

# Analysis Of Some Heavy Metals Present in Spinacia Oleracea (Spinach) From Different Planting Sites of Makurdi and Vandeikya Towns of Benue State.

IORNUMBE FESTUS MSUEGA<sup>1</sup>, ABAH MOSES<sup>2</sup>, MAGASHI NICHOLAS LUPER<sup>3</sup>

<sup>1,2,3</sup>*Department Of Science Laboratory Technology, Federal Polytechnic, Wannune, Benue State, Nigeria.*

**Abstract-** *The consumption of contaminated vegetables may cause health hazard to both human beings and animals. As a result of this, it has become necessary to evaluate some heavy metals contained in spinacia oleracea (spinach) leaves found in some selected areas of Benue state. This study investigate the level of four different heavy metals that are significant but their higher concentrations considered toxic: such metals are zinc (Zn), Chromium (Cr), Copper (Cu) and cadmium (Cd). The area covered in this research work include Wurukum-Makurdi, Gbem, and Aya-Vandeikya irrigation sites. The spinach leaves obtained in these sites was purified, dried and analyzed using atomic absorption spectrophotometer (A.A.S).*

## I. INTRODUCTION

The issue of environmental hazard (pollution) is constantly becoming a serious health problem in most metropolitan cities ( Muhammad Saleh et al., 2019). The use of water from non-conventional sources like polluted water of industrial and household discharge is a common practice in most African countries that are facing problem of water shortage (Al-Ansari et al., 2013). Heavy metals like zinc, lead and chromium are essential environmental contaminants, especially in areas where vegetables are irrigated with waste water. Treatment of vegetable crops with waste water caused increased uptake of heavy metals such as Ni, Mn, Cr, Fe, Pb, Cu and Cd, etc in spinach and other vegetable crops (Gupta, 2008). The consumption of contaminated vegetables such as spinacia oleracea (spinach) by human beings and animals has been reported to place a danger threat on health. Although some heavy metals such as iron, cadmium, and magnesium are essential in plant nutrition, many of them do not play any important role in plant physiology. The uptake of these heavy metals especially in human food chain is achieved through these foliage or leafy vegetables

and these have been found to have harmful effects on health (Jarup, 2003).

Heavy metals which are harmful to humans include arsenic, cadmium, chromium, copper, mercury, lead, zinc, iron, nickel, cobalt, etc. These are found naturally in small amounts and in industrial waste water due to different chemical processes such as filtration, precipitation and ion exchange etc. They are normally found in limited amounts or above the permissible limit which causes little problem (Halnor, 2015).

Many water sources such as streams, rivers and lakes contain wastes like heavy metals, sewage, decaying animals, fertilizers industrial pollutants, etc. These have been proven to be harmful to the aquatic ecosystem (Halnor, 2015). The environmental issues due to globalization and increasing industrialization are becoming harmful to human beings due to increase in pollution. Heavy metals present in wastewater and industrial outflows (effluents) are major problem of environmental pollution.

Heavy metals refers to those metals whose density exceeds 5g/cm<sup>3</sup> (Gunatilake, 2015). The maximum permissible limit standard for chromium, iron, cadmium, lead and copper are 0.05, 0.30, 0.003, 0.01 and 1.00mg/L respectively (SON, 2015).

Metal contamination is of great concern, particularly in agricultural production systems due to their increasing trends in human foods and environment. These metals pose a significant health risk to humans, particularly in higher concentrations above low body requirements. Hence, the metals must be controlled in food sources in order to assure public health safety (WHO, 1995). Higher amount of heavy amount of

heavy metals in food cause a number of diseases such as cardiovascular, neurological, renal and bone diseases (Chailapakul et al., 2007). The contamination of soil and vegetables by heavy metals is a global environmental problem. Under certain environmental conditions, these heavy metals may accumulate to toxic concentration and can cause ecological damages (Freeman, 1989).

The uncontrolled irrigation of crops with sewage water leads to the accumulation of some potentially poisonous metals in agricultural soil and have very adverse effects on the growth of the plants (Muhammad et al, 2013). It has become a common practice in many parts of Nigeria to use municipal sewage water that contain both domestic liquid waste and industrial effluents for irrigation purpose (Odoh and Adebayo, 2011). After this, vegetables take up heavy metals by absorbing them from contaminated soil as well as from deposits on different parts of the vegetables exposed to the air from polluted environments (Oluwole et al, 2013).

