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IMPACTS OF DRINKING WATER SLUDGE FROM THE LUKAYA PLANT ON THE PHYSICO-CHEMICAL QUALITY OF *Amaranthus hybridus* CULTIVATED ON THE TSHILOMBO SITE, KIMUENZA VALLEY

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Abstract

A study was carried out to assess the impact of water purification sludge on the chemical parameters of Amaranthus hybridus and to assess its quality compared to those usually grown. The tests were carried out on the soils of Kimuenza (Tshilombo) amended with sludge. The vegetables sampled were analyzed firstly by X-ray fluorescence from CREN-Kinshasa for major elements and secondly by ICP-MS from the " United Scientific" laboratory in Lubumbashi for metallic trace elements. The precision and reproducibility of the results obtained were considered acceptable, since their coefficient of variation was less than 10%. The results obtained showed that:

- *Major elements (K, Ca, Mg, P and S) are higher in vegetables than in simple and amended soil while Fe, Na, Al and Si are higher in soil than vegetables.*
- *The metallic trace elements of market garden vegetables have a higher than normal concentration [Cr varies between 24.3-29.6 mg/Kg against 1.8 mg/Kg, Cd varies between 0.6-0.9 mg /Kg against 0.05/0.2 mg/Kg, Pb varies between 0.6-0.8 mg/Kg against 0.1 mg/Kg, Ni varies between 10.8-15.9 mg/Kg against 10 mg/Kg] for all the sites and Cu varies between 21.1-22.5 mg/Kg against 20 mg/Kg in the two sites as well as Zn in the Kiala site at 122.2 mg/Kg against 100 mg/Kg . Metallic trace elements were totally absent in the vegetables from the amended soil. On the other hand, Cd and Pb are present but at acceptable proportions for human consumption.*

Keywords: Impacts - Mud - Drinking water - quality - *Amaranthus hybridus* - physicochemistry

Introduction

A study carried out in the city of Kinshasa, on the Kasavubu/Saio site, showed that vegetables (*Amaranthus hybridus*) grown near roadways were contaminated with lead. The average level of lead in the soil decreases with the distance from the road in all seasons. It varies from 2.5 to 0.1 mg/kg and in vegetables, the average level of lead decreases when the distance increases. It varies from 1.65 to 0.00 mg/kg, a content higher than the standards. . The useful area for a safe culture is estimated at 50m from the road with intense motorized frequency [1a-1b].
The City of Kinshasa had 6,062,000 inhabitants in 2000. Currently it is estimated at 16,315,534 inhabitants in 2023, an increase of 4.4% compared to last year [2-3]. Faced with the strong increase in the world's population, in general, and urban, in particular, feeding cities is a major problem [4]. This increase in the urban population concerns both capitals and secondary cities [5]. The consumption of leafy vegetables is about 155,500 tons per year and with an annual increase of 3 to 5% per year in the city of Kinshasa [6].

With overpopulation and poverty in the city of Kinshasa is due to the rural exodus, to repeated wars. This situation leads to a subdivision in non-urbanized areas. This poor urbanization policy leads to the lack of adequate housing, the lack of secure food, the lack of drinking water, the lack of market gardening space and the lack of green space.

Currently, agriculture, in general, and market gardening, in particular, have to face many challenges to which must be added the increase in supply and demand for agricultural products, food safety, which imposes quality nutrition and respect for the environment [7]. Agriculture is one of the main sectors that contributes to socio-economic development. It employs 40% of the working population in the world, 52% in Africa and Asia [8].

Market gardening is an activity of food sovereignty, fight against poverty and increases family incomes [9-10].

In developing countries, regulations on agricultural techniques, sanitary qualities, healthy market gardening areas are either non-existent or are not accompanied by effective control of practices, areas, improved inputs, phytosanitary products and fertilisers. Market gardening is based on the excessive use of agricultural and market gardening fertilizers or mineral and organic chemical fertilizers, waste water, with harmful consequences for human health and the environment [11-12].

These cultures are, sometimes, on places not indicated. Pollutants from motorized traffic, chemical fertilizers and pesticides can occur. Regardless of road traffic, contaminants from chemical fertilizers, uncertified pesticides and nature are absorbed by vegetation and then end up in the food chain [13].

Although market gardening occupies an important place for food in Africa, in general, and in the Democratic Republic of Congo, in particular, their production is confronted with pressure from bio-aggressors which limits their productivity and pushes them to decline. use of pesticides and phytosanitary products [14].

The uncontrolled use of fertilizers and pesticides has significant effects on the quality of market garden crops and leads to contamination of trace metals such as lead, cadmium and zinc. The excess of nutrients such as magnesium, calcium and others in vegetable crops thus have consequences on human health [15].

These cultural practices are far from guaranteeing the sanitary quality of the vegetables produced. Mineral and organic super-fertilization and overexploitation of soils make it difficult to assess soil reserves, volume of organic matter [16].

Regideso-Kinshasa, through its drinking water production plants, generates huge quantities of sludge. This sludge is directly discharged into waterways without any treatment. They modify the physico-chemical parameters and the aquatic ecosystem, because the sludge discharged into the natural environment can generate waterborne diseases and modify treatment parameters. The droppings discharged into the Lukaya River significantly modify the organoleptic and physico-chemical composition of raw water and become intractable with usual inputs for human consumption [17-18].

