly recorded from wet region, while the members of Asteraceae, Faboideae-Fabaceae, Poaceae and Solanaceae were recorded from all the four regions.

Vegetables, fruits and medicinal uses: Vegetables and fruits are the rich source of bio-chemicals such as protein, ascorbic acid, calcium, carotene, folic acid, iron, phosphorus, riboflavin forming the major portion of human's diet. Edible green plants from the wild can be mostly found in countries having variable climatic conditions.

In this study we have found that *Abelmoschus esculentus, Praecitrullus fistulosus, Portulaca oleracea, Luffa acutangula, Allium sativum, Amaranthus viridus, Momordica charantia, Allium cepa, Brassica oleraceae* var. *capitata, Spinacia oleraceae, Coriandrum sativum, Capsicum fruitescens, Cucurbita moschata, Bauhinia variegata, Cucumis sativus* and *Zingiber officinalis* are cultivated vegetables while *Amaranthus viridus, Caralluma tuberculata, Nasturtium officinale, Chenopodium album* and *Trianthema portulacastrum* are some of the wild vegetables extensively used in Pakistan. These plants are also being used for various medicinal purposes such as *Chenopodium album* is used as antipyretic antinociceptive, immobilizing sperm hypertensive and rich in iron contents (Gohar & Elmazar, 1997). Similarly, *Amaranthus viridis* leaves are used as emollient and also used in scorpion and snake bite. Moreover, it is also diuretic, sedative, cooling, hypnotic, diaphoretic, antiseptic, expectorant and used in bronchitis. *Portulaca oleracea* possess antibacterial, antiscorbutic, diuretic and febrifugal properties (Bown, 1995). *Zingiber officinale* (ginger) has been used in diarrhea, nausea, asthma and respiratory disorders along with its anti-inflammatory, anti-oxidant and anti-cancer effects (Medoua *et al*., 2009). In addition to their medicinal activities, Zingiberaceae plants extracts may also serve as a natural larvicidal agent and also can increase the rate of salivation in animal model (Chamani *et al*., 2011).Plants like *Malus domestica, Malus sylvestis, Punica granatum, Morusalba, Morusnigra* and *Vitis vinifera* are some of the fruit plants that are used both as fruit and medicine.

Proximate composition of medicinal plants

Moisture: Plants moisture is an excellent and essential source of human water uptake to maintain life. It is considered that approximately 20% of the body water must come of the moisture originated from food(Anon., 2005).The average amount of moisture was found highest in less humid species (11.20%) such as *Praecitrullus fistulosus* (31.5%) and lowest in wet region (7.22%) such as *Xanthium strumarium* (0.33%) (Table 1). The declining trend in the average moisture contents among four climatic zones can be illustrated as less humid > dry > humid > wet. These differences in the moisture contents might be due to various reasons such as precipitation, temperature, texture and structure of soil, seasonal variations, genetics and period of assessment (Imeh & Khokhar, 2002). The higher moisture contents in plants of less humid and dry region might be due to their higher water retention capabilities because they have xeric nature and xerophytes store water and have sunken stomata to avoid transpiration of water. *Praecitrullus fistulosus* having highest moisture value maintaining it more prone to decline in nutrients since foods with high moisture content are more vulnerable to perishability. Moreover, the difference in moisture contents among different plants may depend on their physiological set up and external climate changes.

Ash: The inorganic and incombustible part of fuel left after complete combustion is called ash and contains the bulk of the mineral portion of the original biomass. Ash have all the important dietary ingredients especially minerals, micro and macronutrients that are very significant for the normal physiological functions of the body. The chief innate ash forming elements in biomass includeiron (Fe), aluminium (Al), magnesium (Mg), calcium (Ca), potassium (K), silicon (Si), phosphorus (P), sulphur (S), sodium (Na), and titanium (Ti).

In our study the lowest ash was noticed in *Morus laevigata* (0.46%) recorded from Chitral and maximum value in *Capsicum fruitescens* (58.08%) collected from Kohat (Table 1). The ash content is greater in the plants of wet region (12.71%) on average basis and lowest in humid region (6.81%) (Table 1). The declining trend in the average ash contents among four climatic zones can be illustrated as wet > less humid > dry > humid. This trend may be due to the difference in soil and environment features that need to be explored. The quantity and composition of ash left over after burning of plant material varies significantly according to plant's age, time, organ to organ (Vermani *et al*., 2006).

Table 1. Medicinal plants of Pakistan and their nutritional composition.

S #	Plant species/ Family name/ Part used/ Locality/ Geography	Proximate composition	Others (micro nutrients, vitamins, non nutritional and anti-nutritional compounds, antioxidant activities)	References
1.	*Abelmoschus esculentus* (L) Moench/ Malvaceae/ Fruit/ Mardan / Humid area	7.4^{Me}, 9.5^{Ah}, 7.8^{Pe}, 5^{Ft}, 70.3^{Ce}, 357.68^{Ev}, 22.5^{Fr}	1^{Ca}, 4.52^{Fe}, 6.46^{Zn}	Hussain *et al.*, 2011a
2.	*Achyranthes aspera* L./ Amaranthaceae/ Whole plant/ Islamabad / Wet area	1.15^{Me}, 12.4^{Ah}, 0.88^{Pe}, 1.08^{Ft}, 45.5^{Ce}, 195.3^{Ev}, 40.1^{Fr}	3.54^{Fe}, 0.27^{Zn}	Hussain *et al.*, 2006; Hussain *et al.*, 2013
3.	*Aerva javanica* (Burm.f.) Juss.ex Schult./ Amaranthaceae/ Whole plant/ Parachinar / Wet area	7.32^{Me}, 14.23^{Ah}, 7.16^{Pe}, 1.15^{Ft}, 70.12^{Ce}, 319.53^{Ev}, 29.18^{Fr}	2.99^{Mg}, 0.27^{Fe}	Hussain *et al.*, 2011c
4.	*Albizia lebbeck* L./ Mimosaceae/ Pods/ Hattar / Humid area	6^{Me}, 6.21^{Ah}, 1.05^{Pe}, 3.7^{Ft}, 43.1^{Ce}, 209.9^{Ev}, 45.9^{Fr}	209.08^{Ph}, 371.27^{Fl}, 981.33^{Te}, 514.23^{Fr}, 98.21^{Tr}, 0.04^{Oa}, 834.13^{Sp}, 16.06^{Ti}, 0.21^{Cn}	Haq *et al.*, 2013; Hussain *et al.*, 2013
5.	*Alhagi maurorum* Medik./ Papilionaceae/ Whole plant/ Tank / Dry area	8.76^{Me}, 12.66^{Ah}, 6.56^{Pe}, 4.88^{Ft}, 56.52^{Ce}, 330.51^{Ev}, 3.33^{Fr}	22.34^{Ca}, 129.2^{Mg}, 10.5^{Fe}, 0.85^{Zn}	Ullah *et al.*, 2013
6.	*Allium cepa* L./ Liliaceae/ Bulb/ Parachinar / Wet area	23.89^{Me}, 10.13^{Ah}, 5.01^{Pe}, 11.15^{Ft}, 49.81^{Ce}, 319.77^{Ev}, 19.53^{Fr}	------	Khan *et al.*, 2013
7.	*Allium sativum* L./ Liliaceae / Bulb/ Karak / Dry area	7.24^{Me}, 4.84^{Ah}, 21.61^{Pe}, 8.93^{Ft}, 57.28^{Ce}, 282.69^{Ev}, 1.86^{Fr}	1.27^{Ca}, 2.28^{Fe}, 4.32^{Zn}, 4^{Aa}, 0.04^{Rf}, 0.28^{Tm}	Hussain *et al.*, 2009a; Bangash *et al.*, 2011
8.	*Alpinia allughas* (Retz.)Roscoe/ Zingiberaceae/ Rhizome/ Faisalabad / Dry area	9.87^{Me}, 1.86^{Ah}, 5.64^{Pe}, 6.1^{Ft}, 76.53^{Fr}	1.25^{Aa}	Shahid & Hussain., 2012
9.	*Amaranthus cruentus* L./ Amaranthaceae/ Leaves/ Kohat / Less Humid	8.18^{Me}, 15.9^{Ah}, 0.82^{Pe}, 2^{Ft}, 45.7^{Ce}, 204.4^{Ev}, 35.5^{Fr}	----	Hussain *et al.*, 2013
10.	*Amaranthus viridus* L./ Amaranthaceae/ Leaves/ Karak / Dry area	6.46^{Me}, 22.84^{Ah}, 16.41^{Pe}, 1.83^{Ft}, 52.68^{Ce}, 10.13^{Fr}	3.9^{Ca}, 41.9^{Fe}, 6.38^{Zn}	Hussain *et al.*, 2009a
11.	*Amomum subulatum* Roxb./ Zingiberaceae/ Whole plant/ Swat / Wet area		11.1^{Fe}, 5.76^{Zn}	Hussain *et al.*, 2009b
12.	*Artemisia maritima* L./ Asteraceae/ Whole plant/ Kalat / Less Humid	9.6^{Ah}, 11.51^{Pe}, 42.46^{Ce}, 21.6^{Fr}	10.25^{Ca}, 15.75^{Mg}, 50.1^{Fe}, 1.96^{Zn}	Hussain & Durrani, 2009; Ashraf *et al.*, 2010
13.	*Artemisia vulgaris* L./ Asteraceae/ Whole plant/ Hattar / Humid area	6.76^{Me}, 5.78^{Ah}, 3.72^{Pe}, 2.62^{Ft}, 81.09^{Ce}, 362.89^{Ev}, 32.62^{Fr}	----	Hussain *et al.*, 2009c
14.	*Azadirachta indica* A. Juss./ Meliaceae/ Leaves/ Peshawar / Less Humid	10.3^{Me}, 8.31^{Ah}, 8.93^{Pe}, 3.37^{Ft}, 10^{Ce}, 13.41^{Fr}	2493.7^{Ca}, 6813^{Mg}, 87.9^{Fe}, 3.05^{Zn}, 0.31^{Aa}	Rizvi, 2007; Kashif & Ullah., 2013
15.	*Bauhinia variegata* L./ Caesalpiniaceae/ Flower buds/ Peshawar / Less Humid	9.18^{Me}, 2.1^{Ah}, 2.9^{Pe}, 0.5^{Ft}, 16.4^{Ce}, 68.59^{Ev}	44^{Aa}, 82^{Ec}	Khattak, 2011
16.	*Berberis lyceum* Royle/ Berberidaceae/ Fruits/ Tank / Dry area	5.55^{Me}, 7.75^{Ah}, 7.67^{Pe}, 5.32^{Ft}, 46.99^{Ce}, 485.7^{Ev}, 13.5^{Fr}	462.1^{Ca}, 324^{Mg}, 7.62^{Fe}, 2.55^{Zn}, 13.68^{Aa}, 15.22^{Dp}, 14.34^{Oa}, 5.97^{Pt}, 7.27^{Tn}	Shad *et al.*, 2013; Ullah *et al.*, 2013
17.	*Brassica campestris* L./ Brassicaceae/ Leaves/ Peshawar / Less Humid	10.07^{Me}, 1.5^{Ah}, 2.9^{Pe}, 0.4^{Ft}, 9.7^{Ce}, 43.35^{Ev}, 0.4^{Fr}	4121.1^{Ca}, 361.5^{Mg}, 189^{Fe}, 3.75^{Zn}, 51.4^{Aa}, 73^{Ec}	Ashraf *et al.*, 2010; Khattak, 2011
18.	*Brassica oleracea* L./ Brassicaceae/ Fruit/ Kohat / Less Humid	14.7^{Me}, 12.34^{Ah}, 22.34^{Pe}, 2.87^{Ft}, 47.72^{Ce}, 306.15^{Ev}, 7.35^{Fr}	45^{Aa}, 0.8^{Rf}, 0.09^{Tm}	Hanif *et al.*, 2006; Hussain *et al.*, 2011b
19.	*Brassica rapa* L./ Brassicaceae/ Leaves/ Peshawar / Less Humid	10.56^{Me}, 0.5^{Ah}, 1^{Pe}, 0.16^{Ft}, 7.54^{Ce}, 1^{Fr}	30^{Aa}, 0.027^{Rf}, 0.013^{Tm}	Bangash *et al.*, 2011
20.	*Bupleurum falcatum* L./ Apiaceae/ Whole plant/ Swat / Wet area	7.42^{Me}, 4.68^{Ah}, 5.53^{Pe}, 1.89^{Ft}, 80.48^{Ce}	854.6^{Ca}, 140.4^{Mg}, 17.6^{Fe}, 1.8^{Zn}	Adnan *et al.*, 2010
21.	*Calotropis procera* (Aiton) Dryand./ Asclepediaceae/ Whole plant/ Parachinar / Wet area	11.25^{Me}, 17.61^{Ah}, 3.15^{Pe}, 5.582^{Ft}, 62.38^{Ce}, 312.41^{Ev}, 29.49^{Fr}	3.59^{Mg}, 0.39^{Fe}	Hussain *et al.*, 2011c

Table 1. (Cont'd.).