Foliage or leafy vegetables occupy a very important place in human diet, but unfortunately constitute a group of food which contributes highly to nitrate and other anions as well as heavy metal consumption. *Spinacia oleracea* (spinach) just like other vegetable plants are used for food and constitute an important part of the human diet because it is rich in vitamins, minerals, protein, carbohydrate and trace elements (Olowale, 2013).

This study therefore aimed at investigating the level of contamination of zinc, chromium, copper and iron in spinach leaves within selected irrigation sites of Makurdi and Vandeikya towns and evaluate their contamination status in line the international food standard.

## II. LITERATURE REVIEW

Over the years, irrigation has become a common practice in some parts of Nigeria including Benue state due to shortage of water. Wastewater has become a common application for irrigation. In Nigeria, about 95 percent of wastewater (sewage water) and industrial effluents is directly used for crop growth and released into various water bodies with barely 5% being cleaned in major towns. In

some parts of Benue state in Nigeria such as Makurdi and Vandeikya towns, wastewater is used in irrigation, which originates from sanitary and domestic wastes. Heavy metals and dangerous wastes may be in sewage sludge (Zafar et al., 2020).

Heavy metals refer to metals and metalloids with a density greater than  $5\text{g/cm}^3$  that are harmful (toxic) in small quantities such as Cr, As, Cd, Fe, Pb, Hg, Ag, Zn and other metals and metalloids. Heavy metals accumulate in nature due to their non-biodegradable habit producing bio accumulation in the food chain, which can lead to environmental and health problems (Leong and Chang, 2020). Vegetables are carriers of heavy metals when taken up by humans and ingested by the human body. This study is therefore, planned to investigate the concentration of some heavy metals such as Zinc, Chromium, Copper and Iron in spinach within selected sites of Makurdi and Vandeikya local government of Benue state in Nigeria.

## III. MATERIALS AND METHODS

### 3.1 Description of Study Area

Makurdi and Vandeikya are Local Government Areas (LGAs) in Benue state, Nigeria. Makurdi is the state capital, with a population estimated at around 433,700 in 2022. Vandeikya, located in the southern part of Benue state, had an estimated population of 338,700 in 2022.

Makurdi town, the capital of Benue state is located at the North-Central zone of Nigeria. It lies on the southern bank of the Benue River. It was founded in 1927 when the railroad from Port-Harcourt 449km south-west was extended to Jos and Kaduna. Makurdi rapidly developed into transportation and market centre. Vandeikya is a local government area in Benue state Nigeria. The capital is Vandeikya town. Vandeikya local government area was carved out of Gboko local government council in 1976. The indigenous community is the Kunav people who speak Tiv language.

### 3.2 Sample Collection and Treatment

Fresh *Spinacia Oleracea* (spinach) was harvested from selected irrigation sites of Makurdi and Vandeikya towns, packed in polythene bags and

labelled, and was transported to the laboratory. All sample collected were carefully washed with distilled water to remove soil and other impurities, and was then dried in an oven at about 60°C TO 80°C for 24 hours (1 day). After drying, the sample was crushed (grinded) into powder, sieved and was be kept in air tight containers (Muhammad et al., 2019).

### 3.3 Sample digestion

One gram of each sample was taken into a digestion flask, mixed with 20cm<sup>3</sup> of concentrated sulphuric acid, and nitric acid (aqua-regia) in the ratio of 1:2:20

and was left to stand overnight. Thereafter, the flask was heated at a temperature of 80°C for 40 minutes, after which the temperature was raised to 120°C. The mixture was observed. Thereafter, the sample solution was filtered using a filter paper, and was taken for atomic absorption spectroscopy (AAS).

## IV. RESULT AND DISCUSSION

### 4.1 Result Analysis

The results obtained from various sites were analyzed to determine the ANOVA at 98% confidence limit.

Table 1: Concentration of heavy metals (mg/kg) in Spinacia Olerecea (Spinach) from selected irrigation sites

S/N	METALS	Aya-River side	Wurukum Makurdi	Gbem- Vandeikya	WHO/FAO LIMIT
1	Copper (Cu)	22.81±0.18	25.0±4.33	28.30±1.18	73.00
2	Chromium (Cr)	5.65 ±0.56	3.70±0.23	1.85±0.25	2.30
3	Cadmium (Cd)	15±0.5	10±0.43	15±0.5	0.20
4	Zinc (Zn)	3.80±0.22	4.16±0.24	1.39 ±0.18	99.40

Mean ± SD (Standard Deviation)

Analyzed using IBM SPSS v31\*64 at 95% confidence limit.

