MICROBIOLOGICAL STUDY OF SELECTED VEGETABLES FROM SOME IRRIGATION FARMS WITHIN KAWO, KADUNA FOR PRESENCE OF BACTERIA AND OTHER PARASITES

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ABSTRACT

Microbiological study of selected vegetables from some irrigation farms within Kawo, Kaduna for the presence of bacteria and parasites was carried out. A total of twenty (20) vegetable samples were collected. Two (2) samples each of fresh lettuce, cabbage, spinach, ugwu leaves and spring onions were collected from two (2) different farms located in Kawo Kaduna. The percentage proximate composition of selected vegetables were investigated. Isolation and identification of the bacteria were carried out using pour plate technique and biochemical characteristics while the removal of parasite eggs, ova, larva and cysts from the vegetable substrate and concentrations were carried out using centrifugation and viewing of prepared slides were done under the microscope using 40x,100x and 400x magnifications. Antibacterial susceptibility pattern of the bacteria isolates were investigated using the agar diffusion method. There were variations in the percentage proximate compositions of the selected vegetables analyzed. The bacteria isolated and identified from the vegetables were Salmonella sp., Escherichia coli, Staphylococcus aureus and Enterobacter species while the intestinal ova, larvae, eggs and cyst of parasites identified were for Schistosoma haematobium, Ascaris lumbricoides, Trichuris trichuria, Spongyloides stercoralis and hookworm. The antibacterial susceptibility against Gram negative bacteria indicated perfloxacin to be effective against Salmonella sp. while septrin was ineffective at different concentrations. Ciprofloxacin was very effective against Escherichia coli. The antibiogram of the Gram positive bacteria indicated Zinacef to be the most effective antibiotic against Staphylococcus aureus. The bacteria and parasites isolated from the selected vegetables could pose health risk to consumers if consumed without any hygienic processing.

Keywords: Proximate, vegetables, bacteria, parasites, antibiogram

INTRODUCTION

Irrigation is the artificial application of water to land or soil food crop farming; it is used to assist in the growing of agricultural produce since it aids nutrients availability to plants in liquid form for their maximal growth and development (Inyinbor *et al.*, 2019). Irrigation is also by far the largest component of anthropogenic demand for fresh water and, as such, constitutes an essential part of the global hydrologic cycle, as illustrated by global hydrologic model simulations (Haddeland *et al.*, 2014). However, many sources of irrigation water are subject to inputs of pathogenic loads from point and nonpoint sources (Truchado *et al.*, 2018).

The water system frameworks are utilized just as the postharvest washing of vegetables,

which is of high microbial contaminations. If such water harbors pathogenic microorganisms, there may be health risks to consumers. Consequently, the promise of nutrition and health benefits from consumption of vegetables may be thwarted by infectious disease outbreaks (Olokun *et al.,* 2019). Vegetables are among the food groups implicated with greater frequency in recent years as causative agents of enteric diseases (Ma *et al.,* 2018). All types of fresh vegetables produce have the potential to harbor pathogens, including but not limited to *Shigella* sp., *Salmonella* sp., enterotoxigenic and enterohaemorrhagic *Escherichia coli*, *Campylobacter* sp., *Listeria monocytogenes*, *Yersinia enterocolitica*, *Bacillus cereus*, *Clostridium botulinum*, enteric viruses, and parasites such as *Giardia lamblia*, *Cyclospora cayetanensis*, and *Cryptosporidium parvum*. Most of these pathogens have also been associated with foodborne illnesses (Olokun *et al.,* 2019).

Raw waste water usually contains high contamination of eggs of human intestinal nematodes and the increasing use of wastewater for irrigation in the 1970s and early 1980s prompted a series of literature reviews and investigation into the global extent of waste water re-use and its associated human health risk (Amaechi *et al.*, 2016). Infection can also be a household problem where infected children or persons provide the chief source of soil contamination by their promiscuous defecation in the soils. Furthermore, market vegetables are often contaminated by eggs of human intestinal nematodes where silt soil is extensively used, as both crop consumers and the agricultural workers have been identified as being at high risk of soil and wastewater transmitted infections (Maikaji *et al.,* 2015).

