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Effects of Tin Mining Pond Water on Proximate Composition of Six Commonly Consumed Vegetables grown in Plateau State, Nigeria

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Abstract:*Vegetables are an excellent source of most of nutrients and essential source minerals that play a vital role in ameliorating food deficit and overcoming nutritional problem. The study was carried out to assess proximate and mineral content of six edible vegetables irrigated with tin mining pond water and those planted around the vicinity during rainy season in three local government areas namely;Bokkos, Barkin – Ladi and Jos – South in North Central Nigeria. The vegetables were analyzed using standard analytical methods of AOAC (2012) and UV spectrophotometer. Vegetable samples were collected from four farms each in three Local Government Areas and analyzed for their proximate value (moisture, ash, protein, crude fibre, and carbohydrate) on dry matter basis and essential minerals in both dry – and – rainy seasons. Results reveal that the values ranged from 2.67 – 11.4 % moisture, 4.82 – 21.5% ash, 2.06 – 14.8% crude protein, 0.19 – 28.7 crude fibre, 0.79 – 4.48% lipid and 34.6 – 81.1% carbohydrate.In case of essential mineral Potassium (K), were found in all samples they ranged from 21.4 – 1317mg/100g Potassium, 0.57 – 167mg/100g Sodium, 2.81 – 369mg/100g Calcium and 1.68 – 98.2mg/100g Phosphorus, respectively in the six types of vegetables. These values when compared to other literatures it was found that tin mining pond water and the vicinity were mining activities has taken place and abandoned still have effect in the nutritive value and essential mineral of vegetables cultivated in the areas.*

Key words: *Nutrients, Essential Minerals, Tin Mining Wastewater, Vegetables*

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I. Introduction

Mining of solid minerals has been identified as a major entry point of heavy metals into the environment consequently polluting various components of the environment (Tsafe et al., 2012). Mining, which involves the extraction of naturally occurring minerals from the earth's crust, is considered the world's second oldest and most important industry after agriculture (Amponsah-Tawiah, 2011). In the process of mining a particular metal the entire soil mass is excavated, laid bare and expose to the environmental agencies of weathering, degradation and transportation, this result in soil erosion and extensive contamination of the surrounding areas.

Opencast mines and underground mines are the most commonly adopted methods of extraction of minerals from the earth, especially in developing country like Nigeria (Ezehet al. 2011). After which the abandoned ponds and dumps tailing scattered still impact the environment by contaminating vegetables as well as pollution of underground water by discharged leachate. In essence, water bodies such as rivers and lakes are used in floatation, a stage in metallurgical process to separate the pure metals from their ore after crushing (Kabiret al. 2017).

In a developing like country like NIgeria, the fight against poverty, hunger, malnutrition and undernourishment continues to be a basic goal of development and a variety of strategies are being applied. Strategies based on micronutrient rich food like vegetables are considered essential (Susane, 1996). Vegetables are the fresh and edible portions of herbaceous plants. They are important class of food substances and highly beneficial for the maintenance of health and prevention of diseases. They contain valuable food ingredients, which can be successfully utilized to build up and repair the body (Okewole2018).The inclusion of vegetables in human diets has been identified as a major means of promoting balanced diets across populations of various income brackets (Ajewole, 1999). This is because green vegetables have been recognized as one of the richest natural sources of essential minerals, protein and vitamins. In addition to being cheap sources of macro and micronutrients, vegetables could also be efficiently produced with limited resources. The regular consumption of vegetables, specifically the dark green leafy vegetables is highly recommended because of their potential in reducing the risks of chronic diseases (Lyimo, et al.1991; Van Duyn and Pivinka, 2000).

In addition to a potential source of important nutrients, vegetables constitute important functional food components by contributing protein, vitamins, iron and calcium which have marked health effects (Arai, 2002). There are different kinds of vegetables which may either be edible roots, stems, leaves, fruits or seeds (Robinson, 1990). Vegetables as a whole are considered as natural caches of nutrients to human beings e.g. carrot is a good source of vitamin A, needed for normal vision, like wise spinach and tomato contains enough amount of vitamin C to prevent and cure scurvy. Some vegetables contain high amount of dietary fibers such as sponge gourd and bottle gourd etc and help to prevent constipation (Aliyu, 2006). As such, vegetable production has been adopted as a strategy for improving livelihood by reducing malnutrition through regular consumption of fruits and green leafy vegetables (SPF, 1995).

Vegetables are the most widely grown crops in Nigeria especially in plateau state were the climate favors the growth of varieties such as; tomatoes, garden egg, cabbage, spinach carrot, and pepper. (Mohammed and Luka, 2013).The production of dry season vegetables has developed from small home garden to a form of commercial farming because of the availability of many abandoned tin mining ponds in the plateau

These vegetables provide vital food security for many subsistence farmers and are reported to play a very important role in income generation (Schippers, 2000). Vegetables are very popular in Nigeria, though, its production is low in rainy season compared to dry season due to differences in environmental conditions, non-availability of high yielding varieties and cultural practices in the crop production (Mohammed et al. 2017). The ingestion of dietary fiber from variety of vegetables prevents colon cancer, heart disease and also normalizes blood lipids thereby reducing cardiovascular diseases etc. The introduction of fiber rich foods in child’s early life and continued consumption of these foods later in life has been encouraged (Nielsen, 2002).

In this study, determination of proximate composition and some mineral constituents of different vegetables consumed daily by majority of people was carried out. The main purpose of the analysis was to investigate for the effects of tin mining activities in regards to the vegetables irrigated with the waste water on the proximate composition of vegetables.

II. Materials And Methods

2.1 Study Area

The study was carried out in three Local Government Areas of Plateau State namely: Barkin – Ladi, Bokkos and Jos – South local Government Areas of Plateau State as shown in Figures 1 – 3, respectively. The study areas lie between latitude 9°18’N to 9°54’N and longitude 8°50’E to 8°59’E and cover an area of about 3224 km^2. The study area played host to a lot of mining activities by foreign companies which rendered the area derelict with numerous waste dumps and ponds.Vegetable samples were collected through stratified random sampling method. For this purpose vegetable were obtained four different farms each irrigated with tin mining ponds pond water from three Local Government Area namely; Bokkos, Barkin – Ladi and Jos – South. 1kg of each of the vegetable samples including carrot, cabbage, garden egg, spinach, pepper and tomato from each stratum was collected. Three replications of each of these samples were analysed for their proximate composition and mineral contents to evaluate their nutritive value in human food.

2.2Proximate analysis

In accordance with method of AOAC (2012), moisture was determined by weight loss after heating in drying oven (DHG-9640A, Hech Instrument Co. Ltd., Shanghai, China) at 105 °C, Ash in a muffle furnace (QSH-1700M, QuanshouElectic Furnace Co. Ltd., Shanghai, China) at 550 °C for 5 h. Crude protein was calculated from nitrogen, determined by Kjeldahl method, multiplying the value by 6.25 as recommended by Koyuncuet al. (2014). Crude fibre was determined by treatment of the samples with 1.25% H2SO4, 1.25% NaOH and then 1% HNO3, filtered and washed with hot water after each step. The residue obtained was dried in oven at 130 ºC and ashed at 550 ºC in furnace. The loss in weight on ignition was expressed as content of crude fiber (Khan et al.2013).

2.3 Determination of some essential minerals content

Approximately 0.5 gm. plant materials (raw powdered sample) were taken in a 50 ml Pyrex beaker and added 10 ml of conc. nitric acid (65%) and digested the sample on a hot plate in low temperature (55-700c) for about 30 minutes. Cooled the sample at room temperature and 5ml perchloric acid (70 to 72%) was added and again digested until the contents become colorless. Cooled and diluted the sample with deionized water and filtered (if necessary) to a 100ml volumetric flask and made the volume up to the mark. Appropriate dilution was made and measurement of sodium (Na), potassium (K) were done by Flame Emission Spectrophotometer (Model: JENWAY, PFP7).

