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Evaluation of some Heavy metals of water *Erucasativax* Irrigated with the water of Chari Riverin Chad

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Abstract: This study aims at evaluating the percentages of some heavy metals in *Erucasativax* samples Irrigated with water of Chari River in Chad which is mixed with (untreated) wastewater in Ndjamena City, and to evaluate the health impact on consumers of those vegetables. The study handled evaluation of the percentages of five hazardous heavy metals; namely (cadmium, zinc, manganese, iron and nickel) using photometer Palintest 5000 in soil, plant and water labs in Chad Agricultural Research Institute as a result of spread of their projection sources from the site of the study, in addition to their hazard and high toxicity. Soil was reclaimed (twice) on the banks of Chari River. Area of 9 square meters (3x3 m) was used, definitely in the site of (untreated) wastewater drainage channel of Central Hospital in Ndjamena. Results of chemical analyses of heavy metals (Cadmium Cd, Zinc Zn, Manganese Mn, Iron Fe, Nickel Ni). Percentages of those heavy metals in *Erucasativax* samples irrigated with river water exceed the allowed limits according to the standards of World Health Organization, Food and Agriculture Organization, Chinese Environment Protection Agency and European Community (. The study addressed the health problems that result from use of those polluted vegetables such as high percentage of urea, hypertension, loss of conscience, emergency fever such as vomiting, muscle strain, kidney failure, lung diseases, Osteoporosis and interruption of kidney functions. The research paper ended by scientific and practical conclusions and recommendations for avoidance of those risks. Required analyses were done in accordance with the standard methods, and every experiment was repeated three times, then results were expressed in average value + standard deviation plus or minus standard deviation. XLSTAT2014 program was used to conduct the statistical analysis of results and took reliability level of those results at $P<0.05$.

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1. Introduction

Erucasativax

Erucasativax needs cold season which is affected by various climate factors. For example, it needs relatively low temperature. The best temperature for its growth ranges between 12-18 C according to type. Length of the period of light affects *Erucasativax*. If long day prevailed, plants rapidly flowers, particularly in late agriculture. This effect varies by types. *Erucasativax* is high light plant so its dense plantation or shadow plantation makes it poor in growth, and forms fragmented heads with disintegrated leaves. *Erucasativax* is planted in all types of soils. It is preferably planted in medium texture soil which is rich in organic matters with good ventilation and drainage, and ph degree between (5.5-6.6).

Erucasativax requires blarge quantity of water, because its root group is surface. It needs regular irrigation throughout its different stages of growth. Water deficiency inhibits growth and expedites its flowering and binding of water, and its color turns to dark green. In the early stages of growth, irrigation shall be reduced to support root infiltration and spread into soil. Any increase of irrigation in this phase leads to weakness and yellowish color of leaves and long stems. *Erucasativax* needs sufficient quantities of nitrogen fertilizers because it is leave crop. However, those fertilizers shall not be added in big quantities in high temperatures as this leads to formation of number of floral carriers.

Erucasativax belongs to plant kingdom and is classified as pieridae order, pieridae class, specie: *Erucasativax*

Planted *Erucasativax* is a plant of leave vegetables such as lettuce. It is periodical herb that grows in wet soil and on the sides of ducts and canals. It is eaten raw and is used in salad dishes. It is not usually cooked.

It is frequently farmed in all countries of the Arab World and North and East Africa. There are many types of it such as orchard *Erucasativa*, winter *Erucasativ*a, soar *Erucasativa*, Indian *Erucasativa*, stone *Erucasativa* and land Eruca Sativa. It must be picked before floral buds appear. It is rich in vitamins, particularly vitamin C and minerals. (1)

Nutritional value of *Erucasativa* lies in its containing of high percentages of vitamins such as vitamin A and vitamin C. It is rich in minerals such as calcium, iron, zinc and phosphor. It is rich for heart, chest, diabetes, liver and thyroid gland patients. It fosters:

- ✓ Strengthening of sexual power
- ✓ Prevents hair fall
- ✓ Prevents constipation because it is rich in fibers
- ✓ Prevents infection with malnutrition diseases
- ✓ Diuretic

Health benefits:

- ✓ Helps maintain bone health because it contains calcium.
- ✓ Helps prevent goiter because it contains iodine in moderate quantity.
- ✓ Lab scientific studies confirmed that *Erucasativa* oil and olive oil eliminate blood fats and lead to significant decrease of kidney fats and cholesterol in the body.
- ✓ Catalyzes treatment of colon diseases, indigestion and cleaning of body from toxics.
- ✓ Helps strengthen memory and enhance brain ability to understand and keep information.
- ✓ *Erucasativa* contains some important vitamins such as: Thiamine, Niacin, Vitamin B16 and others that maintain general health of the body. (2)

General benefits of *Erucasativa*

- Helps weight loss and diet systems.
- Contains nutritional elements which are necessary for pregnant and embryo health.
- Protects skin against old age.
- Regulates level of blood diabetes and cholesterol.
- Helps smokers remove the harmful effects of smoking.
- Helps growth of muscles.

2. Materials and methods

Study site:

Ndjamena is 21 km to the south of Chad Lake at meeting point of Chari River and Logon River in semi plane area at which altitude of 15° 2° east with altitude 12° 8°North. It is the political and administrative capital. Population of Ndjamena are unevenly distributed in the municipalities of the ten departments. Area of the study is concentrated in the third municipal department where the Central Hospital of Ndjamena is located. Population of this department are 47.420 persons, according to the statistic of 2009 AD.

Devices and equipment

2- Zinc Detector) 2-carboxy-2-hydroxy-5-sulformazylbenzène (zincon)

- Iron guide 1.10 phénanthroline
- Cadmium detector (acid 2, 1-dihydroantraquinone – 3- Sodium sulfonates)
- Manganese detector (citrate powder, sodium periodate detector)
- Nickel detector (phthalate-phosphate power, 0.5 ml of PAN detector solution and Ethylenediaminetetraacetic acid (EDTA detector)
- *Erucasativax* plant
- Required according to standard methods (3)
- Photometre Palintest 5000 (Palintest House Kingsway. Tyre and Wear. NE110NS.U.K)
- Sensitive electronic scale (PGWi15i.France)
- Pipette of various sizes
- Glass flasks of various capacities

Analysis of *Erucasa*tivax samples

Method of planting *Erucasativax*

Soil was ploughed twice on the banks of Chari River, mainly in the site of wastewater drainage duct of Central Hospital in quarter next to the sea in the third department. Seedlings were planted on 2 November 2019. Spray irrigation of *Erucasativax* seedlings was followed on daily basis. Area of 9 m^2 (3x3 m) for planting the seedlings.

Space of (1 meter) was left to separate the *Erucasativa*x seedlings which are irrigated with water mixed with wastewater and *Erucasativax* which are irrigated with tap water, then seedlings in lines with spacing of 30 cm from each other. Space between seedlings was 20 cm. Period of growth took 56 days and no type of fertilizers (neither natural nor chemical) was added to *Erucasativax* seedlings up to ripening.

Preparation of *Erucasativax* for analysis

Samples of *Erucasativax* were brought to soil, water and plant analysis lab in Chadi Agricultural Research Institute for Development (ITRAD/ LASEP) on 28 December 2019 in sterilized plastic bags and was washed well with tap water then they were weighed and dried on lab table in fresh air (without exposure to sunrays) till full drying. Period of drying took 15 days. After drying, samples were reweighted (dry sample weight), then it was ground well and sieved with size of (0.2 mesh) per hole

Chemical analysis methods:

Percentage of 5 heavy metals of (Cadmium, zinc, manganese, iron, nickel) was estimated using Photometre Palintest 5000

Results of heavy metals and other elements were expressed as mg/kg (dry matter).

Method of estimation of iron

50 ml of distilled water was added in volume flask 100 ml, and five tablets of (extract A) were added to it and the flask contents were shaken well up to full dissolution. 10 grams of dried *Erucasativax* powder which is sieved by sieve with standard of 0.5 cm^2 has been added to the mix for each hole of sieve. Afterwards, sample was shaken well for two minutes.

Solution was filtered and (Extract A) was taken in another flask to estimate the percentage of Fe in the sample. 1 ml of solution was taken by plastic syringe and it was put in 10 ml glass test tube and was completed with distilled water after which one tablet of iron LRS tablet was added and was moved well till full dissolution. Photometre Palintest 5000 device was adjusted at wavelength 520 nm. Control was read and values of other samples were read afterwards. Therefore, iron concentration was defined and expressed as (mg/kg).