In recent years, there have been an increase in the number of reported cases of food-borne illnesses linked to the consumption of fresh vegetables (Almegrin, 2010). Several surveys in different parts of the world showed that the vegetables can be agents for transmission of protozoan cysts and oocysts as (Giardia, Entamoeba, Cryptosporidium, Cyclospora, Toxoplasma and Isospora) and helminth eggs and larvae (Hymenolepis, Taenia, Fasciola, Toxocara, Ascaris, Trichostrongylus, Strongyloides and Hookworms*)* (Oliveira and Germano, 1992; Darchenkova *et al.*, 2006; Vuong *et al.*, 2006). Intestinal parasitic infections are among the most common infections worldwide (Pozio, 2008). Various epidemiological studies have indicated that the prevalence of intestinal parasites is high especially in developing countries, although in many of these, the environmental risk factors have not been clearly elucidated (Nyarango *et al*., 2008). The passive handling of fresh vegetables is usually performed by farmworkers, who wash produce with irrigation water and pack them in an unhygienic manner for retail and to point of sale. Consumers, who may engage in the habit of touching several vegetables before selecting the one they wish to purchase are also sources of contaminations of the vegetables. Worldwide, it is estimated that 18% of crop land is irrigated, producing 40% of all foods. A significant portion of irrigation water is wastewater. Aleke *et al.* (2018) estimated that at least 20 million ha in 50 countries are irrigated with raw or partially treated wastewater. Eze *et al.* (2018)

estimated that one tenth or more of the world's population consumes foods produced on land irrigated with wastewater. Wastewater and excreta are also used in urban agriculture. A high proportion of the fresh vegetables sold in many cities, particularly in less-developed countries are grown in urban and peri-urban areas (Eze *et al.,* 2018). For example, in Dakar, Senegal, more than 60% of the vegetables consumed in the city are grown in urban areas using a mixture of groundwater and untreated wastewater (Eze *et al.,* 2018). There are likely a large number of unreported cases of gastrointestinal infections that may have been due to contact with irrigation water-related microbial contaminants through passive handling of vegetables. The utilization of inundated vegetables by and large eaten unwashed, uncooked and unhygienically arranged, may prompt parasitic pervasion. The study was aimed at the microbiological study of selected vegetables from some irrigation farms within Kawo area of Kaduna for presence of bacteria and parasites.

MATERIALS AND METHODS

Study Area

The study was carried out in Kawo, Kaduna. Kaduna metropolis is located between Latitude 10°23` and 10°43` N and Longitude 7°17`and 7°37` E. The study area is tightly drawn around Kaduna's developable area. The area consists of four Local Government Areas, namely: Kaduna North and Kaduna South, and parts of Igabi and Chikun Local Governments and about 12,347 km^2. Kaduna is a trade center and a major transportation hub for the surrounding agricultural areas with its rail and road junction. The population of Kaduna was at 760,084 as of the 2006 Nigerian census.

FIG:1: MAP OF KADUNA METROPOLIS SHOWING THE STUDY AREA (KAWO) (NONA.NET)

Collection of Samples

A total of twenty (20) samples of vegetables were collected. Two (2) samples each of fresh lettuce, cabbage, spinach, ugwu leaves and spring onions were collected from two (2) different farms located in Kawo, Kaduna.

Proximate Analysis of Irrigated Vegetables

The proximate composition of the selected irrigated vegetables was analyzed according to the method described by Association of Office Analytical Chemist (AOAC) (2006); Adeniyi *et al.* (2012) and Adeyeye (2018**)**. The proximate parameters include percentage moisture content, ash, protein, fat, fibre and carbohydrate.

Preparation of Media

MacConckey Agar, *Salmonella Shigella* Agar (SSA), Muller Hinton Agar were prepared according to the manufacturer's instruction.

Processing of Vegetable Samples for Isolation of Bacteria

Twenty five (25) g of the vegetables were soaked in 225 ml of normal saline for 10 minutes to get the inoculum for each vegetables respectively. Nine (9) ml of peptone water was introduced into each test tube using sterile pipette. Serial dilution was performed using separate sterile pipette i.e. 1ml from the inoculum was introduced into the first test tube (10^{-1}). It was mixed thoroughly and 1ml was aseptically introduced into the second test tube (10^{-2}). The same procedure was done for the rest of the test tubes to six fold dilution. Exactly 1ml of each of the dilution was aseptically introduced into corresponding labeled sterile Petri dishes. Prepared nutrient agar was poured slowly into the sterile Petri dish with sample and was slightly swirled for uniform distribution of the medium. The plates were incubated for 24 hours (Mary *et al.*, 2018).

