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Original Research Article

Mineral Nutritional Values of Radish Leaves, as Influenced by Varying Irrigation Water Types

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ABSTRACT

Three radish cultivars namely Ufasic, Gigante, and Saxa2 grown under plastic house, irrigated by familiar Life drinking water, well and Dohuk river wastewater. Therefore, 9 treatments were arranged in Split within Randomized Complete Block Design. The obtained results revealed that Well watered fresh leaf gave the highest weight (24.172g), leaf dry weight (3.1258g), Ca content of dry leaves (3342.4µg.g-1) and Ca content of edible tissue (438.6 µg.g-1). Followed by wastewater, which showed the highest Zn content of dry leaves (72.675 µg.g-1), and Zn content in edible tissue (9.732 µg.g-1). Ufasic was the most effective cultivar in all detected traits, followed by Gigante and the worst was Saxa2. Gigante radish cultivar irrigated by well water appeared to be the most effective treatment, since it manifested the highest values in terms of Ca contents of both dry leaves (3370µg.g-1) and edible leaf tissue (438.6µg.g-1).

Keywords: Mineral, Nutritional value, Ca, Ni, Zn, Radish, Water types, waste water

INTRODUCTION

Radish is the main source of Calcium and some other organic mineral for animal and human nutrition, particularly in leaves (Abdel et al., 2014; Abdel and Yousif, 2015). The rediscovery of earlier information that calcium deficiency led to the development of osteoporosis (not rickets and osteomalacia) in experimental animals (Nordin, 1960) resulted in a re-examination of osteoporosis in humans, notably in postmenopausal women. This re-examination yielded evidence in the late 1960s that menopausal bone loss was not due to a decrease in bone formation, but rather to an increase in bone resorption (Young and Nordin, 1967; Christiansen et al., 1982), this has had a profound effect on our understanding of other forms of osteoporosis and has led to a new paradigm that is still evolving. Calcium salts provide rigidity to the skeleton and calcium ions play a role in many, if not most, metabolic processes.

In the primitive exoskeleton and in shells, rigidity is generally provided by calcium carbonate, but in the vertebrate skeleton, it is provided by a form of calcium phosphate, which approximates hydroxyapatite [$Ca10(OH)2(PO4)6$] and is embedded in collagen fibrils. Bone mineral serves as the ultimate reservoir for the calcium circulating in the ECF. Calcium enters the ECF from the gastrointestinal tract by absorption and from bone by resorption. Calcium leaves the ECF via the gastrointestinal tract, kidneys, and skin and enters into bone via bone formation. In addition, calcium fluxes occur across all cell membranes. Many neuromuscular and other cellular functions depend on the maintenance of the ionized calcium concentration in the ECF. Calcium fluxes are also important mediators of hormonal effects on target organs through several intracellular signalling pathways, such as the phosphoinositide and cyclic adenosine monophosphate systems.

The cytoplasmic calcium concentration is regulated by a series of calcium pumps, which either concentrate calcium ions within the intracellular storage sites or extrude them from the cells (where they flow in by diffusion). The physiology of calcium metabolism is primarily directed towards the maintenance of the concentration of ionized calcium in the ECF. This concentration is protected and maintained by a feedback loop through calcium receptors in the parathyroid glands (Brown and Hebert, 1997), which control the secretion of parathyroid hormone (see Figure 3.1). This hormone increases the renal tubular reabsorption of calcium, promotes intestinal calcium absorption by stimulating the renal production of 1,25-dihydroxyvitamin D or calcitriol [1,25-(OH)2D], and, if necessary, resorbs bone.

However, the integrity of the system depends critically on vitamin D status; if there is a deficiency of vitamin D, the loss of its calcaemic action (Jones et al., 1998) leads to a decrease in the ionized calcium and secondary hyperparathyroidism and hypophosphataemia. This is why experimental vitamin D deficiency results in rickets and osteomalacia whereas calcium deficiency gives rise to osteoporosis (Nordin, 196; Wu et al.,

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1990). The utilization of zinc depends on the overall composition of the diet. Experimental studies have identified a number of dietary factors as potential promoters or antagonists of zinc absorption. Soluble organic substances of low relative molecular mass, such as amino and hydroxy acids, facilitate zinc absorption. In contrast, organic compounds forming stable and poorly soluble complexes with zinc can impair absorption.

In addition, competitive interactions between zinc and other ions with similar physicochemical properties can affect the uptake and intestinal absorption of zinc. The risk of competitive interactions with zinc seems to be mainly related to the consumption of high doses of these other ions, in the form of supplements or in aqueous solutions. However, at levels present in food and at realistic fortification levels, zinc absorption appears not to be affected, for example, by iron or copper (Sandstrom and Lonnerdal, 1989). The availability of zinc from the diet can be improved by reducing the phytate content and including sources of animal protein. Lower extraction rates of cereal grains will result in lower phytate content, but at the same time the zinc content is reduced, so that the net effect on zinc supply is limited.