Method of estimation of zinc:

50 ml of distilled water was spilled in volume flask 100 ml, then 5 tablets of (Extract A) was added and the flask contents were shaken well up to full dissolution. 10 gram of dried *Erucasati*vax which is sieved by sieve 0.5 cm^2 to each hole in sieve was added afterwards, and the sample was shaken well for two minutes.

Solution was filtered and (Extract A) was taken in another flask to estimate the percentage of Zn in the sample. 1 ml of solution was taken by plastic syringe and it was put in 10 ml glass test tube and was completed with distilled water after which one tablet of zinc tablet was added and was moved well till full dissolution and was left for 5 minutes. Photometre Palintest 5000 device was adjusted at wavelength 640 nm. Control was read and values of other samples were read afterwards. Therefore, zinc concentration was defined and expressed as (mg/kg).

Method of estimation of manganese:

50 ml of distilled water was spilled in volume flask 100 ml, then 5 tablets of (Extract C) was added and the flask contents were shaken well up to full dissolution. 10 gram of dried *Erucasativax* which is sieved by sieve 0.5 cm^2 to each hole in sieve was added afterwards, and the sample was shaken well for five minutes.

Solution was filtered and (Extract C) was taken in another flask to estimate the percentage of Mn in the sample. 1 ml of solution was taken by plastic syringe and it was put in 10 ml glass test tube and was completed with distilled water after which one tablet of manganese tablet was added and was moved well till full dissolution and was left for 15 minutes. Photometre Palintest 5000 device was adjusted at wavelength 520 nm. Control was read and values of other samples were read afterwards. Therefore, aluminum concentration was defined and expressed as (mg/kg).

Method of estimation of cadmium

50 ml of distilled water was spilled in volume flask 100 ml, then 5 tablets of (Extract C) was added and the flask contents were shaken well up to full dissolution. 10 gram of dried *Erucasativax* which is sieved by sieve 0.5 cm^2 to each hole in sieve was added afterwards, and the sample was shaken well for 10 minutes.

Photo indicate that the sensitive electronic scale used in weighting the dried *Eerucasativax*sample

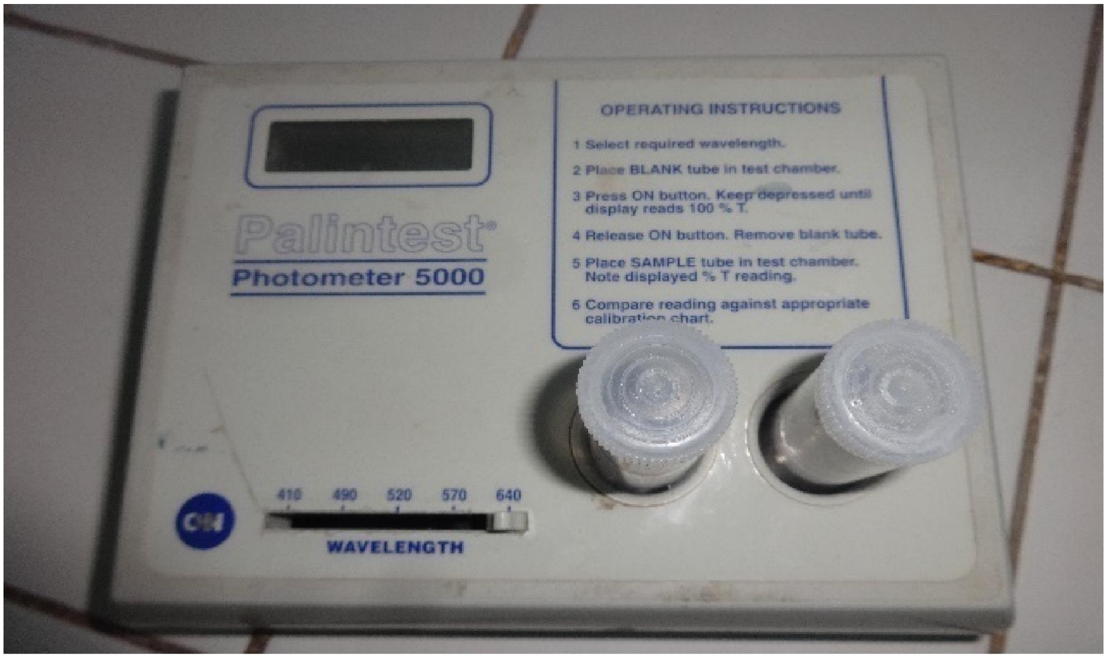


Photo indicates that Photometre Palintest 5000 device which is used for determination of the percentage of heavy metals.