III. Results and Discussion

Table 1a: Mean Proximate Analysis Vegetables Irrigated with Tin Mining Pond Waters in Dry Season

Tomato	Moisture	Ash	Crude Protien	Crude Fibre	Lipid	Carbohydrate
Tomato						
Bokkos	11.6±0.23	8.68±0.08	13.6±1.02	3.12±0.07	1.92±0.08	61.1±3.41
Barkin-Ladi	10.2±0.13	7.60±0.16	14.6±0.56	2.63±0.42	0.83±0.02	64.1±2.32
Jos-South	11.4±0.32	12.4±1.20	14.1±1.12	0.19±0.06	3.30±0.12	58.7±1.15
Garden Egg						
Bokkos	5.17±0.78	7.70±0.56	2.42±0.10	2.98±0.34	0.96±0.02	80.8±3.21
Barkin-Ladi	3.63±0.21	7.16±0.26	13.2±1.23	13.9±1.12	0.86±0.04	61.2±2.10
Jos-South	7.17±0.85	6.38±0.34	7.31±0.21	7.68±0.56	1.08±0.07	70.4±3.08
Pepper						
Bokkos	5.63±0.13	6.12±0.11	2.91±0.12	12.7±0.43	3.98±0.12	68.7±2.43
Barkin-Ladi	6.69±0.07	4.82±0.10	8.67±0.41	26.9±0.82	4.62±0.21	48.3±2.22
Jos-South	7.67±0.43	7.66±0.08	9.68±0.31	28.7±0.65	3.74±0.08	42.6±1.43
Cabbage						
Bokkos	6.36±0.10	7.56±0.14	1.86±0.09	4.23±0.52	1.37±0.34	78.6±1.43
Barkin-Ladi	7.94±0.21	8.26±0.22	3.21±0.02	13.1±0.16	0.83±0.08	66.7±2.02
Jos-South	7.82±0.34	7.04±0.32	2.74±0.06	3.38±0.31	1.86±0.14	77.2±1.87
Carrot						
Bokkos	5.31±0.22	13.6±0.78	8.20±0.04	13.7±0.65	0.87±0.01	58.4±0.87
Barkin-Ladi	5.38±0.13	6.00±0.16	12.7±0.78	4.12±0.68	1.02±0.05	70.8±2.11
Jos-South	7.44±0.15	6.72±0.32	6.94±0.12	22.4±1.02	1.68±0.07	54.8±1.02
Spinach						
Bokkos	3.61±0.04	20.0±1.06	15.1±0.67	6.50±0.23	2.63±0.05	52.2±2.10
Barkin-Ladi	2.76±0.02	20.7±1.12	8.67±0.76	10.2±0.31	3.21±0.23	54.5±1.42
Jos-South	3.84±0.06	21.5±2.10	14.8±0.79	24.3±1.12	1.03±0.02	34.6±0.89

Data are expressed as mean ± standard deviation on a dry weight basi

Table 1b: Mean Proximate Analysis Vegetables Cultivated at Tin Mining site in Rainy Season

Vegetable /site	Moisture	Ash	Crude Protien	Crude Fibre	Lipid	Carbohydrate
Tomato						
Bokkos	10.9 ±0.56	8.32 ±0.23	13.2 ±2.12	3.54 ±0.26	1.87±0.06	62.2±2.07
Barkin-Ladi	10.2 ±0.67	7.38 ±0.43	14.8 ±1.31	2.64 ±0.57	0.81±0.05	64.1±5.01
Jos-South	10.7 ±0.87	11.9 ±1.01	13.1 ±0.98	0.21 ±0.02	3.20±0.12	61.0±3.10
Garden Egg						
Bokkos	5.02 ±0.76	7.45 ±0.75	2.40 ±0.43	3.12±0.09	0.89±0.01	81.1±3.12
Barkin-Ladi	3.39 ±0.43	7.02 ±0.89	18.2 ±1.09	13.7±0.54	0.83±0.05	56.2±2.09
Jos-South	7.18 ±1.02	7.23 ±0.62	7.10 ±0.43	7.45±0.76	1.32±0.06	69.7±2.34
Pepper						

Bokkos	5.16 ±0.54	6.09 ±0.63	2.89 ±0.72	12.5 ±1.56	3.76 ±0.34	69.6 ±2.54
Barkin-Ladi	6.43 ±0.67	6.26 ±0.45	8.82 ±0.42	25.7 ±2.02	4.48 ±0.76	48.3 ±1.34
Jos-South	7.86 ±1.02	7.45 ±0.57	8.97 ±1.01	27.8 ±2.64	2.99 ±0.94	44.9 ±0.98
Cabbage						
Bokkos	6.13 ±0.87	6.54 ±0.56	2.06 ±0.13	4.71 ±0.43	1.36 ±0.09	79.2 ±3.04
Barkin-Ladi	7.63 ±1.03	8.12 ±0.92	3.71 ±0.23	12.4 ±1.65	0.79 ±0.06	66.9 ±2.98
Jos-South	7.94 ±0.78	7.12 ±0.87	2.43 ±0.21	3.19 ±0.65	1.96 ±0.03	77.3 ±2.21
Carrot						
Bokkos	5.11 ±0.76	13.2±1.21	7.92 ±0.89	13.4 ±2.01	0.81 ±0.06	59.6 ±2.54
Barkin-Ladi	5.12 ±0.87	6.77±1.04	13.7 ±1.15	4.24 ±0.45	1.01 ±0.12	68.4 ±1.86
Jos-South	7.62 ±0.57	6.89±0.97	5.87 ±0.67	21.9 ±2.98	1.38 ±0.08	56.4 ±1.72
Spinach						
Bokkos	4.26 ±0.67	18.9 ±1.04	14.9 ±1.06	6.87 ±0.76	2.87 ±0.32	52.2 ±1.45
Barkin-Ladi	2.68 ±0.54	19.7 ±1.23	8.01 ±0.93	11.1 ±1.04	3.12 ±0.41	55.5 ±0.83
Jos-South	5.13 ±0.73	20.6 ±2.01	13.9 ±1.01	23.9 ±1.94	1.01 ±0.07	35.4 ±0.34

3.1Moisture content

The results of proximate analysis shows that moisture content of carrot (duacuscarota) on dry basis irrigated with mining pond water ranged from 5.31 – 7.44% and 5.11 – 7.62% in dry – and – rainy season, respectively (Tables 1 and 2). The highest value was obtained in Jos – South (7.62%), while the lowest was observed in Bokkos (5.11%) in both dry – and - rainy seasons. The values are lower compared to the reported value (8.17%) by (Oni et al. 2015; Humairuet al. 2013. Rajadevan and Schramm 1989) reported moisture content of 12.3%, in cabbage (Brassica oleracea).

The moisture content of Garden Egg (Solanummelongena) ranged from 3.63% - 7.18% in both dry and rainy season. Though the values were almost same in the various local government areas during the two seasons of study, the highest was obtained in Jos – South 7.18% and lowest in Barkin – Ladi 3.63% in rainy – and – dry season, respectively. The value obtained in Jos – South (7.18%) is higher than the value (6.73%) reported by (Olaludeet al. 2015).

The moisture content result obtained for spinach (SpinaciaOleracea) shows a ranged from 2.76% – 3.84% in dry season and 2.68% - 5.13% in rainy season with the highest found in Jos – South 3.84% and lowest 2.68% in Barkin – Ladi, this value is lower than the obtained value of 8.78% by Ukom and Obi, 2018 and that (14.5%) reported by khan et al. 2013 . The moisture content of pepper (Capiscumannuum) ranged from 5.16% - 7.86% and 5.63% - 7.67% for both dry – and – rainy seasons, respectively. The highest and lowest value was obtained in Jos – South 7.86% and Bokkos 5.16% in both dry and – rainy seasons, respectively. The lower values corresponds to the reported 5.7% obtained by Gloria et al.(2010) and lower than that obtained by Sharma et al.(2017) for pepper.

The analysis also shows that the moisture content of cabbage (Brassica oleracea) ranged from 6.36% to 7.94% and 5.13% - 7.94% in dry – and – rainy season, respectively with the highest value 7.94% from Barkin – Ladi and Jos – South, while the lowest was observed in Bokkos in both seasons. All results for cabbage are lower compared to 12.3% and 24.0 reported by Rajadevan and schramm, (1989), respectively.

Tomatoes (Lycopersicumesculentum) has a mean moisture content that ranged from 10.2% to 11.6% and 10.2% – 10.9% with the highest of all moisture obtained (11.6%) in Bokkos and the lowest in Barkin – Ladi (10.2%) respectively in both dry – and rainy season. The values obtained in this work are higher than that reported by Yaroson et al. (2018); Opadotunet al.(2016).The low moisture content in the vegetables is an indication that their shelf life would be prolonged if sundry before storage and that deterioration due to microbial contamination would be limited (Dashak et al. 2001).The data obtained for the proximate analysis of the pepper agree with earlier reports and indicates that they contribute nutrients to the diet (Dashak and Nwanegbo, 2000; Nwinukaet al. 2005; Edeogaet al. 2006).