The phytate content can be reduced by activating the phytase present in most phytate-containing foods or through the addition of microbial or fungal phytases. Phytases hydrolyse the phytate to lower inositol phosphates, resulting in improved zinc absorption (Navert et al., 1985; Sandström and Sandberg, 1992). The activity of phytases in tropical cereals such as maize and sorghum is lower than that in wheat and rye. Germination of cereals and legumes increases phytase activity and the addition of some germinated flour to ungerminated maize or sorghum followed by soaking at ambient temperature for 12–24 hours can reduce the phytate content substantially.

reduction can be achieved by the fermentation of porridge for weaning foods or dough for bread making. Commercially available phytase preparations could also be used, but may not be economically accessible in many populations (Gibson et al., 1998). Low intakes of zinc have been reported for the population of Papua New Guinea, where the principal food sources are roots, tubers and leaves Ros et al., 1969). Unrefined cereal- or legume-based diets can, on the other hand, have a higher zinc content. Analyses of Indian vegetarian diets suggest a typical zinc intake of 16 mg 1.4 mg/MJ per day (Soman et al., 1969).

The zinc content of the total diet is influenced, not only by the range of food items selected, but also by the degree of refinement of any constituent cereals. Fats, from which zinc is virtually absent, tend to dilute zinc from the total diet. Many staple foods provide amounts of zinc similar to those of foods derived from animal tissues. However, energy sources such as fats, oils, sugar and alcohol have a very low zinc content. Green leafy vegetables and fruits are only modest sources of zinc (as of energy) because of their high water content (WHO, 1996). A relative deficiency develops as a result of zinc loss from tissue storage (compartmental displacement), without an increase in excretion.

A relative deficiency is seen on TMA results where the zinc level is within the normal range, but relatively low when compared to an antagonistic mineral such as copper, or cadmium (low Zn/Cu, low Zn/Cd). A relative deficiency state can be contributed to by adrenal insufficiency, hypothyroid, and hyperparathyroidism. As an example, studies performed on a group of pregnant women compared to a control group revealed that urinary zinc excretion was not significantly different from non-pregnant controls except during certain months. Trace element analysis of the hair on both groups revealed a gradual increase in tissue zinc levels in the test group toward the end of the pregnancy (Neldner and Hambidge, 1975). It is well known that copper levels rise during pregnancy as well as during oral contraceptive and estrogen therapy (Prasad et al., 1975). This is usually reflected in TMA studies (Leopold, 1978), and would apparently indicate that copper causes a relative deficiency rather than absolute deficiency of zinc.

In Sweden, the estimated daily nickel intake ranged from 200 to 4460 /µg and averaged 750 µg (Dencker et al., 1970). Early estimates of daily nickel consumption in the U. S. ranged from 300 to 600 µg (Schroeder et al. 1962). The average nickel content of nine institutional diets in North Dakota was 168 Â±11 Hg, or 75/1000 kcal (Myron et al., 1978). Based on extrapolation from animal data, the hypothetical human requirement for nickel would be 16 to 25 µg /1000 kcal or about 75 µg of elemental nickel per day (Nielsen, 1980). Most balanced diets probably exceed that amount of nickel. The issue of nickel in the human diet, however, has further ramifications. Low-nickel diets have been advocated in the management of nickel-sensitivity dermatitis (Rudzki and Grzywa, 977; Kaaber et al., 1978) which apparently is exacerbated by orally-ingested nickel (Christensen and Moller (1975).

The possibility was advanced that a strict nickel elimination diet might have implications for human health (Nielsen, 1980). The biological availability of trace elements in food is justified by extensive experience with dietary iron (Horak. and Sunderman, 1972) and dietary zinc (Sayer et al., 1973; Reinhold et al., 1976). (Ismail-Beigi et al., 1977) showed that nickel was among a host of elements that formed stable complexes with phytic acid in vitro; possibly such complexes would explain interference of unrefined cereal foods with the absorption of nickel (Solomons et al., 1979). Horak and Sunderman (Solomons et al., 1979a). Have estimated from nickel balance experiments that about 10% of the nickel in a normal diet is absorbed.

The objective of this investigation was to determine responses of three radish cultivars to the impacts of water type's namely well water and wastewater contaminated Dohuk river that are used in Dohuk for irrigating vegetable crops besides Life bottled drinking water, as a check.

MATERIALS AND METHODS

An attempt was made in the plastic house, Dohuk Research Center, Dohuk, Iraq, to investigate the responses of Ufasic, Gigante, and Saxa2 radish cultivars to varying irrigation water types, namely bottled life water, Well water and Dohuk river contaminated with wastewater in terms of their growth and mineral nutritional values. Split within Complete Randomized Block Design was selected for this trail, where the main plot (A) represented by life bottled drinking water (a1), well water (a2) and wastewater contaminated Dohuk water (a3). While, sub main plot (B) was represented by Ufasic (b1), Gigante (b2) and Saxa2 (b3). Therefore, 9 treatments were included in this experiment, each was replicated 4 times.

Cultural Practices

Trays of 74 cells filled with peat moss pressed to insure higher peat moss bulk density, and then arranged in three sets to match the main plot design. Two seeds were sown in each cell after they were brought up to field capacity, Seedlings were thinned to one plant per cell at the cotyledon leaf stage. Trays fertilized with mixed with irrigation water at rate 2.5g.l-1 Urea mixed with 2ml.l-1 foliar trace elements. This fertilizer mixture was applied on December, 18th , 31st , January 6th, 11th , 15th and 20th . At maturity, the plant was harvested, the fresh leaves were weighed and then oven-dried at 55oC for 73 hrs and then re weighted to record their dry matter and calculating their dry matter percentages.

