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Variation in concentrations of some elements in leaves and fruits of Guava *(Psidium guajava* L.*)* and soil irrigated with polluted water from Abu Al-Khaseeb River, Southern Iraq.

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Abstract

During the cultivation period, growth and ripeness of Guava *(Psidium guajava)* plant in the fields of Abu Al-Khasseb, Southern Iraq were studied for estimation of chemical elements contents, Cd, Co, Cu , Fe, Mn and Zn in leaves and fruits of Guava irrigated by water from Abu Al-Khaseeb river polluted by crude oil spilled in Shatt Al-Arab River. Two sites were selected, Bab Debagh and Abu Mugherah. The study was conducted throughout two seasons, for the periods,Oct.2003-March 2004 and March 2004–August 2004. The first season is characterized by bud blooming and plants were irrigated with rain water, while the second season is characterized by growth of leaves and buds, bloom and ripeness, water used in this stage for irrigation was from Abu Al-Khaseeb River. Moreover a clear model was used during these seasons as a control irrigated with tab water. Some chemical elements were estimated by adopting the Atomic Absorption Spectrophotometry in the leaves and fruits of Guava plant. Highest differences in the concentrations of studied elements were recorded in leaves and fruits before and after ripeness during the first season and for both sites. While concentrations were increased for all studied elements except Cd in leaves after fruit ripeness in both sites, and all elements except Cd, Fe and Mg in fruits after ripeness in Bab Debagh site, while elements Cd, Cu and Mg decreased with no change in Co and Fe and increase in Zn only in fruits after ripeness for Abu Mugherah site. Guava fruit characterized by diameter, length in cm and weight in gm as 12.6, 5.4 and 30.36 respectively for Bab Debagh site and 15.5, 7.2 and 45.3 respectively for Abu Mugherah site during the first season. For the second season, elements showed decrease in leaves except Co after ripeness of fruits and increased in fruits except Co and Mn with no effect for Cd in Bab Debagh site and decreased in elements except Cd with no effect for Fe in leaves while in fruits, elements were decreased except an increase of Zn with no effect for Cd and Cu. Fruits characterized as 17.7, 8.1 and 59.8 respectively in Bab Debagh site and 19, 9.6 and 83.8 respectively in Abu Mugherah site. Statistical analysis showed non significant differences for Cd and Cu between leaves and fruits for both study sites. Significant differences were recorded for Co and Mn between leaves and fruits, while for Fe significant differences were recorded between leaves and fruits for Bab Debagh only, and for Zn there were significant differences between leaves before ripeness compared with after ripeness and both significantly different from fruits whether before or after ripeness. During the second period of study , Co didn't record any significant differences, but Cu and Fe reported significant differences between leaves before and after ripeness from fruits after ripeness, while Fe and Mn didn't show any significant differences for leaves before and after ripeness from fruits before and after ripeness. It is concluded that concentrations of chemical elements showed alteration levels in leaves and fruits of Guava plant during the cultivation period.

1- Introduction

Vitamins, minerals and amino acids are essential for biological bodies health and development. They are categorized as micronutrients. Minerals which are the inorganic substances are critical to biological tissues which fall into two categories: The major minerals which the body needs are in large amount such as calcium, phosphorous and magnesium; other major minerals which exist in less amount are potassium, sodium and sulphur. The other class is the minor minerals or trace minerals which are required in less amounts by the body and include boron, copper, chromium, iodine, iron, manganese, molybdenum, selenium, zinc and others (Herbal extracts plus, 2005).

Certain trace metals are essential for plant which they play a great role in physiological processes especially the enzymetic ones, such as Cu, Co, Cr, Fe, Mn, Mo, Se, Sn and Zn in low concentrations, while they become as pollutants when they are in high concentrations (Viarengo, 1985 ; Vymazal, 1990). Deficiency in certain trace minerals lead to varying growth for plant tissues. Zinc deficiency results in stunted growth and small leaves, while a universal symptom appears in case of iron deficiency is the chlorosis of young leaves, Fig. 1 (Food and Fertilizer Technology Centre, 2007).