3.2 Ash Content

The Ash content of Carrot ranged from 6.00 - 13.6% and 6.77 - 13.2% in both dry – and rainy seasons. The highest percentage was found in Bokkos (13.6%) with the lowest (6.00%) recorded in Jos – South Local

Government Area, however, these value were far higher compared to the 1.33% reported by Olaludeet al.2015 and 5.05% Humairuet al. 2013.

The concentration of ash in garden egg ranged from 6.38% - 7.70% in both seasons with the highest found in Bokkos in all seasons and the lowest 6.38% in Jos – South and 7.02% in Barkin – Ladi during dry – and – rainy seasons, respectively. The value reported in this work is higher compared to that reported of Nwodoet al.(2011) and Tiagaet al. (2008), but agree with 6.81% reported by Olaludeet al. (2015.

Analysis of spinach shows ash content to range from 20.0% - 21.5% and 18.9% - 20.6% in dry – and – rainy seasons, respectively. The highest concentration was obtained in Jos – South with the lowest observed in Bokkos in both dry - and - rainy seasons. The concentration in obtained in this work agree with the value reported by Khan et al. 2013; but was however, lower than 61.2% reported by Ukom and Obi, (2018).

Ash content of pepper and tomatoes was found to range from 4.82% - 7.66% and 7.60% to 12.4% in dry – and – rainy seasons with the highest values recorded in Jos – South and the lowest in Bokkos (4.82%) for pepper and Barkin – Ladi (7.60%) for tomatoes (Tables1and 2), respectively. The values reported in this work for pepper collaborated with the report of Sharma et al. 2017 but were however, higher than the reported value of Gloria et al. 2010. The value reported in this work for tomatoes is higher compared to that reported by (Sadiq and Aliyu, 2018; Muhammedet al. 2017) but however, lower compared to 42.8% reported by Opadotunet al.(2016). Ash content of a plant material is an index of total mineral content it implies that the vegetables have appreciable mineral elements.

The ash content of cabbage ranged from 6.54% - 8.26% in both seasons with the highest concentration found in Barkin – Ladi and the lowest obtained in Bokkos and Jos – South in dry – and – Rainy seasons, respectively. The value obtained in this is collaborated with the reported value of (Khan et al 2013; Rajadevan and Schramm 1989) reported that cabbage has ash content of 9.0%, and Muinat and Learnmore, (2015), reported ash content as 16.3% which is a little higher than the value obtained in this work. However, this might be attributed to the climatic condition and soil properties of the sources of the samples. The high ash content suggest that the vegetables has mineral substance that are nutritiously required for the body.

3.3 Crude Protein)

Proteins are the main components of nucleic acid, cell membrane and other cell organelles. The crude protein in dry - and rainy – seasons for tomatoes was found to range from 13.6% - 14.6% and 13.1% - 14.8% with the highest value obtained in Barkin – Ladi (14.8%) in and the lowest in Bokkos in both dry and rainy season (Tables 1a and 1b), respectively. The reported value of protein in this work is higher than the value obtained by Muhammedet al.(2017) and Sadiq and Aliyu, (2018), (2.6% and 4.05%), respectively but however, collaborated with 15.8% reported by Opadotunet al. (2016).

The result obtained for garden egg show a range 2.42% - 13.2% and 2.40 – 18.2% in dry – and – rainy season, respectively. The highest concentration was found in Barkin – Ladi and the lowest in Bokkos in both seasons respectively. The lowest value reported in this work agree with result obtained (Olaludeet al. 2015; Tiagaet al. 2008 and Autaet al. 2011). Tabitha (2013) reported a protein content of same species (Solanummelongena) to be 16.25% though lower than highest value obtained in plateau state north central Nigeria.. The variation in protein content may be due sources of the species as these samples were collected from tin mining area and farms irrigated with tin mining pond waters, while Tabitha's samples were collected from Northern Guinea Savanna ecological zone.

The mean value of the crude protein for carrot were 7.92% Bokkos, 13.7% Barkin – Ladi and 5.87% Jos – South in dry seasons while 8.20%, 12.7% and 6.94% were obtained in rainy season, respectively. The protein content obtained in this work is higher compared to the reported value of 4.35% by Ukom and Obi, (2018). This might be due the climatic conditions and mining activities that has devastated the soil nutrient which increases the high amount of protein in the carrot.

The mean protein in spinach was found to be 15.1%, 8.67%, 14.8% in dry season and 14.9%, 8.01%, 13.9% in rainy season, respectively. The highest value in both dry and rainy season was found in Bokkos while the lowest in Barkin – Ladi. These values are low compared to the findings of 17.3% reported by Khan et al(2013).

Pepper in this study has a mean protein of 2.91%, 13.2% and 7.31% in Bokkos, Barkin – Ladi and Jos – South in dry season, while in rainy season the mean content was 2.89%, 8.82% and 8.97%, respectively. The highest mean was obtained in pepper irrigated with mining pond water in dry season at Barkin – Ladi and lowest at Bokkos in rainy season. Though, the mean in other local government studied agree with report of Sharma et al.(2017), the high value in this work is similar to that reported value 12.5% by FAO, (2009).

The mean crude protein in irrigated cabbage with mining pond water in dry season ranged from 1.86 – 3.21% and rainy season 2.06 – 3.71%. The values obtained look similar this is because the samples were pick from mining site in both seasons. The highest value was observed in Barkin – Ladi (3.71%) in rainy season though less than the reported value of 9.59%, 13.34% and 11.9% by (Khan et al. 2013; MuinatLearnmore, 2015;Rajdevan and Schramm, 1989), respectively. Mohammed and Luka (2013) reported the proximate composition of crude protein in cabbage (Brassica Oleracea) as 30.0% far higher than the reported value in this work.

Vegetables are known to be a good source of plant protein and hence may help in body building and repairs**.** Protein content in the treated vegetables is found to decrease in most of the studied vegetables. Heavy metals induce stress condition reduce the protein content by increasing of protease activity (Palma et al., 2002), various structural and functional modifications by the denaturation and fragmentation of proteins (John et al., 2009), DNA- protein cross-links (Atesiet al., 2004), interaction with thiol residues of protein and replacement them with heavy metals in metalloproteinase (Pal et al., 2006). Monterioet al., 2009 also highlighted the reasons behind the decrease of protein content and showed that decrease the synthesis of protein and increase the rate of protein degradation. Nayeket al., 2010 also highlighted the increase of protein content in the treated vegetables due to higher synthesis of metal binding proteins or plant-metal chelators and antioxidant enzymes in response to metal stress (Grataoet al., 2008). The increase of protein content under heavy metals stress also due to the induce synthesis of stress proteins such as enzymes involved in Kerbs cycle, glutathione and phytochelatin biosynthesis and some heat shock proteins (Verma and Dubey, 2003; Mishra et al., 2009). The low value obtained might be due to the irrigation of the farms with tin mining pond water which is believed to contain some heavy metals the suppresses the formation of protein by plants.

