

STUDY OF TRACE ELEMENTS IN FRUITS OF DATES AT TURBAT-PUNJGUR REGION OF BALOCHISTAN WITH REFERENCE TO MEDICINAL AND ENVIRONMENTAL POLLUTION

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Abstract

The aim of this paper is to present the status of Dates in Balochistan and the determination of the level of heavy elements (B, Cu, Cr, Cd, Fe, Pb, Mn, Ni and Zn) in fruits of dates. Date is one of the best fruit crop of Pakistan. Dates are grown on an area of 23.880 acres in Pakistan, with an annual production of 7121,200 tonnes in 2011-12. Most of the dates produced in Pakistan are grown in the provinces of Balochistan and Sindh. Dates grown in Pakistan have a strong demand in the domestic and international markets. The organic dates can be easily grown in Pakistan. To increase the size of exports of organic dates on the international market our farmers to follow biological standards. These criteria safeguard all features of diet making from physical benefit (medicinally) and preservation of wildlife for diet dealing out and wrapping. These were performed to investigation were performed to evaluate the level of heavy elements (B, Cu, Cr, Cd, Fe, Pb, Mn, Ni and Zn), in which most of the trace elements were in small quantities excluding for Fe, Ni and Zn that they might be formed in rock and underground water materials. However, the stage and the choosiness of the plants can play an important role in absorbing elements can be useful as medicinal and as protection of Environmental Pollution.

Key words: Dates, Trace elements, Medicinal plants, Mass spectrometry-induced coupled plasma (MS-ICP) & Environmental pollution.

Introduction

It is believed that the dates have initiated nearby the Persian Bay. They were the main diets of the Middle East people. The palm (*P. dactylifera*) is a Date (palm) in the genera "Phoenix", planted for eatable sweet fruitlets) that are nutritious. It is a medium sized plant, 13 to 25 m high, developing alone or form a cluster of numerous stems from a distinct root structure. The greeneries are 300 to 500 cm lengthy, having spikes on the petioles and pinnate, by means of nearby 151 leaves; the leaves are 33 centimeters long and 2.5 centimeters wide. The total thickness of the head is between 7 and 11 meters.

Date fruits are elongated and cylindrical, 5 to 7 centimeters lengthy and 2 to 3 centimeters in width, and when immature, ranging from rosy to sunny buttery in colour, dependent on the variability. Date's fruits enclose a lone kernel along approximately 1.5 to 3.0 centimeters in length and 7 to 9 millimeters in thickness. The palm is dioecious have distinct masculine besides feminine plant. These are simply grown as of kernel, but merely 51% of

the sprouts will remain feminine and henceforth fruitlet and date's fruit from sprout floras are often slighter plus minor value. Therefore, utmost of the profitable cultivated plants use of thorough cultivars cuttings.

Palms are obviously air cross fertilized nonetheless in mutually outmoded retreat viticulture and in the current profitable plantations they are completely fertilized physically. Ordinary crosspollination happens with almost equivalent numbers of masculine and feminine individuals. Nevertheless, with support, one masculine can self-pollinate up to 110 feminine. Meanwhile masculine have an importance only as pollinator, this permits makers to usage their assets for numerous fruits generating plants. Several cultivators do not equal to tolerate masculine plants as masculine flowers are obtainable in narrow marketplaces in the procedure of cross-fertilization. The cross-pollination is prepared by expert personnel on the stairs. Dates mature in four steps, which are recognized global for Arabic terms Kimmri (juvenile), khlel (complete dimension, crispy), and rutaab (ripe, soft), tammr (ready, sun dried) (Tables 1 and 2).

Table 1. Region underneath farming dates for past 10 years.

