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Morphological Responses and Heavy metals assessment of *Celosia argentea* and *Amaranthus hybridus* to Abattoir Effluent Treatment

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Abstract: The uncontrolled and unauthorized discharge of abattoir waste water into the environment had been on the alarming increase. Morphological Responses and heavy metals assessment of Celosia argentea and Amaranthus hybridus to Abattoir Effluent Treatment were investigated with the aim of determining the effect of abattoir effluents and heavy metal contents on some growth parameters of these vegetables. Seeds of Amaranthus hybridus and Celosia argentea were collected from Institute of Agricultural Research and Training (IAR&T), Ibadan, Nigeria. They were authenticated by an Herbarium curator at the Herbarium unit of the Federal University of Technology, Akure, and voucher deposited. The abattoir effluent was collected from a major slaughter house located at Industrial park, Onyearubgulem, Akure. A screen house experiment was set up to house the pots. Seeds of Amaranthus hybridus and Celosia argentea were sown into perforated plastic pots (30 cm diameter and 33 cm depth) filled with 10 kg of topsoil. The seedlings were allowed to establish for 21 days before the commencement of effluent treatment. Physicochemical properties of the treated soil with effluents were determined. After 21 days of seedling establishment, vegetable seedlings were irrigated with 200ml of abattoir waste water every three days while distilled water served as the control. The observed decrease in the plant height of Celosia argentea and subsequent decrease in leaf number of Amaranthus hybridus may be due to the toxicity of the Abattoir waste water was attributed to plant metabolic activities leading to poor waste absorbance and poor development.

Keywords: Heavy metals, Celosia argentea, Amaranthus hybridus

1. Introduction

An abattoir is an approved facility registered by regulatory authorities or agencies for proper slaughtering, inspection, processing, preservation and storage of meat and meat products for human consumption [1]. This process is carried out under strict hygiene and ethical standards. Slaughtering had also provided employment opportunities to the teeming Nigerian populace thereby reducing the level of insecurity. Abattoir wastewater had continued to pose serious threat to biodiversity because of consistent discharge into the ecosystem [2]. Toxic compounds and heavy metals are present in abattoir effluent.

Although some metals are essential for normal plant growth, many are toxic at high concentrations and their toxicity may be increased in soil [3]. An abattoir effluent contains high levels of organic matter due to the presence of manure, fats, hair, and undigested feeds. It's also rich in salts, nitrates and phosphates [4]. However, because the effluents are rich sources of nitrates, phosphates and organic matter, it had hitherto been used as a substitute for fertilizer to improve crop yield. Increase in urbanization and living standards had resulted in unabated generation of large amounts of effluents and their disposal constitute a great concern [5]. Also, inadequate good quality groundwater for agricultural purposes had mandated the farmers to utilize this waste water. It has been estimated that by 2025, half of the world's population will reside in areas with scarcity of water [6]. This scarcity, notwithstanding, could be attributed to unequal distribution accompanied with exponential increase in population, pollution and climate changes [7]. In order to arrest this scourge, non-conventional methods have been employed of which waste water plays a critical role Vegetables are the fresh and eatable parts of herbaceous plants [8]. Green leafy vegetables are excellent repository of carbohydrates, proteins, vitamins, minerals, as well as antioxidants which promote digestion, reduce oxidative stress, prevent cancer and reduce blood pressure. In Nigeria, a vast majority of the leafy vegetables are succulent leaves of herbaceous plant which are consumed as supplements or as condiments [9]. *Celosia argentea*, is an herbaceous plant of tropical origin, and is known for its very bright colors. In India and China it is known as a troublesome weed [10]. *Celosia argentea* is known as "*Sokoyokoto*" in "Yoruba". The plant is well known for its therapeutic abilities for common cold, gastro-intestinal tract infections, rheumatoid arthritis and as a fertility-regulating agent in China [11]. *Amaranthus hybridus*, popularly known as 'Tete-arowojeja' (Yoruba) belongs to the family Amaranthaceous. The leaves are green and show distinct variations in shape and size [9]. Majority of plants in this family have excellent nutritional qualities and they are used in folk medicine for the treatment of various gastrointestinal and respiratory disorders [12]. Increase in population, urbanization and advancement in science and technology through unwanted dumping of electronic waste into the environment had increased the heavy metal content in the soil [13]. Vegetable species differ widely in their ability to bioaccumulate heavy metals depending on the cultivars and varieties [14]. [15] reported that Pb is significantly accumulated in lettuce and onion, while Cd accumulated to the greatest extents in spinach and lettuce. The objectives of this study are therefore to investigate the morphological responses and heavy metal contents of *Amaranthus hybridus* and *Celosia argentea* treated with abattoir effluents. The reduction in fresh weight and dry weight obtained due to the concentration of 200ml of Abattoir waste