Mineral Analysis

Dry leaves were powdered and then samples of 0.5g were digested with 10 cm3 and perchloric acid exposed to 240oC. Then diluted with 50 cm3 deionized water. Zinc, Nickel, and Calcium were measured by Flame atomic absorption spectrometry perkn Elmar pin AAcle 900T.

RESULTS AND DISCUSSIONS

Wastewater substantially reduced leaves fresh weight, as it showed the lowest value (15.792g), as compared to life (21g) and well water (24.172g) types. However, insignificant differences detected between life and wellness. These results suggested that wastewater contains contaminants effective in retarding leaf developments. Abdel and Yousif (2015) found high levels of lead (Pb) in Dohuk river wastewater, which resulted in limited low leaves fresh weight. (table, R1; figure, R1). Ufasic cultivar gave the highest leaf fresh weight (24.62g), which significantly exceeded Gigante (19.583g) and Saxa2 (16.759g). Insignificant differences were observed between Gigante and Saxa2. The highest leaf fresh weight observed in Ufasic irrigated with well water (29.58 g) wile, the lowest confined to Saxa2 irrigated with wastewater (14.86).

Similar reductions in radish leaves fresh weight observed with wastewater application, as compared to well and Dohuck Dam water (Abdel and Yousif, 2015). Many metals have no biological role (e.g. silver, aluminium, cadmium, gold, lead and mercury), and are nonessential and potentially toxic to microorganisms. Toxicity of nonessential metals occurs through the displacement of essential metals from their native binding sites or through ligand interactions (Anita et al., 1990). In addition, at high levels, both essential and nonessential metals can damage cell membranes; alter enzyme specificity; disrupt cellular functions; and damage the stucture of DNA (Aery and Sarkar, 1991; Alan, 1981; Ambler et al., 1970).

Insignificant differences detected in leaf dry weights between life and well water types. However, both of them substantially exceeded wastewater (table, R2; figure, R2). Ufasic manifested the highest leaf dry weights (3.3342g), which significantly exceeded Gigante (2.5942g) and Saxa2 (2.1033g). The highest combination dry weight of leaves observed with Ufasic irrigated with well water (3.855g), while the lowest value was found in Sexa2 irrigated with life, well and wastewater types (2.2358, 2.15 and 2.1133, respectively). These results might be attributed to the heavy metal contamination of wastewater, which is one of the major environmental stresses in higher plants and there is increased interest in the use of plants to decontaminate soils polluted by heavy metals.

Among the heavy metals, zinc is an important element for both plants and animals. It plays an important role in several plant metabolic processes. It activates enzymes and is involved in protein synthesis and in carbohydrate, nucleic acid and lipid metabolism. It forms complexes with DNA and RNA and affects the stability of these compounds (Collins, 1981; Pahlsson, 1989). But in excess levels, zinc stress causes multiple direct and indirect effects on growth and development of plants. It was found that many metals play an integral role in the life processes of microorganisms. Some metals, such as calcium, cobalt, chromium, copper, iron, potassium, magnesium, manganese, sodium, nickel and zinc, are essential, serve as micronutrients and are used for redox-processes; to stabilize molecules through electrostatic interactions; as components of various enzymes; and for regulation of osmotic pressure (Aery and Sarkar, 1991; Alan, 1981; Ambler et al., 1970). Significant differences were not detected in term of leaf dry matter percentages (table, R3; figure, R3).

The highest Zn content of leaves observed with wastewater (72.675µg.g-1), which substantially exceeded life (64.408µg.g-1) and well (61.967µg.g-1). Insignificant differences obtained among investigated Cultivars (table, R4; figure, R4). Saxa2 irrigated with wastewater exhibited the highest Zn leaf content (73.15µg.g-1). While the lowest leaf content of Zn confined to Saxa2 irrigated with life (59.2µg.g-1). Wastewater irrigation is known to contribute significantly to the heavy metal contents of soils (Mapanda et al., 2005). Although problems occur in waterways when pollutants are leached out of the soil. If the plants die and decay, heavy metals taken into the plants are redistributed, so the soil is enriched with the pollutants. Uptake and accumulation of elements by plants may follow two different paths, i.e., through the roots and foliar surface (Sawidis et al., 2001).

Dry matter yield in various parts of the radish varied according to zinc level. Dry matter of root and shoot was the highest at 50 and 100 mg kg-1 zinc level, but it showed a gradual decline from 150 mg kg-1 level onwards. There is a large number of reports that the heavy metals increased the dry matter yield of various plant parts at lower levels (Lal and Maurya, 1981; Shrikrishna and Singh, 1992). It was found that most biochemical roles of zinc reflect its involvement in a large number of enzymes or as a stabilizer of the molecular structure of subcellular constituents and membranes. Zinc participates in the synthesis and degradation of carbohydrates, lipids, proteins and nucleic acids.

