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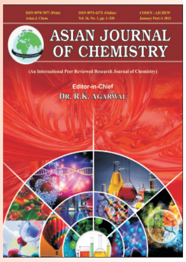

Mineral Composition of Some Fruit, Fruit Tissue and Leafy Vegetables Consumed for Medicinal Purpose in Malatya, Turkey

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This study investigates the presence of K, Mg, Al, Fe, Mn, Zn, Cu, Se, Pb and Cd in the fruit, fruit tissues and leafy vegetable samples frequently consumed for therapeutic purpose in Malatya, located in the region of Eastern Anatolia in Turkey. Microwave digestion procedure for total concentration was applied under optimized conditions for dissolution of plant samples. Element concentrations in plant samples were determined by atomic absorption spectroscopy. The accuracy and precision were verified against leaves certified reference material. The results of this study showed that the average concentrations detected ranged from 114 to 4754.2 mg 100 g^{-1}, 10 to 637.8 mg 100 g^{-1}, 1.45 to 92.83 mg 100 g^{-1}, 0.30 to 61.54 mg 100 g^{-1}, 0.034 to 20.83 mg 100 g^{-1}, 0.06 to 6.26 mg 100g^{-1}, 0.05 to 1.84 mg 100 g^{-1}, 8.91 to 351.55 µg 100 g^{-1}, 0.60 to 56.10 µg 100 g^{-1} and 0.10 to 6.48 µg 100 g^{-1} for K, Mg, Al, Fe, Mn, Zn, Cu, Pb, Se, Cd, respectively. Most of studied species contains the trace below the permissible limit (FAO/WHO 1984). The study revealed that investigated plant samples are good source of K, Mg, Fe, Mn, Zn, Cu and Se. However, some plant samples such as mint, basil, walnut and quince contained high levels of lead.

Keywords: Mineral, Fruit, Vegetables, Atomic absorption spectroscopy, Microwave digestion.

INTRODUCTION

Dietetics professionals, along with other health professionals, have the responsibility of providing consumers with scientifically supported facts to help them make informed dietary decisions. The scientific base supporting the unique health benefits derived from eating fruits and vegetables is growing rapidly[1]. Fruits and vegetables supply the body with minerals, vitamins and certain hormone precursors in addition to protein and energy[2]. They are very important protective food and useful for the maintenance of health and prevention and treatment of various disease[3]. Minerals do not provide any calorie but they play an important role in the metabolic regulations of the human body[4]. Minerals can be divided into three groups; major elements (Na, K, Ca, Mg, Cl, P, S), trace elements (Fe, Zn, Se, Cu, Mn, Co, Cr, Mo, Ni), ultra trace elements (Al, Ba, Bi, Cd, Pb, Sb, Si)[1]. On the other hand, among the trace elements include the heavy metals like cadmium, lead, which may disturb the normal functions of the central nervous system, liver, lungs, heart, kidney; resulting in condition such as hypertension, abdominal pain, skin eruptions, intestinal ulcer and different types of cancer, if they enter the body[5,6]. Fruits and vegetables constitute an important link in the transfer of minerals from soil to man. The level of minerals in fruits and vegetables varies and content being affected by the ability of plants to selectively accumulate some of these elements. Bioavailability of the elements depends on the nature of their association with the constituents of a soil[2]. Additional sources of minerals for fruits and vegetables are rainfall, atmospheric dusts, plant protection agents and fertilizers[7]. A number of minerals essential to human nutrition are accumulated in different parts of plants as it accumulates minerals essential for growth from environment[8]. Thus, it is important to determine the levels of these compounds in common, popular and widely used fruits, fruit tissues and vegetables.