This study aims to:

- Analyze the physico-chemical parameters of *Amaranthus hybridus* grown on two different media;
- Compare the quality of *Amaranthus hybridus* from suburban market gardening with that of the same vegetable grown on soil amended with drinking water sludge
- Evaluate the impact of water purification sludge on the chemical parameters of *Amaranthus hybridus*.

1. Medium and Methods

1.1. Study environment

This research was carried out on five market gardening sites in the Kimuenza valley, commune of Mont Ngafula, city of Kinshasa. These sites are:

- Lake Mavallée site,
- Kiala rubble quarry site,
- Regideso raw water catchment site,
- Tshilombo site
- Mafunfu website.

These sites were chosen according to the quantity of vegetables, the surfaces exploited and the rotation of crops. The vegetables grown are: Amaranth (*Amaranthus hybridus*), Spinach (*Basella alba*), Sweet potato (*Ipomoea batatas*) and sorrel (*Hibiscus acetocella*).

Only *Amaranthus hybridus* has been studied. The market garden soil was also studied.

The Tshilombo site was chosen for experimenting with drinking water sludge in the ground. Retained by Regideso to erect the raw water catchment, it is connected to three rivers including Lukaya, Bomuna and Miwana. There is also the recreational site, a site also for the sale of poultry droppings. Water from the Bomuna River is used to water vegetables and poultry droppings to improve the soil. In addition to this, there is also the use of pesticides to destroy insects and fungicides. This site contains very long flowerbeds 20 m long and 15 m wide, so at least 300 m^2 in area.

1.2.Sampling

The geographical data collected on the sites made it possible to establish the sampling map below:

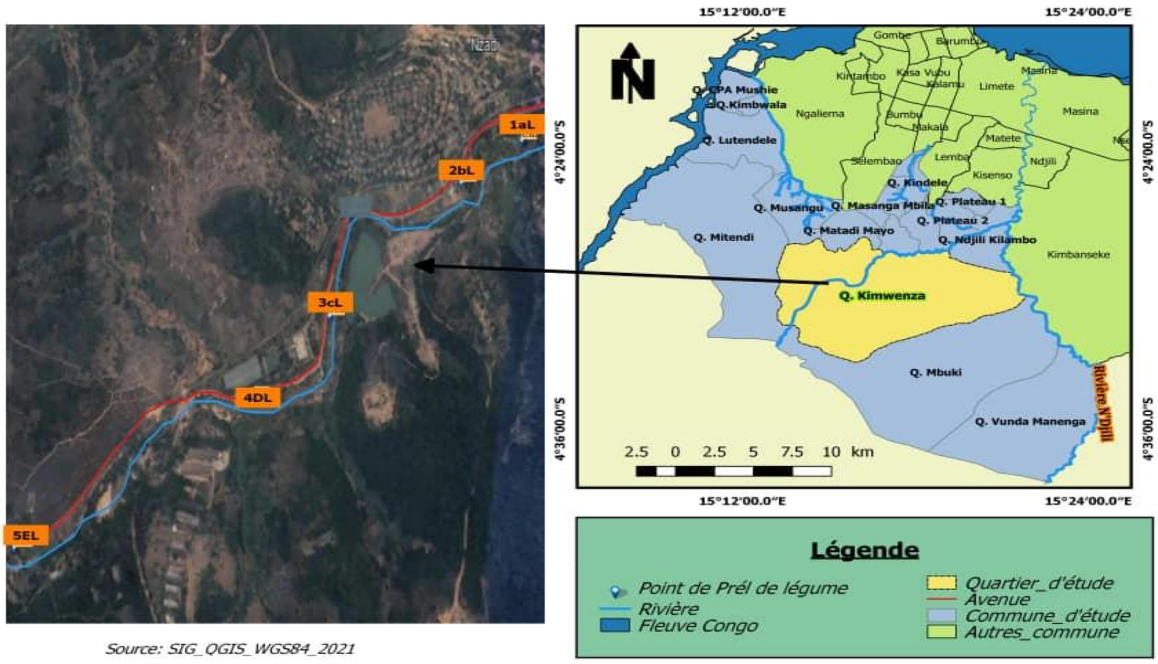


Figure 1: Vegetable sampling map

Five samples of *Amaranthus hybridus* at maturity and 7 days after spraying fertilizers and pesticides from five sites of market gardening soil and three samples *of Amaranthus hybridus* from market gardening soil amended respectively with Lukaya drinking water sludge, droppings poultry and NPK were sampled. These samples were packaged in bags and transported directly to the Soil and Water Laboratory of the Faculty of Agronomy for sample preparation and analysis of the physico-chemical parameters and agronomic values before transmitting them to the CREN-K Chemistry Laboratory in the University of Kinshasa and at the "United Scientific" Laboratory in Lubumbashi .

1.3.Analysis methods

The dosage of phosphorus in the samples of *Amaranthus hybridus* was carried out by Bray's method which consists in complexifying ammonium fluoride with phosphorus. The latter is assayed by a Hach UV-visible spectrophotometer with molybdenum blue.

The dosage of total nitrogen was carried out by Kjeldahl method.