S #	Plant species/ Family name/ Part used/ Locality/ Geography	Proximate composition	Others (micro nutrients, vitamins, non nutritional and anti-nutritional compounds, antioxidant activities)	References
22.	*Capsicum annuum* L./ Solanaceae/ Aerial parts/ Peshawar / Less Humid	10.76^{Me}, 0.6^{Ah}, 1.3^{Pe}, 0.2^{Ft}, 4.8^{Ce}, 25^{Ev}, 1.2^{Fr}	----	Hanif *et al*., 2006
23.	*Capsicum frutescens* L./ Solanaceae/ Fruit/ Kohat / Less Humid	9.03^{Me}, 58.08^{Ah}, 7.57^{Pe}, 1.83^{Ft}, 23.46^{Ce}, 140.65^{Ev}, 22.6^{Fr}	----	Hussain *et al*., 2011b
24.	*Caralluma tuberculata* N. E. Br./ Asclepediaceae/ Shoot/ Karak / Dry area	9.81^{Me}, 1^{Ah}, 2.9^{Pe}, 0.2^{Ft}, 12.5^{Ce}, 53.56^{Ev}	32.6^{Aa}, 695.7^{Ec}	Khattak, 2011
25.	*Cassia angustifolia* M. Vahl/ Caesalpiniacee/ Leaves/ Tank / Dry area	8.81^{Me}, 10.65^{Ah}, 10.55^{Pe}, 4.22^{Ft}, 66.76^{Ce}, 343.31^{Ev}, 10.61^{Fr}	21^{Fe}, 5.04^{Zn}	Hussain *et al*., 2009b
26.	*Chenopodium album* L./ Chenopodiaceae/ Leaves/ Tank / Dry area	9.13^{Me}, 21.15^{Ah}, 15.21^{Pe}, 3.92^{Ft}, 92.65^{Ce}, 420.92^{Ev}, 7.58^{Fr}	2.2^{Ca}, 164^{Fe}, 6.16^{Zn}, 43.7^{Aa}, 454.7^{Ec}	Hussain *et al*., 2009b; Khattak, 2011; Ullah *et al*., 2013
27.	*Cicer arietinum* L./ Papilionaceae/ Leaves/ Karak / Dry area	8.85^{Me}, 2^{Ah}, 6.6^{Pe}, 1.3^{Ft}, 14.8^{Ce}, 74.13^{Ev}	105.3^{Aa}, 100^{Ec}	Khattak, 2011
28.	*Convolvulus leiocalycinus* Boiss/ Convolvulaceae/ Whole plant/ Kalat / Less Humid	8.24^{Ah}, 9.35^{Pe}, 47.63^{Ce}, 29.33^{Fr}	----	Hussain & Durrani, 2009
29.	*Coriandrum sativum* L./ Apiaceae/ Leaves/ Parachinar / Wet area	10.49^{Me}, 20.07^{Ah}, 18.36^{Pe}, 1.43^{Ft}, 49.65^{Ce}, 284.87^{Ev}, 23.3^{Fr}	----	Khan *et al*., 2013
30.	*Crataegus songarica* K.Koch/ Rosaceae/ Fruit/ Dir upper / Wet area	4.8^{Me}, 4.79^{Ah}, 3.7^{Pe}, 3.03^{Ft}, 65.88^{Ce}, 17.8^{Fr}	----	Nisar *et al*., 2009
31.	*Cucumis sativus* L./ Cucurbitaceae/ Fruit/ Kohat / Less Humid	11.73^{Me}, 10.5^{Ah}, 10.57^{Pe}, 2.52^{Ft}, 64.62^{Ce}, 323.46^{Ev}, 8.21^{Fr}	15^{Fe}, 5.94^{Zn}	Hussain *et al*., 2010c; Khan *et al*., 2013
32.	*Cucurbita maxima* Duchesne/ Cucurbitaceae/ Fruit/ Kohat / Less Humid	10.21^{Me}, 14.72^{Ah}, 5.59^{Pe}, 1.49^{Ft}, 67.87^{Ce}, 307.31^{Ev}, 17.49^{Fr}	----	Hussain *et al*., 2011b
33.	*Cucurbita moschata* Duchesne/ Cucurbitaceae/ Fruit/ Mardan / Humid area	5.8^{Me}, 10.4^{Ah}, 14.3^{Pe}, 6.1^{Ft}, 63.4^{Ce}, 365.85^{Ev}, 21.1^{Fr}	21^{Ca}, 12^{Mg}, 44^{P}, 0.8^{Fe}, 0.32^{Zn}	Hussain *et al*., 2011a
34.	*Cuscuta reflexa* Roxb./ Cuscutaceae/ Whole plant/ Hattar / Humid area	7.78^{Me}, 10.13^{Pe}, 1.96^{Ft}, 72.32^{Ce}, 347.42^{Ev}, 22.5^{Fr}	----	Hussain *et al*., 2009c
35.	*Cymbopogon jwarancosa* (Jones) Schult./ Poaceae/ Whole plant/ Kalat / Less Humid	8.03^{Ah}, 6.83^{Pe}, 56.52^{Ce}, 26.23^{Fr}	----	Hussain & Durrani, 2009
36.	*Dactyloctenium aegyptium* (L.) Willd./ Poaceae/ Whole plant/ Sargodha / Dry area	5.3^{Me}, 7^{Ah}, 26^{Pe}, 22^{Fr}	----	Ahmed *et al*., 2013
37.	*Dalbergia sissoo* DC./ Papilionaceae/ Whole plant/ Kohat / Less Humid	8.74^{Me}, 12.33^{Ah}, 12.12^{Pe}, 3.35^{Ft}, 63.64^{Ce}, 333.19^{Ev}, 12.85^{Fr}	----	Hussain *et al*.,2010a
38.	*Datura alba* Rumph. ex Nees/ Solanaceae/ Whole plant/ Tank / Dry area	14.22^{Me}, 6.58^{Ah}, 12.1^{Pe}, 16.49^{Ft}, 65.64^{Ce}, 290.4^{Ev}, 9.21^{Fr}	3.53^{Fe}, 0.29^{Zn}	Hussain *et al*., 2006; Ullah *et al*., 2013
39.	*Daucus carota* L./ Apiaceae/ Root/ Peshawar / Less Humid	9.29^{Me}, 0.8^{Ah}, 1.5^{Pe}, 0.2^{Ft}, 10.4^{Ce}, 40^{Ev}, 0.6^{Fr}	15^{Aa}, 0.05^{Rf}, 0.05^{Tm}	Hanif *et al*., 2006; Ghani *et al*., 2012
40.	*Dipterygium glaucum* Decne/ Cappararaceae/ Whole plant/ Cholistan / Dry area	5.6^{Me}, 4.75^{Ah}, 0.08^{Pe}, 13.3^{Ft}, 0.15^{Ce}, 26.83^{Fr}	----	Mehmood *et al*., 2010
41.	*Emblica officinalis* Gaertn./ Phyllanthaceae/ Dried fruits/ Peshawar / Less Humid	10.8^{Me}, 10^{Ah}, 9.1^{Pe}, 3.8^{Ft}, 54.5^{Ce}, 11.8^{Fr}	2035.7^{Aa}, 193.7^{Ph}, 30^{Fl}, 74.3^{Ec}, 0.4^{Sp}, 3.5^{Al}, 199^{Tn}	Khattak, 2013
42.	*Eragrostis pilosa* (L.) P.Beauv. / Poaceae/ Whole plant/ Sargodha / Dry area	5^{Me}, 13^{Ah}, 17^{Pe}, 24^{Fr}		Ahmed *et al*., 2013

Table 1. (Cont'd.).