An analysis method has to possess accuracy, precision, repeatability and minimum interference, otherwise it is not valid. The preparation of a sample before analysis is a critical step in trace element analysis by atomic absorption spectrometry. A classical digestion method requires hours or days to ensure complete destruction of the sample[9]. Moreover, these methods are exposed to atmospheric contamination with high background contribution and causes loss of volatile compounds. To overcome these problems, the microwave-

TABLE-1
PLANT SAMPLES SELECTED FOR THE STUDY

Sample number	Local name	Botanical name	Parts analysed	Medicinal uses
1	Pear	*Pyrus communis L.*	Pulp	Digestive disorders, kidney disease, diuretic, rheumatism pains
			Leaves	Tachycardia, heartache
2	Quince	*Cyndonia vulgaris*	Pulp	Cardiovascular diseases, digestive disorders, varicosis
			Leaves	Diarrhoea, nerve disease
			Seed	Common cold, dry cough and dyspnea, inflammation of the mouth and throat
3	Walnut	*Juglans regia L.*	Nutmeat	Digestive disorders, high cholesterol, diabetes
			Leaves	All mucosal inflammation, rheumatism pains, throat ache, hair loss, skin diseases
4	Strawberry	*Fragaria vesca L.*	Pulp	Cholesterol, embolism, immune system, cancer, digestive disorders, diuretic, hypertension
			Leaves	Diuretic, stomatitis
5	Apple	*Malus communis L.*	Pulp	Rheumatism, gastrointestinal diseases, constipation, eczema, cholesterol, kidney disease, Parkinson, Alzheimer
			Leaves	Snake-scorpion bite
			Seed	Bronchitis, intestinal worms
6	Cherry	*Prunus avium L.*	Pulp	Gastrointestinal diseases, urinary tract diseases, gout, constipation, rheumatism, arteriosclerosis, ulcer
			Stalk	Diuretic, nephritis, intestinal regulator, rheumatism, arteriosclerosis
7	Pomegranate	*Punica granatum L.*	Seed	Immune system, cancer, arteriosclerosis, cardiovascular diseases, blood pressure
			Peel	Gastroenteritis, sores in the mouth, diarrhea, dysentery, haematuria
8	Mint	*Mentha piperita L.*		Gastroenteritis, bile and liver disease, digestive system, constipation and diarrhea, antimicrobial
9	Basil	*Ocimum basilicum L.*		Digestive system, shortness of breath, urinary infection, antibacterial

assisted HNO_3-H_2O_2 digestion system is used in the present study.

The main and important instrument for the determination of minerals in fruit and vegetable samples is AAS methods[1,10-14]. These methods have advantages of speed, ease of analysis and reduction of blank levels.

In the present study we have selected pear (pulp and leaf), quince (pulp, leaf and seed), walnut (nutmeat and leaf), strawberry (pulp and leaf), apple (pulp, leaf and seed), cherry (pulp and stalk), pomegranate (seed and peel), mint and basil for the analysis because of their medicinal importance[15]. A brief review of the importance of these fruits and vegetables in medicine with their common and scientific names are given in Table-1.

The main purpose of this study is to investigate the levels of some macro- and micro elements in the fruit, fruit tissues and vegetable samples frequently consumed for therapeutic purpose in the city of Malatya-Turkey.

EXPERIMENTAL

The fruit and vegetable samples were purchased from several local suppliers and markets in Malatya City, Turkey. The sampling comprised from 0.50 to 2 kg for each commodity sold in each district and was considered to be quite representative since the districts were scattered randomly throughout the city.

Surface contaminants of the plant samples were removed by washing with deionized water twice and then with deionized double distilled water. The fruits were separated into edible and inedible parts, seeds and leaves. All of the plant samples were then oven-dried at 70 °C for 72 h to a constant weight. Fresh and dry fruits parts were weighed. Prior to chemical analysis, all dry plant samples were ground into fine powder by stainless steel mill and stored in polyethylene bottles until analysis.

Digestion procedure: A Milestone Start D closed vessel microwave digestion system (maximum pressure 1450 psi, maximum temperature 300 °C) of teflon reaction vessels was used in all the digestion procedures. The reaction vessels were cleaned using 5 mL of concentrated nitric acid before each digestion.

Portion (0.50 g) of the dried plant samples were transferred into polytetrafluoroethylene (PTFE) vessels. Then 7 mL of concentrated nitric acid (65 %, Riedel-de Haën, 7697-37-2) and 2 mL of H_2O_2 (30 %, Merck, K35522500604) were added into the vessels. The vessels were closed, placed on the rotating turntable of the microwave oven and the digestion process was started. Digestion conditions for the microwave system applied were: 4 min for 500 W, 200 °C, 14 min for 500 W, 200 °C, went: 10 min. The blank digest was carried out in the same way. The digested solutions were diluted to 25 mL with double distilled water (Milli-Q, Millipore 18.2 MΩ cm resistivity).

