Proximate Composition, Minerals and Vitamins Content of Selected Vegetables Grown in Peshawar

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(Received on 14th April 2010, accepted in revised form 29th June 2010)

Summary: Ten vegetables namely Pot purslane, Spinach, Turnip, Garlic, Mustard (Sarson), Radish, Bitter gourd, Lady finger, Bath sponge and Brinjal were analyzed for their proximate composition, vitamin and mineral contents to evaluate their importance in human nutrition. The results showed that almost all vegetables contain appreciable amount of essential nutrients. The maximum content of moisture, carbohydrate, crude protein, crude fat, crude fiber, and ash recorded in these vegetables was (92.50 %, 26.88 %, 5.0%, 0.40%, 1.4% and 1.9%), respectively, with a minimum content (66.80 %, 3.91 %, 0.7%, 0.08%, 0.4% and 0.38%), respectively. Maximum concentration of macro minerals K, Ca, Mg, and Na, observed was (400, 210, 109, and 55) mg/100 g, respectively, with a minimum concentration (26, 15, 17, and 10) mg/100 g, respectively. Maximum concentration of micro minerals Fe, Cu, Zn, Mn and Cr observed was (29, 0.33, 3.05, 1.70, and 0.36) mg/100 g with a minimum concentration (2, 0.05, 0.43, 0.21, and 0.06) mg/100 g, respectively. Maximum concentration of water soluble vitamins *i.e.* thiamine, riboflavin, niacin and ascorbic acid recorded was (0.280, 0.190, 0.69, and 65) mg/100 g with a minimum concentration (0.011, 0.015, 0.23, and 4.00) mg/100 g, respectively. From this study it can be concluded that consumption of vegetables in different combinations could provide a reasonable daily recommended amount of essential nutrients for the maintenance of healthy life and normal body functioning.

Introduction

Proximate and nutrient analysis of edible fruit and vegetables plays a crucial role in assessing their nutritional significance [1].

Nutrients are of six types, fats, carbohydrates, proteins, water, mineral elements, and vitamins. All of these are present in the diet of a healthy person. Nutrients can be considered from two points of view, their function in the body and their chemical composition [2].

Leafy vegetables are good source of vitamins and minerals. Vegetables are generally high in carbohydrates and especially low in proteins. However, their nutritive value depends in part on the soil and climate in which they are grown [3].

How can we increase vegetable consumption in places where the economy does not encourage it? This is only possible through policies intended to reduce the relative prices of vegetables, increased income, enhancement of micronutrient contents in vegetables, generating awareness among consumers about the role of vegetables in human health, and improvements in vegetable cooking and processing methods [4].

Vegetables are the fresh and edible portions of herbaceous plants. They are important food and highly beneficial for the maintenance of health and prevention of diseases. They contain valuable food ingredients which can be successfully utilized to build up and repair the body. They are valued mainly for their high carbohydrate, vitamins, and mineral contents. There are different kinds of vegetables. They may be edible roots, stems, leaves, fruits or seeds. Each group contributes to diet in its own way [5].

Researchers have repeatedly observed health benefits associated with high fruit and vegetable consumption, it has not been possible to identify a specific constituent or, more likely, combinations of several constituents that may be responsible for these benefits [6, 7].

Vegetables contribute minerals, vitamins and fiber to the diet. Minerals are naturally occurring inorganic substances with a definite chemical composition and an ordered atomic arrangement [8].

Vitamins are organic compounds in natural foods especially in vegetables. Vitamins are needed for maintenance of skin, mucous membranes, bones, teeth and hair, vision, and reproduction. They help body to absorb calcium and phosphorous; need for bone growth and maintenance. Vitamins are involved in blood clotting, normal function of nervous system and endocrine glands. They are also needed for metabolism of macro molecules [9]. The main

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objective of the present study was to evaluate these vegetables for carbohydrates, macro- and micro nutrients and for vitamin contents. The study is of high value for knowing the daily uptake of these nutrients. Beside this a scientific data baseline is also furnished for the consumers.