S #	Plant species/ Family name/ Part used/ Locality/ Geography	Proximate composition	Others (micro nutrients, vitamins, non nutritional and anti-nutritional compounds, antioxidant activities)	References
43.	*Fagonia indica* Burm.f./ Zygophyllaceae/ Whole plant/ Karak / Dry area	11.13^{Me}, 15.68^{Ah}, 6.48^{Pe}, 2.46^{Ft}, 64.25^{Ce}, 305.06^{Ev}, 18.69^{Fr}	2.78^{Ca}, 181.9^{Mg}, 57.9^{Fe}, 0.04^{Zn}	Hussain *et al.*, 2010b; Zafar *et al.*, 2010
44.	*Forsskaolea tenacissima* L./ Urticaceae/ Whole plant/ Kohat / Less Humid	2.97^{Me}, 24.38^{Ah}, 8.59^{Pe}, 2.66^{Ft}, 61.397^{Ce}	7037^{Ca}, 341.5^{Mg}, 62.5^{Fe}, 3.9^{Zn}	Adnan *et al.*, 2010
45.	*Fumaria officinalis* L./ Papavaraceae/ Whole plant/ Hattar / Humid area	9.42^{Me}, 18.56^{Ah}, 10.43^{Pe}, 5.76^{Ft}, 55.81^{Ce}, 316.87^{Ev}, 18.56^{Fr}	----	Hussain *et al.*, 2009c
46.	*Hertia intermedia* (Boiss.) Kuntze/ Asteraceae/ Whole plant/ Kalat / Less Humid	11.17^{Ah}, 8.23^{Pe}, 21.38^{Ce}, 19.37^{Fr}	----	Hussain & Durrani, 2009
47.	*Hippophae rhamnoides* L./ Elaeagnaceae./ Leaves/ Skardu / Dry area	8.1^{Me}, 7.12^{Ah}, 11.06^{Pe}, 5.81^{Ft}, 27.29^{Ce}, 17.31^{Fr}	1.12^{Aa}	Kashif & Ullah, 2013
48.	*Hypericum perforatum* L./ Hypericaceae/ Whole plant/ Swat / Wet area	8.31^{Me}, 4.54^{Ah}, 9.54^{Pe}, 5.06^{Ft}, 72.2^{Ce}, 374.09^{Ev}, 13^{Fr}	----	Hussain *et al.*, 2009d
49.	*Indigofera gerardiana* Baker/ Papilionaceae/ Whole plant/ Dir upper / Wet area	3.06^{Me}, 4.23^{Ah}, 3.7^{Pe}, 2.37^{Ft}, 68.84^{Ce}, 17.8^{Fr}	----	Nisar *et al.*, 2009
50.	*Lactuca sativa* L./ Asteraceae/ Leaves/ Peshawar / Less Humid	11.04^{Me}, 0.8^{Ah}, 1.2^{Pe}, 0.25^{Ft}, 3^{Ce}, 17^{Ev}, 0.7^{Fr}	10^{Aa}, 0.1^{Rf}, 0.06^{Tm}	Hanif *et al.*, 2006
51.	*Lagenaria vulgaris* Ser. / Cucurbitaceae/ Aerial parts/ Peshawar / Less Humid	11.12^{Me}, 0.5^{Ah}, 1.2^{Pe}, 0.2^{Ft}, 3.75^{Ce}, 15^{Ev}, 0.7^{Fr}	12^{Aa}, 0.05^{Rf}, 0.03^{Tm}	Hanif *et al.*, 2006
52.	*Lavandula angustifolia* Mill./ Lamiaceae/ Whole plant/ Kohat / Less Humid	6.8^{Me}, 7.49^{Ah}, 6.13^{Pe}, 6.52^{Ft}, 73.06^{Ce}	1050^{Ca}, 219.2^{Mg}, 48^{Fe}, 2.3^{Zn}	Adnan *et al.*, 2010
53.	*Luffa acutangula* (L.) Roxb./ Cucurbitaceae/ Fruit/ Kohat / Less Humid	7.31^{Me}, 5.55^{Ah}, 13.47^{Pe}, 2.09^{Ft}, 71.54^{Ce}, 358.94^{Ev}, 12.55^{Fr}	1.05^{Ca}, 14.5^{Fe}, 6.84^{Zn}, 13^{Aa}, 0.038^{Rf}, 0.026^{Tm}	Hussain *et al.*, 2009a; Bangash *et al.*, 2011; Hussain *et al.*, 2010c
54.	*Lycopersicon esculentum* Mill./ Solanaceae/ Fruit/ Peshawar / Less Humid	11^{Me}, 0.9^{Ah}, 0.9^{Pe}, 0.2^{Ft}, 3.9^{Ce}, 23^{Ev}, 0.3^{Fr}	26^{Aa}, 0.3^{Rf}, 0.1^{Tm}	Hanif *et al.*, 2006
55.	*Malus domestica* Borkh./ Rosaceae/ Fruit/ Zhob/ Dry area	8.94^{Me}, 1.15^{Ah}, 0.45^{Pe}, 0.66^{Ft}, 16.65^{Ce}, 8.7^{Fr}	0.97^{Va},4.2^{Aa}	Aziz *et al.*, 2013
56.	*Malus sylvestris* (L.) Mill./ Rosaceae/ Fruit/ Zhob / Dry area	9.41^{Me}, 1^{Ah}, 0.2^{Pe}, 0.18^{Ft}, 8.4^{Ce}, 3.2^{Fr}	0.92^{Va}, 8.1^{Aa}	Aziz *et al.*, 2013
57.	*Medicago denticulate* Willd./ Papilionaceae/ Leaves/ Peshawar / Less Humid	9.75^{Me}, 1.33^{Ah}, 5.99^{Pe}, 0.14^{Ft}, 55.05^{Ev}, 3.11^{Fr}	160^{Aa}	Din *et al.*, 2012
58.	*Melia azedarach* L./ Meliaceae/ Leaves/ Hattar / Humid area	10.45^{Me}, 4.778^{Ah}, 5.6^{Pe}, 3.82^{Ft}, 75.39^{Ce}, 358.36^{Ev}, 30.43^{Fr}	----	Hussain *et al.*, 2009c; Ghani *et al.*, 2012
59.	*Mentha sylvestris* L./ Lamiaceae/ Whole plant/ Kohat / Less Humid	6.85^{Me}, 13.05^{Ah}, 10.93^{Pe}, 6.09^{Ft}, 62.86^{Ce}, 350.75^{Ev}, 6.474^{Fr}	80.8^{Fe}, 11.5^{Zn}	Hussain *et al.*, 2009b
60.	*Momordica charantia* L./ Cucurbitaceae/ Fruit/ Mardan / Humid area	5.4^{Me}, 9.4^{Ah}, 16.9^{Pe}, 8.3^{Ft}, 59.9^{Ce}, 382.64^{Ev}, 10.3^{Fr}	1.6^{Ca}, 13.9^{Fe}, 7.24^{Zn}, 65^{Aa}, 0.045^{Rf}, 0.063^{Tm}	Hussain *et al.*, 2009a; Bangash *et al.*, 2011, Hussain *et al.*, 2011a
61.	*Moringa oleifera* Lam./ Morinagaceae/ Inflorescence/ Peshawar / Less Humid	9.22^{Me}, 2.3^{Ah}, 3.1^{Pe}, 0.3^{Ft}, 15.8^{Ce}, 65.36^{Ev}	120.1^{Aa}, 376^{Ec}	Khattak, 2011
62.	*Morus alba* L./ Moraceae/ Fruits/ Chitral / Humid area	5.3^{Me}, 8.91^{Ah}, 18.41^{Pe}, 6.57^{Ft}, 10.11^{Fr}	15.2^{Aa}, 0.088^{Rf}, 1650^{Ph}, 660^{Al}	Imran *et al.*, 2010; Iqbal *et al.*, 2012

Table 1. (Cont'd.).

S #	Plant species/ Family name/ Part used/ Locality/ Geography	Proximate composition	Others (micro nutrients, vitamins, non nutritional and anti-nutritional compounds, antioxidant activities)	References
63.	*Morus laevigata* Wall. ex Brandis cv (large black fruit)/ Moraceae/ Fruits/ Chitral / Humid area	9.18^{Me}, 0.87^{Ah}, 1.73^{Pe}, 0.6^{Ft}, 17.96^{Ce}, 84.22^{Ev}, 0.81^{Fr}	17.03^{Aa}, 0.072^{Rf}, 1100^{Ph}, 630^{Al}	Imran *et al*., 2010
64.	*Morus laevigata* Wall. ex Brandis cv (large white fruit)/ Moraceae/ Fruits/ Chitral / Humid area	9.58^{Me}, 0.46^{Ah}, 1.57^{Pe}, 0.71^{Ft}, 15.21^{Ce}, 73.51^{Ev}, 0.57^{Fr}	16.35^{Aa}, 0.055^{Rf}, 1300^{Ph}, 390^{Al}	Imran *et al*., 2010
65.	*Morus nigra* L./ Moraceae/ Fruits/ Chitral / Humid area	9.69^{Me}, 0.5^{Ah}, 0.55^{Pe}, 0.55^{Ft}, 13.83^{Ce}, 64.11^{Ev}, 11.75^{Fr}	15.37^{Aa}, 0.04^{Rf}, 880^{Ph}, 630^{Al}	Imran *et al*., 2010
66.	*Morus rubra* L./ Moraceae/ Fruits/ Chitral / Humid area	4.5^{Me}, 11.73^{Ah}, 24.63^{Pe}, 4.24^{Ft}, 8.17^{Fr}	----	Iqbal *et al,* 2012
67.	*Nasturtium officinale* R.Br./ Brassicaceae/ Aerial parts/ Karak / Dry area	9.42^{Me}, 3.07^{Ah}, 3.61^{Pe}, 1.12^{Ft}, 37.32^{Ev}, 9.43^{Fr}	51.85^{Aa}, 37.96^{Dp}, 362.66^{Oa}, 13.55^{Pt}, 59.66^{Tn}	Shad *et al*., 2013
68.	*Nepeta kurramensis* Rech. f./ Lamiaceae/ Whole plant/ Parachinar / Wet area	3.53^{Me}, 18.55^{Ah}, 6.31^{Pe}, 8.27^{Ft}, 53.02^{Ce}, 311.73^{Ev}, 10.33^{Fr}	----	Shinwari *et al*., 2013
69.	*Nepeta leavigata* (D. Don) Hand. Mazz/ Lamiaceae/ Whole plant/ Swat / Wet area	2.63^{Me}, 35.15^{Ah}, 10.22^{Pe}, 3.72^{Ft}, 42.52^{Ce}, 244.39^{Ev}, 5.77^{Fr}	----	Shinwari *et al*., 2013
70.	*Nepeta suavis* Stapf / Lamiaceae/ Whole plant/ Parachinar / Wet area	8.45^{Me}, 7.91^{Ah}, 4.64^{Pe}, 12.59^{Ft}, 20.28^{Ce}, 398.49^{Ev}, 40.15^{Fr}	1^{Mg}, 0.82^{Fe}	Hussain *et al*., 2011c
71.	*Nigella sativa* L./ Ranunculaceae/ Seeds/ Chakwal / Less Humid	6.46^{Me}, 4.2^{Ah}, 22.8^{Pe}, 31.16^{Ft}, 6.03^{Fr}	80.25^{La}, 172.56^{Sp}	Sultan *et al*., 2009
72.	*Ocimum tenuiflorum* L./ Lamiaceae/ Leaves/ Peshawar / Less Humid	31.35^{Me}, 14.21^{Ah}, 4.93^{Pe}, 3.12^{Ft}, 27.23^{Ce}, 16.81^{Fr}	2.41^{Aa}	Kashif & Ullah, 2013
73.	*Otostegia limbata* (Benth.) Boiss./ Lamiaceae/ Whole plant/ Kohat / Less Humid	1.32^{Me}, 11.15^{Ah}, 6.4^{Pe}, 2.278^{Ft}, 78.81^{Ce}	2481.2^{Ca}, 195^{Mg}, 38^{Fe}, 2^{Zn}	Adnan *et al*., 2010
74.	*Oxalis stricta* L./ Oxalidaceae/ Aerial parts/ Buner / Humid area	9.97^{Me}, 2.48^{Ah}, 3.08^{Pe}, 0.89^{Ft}, 26.58^{Ev}, 7.55^{Fr}	52.48^{Aa}, 23.97^{Dp}, 321.34^{Oa}, 28.36^{Pt}, 11.29^{Tn}	Shad *et al*., 2013
75.	*Parthenium hysterophorus* L./ Asteraceae/ Whole plant/ Sargodha / Dry area	5.3^{Me}, 10^{Ah}, 23^{Pe}, 32^{Fr}	2899^{Ca}, 281^{Mg}, 68.8^{Fe}, 2.89^{Zn}	Ashraf *et al*., 2010; Ahmed *et al*., 2013
76.	*Pennisetum orientale* Rich/ Poaceae/ Whole plant/ Kalat / Less Humid	8.94^{Ah}, 9.95^{Pe}, 38.58^{Ce}, 23.93^{Fr}	----	Hussain & Durrani, 2009
77.	*Perovskia abrotanoides* Kar./ Lamiaceae/ Whole plant/ Kalat / Less Humid	8.47^{Ah}, 9.77^{Pe}, 25.8^{Ce}, 20.53^{Fr}	----	Hussain & Durrani, 2009
78.	*Perovskia atriplicifolia* Benth./ Lamiaceae/ Whole plant/ Kalat / Less Humid	10.07^{Ah}, 8.67^{Pe}, 34.48^{Ce}, 19.97^{Fr}	----	Hussain & Durrani, 2009
79.	*Phlomis bracteosa* Royle ex Benth./ Lamiaceae/ Whole plant/ Parachinar / Wet area	7.22^{Me}, 10.83^{Ah}, 10.61^{Pe}, 24.24^{Ft}, 47.09^{Ce}, 449^{Ev}, 24.5^{Fr}	----	Hussain *et al*., 2010a
80.	*Phlomis cashmeriana* Royle ex Benth./ Lamiaceae/ Whole plant/ Parachinar / Wet area	7.13^{Me}, 17.66^{Ah}, 9.51^{Pe}, 2.84^{Ft}, 62.85^{Ce}, 315.04^{Ev}, 23.96^{Fr}	----	Hussain *et al*., 2010a
81.	*Pistacia vera* L./ Anacardiaceae/ Seeds/ Parachinar / Wet area	4.36^{Me}, 3.26^{Ah}, 19.12^{Pe}, 51.75^{Ft}, 21.49^{Ce}, 628.22^{Ev}, 3.88^{Fr}	8.1^{Fe}, 3.96^{Zn}	Hussain *et al*., 2009b
82.	*Plantago major* L./ Plantaganaceae/ Leaves/ Swat / Wet area	9.25^{Me}, 2.77^{Ah}, 4.72^{Pe}, 1.63^{Ft}, 69.62^{Ev}, 4.28^{Fr}	42.57^{Aa}, 27.51^{Dp}, 103^{Oa}, 21.23^{Pt}, 24.34^{Tn}	Shad *et al*., 2013
83.	*Polypodium vulgare* L./ Polypodiaceae/ Whole plant/ Hattar / Humid area	8.45^{Me}, 5.22^{Ah}, 5.66^{Pe}, 2.27^{Ft}, 78.44^{Ce}, 356.64^{Ev}, 13.3^{Fr}	----	Hussain *et al*., 2009c

Table 1. (Cont'd.).