FAAS and GF-AAS analysis: A Perkin-Elmer AAnalyst 800 Atomic Absorption Spectrometer (FAAS) equipped with THGA graphite furnace and with Zeeman-effect background corrector was used in the experiments. For flame measurements, a 10 cm single slot-burner head, a lamp an air-acetylene flame/N_2O-acetylene was used. For graphite furnace measurements, argon was used as inert gas. The operating parameters for the working elements were set as recommended by the manufacturer. Pyrolytic-coated graphite tubes (Perkin-Elmer part No. B3000641) with a platform were used. Samples were injected into the graphite furnace using a Perkin-Elmer AS-91 auto sampler.

Elemental content was determined in the clear solutions were prepared each day by dilution from stock standard solutions (Custom-Grade Standard, Inorganic Ventures/IV Labs) in enough suprapur nitric acid to give a final acid concentration similar to the digested samples. The result of each sample represents an average of three replicate readings. A calibration curve of absorbance against concentrations of each element under investigation was constructed and finally the concentration of each element was determined from the calibration curve of its standards by interpolation.

Matrix modifier were added: 2 µL $Mg(NO_3)_2$ and 1 µL Pd for Cd; 5 µL $Mg(NO_3)_2$ for Pb; 3 µL $Mg(NO_3)_2$ for Se.

Quality control: Accuracy and precision were tested three standard reference materials (SRMs): SRM 1515 apple leaves, SRM 1573a tomato leaves and SRM 1547 peach leaves (US Department of Commerce national Institute Standards and Technology: NIST Gaithersburg, MD, USA).

RESULTS AND DISCUSSION

For quality control, the three SRMs listed above, SRM 1515 apple leaves, SRM 1573a tomato leaves and SRM 1547 peach leaves were used. Determination of accuracy percentages, based on SRMs, ranged from 75 to 113 % (Table-2). For some essential elements, accuracy percentages of iron, magnesium, manganese and zinc were 98-99 %, 97-98 %, 86-93 and 98-99 %, respectively. Results obtained from F-AAS and GF-AAS analysis were in good agreement with certified values. For this reason, it could be accomplished that digestion and analysis were in accordance with quality requirements.

The trace element concentrations in the analyzed plant samples are summarized in Table-3. All element concentrations were determined on dry weight basis. It is to be noted that each result is an average of at least three in dependent measurements with a precision of about ± 1 %. The values are given as mean ± standard deviation. Cd, Pb and Se concentrations were found to be below detection limits of F-AAS. These elements were determined using GF-AAS by autosampler.

The presence and concentrations of various elements in different plants depend on composition of the soil, water and fertilizers used as well as permissibility, selectivity and absorbability of plants for the uptake of these elements. Like all other living organisms, plants have the ability to maintain an internal environment with a composition different from that of their surroundings. The internal environment (chemical content) of the plant body remains more or less constant whereas the outside environment is highly variable. Thus, the observed variations in concentration of elements are attributed to the nature of the plant in addition to its surroundings[16].

Fruit/fruit tissues and vegetables are important sources of minerals. The minerals are present at varying concentrations in different parts of the plants, especially in roots, seeds, pulp and leaves which are used as dietary item as well as ingredient in the medicinal preparation. Thus, the nutritional value of plant tissues is an important aspect that should be considered especially with respect to element intake such as iron, magnesium, potassium, manganese, selenium, copper and zinc[17]. On the contrary, the intake of heavy metal-contaminated fruit and vegetables may pose a risk to human health; so the heavy metal contamination of food is one of the most important aspects of food quality assurance[18,19].