Year	(Area '000' Acres)				
	Punjab	Sindh	Khyber Pakhtoonkhaw	Balochistan	Pakistan
2000-01	28.17	57.08	2.47	106.5	194.23
2001-02	28.32	57.74	2.53	105.32	193.9
2002-03	20.92	62.46	3.06	105.97	192.41
2003-04	14.12	63.05	3.24	104.4	184.82
2004-05	14.31	65.34	3.39	118.92	201.96
2005-06	14.32	65.93	3.4	118.95	202.61
2006-07	14.56	72.31	3.43	118.99	209.29
2007-08	14.67	79.09	3.52	125.45	222.73
2008-09	14.77	80.08	3.54	125.69	224.07
2009-10	14.83	80.56	3.46	125.04	223.88

Source: Agricultural Statistics of Pakistan

Table 2. Province wise dates production for last 10 years.

Year	(Production '000' Tonnes.)				
	Punjab	Sindh	Khyber Pakhtoonkhaw	Balochistan	Pakistan
2000-01	97.9	266	6.6	242	612.5
2001-02	94.12	288.9	6.69	240.57	630.28
2002-03	62.11	317.1	8.15	237.68	625.04
2003-04	41.69	151.61	8.59	224.93	426.82
2004-05	42.71	318.23	9.3	252.16	622.4
2005-06	42.58	192.81	8.87	252.32	496.58
2006-07	43.16	201.02	9.97	172.13	426.28
2007-08	44.36	253.09	10.38	249.69	557.52
2008-09	44.61	261.95	11.34	248.59	566.49
2009-10	44.7	265.3	11.3	209.9	531.2

Source: Agricultural Statistics of Pakistan



Fig. 1. Fruit dates plant in Turbat.

The fruitlets remain an essential portion of the anthropological food, as these provide minerals and vitamins, which are vital nutrients necessary to anthropological fitness (Mumzuroglu *et al.*, 2003). The date (*Phoenix dactylifera* L. Arecaceae family) is some of the ancient plants, planted in dry and semi dry areas. The tree is particularly appreciated fruit “date”, it is also decorative and planted at street corners in Pakistan (Balochistan). The agricultural plants of dates with fruits are shown below in Figs. 1 and 2.

Dates are one of the best significant fruit harvests of Pakistan. Dates are grown on a range of 223,880 acres in Pakistan, with an annual report production of 531,200 tons in 2009-10. Maximum of the dates produced in Pakistan are grown in the areas of Balochistan and Sindh. The main producing zones in the country dates are Turbat, Panjgur, Gwadar, Khairpur and Dera Ismail Khan. Several key trade marketplaces for the palm are Australia, Canada, Germany, India, the United States, United Kingdom, China, Denmark, Nepal, Bangladesh, Sri Lanka, Africa, Japan, Dubai, South Korea, North Korea, etc.

The emission of trace elements from manufacturing and automobiles might result in the settling of these heavy metals on the superficial parts of fruit and root as these trace elements can seriously harm the human health, for example, declined immune defense, nervous disorders, intrauterine growth retardation. In addition, contaminants exist in date Palm then differing in the environment of arid

and semi-arid areas of Balochistan. (Fayadh & Al-Showiman, 1990, Al-Shayeb *et al.*, 1995). In 1999, the highest level of environmentally friendly Pb (lead) contamination was originated in the principal zone of Riyadh (Bounessah *et al.*, 2001). Educations in the field of heavyweight metals pollution in the palm fruit are scarce. Therefore, it is important to study the heavy metal pollution in date palm that may apparently be castoff as a biotic pointer of heavy metal toxic waste to agree whether or not it is harmless for humanoid intake. In recent years, there is an upsurge in the levels of upper plants as bio monitoring of heavy metal contamination on the ground (Aksoy & Ozturk 1997, Due & Kreeb, 1993, Aksoy *et al.*, 2000).

The date palm is very disposed to contamination by heavy metals. It could be the primary in this respect and a two-pronged methodology to evaluate ecological contamination with palm ovary as pointer of contamination and evaluate the excellence of the ovary on the foundation of the contented of heavy metals, but the amount of heavy metals in the manure should not exceed as shown in Table 3.