3.4 Crude Fibre

The crude fibre was determined and found to range from 0.19 - 27.8% in the three local government areas studied in both the irrigated vegetables with mining pond water in dry season and that planted in rainy season within the farm vicinity. The crude fibre in the vegetables were tomatoes 0.19 – 3.12%, garden egg 2.98 – 13.9%, pepper 12.7 – 28.7%, cabbage 3.38 – 13.1%, carrot 4.12 – 22.4% and spinach 6.50 – 24.3% in dry season. The highest was obtained in dry season was in pepper grown in Jos – South and the lowest in tomatoes cultivated in Jos – South. The mean crude fibre of the vegetables cultivated at mining pond vicinity in rainy season were tomatoes0.21 – 3.54%, garden egg 3.12 – 13.7%, pepper 12.5 – 27.8%, cabbage 3.19 – 12.4%, carrot 4.24 – 21.9% and spinach 6.87 – 23.9% The highest was obtained from Jos – South (27.8%) in pepper, while the lowest in Barkin – Ladi (0.21%) in tomatoes. Sharma et al. (2017) reported similar findings on the proximate composition of pepper (capsicum annuum) commonly consumed in Nigeria as crude fiber, 12.7%This high value of crude fibre collaborated with the value reported by Humairaet al. 2013. The result of the crude fibre, content in this work is in agreement with that reported by Ali, 2010; Autaet al. (2011) on garden egg. These values are in accordance with the report of Akindahunsi and Salawu, (2005) but, lower than the reported value of 33.3% by Mohammed and Luka, (2013); 19.19% Muinat and Learnmore, (2015) for cabbage. Dietary fiber is important in intestinal health and in prevention of excess cholesterol absorption. Dietary fibre, mainly cellulose and hemicellulose add bulk to the diet, ease waste elimination and prevent absorption of excess starchy diets which protects metabolic conditions against hypercholesterolemia, diabetes mellitus (Khan et al. 2013). The crude fiber content in the leaves of this study is low but can still make significant contribution to dietary intakes since fiber lowers the body cholesterol level, thus decreasing the risk of cardiovascular diseases Hanifet al. 2006.

3.4 Fats and Carbohydrate

The fats and carbohydrate content in the vegetables ranged from 0.83% - 4.48% and 35.4% - 81.1% (Tables 1 and 2) in dry- and – rainy season respectively. Wakiliet al. (2015) in his work on the proximate composition of some Horticultural products in Northern Nigeria reported 0.06% value fat. The result of the carbohydrate content in this work is in agreement with that reported by Ali, 2010; Autaet al. (2011) on garden egg. These values are in accordance with the report of Akindahunsi and Salawu, 2005. Mohammed and Luka (2013) reported the proximate composition of cabbage (Brassica Oleracea), Crude Fat content of garden egg to be 0.52%. Rajadevan and Schramm (1989) reported that cabbage has a crude fat 3.1% and carbohydrate content of 62.6%. Gloria et al. (2010); Sharma et al. (2017) reported similar findings on the proximate composition of pepper (capsicum annuum) commonly consumed in Nigeria as 12.7% Crude Fat, and 62.9% Carbohydrate. The total carbohydrate content also showed irregular response with the accumulation of heavy metals in the vegetables. In this study, total carbohydrate decreased in treated vegetables than control except garden egg and cabbage (Table 1). All the values of total carbohydrates are significantly differs in treated plots vegetables as compared with the grown vegetables in rainy season even though they were planted in the vicinity. It may be due to the restriction in the biosynthesis of carbohydrates and in case of garden and cabbage it is possibly due to adaptive mechanism in stress condition (Verma and Dubey, 2001). Decreased in total sugar content in the heavy metals treated vegetables are supported the findings of (Ahmad et al., 2007; Singh et al., 2007; John et al., 2008 and Bamniyaet al., 2010).

The result of the carbohydrate content in this work is in agreement with that reported by Ali, 2010; Autaet al. (2011) on garden egg. These values are in accordance with the report of Akindahunsi and Salawu, 2005. Mohammed and Luka (2013) reported the proximate composition of cabbage (Brassica Oleracea), Crude Fat content of garden egg to be 0.52%. Rajadevan and Schramm (1989) reported that cabbage has a crude fat 3.1% and carbohydrate content of 62.6%. Gloria et al. (2010); Sharmaet al. (2017) reported similar findings on the proximate composition of pepper (capsicum annuum) commonly consumed in Nigeria as 12.7% Crude Fat, and 62.9% Carbohydrate.Miunat and Learnmore, (2015), reported fat content in cabbage as 7.94% higher than recorded value in this work with low carbohydrate content 43%. Fat is good source of energy and a medium for dissolving vitamin A, B, E and K and its deficiency may results in suboptimal growth, fatty liver problem and susceptibility to respiratory disease (Tabitha, 2013; Ogunmoyelaet al. 2013).

3.5 Mineral Contents in Vegetables

The results in figures below revealed the mineral content of six vegetables irrigated with tin mining pond water and those planted at the vicinity in dry – and - rainy seasons namely: Carrot (Daucuscarota), Pepper (Capiscumannuum), Spinach (Spinaciaoleracea), Cabbage (Brassica oleracea), Garden Egg (Solanummelongena) and Tomatoes (Lycopersicumesculentum). In the vegetables, mineral contents such as potassium, sodium, calcium and phosphorus varied significantly.

Potassium content in the vegetables

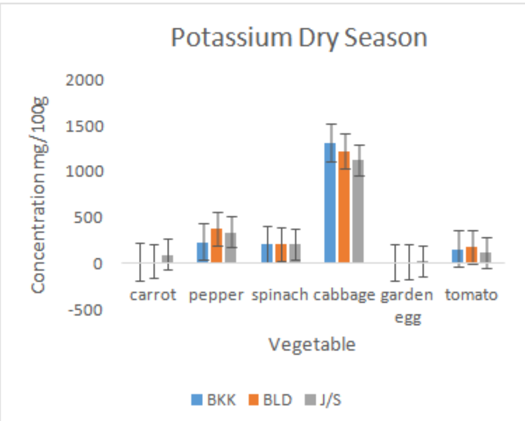
Thethree study sites Bokkos, Barkin – Ladi and Jos – South revealed Potassium concentrations in all the six vegetables studied were high. Potassium is a macronutrient and a major intracellular cation in the human body. Its deficiency causes nerve irritability, cardiac and mental disorder, muscular weakness and paralysis. Potassium also facilitates the transmission of nerve impulses. Results in (Fiqure 1a and b) below.

Result of carrot in the three study areas;Bokkos, Barkin – Ladi and Jos – South revealed that potassium was significantly higher in Jos – South with the ranged of 23.7 - 102 mg/100g and lower in Bokkos 20.3 – 97.4 mg/100g in dry – and – rainy season respectively. The highest value in this work is in agreement with reported value (Hanifet al. 2006).

In pepper, potassium contents ranged with mean of 239 - 384mg/100g and 374mg/100g in with the highest concentration found in Barkin – Ladi in both dry – and- rainy seasons, while the lowest value was foundinBokkos with the range of 224 – 374 mg/100g during rainy season. The values obtain in this workfor pepper are in agreement with the value obtained by Gloria et al. (2010) but lower compared to (5041mg/100g) reported by sharmaet al.(2017) and higher the value reported Hanif, et al. 2(006).

The mean content of potassium in spinach under consideration ranged from from 210 – 216 mg/100g and 198 – 212m g/100g with the highest mean of obtained in Jos – South as 216mg/100g in both in dry – and – rainy season. The lowest value was seen in Barikin – Ladi 198mg/100g in rainy season. The concentration of potassium in spinach irrigated with tin mining pond water in this work is higher compared to the 210mg/100g reported by Ukom and Obi with the exception of the values obtained in rainy season.

For cabbage, the potassium content was in the range of 1132 – 1317 mg/100g and 1218 – 1303 mg/100g. The highest value was recorded in Bokkos and both in dry – and – rainy seasons, respectively. The values obtained in this work for potassium, are far higher than the value 12mg/100g obtained by Hanifet al. (2006) and lower compare with findings reported 1917mg/100g, by Yahaya and Iyaka, (2014).



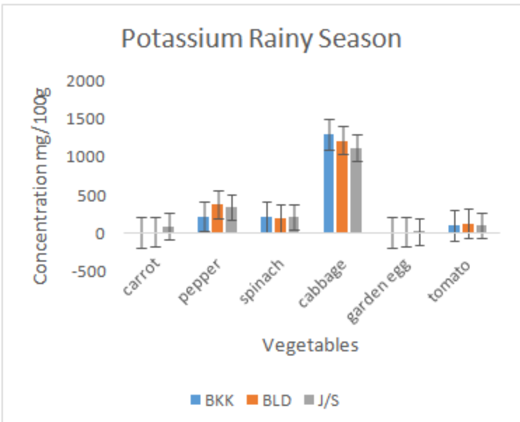


Fig.a Fig.b

Figures a and b showing concentration of Potassium in Dry and Rainy Seasons

Potassium in garden egg was found to vary from 17.7 – 26.2 mg/100g and 16.6 – 24.4mg/100g. Garden egg show highest mean potassium content in Jos – South 26.2 mg/100g and the lowest mean value were found in Bokkos in the two seasons, these values are higher than the reported values potassium 17.64mg/100g, by Kadiriet al. (2015) and lower than the reported value of 104.5mg/Kg by Wakil, et al. (2015).