Processing of Vegetable Samples for Presence of Parasites

Each of the samples was examined carefully macroscopically for the presence of segment of adult intestinal parasites. The experimental procedure consist of the removal of eggs from the vegetable substrate, concentration and viewing of prepared slide under microscope (40x, 100x and 400x). The vegetables were soaked in normal saline solution for 30 minutes in different 20 ml beakers for the removal or elution of the parasite's ova, larva or cyst. The elute was filtered through wet gauze into a clean conical flask to remove debris. The filtrate was allowed to settle for 10 hours and decanted to obtain the sediment (Auta *et al.*, 2017). Concentration of the eggs in the sediments were done by centrifugation. The sediment was dispensed equally into centrifuge tubes and centrifuged at 5000 rpm for 5 minutes. The supernatant was decanted and the sediment was mixed. A drop of each of the sediments was applied on the center of a clean grease free glass slide, stained with lugols' iodine, a clean cover slip was placed gently to avoid air bubbles and over flooding. The preparation was examined under the microscope for any parasite form using 10x and 40x objective lens (Dankwa *et al.*, 2018).

Characterization of Bacteria Isolates from Vegetables

The characterization of bacteria isolates from vegetables were based on Grams staining and selected biochemical tests which include

Catalase test, Indole production test, Voges-Proskauer (VP), Methyl red test, Citrate, Coagulase test as described by Amaechi *et al.* (2016), Dankwa *et al.,* (2018), Ma *et al.* (2018), Inyinbor *et al.,* (2019), Olokun *et al.* (2019).

Standardization of Inoculum

Turbidity standard equivalent to McFarland 0.5 was used to adjust the turbidity (concentration) of the inoculum for antimicrobial susceptibility tests. A 0.5 McFarland Standard is a chemical solution of barium chloride (0.05 mL of 1% $BaCl_2$) and sulphuric acid (9.95 mL of 1% H_2SO_4); the reaction between these two chemicals results in the production of a fine precipitate of barium sulfate. When shaken well, the turbidity of this McFarland Standard is visually comparable to an approximate bacterial suspension of 1.0 x 10^8 CFU/mL.

Antimicrobial Susceptibility Testing of Selected Antibiotics against the Bacteria Isolates

Mueller Hinton Agar was prepared according to the manufacturer's instructions. A suspension of the bacteria to be tested were prepared to equal the turbidity of a 0.5 McFarland standard (1×10^8) colony forming units (CFU) ml^{-1}, and 1–5 µl of this suspension was placed on each of the series of plates with increasing concentrations of the antimicrobial agent using a replicator device (final inoculum was 5×10^4 CFU/spot). The plates were incubated at 37^{o}C for 24 hours (Dankwa *et al.,* 2018).

Statistical Analysis of Data

Data generated from this study were subjected to statistical analysis. T-test was used to determine the level of significance between the proximate compositions of vegetable samples A and B while analysis of variance (ANOVA) was used to test the level of significance (p<0.05) of the effectiveness at different concentrations of the antibiotics on the different test bacterial isolates.

RESULTS

The microbiological study of selected vegetables were carried out on irrigated farms in Kawo. The Table 1 indicated the proximate composition of selected vegetable samples. Sample A indicate moisture content of 89.6 %, 2.0% of ash, 3.10 % of crude protein, 0.31 % of crude fat, 1.0 % crude fiber and 3.99 % of carbohydrate (CHO). Sample B showed similar percentage composition of 91.2 % of moisture content, 1.62 % of ash, 3.80 % of ash crude protein, 0.22 % of crude fibre and 1.28 % of CHO. There were significant difference (P< 0.05) between the proximate compositions of sample A and B. The characterization and identification of bacterial isolates from irrigated vegetables are presented on Table 2. The bacteria identified from the vegetables analyzed were *Escherichia coli, Staphylococcus aureus. Enterobacter* species. The presence of protozoan cyst and ova from the irrigated vegetables are shown in Table 3. Vegetables from farm A indicated the presence of *Schistosoma haematobium, Ascaris lumbricoides* and *Trichuris trichuria* from lettuce (LS1). *Spongyloides stercoralis, Ascaris lumbricoides* and Hookworm were identified in cabbage (CB1). *Ascaris lumbricoides* and *Schistosoma haematobium* were present in spinach (SP1) while *Ascaris lumbricoides* and Hookworm were identified