Trace metals dissolved in water could be filtered from water and plantation soil into the body of plant which incorporated in its tissues (Skaar *et al.*, 1973). Certain plants in southern

Iraq were shown to be polluted by trace metals. The only plants in southern Iraq which have been given attention for pollution by trace metals were vascular plants (Mustafa *et al.*, 1995) and date palm (Ibrahim, 2000 b).

Shatt Al-Arab River is exposed to pollution by petroleum hydrocarbons and trace metals from oil terminals, transportation of oil, municipal wastes and sinking ships. Most branches from Shatt Al-Arab River such as Abu Floos and Abu Al-Khaseeb rivers are used for irrigation of date palms as well as other plants that exist in the area which are effected by pollutants from these rivers. The rare growing Guava plant is present under the shadow of date palm trees, it is effected by irrigated water from branches of Shatt Al-Arab River (Ibrahim and Aziz,2001). Aziz *et al.*, (2000) were detected n-alkanes in the fruits and leaves of date palm *Phoenix dactylifera* from southern Iraq irrigated with water from Shatt Al-Arab River. On the other hand, aquatic plants in the southern wetlands of Iraq, such as *Phragmites australis* and *Typha domengensis* were found to be good bioaccumulation species for trace metals in all parts of the body under ground and above ground (Aziz, 2004).

In this study the plant guava was studied for the levels of trace metals in its fruits and leaves after irrigation with polluted water from Shatt Al-Arab river through its branches.

The Aim

The aim of this study is to evaluate the levels of trace metals in fruits and leaves of Guava plant *(Psidium guajava)* after irrigation with polluted water from Shatt Al-Arab river through its branch Abu Al-Khaseeb river.

2-Materials and Methods

The Plant:

One of the most gregarious of fruit trees, the guava, *Psidium guajava* L., of the myrtle family, Myrtaceae. The guava is cultivated in tropical and semi-tropical areas, it is a small tree 6-25 ft in height. The fruit is small, 3-6 cm long, pear-shaped, reddish-yellow when ripe. The leaves are evergreen, opposite, short-petioled, oval or oblong-elliptic, irregular in outline 7-15 cm long, 3-5 cm wide, Fig. 1 (Morton, 1987).

For Guava all over the world, there are 2 crops per year, the first during late summer and early fall, being the heaviest, with small fruits. The second, with larger fruits, during late winter and early spring (Morton, 1987).

The fruit of Guava contains vitamin C, vitamin A. iron, manganese, calcium, phosphorous, saponin, glycoside(Guiajaverin), … etc. The fruit matures 90 to 150 days after flowering (Morton, 1987). Unripe fruit is indigestible, causes vomiting and feverishness, ripe fruit is laxative, and juice with good taste and nutritional benefit. The leaves contain essential fixed and volatile oils (Sixty compounds, 90.56%), resin, fat, cellulose, tannin, flavonoids, mineral salts, … etc (Dweck, 2003),

leaves are astringently. The whole plant is used for sore throats, vomiting, stomach upset, diarrhea, dysentery, antispasmodic, CNS depression, and antibacterial activity. Guava has recently demonstrated cardiac depressant and lower blood sugar levels (Tropical Plant Database, 1996). The leaves contain certain levels of trace metals, a shortage of any of them will cause damage such as shown for the shortage of Fe (Fig, 2).

Fig. 1. Gauava plant showing the fruits and leaves.

Fig 2. Iron deficiency in Guava cause leave damage.

The Analysis

This study has been conducted during two seasons; the first: October –March represented by bud blooming, and the second: March-August represented by growth of buds and leaves during March and beginning of rose blooming and finally fruit ripeness during July/August. Samples of leaves and fruits of Guava plant were collected at different occasions before and after fruits ripeness from two stations; Bab Debagh and Abu Mugherah at Abu Al-Khaseeb orchards, Southern Iraq, Samples were transferred to the laboratory in marine science centre, washed with tap water and distilled water, dried and dimensions and weights were measured.