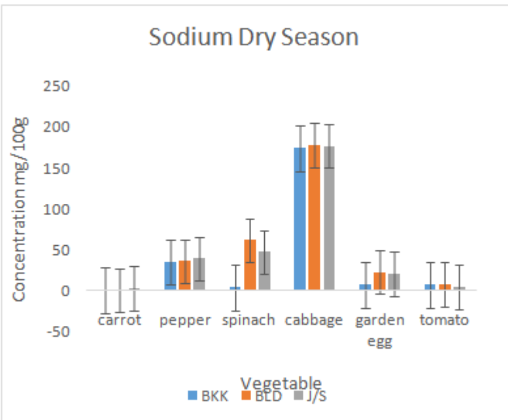
The mean of potassium content in tomatoes was found to be at the ranged of 124 – 183 mg/100gand 111 – 134 mg/100g in dry –and - rainy seasons, respectively.The highest and the lowest mean value were obtained in Barkin – Ladi 183mg/100g in the tomatoes irrigated with tin mining pond water and 134mg/100g during rainy season cultivated within the vicinity of the mining ponds.The concentration of potassium from this work is in agreement with the result 114mg/100g obtained by Hanifet al.2006 and lower compared with reported value of 783mg/100g by Shina and Tambai, 2018.

The results from the study shows that potassium content in cabbage irrigated with tin mining pond has the highest concentration (1317mg/100g) in Bokkos with the lowest mean content (16.6mg/g) found in garden egg during rainy season in Bokkos.However, some of the contents of potassium in garden eggs overlapped with the contents in other vegetables. The marked variation in the concentration of potassium in the vegetables might be due to the levels of potassium in the soils in which the vegetables were cultivated and tin mining water. In addition, the nutrient levels in soils vary geographically. The high potassium content in cabbage may be attributed to the preferential uptake of potassium from the soil by the cabbage. In addition, the content may have been influenced by genetic diversity. Amendment of the soil by the application of top dressings and agrochemicals could also have had a significant influence on the potassium content in the soil, thereby affecting the content in the vegetables.

Sodium content in the vegetables

Sodium content in the vegetables from the sites Bokkos, Barkin – Ladi and Jos – South was analyzed and the mineral content of sodium in carrot ranged from 0.57 – 3.24 in the two seasons with the highest concentration obtained Jos – South (3.24mg/100g) in dry season and the lowest at Barkin – Ladi (0.57mg/100g) (Figure 1c and d). The value in this work is lower compared reported value 32.0mg/100, ofHanifet al. 2006 and 170mg/100gby Yahayaet al.(2014).

The concentration in pepper ranged from with mean of 35.0 – 39.4mg/100g and 32.5 – 37.6mg/100g in dry – and – rainy season, respectively. The highest concentration was found in Jos – South 39.4mg/100g and 37.6mg/100g both dry – and- rainy seasons, while the lowest value was found in Barkin – Ladi 32.5mg/100g in rainy season grown pepper.



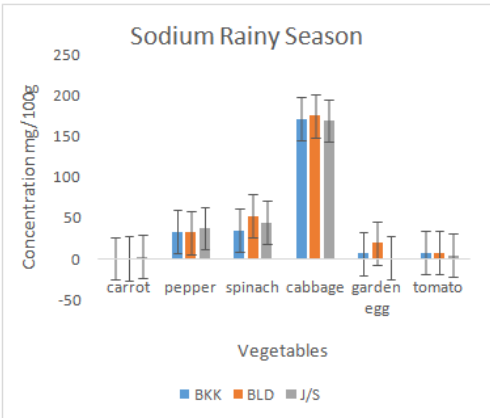


Fig.c Fig.d

Figures c and d showing concentration of Sodium in Dry and Rainy Seasons

The results obtained in this study shows a close agreement with those found in literature (Gloria et al. 2010 and Oke, 1988). The differences in chemical composition is not unexpected, as some of the factors might be linked to species, climate, growing conditions, nature of soil, application of tin mining pond water or artificial manure and period of analysis.

The mean content of sodium in spinach ranged from from 3.83 – 61.8 mg/100g and 34.3 – 52.4 mg/100g with the highest mean of obtained in Brakin - Ladi as 52.4mg/100g in both in dry – and –rainy season. The lowest value was seen in Bokkos 3.83 mg/100g in dry season. The concentration in spinach irrigated with tin mining pond water in Bokkos is the same compared to the 3.83 mg/100g reported by Ukom and Obi with the exception of the values obtained in rainy season. Some concentrations of sodium in the sites were higher than the value of 58.0 mg/100 reported by Hanifet al. 2006.

For cabbage, the sodium content was in the range of 167 - 178 mg/100g and 169 - 175 mg/100g. The highest value was recorded in Barkin - Ladi and both in dry – and – rainy seasons, respectively. The values obtained in this work for sodium, are far higher than the value 8.0mg/100g obtained by Hanifet al. (2006) and 170mg/100g, by Yahaya and Iyaka, (2014) but however, lower compared with findings of 982mg/100g reported by Muinat and Learnmore, (2015); Adoteyet al. (2009). It was observed that majority of the minerals considered were more in the dry season compared to rainy season showing that mining pond water influences the mineral content.

Sodium in garden egg was found to vary from 7.02– 23.0 mg/100g and 6.89 –19.7 mg/100g. Garden egg show highest mean content was in Jos – South 26.2 mg/100g and the lowest mean values of garden egg were found in Bokkos in the two seasons. These values are higher compared to the reported sodium 7.02mg/100g by Kadiriet al. (2015) and lower than the reported value of 3.79mg/Kg by Adoteyet al. (2009). There was no significant variation in the sodium contents in garden egg and onion. This could be attributed to the sodium content in the soils in which the garden egg and onion were grown, even though they might not have come from the same geographical location.

The mean concentration of sodium in tomatoes irrigated with tin mining pond was found to be at the ranged of 4.64 – 7.65 mg/100g and 4.38 – 7.23 mg/100g in dry –and - rainy seasons, respectively. The highest and the lowest mean value were obtained in Barkin – Ladi 7.65mg/100g and Jos – South 4.38 dry - and - rainy season tomatoes cultivated within the vicinity of the mining ponds. The concentration of sodium from this work is collaborated with reported of Kadiriet al. (2015) and far lower compared to the 75.8 mg/100g reported by Shina and Tambai, (2018).

Variation in the sodium content in tomato were significant. The variations in the content of sodium in, cabbage, pepper, spinach, carrots and tomato may be attributed to factors such as the preferential uptake of sodium by these vegetables, which can also be influenced by the age of the plant. Ambient climatic conditions and mineral composition of the soil in which the vegetables were grown as well as the type of fertilizer and pesticides sprayed might have influenced the concentration of the elements obtained. Sodium is a major physiological element and a primary extra – cellular cation in humans. Na,Cl and K are electrolytes that maintain normal fluid balance inside and outside cells and a proper balance of acid and bases in the body. Deficiency of this element may result in muscle cramp and hypertension.

Calcium content in the vegetables

The concentration of calcium in carrot was found to vary from 0.77 – 3.24mg/100g and 2.81 – 4.12 mg/100g in vegetable irrigated with tin mining pond and those grown within the vicinity in rainy season. The highest value was obtained from Barkin – Ladi 4.12mg/100g while the lowest at Bokkos 2.80 mg/100g in dry – and – rainy seasons respectively in (figure .1e and f).The value of calcium recoded in this work is lower than the reported literature value of 39.0 mg/100g by Hanifet al. 2006 and 174.7mg/100g reported by Yu Zou (2015).
The mean concentration of calcium in pepper 2.93 – 8.46 mg/100g and 1.98 – 6.46mg/100g in dry – and – rainy seasons. The highest value of 8.46mg/100g was found in dry season at Jos – South and the lowest 1.98mg/100g in rainy season at Bokkos. Sharma et al (2017) reported 60.12mg/100g, Gloria (2010) reported 23.45mg/100g mean pepper higher than the mean reported in this work. The differences in chemical composition is not unexpected, as some of the factors might be linked to species, climate, growing conditions, nature of soil, application of tin mining pond water or artificial manure and period of analysis.