It has recently been shown to play an essential role in polynucleotide transcription and translation and thus in the processes of genetic expression. Its involvement in such fundamental activities probably accounts for the essentiality of zinc for all forms of life (WHO, 1996).Lean red meat, whole-grain cereals, pulses, and legumes provide the highest concentrations of zinc: concentrations in such foods are generally in the range of 25–50mg/kg (380–760mmol/kg) raw weight. Processed cereals with low extraction rates, polished rice, and chicken, pork or meat with high fat content have a moderate zinc content, typically between 10 and 25mg/kg (150–380 mmol/kg). Fish, roots and tubers, green leafy vegetables, and fruits are only modest sources of zinc, having concentrations <10mg/kg (<150mmol/kg). Saturated fats and oils, sugar, and alcohol have very low zinc contents (Sandstrom, 1989).

Insignificant differences were detected among treatments in term of Ni leaves content (table, R5; figure, R3). The highest Ca content (3342.4µg.g-1) found in well water, which highly exceeded life (2887.6 µg.g-1) and wastewater (2722.6 µg.g-1). Ufasic and Saxa2 gave the highest Ca content of dry leaves (3123.3 and 3041.8 µg.g-1, respectively). They profoundly bypassed Gigante, which showed the lowest Ca content (2787.5 µg.g-1). The highest accumulated Ca 3370 µg.g-1) observed in Gigante irrigated with well water. However, the lowest Ca of dried leaves (2302 µg.g-1) detected in Gigante irrigated with wastewater (table, R6; figure, R6). Similar results were found by Abdel and Yousif (2015). They attributed their results to the high content of well water Calcium.

Table (R1). Leaves fresh weigh per (g) responses of Radish cultivars to varying water types, (*)				
Water type/ Cv.	Life	Well	Waste	CV. Means
Ufasic	27.163A	29.58A	17.118B	24.62A
Gigante	18.053B	25.3A	15.398B	19.583B
Saxa 2	17.783B	17.635B	14.86B	16.759B
Water type means	21A	24.172A	15.792B	
(*). Figures of unshared characters are significant at 0.05 level, Duncan test				

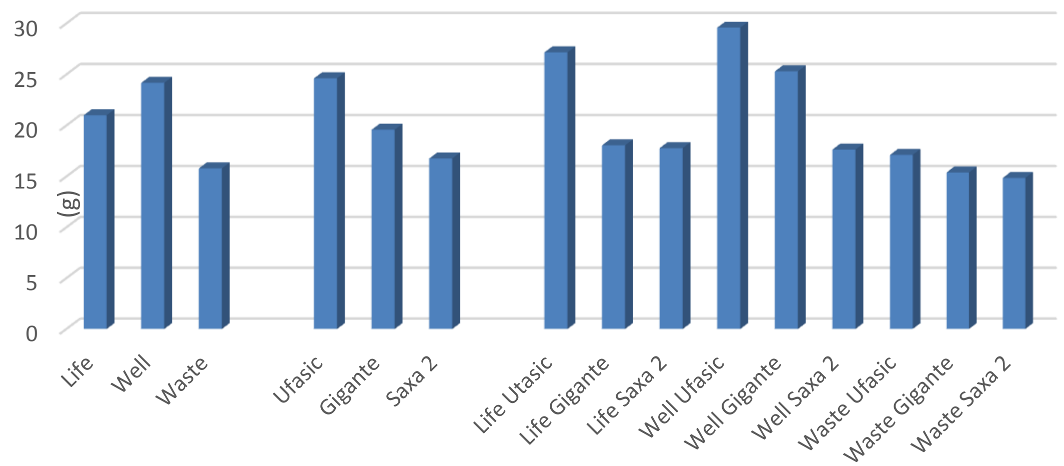


Figure (R1). Leaf fresh weigh (g), as influenced by water types

Table (R2). Leaf dry weigh (g) responses of Radish cultivars to varying water types, (*)				
Water type/ Cv	Life	Well	Waste	CV. Means
Ufasic	3.68A	3.855A	2.7925A	3.3342A
Gigante	2.4625B	3.3725A	3.1258A	2.5942B
Saxa 2	2.235B	2.15B	2.1133B	2.1033B
Water type means	2.7925A	3.1258A	2.1133B	
(*). Figures of unshared characters are significant at 0.05 level, Duncan test				