For these reasons, we want to determine certain trace elements such as contaminants in the palm of dates fruit and agrarian soils at Panjgur in Balochistan province. The data are very gorgeous in nutritious modules, celluloses, fats, minerals, protein, vitamins and nutritional fiber. The macro and micro elements play an important role in preserving health in humans (Anon., 2000). Nevertheless, non-vital heavy metals such as Cd, Pb, Cr and Ni, are not decomposable, so wherever continue inside the atmosphere. Metallic elements have the capacity to be deposited in different body parts that possesses a countless danger to anthropological health (Singh *et al.*, 2004).

The chemical structure of the fruitlets of 11 palm date cultivars grownup in Riyadh area throughout the 1983 season were studied (Saad *et al.*, 1986). It is shown that the leaves of this three are bio-indicators of road traffic connected Pb contamination throughout the altered spells in Pakistan (Sargodha) (Naima *et al.*, 2010). Heavy metals in the fruit of palm tree that cultivated in various sites in Riyadh (Ibrahim *et al.*, 2011) were also examined are for the content of mineral ions from date palm (Imdadullah & Mahgoub 2010) in different places. Growing and uptake of heavy metals from the date palm mature in single and double culture in the earth contaminated with heavy metals was determined by AAS (Mohebi, 2011). The significance of date palms as a food source in Iraq (Goar, 1924) was studied.

The quality of fruit, nutritious value and performance dates Zaghlou applying fertilizers and / or organic minerals have been enhanced (Marzouka & Kassemb 2011). Gasiform and particulate contaminants have been measured during incineration of palm waste for energy recapture (Yassine *et al.*, 2012). A relative learning between automated and manual contamination in two cultivars of date palm is Saudi Arabia (Al-Wusaiba, 2012). Classic quantities of seventeen elements in the palm are précised and related with present data (Williams & Pillay, 2011). Spreading of heavy metals in earth and amassing in plants in an agricultural zone was studied in Umudike, Nigeria

(Princewil *et al.*, 2013). Mg, Ca, Cu, Fe and Pb in the oil palm (*Elaeis guineensis*) in diverse phases of the purifying process were determined by mass spectrometry of inductively coupled plasma “(MS-ICP)” after breakdown with microwave (Abdelrahman *et al.*, 2011).

The objective of this investigation was to regulate the quantities of trace elements in the sprinkle hastened on the surface of plams. Additionally, this trial was targeted at estimating the fruit as a biomonitoring of trace elements pollution in Turbat and Punjgur in Balochistan in order to consider whether the fruitlets were harmless for human eating.



Fig. 2. Fruits dates plants farm in Punjgur, Balochistan.

Table 3. Recommendation for harmless restrictions of weighty metals in floras (mg/kg).

Standards / Elements	Cd	Cu	Pb	Zn	As	Ni	Cr
WHO/FAO (2007)	0.2	40	5	60	-	-	-
European Union (EU 2006)	0.2	-	0.3	-	0.4	-	2.3
Indian Standard (Awashthi, 2000)	1.5	30	2.5	50	-	1.5	20

Material and Methods

Specimen: Fruitlets were gathered from diverse locations of Balochistan, Turbat Farm, Turbat Garden, Punjgur Farm and Irani Farm in September, 2015 and kept in storage in the freezer.

Dust washing: To discover the amount of, Cu, Fe, Cr, Mn, Cd, Pb, Ni, Zn and B in the observed powder on fruitlets, the powder was obtained from individual fruitlet tester together starting to each location. Testers were biased and wash away thrice with de-ionized distilled water (DDW) and the wash remained were placid in a glassware upholding the concluding bulk up to 155 mL using de-ionized distilled water. Entire glass wares were

reserved on burning platter for comprehensive dryness. The residual remaining was kept for B, Cu, Cr Cd, Fe, Mn, Ni, Pb and Zn approximation. After wash, all fruitlet testers were yet again reserved for the approximation of B, Cr, Cu, Fe, Cd, Mn, Pb, Ni and Zn quantities in the flesh of the fruitlets.