The mean content of calcium in spinach was found to range from 78.4 – 86.7 mg/100g and 73.8 – 84.9 mg/100g in the irrigated tin mining pond water vegetable and the rainy season cultivated spinach. The highest value was recorded in Jos – South 86.7mg/100g and the lowest at Barkin – Ladi 73.8mg/100g in dry – and – rainy seasons, respectively. The result obtained in this workisagreement with Hanif et al. 2006, and higher compared to the concentration of calcium 55.0 mg/100g reported by OLaludeet al. 2015 and lower compared to 241.4mg/100g reported by Ukom and Obi (2018).

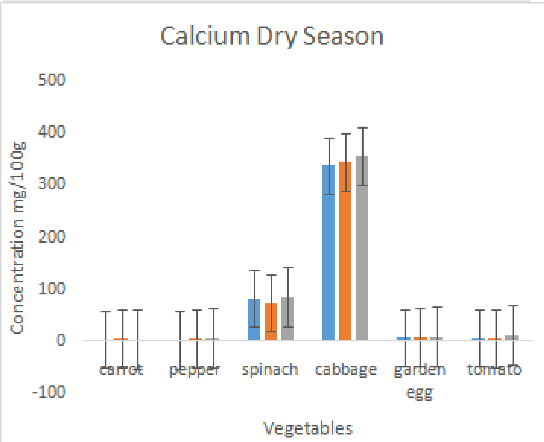


Fig.e

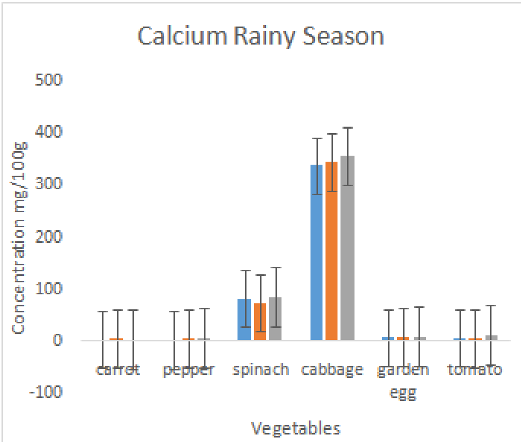


Fig.f

Figures 1e and f showing concentration of Calcium in Dry and Rainy Seasons

It was also observed that the mean calcium content in cabbage range from 347 – 369 mg/100g in irrigated vegetable with tin mining water pond and 339 – 357mg/100g in rainy season. The highest concentration was obtained in Jos – South with the lowest at Bokkos. The values obtained in this work for calcium is far higher than the one obtained by Hanif et al. (2006) and lower compared with findings report of 387mg/100g by Yahaya and Iyaka, (2014). The observation is that majority of the minerals considered were more in the dry season compared to rainy season showing that mining pond water influences the mineral content.

Calcium in garden egg was found to vary from 7.13 – 10.4 mg/100g and 6.95 – 9.45 mg/100g in dry – and – rainy season respectively. The highest value was recorded in Jos – South 10.4 mg/100g and least in Bokkos 6.95 mg/100g in rainy season. These values are higher than the reported values calcium 7.02mg/100g Kadiriet al. (2015) and lower than the reported value of 77.3mg/100g calcium by Wakil, et al. (2015

The mean of calcium in tomatoes in dry – and – rainy season was found to range from 0.62 – 14.3 mg/100g and 5.74 – 12.1 mg/100g. The highest value of 14.3 mg/100g was found vegetable irrigated with tin mining pond water and lowest was 0.62 mg/100g found in Barkin – Ladi. The concentration of calcium from Bokkos in this work is in agreement with the values 7.49 mg/100g reported by Kadiriet al. (2015). The results from the study show high calcium content in cabbage to have the highest value in both dry – and rainy season 369 and 357 mg/100g.The mean content in tomato was the lowest (0.62 mg/100g. Carrots and pepper contains appreciable levels of calcium. Even though plant foods like vegetables can be excellent sources of several minerals, the mineral content of plant food can vary dramatically depending on the minerals in the soil where the plants are cultivated. The maturity level of a vegetable can also influence its mineral content. These factors could have accounted for the wide variation in the content of calcium in the vegetables. Other soil factors which may have influenced the variations are pH and salinity. Calcium acts as the main structural element of bones and teeth in humans. Calcium is also essential for the formation of fibrinogen which is vital for blood clotting. Low Ca intake causes deficiency in the body leading to osteoporosis. Calcium deficiency may also cause rickets in children. The functions of calcium in the human system demand sufficient intake of this mineral. The study revealed that vegetables grown in the Plateau state contain appreciably high content of calcium. Though the calcium content in some of the vegetables are relatively low, these vegetables are good sources of calcium. The quantification of these minerals in higher amount in the vegetables is an indication that the plants are rich sources of most essential minerals and that could explain why vegetables of these plants are cultivated and consumed in this part of the country (Ebrahimet al . 2012).

Phosphorus content in the vegetables

The mean content of phosphorus ranged from 2.60 – 3.70 mg/100g and 2.23 – 3.26 mg/100g with the highest mean of obtained in Bakin – Ladimg/100g and 2.23 mg/100g found in Jos - South in carrot both in dry – and –rainy season, respectively. This result is lower than the reported work of 26.0 mg/100g by Hanif et al. 2006 and higher the 0.511 mg/100g reported by Jolly et al. (2013).

The phosphorus content of pepper in all the selected sites varied comparatively, with a mean range 9.89 mg/100g – 14.9 mg/100g and 10.2 – 16.4 mg/100g. The highest mean was found to be 16.4 mg/100g in Jos – South in vegetable grown in the vicinity of the mining ponds and the lowest 9.89 in Bokkos irrigated vegetables with tin mining pond water in dry season.Comparingmean phosphorus content, it observed that they were very low thus, shows a close agreement with those found in literature (Gloria et al. 2010; Oke, 1988; Muinat and Learnmore 2015); they were lower compared to 27.0 mg/100g reportedbyHanifet al. 2006).

Phosphorus mean ranged spinach were in range of 82.3 – 98.2 mg/100g and 81.6 – 92.3 with the highest mean of obtained in Bokkos as 98.2mg/100g vegetable irrigated with mining pond water and 81.6 mg/100g found in Barkin - Ladi in carrot both in dry – and –rainy season, respectively. The result obtained in this work is in agreement with the reported value of 84.0 mg/100g by Hanif, et al. (2006) and lower compared with 127.2 reported by Jolly et al. (2013).

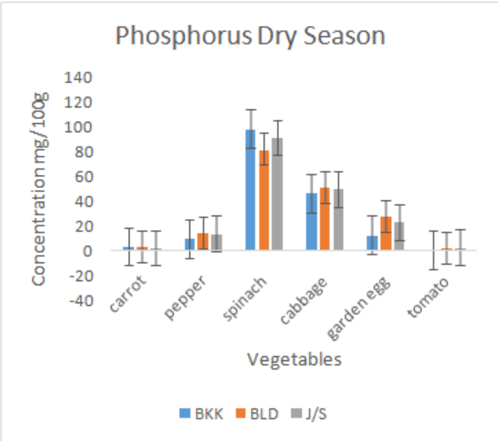


Fig.g

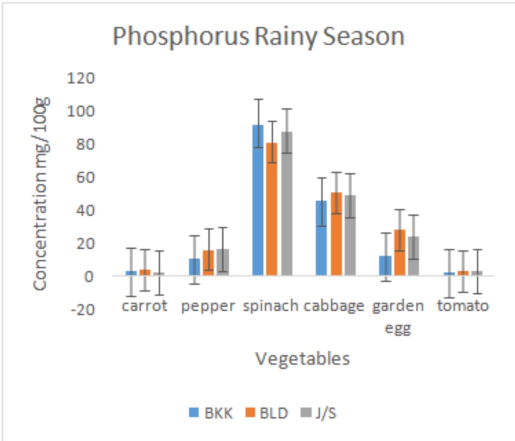


Fig.h

Figures1g and h showing concentration of Phosphorus in Dry and Rainy Seasons

The mean content of phosphorus in cabbage under consideration ranged from 46.2 – 51.3 mg/100g intin mining pond water irrigated vegetables and 45.1 – 50.4 mag/100g with the highest mean of obtained in Jos – South as 51.3mg/100g and lowest 45.1 mg/100g in both dry – and –rainy seasons. The concentration reported in this work is far higher compared with 0.56 mg/100g reported by Muinat and Learnmore, (2015) and a little above the reported literature 44.0 mg/100g by Hanif et al. (2006).