The exchangeable cation content was determined according to standard NF X31-161 [19]. 5 g of *Amaranthus hybridus* from market garden soil, 5 g from soil amended with sludge, 5 g from soil amended with droppings and 5 g from soil amended with NPK are successively subjected to a suspension of 1 mol/L ammonium acetate adjusted the pH=7 using acetic acid at mol/L and ammonia at 1 mol/L. The mixture is stirred for 1 hour (1 KA Labor technik KS 501-digital model orbital magnetic stirrer -150 revolutions/min), centrifuged for 14 min at 3000 –

Bioblockscientific and sigma 2-15 type, then filtered at 0.45 µm. the dosage is carried out by a HACH visible UV spectrophotometer based on the Beer–Lambert law, the wavelength of each element of which is associated with its capsule (buffer).

Saturation and major elements were obtained by CREN-K X-ray fluorescence. Each *Amaranthus hybridus* and soil sample was heated to 105°C, cooled and crushed and sieved with a 2mm sieve. 4 g of the sample and associated with 1 g of CEREOX then formed the pellets using a pelletizer. The pellets obtained are analyzed by X-ray fluorescence and carried out on each face of the pellet to obtain the chemical composition of each pellet and the different proportions and the results are expressed in %.

The determination of metallic trace elements was carried out by mass spectrometry with induced coupling plasma (ICP-MS) of the ACRO brand. The results are expressed in mg/Kg. The amended soil samples were taken by solution treatment at the “United Scientific” Laboratory in Lubumbashi. The samples were weighed and dried in an oven at a temperature of 60° C. until a constant weight was obtained. After drying, the samples were weighed, ground and sieved separately at 2 mm. Half a gram (0.5g) of each sample was dissolved by mixing 6 mL of hydrogen peroxide (H_2O_2) and 6 mL of nitric acid (HNO_3) in a DigiPREP at a temperature of 95°C for a duration of 3 hours. And then assay with ICP-MS.

All the results obtained were subjected to statistical methods including the Dixon test, the coefficient of variation and Student's T to identify either the differences or a comparison.

2. Results

2.1. Major elements in *Amaranthus hybridus* of market garden soil

The major elements present in *Amaranthus hybridus* from market garden soil are listed in Table 1 a and b below:

Table 1: Major elements in *Amaranthus hybridus* in market garden soil

	Ca	Mg	K	Fe	Al

Site (s	Measure	CV %	Measure	CV%	Measure	CV%	Measure	CV%	Measure	CV%
Mavallee	5.056±0.11	2,181	2.199±0.023	1,062	6.3755±0.00315	0.0495	0.181±0.0157	8,674	0.235±0.0243	10,358
Kiala	8.0018±0.345	4,323	2.547±0.2121	8.33	6.261±0.104	1,663	0.256±0.079	30,867	0.375±0.0365	9.72
Cape Regideso	4.7303±0.145	3,072	2.233±0.16	7.205	9.549±0.237	2.49	0.443±0.259	58,546	0.328±0.024	7,423
Tshilombo	3.859±0.131	3,407	2.782±0.188	6,763	5.9072±0.0877	1,486	0.504±0.0133	2.65	0.285±0.0648	22,733
Mafunfu	3.859±0.131	3,407	2.441±0.252	10,337	5.907±0.0877	1,486	0.504±0.0133	2.65	0.299±0.0253	8,463

This table shows that calcium is very high on the Kiala site following the presence of the rubble stone quarry and low at the Regideso catchment. Potassium is very high at the Regideso catchment site following the discharge of water purification sludge upstream of it and low at Mafunfu and Tshilombo. There is a low amount of iron and aluminum in A *maranthus hybridus* from each site**.** The coefficient of variation is less than 10% for the majority of analysis.

Table 1b: Other major elements in A *maranthus hybridus* in market garden soil

Site	Whether		S		P	
	Measure	**CV%**	**Measure**	**CV%**	**Measure**	**CV %**
Mavallee	2.998±0.276	9.22	1.728±0.072	4,168	2.191±0	0
Kiala	3.871±0.166	4,307	1.421±0.0785	5,522	2.648±0.15	5,684
Cape Regideso	2.192±0.113	5,178	1.5±0.412	27,512	2.28±^{2}0.055	2,418
Tshilombo	1.1075±0.0031	0.285	1.1025±0.00947	0.859	2.105±0.0356	1,695
Mafunfu	1.277±0.12848	10,061	0.989±0.0126	1,276	2.509±0.0726	2,896

This table indicates that sulfur is high at the Mavallée site and low at Mafunfu. Phosphorus is high at the Kiala site and low at the Tshilombo site.