Tester preparation: Formation of the testers (wash remains and the material of palms afterward elimination of kernels) stood ready by assuming the method of damp wash (Al-Whaibi, 2008) for the approximation of Cadmium and lead. Entirely the material substances, cast-off in this process, remained of systematic ranking. The ingestion tactic was partially revised by (Hseu, 2004) from that of (Zheljzakov *et al.*, 1996). Entire samples

were broken down with conc. HCl to regulate certain elementary micro and macro components by means of inductively coupled plasma (ICP) device. Statistics were examined using the examination of alteration and the means was associated at the possibility level of 5% (Anon., 1998).

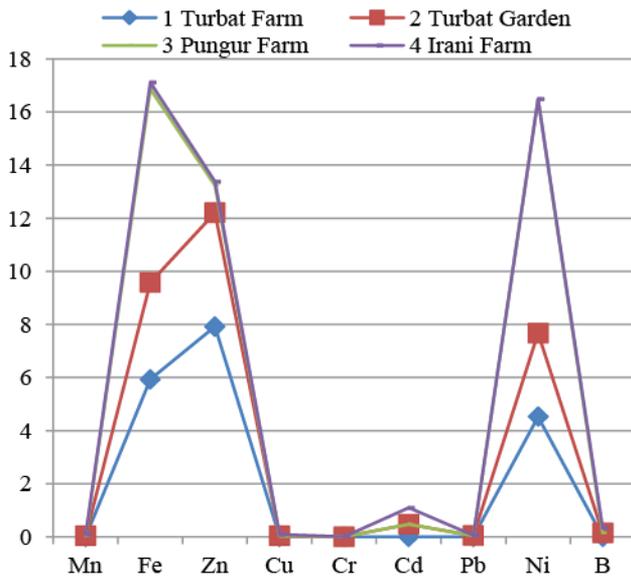


Fig. 3. Level trace elements level in the samples of fruits of dates collected from Turbat-Punjgur.

Results and Discussion

The data presented in Table 4 and Figure 3 show, that was detected the amassing of heavy metals in the eatable portion of the fruits of date palms, that had a negative impact of anthropological and living organism health through the food chain (Abd-Elfattah *et al.*, 2002). Outcome of irrigation with waste water was the accumulation of heavy metals in date fruits. Long-terms use of treated waste water for irrigation caused a substantial upsurge of the content of the various heavy metals in the topsoil available. These high concentrations of heavy metals may be poisonous to floras, animals and humans, when they meet their dietary materials Abd-Elfattah *et al.*, (2002). Date shown that was an important change in the heavy metals insides of fruits and heavy metals (Cu, Cd, Fe, Ni, Mn, Pb, Zn) in waste water treated fruit than with clean water both situations.

It could be because of the occurrence of heavy metals in topsoil and genomic type of flora emergent in dissimilar sites of the town. Delibacak *et al.*, (2002), it is informed raised levels of heavy metals in the fruitlets of apple, plum, walnut, pomegranate, water-melon, and grape together from 12 diverse spots. Nevertheless, additional comprehensive analysis is looked-for to measure the environmentally friendly contamination on the root and genomic flora that could be used as a bio-monitoring cause concerning heavy metal effluence. Little (1973) stated that metallic gathering may possibly happen moreover finished retaining of heavy metals on leaves or finished statement of heavy metals on greenery and acceptance from the soil. Metallic acceptance by plant is an important way through which metals arrive the diet

series. The buildup of heavy metals diverges with herbal types (Antonious & Snyder 2007; Melo *et al.*, 2007; Antonious & Kochher 2009; Motto *et al.*, 1970) presented that the endorsement of Pb by floras in the glasshouse is through the system of root but in the ground it is typically through the leaves of plants.

The data collected by Mardi *et al.*, (1995) on the amounts of numerous elements in the mango, pomegranate and mulberry were combined and examined to display the total quantities in the fruitlet. In general, the fruitlets had upper macronutrients and heavy metals, while the leaves encompass an upper quantities of micronutrients B, Fe, Mn and. This is attributable to the capability to move crops some elements inside the plants. This may likewise pointed out that these components do not mount up inside the system for long stages of irrigation. Therefore, the level of trace elements should be in the limit of organic standards, according to the rules and regulations of the World Health Organization (WHO).