Garden egg shows a mean phosphorus concentration range of 12.8 – 27.5 mg/100g during the irrigation season in Jos – South and a range of 11.8 – 28.2 mg/100g. The mean value 28.2 mg/100g in rainy season was the highest mean of phosphorus and lowest obtained was 11.8 mg/100g also in rainy season. The results obtained in both seasons are alike and higher than 7.02mg/100g reported by Kadiriet al. (2015).

The concentrations of phosphorus in tomato samples analysed ranged from 1.02 - 2.97 mg/100g and 1.68 – 2.95 in both dry – and – rainy seasons. The highest mean value was obtained for in Jos Southinthetomatoirrigated with tin mining pond water, while the lowest was observed in Bokkosin dry season irrigated tomato. The concentration of phosphorus from Bokkos in this work is in agreement with the values 1.02mg/100g reported by Kadiriet al. (2015) and the value 2.84 mg/100g reported by Shina and Tambai, (2018) collaborated with the reported results in this work from Barkin – Ladi and Jos – South local government areas.

Comparing the result of the dry and rainy season it is observed that even though all the vegetables have their highest mineral contents during dry season, the concentration of the vegetables during rainy season were also appreciably high as these vegetables even though not irrigated during the season they were planted in the same vicinity. This might have been as a result of water runoff and washing of the piled dumps of mining soil around the sites invstigated.

3.6 Conclusion

In conclusion, the results of the proximate analysis and mineral content of the commonly consumed vegetable irrigated with tin mining pond water indicated that, Carrot (Daucuscarota), Pepper (Capiscumannuum), Spinach (Spinaciaoleracea), Cabbage (Brassica oleracea), Garden Egg (Solanummelongena) and Tomatoes (Lycopersicumesculentum) contain very useful quantity of food classes necessary for the maintenance of good body health. It is therefore, recommended that Government and Non-governmental Organizations should assist in providing storage facilities to guard against spoilage and farming incentives be provided to the local farmers with little or no difficulty to, so as to improve on the present production level for economic enhancement of the farmers involved. Monitoring of the mining pond water is very important to avoid contamination and enrichment of the vegetables with heavy metals. Extension services is also needed to adequately provide for enhanced production of local varieties of horticultural crops to be improved.

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References

[1]. Adotey D. K, Serfor-Armah Y, Fianko J. R and Yeboah P. O (2009). Essential elements content in core vegetables grown and consumed in Ghana by instrumental neutron activation analysis. African Journal of Food Science. 3(9):243-249.
[2]. Ajewole K.(1999). Analysis of the nutritive elements in some Nigerian leafy vegetables. Proceedings23rdAnnual NIFST Conference, Abuja. 25-27.
[3]. Akindahunsi A. A, Salawu S.O (2005). Phytochemical screening and nutrient- anti nutrient composition of selected tropical green vegetables, African Journal Biotechnology4:497-501.
[4]. Ali, H. H. and Khairia, M. Al-Qahtani (2012). Assessment of some heavymetals in vegetables, cereals and fruits in Saudi Arabian markets. Egyptian Journal of Aquatic Research, 38:31–37.
[5]. Ali, I. (2010). Proximate and Phytochemical Analyses of Bitter Garden Egg (Solanumincanum). B.Sc Thesis, Kaduna State University. 42 pp.
[6]. AOAC.2012.Official methods of analysis. 19th ed., Association of Official AnalyticalChemists (AOAC), Washington, DC, USA.
[7]. Atesi, I., Suzen, H.S., Aydin, A., Karakaya, A (2004). The oxidative DNA base damage in tests of rats after intraperitoneal cadmium injection. Biometals 17:371-377.
[8]. Auta, R, James S. A, Auta, T. and Sofa, E. M. (2011). Nutritive value and Phytochemical Composition of Processed Solanumincanum (Bitter Garden Egg). Science WorldJournal, (3):5-6
[9]. Aliyu H. M (2006). Proximate analysis of some leafy vegetables (Roselle, Jute and Bitterleaf). International J. Food Agric. Res. **3**(1): 11-14.
[10]. A.O.A.C., 2000. Official method of analysis, 17th edn. Vol. 1&2. Horowitz edition intern,Maryland, USA. Washington DC. Pp. 452 456.
[11]. Bamniya, B.R., Kapasya, V. and Kapoor, C.S. (2010). Physiological and biochemical studies on the effect of waste water on selected crop plants. Biological Forum – An International Journal, **2**(2): 1-3
[12]. Dashak DA, Edeoga HO, Okwu DE, Mbaebie BO (2005). Phytochemical constituents of some Nigerian medicinal plants. African Journal of Biotechnology. 4(7): 685-688.
[13]. Dashak DA, Nwanegbo VN (2000). Chemical composition of the seeds and calyx of Hibiscus sabdariffa grown in Jos North L.G.C of Plateau State. African Journal of Natural Sciences. **3**(10): 6-9.
[14]. Ebrahim, A., K.M. Mohammad, M. Maral and R.B. Hamid. 2012. Effects of bio, mineral nitrogen fertilizer management, under humic acid foliar spraying on fruit yield andseveral traits of eggplant (Solanummelongena L.). African Journal of Agricultural Research **7**(7):1104-1109.
[15]. Edeoga H. O, Omosun G and Uche L. C (2006). Chemical Composition of hyptissuaveolens and Ocimumgratissimum hybrids from Nigeria. African Journal of Biotechnology. **5**(10):892-895.
[16]. Ezeh H. N, Chukwu E, (2011). Small scale mining and heavy metals pollution of agricultural soil. Nig. J. Geol. Mining Res. 3(4): 87-104.
[17]. FAO Corporate Document Repository (2006b). Proximate Composition of Foods. [Http:/Www.Fao.Org/Ag].
[18]. FAO. United Nations Food and Agriculture Organization. Increasing fruit and vegetable consumption becomes a global priority; 2003.Available:http://fao.org/english/newsroom/f ocus/2003/fruitveg1.htm
[19]. Gloria A. O, Oyelola B. O, Adenike T. O and Anthony J. A (2010) Comparative analysis of the chemical composition of three spices – Allium sativum L. Zingiberofficinale Rosc and Capsicum frutescens L. commonly consumed in Nigeria. African Journal of Biotechnology, **9**(41):6927-6931.
[20]. Humaira G, Altaf H. M, Heena J, Saima A and Ambreen M (2013). Proximate Composition of Carrot Powder and Apple Pomace Powder. International Journal of FoodNutrition and Safety, **3**(1): 25-28
[21]. ImaobongU and Promise E (2013). Assessment of Proximate Compositions of Twelve Edible Vegetables in Nigeria. International Journal of Modern Chemistry,**4**(2): 79-89.