Samples of Guava fruits and leaves were dried in 80C for 24 hours, then each was ground and prepare for chemical analysis as follows: Sub- samples of dried parts in triplicate were digested in mixed sulfuric and perchloric acids(1:1 v:v) then analyzed for Cd, Co, Cu, Fe, Mn and Zn according to the standard methods by using Atomic Absorption Spectrophotometer Pye Unicom model SP9.

3-Results

The concentrations of studied trace metals in planting soil (µg/g) and irrigation water (µg/l) for Guava plants are given in Table 1.

The concentrations of studied elements in the leaves and fruits (µg/g) of Guava plant before and after ripeness are listed in Table 2 for the first season and Table 3 for the second season.

The effect of irrigation water have been studied thoroughly by using tab and river waters. Results are listed in Table 4.

Fruits were characterized by length; diameter and weight from both stations during both seasons are listed in table 5.

Table 1. Concentrations of elements in planting soil (µg/g) and irrigation water (µg/l) for Guava plants from both stations during the first season of this study.

Station	Samples		Cd	Co	Cu	Fe	Mn	Zn
	First	Soil	6.294	147.78	31.153	1240.315	7077.81	16.286
Bab Debagh	Season	Water						
	Second	Soil	6.291	177.336	23.823	1108.04	7093.3	10.354
	Season	Water	6.21	165.62	4.20	172.93	49.05	37.68
	First	Soil	5.045	87.55	40.76	1319.42	48.88	33.39
Abu	Season	Water						
Mugherah	Second	Soil	3.24	76.83	36.38	1282.76	52.54	30.94
	Season	Water	4.39	45.45	9.73	96.76	24.52	76.58

Table 2. Concentrations of elements in leaves and fruits (µg/g) of Guava plant before and after being ripe from both stations during the first season of this study.

Station	Samples	Cd	Co	Cu	Fe	Mn	Zn
	Leaves.br	2.517	68.876	29.321	992.280	2209.349	26.964
Bab Debagh	Leaves.ar	2.517	59.112	36.651	1157.660	1968.564	42.343
	Fruits,br	7.552	177.336	14.660	567.830	714.841	7.55
	Fruits,ar	7.143	209.020	14.980	788.345	698.120	8.92
	Leaves,br	4.352	38.234	18.143	821.17	1927.108	24.150
Abu	Leaves,ar	4.352	13.590	21.932	986.93	1586.090	41.925
Mugherah	Fruits,br	5.035	153.980	18.326	454.087	917.821	7.65
	Fruits,ar	3.590	78.056	17.210	328.193	205.920	8.09

Nd= Below the detection limits of the instrument, br= before ripeness and ar= after ripeness.

Table 3. Concentrations of elements in leaves and fruits (µg/g) of Guava plant before and after being ripe from both stations during the second season of this study.

Station	Samples	Cd	Co	Cu	Fe	Mn	Zn
	Leaves.br	3.776	350.65	51.311	661.520	8754.6	11.648
Bab Debagh	Leaves.ar	1.259	354.67	43.980	496.140	7960.138	8.196
	Fruits,br	Nd	147.78	102.623	165.380	1685.61	10.786
	Fruits,ar	Nd	254.65	212.576	165.38	432.431	24.807
	Leaves,br	Nd	295.56	47.646	661.520	8878.15	10.986
Abu	Leaves,ar	2.517	59.112	36.651	661.520	8631.69	7.338
Mugherah	Fruits,br	Nd	177.336	120.948	165.380	776.618	13.805
	Fruits,ar	Nd	118.224	120.948	165.380	467.736	16.394

Nd= Below the detection limits of the instrument, br= before ripeness and ar= after ripeness.

Table 4. Levels of studied elements(µg/g) in leaves and fruits of Guava plant irrigated by river water and tab water for comparison.