S #	Plant species/ Family name/ Part used/ Locality/ Geography	Proximate composition	Others (micro nutrients, vitamins, non nutritional and anti-nutritional compounds, antioxidant activities)	References
84.	*Portulaca oleracea* L./ Portulacaceae/ Shoot/ Mardan / Humid area	5.5^{Me}, 23.2^{Ah}, 15.9^{Pe}, 4.2^{Ft}, 51.3^{Ce}, 305.95^{Ev}, 17.7^{Fr}	50.6^{Aa}, 950.3^{Ec}	Khattak, 2011; Hussain *et al*., 2011a
85.	*Praecitrullus fistulosus* (Stocks) Pangalo/ Cucurbitaceae/ Fruit/ Karak / Less Humid	31.5^{Me}, 11.67^{Ah}, 15.34^{Pe}, 2.52^{Ft}, 38.96^{Ce}, 239.85^{Ev}, 9.57^{Fr}	1^{ca}, 16.6^{Fe}, 4.86^{Zn}	Hussain *et al*., 2009a, Hussain *et al*., 2010c
86.	*Punica granatum* L./ Punicaceae/ Seeds/ Kohat / Less Humid	18.21^{Me}, 5.75^{Ah}, 2.84^{Pe}, 4.91^{Ft}, 68.42^{Ce}, 328.7^{Ev}, 4.449^{Fr}	0.165^{Ca}, 0.3^{Mg}, 0.04^{Fe}, 0.04^{Zn}, 6.1^{Aa}	Hussain *et al*., 2009b, Haq *et al*., 2013
87.	*Raphanus sativus* L./ Brassicaceae/ Leaves/ Peshawar / Less Humid	10.92^{Me}, 0.8^{Ah}, 1.3^{Pe}, 0.1^{Ft}, 4.56^{Ce}, 23^{Ev}, 0.9^{Fr}	66.5^{Aa}, 1390^{Ec}	Hanif *et al*., 2006; Khattak, 2011
88.	*Rhazya stricta* Decne./ Apocyanaceae/ Leaves/ Kohat / Less Humid	30.5^{Me}, 6.21^{Ah}, 9.67^{Pe}, 3.98^{Ft}, 50.09^{Ce}, 274.86^{Ev}, 12.85^{Fr}	4.01^{Fe}, 3.01^{Zn}	Hussain *et al*., 2010a; Niaz *et al*., 2013
89.	*Rhynchosia reniformis* (Pursh) DC. / Papilionaceae/ Whole plant/ Karak / Dry area	2.35^{Me}, 11.95^{Ah}, 0.44^{Pe}, 1.79^{Ft}, 51.88^{Ce}, 225.48^{Ev}, 31.59^{Fr}	----	Shinwari *et al*., 2013
90.	*Rosa hybrida* cv Anjleeq/ Rosaceae/ Flower/ Faisalabad / Dry area	21.42^{Me}, 6.65^{Ah}, 0.25^{Pe}, 36.1^{Ft}, 35.63^{Ce}	13.06^{Tn}	Jilani *et al*., 2012
91.	*Rosa hybrida* cv Kardinal/ Rosaceae/ Flower/ Faisalabad / Dry area	22.42^{Me}, 6.32^{Ah}, 0.31^{Pe}, 30.66^{Ft}, 40.3^{Ce}	17.89^{Tn}	Jilani *et al*., 2012
92.	*Rosa hybrida* cv Maria shever/ Rosaceae/ Flower/ Faisalabad / Dry area	23.42^{Me}, 5.91^{Ah}, 0.12^{Pe}, 30. 56^{Ft}, 39.99^{Ce}	6.03^{Tn}	Jilani *et al*., 2012
93.	*Rumex crispus* L./ Polygonaceae/ Leaves/ Peshawar / Less Humid	10.78^{Me}, 2.84^{Ah}, 1.82^{Pe}, 0.3^{Ft}, 21.15^{Ev}, 0.94^{Fr}	30.73^{Aa}	Din *et al*., 2012
94.	*Rumex hastatus* D. Don/ Polygonaceae/ Leaves/ Swat / Wet area	5.89^{Me}, 1.48^{Ah}, 13.78^{Pe}, 2.5^{Ft}, 96.62^{Ev}, 28.43^{Fr}	29.29^{Aa}, 32.34^{Dp}, 320.33^{Oa}, 33.09^{Pt}, 108.49^{Tn}	Shad *et al*., 2013
95.	*Setaria viridis* (L.) P. Beauv./ Poaceae/ Aerial parts/ Mansehra / Wet area	5^{Me}, 20.85^{Ah}, 20.53^{Pe}, 49.98^{Ce}, 16.15^{Fr}	----	Bahadur *et al*., 2011
96.	*Sisymbrium officinale* (L.) Scop./ Brassicaceae/ Aerial parts/ Peshawar / Less Humid	8.88^{Me}, 1.84^{Ah}, 4.76^{Pe}, 1.51^{Ft}, 42.44^{Ev}, 14.72^{Fr}	32.05^{Aa}, 45.66^{Dp}, 254^{Oa}, 10.53^{Pt}, 83.66^{Tn}	Shad *et al*., 2013
97.	*Solanum melongena* L./ Solanaceae/ Fruit/ Kohat / Less Humid	11.21^{Me}, 10.86^{Ah}, 9.65^{Pe}, 0.37^{Ft}, 68.14^{Ce}, 314.76^{Ev}, 15.6^{Fr}	9.7^{Ca}, 14^{Mg}, 25^{P}, 1.25^{Fe}, 0.16^{Zn}, 4^{Aa}, 0.066^{Rf}, 0.09^{Tm}	Bangash *et al*., 2011; Hussain *et al*., 2011a
98.	*Solanum tuberosum* L./ Solanaceae/ Aerial parts/ Peshawar / Less Humid	9.06^{Me}, 0.9^{Ah}, 1.9^{Pe}, 0.2^{Ft}, 19^{Ce}, 81^{Ev}, 0.4^{Fr}	12^{Aa}, 0.05^{Rf}, 0.1^{Tm}	Hanif *et al*., 2006
99.	*Sonchus arvensis* L./ Asteraceae/ Aerial parts/ Mansehra / Wet area	6.72^{Me}, 21.78^{Ah}, 20.53^{Pe}, 44.87^{Ce}, 15.11^{Fr}	----	Bahadur *et al*., 2011
100.	*Sonchus asper (*L.) Hill/ Asteraceae/ Aerial parts/ Kohat / Less Humid	12.72^{Me}, 10.62^{Ah}, 42.72^{Pe}, 2.59^{Ft}, 18.28^{Ce}, 267.56^{Ev}, 36.29^{Fr}	----	Hussain *et al*., 2010b
101.	*Sophora griffithii* Stocks/ Papilionaceae/ Whole plant/ Kalat / Less Humid	8.24^{Ah}, 9.35^{Pe}, 47.63^{Ce}, 29.33^{Fr}	----	Hussain & Durrani, 2009
102.	*Sphaeranthus hirtus* Willd/ Asteraceae/ Leaves/ Hattar / Humid area	3.71^{Me}, 6.54^{Ah}, 7.41^{Pe}, 3.68^{Ft}, 78.42^{Ce}, 377.4^{Ev}, 4.39^{Fr}	423^{Fe}, 4.5^{Zn}	Hussain *et al*., 2009c
103.	*Spinacia oleracea* L./ Amaranthaceae/ Leaves/ Parachinar / Wet area	14.51^{Me}, 22.5^{Ah}, 17.29^{Pe}, 1.12^{Ft}, 44.58^{Ce}, 257.51^{Ev}, 24.08^{Fr}	42^{Ca}, 24.9^{Fe}, 4.2^{Zn}, 76^{Aa}, 0.15^{Rf}, 0.13^{Tm}	Hanif *et al*., 2006; Hussain *et al*., 2009a; Khan *et al*., 2013
104.	*Stipa pennata* L./ Poaceae/ Whole plant/ Kalat / Less Humid	8.7^{Ah}, 9.27^{Pe}, 48.3^{Ce}, 25.87^{Fr}	----	Hussain & Durrani, 2009

Table 1. (Cont'd.).