The investigation for various trace elements in fruits, fruit tissues and leafy vegetables showed that K, Mg, Al, Fe, Mn, Zn, Cu, Se, Pb and Cd were present in all samples each plant species in different concentration. These elements are responsible for curing various diseases and play a vital role in the formation of secondary metabolites. Table-3 shows that the elements present in various plants and plant tissues (leaf, seed and pulp) are in the order K > Mg > Al > Fe > Mn > Zn > Cu > Pb > Se > Cd. The concentration ranges for the elements under study were found as, 114-4754.2 mg 100 g^{-1} for K, 10-637.8 mg 100 g^{-1} for Mg, 1.45-92.83 mg 100 g^{-1} for Al, 0.30-61.54 mg 100 g^{-1} for Fe, 0.034-20.83 mg 100 g^{-1} for Mn, 0.06-6.26 mg 100 g^{-1} for Zn, 0.05-1.84 mg 100 g^{-1} for Cu, 8.91-351.55 µg 100 g^{-1} for Pb, 0.60-56.10 µg 100 g^{-1} for Se and 0.10-6.48 µg 100 g^{-1} for Cd. Epidemiological and clinical studies have shown that K intake has an important role in regulating blood pressure in both the general population and people with high blood pressure[20]. High K intake reduces the risk of stroke and prevents renal vascular, glomerular and tubular damage[21-23]. Increasing K intake also reduces urinary calcium excretion, which reduces the risk of kidney stones and helps prevent bone demineralization[24]. Several prospective epidemiological studies have shown that increasing consumption of fruits and vegetables protects against stroke[25,26]. New *et al.*[27] found significant associations between past reported fruit intake and bone mineral density(BMD) at the spine and

TABLE-2
COMPARISONS BETWEEN CERTIFIED AND MEASURED VALUES OF ELEMENTAL COMPOSITION IN SRMs

Element	SRM 1515 (mg kg^{-1})		SRM 1573a (mg kg^{-1})		SRM 1547(mg kg^{-1})	
	Certified	Found	Certified	Found	Certified	Found
Al	286 ± 9	281.2 ± 7.1	598 ± 12	585.5 ± 73	249 ± 8	243.35 ± 6.3
Cd	0.013 ± 0.002	0.0119 ± 0.0007	1.52 ± 0.04	1.14 ± 0.05	0.026 ± 0.003	0.0235 ± 0.0006
Cu	5.64 ± 0.24	5.6 ± 0.15	4.70 ± 0.14	4.18 ± 0.03	3.7 ± 0.4	4.05 ± 0.46
Fe	83 ± 5	81.5 ± 2.6	368 ± 7	358.8 ± 55	218 ± 14	217.4 ± 18.03
K	16100 ± 200	18200 ± 160	27000 ± 500	29100 ± 1100	24300 ± 300	25800 ± 600
Mg	2710 ± 80	2670 ± 82	12000	11800	4320 ± 80	4210 ± 180
Mn	54 ± 3	51.9 ± 1.65	246 ± 8	210.8 ± 9.2	98 ± 3	91.48 ± 0.93
Pb	0.470 ± 0.024	0.465 ± 0.024	-	1.38 ± 0.41	0.87 ± 0.03	0.84 ± 0.016
Se	0.050 ± 0.009	0.045 ± 0.0125	0.054 ± 0.003	0.052 ± 0.004	0.120 ± 0.009	0.116 ± 0.02
Zn	12.4 ± 0.3	11.65 ± 0.45	30.9 ± 0.7	28.9 ± 3.2	17.9 ± 0.4	17.8 ± 1.99

trochanter in premenopausal women. Only a few population-based studies have reported associations between dietary intake of potassium, magnesium or fruit and vegetables and bone status in women[27-29]. Within the selected fruit and fruit tissues, the highest concentrations of potassium were noticed in cherry stalks followed by apple leaves, walnut leaves, strawberry leaves, quince leaves, pear leaves, quince seeds, apple seeds, pomegranate seeds, fruit of sweet cherry, quinces, strawberries, apple in decreasing concentrations, as for in the vegetables studied the highest concentration of potassium was found in basil (4754.2 mg 100 g^{-1}) followed by mint (2791.7 mg 100 g^{-1}).