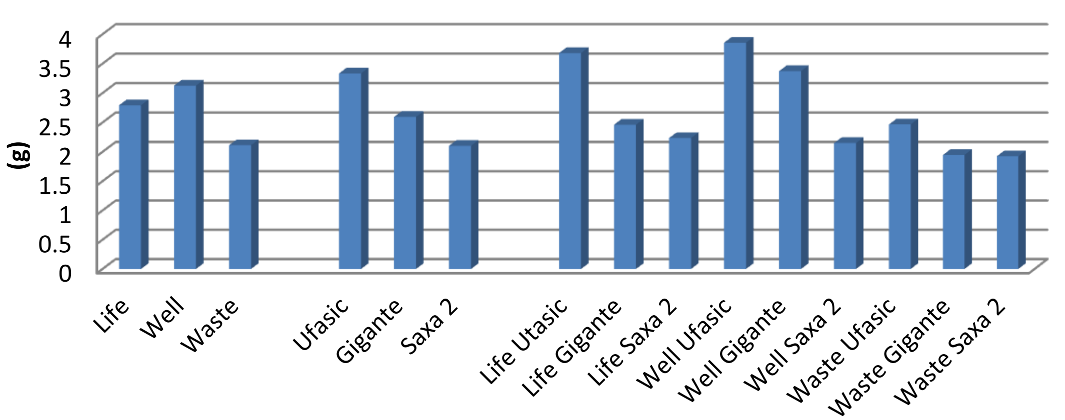


Figure (R2). Leaves dry weight per plant (g), as influencd by water types

Table (R3). Leaf dry matter (%) responses of Radish cultivars to varying water types (*)				
Water type/ Cv	Life	Well	Waste	CV. Means
Ufasic	13.616A	13.0775A	14.3125A	13.6687A
Gigante	13.905A	13.46A	12.7375A	13.3675A
Saxa 2	12.8A	12.955A	13.1425A	12.9658A
Water type means	13.4403A	13.1642A	13.3975A	
(*). Figures of unshared characters are significant at 0.05 level, Duncan test				

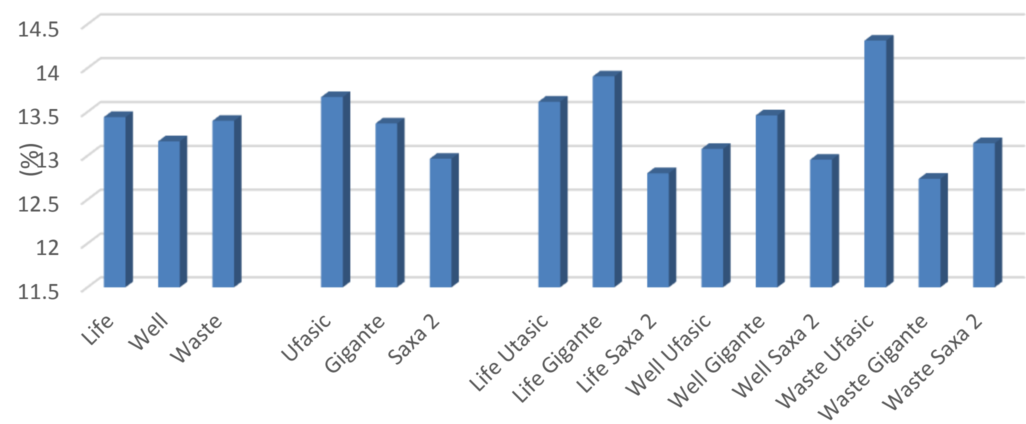


Figure (R3). Leaf dry matter percentages, as influenced by water types

Nearly all (99%) of total body calcium is located in the skeleton. The remaining 1% is equally distributed between the teeth and soft tissues, with only 0.1% in the extracellular fluid (ECF). In the skeleton it constitutes 25% of the dry weight and 40% of the ash weight. The ECF contains ionized calcium at concentrations of about 4.8mg/100ml (1.20mmol/l) maintained by the parathyroid–vitamin D system as well as complexed calcium at concentrations of about 1.6mg/100ml (0.4mmol/l). In the plasma there is also a protein-bound calcium fraction, which is present at a concentration of 3.2mg/100ml (0.8mmol/l). In the cellular compartment, the total calcium concentration is comparable with that in the ECF, but the free calcium concentration is lower by several orders of magnitude (Robertson and Marshall, 1981).

The highest edible tissue content of Zn (9.732 µg.g-1 Ed) accompanied by wastewater irrigation (table, R7; figure R7), which substantially exceeded life (8.6717 µg.g-1 Ed) and well 8.1283 µg.g-1 Ed). Ufasic radish cultivar gave the highest edible tissue content of Zn (9.3946 µg.g-1 Ed), which showed significantly higher Zn content of edible tissue than Gigante (8.9647 µg.g-1 Ed). The highest edible tissue content of Zn (9.732 µg.g-1 Ed) and Saxa2 (8.1727 µg.g-1 Ed). The highest edible tissue content of Zn was (10.3856 µg.g-1 Ed) obtained from Ufasic radish cultivar irrigated with waste water. While, the lowest was detected in Saxa2 irrigated with either life (7.5819 µg.g-1 Ed) or well (7.3208 µg.g-1 Ed).

Disposal of sewage water and industrial wastes is a great problem. Often it is drained to the agricultural lands where it is used for growing crops including vegetables. These sewage effluents are considered not only a rich source of organic matter and other nutrients but also they elevate the level of heavy metals like Fe, Mn, Cu, Zn, Pb, Cr, Ni, Cd and Co in receiving soils (Singh et al., 2004). As a result, it leads to contamination of the food chain, because vegetables absorb heavy metals from the soil polluted air and water. One important dietary uptake pathway could be through crops irrigated with contaminated wastewater. Heavy metals are not easily biodegradable and consequently can be accumulated in human vital organs. This situation causes varying degrees of illness based on acute and chronic exposures (Demirezen and Ahmet, 2006).