S #	Plant species/ Family name/ Part used/ Locality/ Geography	Proximate composition	Others (micro nutrients, vitamins, non nutritional and anti-nutritional compounds, antioxidant activities)	References
105.	*Swertia chirata* Buch. Ham. Ex Wall./ Gentianaceae/ Whole plant/ Hattar / Humid area	7.43^{Me}, 7.73^{Ah}, 8.65^{Pe}, 2.1^{Ft}, 73.84^{Ce}, 349.05^{Ev}, 27.67^{Fr}	----	Hussain *et al.*, 2009c
106.	*Taraxicum officinale* F.H. Wigg/ Asteraceae/ Whole plant/ Peshawar / Less Humid	10.01^{Me}, 3.5^{Ah}, 2.74^{Pe}, 0.21^{Ft}, 48.46^{Ev}, 2.41^{Fr}	34.38^{Aa}	Rizvi, 2007; Din *et al.*, 2012
107.	*Tecomella undulate* (Sim.)Seem. / Bignoniaceae/ Seed/ Tank / Dry area	7.73^{Me}, 4.52^{Ah}, 9.44^{Pe}, 2.52^{Ft}, 74.08^{Ce}, 380.39^{Ev}, 18.3^{Fr}	132.1^{Ca}, 402.1^{Mg}, 1.82^{Fe}, 0.64^{Zn}	Ullah *et al.*, 2013
108.	*Tephrosia purpurea* (L.) Pers./ Papilionaceae/ Whole plant/ Hattar / Humid area	7.43^{Me}, 7.73^{Ah}, 8.65^{Pe}, 2.1^{Ft}, 73.84^{Ce}, 349.05^{Ev}, 27.67^{Fr}	----	Hussain *et al.*, 2009c
109.	*Terminalia bellirica* (Gaertn.) Roxb./ Combretaceae/ Aerial parts/ Hattar / Humid area	8.58^{Me}, 2.64^{Ah}, 3.27^{Pe}, 0.71^{Ft}, 84.8^{Ce}, 358.75^{Ev}, 2.95^{Fr}	----	Hussain *et al.*, 2009c
110.	*Terminalia chebula* Retz./ Combretaceae/ Aerial parts/ Hattar / Humid area	7.37^{Me}, 8.66^{Ah}, 10.58^{Pe}, 4.073^{Ft}, 69.6^{Ce}, 357.41^{Ev}, 24.65^{Fr}	0.273^{Ca}, 0.44^{Mg}, 0.07^{Fe}, 0.05^{Zn}	Haq, 2011; Hussain *et al.*, 2009c
111.	*Tetrapogon villosus* Desf./ Poaceae/ Whole plant/ Kalat / Less Humid	10.4^{Ah}, 8.18^{Pe}, 60.35^{Ce}, 26.85^{Fr}	----	Hussain & Durrani, 2009
112.	*Tinospora cordifolia* (Willd.) Miers/ Menispermaceae/ Whole plant/ Hattar / Humid area	8.65^{Me}, 2.68^{Ah}, 3.77^{Pe}, 1.45^{Ft}, 83.43^{Ce}, 361.89^{Ev}, 19.33^{Fr}	----	Hussain *et al.*, 2009c
113.	*Trianthema portulacastrum* L./ Aizoaceae/ Leaves/ Kohat / Less Humid	5.33^{Me}, 30.22^{Ah}, 19.63^{Pe}, 3.81^{Ft}, 40.99^{Ce}, 276.85^{Ev}, 8.66^{Fr}	31.1^{Ca}, 119^{Fe}, 14.8^{Zn}	Hussain *et al.*, 2010c
114.	*Valeriana officinalis* L./ Valerianaceae/ Roots/ Swat / Wet area	6.82^{Me}, 27.91^{Ah}, 5.26^{Pe}, 14.35^{Ft}, 45.66^{Ce}	1334^{Ca}, 183^{Mg}, 279^{Fe}, 3.2^{Zn}	Adnan *et al.*, 2010
115.	*Vigna radiata*cv M1 (L.) R. Wilczek / Papilionaceae/ Seeds/ Kohat / Less Humid	9.4^{Me}, 3.9^{Ah}, 23.7^{Pe}, 1.9^{Ft}, 340^{Ev}, 6.8^{Fr}	----	Ullah *et al.*, 2007
116.	*Vigna radiata*cv NM-92 (L.) R. Wilczek / Papilionaceae/ Seeds/ Kohat / Less Humid	8.3^{Me}, 3^{Ah}, 20.8^{Pe}, 2.2^{Ft}, 347^{Ev}, 7.1^{Fr}	----	Ullah *et al.*, 2007
117.	*Vitis venifera* L. cv (large)/ Vitaceae/ Fruit/ Hattar / Humid area	19.2^{Me}, 3.3^{Ah}, 4.85^{Pe}, 3.1^{Ft}, 69.49^{Ce}, 325.78^{Ev}, 1.22^{Fr}	----	Hussain *et al.*, 2009c
118.	*Vitis venifera* L. cv (small)/ Vitaceae/ Fruit/ Hattar / Humid area	17.42^{Me}, 2.45^{Ah}, 2.89^{Pe}, 1.64^{Ft}, 75.45^{Ce}, 316.87^{Ev}, 1.2^{Fr}	----	Hussain *et al.*, 2009c
119.	*Withania coagulans* (Stocks) Dunal/ Solanaceae/ Whole plant/ Tank / Dry area	6.82^{Me}, 2.32^{Ah}, 4.51^{Pe}, 8.24^{Ft}, 32.35^{Ce}, 261.33^{Ev}, 8.85^{Fr}	926^{Ca}, 3528^{Mg}, 9.88^{Fe}, 4.02^{Zn}	Ullah *et al.*, 2013
120.	*Xanthium strumarium* L./ Asteraceae/ Aerial parts/ Rawalpindi / Wet area	0.33^{Me}, 12.6^{Ah}, 0.64^{Pe}, 5.51^{Ft}, 19.3^{Ce}, 129.6^{Ev}, 61.8^{Fr}	----	Hussain *et al.*, 2006; Hussain *et al.*, 2013
121.	*Zanthoxylum alatum* Roxb./ Rutaceae/ Aerial parts/ Swat / Wet area	4.68^{Me}, 2.28^{Ah}, 6.58^{Pe}, 4.13^{Ft}, 218.46^{Ev}, 11.67^{Fr}	1.65^{Aa}, 9.67^{Dp}, 23.34^{Oa}, 6.67^{Pt}, 16.57^{Tn}	Shad *et al.*, 2013
122.	*Zingiber officinale* Roscoe/ Zingiberaceae/ Rhizome/ Kohat / Less Humid	9.21^{Me}, 4.83^{Ah}, 7.27^{Pe}, 7.3^{Ft}, 72.36^{Ce}, 380.3^{Ev}, 16.36^{Fr}	3.75^{Aa}	Shahid & Hussain, 2012; Hussain *et al.*, 2009d
123.	*Zizyphus vulgaris* Mill./ Rhamnaceae/ Whole plant/ Hattar / Humid area	11.84^{Me}, 2.84^{Ah}, 1.81^{Pe}, 0.41^{Ft}, 83.12^{Ce}, 343.87^{Ev}, 3.45^{Fr}	----	Hussain *et al.*, 2009c

Proximate (Moisture % (Me), Ash %, (Ah), Protein % (Pe), Fats % (Ft), Carbohydrates % (Ce), Energy values k cal/100gm (Ev), Fiber % (Fr)). Micronutrients (Fe represents Iron mg/ 100g, Zn represents Zinc mg/ 100g, Ca represents Calcium mg/ 100g, Mg represents Magnesium mg/ 100g, Ph represents Phosphorous mg/ 100g. Vitamins (As represents Ascorbic acid mg/100g, Va represents vitamin A mg/100g, Rf represents Riboflavin mg/100g, Tm represents Thiamine mg/100g). Non nutritional compounds (Ph represents Phenols mg/100g, Fl represents Flavonoids mg/100g, Tn represents tannins mg/100g). Anti-nutritional components (Oa represents oxalic acid mg/100g, Sp represents saponine mg/100g, Ti represents trypsin inhibitor µg /100g, Cn represents cyanide mg/100g, Al represents alkaloids mg/100g, Pt represents phytate mg/100g). Note: part use, locality and geography have been determined only for the major nutrients. Antioxidant activities (Dp represents DPPH %, Te represents TEAC µmol/g, Fr represents FRAP µmol/g, Tr represents TRAP µmol/g, Ec represents E50 µg/ml, La represents linolic acid inhibition %)

Protein: Protein is the main component of body tissues next to water and is indispensable nutrient for growth. In human diet proteins are derived from plant proteins (pulses, cereals, nuts, beans etc.) and animal proteins (egg, meat, fish, milk etc.). Mainly, protein from plants resources has minor amounts of amino acids than animal sources. However, many legumes and wild vegetables are assumed to have considerable amount of proteins in order to be used as an alternative to animal proteins.

The reported plant species contain enough contents of crude protein, which can accomplish the protein requirement of animals and humans. The protein content of plants ranges between (0.08%) in *Dipterygium glaucum* to (42.72%) in *Sonchus asper* (Table 1).Protein contents in green leafy vegetables ranges between 20-41.66% (Roger *et al*., 2005). The plants that supplies food over 12% of its caloric content from protein is an excellent source of protein. The daily requirement of proteins for adults is 34-56 g (Anon., 2002). The value of protein in different localities is as follow, wet > less humid > dry > humid. The average protein content is maximum in wet region (8.84%) and minimum in humid (7.73%) (Table 1). Different agro-climatic conditions may be a reason for variable protein contents. The deficiency of protein causes kwashiorkor disease (mostly protein deficient). The low level of protein in plants can be overcome by supplementation with animal protein.

Fats: Fats are also an important group of compounds being soluble in organic solvents and water insoluble. A diet with extra fats should be more appetizing than that with little fats because nutritional fats function to raise food palatability by absorbing and retaining flavors. A diet that provide 1-2% of its caloric energy as fat is considered to be enough to human beings, as excess amount of fats use causes certain diseases like cardiovascular disorders, atherosclerosis, aging and cancer (Kris- Etherton *et al*., 2002). The amount of fat is greater in wet region followed by dry, humid and less humid. On average basis that is highest in wet region (7.61%) and lowest in less humid region (2.74%).*Raphanus sativus* belongs to family Brassicaceae recorded from less humid area has minimum value of 0.1 % fat (Table 1), while Hussain *et al*. (2009b) noticed highest value of fats in *Pistacia vera* (51.75%) of family Anacardiaceae. *Pistacia vera* is cultivated as dry nut fruit and dry nut fruits are good source of fats and energy.

Carbohydrates: Carbohydrates are vital constituents in many foods, and are considered the significant energy's source. The composition of carbohydrate was evaluated by subtracting the sum of ash, lipid, protein and moisture from 100. Recommended dietary intake values of carbohydrates for children and adults are 130g. However in Pakistan, an intake of 349 g of carbohydrate has been reported which is promising (Ministry of Health and Nutrition, 1994). Average values for carbohydrates were found highest in humid region plants (63.51%) and lowest in less humid (38.38%) (Table 1). The decreasing trend in average amount of carbohydrates among different regions is in such a way, humid > wet > dry > less humid. If we look at the overall percentage of the carbohydrate composition, it was found highest in *Terminalia belerica* (84.8%) and (83.43%) in *Tinospora cordifolia* and lowest in *Dipterygium glaucum* (0.15%) recorded from Cholistan (Table 1). The low value in *Dipterygium glaucum* might be due to xeric condition but it needs further research.

Fibers: Fibers are the types of carbohydrates that cannot be digested by the body. Fiber assists in controlling the body's use of sugars, helping to maintain appetite and blood sugar. Children and adults require at least 20 to 30 g of fiber per day for good health, but most Americans get only about 15 g a day (Ministry of Health and Nutrition, 1994). Chief sources of fibers are vegetables, whole fruits, whole grains and beans. The recommended daily allowance of fibers for children and adults are 19-25%, 21-38%respectively. Some plants were found to be low in fiber content while others like *Alpinia allughas* have 76.53% fiber (Table 1).The fiber values are as follows in different geographical areas; wet > dry > humid > less humid. The highest average value of fiber was found in wet region (21.33%) while lowest was noticed in less humid region (12.70%). The richest sources of dietary fibers are non-starchy vegetables. The content of total dietary fibers in plants may be different due to variation in seasonal changes, use of fertilizers, plant maturity stages, plant variety and geographical position. In addition to that, cooking of plant tissues changes the properties of cell walls, this also affects their performance as dietary fibers. According to Saldanha (1995) fibers are employed in the cure of diseases such as obesity, gastrointestinal disorders and diabetes. This makes *Alpinia allughas* (Table 1) a more favorable plant since high fiber content of foods help in digestion, prevention of constipation and colon cancer.

Energy value: Plants are good source of energy because plants contain high amount of sugar. The energy requirements of adult men ranged from 2300-2900 kcal/day and adult women ranged from 1900-2200 kcal/day (NIM, 2001).Based on the results of the energy values, it was revealed that *Pistacia vera* has 628.22 kcal of energy per 100g which is highest recorded in all the analyzed plants (Table 1) while it is lowest in *Lageneria vulgaris*. The highest energy value was recorded in the region of humid followed by wet, dry and less humid (Table 1). Asibey-Berko & Tayie (1999) also recorded high energy value in some green leafy vegetables of Ghana such as sweet potato leaves (288.3 kcal/100g) and *Corchorus tridens* (283.1 kcal/100g). The plants with low lipid values result in the low energy value. Hence, a segment of 100 g of plants produces around 12 to 15% of the total energy requirement per day/per adult. Animals need food for obtaining energy and plants provide substantial energy to human and animals. Maximum energy was recorded in the plants of humid region on average basis (293.59%) and lowest in less humid area (178.74%) (Table 1). The energy values are as follows; humid > wet > dry > less humid.