Magnesium is an essential cation playing a crucial role in many physiological functions. It is critical in energy-requiring metabolic processes, in protein synthesis, membrane integrity, nervous tissue conduction, neuromuscular excitability, muscle contraction, hormone secretion and in intermediary metabolism[30]. Magnesium improves insulin sensitivity, protects against diabetes and its complications, reduces blood pressure, prevent heart rhythm abnormalities[31,32]. A large part of the population may have an inadequate Mg intake and in particular elderly people[33,34] and athletes[35] may be prone to chronic latent Mg deficiency. Magnesium deficit is frequently observed in alcoholics and diabetic patients[36]. Magnesium is an essential mineral for nutrition. It is found naturally in a variety of foods including colorful fruits and vegetables[37]. Consuming a varied diet that incorporates all the major groups of food pyramid will ensure you get adequate Mg daily. Vegetables that contain green pigment or chlorophyll provide natural sources of Mg. Some examples of green leafy vegetables include spinach, legume, peas, beans and broccoli. Fruits that provide significant sources of magnesium include avocados, dried apricots, bananas, *etc*. Also, nuts and seeds such as almond, cashew, walnut and hazelnut are other vegetarian sources of magnesium[38]. Magnesium concentrations in all the fruit and fruit tissue ranged from 9.99 to 637.79 mg 100 g^{-1} and 508.33 (leaves of mint) to 600.69 (leaves of basil) mg 100 g^{-1} in vegetables (Table-3). The amount of Mg in leaves of strawberry with the strength of 637.79 mg 100 g^{-1} remained high which is followed by leaves of quince contained 609.85 mg 100 g^{-1}. The minimum content of Mg was observed in 9.99 and 11.03 mg 100 g^{-1} in quince and pear.

Aluminum is the most widely distributed metal in the environment and is extensively used in modern daily life. Aluminium enters into the body from the environment and from diet and medication. The main source of Al intake is food. Aluminium in the food supply comes from natural sources, water used in preparation and food additives[39]. Depending on the plant varieties and soil conditions, the Al content of food can vary greatly and soil adhering to vegetables may be the source of some Al in certain fruits and vegetables. While the Al content of soil is variable, some foods known as Al accumulators (herbs, spices and tea leaves), may naturally contain more than 5 μg Al g^{-1} food[40]. The estimated aluminum concentrations of some fruits and vegetables are given Table-3. Some of values given in the table indicate that in the Malatya (Turkey), the Al intake from some food commodities is relatively high. For example, the amount of Al present in mint and basil was found to be 19.16 and 12.80 mg100 g^{-1}, respectively. It is also interesting to note from Table-3 that the highest level of Al is in dried walnut leaves at 92.83 mg 100 g^{-1}, followed by pear leaves 53.55 mg 100 g^{-1} and then strawberry leaves 32.79 mg 100 g^{-1}. In contrast the lowest Al content was found in pear, apple, quince and walnut being < 0.5 mg 100 g^{-1}. A diet high in fruits and vegetables would not be expected to expose humans to toxic levels of Al. However, over prolonged