Dehydrated or soft dates are castoff straight or stuffed with almonds, candied walnuts, orange and lemon peel. Arabs use dates in bread, cakes and additional sweet stuffs. Among the recent innovations contain dates with chocolate and fruit juice foodstuffs such as dates, used in certain Islamic republics for extraordinary spiritual events such as Fast (Ramadan).

Importance of exports in the development of an economy cannot be denied. This is particularly true in case of a developing economy like Pakistan. The commodity concentration and the supply side fluctuations in fruit exports are known to have serious consequences for overall export earnings. The global market stake of Pakistani dates in the world is about 18%, which is a gigantic percentage. Dates cultivated in Pakistan have a great demand of national and international market, irrespective of the fact that most of our low export search value because of poor quality, irregular processing, and lack of value. Organic Dates can be grown easily in Pakistan by following the org. standards as given in Table 3.

Wastewater irrigated agronomic earths are severely contaminated per metal cups pseudos. Las grown in such top soil can amass a important sum of heavy metals in diverse muscles (Khairiah *et al.*, 2004, Chuojnaha *et al.*, 2005; Muchuweti *et al.*, 2006). The release of heavy metals as of manufacturing and automobiles might outcome in the unseating of these metals on the superficial part of fruit and vegetables (Jassir *et al.*, 2005). Because these heavy metals can harm human health extremely, for example, lowered immunity, nervous disorders, intrauterine growth obstacle, reduced psychosocial behavior related with undernourishment and a high of upper abdominal tumor incidence of incapacity (Arora *et al.*, 2008). Therefore, the regular monitoring sequencers and observing of the pollution by heavy metals in foods for years focused mainly in advanced countries (Johnson *et al.*, 2002 Milacic & Kralj, 2003; Saracoglu *et al.*, 2004).

Furthermore, Dates aren't precisely a nutritious power-house when associated to particular other diets like kiwi or sesame kernels, but as medicinal uses, fruitlet does still deal many healthiness profits accompanied by excessive sense of taste as for example.

Table 4. Trace elements level in the samples of fruits of dates collected from Turbat-Punjgur.

S.No.	Palm fruits	Mn	Fe	Zn	Cu	Cr	Cd	Pb	Ni	B
1.	Turbat Farm	0.001	5.93	7.92	0.001	0.001	0.001	0.001	4.52	0.001
2.	Turbat Garden	0.03	3.65	4.29	0.03	0.001	0.47	0.04	3.15	0.14
3.	Punjgur Farm	0.001	7.29	1.02	0.001	0.001	0.001	0.001	8.82	0.001
4.	Irani Farm	0.06	0.25	0.15	0.05	0.001	0.62	0.01	0.001	0.18

Encouraging digestive health, get rid of constipation:

Fiber is vital for the advancement of colon healthiness and do for steady bowel activities. The soluble and insoluble fiber present in palm dates aids to cleanse the intestinal tract, permitting intestine to grind for the highest levels of proficiency. Several other related fiber and intestine health benefits are, lower colitis, hemorrhoids and risk of colon tumor. (Dates can also be combined with additional home-based medications for piles.)

Enhancing heart healthiness: Moreover, to help the health of the colon, fiber is likewise acknowledged to increase cardiac strength.

Anti-seditious: Dates Palm are gorgeous in Mg – an inorganic substance identified for its anti-pain assistances. Some learning initiate that provocative signs in the physique such as CRP, tumor necrosis factor alpha (TNF), and interleukin 6 (IL6) remained all concentrated when Mg ingestion was enlarged. In addition, irritation in also reduced with the intake of Mg by walls of arteries. Established on the anti-inflammatory properties of Mg and outcomes of this research, Mg can efficiently lessen the danger of cardiac syndrome, stiffness, Alzheimer's sickness and some other sicknesses correlated to irritation.

Lower blood pressure: Mg is made known to support lesser blood pressure - and once more, the palm dates are filled with the inorganic minerals. In addition, K is additional dates mineral has numerous purposes within the body, contributing with the suitable functioning of the heart and helping to lower the blood pressure.