Carbohydrates, fats and proteins show more significant correlation with energy and these are considered good sources of energy. Ash fibers, ash fats, ash energy, protein fats, protein carbohydrates and fats carbohydrates also show significant correlation. Carbohydrates and protein shows no significant correlation with fibers. The relation of moisture is negative with protein, fats, ash, fibers and energy while that of carbohydrates is not significant (Fig. 1).

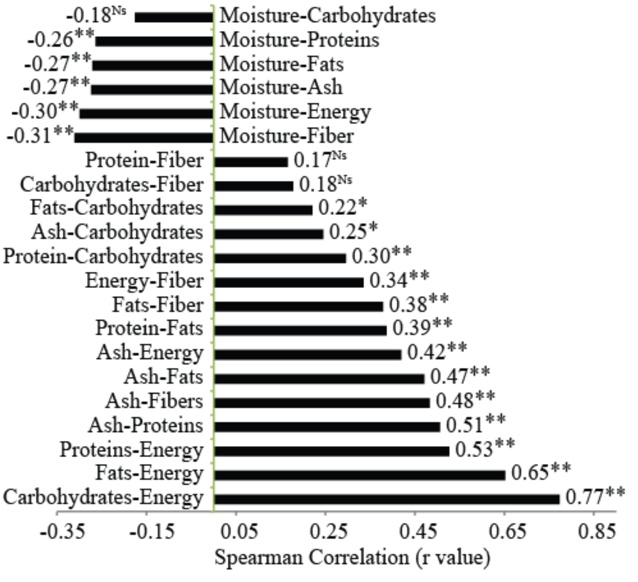

Fig. 1. Spearman correlation between various nutritional components. ** represents higher significance ($p<0.01$), * represents significance ($p<0.05$) and Ns represents not significant.

Micronutrients: The major global health problem is the deficiencies of micronutrients. According to economic survey of Pakistan (2002) more than 2 billion people in the world today are probably deficient in vital minerals and vitamins chiefly iron, iodine, zinc and vitamin A. Most of them live in those countries where income is very low and are naturally scarce in more than one micronutrient. Pakistan is a developing country and micronutrients deficiencies prevail in different sections of population. The National Nutritional Survey of Pakistan is aware of the fact that major portion of Pakistani population is in danger of micronutrient deficiencies such as zinc, iron, iodine and vitamin A. These deficiencies are more common in pregnant, lactating women and children. In Pakistan much work has been done on micronutrient contents of various plants species, but we selected those plants species that are mentioned in proximate analysis. Table 1 shows mineral content of plants. Minerals are usually vital as constituents of hemoglobin, muscles, nerve cells, teeth and bones. Some of the important micronutrient present in plants and their promising contribution to health are mentioned below.

Iron: Some plants are good source of iron but their levels are affected by different factors such as availability of water to the plant, type of soil and its pH, plant variety, climatic conditions, age of the plant and the use of fertilizers (Gupta *et al*., 1989). The recommended daily intake of iron is 27 mg for women and 5.8 mg for children (Anon., 2001). The National Nutritional Survey carried out in Pakistan during the year 2001-02 has revealed that iron deficiency is alarmingly high in Pakistan particularly in children and women. 48.7% mothers and 27 % children are iron deficient in Pakistan. This could be overcome by using these plants in mixture with other foods. The range of iron content varies in Pakistani plants from 0.043 to 422.5 mg/g in *Punica granatum* and *Spharanthus hirtus* respectively (Table 1). Apart from *Sphaeranthus* which is an excellent source of iron, *Chenopodium album, Amaranthus, Valeriana officinalis, Artemisia maritime, Brassica campestris* and *Trianthema portulacastrum* are also good source of iron. The absorption of non-haemiron is dependent on several factors such as the enhancers like organic acids, b-carotene, ascorbic acid and fermentable carbohydrates and the inhibitors like phytate, fiber and oxalates. Minerals do not change drastically due to cooking because they have greater stability in comparison to vitamins (Kala & Prakash, 2004).

Zinc: The zinc content ranges from 0.04 to 14.8 mg/100g in *Fagonia indica* and *Trianthema portulacastrum* respectively (Table 1). Zinc is badly affected by anti-nutritional contents like phytate. The zinc phytate molar ratio of 1:15 reduced zinc bioavailability (Turnlund *et al*., 1984). In developing nations Zinc deficiency in human is a severeworldwideproblem. Zinc deficiency also prevails in Pakistan especially in pre-school children (37.1%) and in mothers (41.4%). The deficiency of zinc is linked with impaired immune and gastrointestinal functions. The recommended daily intake of zinc is 10 mg for women and 4.1 mg for children (Anon., 2001). Like iron most plants do not provide significant amount of zinc but some plants can be recommended as food along with other diet.

Calcium, magnesium and phosphorus: The range of calcium in Pakistani plants is between 0.165 mg/100 g in *Punica granatum* and 7037 mg/100 g in *Forsskaolea tenacissima,* while that of magnesium is between 0.3 mg/100 g in *Punica granatum* and 6857 mg/100 g in *Datura metel* (Table 1). The amount of phosphorus ranges from 10 mg/100 g in *Mentha longifolia* to 295 mg/100g in *Datura metel,* so *D. metel* is a good source of these minerals. The bioavailability of Ca, Mg and P is reliant on the sex and age of an individual, presence of fat concentration in diet and anti-nutrients. Majority of these plants could appreciably contribute towards the dietary requirements of these three minerals. All the three minerals are the most significant involving in building of stiff structures to support the body (Osborne & Voogt, 1978) and are well supplied by the plant species. These minerals in considerable amounts are indispensable for the formation of teeth and bones. As an example, 1000 g to 1200 g calcium in adults and 600 g to 700 g of phosphorus occurs in the teeth and bones. The two elements together with a much smaller amount of magnesium (20 to 80 g) form a crystal lattice that is responsible for firmness and vigor of teeth and bones.

Vitamins: Table 1 shows the vitamins content of medicinal plants of Pakistan. Plants parts like stem, leaf and root are generally moderate but their fruits are good source of vitamins. The daily recommended intake of vitamin A, C, thiamine (B1) and riboflavin (B2) for pregnant women and children are (800 and 400 µg, 55 and 30 mg, 1.4 and 0.5 mg, 1.4 and 0.5 mg) respectively (Anon., 2001). Little data is available on vitamin A content while there is a lot of data available on vitamin C in medicinal plants of Pakistan. The study revealed that most of the plants are moderate source of vitamin C (Table 1). Riboflavin and thiamine are present in low quantity. Vitamin A in plants is mostly present in the form of provitamin A carotenoids (b-carotene, lutein, neoxanthin and violaxanthin), of which the most important is beta-carotene in terms of the relative activity of provitamin A and their potential contribution to diet (SACN, 2005). The ascorbic acid ranges from 0.31-2035.7 mg/100 g in *Azadaricha indica* and *Emblica officinalis* respectively, while the range of thiamine varies from 0.013-0.28 mg/100g in *Brassica rapa* and *Allium sativum* respectively (Table 1). Absorption of soluble non-haem iron is being promoted by ascorbic acid by keeping the reduced iron form or chelation (Anon., 2001). Furthermore, it also noticeably offsets the inhibition of iron absorption by phytates in the diet. Vitamins are considered important nutrients in foods and carry out specific functions essential for health though their daily requirements are minute. B-complex and C are water soluble vitamins occurs in plants, which are continuously needed in our diets as they are not stored in the body, and are excreted in urine. In contrast, fat-soluble vitamins (A, D, E and K) dissolve in fat prior to be absorbed in blood stream in order to perform specific functions. Liver stores these vitamins in excess amount. Vitamins B and C acts as coenzymes, which make possible the working of every cell in the body. They are active in the metabolism of carbohydrates, fat and protein, and DNA regenerating of new cells. Vitamin C defends tissues from oxidative stress and plays a key role in preventing ailments (Whitney & Rolfes, 2002).

Non nutritional components (Phenols, Flavonoids and Tannins): Plant phenols consist of phenolic acids, flavonoids, stilbenes, coumarins, tannins and lignins. The Flavonoids reported in plants are quercetin, luteolin, kaempferol, myricetin and isorhamnetin (Trichopoulou *et al*., 2000). Little work has been done on the phenolic and flavonoids compounds of Pakistani medicinal plants. The concentration of phenols ranges from 193.7 mg/100g in *Emblica officinalis* to 1650 mg/100 g in *Morus alba*, while the flavonoids ranges from 30-371.27 mg/100g in *Emblica officinalis* and *Albizzia lebbek* respectively (Table 1). Plants that contain greater amount of polyphenols show high antioxidant activity. Mai *et al*. (2007) worked on extracts of Vietnamese plants and noticed highest antioxidant activity because these plants contain too much polyphenols. Maisuthisakul *et al*. (2007) recorded a distinct association between total flavonoid and phenolic contents and antiradical activity in the selected Thai traditional plants. Mai *et al*. (2007) also found a relationship between polyphenol content and antioxidant activity of many Vietnamese plants. The association between flavonoid or phenolic content and antioxidant activities depends on the methodology used and type of plant species. A significant association exists between the age of plant, temperature and growth with respect to antioxidant activity of boiled *Amaranthus*. Modi (2007) found highest antioxidant activity in *Amaranthus* when boiled for 60 days. Hence, plant developmental stage is important during harvesting for optimum antioxidant activity.

A tannin range of 6.03-199 mg/100 g was determined in Pakistani medicinal plants used in this study (Table 1). The tannin contents in the samples were relatively lower than other works reported on (Gupta *et al*., 1989). The interest in dietary tannins is mainly due to the proof of harmful effects. It is reported that diet containing can cause depression of growth and have the potential to complex divalent ions (Zn, Cu, Fe etc.) that result in their unavailability. Moreover, Zn unavailability causes paralysis (Marfo *et al*., 1986).

Anti- nutritional components

Oxalic acid: The level of oxalate determined in Pakistani medicinal plants ranges from 0.04-362.66 mg/100g in *Albizzia lebbek* and *Nasturtium officinale* respectively (Table 1). This concentration is lower than that concluded by Gupta *et al*. (1989) in six leafy vegetables. Oxalic acid is present in the cell sap as soluble salts of sodium and potassium or as insoluble salts of iron, calcium and magnesium or combination of these two depending on the species. The oxalic acid in soluble form is absorbed in the body while the insoluble one is excreted from the body in faeces. When the oxalate is in soluble, it forms strong chelates with nutritional calcium, making it unavailable for absorption and assimilation. High intake of nutritional soluble oxalate may lead to the creation of stones in kidney. Excess oxalates in diets may need other divalent minerals to be supplemented to stop deficiencies. The amount of soluble oxalate can be reduced in the intestine by the addition of a source of calcium to vegetables that are eaten as food (Radek & Savage, 2008).

Phytate: The level of phytate or phytic acid ranges from 5.97-33.09 mg/100g in *Berberis lyceum* and *Rumex hastatus* respectively (Table 1). It is the chief phosphorus storage compound in plants. It is reported that excess dietary phytate content cause reduction in growth and affects value of food through binding. This makes the unavailability of mineral ions to the consumer and affects the homeostasis of Fe and Zn, hinder the digestion of proteins by enzymes by forming complexes with proteins (Marfo *et al*., 1990). On the other side, low phytate contents in plants would be nutritionally beneficial.