Growth of *Erucasativax*30 days later

Growth of Erucasativax7 days later

Solution was filtered and (Extract C) was taken in another flask to estimate the percentage of Mn in the sample. 1 ml of solution was taken by plastic syringe and it was put in 10 ml glass test tube and was completed with distilled water after which one tablet of cadmecol N 0 1S LR tablet was added and was moved well till full dissolution. Afterwards, one tablet of cadmecol N0 2 S LR Tablet, and was left for 20 minutes. Photometre Palintest 5000 device was adjusted at wavelength 640 nm. Control was read and values of other samples were read afterwards.

Therefore, aluminum concentration was defined and expressed as (mg/kg).

Nickel (Ni)

50 ml of distilled water was spilled in volume flask 100 ml, then 5 tablets of (Extract A) was added and the flask contents were shaken well up to full dissolution. 10 gram of dried *Erucasativax* which is sieved by sieve 0.5 cm^2 to each hole in sieve was added afterwards, and the sample was shaken well for 5 minutes.

Solution was filtered and (Extract C) was taken in another flask to estimate the percentage of Ni in the sample. 1 ml of solution was taken by plastic syringe and it was put in 10 ml glass test tube and was completed with distilled water after which one tablet of Nickel Detector (phthalate- phosphate powder) was added and was moved well till full dissolution. It was left for 15 minutes and 0.5 m lf PAN detector solution 0.3% was added in the sample. Powder detector of dissolving salt Ethylenediaminetetraacetic (EDTA) acid in the sample. Photometre Palintest 5000 device was adjusted at wavelength 620 nm. Control was read and values of other samples were read afterwards. Therefore, aluminum concentration was defined and expressed as (mg/kg).

3. Results:

1- There is no treatment plant in Ndjamena for the wastewater coming from hospitals, health centers, pharmacies, industrial stores, wine factories, restaurants, markets, hotels and houses.

Wastewater are delivered from their sources in open water streams that extend along the streets of Capital Ndjamena to end in Chari River.

2- Results of chemical analysis for determination of the percentages of some heavy metals confirmed that Erucasativax samples which are irrigated with river water exceeded the allowed limits according to the standards of World Health Organization (4) and Food and Agriculture Organization (5), Chinese Environmental Protection Agency (6) and European Group (7).

3- Wastewater which is continuously delivered in Chari river caused death of the animal resources in the river and immigration of the remaining resources.

4- Change of Chari River steam for more than one century caused spread of dust islands in the river stream. No dams and reservoirs were created in Chari River Stream and its tributaries.

5- Wastewater has the property of biological accumulation in the bodies of living organisms so they cause many health problems.

Recommendations: Through the analysis results, the researcher recommends as follows:

1- To avoid consumption of vegetables which are planted on the banks of Chari River without good cleaning of them.

2- To order wine factories, hospitals and health centers to establish their wastewater treatment plants before delivery in the river.

3- Appropriate authorities shall pay attention to the coasts of Chari River and transform them to tourist facilities and natural parks.

4- Professionals of laundry on Chari River beaches shall not exercise this profession on beaches.