2.2. **Metallic trace elements in *Amaranthus hybridus* in market garden soil**

The metallic trace elements present in *Amaranthus hybridus* in market garden soil are presented in Table 2 below:

Table 2 : **Metallic trace elements in *Amaranthus hybridus* in market garden soil**

Site	**Mn**		**Cr**		**Ni**		**Cu**		**Zn**		**As**		**Rb**		**Mo**		**Cd**		**Pb**	
	Measure	**CV %**	**Measure**	**CV %**	**Measure**	**CV %**	**Measure**	**CV %**	**Measure**	**CV %**	**Measure**	**CV %**	**Measure**	**CV%**	**Measure**	**CV %**	**Measure**	**CV%**	**Measure**	**CV%**
Mavallee	143.433±0.487	0.34	24.3±0.718	2,954	12.9±0.631	4,896	16.7±1.777	10,643	11.3±0.63	5,581	0.1±4.1	4.1	55.2± 2,336	4,231	5.7±0.584	10.24	0.7± 0.389	55.6	0.8±0.00	0.0
Kiala	106±0.00	0	29.6±1.752	5,918	15.9±1.557	9.79	22.7±0.00	0	121.233±0.908	0.749	0.5±0	0	65.15±0.3157	0.4845	6±0.584	9,733	0.9±0	0.00	0.9±0	0
Cape Regideso	98±1.9466	1,986	28.6±1.557	5,445	19.8±1.362	6,882	21.1±0.778	3.69	99.4±0.584	0.587	0.4±0	0	68.4±1.946	2.846003899	5.8±0.584	10,068	0.8±0.194	24.33	0.6±0.194	32,444
Tshilombo	88±5.84	6,636	25.4±0.973	3,832	12.6±1.752	13,904	17.7±0.584	3,299	68.9±1.557	2.26	0.4±0.1946	48,666	66.7±1.168	1.7511	4.2±13.904	0.584	0.7±0.00	0	0.6±0.194	32,444
Mafunfu	85±2.29	2.92	27.6±10.579	2.92	12.4±0.00	6,314	16.8±0.00	6,314	66.7±0.00	6,314	0.4±48.66	2.92	82.6±1.414	2.92	4.8±4.055	2.92	0.8±24.33	2.92	0.8±24.444	2.92
FAO /WHO			1.82														0.05		0.1	
SEPA			0.5																0.1	
EEC / CSPHF					10		20		200								0.2			

Vegetables from the Kimuenza market gardens contain metallic trace elements (ETM) such as Cr, Cd, Pb, and Ni at very high concentrations in all the sites under study and Cu and Zn in a single site, compared to standards required for human consumption.

- The concentration of Cr in Amaranthus *hybridus* varies between 24.3 and 29.6 mg/Kg in all market garden sites. Higher values compared to FAO/WHO (1.82 mg/Kg) and SEPA (0.5 mg/Kg) standards.
- The concentration of Cd in Amaranthus *hybridus* varies between 0.6 and 0.9 mg/Kg in all market garden sites. Values higher than FAO/WHO (0.05 mg/Kg), CSHPF and EEC (0.2 mg/Kg) standards. Values almost identical to those recommended for public landfill (0.7 mg/Kg).

- Pb values in Amaranthus hybridus vary between 0.6 and 0.8 mg/Kg in all market garden sites. These values are higher than the limit values set by the WHO (0.1 mg/Kg), but lower than the limit values as provided for by SEPA.
- Copper values in Amaranthus *hybridus* vary between 16.7 and 22.5 mg/Kg in all sites, but Kiala site values (22.4 mg/Kg,) Regideso catchment (21.1 mg/Kg) , are higher than the EEC standards (20 mg/Kg) for edible leafy vegetables.
- Higher zinc values in *Amaranthus hybridus on the Kiala site (122.2 mg/Kg).* These values exceed those provided for by the EEC standards (100 mg/Kg).
- Nickel values in Amaranthus *hybridus* higher in all vegetable sites (10.8 mg/Kg to 15.9 mg/Kg) compared to EEC standards (10 mg/Kg) for human consumption.

2.3. **Comparative study between the metallic trace elements of *the Amaranthus hybridus* of the market garden soil and those of the market garden soil in Tshilombo**

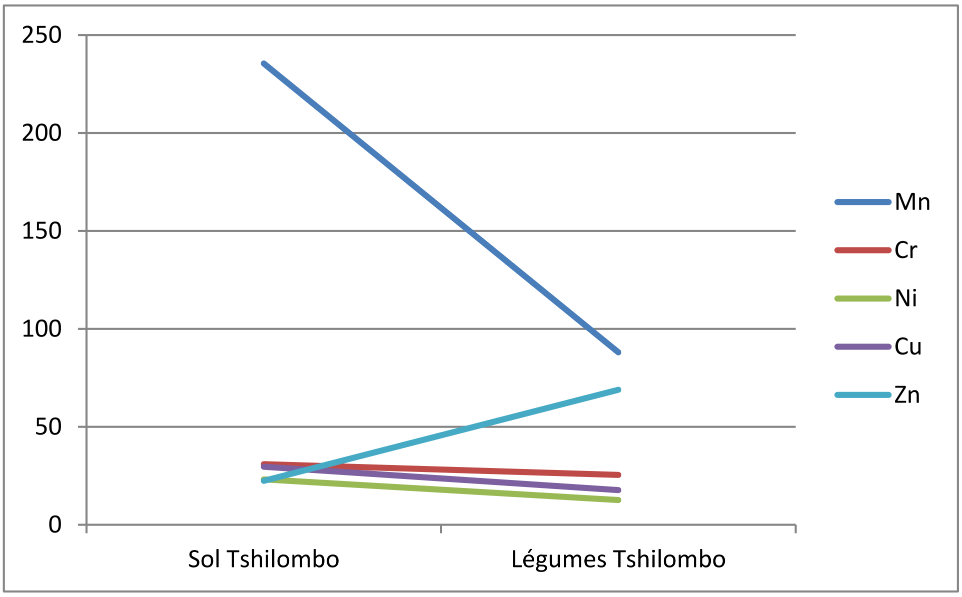
The difference between metallic trace elements present in the soil and vegetables are presented in Table 3 below:

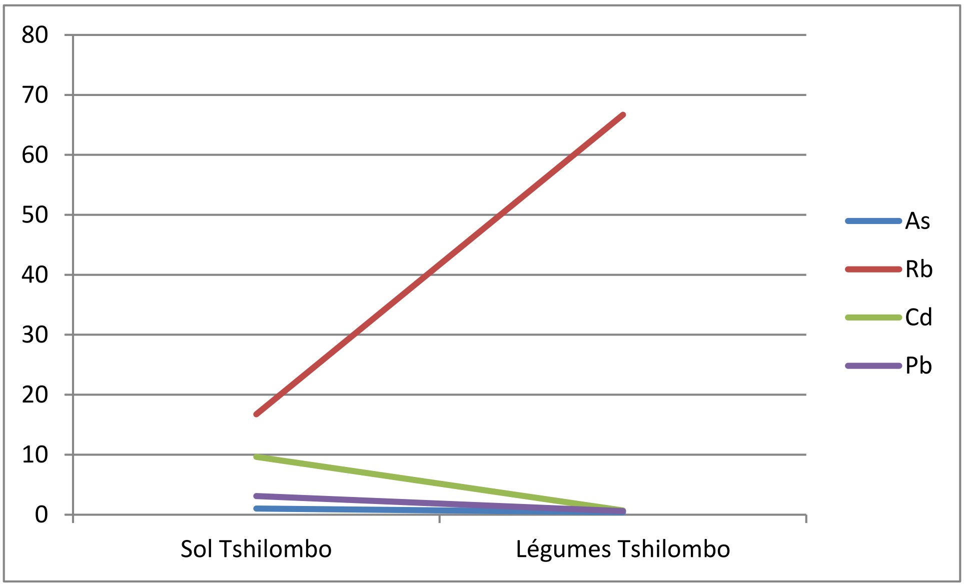
Table 3: Difference between metallic trace elements in the soil and market garden vegetables of Kimuenza.

	Mn		Cr		Ni		Cu		Zn		As		Rb		Cd		Pb	
	Measure	**CV%**	**Measure**	**CV%**	**Measure**	**CV%**	**Measure**	**CV%**	**Measure**	**CV%**	**Measure**	**CV%**	**Measure**	**CV%**	**Measure**	**CV%**	**Measure**	**CV%**
Sol Tshilombo	235.466±8.630	3,665	30.933±1.103	3,566	23.166±1.232	5,321	29.6±1.946	6,576	22.4±1.946	8.69	1.01±0.00	0	16.733±**2.400**	14,347	9.633±0.908	9.43	3.1±0.194	6,279
Vegetables Tshilombo	88±5.84	6.636363636	25.4±0.973	3,832	12.6±1.752	13.90476	17.7±0.584	3,299	68.9±1.557	2.2602806	0.4±0.194	48.666667	66.7±1.168	1.75112444	0.7±0.00	0	0.6±0.194	32,444

Table 3 shows the difference between the ETMs in the soil and market garden vegetables, graphs 1 and 2 give the appearance of this difference:

Graph 1 and 2: Difference in ETM between soil and vegetables



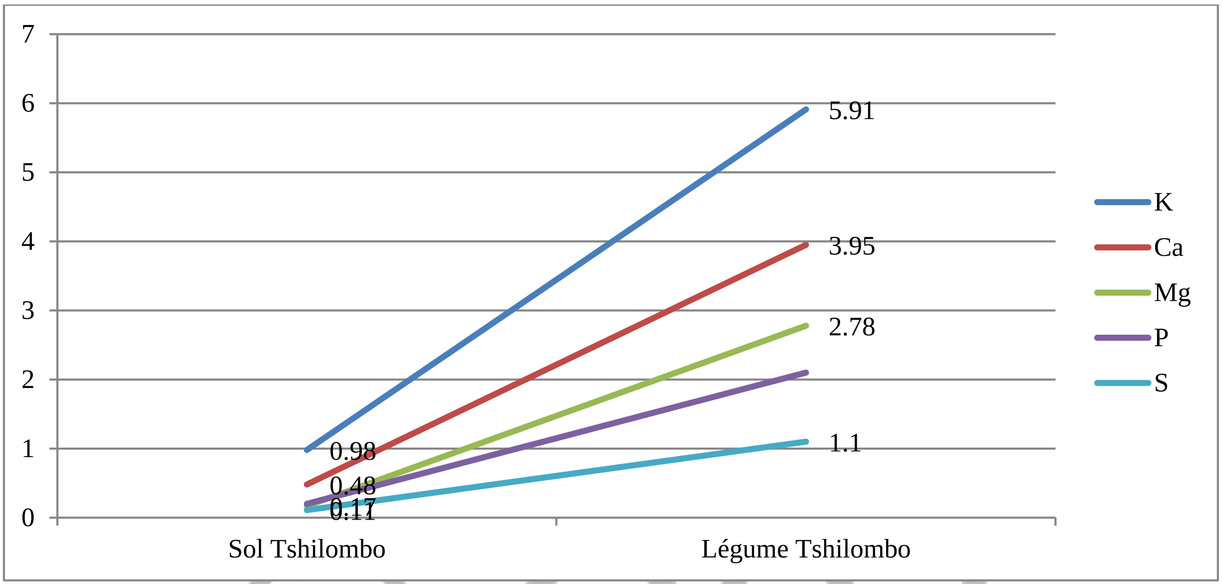


Graph 1 shows that Mn, Cr, Cu, As, Cd, and Pb have a higher concentration in soil compared to those present in Amaranthus hybridus *and* that of Zn is higher in *Amaranthus hybridus* compared to on the market garden. Graph 2 shows the concentrations of Cd, As and Pb have decreased compared to those of the ground except for Rb.