Carbon-based criterions are rules and guidelines that describe in what way an organic item for consumption must be synthesized. All that the "organic" level, which is intended for human-being intake essentially come across these criteria at the least. The instructions cover all features of diet manufacture, from living organisms safety and preservation of flora and fauna for diet handling and packing.

Biological criteria are to be followed so that you can be sure that you are purchasing a unaffected biological invention that has been formed inside the normal values. Trade in organic diet obligation have been synthesized and verified to equal criteria. It would also be a filled traceability of the new organic components for the agriculturalist.

Reference for carbon-based agriculture and the environment, all manufacturer of food causes some disturbance in a normal atmosphere. Organic agriculture reduces the inconvenience for:

Warning the kinds and amounts of insecticides and manures used. Growing soil richness and soil permanence, and preserving and growing environmental variety inside and nearby harvested land.

Selected publically maintainable as well as environmentally maintainable with deference for good customary and green grazing methods, and understandingly within the boundaries of local type of weather and geography (such as mountain, hill and upland farming).

Conclusion

In conclusion the fruits of dates are a good source of income for farmers in Balochistan therefore, they need to be free of metal contaminants. Dates can also be combined with additional home-based medications for piles. The date fruits as medicinal uses deal may healthiness profits accompanied by excursive source of taste and benefits to human body. In this research, maximum of the heavy metals were small quantities except for Fe, Ni and Zn that may be formed in rock and underground resources. Nevertheless, the age and the choosiness of plants can play a significant role in the absorption of the elements. The metal Fe, Ni and Zn levels in different collected of samples dates were in higher level and not according to the standards of WHO that had negative impacts on living organism health through the food chain. Similarly then these higher metals level make environmental problem with respect to pollution.

Recommendations

- Farmers must keep an updated preservation plan for the entire property, prepared by a consultant.
- Pruning should not be done between 1 March and 31 August. This is to allow nesting birds.
- There should be a zone of uncultured strips of grassland and flowers around any large area of two hectares. This is to offer home and diet for birds, mammals and insects.
- Storage locations must not be smashed, except with acquiescence, which usually involve getting authorization for a suitable organization of protection.
- To allow wildlife trips between habitats must not exceed 200 m between each part of the field of culture and an area not permanently cultivated as a hedgerow, ditch or beetle bank.
- To promote biodiversity and protect sensitive habitats and landscape features.
- Optimize the use of renewable and recycled resources.
- To minimize pollution and waste.
- Create high biological activity fertile land to provide balanced feed crops Nutritious
- Encourage natural predators in crop area:
- Companion planting, sowing and planting
- Leaving the hedges, windbreaks, wildlife corridors and margins of fallow fields
- The choice of unaffected harvests and variations suited to local agronomic conditions
- Careful arrangement and implanting dates
- Use worthy hygienic diet and farming performs to edge the blowout of any pest or disease.