[22]. John R, Ahmad P, Gadgil K, Sharma, S(2009). Heavy metal toxicity: Effect on plant growth, biochemical parameters and metal accumulation by Brassica juncea L. International Journal of Plant Production **3**(3), 65-76.
[23]. Jolly N. Y, Islam A and Akbar S (2013). Transfer of metals from soil to vegetables and possible health risk assessment. Springer Plus; 2:385
[24]. Kadiri, M, Ojewumi, A.W and Olawale, S. (2015). Minerals, vitamins and chlorophyll contents of fruits, stems and leaves of tomato and garden egg Pakistan Journal of Food Science, 2**5**(3): 150-154
[25]. Kabir A. S, Mohammed S. H, Muazu A. A and Aishatu M. K (2017). Assessment of heavy metals contamination of soil and water around abandoned Pb-Zn mines in Yelu,Alkaleri Local Government Area of Bauchi State, Nigeria International ResearchJournal of Environmental heathvol.**4**(5):72-77.
[26]. Khan, K., Lu, Y., Khan, H., Ishtiaq, M., Khan, S., Waqas, M., Wei, L. andWang, T. (2013). Heavy metals in agricultural soils and crops and their health risks in Swat District, Northern Pakistan. Food and Chemical Toxicology, 58: 449-458.
[27]. Lyimo, M., Nyagwegwe, S. and Mnkeni, E. 1991. Investigation of the traditional food processing, preservation and storage methods on vegetable nutrients: A case studyof Tanzania. Plant Food Human Nutrition, 41:53-57.
[28]. Mishra, A., Tripathi, B.D. (2008). Heavy metal contamination of soil, and bioaccumulationin vegetables irrigated with treated wastewater in the tropical city of Varanasi,India. Toxicological and Environmental Chemistry, **90**(5):861-871.
[29]. Mohammed, A and Luka, C. D (2013) Comparative Analysis of the Different Brassica OleraceaVarieties Grown on Jos, Plateau Using Albino Rats. IOSR Journal ofPharmacy and Biological Sciences (IOSR-JPBS). **6**(2):85-88.
[30]. Mohammed, S. M, Abdurrahman, A. A. and Attahiru M. (2017). Proximate Analysis and Total Lycopene Content of Some Tomato Cultivars Obtained from Kano State, Nigeria. Chemical Search Journal **8**(1): 64 – 69.
[31]. Muhammad Tayyeb, Nadeem Rashid, Safi Ullah Khan Achakzai, Saif Ur Rehman,Waseem Akhtar, Kamran Baseer and Muhammad Sabir (2017). Mineral profile and proximate analysis of fresh and waste water irrigated cabbage from QuettaBalochistan. Pure and Applied Biology. http://dx.doi.org/10.19045/bspab.
[32]. Muinat N. Lewu, and LearnmoreKambizi (2015). Nutritional Assessment of Selected Leafy Vegetables. International Conference on Biotechnology and Food Technology (ICBFT'15) July 14-15, 2015 Harare (Zimbabwe).
[33]. Nayek, S., Gupta, S., Saha, R. N (2010). Metal accumulation and its effects in relation to biochemical response of vegetables irrigated with metal contaminated water and wastewater. Journal of Hazardous Materials 178:588-595
[34]. Nwinuka NM, Ibeh GO, Ekeke GI (2005). Proximate composition and levels of some toxicants in four commonly consumed spices. Journal of Applied Sciences andEnvironmental Management. **9**(1):150-155
[35]. Nwodo S.C, Abayomi C. O, Okwuchukwu K. E, Opeyemi C. E, Olajumoke K. A and Damilola I. D (2011). Proximate and Phytochemical Analyses of SolanumaethiopicumL.andSolanummacrocarponL. Fruits. Research Journal of Chemical Sciences **1**(3):63-71.
[36]. Ogunlade I, Ilubbiyin A, Osasona A. I. (2011). A comparative study of proximatecomposition, anti-nutrient composition and functional properties of PachiraglabraandAfzeliaafricana seed flour. African Journal of Food Sciences, **5**(1): 32 35.
[37]. Ogunmoyela, O. A.., Adekoyeni, O., Aminu, F., &Umunna, I. O. (2013). A Critical Evaluation of Survey Results on Vitamin A and Iron Levels in the mandatory fortified Vehicles and Some Selected Processed Foods in Nigeria. Nigerian Food Journal. 31(2), 52-62. http://dx.doi.org/10.1016/S0189-7241(15)30077-1
[38]. Oke L. O (1988). Chemical studies on commonly used leafy vegetables in Nigeria. Journal of West African Science Association, **2**: 47- 49.
[39]. Olalude C.B, Oyedeji F.O and Adegboyega A.M (2015). Physico-Chemical Analysis of DaucusCarota (Carrot) Juice for possible industrial applications. IOSR Journal of Applied Chemistry (IOSR-JAC) 8(8):110-113.
[40]. Okewole S. A, kunle S.A, Akande, O.O, Adebisi T. T and Olubode T.P (2018). Nutritional Compositions of Selected Green Leafy Vegetables in Oyo State, Nigeria. Asian Journal of Applied Chemistry Research. **1**(1): 1-7.
[41]. Omale J and Ugwu C (2011). Comparative studies on the protein and mineral composition of some selected Nigerian vegetables. African Journal of Food Science, **5**(1):22 – 25.
[42]. Oni P. I, Malomo O, Adekoyeni O.O. (2015). Preliminary evaluation of the ecology,economic importance and nutritional potentials of Pachiraglabra (Pasq); a neglected fruit tree in Nigeria. International Journal of Current Microbiological Applied Science, **4**(2): 103- 109.
[43]. Opadotun, O.O, Adekeye, S.A, Ojukwu, E.O, and Adewumi, A.A (2016). Comparative Analysis of Nutritional Values of Tomatoes Subjected to Different Drying Condition. International Journal of Basic and Applied Sciences. **5** (1):6-9.
[44]. Pal, M., Horvath, E., Janda, T., Paldi, E., Szalai, G (2006). Physiological changes and defense mechanisms induced by cadmium stress in maize. Journal of Plant Nutrition and Soil Science **69**:239-246.
[45]. Palma, J.M., Sandalio, L.M., Javier Corpas, F., Romero- Puertas, M.C., McCarthy, I., Del Rio L. A (2002). Plant proteases protein degradation and oxidative stress: role of peroxisomes. Plant Physiology and Biochemistry**40**:521-530.
[46]. Rajadevan P and Schramm M (1989). Nutritional value of cabbage and kikuyu grass asfood for grass carp, Ctenopharyngodonidella Val. South African Journal of Animal Sciences, **19**(2):67-70.
[47]. Robinson, D. S. (1990). Food biochemistry and nutritional value. Longman scientific andtechnical publisher, New York. USA
[48]. Rumeza Hanif1, Zafar Iqbal1, Mudassar Iqbal1, Shaheena Hanif1 and MasoomaRashee(2006). Use of Vegetables as Nutritional Food: Role in Human Health. Journal of Agricultural and Biological Science, **1**(1):18-22.
[49]. Schippers RR. (2000). Economic and social importance of indigenous African vegetables: African indigenous vegetables, an overview of the cultivated species. Natural Resource Institute/ACP-EU Technical Centre for Agriculture and Rural Cooperation. Chatham, UK; 2000.
[50]. Shina I. S and Tambai I. A (2018).Comparative Nutritional Composition of RawandCannedTomatoesSolanumlycopersicum (Lycopersiconesculentum) DutseMarketJigawa State, Nigeria.Dutse Journal of Pure and Applied Sciences (DUJOPAS), **4**(2):423-433.
[51]. Tabitha, J. (2013). An evaluation of the nutritional status of some horticultural crops. Jewel Journal of Science Research, **1**(1): 44 49.
[52]. Taiga A, Suleiman M. N, Aina D. O, SuleW. F and AlegeO. G (2008). Proximate analysis of some dry season vegetables in Anyigba, Kogi State, Nigeria.African Journal of Biotechnology, **7**(10):1588-1590.
[53]. Tsafe A. I, Hassan L. G, Sahabi DM, Alhassan Y, Bala B. M (2012). Evaluation of Heavy Metals Uptake and Risk Assessment of Vegetables Grown in Yargalma of Northern Nigeria. Journal of Basic and Applied Science Research. **2(**12): 6708-6714.
[54]. Ukom A.N and Obi (2018). Comparative Evaluation of the Nutrient Composition and Phytochemical Content of Selected Vegetables Consumed in Nigeria. International Letters of Natural Sciences. 71:43-50

[55]. Van Duyn, M. A. and Pivonka, E. 2000. Overview of health benefits of fruit and vegetable consumptionforthedieteticsprofessional. Selective literature. Journal of AnimalDiet. Association. 100:1511-1521.
[56]. Wakili A, Abdullahi M. B and Madara M. S (2015). Proximate Composition of FiveCommonly Used Horticultural Products in Northern Nigeria. International Journalof Current Microbiological Applied Sciences, **4**(7): 924-928
[57]. Yaroson, A. Y.; Nanven, A. D.; *Ibrahim, Iro, I and Lawal, I. H. (2018). ComparativeAnalysis of two Different Processing Methods of Tomato (LycopersicumSolanum) Pastein Federal College of Forestry, Jos, Plateau State, Nigeria. InternationalJournal of Advanced Academic Research | Sciences, Technology & Engineering, **4**(7):1-8.
[58]. Yahaya A. I,Rahmatallah A. A and Bello U. B (2014). Nutrient content of selected edible leafy vegetables. American Journal of Applied Chemistry,**2**(3): 42-45.
[59]. Yu ZOU, Kun MA, Mixia T (2015). Chemical composition and nutritive value of hot pepper seed (Capsicum annuum) grown in Northeast Region of China, Journal ofFood Science and Technology.D httpI://dx.doi.org/10.1590/1678-457X.6803.

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