from ugwu leaves (UG1). *Trichiris trichuria* and *Schistosoma haematobium* were identified from spring onion (SO1). Vegetables from farm B indicated the presence of *Ascaris lumbricoides* and *Trichuris trichuria* from lettuce (F2L2), Fasciola sp., *Ascaris lumbricoides* and *Giarda lamblia* were identified from cabbage (F2C2). *Ascaris lumbricoides* and *Giarda lamblia* were identified from spinach (F2SP2). *Ascaris lumbricoides* was identified from ugwu leaves (F2U2) and no cyst or ova was present in spring onions.

Table 4 showed the antibacterial susceptibility profile of *Salmonella* species and *Escherichia coli* on selected antibiotic. *Salmonella* species were resistant to septrin, ampicillin and streptomycin at different concentrations. Spafloxacin, chloramphenicol, tarvid, pefloxacin, gentamycin, and ciprofloxacin were effective on *Salmonella* species. Augmentin was moderately sensitive to *Samonella* species. *Escherichia coli* was resistant to Septrin and Augmentin but was susceptible to Choramphenicol, Spafloxacin, Ciprofloxacin, Ampicillin, Gentamycin, Pefloxacin, Tarvid and Streptomycin at different concentrations. There were no significant difference ($P>0.05$) between the concentrations of antibiotics used and the zone of inhibitions recorded against *Salmonella* sp. Significant difference ($P<0.05$) were recorded between the concentrations of the antibiotics (sparfloxacin (10 µg), Ampicillin (30 µg), Augmentin (10 µg) and Tarivid (10 µg) used and the zones of inhibitions for *Salmonella* sp. and *Escherichia coli* (Table 4).

The antibacterial susceptibility profile of *Staphylococcus aureus* isolated from the irrigated vegetables showed that *Staphylococcus aureus* isolated from Lettuce indicated no zone of inhibition with Septrin, Streptomycin recorded 11 mm effectiveness. ciprofloxacin (12 mm), Rocephin (14 mm), Ampicillin (9 mm), Zinacef (13 mm), Ampiclox (9 mm), Gentamycin (10 mm), pefloxacin (11 mm) and Erythromycin recorded 12 mm zones of inhibition against *Staphylococcus aureus.* The septrin had antibiotic effectiveness of 9 mm streptomycin (11 mm), ciprofloxacin (13 mm), Rocephin (10 mm), Ampicillin (8 mm), Zinacef (12 mm), ampiclox (10 mm), gentamycin (8 mm), pefloxacin (13 mm) and 10 mm against *Staphylociccus aureus* isolated from Cabbage. *Staphylococcus aureus* isolated from spinach had range of zones of inhibition from septrin with 4mm, Ciprofloxacin (14 mm). *Staphylocccus aureus* isolated from ugwu leaves had inhibition zone of 8 mm with septrin and 14 mm was recorded using perfloxacin. *Staphylococcus aureus* isolated from Spring onion had inhibition range of 6 mm with rocephin to 17 mm zone of inhibition with Ampiclox which was the highest recorded (Table 5). There were significant difference ($P<0.05$) between the concentrations of most antibiotics used in relation to the zones of inhibition obtained against *S. aureus* isolated from the different vegetables analyzed. No significant difference were recorded with the concentrations of antibiotics and the zones of inhibitions of *S. aureus* isolated from lettuce and other vegetables analyzed (Table 5).