TABLE-3
ELEMENTAL CONCENTRATIONS IN SELECTED PLANT SAMPLES

Sample	Al (mg 100 g^{-1})	Cu (mg 100 g^{-1})	Fe (mg 100 g^{-1})	K (mg 100 g^{-1})	Mg (mg 100 g^{-1})	Mn (mg 100 g^{-1})	Zn (mg 100 g^{-1})	Cd (μg 100 g^{-1})	Pb (μg 100 g^{-1})	Se (μg 100 g^{-1})
Pear										
Pulp	nd	nd	0.33±0.027	114±7.41	11.03±0.23	0.050±0.010	0.26±0.0083	0.20±0.083	22.25±1.83	0.60±0.42
Leaves	53.55±1.13	0.49±0.039	30.94±0.48	1004.08±73.86	589.19±3.12	6.26±0.14	1.88±0.071	2.70±0.37	49.73±9.58	21.00±4.39
Quince										
Pulp	nd	0.11±0.019	0.44±0.078	176.63±42.00	9.99±1.59	0.11±0.015	0.30±0.011	0.24±0.18	32.55±1.88	0.55±0.35
Leaves	28.89±3.68	0.81±0.082	20.59±2.04	1093.75±29.76	609.85±20.20	5.88±0.58	3.99±0.38	1.83±0.18	42.14±17.19	45.98±1.15
Seed	nd	1.71±0.087	8.95±1.95	818.88±195.92	475.73±17.26	1.25±0.0045	6.26±0.68	1.41±0.72	18.39±2.65	2.92±0.69
Walnut										
Nutmeat	nd	1.84±0.15	3.47±0.56	653.83±61.25	263.19±10.32	3.08±0.39	3.19±0.0048	nd	58.42±28.36	19.58±0.24
Leaves	92.83±6.41	0.69±0.12	61.54±2.75	2041.67±330.97	583.50±4.22	10.97±0.37	1.93±0.074	2.87±0.51	94.11±7.58	31.53±4.80
Strawberry										
Pulp	1.45±0.22	nd	0.46±0.036	146.08±0.74	15.25±0.13	nd	0.33±0.0079	nd	16.64±2.45	nd
Leaves	32.79±1.56	0.74±0.20	12.73±0.76	1683.33±149.09	637.79±18.45	20.83±0.73	3.18±0.022	1.50±0.15	27.27±10.20	45.45±7.42
Apple										
Pulp	nd	nd	nd	119.50±41.76	nd	0.034±0.012	0.059±0.019	nd	10.54±1.56	nd
Leaves	19.65±0.76	0.23±0.034	25.99±0.79	2610.42±243.60	594.21±7.46	5.49±0.22	1.40±0.052	0.98±0.083	55.03±3.49	53.4±9
Seed	6.62±1.68	1.60±0.067	4.83±0.093	697.25±18.40	474.79±6.75	3.84±0.098	2.57±0.15	nd	351.55±0.07	2.33±0.71
Cherry										
Pulp	4.99±0.47	0.32±0.012	0.42±0.0049	248.25±20.26	15.84±0.56	0.061±0.0066	0.17±0.025	0.17±0.16	23.47±16.91	nd
Stalk	20.61±0.77	1.61±0.12	18.80±3.02	4658.33±1721.37	176.00±16.50	0.93±0.037	3.46±0.38	1.67±0.44	111.53±9.92	6.82±0.33
Pomegranate										
Seed	3.84±0.10	0.59±0.024	0.72±0.071	261.00±4.00	24.45±0.52	0.29±0.020	0.78±0.043	0.10±0.066	29.67±2.22	1.03±0.28
Peel	3.80±0.20	0.30±0.017	0.30±0.045	332.50±37.66	15.93±0.63	0.12±0.013	0.30±0.011	nd	8.91±0.86	2.63±0.47
Mint	19.16±1.55	0.34±0.094	30.00±3.31	2791.67±535.18	508.33±26.46	5.07±0.26	2.59±0.12	nd	63.22±7.77	41.9±3.5
Basil	12.80±2.42	1.03±0.090	29.91±3.89	4754.17±574.93	600.69±18.28	5.67±0.27	4.48±0.19	6.48±1.8	115.38±23.57	56.1±6.9

The results are expressed as mean ± standard deviation (n = 3). nd – not detected periods 'a small leak can sink a big ship'. Lione[41] reported that an average human daily consumes 3-100 mg Al through foods and drinks. In the normal European diet, the daily aluminum intake from various foods is estimated at 3-10 mg, depending on the type of food. In the USA this is normally higher because of greater use of intentional food additives[42]. The total diet study showed that mean Al intake by an adult male is 10 mg/day, whereas that by an adult female is 7 mg/day[43]. The WHO revised the Provisional Tolerable Weekly Intake (PTWI) from 7 mg/kg of body weight to 1 mg/kg of body weight in 2006 on the conclusions that levels lower than the previous PTWI may affect the developing nervous and reproductive systems[44].

Iron is essential for all tissues in the human body and represents approximately 35 and 45 mg/kg of body weight in adult women and men, respectively[45]. Being one of the most abundant metals in the human body, Fe is a component of hemoglobin in red blood cells and of myoglobin which respectively distribute oxygen around the body and store oxygen in muscles and tissues. Iron is also a component of enzymes that are integral for energy metabolism, the metabolism of proteins and nucleotides and the synthesis of proteins, tissues, some hormones and neurotransmitters[46-48]. Furthermore, Fe can interfere with the absorption of other nutrients and, in excess, can generate free radicals that impair cellular functions and suppress enzymatic activity[49]. The body cannot excrete Fe, so the amount in the body is controlled by matching the intestinal uptake and transfer of iron to the amount needed to replace adventitious losses of Fe and the amount needed for growth and reproduction. Therefore, the principal determinant of the amount of Fe that enters the body from diet is the body's need for Fe to meet these requirements[45,47]. Approximately 5 to10 % food Fe seems to be assimilated by normal adults; daily retention on a diet containing 12 to 15 mg of Fe, therefore, may be estimated to be about 0.6 to 1.5 mg[50]. Dietary iron exists in two forms; haem and non-haem. The richest sources of non-haem iron are cereals, vegetables, nuts, eggs, fish and meat[51]. The range of iron in the studied fruit pulp varies from 0.30 to 3.47 mg100 g^{-1} while the range for fruit leaf samples 12.73 to 61.54 mg 100 g^{-1} (Table-3). As for that leafy vegetables, the range of Fe varied between 30 mg100 g^{-1} in mint leaves to 29.92 mg100 g^{-1} in basil leaves (Table-3). The permissible limit set by FAO/WHO in edible plants was 20 mg/kg[52]. Except walnut, all other investigated fruit pulp samples accumulate iron below the permissible limit set by FAO/WHO limit in edible plants. However, the high concentration of iron in the investigated vegetables indicates they are unsafe.