Sample	Irrigation Water	Cd	Co	Cu	Fe	Mn	Zn
Leave,br		46.102	135.73	100.61	22.74	89.48	62.95
Fruit,br	River	29.81	24.87	80.06	23.75	29.67	66.0
Leave,ar		46.78	137.78	204.26	24.24	121.11	86.35
Fruit,ar	River	25.3	136.4	48.01	18.68	60.67	56.83
Leave,br	Tab	48.56	143.33	191.76	23.96	59.84	76.8
Fruit,br	water	40.45	135.5	133.6	17.23	28.29	75.85
Leave,ar	Tab	51.53	129.99	146.46	23.65	31.01	75.53
Fruit,ar	water	32.49	173.6	39.12	16.63	57.99	54.58

Table 5. Properties of the studied Guava fruits

	Bab Debagh			Abu Mugherah		
Seasons	Length (cm)	Diameter (cm)	Weight (gm)	Length (cm)	Diameter (cm)	Weigh (gm)
First	17.7	8.1	59.8	19	9.6	83.8
Second	12.6	5.4	30.36	15.5	7.2	45.3

4- Discussion

From Tables 2 and 3 it is shown that there were an alteration in the concentrations of studied elements in leaves and fruits of Guava fruit in both seasons of study as well as both stations, in which highest levels recorded were for Manganese during both periods of study and in both leaves and fruits being higher before ripeness and decreased after ripeness which could be explained by dilution with water as well as increase of surface area of leaves and weight of fruits, followed by Fe, Co and Cu which behave alternatively. In his study of leaves and fruits of five species of date palm from Abu-Al-Khaseeb area, Ibrahim (2000a) detected higher levels of Fe and Mn compared with Cu and Zn.

Soil irrigated by Abu Al-Khaseeb river , which receives polluted water from Shatt Al-Arab river as well as domestic wastes, could be contaminated with pollutants and in turn pollutants could be absorbed by plants and accumulated in their leaves and fruits (Ibrahim and Aziz,2001).

There were certain levels of Cu, Mn and Zn, while Cd and Co were not fully recorded in the leaves and fruits of guava plant, as it is reported for date palm in the same area (Ibrahim,2000b).

Fe and Mn were recorded in leaves in greater amounts than fruits at both stations, which could be explained on the bases of fallen particulate matter in the area as a result of airborne pollutants (Thomas *et al.*, 1984). Recent study on the fallen dust on southern Part of Basrah Governorate indicated that levels of Fe and Mn were quite high (Kevork, 2007). This reason could be behind the enrichment of those elements. The other elements Cd, Co, Cu and Zn are characterized by lower retention capacities of the guava plant and a selective uptake mechanism (Thomas *et al.*, 1984).

Statistical analysis showed no significant differences for Cd and Cu between leaves and fruits for both study sites. Significant differences were recorded for Co and Mn between leaves and fruits, while for Fe significant differences were recorded between leaves and fruits for Bab Debagh only, and for Zn there were significant differences between leaves before ripeness compared with after ripeness and both significantly different from fruits whether before or after ripeness. During the second period of study , Co didn't record any significant differences, but Cu and Fe reported significant differences between leaves before and after ripeness from fruits after ripeness, while Fe and Mn didn't show any significant differences for leaves before and after ripeness from fruits before and after ripeness.

For method of irrigation, there were non significant differences for Co, Fe and Mn, significant differences were reported for Cu and Zn in leaves and fruits after being ripe, while for Cd significant differences were reported in leaves and fruits during both stages before and after being ripe.

5-References

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تغاير تراكيز بعض العناصر في اوراق وثمار نبات الجوافة والتربة المروية بمياه نهر ابي الخصيب , جنوب العراق.