References

- Abd-Elfattah, A., S.M. Shehata and A.S. Talab. 2002. Evaluation of irrigation with either raw municipal Treated Waste or river water on elements up take and yield of lettuce and potato plants. *Egypt. J. Soil. Sci.*, 42(4): 705-714.
- Abdelrahman, H.A., S.A. Alkhamisi, M. Ahmed and H. Ali. 2011. Effects of treated wastewater irrigation on element concentrations in soil and maize plants. Conference proceeding. Sultan Qaboos University, Oman.
- Aksoy, A. and M.A. Öztürk. 1997. *Nerium oleander* L. as a bio-monitor of lead and other heavy metal pollution in Mediterranean environments. *Sci. Total Environ.*, 205(2-3):145-150.
- Aksoy, A., U. Sahin and F. Duman. 2000. *Robinia pseudoacacia* L. as a possible bio-monitor of heavy metal pollution in Kayseri. *Turk. J. Bot.*, 24: 279-284.
- Al-Shayeb, S.M., M.A. Al-Rajhi and M.R.D. Seaward. 1995. The date palm (*Phoenix dactylifera* L.) as a bio-monitor of lead and other elements in arid environments. *Sci. Total Environ.*, 168(1): 1-10.
- Al-Whaibi, M.H. 2008. Biology of Date Palm, second ed. Scientific Publications, King Saud University Press, Riyadh, Saudi Arabia (in Arabic).
- Al-Wusaiba N.A. 2012. Spectroscopic Determination of Some Trace Elements as Pollutants in Fruit Dates Palm and Agricultural Soils at Zilfi Province. *Indi. J. Sci. and Tech.*, 5(4): pp. 2487.
- Anonymous. 1998. SPSS Base 8.0 for Windows User's Guide. SPSS Inc., Chicago
- Anonymous. 2000. Official Methods Association of the Official Analytical Ed. Arlington Virginia USA.
- Antonious, G.F. and J.C. Snyder. 2007. Accumulation of heavy metals in plants and potential phytoremediation of lead by potato, *Solanum tuberosum* L. *J. Environ. Sci. (Health Part A)*, 42(6): 811-816.
- Antonious, G.F. and T.S. Kochher. 2009. Mobility of heavy metals from soil into hot pepper fruits: A field study. *Bull. Environ. Contam. Toxicol.*, 82(1): 59-63.
- Arora, M., K. Bala, R. Shweta, R. Anchal and Neeraj. 2008. Heavy metal accumulation irrigated with water from different sources. *Food Chem.*, 111: 811-815.
- Bounessah, M., S.M. Al-Shayeb, K.M. Al-Ghefaily and B. Abdulfatah. 2001. Assessment of lead levels in dust and date palm (*Phoenix dactylifera* L.) in 6-10 year-old school children environment in Riyadh City, Saudi Arabia. *Asian J. Chem.*, 3(4): 1435-1442.
- Chojnacha, K., A. Chojnacki and H. Gorecka. 2005. Bioavailability of heavy metals from polluted soils to plants. *Sci. Total Environ.*, 333: 175-182.
- Delibacak, S. and O.L. Elmaci, M. Secer and A. Bodur. 2002. Trace element and heavy metal concentrations in fruits and vegetables of the Gediz River region. *Int. J. Water.*, 2(2-3): 196-211.
- Due, M. and K.H. Kreeb. 1993. Seasonal variations of foliar metal content in three fruit tree species. In: (Ed.): Markert B. Plant as Bio-monitors/Indicator for Heavy Metals in the Terrestrial Environment. VCH Publisher; Weinheim: pp. 577-592.
- Fayadh, J.M. and Al-Showiman. 1990. Chemical composition of the flesh and the pit of date palm fruit and radical scavenging activity of their extracts. *J. Chem. Soc. Pak.*, 12(1): 84-103.
- Goar, L.G. 1924. Curing seedling dates. *Date Grow. Inst. Rep.*, 1: 33.
- Hseu, Z.Y. 2004. Evaluating heavy metal contents in nine composts using four digestion methods. *Bioresource Technol.*, 95(1): 53-59.
- Ibrahim, M., A. Aldjain, H. Mohamed, S.S. Al-Whaibib, C. Al-Showiman and M.H. Siddiqui. 2011. Determination of heavy metals in the fruit of date palm growing at different locations of Riyadh. *Saudi J. Biol. Sci.*, 18(2): 175-180.
- Imdadullah, M.Z. and Mahgoub N.S. 2010. Spectroscopic determination of some trace elements as pollutants in fruit dates palm and agricultural soils at zilfi province. *J. Chem. Soc. Pak.*, 32(1): 11-16.