Results and Discussion

Proximate composition of each vegetable is shown in Table-1. The moisture content in all vegetables was very high ranging 66.80% in garlic and 92.50% both in radish and bath sponge. After moisture the second major chemical constituent found was carbohydrate with a maximum content (26.88%) in garlic and minimum content (3.91%) in spinach. Crude protein content was estimated 0.7% in radish and 5.0% in mustard (Sarson), while Garlic showed second high concentration 4%. Crude fat content observed was 0.08% in radish and 0.40% in Mustard (Sarson). The crude fiber content with maximum concentration 1.4% was determined in Bitter gourd and Lady finger, while minimum amount 0.4% was found in Pot purslane and Mustard (Sarson). Ash contents were 0.38% in bath sponge and 1.9% in spinach.

Vegetables are very rich source of essential biochemical's and nutrients such as carbohydrates, carotene, vitamins, calcium, iron, ascorbic acid, and palpable concentrations of trace minerals [10, 11].

The macro and micro elements composition of different vegetables is given in Table-2.

Potassium (K) content was high as compare to other minerals. Pot purslane showed maximum concentration of 400 mg/100 g, while its minimum concentration 26 mg/100 gm was found in Bath sponge. Calcium was the Second abundant mineral found in most vegetables. Its maximum concentration 210 mg/100 g was observed in pot-purslane and minimum concentration 15 mg/100 g in Bath sponge. Magnesium was also found in appreciable amount, maximum amount was found in the spinach 137 mg/100 g while minimum amount was found in radish and bath sponge 17 mg/100 g. Sodium maximum concentration 55 mg/100 g was found in radish with a minimum concentration of 10 mg/100 g in bath sponge.

Because of the reciprocal effects of Na and K authorities have argued that a diet high in potassium and low in sodium (low urinary Na and K ratio) favours lower blood pressure. Increase in dietary potassium as the chloride salt has shown to decrease blood pressure in some hypertensive individuals [12].

It is also possible that a low Na and high K diet would decrease the development of cardio vascular disease [13]. The sodium requirement from plant source is not much important because of its availability as NaCl salt.

Deficiency of calcium, phosphorous and vitamin D leads to the classic bone symptoms associated with rickets, such as bowlegs, knock knees, curvature of the spine and pelvic and thoracic deformities [14].

Magnesium plays important role in the structure and the function of the human body. The adult human body contains about 25 grams of magnesium. Over 60% of all the magnesium in the body is found in the skeleton, about 27% is found in muscle, while 6 to 7% is found in other cells, and less than 1% is found outside of cells [15].

Maximum concentration of micro minerals Fe, Mn, Zn, Cu, and Cr (29, 0.33, 3.05, 1.70, and 0.36) mg/100 g was observed in spinach, garlic, mustard and lady finger, respectively. While minimum concentration of Fe, Mn, Zn, Cu and Cr (2, 0.05, 0.43, 0.21, and 0.06) mg/100 g was observed in Brinjal, radish and bath sponge, respectively (Table-2).

Table-1: Proximate composition of selected vegetables (on dry weight basis g/100 g).