### 4.2 Discussion

The spinacia olerecea (spinach) leave was gotten from three irrigation sites namely; Wurukum in Makurdi, Aya-River side and Gbem in Vandeikya respectively. The samples were digested and analyzed for heavy metal determination using atomic absorption spectrometer (A.A.S). The concentration of heavy metals in spinacia olerecea from Aya-River side irrigation site had the highest content of Cu, followed by Cd, Cr, and Zn as shown in Table 1. All the heavy metals were found to be below the approved limit of W.H.O/F.A.O except cadmium which was found to be 0.5mg/kg while its safe limit is 0.20mg/kg. This higher concentration of cadmium in Aya-River side irrigation site may be attributed to the source of irrigation water. The World Health Organization (WHO) notes that irrigation water can be a significant source of cadmium contamination in vegetable crops including spinacia olerecea (spinach). The spinach grown at this irrigation site

could be safe for consumption if the cadmium source is identified and controlled. Moreover, the other essential elements should also be controlled to meet the daily elemental requirement of Zn, Cu, Cd and Cr that has the value of 60mg/day, 0.7-1.0mg/day, 16-30µg/day and 25µg/day of Zn, Cu, Cd and Cr respectively (W.H.O 2007).

The heavy metals (Zn, Cd, Cr and Cu) determined in Wurukum irrigation site were found to be below the permissible limit given by W.H.O/F.A.O except cadmium whose level was 0.33mg/kg and above the permissible limit. This higher value of cadmium in Wurukum irrigation site may be due to municipal refuse disposal along the water channels leading to the irrigation site. Municipal refuse may contain paper, food wastes, metals, glass, ceramics and ashes. Studies have shown that these wastes can accumulate heavy metals which can persist in soil at environmentally hazardous level (Salawu *et al.*, 2015). Spinacia olerecea (Spinach) grown in this area can be safe for consumption if there is good environmental sanitation, use of borehole water for

irrigation, banned use of contaminated stream and/or good soil analysis to confirm the source of the heavy metals for proper control. Considering the daily requirements of 60mg/day, 0.7-1.0mg/day, 16-30µg/day and 25µg/day of Zn, Cu, Cd and Cr respectively reported by W.H.O in 2007, spinach can be a good supplement that will provide some balances in the uptake of these metal ions to the body.

However, the result of heavy metal concentration in the spinach obtained from Gbem irrigation site is shown in Table 1. The sample from this site reveals lower levels of these metals (Zn, Cr, and Cu) when compared with the WHO/FAO dosage level. While cadmium have concentration of 0.5mg/kg which was above the permissible limit provide by W.H.O/F.A.O. This may be attributed to the indiscriminate dumping of domestic and industrial wastes on the water channels that passes through the farm land which may subsequently be absorbed by the vegetable (spinach) grown in the area. Plants watered with the wastewater are usually contaminated with heavy metal and pose health concern. The accumulation of heavy metals such as Fe, Mn, Cu, Zn and Pb in plant significantly increases by sewage water irrigation (Mohammed *et al.*, 2019). Similar work reported by Muhammad *et al.*, (2019), observed that vegetables accumulate considerable amount of heavy metals especially Pb, Cr, Cu, and Zn in roots and leaves.

## V. CONCLUSION AND RECOMMENDATION

### 5.1 Conclusion

The levels of some of the heavy metals determined were within the approved limits of international agencies (WHO/FAO). However, the practice of irrigating the vegetables with contaminated water should be controlled and proper soil and vegetable analysis should be conducted regularly to ensure that the amount of heavy metals contained is within the admissible limit. This will assist in controlling the perceived threat of possible health hazard to the consumers on long term basis.

Therefore, there is the need to continually monitor, control and publicize a policy on the use of waste water for irrigation purposes. However, farmers from this study areas and others are advised to use good

water for irrigation purposes instead of contaminated sources.

### 5.2 Recommendations

Based on the findings of this study, the following recommendations are proposed:

- i. Use alternative water sources: Farmers should consider using alternative water sources, such as rainwater or treated water for irrigation to reduce the risk of heavy metal contamination.
- ii. Implement wastewater treatment: Wastewater treatment plant should be equipped with advanced technologies to remove heavy metals and other pollutants before discharging water for irrigation.
- iii. Regular monitoring: Regular monitoring of water quality and vegetable samples should be conducted to detect heavy metal contamination and take prompt action.
- iv. Awareness and training: Farmers, consumers, and policymakers should be educated about the risks associated with wastewater irrigation and the importance of safe agricultural practices.
- v. Policy development: Government and regulatory agencies to prevent the use of untreated wastewater for irrigation and ensure food safety.

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