2. Materials and Methods

2.1. Collection and Identification of plant materials

Seeds of *Amaranthus hybridus* and *Celosia argentea* were collected from Institute of Agricultural Research and Training (IAR&T), Ibadan, Nigeria. They were authenticated by a Herbarium curator at the Herbarium unit of the Federal University of Technology, Akure, and voucher deposited.

2.2. Collection of Abattoir Effluent

The abattoir effluent was collected from a major slaughter house located at Industrial park, Onyearubgulem, Akure. The effluents were collected very early in the morning once in three days. A protective covering with hand gloves, nose mask and 'overall' were worn to the site for protection against microbial infection during collection. They were transferred to a labelled black keg to prevent fungal growth.

2.3. Experimental setup

A screen house experiment was set up to house the pots. This was necessary to protect the plants from rainfall contaminations and to avoid being destroyed by rodents as the plants develop.

2.4. Source of soil

Sandy-loamy soil was used for this study. The soil was collected with soil auger from the school farm of the Federal University of Technology, Akure. They were thoroughly mixed together and transferred to perforated plastic pots in the screen house.

2.5. Planting procedure

Seeds of *Amaranthus hybridus* and *Celosia argentea* were sown into perforated plastic pots (30 cm diameter and 33 cm depth) filled with 10 kg of topsoil. The seedlings were allowed to establish for 21 days before the commencement of effluent treatment.

2.6. Soil Analysis

Preliminary soil analysis was carried out at the Department of Crop, Soil and Pest Management, School of Agriculture and Agricultural Technology, Federal University of Technology, Akure. The following physicochemical properties of the treated soil with effluents were determined; dissolved oxygen, conductivity, nitrogen, phosphorus, copper, iron, organic matter and organic carbon.

2.7. Application of effluents

After 21 days of seedling establishment, vegetable seedlings were irrigated with 200ml of abattoir waste water every three days while distilled water (control) was used to irrigate the vegetables every other day. This is necessary to avoid contamination.

2.8. Determination of Growth Parameters

2.8.1. Growth Parameters

After 2 weeks of effluent treatment, the following morphological growth parameters were determined; Plant height, number of leaves/plants, leaf length, stem diameter, fresh weight, dry weight and leaf weight ratio.

2.8.2. Heavy Metals Analysis

The following heavy metal contents were determined in the soil and in the vegetable samples; Cr, Ni, Cd, Fe and Pb. One gram of soil was digested with 15 ml of aqua regia (HNO_3: HCl in 3:1 ratio) and 1 g each of air-dried stem and root sample of *Amaranthus hybridus* and *Celosia argentea* were digested with 15 ml of triacid mixture (HNO_3:H_2SO_4:$HClO_4$ in 5:1:1 ratio) at 80 °C till a transparent solution was obtained (Allen *et al.*, 1986). The digested samples were filtered and diluted with de-ionized water up to 50 ml and analyzed for the metals Chromium (Cr), Nickel (Ni) cadmium (Cd) Iron (Fe) and lead (Pb) by flame atomic absorption spectrophotometer (AAS) (Agilent 240 FS AA model).

2.8.3. Proximate Analysis

Proximate analysis of the vegetable samples was carried out following the procedure of [14].

2.9. Statistical Analysis

Data collected were subjected to analysis of variance and significant means were separated using Duncan New Multiple Range Test.