TABLE 1 AVERAGE PROXIMATE COMPOSITION OF SELECTED IRRIGATED VEGETABLES

Parameters (%)	Sample:			
	A	B	t-cal	p-value
Moisture content	89.60 ±0.208	91.20±0.208	0.039	0.001
Ash	2.00 ±1.670	1.62±0.040	0.814	0.001
Ash crude protein	3.10±0.040	3.80±0.060	0.185	0.000
Crude fat	0.31±0.300	0.22±0.050	0.138	0.023
Crude fibre	1.00±0.020	1.88±0.020	1.020	0.210
CHO	3.99±0.060	1.28±0.010	0.981	0.056

Key: A and B are samples of spinach, t-cal= T-test calculated, p-value= Level of statistical significance

Table 2. Biochemical Characterization and Identification of Bacterial Isolates from Irrigated Vegetables

Sample Code	Gram Reaction	Catalase	Oxidase	Coagulase	Indole	V.P	M.R.	Citrate	Probable org
F1C	-rod	+	-	-	+	-	+	-	*E.coli*
F1C2	-rod	+	-	-	+	-	+	+	*Salmonella* sp.
F1L	+ cocci	+	-	+	-	+	+	+	S. *aureus*
F1L2	-rod	+	-	-	+	-	+	-	*E.coli*
F1O	-rod	+	-	-	+	-	+	+	*Salmonella* sp.
F1O2	-rod	+	-	-	+	-	+	-	*E.coli*
F1 U	+cocci	+	-	+	-	+	+	+	S. *aureus*
F1 U2	-rod	+	-	-	+	-	+	+	*Salmonella* sp
F1 SP	-rod	+	-	-	+	-	+	-	*E.coli*
F1 SP2	-rod	+	-	-	+	-	+	+	*Salmonella* sp.
F2C	+cocci	+	-	+	-	+	+	+	S. *aureus*
F2 C2	-rod	+	-	-	+	-	+	-	*E.coli*
F2L	-rod	+	-	-	+	-	+	+	*Salmonella* sp
F2L2	-rod	+	-	-	+	-	+	-	*E.coli*
F2O	-rod	+	-	-	+	-	+	-	*E.coli*
F2O2	+ cocci	+	-	+	-	+	+	+	S. *aureus*
F2U	-rod	+	-	-	+	-	+	-	*E.coli*
F2U2	-rod	+	-	-	+	-	+	-	*E.coli*
F2SP	-rod	+	-	-	+	-	+	-	*E.coli*
F2SP2	+cocci	+	-	-	-	-	+	+	S. *aureus*

Keys: - rod: gram negative rod**, +** cocci: Gram positive, F1C: First Cabbage sample collected from farm one, F1C2: second cabbage sample collected from First farm, F1L: first lettuce sample collected from farm one. F1O1, F1O2: first and second samples of spring onion collected from farm one. F1U, F1U2: first and second samples of ugwu collected from first farm. F2C, F2C2: Second cabbage sample, collected in second farm, F2O, F2 O2: first and second samples of spring onion collected in farm two, F2L, F2L2: first and second samples of lettuce collected from second farm, F2SP2: first and second samples of spinach collected, *E.coli: Escherichia coli, Salmonella* sp. : *Salmonella* species and *S. aureus: Staphylococcus aureus.*

TABLE 3. IDENTIFICATION OF PROTOZOAN EGGS, CYSTS AND OVA FROM IRRIGATED VEGETABLES

Farm A	Protozoa	Farm B	Protozoa
LS1	*Schistosoma haematobium, Ascaris lumbricoides* and *Trichuris trichuria*	F2LS1	*Ascaris lumbricoides, Trichuris trichuria*
LS2	*Spongyloides stercoralis, Ascaris lumbricoides* Hookworm	F2LS2	*Fasciola* sp. *Ascaris lumbricoides* *Giarda lamblia*
CB1	*Ascaris lumbricoides, Schistosoma haematobium*	F2CB1	*Ascaris lumbricoides* *Giarda lamblia*
CB2	*Ascaris lumbricoides,* Hookworm	F2CB2	*Ascaris lumbricoides*
SP1	*Trichiris trichuria* and *Schistosoma haematobium*	F2SP1	*Ascaris lumbricoides,*
SP2	*Ascaris lumbricoides,*	F2SP2	
UG 1	*Schistosoma haematobium*	F2UG 1	*Trichuris trichuria*
UG2		F2UG2	*Ascaris lumbricoides*
SO1	*Trichuris trichuria*	F2SO1	*Trichuris trichuria*
SO 2	*Ascaris lumbricoides*	F2SO 2	*Ascaris lumbricoides*

Keys: LS1: LS1, LS2: Sample 1 and 2 of lettuce, CB 1, CB 2: Sample 1 and 2 of Cabbage, SP1, SP 2: Sample 1 and 2 of spinach, UG 1, UG2: Sample 1 and 2 of ugwu and SO1, SO2: sample 1 and 2 of spring onion.