2.4. Comparative study between the major elements of vegetables and market garden soil

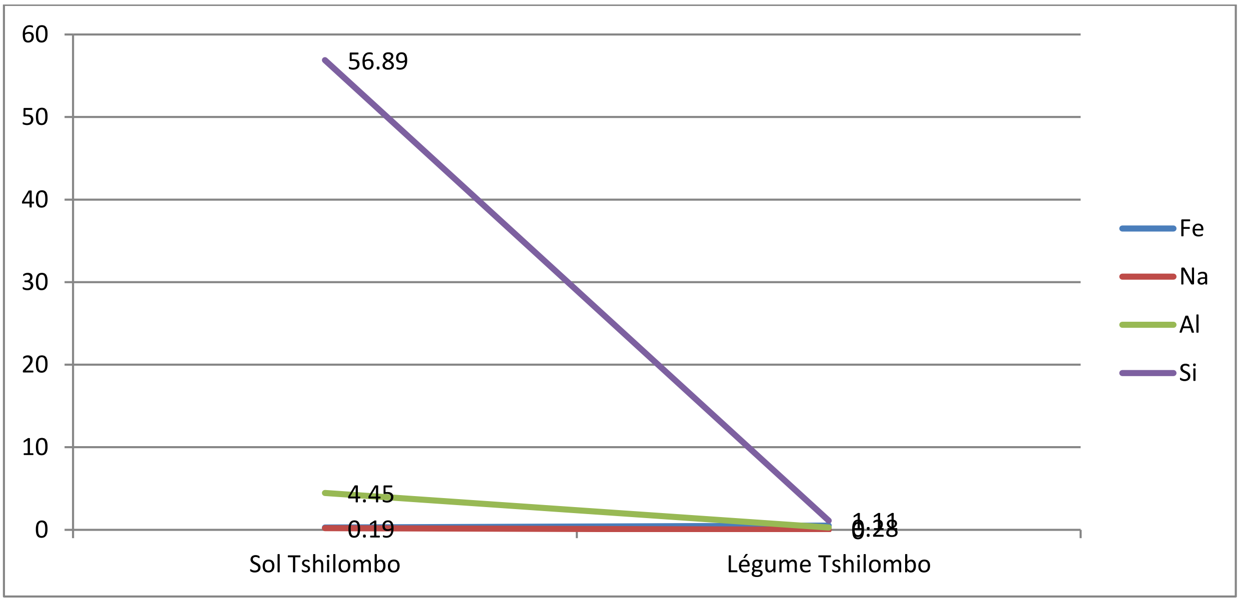
The difference between the major elements in *Amaranthus hybridus* and market garden soil is demonstrated by graphs 3 and 4 below:

Graph 3: Difference between major elements in soil and in *Amaranthus hybridus*



Graph 3 shows that the concentrations of major elements (K, Ca, Mg, P and S) are low in market garden soils and higher in *Amaranthus hybridus.*

Graph 4: Difference between other major elements in soil and in *Amaranthus hybridus*



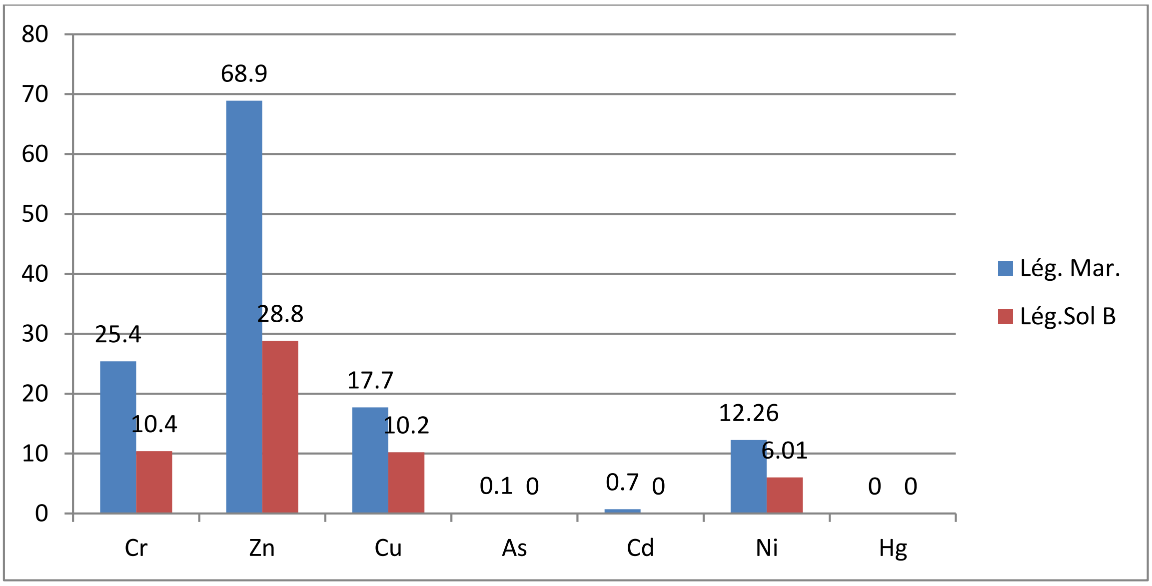
Graph 4 shows that the concentrations of major elements (Fe, Na, Al and Si) are low in Amaranthus *hybridus* and higher in market garden soils.