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الملخص

خلال مراحل زراعة ونمو ونضوج نبات الجوافة في بساتين ابي الخصيب, جنوب العراق , اجريت دراسة لتقييم محتوى العناصر , الكادميوم والكوبلت والنحاس والحديد والمنغنيز والخارصين في اوراق وثمار نبات الجوافة المروية بمياه ملوثة بالنفط المنسكب في مياه شط العرب حيث اختيرت محطتين هما باب د باغ وابومغيرة. قسمت الدراسة الى موسمين للفترتين تشرين اول 2003 - اذار 2004 و اذار 2004 – اب 2004. تميز الموسم الاول ببداية تفتح البراعم وسقي المزروعات بمياه الامطار. اما الموسم الثاني فقد تميز بنمو الاوراق والبراعم والتزهير والنضج, واستخدم للسقي خلال هذه الفترة مياه نهر ابي الخصيب. كما استخدم خلال هذه الدراسة نموذج سيطرة روي بمياه الاسالة. تم تقدير بعض العناصر باعتماد تقنية الامتصاص الذري وذلك في كل من مياه السقي والتربة واوراق وثمار نبات الجوافة . سجلت اعلى فروقات بتركيز العناصر لعينات اوراق وثمار قبل وبعد النضج خلال الموسم الاول ولمحطتي الدراسة, حيث ازداد تراكيز كل العناصر المدروسة عدا الكادميوم في الاوراق بعد نضج الثمار وللمحطتين وكل العناصر عدا الكادميوم والحديد والمنغنيز في الثمار بعد النضج لمحطة باب د باغ, بينما تناقصت عناصر الكادميوم والنحاس والمنغنيز وبقيت عناصر الكوبلت والحديد على حالها وازداد الخارصين فقط في الثمار بعد النضج لمحطة ابو مغيرة. وتميزت الثمار بالمواصفات التالية , قطر (سم) و طول (سم) ووزن (غم) الثمرة و كما يلي (12.6 و 5.4 و 30.36)على التوالي لمحطة باب د باغ و (15.5 و 7.2 و 45.3) على التوالي لمحطة ابو مغيرة. اما خلال الموسم الثاني فقد اظهرت كل العناصر تناقصاً عدا الكوبلت في الاوراق بعد نضج الثمار وتزداد العناصر في الثمار بعد النضج عدا عنصري الكوبلت والمغنيسيوم وعدم تأثر عنصر الكادميوم في محطة باب د باغ وتتناقص العناصر عدا الكادميوم وعدم تأثر الحديد في الاوراق بعد نضج الثمار بينما في الثمار تتناقص العناصر عدا ازدياد عنصر الخارصين وعدم تأثر الكادميوم والنحاس. وتميزت الثمار خلال الموسم الثاني بالمواصفات التالية: قطر ثمرة سم و طول سم ووزن غم كما يلي (17.7, 8.1, 59.8) على التوالي في محطة باب د باغ و (19, 9.6 , 83.8) على التوالي في ابو مغيرة . اظهر التحليل الاحصائي عدم وجود فروق معنوية للكادميوم والنحاس بين الاوراق والثمار ولكلا منطقتي الدراسة, وسجلت فروق معنوية للكوبلت والمنغنيز بين الاوراق والثمار, بينما سجلت فروق معنوية للحديد بين الاوراق والثمار لمنطقة باب دباغ فقط.وللخارصين كانت هناك فروق معنوية في الاوراق قبل النضج مقارنة بتلك بعد نضج الثمار وكل منهما فرقت معنوياً عن الثمار سواء قبل او بعد النضج. وخلال الفترة الثانية من الدراسة لم يسجلالكوبلت اي فروق معنوية, وقد سجلت فروق معنوية للنحاس والحديد بين الاوراق قبل وبعد النضج عن الثمار بعد النضج, بينما للحديد والمنغنيز لم يفرق تركيزها في الاوراق قبل او بعد النضج معنويا عن الثمار قبل وبعد النضجً. يستنتج من الدراسة ان هناك تغاير في تراكيز العاصر في اوراق وثمار نبات الجوافة خلال مراحل النضج.