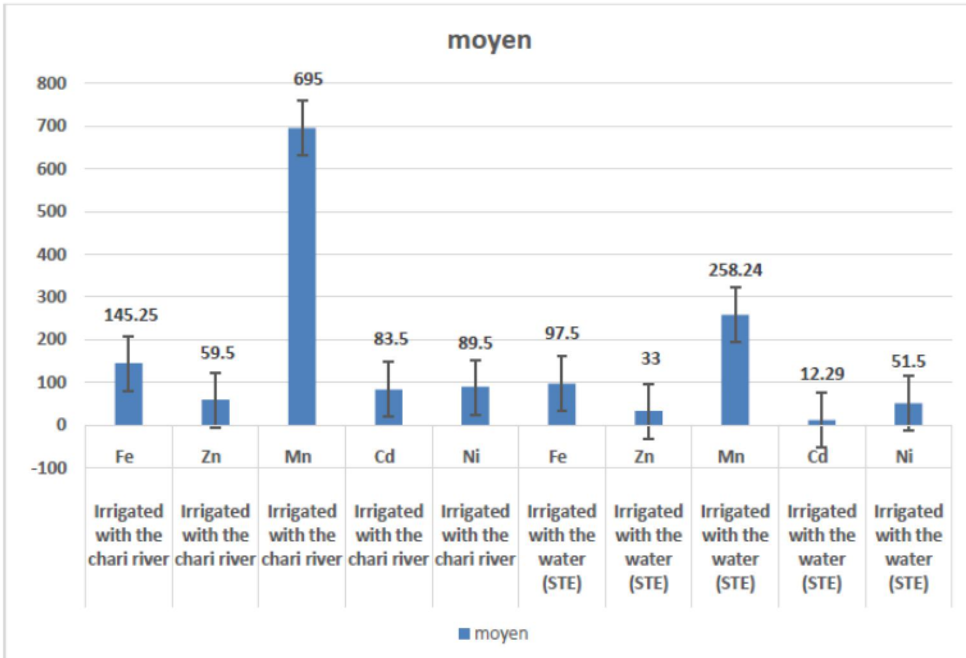
5- Ndjamena City Municipality shall repair the deteriorated water courses in the quarters of the capital and cover them.

6- Further chemical analysis of toxic heavy elements the percentages of which are not identified and some biochemical analyses of vegetables which are irrigated on river beach shall be conducted to identify the expected risk.

Results of *Erucasativax* chemical analyses, **Table (1) contains the results of percentages of some heavy metals in** *Erucasativax* leaves.

Table 1: *Erucasativax* chemical analysis

Sample	Mineral/ Ion	Average dry weight (mg/kg)
Irrigated with river water	Fe	145.25 ± 06.840
	Zn	59.5 ± 04.920
	Mn	695 ± 04.0700
	Cd	83.5 ± 04.6100
	Ni	89.5 ± 04.1900
Irrigated with tap water	Fe	97.5 ± 0.350
	Zn	33 ± 22.003
	Mn	258.24 ± 13.4101
	Cd	12.29 ± 0.5780
	Ni	51.5 ± 01.0711



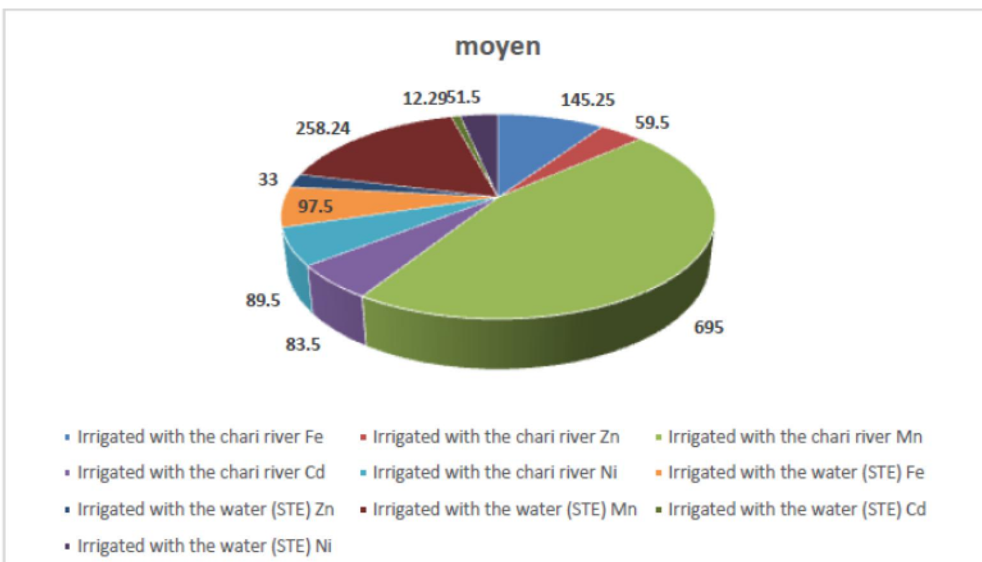


Figure (1) indicates the results of analyses of percentages of heavy metals in *Erucasativa*x samples

4. Discussion:

Iron (Fe^{2+})