3. Results and Discussion

According to [15], abattoir waste effluent had negative impact on the growth of Okra. This was attributed to the presence of toxic metals most especially Lead, Cadmium, Cromium and Nickel which retard germination and growth. The uptake, translocation and accumulation of metabolites when plants are subjected to effluent stress varies considerably depending on their genome and environment [16]. Moisture content, ash content, crude protein, crude lipid, crude fibre and carbohydrate (Table 1) revealed that moisture content varies from 65.80% in *Amaranthus hybridus* to 42.5% in *Celosia argentea*. This range had earlier been reported by [17], while working on *Abelmoscus esculentus and Telfaria occidentalis*. The ash content of any sample is an indication of the mineral composition of the food [18]. This result did not contradict the report of [19]. Mean fibre content was higher in *Amaranthus* (10.42) than in *Celosia argentea* (6.85). This was in agreement with those reported by [10]. Similar trend was also observed as the result of crude protein content showed that it was higher in *Amaranthus* (13.68) than in *Celosia* (9.65). Results of the lipid content revealed that Amaranthus had a higher value (1.68) than in Celosia (0.56). However, there was no significant difference in the lipid contents of both vegetable samples. This is a clear demonstration that vegetables are low in lipids.

Each value represent mean ± standard error, mean values of the same column followed by different letters differ significantly using Duncan's New Multiple Range Test (DNMRT) CHO-carbohydrate

Temperature is one of the most important factors determining chemical and biological characteristics of effluents. The high temperature recorded in the effluents enhances biodegradation of wastes into simple components. TSS and turbidity varied from 15.94 mg/l and 12.78 (Table 2). The high concentration of TSS and turbidity is a clear reflection of direct discharge of wastes from abattoir [20]. An important factor affecting enzymatic, synthesis and dissolution of mineral components is pH. The slightly alkaline pH of waste water (7.20) is suggestive of the high concentration of organic compound present in the waste water [21]. The pH of the sample indicated a slightly alkaline environment comparable to pH of previous studies on abattoir effluents in Nigeria [22-23]. Conductivity and TDS showed similar trend as they were high in abattoir effluent. The strength of a domestic sewage is determined by the degree of its BOD value [21]. The amount of dissolved oxygen consumed by bacteria in the degradation of organic matter in sewage is determined by its BOD value

The observed decrease in the plant height of *Celosia argentea* and subsequent decrease in leaf number of *Amaranthus hybridus* may be due to the toxicity of the Abattoir waste water used for the irrigation.

Findings from this research are in conformity with [24] who reported that plants growing in polluted area were significantly reduced than plants grown in unpolluted area. *Celosia argentea* have the highest biomass followed by *Amaranthus hybridus*. This result is in agreement with Vihotogbe [25] who confined in his report of a reduction in total plant biomass in waste polluted habitats.

Table 1. Proximate composition (%) of Amaranthus hybridus and Celosis argentea under effluent treatment

Vegetables	Moisture	Protein	Crude fibre	Crude lipid	Ash	CHO
Amaranthus hybridus	65.8[b]	13.68[b]	10.42[b]	1.68[a]	8.56[b]	11.46[b]
Celosia argentea	42.5[a]	9.65[a]	6.85[a]	0.56[a]	4.75[a]	8.56[a]
P value	$P<0.05$	$P<0.05$	$P<0.05$	$P<0.05$	$P<0.05$	$P<0.05$

Table 2. Physicochemical properties of abattoir effluents and its comparison with regulatory standards.

	Vegetables		Regulatory Standards	
Parameters	***Amaranthus hybridus***	***Celosia argentea***	**FEPA**	**WHO**
pH	6.86	7.20	7	6.5-8.5
Temperature	24.72	27.65	<40°C	24-30°C
Conductivity (µs/cm)	78.40	70.62	NS	500
TSS (mg/l)	15.94	12.78	-	-
TDS (mg/l)	68.74	65.54	2	0
DO (mg/l)	3.56	2.84	<0.007	NS
BOD (mg/l)	11.58	12.71	50	>4.00
Turbidity (NTU)	25.10	26.40	NS	40

TSS-Total Suspended Solid; TDS-Total Dissolved Solid; DO-Dissolved oxygen; BOD-Biological Oxygen Demand; EPA-Environmental Protection Agency; WHO-World Health Organization.