Insignificant difference were not found between treatments (table, R8; figure, R*). Notwithstanding, it was found that the concentrations of heavy metals in these samples are quite variable such as Cd (0.011–0.073 mg kg-1), Pb (1.121−2.652 mg kg-1), Cu (0.161–0.923 mg kg-1), Zn (0.361–1.893 mg kg-1) and Ni (0.288–0.546 mg kg-1). The magnitude of heavy metals detected in different kinds of vegetables was Cd < Cu < Cr < Zn, than other vegetables (Farooq et al., 2008). Animal and Human required Zn for many cell metabolism. Subsequently, Zinc is present in all the tissues and fluids of the body. The total body content has been estimated to be approximately 2 g.

The zinc concentration of the lean body mass is approximately 30 pg/g. Skeletal muscle accounts for approximately 60% of the total body content, and bone, with a zinc concentration of 100-200 pg/g, for about 30%. Plasma zinc accounts for only about 0.1% of total body content; it has a rapid turnover, and its level appears to be under close homoeostatic control. High concentrations of zinc are found in the choroid of the eye (274 pg zinc/g) and in prostatic fluids (300-500 pg/ml) (Hambidge, 1987). There is no "store" of zinc in the conventional sense. Under conditions of bone resorption and tissue catabolism, zinc can be released and, to some extent, reutilized. Human experimental studies with low-zinc diets (2.6-3.6 mg/day) have shown that circulating plasma zinc and the activities of zinc-containing enzymes can be maintained within a normal range over several months, indicating that some zinc can be made available from tissues (Lukaski HC et al., 1984; Milne DB et al., 1987). Ni plant source for human nutrition was reported in dry beans, cocoa products, baking soda, and some nuts contain high levels of nickel (>2.0 Mg/g); wheat and wheat products, shellfish, processed meats and many vegetables contain intermediate levels (0.2-2.0 Mg/g); and whole and dried milk, fresh fruits, meat, eggs and Coca Cola contain low levels of nickel (<0.2 µg/g). Thomas et al. (1974) suggested that contact between food and machinery and or cans, can contribute to dietary nickel, as processed and canned vegetables contain more than fresh. In some areas of Europe, where nickel is used as a catalyst in hydrogenation, margarine can be a substantial dietary source of nickel (Rudzki and Grzywa, 977).

The highest Ca content of edible tissue (438.61 µg.g-1 Ed) observed in well water irrigated radish (table, R9; figure, R9), which gave significant higher values than radish irrigated by life water (386.86 µg.g-1 Ed) and wastewater (365.61 µg.g-1 Ed). The highest Ca content of edible tissue occurred with Gigante cultivar irrigated by well water (453.44 µg.g-1 Ed). While, the lowest observed in Gigante irrigated with wastewater (292.56µg.g-1 Ed). Higher Calcium content was detected in radish leaves, as compared to calcium storage root content (Abdel et al.,, 2014; Abdel and Yousif, 2015). Calcium is a divalent cation with an atomic weight of 40. In the elementary composition of the human body, it ranks fifth after oxygen, carbon, hydrogen, and nitrogen, and it makes up 1.9% of the body by weight (Nordin, 1976; Abdel, 2014).

Carcass analyses show that calcium constitutes 0.1–0.2% of early fetal fat-free weight, rising to about 2% of adult fat-free weight. In absolute terms, this represents a rise from about 24g (600mmol) at birth to 1300g (32.5mol) at maturity, requiring an average daily positive calcium balance of 180mg (4.5mmol) during the first 20 years of growth.

Table (R4). Zn leaf content (µg.g-1) responses of Radish cultivars to varying water types, (*)

Water type/Cv	Life	Well	Waste	CV. Means
Ufasic	65.95AB	67.65AB	72.825A	68.808A
Gigante	68.075AB	61.325AB	72.05A	67.15A
Saxa 2	59.2B	56.925B	73.15A	63.092A
Water type means	64.408B	61.967B	72.675A	

(*). Figures of unshared characters are significant at 0.05 level, Duncan test

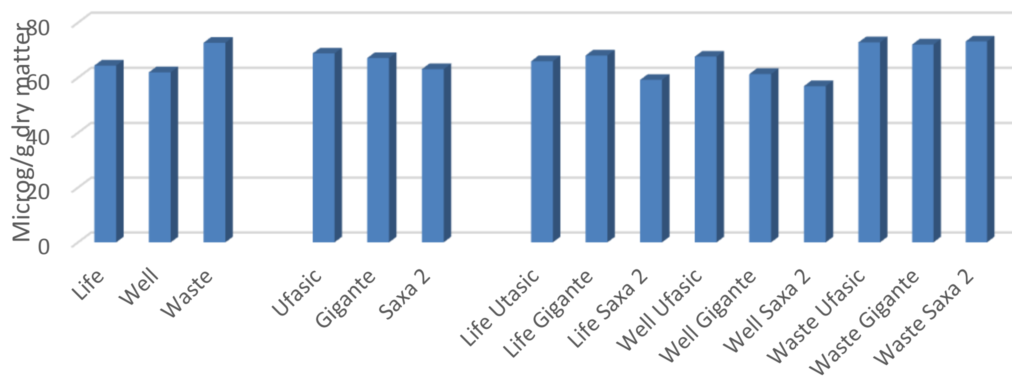


Figure (R4). Zn leaf content (microgram/g dry weight), as influenced by water types