S. No	Name of Vegetables		Moisture (g)	Protein (g)	Fats (g)	Carbohydrates (g)	Fiber (g)	Ash (g)
	English	Scientific						
1	Pot purslane	*Portulaca oleracea*	92.00 ± 0.26*	1.4 ± 0.06	0.16 ± 0.02	4.44 ± 0.04	0.4 ± 0.05	1.6 ± 0.03
2	Spinach	*Spinacea oleracea*	90.70 ± 0.13	2.5 ± 0.04	0.29 ± 0.01	3.91 ± 0.02	0.7 ± 0.06	1.9 ± 0.02
3	Turnip	*Brassica rapa*	89.80 ± 0.17	1.0 ± 0.05	0.16 ± 0.06	7.54 ± 0.01	1.0 ± 0.05	0.5 ± 0.06
4	Garlic	*Allium sativum*	66.80 ± 0.26	4.0 ± 0.02	0.22 ± 0.05	26.88 ± 0.01	0.6 ± 0.05	1.0 ± 0.01
5	Mustard (Sarson)	*Brassica campestris-var sarson*	88.00 ± 0.11	5.0 ± 0.01	0.40 ± 0.03	4.60 ± 0.12	0.4 ± 0.01	1.6 ± 0.04
6	Radish	*Raphanus sativus*	92.50 ± 0.22	0.7 ± 0.09	0.08 ± 0.02	5.52 ± 0.10	0.6 ± 0.03	0.6 ± 0.05
7	Bitter gourd	*Momordica charantia*	91.80 ± 0.10	1.5 ± 0.08	0.20 ± 0.10	4.20 ± 0.09	1.4 ± 0.07	0.9 ± 0.09
8	Lady finger	*Hibiscus esculentus*	89.80 ± 0.67	2.0 ± 0.02	0.18 ± 0.09	5.42 ± 0.21	1.4 ± 0.02	1.2 ± 0.08
9	Bath sponge	*Luffa acutangula*	92.50 ± 0.24	0.9 ± 0.01	0.19 ± 0.08	5.08 ± 0.11	0.9 ± 0.04	0.38 ± 0.01
10	Brinjal/egg-plant	*Solanum melongena*	92.00 ± 0.20	1.2 ± 0.03	0.17 ± 0.06	5.38 ± 0.23	0.8 ± 0.02	0.45 ± 0.04

*Average of triplicate determinations ± SD (standard deviation)

Table-2: Macro and micro mineral content in mg/100 g of selected vegetables.

S. No	Name of Vegetables		Ca	Na	K	Mg	Fe	Cu	Zn	Mn	Cr
	English	Scientific									
1	Pot purslane	*Portulaca oleracea*	210 ± 0.03*	45 ± 0.05	400 ± 0.22	109 ± 0.11	23 ± 0.03	0.11 ± 0.04	0.70 ± 0.06	0.72 ± 0.05	0.11 ± 0.04
2	Spinach	*Spinacea oleracea*	100 ± 0.01	50 ± 0.09	310 ± 0.11	137 ± 0.16	29 ± 0.02	0.17 ± 0.01	1.21 ± 0.02	1.52 ± 0.02	0.20 ± 0.03
3	Turnip	*Brassica rapa*	34 ± 0.06	25 ± 0.06	35 ± 0.09	31 ± 0.22	6 ± 0.04	0.08 ± 0.02	0.79 ± 0.04	0.51 ± 0.07	0.06 ± 0.04
4	Garlic	*Allium sativum*	30 ± 0.11	23 ± 0.03	70 ± 0.08	26 ± 0.09	5 ± 0.01	0.33 ± 0.03	3.05 ± 0.06	0.66 ± 0.03	0.26 ± 0.02
5	Mustard (Sarson)	*Brassica campestris-var sarson*	180 ± 0.08	17 ± 0.01	180 ± 0.05	44 ± 0.12	11 ± 0.03	0.14 ± 0.06	1.10 ± 0.07	1.70 ± 0.05	0.10 ± 0.03
6	Radish	*Raphanus sativus*	45 ± 0.05	55 ± 0.01	40 ± 0.03	17 ± 0.10	4 ± 0.06	0.05 ± 0.01	0.43 ± 0.02	0.33 ± 0.04	0.06 ± 0.01
7	Bitter gourd	*Momordica charantia*	45 ± 0.12	31 ± 0.03	390 ± 0.08	31 ± 0.10	7 ± 0.07	0.08 ± 0.01	0.85 ± 0.08	0.26 ± 0.04	0.11 ± 0.05
8	Lady finger	*Hibiscus esculentus*	100 ± 0.02	16 ± 0.03	250 ± 0.02	33 ± 0.09	3 ± 0.02	0.12 ± 0.06	1.18 ± 0.06	0.55 ± 0.08	0.36 ± 0.05
9	Bath sponge	*Luffa acutangula*	15 ± 0.04	10 ± 0.07	26 ± 0.06	21 ± 0.04	3 ± 0.06	0.12 ± 0.03	0.63 ± 0.07	0.21 ± 0.03	ND
10	Brinjal/egg-plant	*Solanum melongena*	30 ± 0.02	17 ± 0.03	28 ± 0.01	17 ± 0.05	2 ± 0.04	0.19 ± 0.07	0.73 ± 0.04	0.24 ± 0.08	0.06 ± 0.03