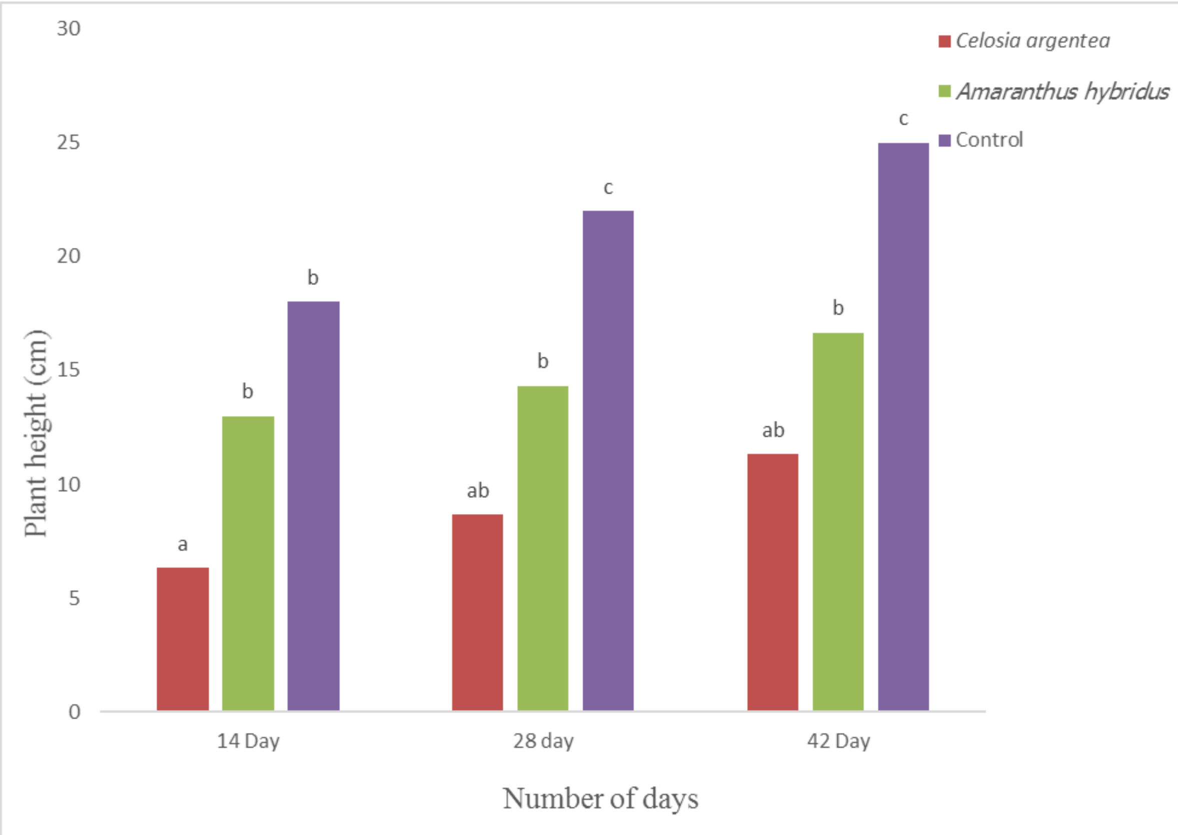

Figure 1. Plant height of *Amaranthus hybridus* and *Celosia argentea* as influenced by Abattoir effluent

Similarly, John [26] also reported the effect of waste water polluted soil on the biomass of vegetables seedlings, in which the effect was attributed to reduction in cell expansion and photosynthesis which play a major role in reduction of fresh weight and dry weight. The reduction in fresh weight and dry weight obtained due to the concentration of 200ml of Abattoir waste water was exemplified by [27] that, it was possible that the toxicity of Abattoir waste water could have interfered with the plant metabolic activities leading to poor waste absorbance and poor development.