Results of iron concentrations analysis demonstrated increase of the percentage of iron in *Erucasativax* samples which are irrigated with river water (145.25 mg/ kg) from those samples of *Erucasativax* which are irrigated with tap water (97.5 mg/ kg). However, there is significant approximation in the values of the percentages of iron in both cases (irrigated with river water or irrigated with tap water). This percentage doesn't exceed the maximum allowed percentage of iron in vegetables according to the standards of World Health Organization (4) and Food and Agriculture Organization (5) (275 mg/ kg). However, average percentage of iron in the two types of samples exceeds the allowed limits of the percentages of iron defined by the Chinese Environmental Protection Agency (6) for vegetable irrigation water (75 mg/ kg). This percentage of iron in *Erucasativax* plant is because of throwing the wastes of domestic utensils and containers which are made of iron after use in this site indifferently without health control, which causes many health problems to consumers of those vegetables. This study is enhanced by the results of analysis of sanitary sewerage water of the same site where the iron percentage was high.

Zinc (Zn^{2+})

Results of zinc concentrations analysis in *Erucasativax* samples according to the above table showed significantly high percentage of zinc in the *Erucasativax* sample which is irrigated with river water mixed with wastewater in tap in site (59.5 mg/ kg) from the average percentage of zinc of the *Erucasativax* samples irrigated with tap water (33 mg/ kg). It is noted that percentage of zinc in *Erucasativax* samples irrigated with river water exceeds the maximum allowed limits of zinc in vegetables in general (50-40 mg/ kg) according to the standards of World Health Organization (4) and Food and Agriculture Organization (5). This increase may be attributed to the wastes of the reference hospital in Ndjamena of high percentage of zinc. Percentage of increase of zinc in the vegetables consumed by man cause many health problems like vomiting, muscle strain and kidney failure (8).

Cadmium (Cd^{2+})

Maximum allowed limit of cadmium percentage in fresh vegetables is (30 mg/ kg) according to the standards defined by the Chinese Environmental Protection Agency (6) and (7) according to the study of (9,10). Reading of the average percentage of cadmium in the *Erucasativax* sample irrigated with river water mixed with wastewater is (83.5 mg/ kg). The average percentages of cadmium of the *Erucasativax* samples irrigated with tap water recorded (12.9 mg/ kg). All those values don't exceed the above limits which are allowed. This decrease of the average percentage of cadmium in the *Erucasativax* sample agrees with the cadmium concentrations analysis results of wastewater samples for this site where cadmium is completely nonexistent for several months. Having minor percentage of cadmium (through the food chain) causes problems of kidney, lung diseases, hypertension and Osteoporosis, in addition to interruption of liver functions, because cadmium is distinguished by the property of biological accumulation, even if in small percentages (2)

Manganese (Mn^{2+})

Results of manganese concentration analyses in *Erucasativax* samples irrigated with river water as indicated in the above table recorded very high readings (695 mg/ kg) over the average percentages of copper of *Erucasativax* samples which are irrigated with tap water (258.24 mg/ kg). We note that all those averages exceed the maximum percentage of zinc in vegetables in general according to the standards of World Health Organization (4) and Food and Agriculture Organization (5) (17-20 mg/ kg) and Chinese Environmental Protection Agency (6) and (7), according to the study of (9; 10 Rodier and Jean 1996). This high concentration of the percentages of copper in *Erucasativax* samples matches the analysis results of wastewater samples of this site. Reason for high percentage of copper in this site may be erosion of copper pipe whether the one used for drainage of hospital wastewater and the one that directly delivers to the river, or the old one that distributes drinking water. Increase of the percentage of copper in human body causes high percentage of urea, hypertension, loss of conscious and emergency fever (2).

Nickel (Ni^{2+})

Analysis results of Nickel concentrations in *Erucasativax* samples as indicated in the above table demonstrated considerably high percentage of nickel in the *Erucasativax* sample irrigated with river water mixed with wastewater in site (83.5 mg/ kg) over the average percentages of zinc for the *Erucasativax* samples irrigated with tap water (51.5 mg/ kg). Zinc percentage in *Erucasativax* samples irrigated with river water appeared to exceed the allowed maximum limits of zinc in vegetables in general (60 mg/ kg) according to the standards of World Health Organization (4) and Food and Agriculture Organization (5). This high concentration of the percentages may be attributed to drainage of wastewater of beauty centers which are abundant in that area, which contain bleaching media, hair colors, and some foods. This rise of the average percentages of nickel in the wastewater samples of those sites. This predicts health risks (hypertension, loss of conscious and kidney failure) and inevitable environmental risks because of the certain damages of nickel.

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