Saponin: The value of saponin ranges from 0.4 to 834.13 mg/100 g in *Emblica officinalis* and *Albizzia lebbek* respectively (Table 1). Saponins have cholesterol lowering effect as well as haemolytic, anti-inflammatory, antimicrobial, antifungal, cytotoxicity antitumour and other biological activities (Sparg *et al*., 2004). The absorption of saponin is poor and most of their effects are attributable to their hydrophobic/hydrophilic asymmetry and as a result their ability to decrease interfacial tension.

Alkaloids: *Emblica officinalis* contained the lowest alkaloid content of 3.5mg/100 g while the highest of 660mg/100 g was found in *Morus alba* (Table 1). The bitterness represents the presence of alkaloids in the diet and it invariably influence the nutritive value of diets, however, consumed as medicinal plant it does not cause a problem. Alkaloids also have medicinal properties. In small intestine, the alkaloids show microbicidal properties due to their effects on transit time (Cowan, 1998).

Trypsin inhibitor and cyanide: Little data is available on trypsin inhibitor and cyanide. The level of trypsin inhibitor is 16.04µg/100 g and cyanide is 0.21 mg/100 g in *Albizzia lebbek* (Table 1). Trypsin and cyanide damages the consumption of amino acids and proteins (Glew *et al*., 2005) by acting together with proteolytic enzymes making their unavailability for protein digestion. The activity of trypsin inhibitor is strongly affected by temperature, heating period and the presence of water.

Antioxidant activity: Free radicals are extremely reactive chemical substances, which can show the way to speed upd aging, injuries to cell, cancers, inflammations and cardiovascular diseases etc. Fresh vegetables have multifaceted mixtures of antioxidants and are therefore, liable for many health benefits. Khattak (2011) worked on antioxidant activity of some vegetables. Methanolic extracts of three plants namely *Cicer arietinum*, *Bauhinia variegate* L. and *Brassica campestris* L. displayed EC50 values below 100µg/ml, representing a very good prospective as free radical scavengers. *Moringa oleifera* L, *Chenopodium album*, *Caralluma tuberculata* and *Portulaca oleracea* leaves represented EC50 376.0, 454.7, 695.7 and 950.3µg/ml, respectively (Table 1). The EC50 values of all the studied plants illustrated low values representing strong free radical scavenging activity. The data available for antioxidants so far is mostly analyzed by the DPPH method**.** Moreover, antioxidant activity in percentage was observed to be maximum in *Sisymbrium officinale* (45.66%), whereas minimum in *Zanthoxylum alatum* (9.67%). Sultan *et al*. (2009) worked on the antioxidant activity of *Nigella sativum*. *In vitro* antioxidant capacity showed that essential and fixed oil inhibited lipid peroxidation by 92.56 and 25.62% and 2, 2-diphenyl-1 picrylhydrazyl (DPPH) radical scavenging activity by 80.25 and 32.32% respectively (Table 1).

Conclusions and Recommendations

Most of the plants reported for nutritional value were recorded from less humid areas. The highest number of plants was reported from the family Lamiaceae, Asteraceae and Papalionaceae. The methodology of AOAC was used for proximate analysis. The data displayed in this article shows that plants may be regarded as a nutritious food and can play a vital function in human health sidewise. Plants are rich sources of protein, fats, carbohydrates and dietary fiber and natural antioxidative compounds that could be utilized as an addition of fiber and antioxidants in pharmaceutical, nutraceutical and medicine industries. Plants may be regarded as good example of food. In the presence of anti-nutritional components like phytates, the bioavailability of minerals such as zinc and iron from plant materials is little while their efficacy can be improved by the presence of protein and vitamin C. If the diet is in principal plant-based with high levels of anti-nutritional components, it may lead to mineral deficiencies. Depending on the bioavailability and dose some compounds with anti-nutritional aspects may have useful effects on human health. By the addition of small amount of animal origin food will assist to improve the bioavailability of some nutrients in plant-based diets. They are rich in insoluble fiber and also with high antioxidant activity which is important for gastrointestinal health. They are regarded as functional foods. For these reasons plants consumption and utilization should be recommended.

Acknowledgements

The authors thank all the previous researchers whose works have been cited in this review. Authors are also grateful to the colleagues and friends for supporting in manuscript writing.

Disclosure statement: The study had no requirements related to ethical consent.

Conflicts of interest: The authors have no conflicts of interests.

References

Adnan, M., J. Hussain, M.T. Shah, Z.K. Shinwari, F. Ullah, A. Bahadar, N. Khan, A.L. Khan and T. Watanabe. 2010. Proximate and nutrient composition of medicinal plants of humid and sub-humid regions in North-West Pakistan. *J. Med. Plants Res.*, 4: 339-345.

Ahmed, K., M. Shaheen, F. Mirzaei, Z.I. Khan, S. Gondal, A. Fardous, A. Hussain, F. Arshad and T. Mehmood. 2013. Proximate analysis: Relative feed values of various forage plants for ruminants investigated in a semi-arid region of Punjab, Pakistan. *Agric. Sci*., 4: 302-308.

Ali, S., Y. Liu, M. Ishaq, T. Shah, Abdullah, A. Ilyas and I.U. Din. 2017. Climate change and its impact on the yield of major food crops: Evidence from Pakistan. *Foods*, 6: 1-19.

Anonymous. 2001. Human Vitamin and Mineral Requirements, 2nd ed. Geneva, Switzerland.

Anonymous. 2002. Food and Nutrition Board, institute of medicine. National academy of sciences. Dietary reference intake for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein and amino acid (micronutrients). www.nap.edu, Accessed 06/06/2005).

Anonymous. 2005. Food and Nutrition Board. Dietary reference intakes for water, potassium, sodium, chloride, and sulfate. The National Academies Press, 500 Fifth Street, N.W. Washington, DC 20001, USA 77-185.

Ashraf, M., M.Q. Hayat and A.S. Mumtaz. 2010. A study on elemental contents of medicinally important species of *Artemisia* L. (Asteraceae) found in Pakistan. *J. Med. Plants Res*., 4: 2256-2263.

Asibey-Berko, E. and F.A.K. Tayie. 1999. Proximate analysis of some under-utilized Ghanaian vegetables. *Ghana J. Sci.*, 39*:* 91-96.

Aziz, M., M. Anwar, Z.U. Din, H. Amanat, H. Ayub and S. Jadoon. 2013. Nutrition comparison between genus of apple (*Malus sylvestris* and *Malus domestica*) to show which cultivar is best for the province of Balochistan. *JASR*., 3: 417-424.

Bahadur, A., Z. Chaudhry, G. Jan, M. Danish, A.U. Rehman, R. Ahmed, A. Khan, S. Khalid, I. Ullah, Z. Shah, F. Ali, T. Mushtaq and F.G. Jan. 2011. Nutritional and elemental analysis of some selected fodder species used in traditional medicine. *Afr. J. Pharm. Pharmacol*., 5: 1157-1161.

Bangash, J.A., M. Arif, F.U. Khan, A.U. Rahman and I. Hussain. 2011. Proximate composition, minerals and vitamins content of selected vegetables grown in Peshawar. *J. Chem. Soc. Pak.,* 33: 118-122.

Bown, D. 1995. Encyclopaedia of herbs and their uses. Dorling Kindersley, London. ISBN 0-7513-020-31.

Chamani, G., M.R. Zarei, M. Mehrabani and Y. Taghiabadi. 2011. Evaluation of effects of *Zingiber officinale* on salivation in rats. *Acta. Medica Iranica*., 49: 336-340.

Cowan, M.M. 1998. Plant products as antimicrobial agents. *Clin. Microbiol. Rev*., 12: 564-582.

Din, N.U., T. Masood, M. Arif, S.S. Shah, N. Azhar and S. Ullah. 2012. Nutritional content of some medicinal herbs of Peshawar District, Pakistan. *Sarhad J. Agric*., 28: 635-639.

Ghani, A., S. Saeed, Z. Ali, I. Ahmed and M. Ishtiaq. 2012. Heavy metals and nutritional composition of some selected herbal plants of Soan valley, Khushab, Punjab, Pakistan. *Afr. J. Biotechnol*., 11: 14064-14068.

Glew, R.S., D.J. Vanderjagt, R. Bosse, Y.S. Huang, L.T. Chuang and R.H. Glew. 2005a. The nutrient content of three edible plants of the Republic of Niger. *J. Food Compos Anal*., 18: 15-27.

Gohar, A.A. and M.M.A. Elmazar. 1997. Isolation of hypotensive flavonoid from *Chenopodium*species growing in Egypt. *Phytother Res*., 11: 564-567.

GoP (Govt of Pakistan). 2002. Economic Survey Finance Division. Economic Advisors Wing, Islamabad.

Gupta, K., G.K. Barat, D.S. Wagle and H.K.L. Chawla. 1989. Nutrient contents and antinutritional factors in conventional and non-conventional leafy vegetables. *Food Chem.,* 31: 105-116.

Hanif, R., Z. Iqbal, M. Iqbal, S. Hanif and M. Rasheed. 2006. Use of vegetables as nutritional food: Role in human health. *JABS.,* 1: 18-22.

Haq, F. and R. Ullah. 2011. Comparative determination of trace elements from *Allium sativum, Rheum austral* and *Terminalia chebula* by atomic absorption spectroscopy. *IJB*., 1: 77-82.

Haq, F., S. Rehman, H. Ahmad, Z. Iqbal and R. Ullah. 2012. Elemental analysis of *Paeonia emodi* and *Punica granatum* by atomic absorption spectroscopy. *AJB*., 2: 47-50.

Haq, M.Z., S. Ahmed, M. Qayum and S. Ercişlis. 2013. Compositional studies and antioxidant potential of *Albizia lebbeck* (L.) Benth. pods and seeds. *Turk. J. Biol*., 37: 25-32.

Hussain, F. and M.J. Durrani. 2009. Nutritional evaluation of some forage plants from harboi rangeland, Kalat, Pakistan. *Pak. J. Bot.,* 41: 1137-1154.

Hussain, I., F. Khan, I. Khan, L. Khan and W. Ullah. 2006. Determination of heavy metals in medicinal plants. *J. Chem. Soc. Pak*., 28: 347-351.

Hussain, J., A. Bahadur, F. Ullah, N.U. Rehman, A.L. Khan, W. Ullah and Z.K. Shinwari. 2009d. Proximate and nutrient analysis of the locally manufactured herbal medicines and its raw material. *J. A. Sci*., 5: 1-5.

Hussain, J., A.L. Khan, N.U. Rehman, M. Hamayun, T. Shah, M. Nisar, T. Bano, Z.K. Shinwari and I.J. Lee. 2009a. Proximate and nutrient analysis of selected vegetable species: A case study of Karak region, Pakistan. *AJB*., 8: 2725-2729.

Hussain, J., A.L. Khan, N.U. Rehman, M. Hamayun, Z.K. Shinwari, W. Ullah and I.J. Lee. 2009c. Assessment of herbal products and their composite medicinal plants through proximate and micronutrients analysis. *J. Med. Plants Res.,* 3: 1072-1077.

Hussain, J., A.L. Khan, N.U. Rehman, Z. Ullah, F.U. Khan, S.T. Hussain and Z.K. Shinwari. 2009b. Proximate and nutrient investigation of selected medicinal plants species of Pakistan. *Pakistan. J. Nutr*., 8: 620-624.

Hussain, J., F.U. Khan, R. Ullah, Z. Muhammad, N. Rehman, Z.K. Shinwari, I.U. Khan, M. Zohaib, I. Din and S. M. Hussain. 2011c. Nutrient evaluation and elemental analysis of four selected medicinal plants of Khyber Pakhtunkhwa, Pakistan. *Pak. J. Bot.,* 43: 427-434.