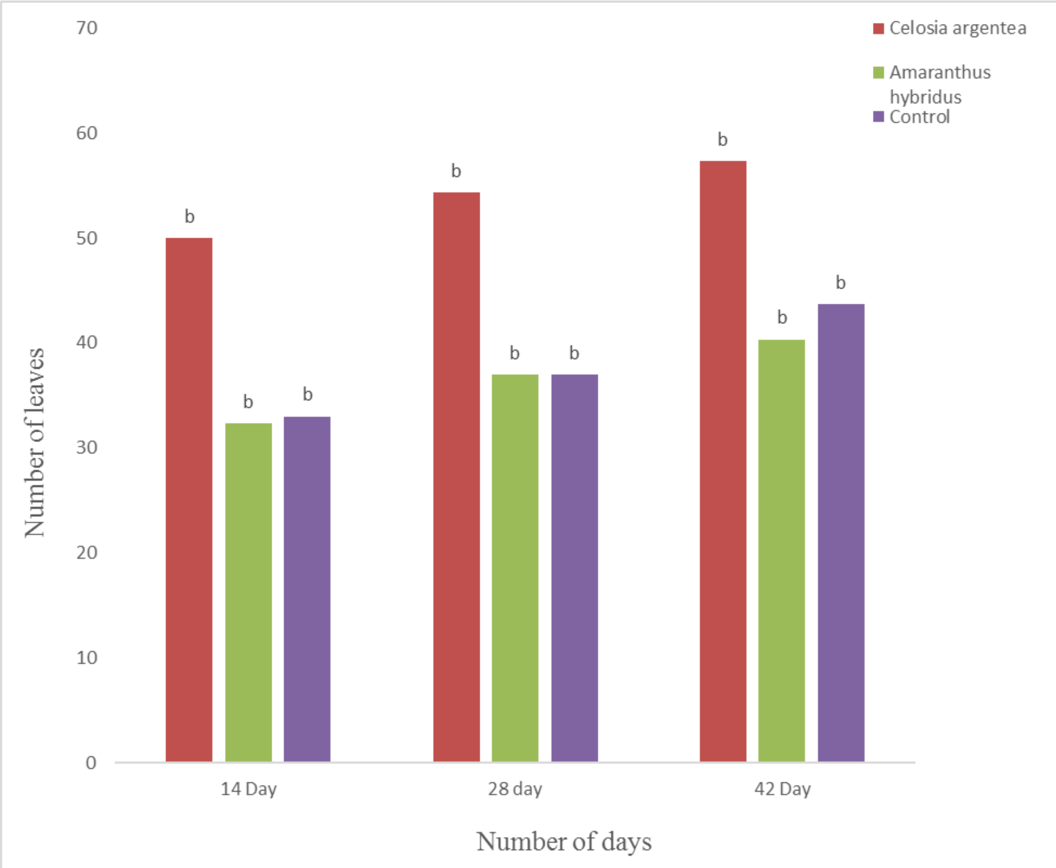

Figure 2. Number of leaves of Amaranthus hybridus and Celosia argentea as influenced by Abattoir effluent

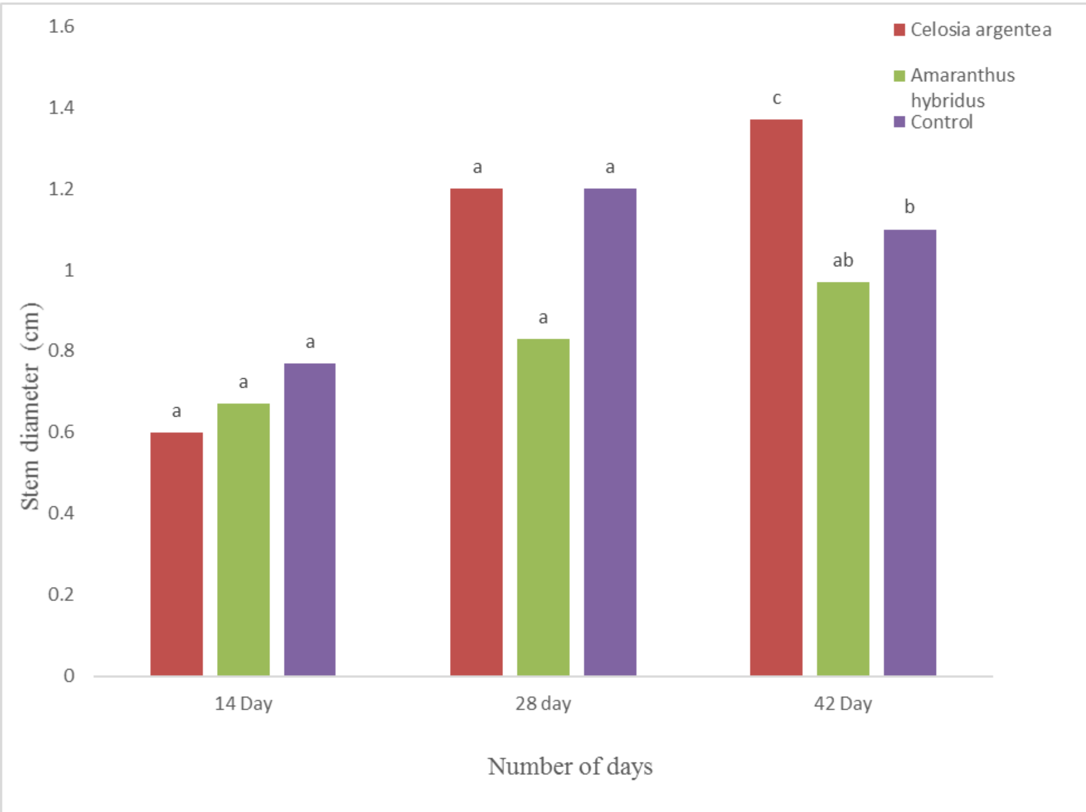

Figure 3. Figure 1: Stem diametter of Amaranthus hybridus and Celosia argentea as influenced by Abattoir effluent