Manganese is one of the most plentiful metals in the Earth's crust. Manganese is also an essential nutrient for humans and animals[53]. Health benefits of Mn ensure healthy bone structure, bone metabolism, helping in building essential enzymes for building bones[54]. It acts as a coenzyme to assist metabolic progression in the human body. Apart from these, there are other health benefits of Mn actively in forming connective tissues, absorption of calcium, proper functioning of thyroid, sex hormones, regulating blood sugar level and metabolism of fats and carbohydrates[4,55-56]. Adverse health effects can be caused by inadequate intake or over exposure[57,58]. Manganese deficiency in humans appears to be rare because Mn is present in many common foods. Certain foods, such as tea leaves, pecans, grains, fruits, legumes, leafy vegetables and grape nuts have especially high levels of Mn[59,60]. Heavy tea drinkers may have a higher Mn intake than the general population. An average cup of tea may contain 0.4 to 1.3 mg Mn[60]. The IOM[61] set a tolerable upper intake level of 11 mg/day for adults, based on a recent review[62]. Manganese concentration in vegetables in the present study was higher than in fruit pulp samples. It can be seen from Table-3 that highest level of Mn is in basil and mint, 5.67 and 5.07 mg 100 g^{-1}. For this reason, basil and mint are a good source of Mn. Also, fruit leaf samples contained the highest concentration of Mn (ranged from 5.49 in apple leaves to 20.83 mg 100 g^{-1} in strawberry leaves).

Zinc is an essential trace element for humans, animals and plants, playing a significant role in several biochemical processes[63]. The significance of zinc in human nutrition and public health was recognized relatively recently[64]. Zinc is such a critical element in human health that even a small deficiency is a disaster. Zinc is required for the metabolic activity of the body's enzymes and is considered essential for cell division and the synthesis of DNA and protein[65]. Among dietary sources green leafy vegetables and fruits are only modest source of zinc having concentrations < 10 mg/kg[66]. In the studied plant zinc concentration ranged from 0.06 mg 100 g^{-1} in apple pulp to 6.26 mg 100 g^{-1} in quince seed. Zinc uptake has been determined in higher amount in leafy vegetables and fruit tissues as seen in Table-3 while fruit pulps shown slightly lower uptake of zinc. In 1982, JECPA proposed a daily dietary requirement of zinc of 0.3 mg/kg of body weight and a provisional maximum tolerable daily intake (PMTDI) of 1 mg/kg of body weight[67]. Zinc in all the studied plant samples is found to be below the recommended tolerable levels proposed by Joint FAO/WHO Expert Committee on Food Additives[67].

Copper is a natural element that is an essential micronutrient to ensure the well being of all aerobic life forms. It plays a vital part in the development and performance of the human nervous and cardiovascular systems, as well as the skin, bone, immune and reproductive systems, including gene transcription[68-70]. Effects of copper deficiency can include anemia, low numbers of white blood cells, osteoporosis in infants and children and defects in connective tissue leading to skeletal problems. Within the selected fruit/fruit tissue the highest concentrations of copper were noticed in walnuts followed by quince seeds, apple seeds, quince leaves, strawberry leaves, pomegranate and so on in decreasing concentrations (Table-3). As for that leafy vegetables, the range of copper varied between 1.03 mg 100 g^{-1} in basil leaves to 0.34 mg 100 g^{-1} in mint leaves (Table-3). Most of the studied edible plant samples (pear, quince, strawberry, apple, pomegranate) contain copper below the permissible level set by FAO/WHO (3 mg/kg)[52].