2.5 Impact of sludge on the chemical quality of *Amaranthus hybridus*

2.5.1. Impact of water purification sludge on metallic trace elements of *Amaranthus hybridus*

	Cr	Zn	Cu	As	Cd	Ni	Hg
Leg. Mar.	25.4 ±0.97	68.9 ±1.557	17.7 ±	0.1 ±4.1	0.7 ±	12.26 ±1.75	< 1.0
Ground Leg B	10.4 ±0.88	28.8 ±1.48	10.2 ±	0.0 ±0.0	0.0 ±0.0	6.01 ±1.45	0.0

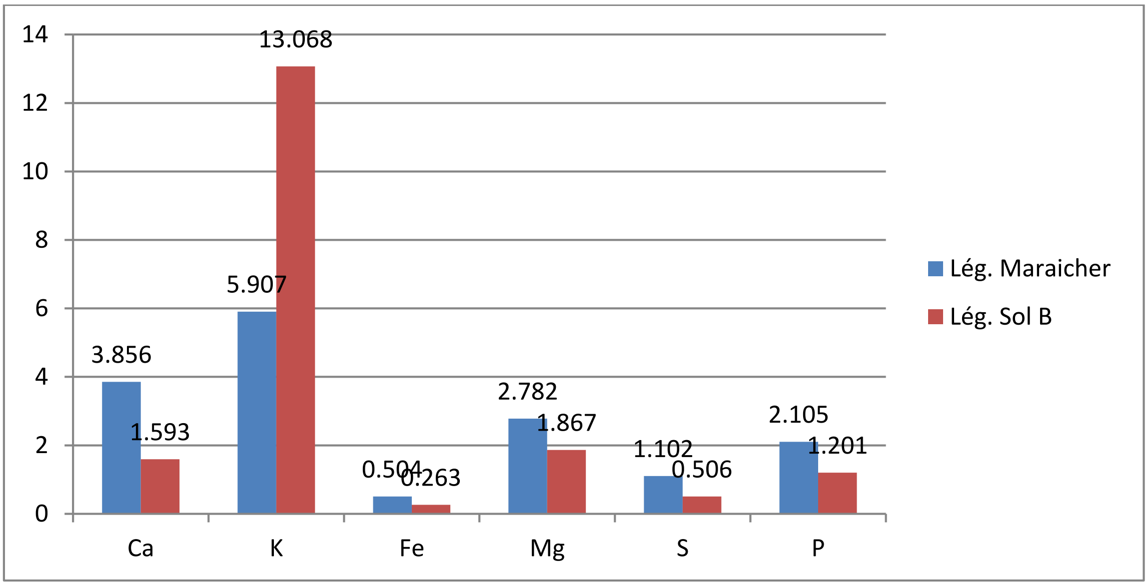
Graph 5: Impact of drinking water sludge on metallic trace elements of *Amaranthus hybridus*



This graph shows that sludge has an effect on metallic trace elements in Amaranthus *hybridus*, because there are more TE in *Amaranthus hybridus* from market garden soil than those from soil amended with sludge from drinking water.

2.5.3. Difference Between Major Elements of *Amaranthus hybridus* of Vegetable Soil and Amended Soil

	Ca	K	Fe	Mg	S	P
Leg. market gardener	3,856	5.907	0.504	2,782	1,102	2.105
Leg. Floor B	1,593	13,068	0.263	1,867	0.506	1,201



There is an excess of calcium in market garden vegetables and a good proportion in vegetables from soil amended with standard sludge (0.5 to 3.5%). Similarly, potassium is high in both cases compared to the standards (0.1 to 3%) but the vegetables from sludge have a high concentration compared to that from market garden soil. Magnesium is very high in leafy vegetables from market garden soil than those from sludge-amended soil. Sulfur and phosphorus are higher in vegetables from garden soil and lower in those from sludge-amended soil.

Discussion of results

The Dixon test was carried out, the results obtained showed that the values obtained were not aberrant. The coefficient of variation was less than 10% for the majority of all analyses. This indicates that the test results and devices are accurate.