4. Conclusion

The high concentration of TSS and turbidity is a clear reflection of direct discharge of wastes from abattoir thereby affecting enzymatic, synthesis and dissolution of mineral components. The uptake, translocation and accumulation of metabolites when plants are subjected to effluent stress varies considerably depending on the constituents of the effluents. The strength of a domestic sewage is determined by the degree of its BOD value. The physicochemical parameters of the effluents were below the regulatory standards established by WHO and FEPA.

References

[1] O.A. Adeyemi-Ale, Impact of abattoir effluent on the physico-chemical parameters of Gbagi Stream (Odo-Eran), Ibadan, Nigeria, *Ilorin Journal of Science*, 1 (2014) 100-109.

[2] H.B. Raghupathi, A.N. Ganeshamurthy, H. Ravishankar, Comparison of DRIS ratio norms of selected fruit crops, *Indian Journal of Horticulture,* 71(2) (2014) 168-175.

[3] U.D. Emmanuel, A.E. Godwin, U.E. Udo, Air Pollution Tolerance Indices of Vegetables around Abattoirs within Uyo Municipality, Niger Delta Region of Nigeria, *International Research Journal of Pure and Applied Chemistry,* 21(8) (2020) 1-11. https://doi.org/10.9734/irjpac/2020/v21i830183

[4] N. Ain, Q. Ain, S. Javeria, S. Ashiq, M. Akhtar, Effects of different industrial and domestic effluents on growth, yield and heavy metal accumulation in *Brassica rapa* L, *Journal of Applied Biology and Biotechnology*, 7(5) (2019) 35-40. http://dx.doi.org/10.7324/JABB.2019.70506

[5] I.M. Makhadmeh, S. Gharaiebeh, A. Albalasmeh, Impact of irrigation with treated domestic waste water on squash (*Curcubita pepo* L.) Fruit and Seed under Semi-Arid Conditions, *Horticulturae,* 7(8) (2021) 226-232. https://doi.org/10.3390/horticulturae7080226

[6] J.R. Dhellot, E. Matouba, M.G. Maloumbi, J.M. Nzikou M.G. Dzondo, M. Linder, Nutritive Composition and consumer acceptance of some Nigerian edible leafy vegetables, *African Journal of Food and Agricultural Nutritional Development,* 7 (2006) 1-18.

[7] Y.A.Taofeek, O.I. Akintaro, A. Akinboro, M.A. Azeez, Evaluation of cytogenotoxic and nutrient composition of three commonly consumed vegetables in south-western Nigeria, *African journal of food, agriculture, nutrition and development*,13(2) (2013) 1-15.

[8] Vegetable Production Guide for Commercial Growers, (2020) University of Kentucky, college of agriculture, food and environment,

[9] O. Olorundare, A. Akinsola, S. Soyemi, A. Mgbehoma, I. Okoye, J. Ntambi, H. Mukhtar, African Vegetables (*Clerodendrum volibile* Leaf and *Irvingia gabonensis*) Seed Extracts) Effectively Mitigate Trastuzumab-Induced Cardiotoxicity in Wistar Rats, Oxidative Medicine and Cellular Longevity, 2020 (2020) 1-15. https://doi.org/10.1155/2020/9535426

[10] K.M.E. Iheanacho, A.C. Udebuani, Nutritional Composition of Some Leafy Vegetables Consumed in Imo State, Nigeria, *Journal of Applied Science and Environmental Management*, 13(3) (2009) 35-38. https://doi.org/10.4314/jasem.v13i3.55349

[11] N. F. Okeke, C.V. Ilodibia, B.E. Okoli, A Comparative Morphological Study on *Amaranthus spinosus* L., *Celosia argentea* L. and *Gomphrena celosioides* Mart (Amaranthaceae), Universal Journal of Plant Science, 8(1) (2020) 1-10. https://doi.org/10.13189/ujps.2020.080101

[12] A.F. Aiyesanmi, G.A. Idowu, Levels of heavy metals in leafy vegetables grown around waste dumpsites in Akure, southwestern Nigeria, *FUTA Journal of Research in Sciences,* 8(2) (2012) 27-35.