Table (R5). Ni leaf content (µg.g-1) responses of Radish cultivars to varying water types (*)

Water type/ Cv	Life	Well	Waste	CV. means
Ufasic	16.175A	17.85A	14.125A	16.05A
Gigante	15.5A	16.65A	16.8A	16.317A
Saxa 2	13.325A	14.7A	17.9A	15.308A
Water type means	15A	16.4A	16.275A	

(*). Figures of unshared characters are significant at 0.05 level, Duncan test

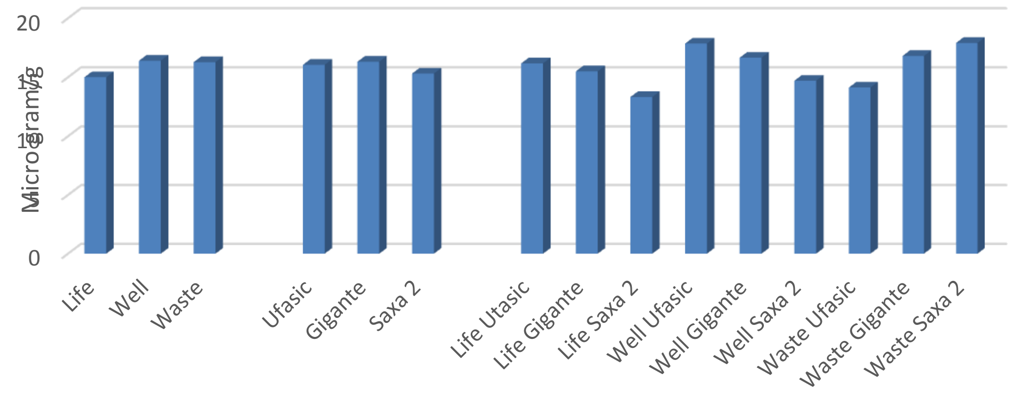


Figure (R5). Ni content of dry leaf (Microgram/g), as influenced by water types

Table (6). Ca leaf content (µg.g-1) responses of Radish cultivars to varying water types, (*)				
Water type/ Cv	Life	Well	Waste	CV. Means
Ufasic	3127.5ABC	3349.3AB	2893.3BC	3123.3A
Gigante	2690.3DC	3370A	2302.3D	2787.5B
Saxa 2	2845C	3308AB	2972.3ABC	3041.8A
Water type means	2887.6B	3342.4A	2722.6B	
(*). Figures of unshared characters are significant at 0.05 level, Duncan test				

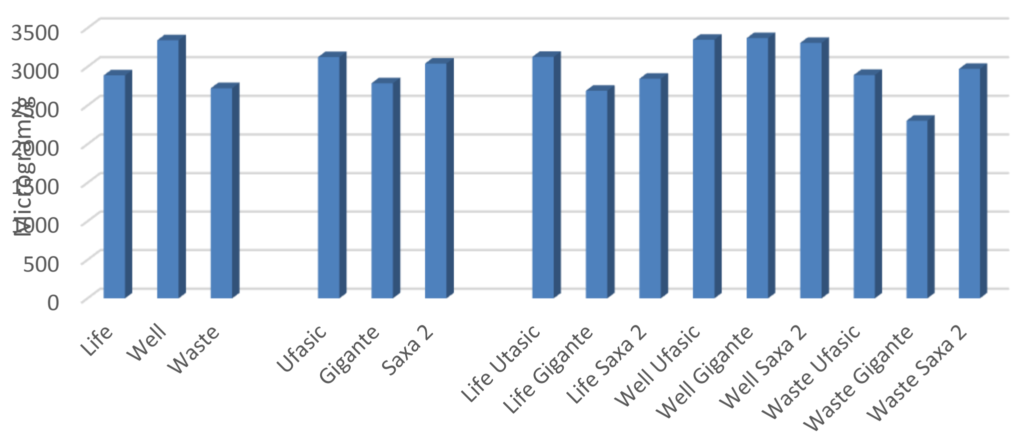


Figure (R6). Ca content of dry leaf (Microgram/g), as influenced by water types

Table (R7). Zn Content of edible tissue (µg.g-1 Ed) responses of Radish cultivars to varying water types, (*)				
Water type/ Cv	Life	Well	Waste	CV. Means
Ufasic	8.9649AB	8.8333AB	10.3856A	9.3946A
Gigante	9.4683AB	8.2309B	9.195AB	8.9647AB
Saxa 2	7.5819B	7.3208C	9.6155AB	8.1727B
Water type means	8.6717B	8.1283B	9.732A	
(*). Figures of unshared characters are significant at 0.05 level, Duncan test				