The major elements useful for the plant are present at more or less acceptable concentrations depending on the case. Vegetables from market garden soil at all study sites have a lower potassium concentration compared to vegetables from soil amended with water purification sludge. But in any case potassium is far higher in leafy greens than soil. Potassium is very mobile in the plant and plays a big role in water management in the soil, it is in the form of K^{+} ^{ions} in the soil, in the exchangeable fraction and absorbed on the negatively charged surface of the complex clay-humus. It varies between 5.9 to 9.5% in market garden sites and 13.% in vegetables soil amended with sludge. These concentrations are very high compared to the required standards [0.1 to 3%][20]. An excess is observed in the vegetables under study. Market garden soil is depleted in potassium due to overexploitation and intense crop demand.

Overexploitation of soils leads to difficulty in evaluating soil reserves, volume of organic matter [16].

- In vegetables from peri-urban market gardening perimeters, calcium is very high in Kiala, in the rubble stone exploitation site (8.96%) which stores dust from it and the low rate is located in the Tshilombo site. (3.8584%). Calcium in vegetables is higher than that in vegetable soils. In vegetables from sludge-amended soils (have a lower calcium concentration (1.593%) compared to those from Tshilombo market garden soil (3.856%). But the calcium level of amended soils remains low compared to market garden soils Calcium is higher in leafy vegetables than in soil because the calcium acts in the roots as Ca^{+2} and absorbs it as needed during the transpiration process and carries it back to the plant for growth. This is why there is more calcium in the leaves than in the soil. The standard in leafy vegetables required varies between 0.5 to 3.5%, but the calcium obtained varies is greater than 3.8% in vegetables. of market garden soil and 1.5% in vegetables amended with bous A discrepancy emerges around the calcium of vegetables from market garden soil having higher than normal concentrations Consumers are at risk of hypercalcemia.

- The concentration of magnesium in vegetables from market garden soil and low in those from soil amended with water purification sludge. But in both cases, it remains higher compared to the respective soils. Magnesium decreases with the absorption of potassium. When potassium increases, magnesium decreases. To properly interpret the results, it is necessary to use the K/Mg ratio. THE
- The vegetables of all the sites of the market garden perimeters are less concentrated in iron than the market garden soils. Its concentrations vary between 0.1542% (Mafunfu site) and 0.5065% (Tshilombo site). The same goes for sludge-amended soil vegetables. Iron is low in leafy greens compared to vegetables because it acts
- Regarding sulfur, their concentrations in leafy vegetables are very high compared to market garden soil and amended soil. Leafy vegetables from market garden soil have a higher sulfur concentration (01.102%) than those from soil amended with water purification sludge (0.506%). In vegetables from market garden sites sulfur varies from 0.9 to 1.17%, an excess is observed compared to the standards (0.1 to 0.5%) as defined by [21] **.** While vegetables from amended soil have a concentration within the standards (0.5%).

- Phosphorus in vegetables from market garden sites has values ranging from 2.1 to 2.6%, beyond the required standards (0.05 to 1%) and those from amended soil have concentrations within the required limit [21]
- Silicon is more concentrated in soil than in vegetables. An excess is observed at the Kiala site with a rate of 3.8%. But the other sites and the vegetables of soil amended with sludge have a rate conforming to the standards (0.2 to 3.5%).
- The aluminum content present in the water purification sludge (18.55%), high concentration but does not affect the quality of leafy vegetables because its pH and that of the soil being higher than 5.5, keeping it at state of aluminum hydroxide precipitate, which cannot migrate from the soil to the plant. Its rate remains low in leafy vegetables.
- In vegetables from market gardens, TMs are present but the concentrations of Cr, Cd, Pb, Cu, Zn and Ni are above the norm for human consumption. These results confirm those of Ngweme et al. In the Riflart and Cecomaf sites where the leafy vegetables had concentrations of Cr, As, Cd, Pb and Hg exceeding the FAO/WHO health limits. Excess and their cumulative effect can cause non-communicable diseases that impoverish the population. But the vegetables from soil amended with sludge have TMEs at significantly reduced concentrations following my presence of sludge as a chemical amendment. Therefore drinking water sludge has a positive effect on the reduction of ETM in the soil and in leafy vegetables. This situation is due to the increase in pH which reduces their mobility and their availability and the presence of calcium and iron which decreases their toxicity.

Conclusion

A study was carried out in order to evaluate, on the one hand, the physico-chemical quality of *Amaranthus hybridus* of the peri-urban market gardening perimeters of Kimuenza and, on the other hand, to evaluate the impact of sludge from water purification on the physico-chemical quality of *Amaranthus hybridus* .

The results obtained showed that the *Amaranthus hybridus* of the peri-urban market gardening perimeters of Kimuenza is contaminated by Cd, Cr, Pb, Cu, Zn and Ni following overexploitation and over-fertilization of the soil. The application of water purification sludge to peri-urban market garden soil has contributed to the reduction of metallic trace elements down to leaf vegetable consumption standards. A significant reduction was observed in metallic trace elements in Amaranthus hybridus from soil amended with water purification sludge from Lukaya where the concentrations dropped respectively for [(Cr: 24.4 to 10.2 mg/Kg); (Cd: 0.7 to 0.0 mg/Kg); (Zn: 68.9 to 28.8 mg/Kg); (Cu: 17.7 to 10.2 mg/Kg); (As: 0.1 to 0.0 mg/Kg); and (Ni: 12.26 to 6.01)].

This is why we recommend the use of water purification sludge as a chemical fertilizer and the consumption of leafy vegetables from the Kimuenza Valley must be reduced and controlled.

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