TABLE 4. ZONES OF INHIBITION OF *SALMONELLA* SPECIES AND *ESCHERICHIA COLI* TO SELECTED ANTIBIOTICS

Antibiotics	Zones of Inhibition (mm) against *Salmonella* sp	Zones of Inhibition (mm) against *Escherichia coli*
Septrin (30µg)	4^a	5^a
Chloramphenicol (30µg)	12^a	16^a
Sparfloxacin (10µg)	13^a	18^b
Ciproflaxacin (30µg)	20^a	23^a
Ampicillin (30µg)	6^a	20^b
Augmentin (10µg)	10^a	0^b
Gentamycin (30µg)	18^a	18^a
Pefloxacin (30µg)	23^a	19^a
Tarvid (10µg)	20^a	13^b
Streptomycin (10µg)	6^a	13^b

Mean values bearing different superscripts (alphabets) in each row of the table are significantly different ($P<0.05$), Sensitive: 12mm Above, Moderate: 7mm to 11mm, Resistant: 0mm to 6mm.

TABLE 5. ZONES OF INHIBITION OF *STAPHYLOCOCCUS AUREUS* ISOLATED FROM IRRIGATED VEGETABLES

Gram positive antibiotic disc (µg)	Lettuce	Cabbage	Spinach	Ugwu leaves	Spring onion
Septrin	0^{b}	9^{a}	4^{b}	8^{a}	12^{a}
Streptomycin	11^{a}	13^{a}	6^{b}	10^{a}	10^{a}
Ciprofloxacin	12^{a}	9^{a}	14^{b}	6^{c}	15^{b}
Rocephin	14^{a}	10^{a}	12^{a}	11^{a}	6^{b}
Ampicillin	9^{a}	8^{a}	10^{a}	13^{a}	10^{a}
Zinacef	17^{a}	12^{b}	11^{b}	7^{b}	11^{b}
Ampiclox	9^{a}	10^{a}	9^{a}	6^{b}	10^{a}
Gentamycin	10^{a}	8^{a}	11^{a}	7^{a}	8^{a}
Pefloxacin	15^{a}	13^{a}	5^{b}	14^{a}	9^{a}
Erythromycin	12^{a}	10^{a}	8^{a}	9^{a}	5^{b}

Mean values bearing different superscripts (alphabets) are significantly different ($P<0.05$) across the table, ZI: Zone of Inhibition, *Staphylococcus aureus*, 12mm above: sensitivity, 7mm -11mm: Moderat, 0mm-6mm: Resistant

DISCUSSION

The proximate composition of vegetables samples A and B indicated moisture content with the highest % composition of 89.60 and 91.2, respectively. Vegetables are made up of mostly water and water are needed for the nourishment and growth of the plants. This result is similar to the findings of Adeyeye (2018) who reported the moisture content of *Amaranthus hybridus* and *Corchorus olitorius* as 85.40% and 86.35% respectively. Similarly, a study conducted by Adeniyi *et al.* (2012) indicated the moisture content of leafy vegetables with values ranging from 79.98% to 89.47%. If the moisture content of vegetable is high, it ensures the content of the vegetable material. It is therefore important to consider that before the consumption because it affects the physical and chemical aspects of the food and relates to freshness of the vegetable. Fat content of vegetables samples A and B were the low with 0.31 % and 0.32% respectively. The very low fat contents of the vegetables could be advantageous for individuals suffering from obesity and other related diseases as reported by Adeyeye (2018). Crude fiber recorded 1.00% for sample A and 1.88% for sample B. This result is similar to that of Adedeye (2018) who reported crude fiber to range from 1.05% in *A. hybridus* and 1.2% *C. olitorius.* Crude fibre plays an important role in the maintenance of internal distension for a normal peristaltic movement of the intestinal tract (Balogun and Olatidoye, 2012). Fibre aids and speeds up the excretion of waste and toxins from the body, preventing them from sitting in the intestine or bowel for too long, which could cause a build-up and lead to several diseases. It is involved in preventing colon cancer and constipation as reported by Ajiboye *et al.* (2016). The statistical analysis of the vegetables sample A and B indicated no significant difference ($p>0.05$) in the percentage moisture content, ash crude protein, crude fat, crude fiber and CHO. The bacteria isolated from the vegetables sample