*Average of triplicate determinations ± SD (standard deviation)
ND= Not Determined

Iron has the longest and best described history among all the micronutrients. It is a key element in the metabolism of almost all living organisms. In humans, iron is an essential component of hundreds of proteins and enzymes [16, 17].

Copper (Cu) is an essential trace element for humans and animals. In the body, copper shifts between the cuprous (Cu^{1+}) and the cupric (Cu^{2+}) forms, though the majority of the body's copper is in the Cu^{2+} form. The ability of copper to easily accept and donate electrons explain its important role in oxidation-reduction (redox) reactions and the scavenging of free radicals [18].

Manganese (Mn) plays an important role in a number of physiological processes as a constituent of some enzymes and an activator of other enzymes [19]. Zinc plays an important role in the structure of proteins and cell membranes. A finger-like structure, known as a zinc finger motif, stabilizes the structure of a number of proteins. For example, copper provides the catalytic activity for the antioxidant enzyme copper-zinc superoxide dismutase (Cu, Zn, SOD), while zinc plays a critical structural role [20]. The structure and function of cell membranes are also affected by zinc. Loss of zinc from biological membranes increases their susceptibility to oxidative damage and impairs their function [21].

A biologically active form of chromium participates in glucose metabolism by enhancing the effects of insulin. Insulin is secreted by specialized cells in the pancreas in response to increased blood glucose levels, for example, after a meal, insulin binds to insulin receptors on the surface of cells, activating those receptors and stimulating glucose uptake by cells. Through its interaction with insulin receptors, insulin provides cells with glucose for energy and prevents blood glucose levels from becoming elevated. In addition to its effects on carbohydrate (glucose) metabolism, insulin also influences the metabolism of fat and protein. A decreased response to insulin or decreased insulin sensitivity may result in impaired glucose tolerance or type 2 diabetes, also known as non-insulin dependent diabetes mellitus (NIDDM). Type 2 diabetes is characterized by elevated blood glucose levels and insulin resistance [20].

Results of some of the water soluble vitamins namely thiamine, riboflavin, niacin, and ascorbic acid are shown in Table-3. Maximum concentration of water soluble vitamins thiamine, riboflavin, niacin and ascorbic acid (0.280, 0.190, 0.69, and 65) mg/100 g was found in garlic, pot-purslane, spinach and bitter gourd, respectively, while minimum concentration of water soluble vitamins *i.e.* thiamine, riboflavin, niacin and ascorbic acid (0.011, 0.015, 0.23, and 4.00) mg/100 g was found in mustard, radish, mustard and garlic, respectively.

Table-3: Vitamins content in mg/100 g of selected vegetables.