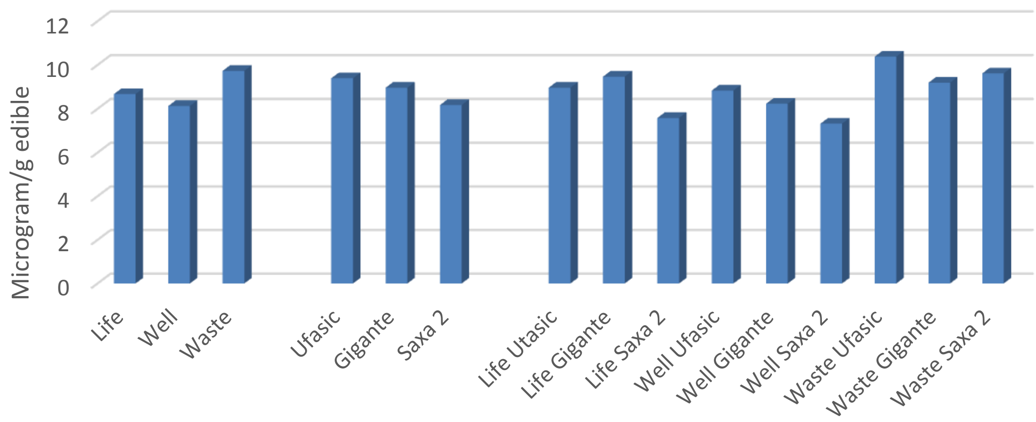


Figure (R7). Edible tissue content of Zn (microgram/g), as influenced by water types

Table (R8). Ni Content of edible tissue (µg.g-1 Ed) responses of Radish cultivars to varying water types (*)				
Water type/ Cv	Life	Well	Waste	CV. Means
Ufasic	2.2009A	2.3214A	2.0438A	2.1887A
Gigante	2.1581A	2.2164A	2.1627A	2.1791A
Saxa 2	1.7011A	1.9053A	2.3783A	1.9949A
Water type means	2.02A	2.1477A	2.195A	
(*). Figures of unshared characters are significant at 0.05 level, Duncan test				

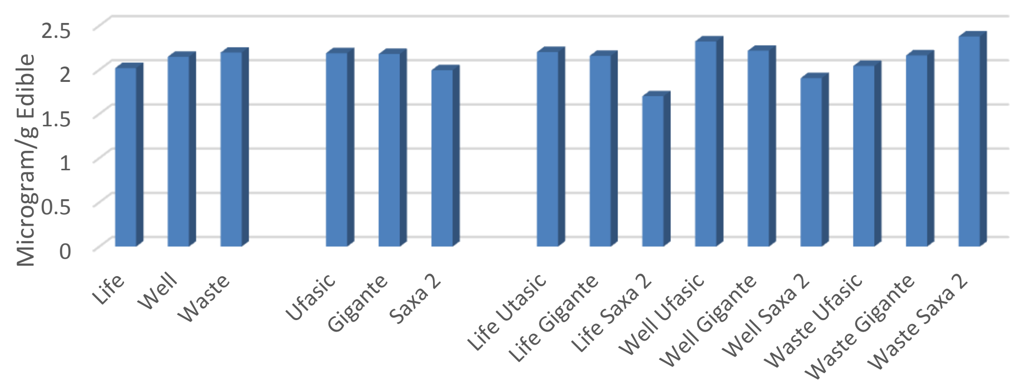
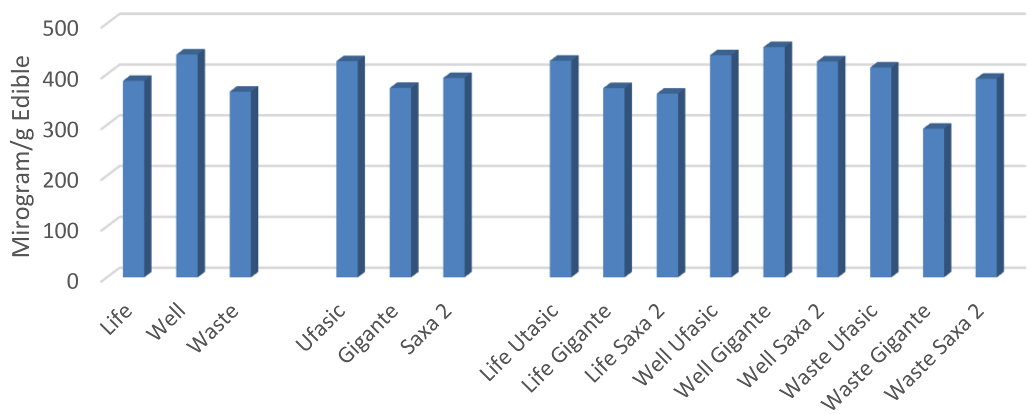


Figure (R8). Edible tissue content of Ni (microgram/g), as influenced by water types

Table (9). Ca Content of edible tissue (µg.g-1 Ed) responses of Radish cultivars to varying water types (*)				
Water type/ Cv	Life	Well	Waste	CV. Means
Ufasic	426.4AB	437.53AB	413.25AB	425.73A
Gigante	372.54ABC	453.44A	292.56C	372.85B
Saxa 2	361.64BC	424.86B	391.03AB	392.51AB
Water type means	386.86B	438.61A	365.61B	
(*). Figures of unshared characters are significant at 0.05 level, Duncan test				



Fiure (R9). Edible tissue content of Ca (microgram/g), as influenced by water types

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