Selenium is an essential nutrient for animals, humans and microorganisms. Selenium is a naturally occurring element found in soil, rocks and water. Selenium enters the food chain through plants, which take it up from the soil[71]. The amount of Se in foods depends on a number of geological, geographical and other factors[71]. The distribution of Se in various parts of plant depends on species, phase of development and physiological condition[72]. In selenium-accumulators such as Brazil nuts, garlic, onions, broccoli *etc.*, selenium accumulates in young leaves during early vegetative stage of growth but during the reproductive stage it is found at much higher levels in seeds. In non-accumulator cereal crops, there is often about the same amount in grain and roots with smaller amount in stems and leaves[72]. The importance of Se to human health has become a focus in recent years. Intake of Se ranges from deficient to toxic. Selenium deficiency diseases in human have been recognized in China and Tibet[71]. Keshan disease, an endemic cardiomyopathy and Kashin-Beck disease, a deforming arthritis[73,74]. Selenium toxicity in human is far less widespread than Se deficiency. Chronic toxicity of Se in humans results in selenosis, a condition characterized by brittleness or loss of hair and nails, gastrointestinal problems, rashes, garlic breath odor and nervous system abnormalities[75]. The European Commission and the WHO have proposed the lower daily upper limit of 300 μg/day for adults[76,77]. It can be seen in Table-3 that mint and basil leaves are an excellent source of Se 41.9 and 56.1 μg 100 g^{-1}, respectively, that is particularly important for those who eat little red meat or are vegetarians. Se variation in fruit pulps is 0.05-19.58 μg 100 g^{-1}. In seeds and leaves fruits maximum content was 2.92 μg 100 g^{-1} in apple seeds and 53.4 μg 100 g^{-1} in apple leaves. In comparison tissues of plant shown a significant selenium uptake while fruit pulps and seeds, leafy vegetables have showed variable differences in selenium uptake.

The trace elements lead and cadmium caused major human health problems in several parts of the world. The major health effects of lead are evince in three organ systems; the hematological system, the central nervous system[78]. Cadmium has been shown to exert toxic effects on kidney and bones in human after long term exposure[79,80]. Generally, the predominant route of exposure for Cd and Pb elements is ingestion, although inhalation is an important source of lead[81,82], particularly in urban-dwelling population. In addition to the smoking of tobacco can be an important source of Cd[81]. Diet is also the major of Cd exposure in non-smokers[81]. Among the investigated edible fruits, walnut pulp exhibits higher concentration of lead 584.2 μg/kg while apple pulp contains minimum amount of lead 105.4 μg kg^{-1} (Table-3). Also, in the leafy vegetables studied the highest concentration of Pb was found in basil (1150 μg kg^{-1}). Cadmium variation in investigated all plant samples is 1.70 (in cherry)-64.8 (in basil) μg kg^{-1} (Table-3). The present results also indicated that most elemental concentrations, including the toxic elements were higher in leafy vegetables than in edible fruit tissues. After all, these concentration were still lower than the maximum levels of Cd in leafy vegetables as regulated by Commission Regulation No. 1881/2006 (European Commission 2006) and Codex Committee on Food Additives and Contaminants (CODEX Standard 193-1995) 200 μg kg^{-1} for Cd[83]. However, for lead almost all plant samples were higher than lead permissible limits (300 μg kg^{-1})[83].

In conclusion, various types of fruits, fruit tissues and leafy vegetables having appreciable medicinal properties have been analyzed for concentrations of both essential and toxic elements. Some of them are consume in human diet while other parts have medicinal value. Hence determination of elements in this plant samples is also important. Most of studied species contains the trace below the permissible limit[52]. The study revealed that investigated plant samples are good source of K, Mg, Fe, Mn, Zn, Cu and Se. However, some plant samples such as mint, basil, walnut and quince contained high levels of lead. Therefore, these should not to be used feed infants or children frequently because this element can be accumulated in the human body, leading to health effects in the future. The data obtained in present study will be helpful in the synthesis is of new modern drugs with various combinations of plant samples which can be used in the cure of many diseases ethnomedicinally. However, more detailed analysis of chemical composition of these plant samples is required.

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