[13] S.S. Asaolu, O.S. Adefemi, I.G. Oyakilome, K.E. Ajibulu, M.F. Asaolu, Proximate and Mineral Composition of Nigerian Leafy Vegetables, *Journal of Food Research*, 1(3) (2012) 1-6. https://doi.org/10.5539/jfr.v1n3p214

[14] P. D. Alexander, B. J. Alloway, A. M. Dourado, Genotypic variations in the accumulation of Cd, Cu, Pb and Zn exhibited by six commonly grown vegetables, Environmental pollution, 144 (3) (2006) 736-745. https://doi.org/10.1016/j.envpol.2006.03.001

[15] AOAC, (1999) Official methods of analysis, 21st Edition, Association of official analytical chemists, Washington D.C., USA.

[16] S. Ramana, A.K. Biswas, S. Kundu, R.B.R. Yadava, Effect of distillery effluent on seed germination in some vegetable crops, *Bioresource Technology*, 82(3) (2002) 273-275. https://doi.org/10.1016/s0960-8524(01)00184-5

[17] O. Akinbuwa, O. Kekere, E.C. Constance, Growth of *Abelmoshus esculentus* L. (Okra) and *Telfairia occidentalis* Hook F. (Fluted Pumpkin) Treated with Beauty Salon Wastewater, *American Journal of Bioscience*, 7(2) (2019) 31-37. https://doi.org/10.11648/j.ajbio.20190702.11

[18] C. V. Nnamani, H. O. Oselebe, A. Agbatutu, Assessment of nutritional values of three underutilized indigenous leafy vegetables of Ebonyi State, Nigeria, *African Journal of Biotechnology*, 8(10) (2009) 2321 - 2324.

[19] A. Taiga, M.N. Suleiman, D.O. Aina, W.F. Sule, G.O. Alege, Proximate analysis of some dry season vegetables in Anyigba, Kogi State, Nigeria, *Africa Journal Biotechnology*, 7(10) (2008) 1588 - 1590.

[20] J.O. Ojo, Environmental impact assessment of effluents from Oko-Oba municipal abattoir at Agege, Lagos State, Nigeria, *Global Advanced Research Journal of Agricultural Science*, 3(10) (2014) 317-320.

[21] G. Asibor, O. Edjere, C. Azubuike, Status of discharged abattoir effluent and its effects on the physico-chemical characteristics of Orogodo river, Delta State, Nigeria, *Water pollution*, xv (2017) 51-59.

[22] O. Osibanjo, G.U. Adie, The impact of effluent from Bodija abattoir on the physicochemical parameters of Oshunkeye stream in Ibadan City, Nigeria, *African Journal of Biotechnology*, 6(15) (2007) 1806-1811. https://doi.org/10.5897/AJB2007.000-2266

[23] M.R. Law, J.K. Morris, By how much does fruit and vegetable consumption reduce the risk of ischemic heart disease?, *European Journal of Clinical Nutrition*, 52 (1998) 549-553. https://doi.org/10.1038/sj.ejcn.1600603

[24] R Pathirana, Vegetable and Spice Capsicums, 2nd edition, by Paul W. Bosland and Eric J. Votava, *New Zealand journal of crop and horticulture* science, 41 (2012) 102-103. https://doi.org/10.1080/01140671.2012.745161

[25] C.N. Vihotogbe-Sossa, N.H. Akissoe, V.B. Anihouvie, Bonaventure C. Ahohuendo, Adam Ahanchede, Ambaliou Sanni, D. Joseph Hounhouigan, Endogenous knowledge of four leafy vegetables used by rural populations in Benin, *Ecology, Food and Nutrition*, 51(1) (2012) 22-39. https://doi.org/10.1080/03670244.2012.635570

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Conflict of interest

The Authors declared that they have no conflict of interest

Does the Article Screened for Similarity?

Yes.

Data Availability

No additional data are available.

Ethics Approval

Ethics approval doesn't require for this study

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