Hussain, J., N.U. Rehman, A. Al-Harrasi, L. Ali, R. Ullah, F. Mabood, H. Hussain and M. Ismail. 2011b. Nutritional prospects and mineral compositions of selected vegetables from Dhoda Sharif, Kohat. *J. Med. Plants Res.,* 5: 6509-6514.

Hussain, J., N.U. Rehman, A.L. Khan, H. Hussain, A. Al-Harrasi, L. Ali, F. Sami and Z.K. Shinwari. 2011a. Determination of macro and micronutrients and nutritional prospects of six vegetable species of Mardan, Pakistan. *Pak. J. Bot.,* 43: 2829-2833.

Hussain, J., N.U. Rehman, A.L. Khan, L. Ali, A. Al-Harrasi, Z.K. Shinwari, H. Hussain and T.S. Rizvi. 2013. Proximate based comparative assessment of five medicinal plants to meet the challenges of malnutrition. *European J. Med. Plants*, 3: 444-453.

Hussain, J., N.U. Rehman, A.L. Khan, M. Hamayun, S.M. Hussain and Z.K. Shinwari. 2010c. Proximate and essential nutrients evaluation of selected vegetables species from Kohat region, Pakistan. *Pak. J. Bot.,* 42: 2847-2855.

Hussain, J., R. Ullah, N.U. Rehman, A.L. Khan, Z. Muhammad, F.U. Khan, S.T. Hussain and S. Anwar. 2010a. Endogenous transitional metal and proximate analysis of selected medicinal plants from Pakistan. *J. Med. Plants Res.,* 4: 267-270.

Hussain, J., Z. Muhammad, R. Ullah, F.U. Khan, N.U. Rehman, N. Khan, S.M. Ahmed, F. Khan and M. Ismail. 2010b. Proximate composition and metal evaluation of four selected medicinal plant species from Pakistan. *J. Med. Plants Res.,* 4: 1370-1373.

Imeh, U. and S. Khokhar. 2002. Distribution of conjugated and free phenols in fruits: Antioxidant activity and cultivar variations. *J Agric. Food Chem*., 50: 6301-6306.

Imran, M., H. Khan, M.U. Shah and R. Khan. 2010. Chemical composition and antioxidant activity of certain *Morus* species. *Journal of Zhejiang University SCIENCE B (Biomed & Biotechnol)*., 11: 973-980.

Institute of Medicine. 2001. Dietary Reference Intakes: Proposed definition of dietary fiber. National Academy Press, Washington, D.C.

Iqbal, S., U. Younas, S.U. Din, K.W. Chan, R.A. Sarfaraz and M.K.U. Din. 2012. Proximate composition and antioxidant potential of leaves from three varieties of Mulberry (*Morus* sp.): A comparative study. *Int. J. Mol. Sci*., 13: 6651-6664.

Jilani, M.I., M.I. Ahmad, R. Hanif, R. Nadeem, M.A. Hanif, M.A. Khan, I. Ahmad and T. Iqbal. 2012. Proximate analysis and mineral profile of three elite cultivars of *Rosa hybrid* flowers. *Pak. J. Bot.,* 44: 1711-1714.

Kala, A. and J. Prakash. 2004. Nutrient composition and sensory profile of differently cooked green leafy vegetables. *Int. J. Food Prop*., 7: 659- 669.

Kashif, M. and S. Ullah. 2013. Chemical composition and minerals analysis of *Hippophae rhamnoides*, *Azadirachta indica, Punica granatum* and *Ocimum sanctum* leaves. *World J. Dairy Food Sci*., 8: 67-73.

Khan, N., B. Ruqia, J. Hussain, N. Jamila, N.U. Rahman and S.T. Hussain. 2013. Nutritional assessment and proximate analysis of selected vegetables from Parachinar Kurram Agency. *AJRC.,* 1: 184-198.

Khattak, K.F. 2011. Nutrient composition, phenolic content and free radical scavenging activity of some uncommon vegetables of Pakistan. *Pak. J. Pharm. Sci*., 24: 277-283.

Khattak, K.F. 2013. Proximate composition, phytochemical profile and free radical scavenging activity of radiation processed *Emblica officinalis. Int. Food Res. J.,* 20: 1125-1131.

Kris-Etherton, P.M., K.D. Hecker, A. Bonanome, S.M. Coval, A.E. Binkoski, K.F. Hilpert, A.E. Griel and T.D. Etherton. 2002. Bioactive compounds in foods: their role in the prevention of cardiovascular disease and cancer. *Am. J. Med*., 113: 71S-88S.

Mai, T.T., N.N. Thu, P.G. Tien and N.V. Chuyen. 2007. Alpha-glucosidase inhibitory and antioxidant activities of Vietnamese edible plants and their relationships with polyphenol contents. *J. Nutr. Sci. Vitaminol*., 53: 267-276.

Maisuthisakul, P., M. Suttajit and R. Pongsawatmanit. 2007. Assessment of phenolic content and free radical-scavenging capacity of some Thai indigenous plants. *Food Chem.,* 100: 1409-1418.

Marfo, E.K., B.K. Simpson, J.S. Idowu and O.L. Oke. 1990. Effect of local food processing in phytate levels in cassava, cocoyam, yam, maize, sorghum, rice, cowpea and soybean. *J. Agric. Food Chem*., 38: 1580-1585.

Marfo, E.K., O.L. Oke and A. Afolabi. 1986. Chemical composition of papaya (*Carica papaya)* seeds. *Food Chem.,* 22: 259-266.

Medoua, G.N., A.A. Egal and H.W. Oldewage-Theron. 2009. Nutritional value and antioxidant capacity of lunch meals consumed by elderly people of Sharpeville, South Africa. *Food Chem.,* 115: 260-264.

Mehmood, K., S. Mehmood, M. Ramzan, M. Arshad and F. Yasmeen. 2010. Biochemical and phytochemical analysis of *Dipterygium glaucum* collected from Cholistan desert. *JSR.,* 40: 13-18.

Ministry of Health and Nutrition. 1994. Recommended Dietary Allowances for dietary fiber. In: Recommended Dietary Allowance for the Japanese 5th edn. Daiich Shuppan Press: Tokyo. 58-59.

Modi, A.T. 2007. Growth temperature and plant age influence on nutritional quality of *Amaranthus* leaves and seed germination capacity. *Water SA*., 33: 369-375.

Motley, T.J. 1994. The ethnobotany of sweet flag, *Acoras calamus* (Arecaceae). *Econ. Bot.,* 48: 397-412.

Niaz, A., N. Ullah, A. Rehman, I. Ahmad, M. Ikhlaq and H. Rehman. 2013. Pollution based study of heavy metals in some selected medicinal plants by dry digestion method. *IJPSR.,* 4: 17-24.

Nisar, M., S.A. Tariq and I. Ullah. 2009. Nutritional levels of *Indigofera gerardiana* Wall. and *Crataegus songrica* K. Koch. *Pak. J. Bot.,* 41: 1359-1361.

Osborne, D.R. and D. Voogt. 1978. The analysis of nutrients in foods. London; New York: Academic Press.

Pieroni, A., L. Houlihan, N. Ansari, B. Hussain and S. Aslam. 2007. Medicinal perceptions of vegetables traditionally consumed by south-Asian migrants living in Bradford, Northern England. *J. Ethnopharm*., 113: 100-110.

Radek, M. and G.P. Savage. 2008. Oxalates in some Indian green leafy vegetables. *Int. J. Food Sci. Nutr.,* 59: 246-260.

Rizvi, M.A. 2007. Elemental composition of medicinal flowers. *Pak. J. Bot.,* 39: 2541-2552.

Roger, P., F. Elie, L. Rose, F. Martin, S. Jacop, A.B. Mercy and M.T. Felicite. 2005. Methods of preparation and nutritional evaluation of Dishes consumed in a malaria endemic zone in Cameroon (Ngali II). *Afr. J. Biotechnol*., 4: 273-278.

SACN (Scientific Advisory Committee on Nutrition). 2005. Review of dietary advice on vitamin A. TSO, London, UK.

Saldanha, L.G. 1995. Fiber in the diet of U. S. Children: Results of national surveys. *Pediatrics*, 96: 994-996

Shad, A.A., H.U. Shah and J. Bakht. 2013. Ethnobotanical assessment and nutritive potential of wild food plants. *J. Anim. Plant Sci.,* 23: 92-97.

Shahid, M. and F. Hussain. 2012. Chemical composition and mineral contents of *Zingiber officinale* and *Alpinia allughas* (Zingiberaceae) Rhizomes. *IJCBS*., 2: 101-104.

Shinwari, Z.K. & M. Qaiser. 2011. Efforts on conservation and sustainable use of medicinal plants of Pakistan. *Pak. J. Bot.,* SI: 5-10.

Shinwari, Z.K. 2010. Medicinal plants research in Pakistan. *J. Med. Plants Res*., 4: 161-176.

Siddique, S.M. 1998. Nutritional composition of May grass. *Pak. J. Sci. Ind Res.,* 35: 66-70.

Sparg, S.G., M.E. Light and J. van Staden. 2004. Biological activities and distribution of plant saponins. *J. Ethnopharmacol.,* 94: 219-243.

Sultan, M.T., M.S. Butt, F.M. Anjum, A. Jamil, S. Akhtar and M. Nasir. 2009. Nutritional profile of indigenous cultivar of black cumin seeds and antioxidant potential of its fixed and essential oil. *Pak. J. Bot.,* 41: 1321-1330.

Trichopoulou, A., E. Vasilopoulou, P. Hollman, C.H. Chamalides, E. Foufa, T.R. Kaloudis, D. Kromhout, P.H. Miskaki, I. Petrochilou, E. Poulima, K. Stafilakisand and D. Theophilou. 2000. Nutritional composition and flavonoid content of edible wild greens and green peas: a potential rich source of antioxidant nutrients in the Mediterranean diet. *Food Chem.,* 70: 319-323.

Turnlund, J.R., J.C. King, W.R. Keyes, B. Gong and M.C. Michel. 1984. A stable isotope study of zinc absorption in young men: effects of phytate and alpha-cellulose. *AJCN.,* 40: 1071-1077.

Ullah, H., M. Abbas and H.U. Shah. 2007. Proximate and mineral composition of mung bean. *Sarhad J. Agric*., 23: 463-466.

Ullah, Z., M.K. Baloch, J.A. Khader, I.B. Baloch, R. Ullah, N.M. AbdEIslam and S. Noor. 2013. Proximate and nutrient analysis of selected medicinal plants of Tank and South Waziristan area of Pakistan. *Afr. J. Pharm. Pharmacol*., 7: 179-184.

Vermani, A., P. Navneet and A. Chauhan. 2006. Physico-chemical analysis of ash of some medicinal plants growing in Uttarakhand, India. *Nat. Sci*., 8: 88-91.

Whitney, E. and S. Rolfe. 2002. Understanding nutrition, Ninth edition. Wadsworth/Thomson Learning Belmont, CA, 351.

Zafar, M., M.A. Khan, M. Ahmad, G. Jan, S. Sultana, K. Ullah, S.K. Marwat, F. Ahmad, A. Jabeen, A. Nazir, A.M. Abbasi, Z. Rehman and Z. Ullah. 2010. Elemental analysis of some medicinal plants used in traditional medicine by atomic absorption spectrophotometer (AAS). *J. Med. Plants Res.,* 4: 1987-1990.

(Received for publication 29 January 2017)