- Jassir, M.S., A. Shaker and M.A. Khaliq. 2005. Deposition of heavy metals on green leafy vegetables sold on roadsides of Riyadh city, Saudi Arabia. *Bull. Environ.*, 75: 1020-1027.
- Johnson, D. V., E. Joyal and R. K. Harris. 2002. Date palm varieties in Arizona. *Fruit Gard.*, 34(5): 6-9, 26.
- Khairiah, T., M.K. Zalifah and Y.H. Yin. 2004. The uptake of heavy metals by fruit type selected agricultural areas. *Pak. J. Biol. Sci.*, 7: 1438-1442.
- Little, P. 1973. A study of heavy metal contamination of leaf surfaces. *Environ. Pollut.*, 5(3): 159-172.
- Mardi, M.O., S.B. Salama, E.C. Consolacion and M.S. Al-Shabibi. 1995. Effect of treated sewage water on vegetative and reproductive growth of date palm. *Commun. Soil Sci. Plant Anal.*, 26: 1895-1904.
- Marzouka, H.A. and H.A. Kassemb. 2011. Spectroscopic determination of some trace elements as pollutants in fruit dates palm and agricultural soils at zilfi province. *Scientia Horti.*, 127: 249-254.
- Melo W.J., P. Aguiar, G.M. Melo and V.P. Melo. 2007. Nickel in a tropical soil treated with sewage sludge and cropped with maize in a long-term field study. *Soil Biol. Biochem.*, 39(6): 1341-1347.
- Milacic, R. and B. Kralj. 2003. Detrmination of Zn, Cu, Cd, Pb, Ni and Cr in some Solvenian Food stuffs. *Euro. Food Res. Technol.*, 217: 211-214.
- Mohebi, A.H. 2011. Phytoremediation potential of three plant grown in monoculture and intercropping with date palm in contaminated soil. *World Appl. Sci. J.*, 15(3): 429-435.
- Motto, H.L., R.N. Daines, D.M. Chilko and C.K. Motto. 1970. Lead in soil and plants: its relationship to traffic volume and proximity to highways. *Environ. Sci. Technol.*, 4: 231-234.
- Muchuweti, M., J.W. Birkett, E. Chinyanga, Scrimshah and J. Lester. 2006. Heavy metal content of vegetables irrigated with mixture of waste sludge in Zimbabwe, implications for human health. *Agri. Ecosys. Environ.*, 112: 41-48.
- Mumzuruglu, O., F. Karatas and H. Geekil. 2003. The vitamin and selenium contents of apricot fruit of different varieties cultivated in different geographical regions. *Food Chem.*, 83: 205-212.
- Naima, H.N., I.B. Aima, R. Fayyaz and H. Uzma. 2010. Leaves of roadside plants as bioindicator of traffic related lead pollution during different seasons in Sargodha, Pakistan. *Afri. Sci. and Tech.*, 4(11): pp. 770-774.
- Princewill, C., A. Ogbonnaa and T. da-Silvab. 2013. Distribution of heavy metals in soil and accumulation in plants at an agricultural area of Umudike, Nigeria. *Chem. and Ecol.*, 29(7): 595-603.
- Saad, F.A., M.A. Shaheen and M.A. Bacha. 1986. Spectroscopic determination of some trace elements as pollutants in fruit dates palm and agricultural soils at zilfi province. *Proc. Saudi Biol. Soc.*, 9. pp. 25-33.
- Saracoglu, S., M. Tuzen and D.M. Dogan. 2004. Heavy metal content of hard biscuits produced in Turkey. *Environ. Contam. Toxicol., Bull.*, 73: 264-269.
- Singh, K.P., D. Mohan and S. Sinha. 2004. Impact assessment of treated/untreated discharged by sewage treatment plants and environmental quality in the waste water disposal areas. *Chemosphere*, 55: 227-255.
- Williams, John R; Pillay. 2011. Metals, metalloids and toxicity in date palms: potential environmental impact, avin e. *J. Environ. Protec.*, 2(5): 592-600.
- Yassine, E.M., D. Sophie, J. Mejdj, T. Gwénaelle and S. Rachid. 2012. Measurement of gaseous and particulate pollutants during combustion of date palm wastes for energy recovery. *Aerosol and Air Quality Research*, 12: 814-825.
- Zheljazkov, V.D. and N.E. Nielson. 1996. Effect of heavy metals on peppermint and cornmint. *Plant Soil.*, 178(1): 59-66.