S. No	Name of Vegetables		Vitamin B_1 Thiamine	Vitamin B_2 Riboflavin	Vitamin B_5 Niacin	Vitamin C Ascorbic Acid
	English	Scientific				
1	Pot purslane	*Portulaca oleracea*	0.071 ± 0.05*	0.190 ± 0.02	0.44 ± 0.01	10 ± 0.08
2	Spinach	*Spinacea oleracea*	0.102 ± 0.02	0.150 ± 0.01	0.69 ± 0.01	48 ± 0.08
3	Turnip	*Brassica rapa*	0.013 ± 0.02	0.027 ± 0.01	0.42 ± 0.07	30 ± 0.07
4	Garlic	*Allium sativum*	0.280 ± 0.01	0.040 ± 0.03	0.25 ± 0.05	4 ± 0.04
5	Mustard (Sarson)	*Brassica campestris-var sarson*	0.014 ± 0.03	0.032 ± 0.04	0.23 ± 0.04	28 ± 0.05
6	Radish	*Raphanus sativus*	0.011 ± 0.02	0.015 ± 0.02	0.33 ± 0.05	20 ± 0.08
7	Bitter gourd	*Momordica charantia*	0.063 ± 0.01	0.045 ± 0.02	0.35 ± 0.09	65 ± 0.07
8	Lady finger	*Hibiscus esculentus*	0.050 ± 0.03	0.080 ± 0.02	0.43 ± 0.02	7 ± 0.02
9	Bath sponge	*Luffa acutangula*	0.026 ± 0.01	0.038 ± 0.02	0.28 ± 0.01	13 ± 0.04
10	Brinjal/egg-plant	*Solanum melongena*	0.090 ± 0.01	0.066 ± 0.01	0.48 ± 0.04	4 ± 0.08

*Average of triplicate determinations ± SD (standard deviation)

Vitamin C (Ascorbic acid) is water-soluble vitamin required in high amount, as its loss is frequent from body. It participates in reversible oxidation-reduction system. Vitamin C prevents scurvy disease and also aids in the formation of folic acid derivatives, which are essential for DNA synthesis [9].

The largest number of vitamins (*e.g.* B complex vitamins) functions as precursors for enzyme cofactors, that help enzymes in their work as catalysts in metabolism. In this role, vitamins may be tightly bound to enzymes as part of prosthetic groups [22].

Water-soluble vitamins dissolve easily in water, and in general, are readily excreted from the body, to the degree that urinary output is a strong predictor of vitamin consumption [23]. Because they are not readily stored, consistent daily intake is important.

Experimental

Experimental vegetables included in the study were grown in the premises of Pakistan Council of Scientific and Industrial Research, Laboratories Complex, Peshawar. After harvesting vegetables at their respective times these were brought to the laboratory and analyzed in triplicate for their proximate composition, mineral contents and vitamins as per standard procedures.

Proximate Composition

Proximate composition includes moisture, crude protein, ether extract, crude fiber, ash, and nitrogen free extract. Moisture was determined by oven dehydration method at 105 $^{\circ}$C up to the constant weight. Crude protein was determined by using Kjeldhal method; crude fat was determined by ether extraction method using soxhlet apparatus. Crude fiber was determined by acid digestion and alkali digestion method. Ash content was determined in muffle furnace at 550 $^{\circ}$C for 6 h. For all these determinations powdered and oven dried sample were used in triplicate in accordance with standard procedures [24]. NFE was calculated by difference.

Determination of Minerals

For minerals determination 0.5 g of each sample was wet digested with HNO_3: $HClO_4$ (2:1) for 2-3 h on heating mantle [25]. Digested samples were filtered through 0.45 µm pore size Millipore filter and volume was made to 100 mL with distilled water. Concentration of Ca, Mg, Fe, Cu, Mn, Zn, and Cr was determined on Hitachi Zeeman Japan Z-8000, Atomic Absorption Spectrophotometer equipped with standard hallow cathode lamps as radiation source and air acetylene flames, while Na and K concentration was determined on Flame Photometer.

Determination of Vitamins

Regarding vitamins, only ascorbic acid, niacin, riboflavin, and thiamin contents were determined. Vitamin C was determined in fresh vegetable samples by dichlorophenol Indophenol dye reduction method [26]. Niacin was determined by colorimetric method [8] whereas thiamine and riboflavin was determined by flouro metric method [27].

Conclusion

In the present study maximum content of carbohydrate and protein was observed in garlic and mustard, respectively. Higher content of fiber was found in bitter gourd and lady finger. Similarly, pot purslane showed maximum concentration of potassium, calcium and vitamin B_2. Thus it can be concluded that nutrients found in all the selected vegetables are in variable concentrations. Therefore their consumption in different combinations is recommended for normal body function and healthy life.

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