were *Escherichia coli*, *Salmonella* species and *Staphylococcus aureus*. The bacteria isolates in this study were similar to the findings of Gimba and Madueke (2015) who conducted microbiological assessment of vegetables at Owena Ijesa of Osun State Nigeria. These bacteria are capable of causing various types of illnesses, some of which can result in death. The *Staphylococcus aureus* isolated was an indication of poor hygienic practices by both the farmers. *Escherichia coli* was the most occurring microorganism in this study which could be as a result of fecal contamination in the waste water.

The *E. coli* is a well-established index of fecal contamination. The presence in the sample may be suggestive of faecal contamination due to poor hygiene and the unhygienic condition of the water used for irrigation as reported by Slater *et al*. (2018). Salmonellosis are the most commonly and widely distributed foodborne diseases in several countries including Nigeria. The symptoms of these diseases include abdominal cramps, diarrhea, head ache, nausea, acute fever, hemorrhagic fever, elevated white blood cell count etc. Some strains of Salmonella cause typhoid and dysentery in children (Ehimemen *et al*., 2018).

Intestinal parasites ova and cyst identified in this study were that of *Schistosoma haematobium, Ascaris lumbricoides, Trichuris trichuria, Spongyloides stercoralis* and hookworm. This findings is in agreement with the findings of Akinseye *et al.* (2017) who identified *Trichuria trichuris, Taenia, Fasciola, Entamoeba histolytica, Giardia lamblia* among many other intestinal parasites from vegetables. Consumption of vegetables irrigated with raw waste water is exposure to the risk of infection as reported by Auta *et al. (*2017). Ascariasis and Gardiasis dieases are among the commonest parasitic infections associated with raw vegetables, which causes considerable morbidity in pregnant women, children and adults. The detection of these helminth and protozoan cysts, ova/ larvae on vegetables has a significant public health implication. Some of the vegetables are processed and eaten uncooked, which could lead to infection and disease especially when served to the public (Al-Mekhlafi *et al.*, 2019).

Internal parasites observed in this study can reduce food absorption by causing inflammation of the intestinal wall. If organs such as liver and kidneys cannot get rid of the toxins produced by some of these parasites, then poisons might get out through skin causing skin problems and hair loss. Damaged nervous system and stress hormones can lead to insomnia. Some blood sucking worms leave open wounds resulting in darker feces as reported by Parasites in Humans (2015)**.**

The antibacterial susceptibility pattern revealed that some of the bacteria isolates from the different vegetables analyzed were sensitive or resistant to the antibiotics at different concentrations as the case may be.

CONCLUSION

There were variations in proximate compositions of the irrigated vegetables analyzed. The bacteria isolates from the irrigated vegetables were *Escherichia coli*, *Staphylococus aureus* and *Salmonella* species and protozoans identified were

Schistosoma haematobium, Ascaris lumbricoides, Trichuris trichuria, Spongyloides stercoralis and hookworm. The antibacterial susceptibility showed that the bacteria isolates had different affinity to the concentrations of antibiotics used. Some were sensitive while others were resistant to the antibiotics at different concentrations.

RECOMMENDATIONS

It is recommended that consumers should thoroughly washed vegetables bought from the farm/market in order to help minimize contamination of intestinal parasites and bacteria. The government should provide a means for recycling of waste water before use in irrigation in order to reduce the incidence of bacteria and parasites on cultivated vegetables.

REFERENCES

Adeniyi, S. A., Ehiagbonare, J. E. and Nwangwu, S. C. O. (2012). Nutritional evaluation of some staple leafy vegetables in Southern Nigeria. *International Journal of Agricultural Food Sci*ence, 2(2): 37 – 43.

Adeyeye, A., Ayodele, O. D. and Akinnuoye, G.A. (2018). Evaluation of the nutritional composition of some less common edible leafy vegetables in Nigeria. *American Journal of Food Science and Nutrition,* 5(1), 26 – 31.

Ajiboye, B. O., Muhammad, N. O. and Ojo, O. A. (2016). Effect of rana galamensis–based diet on the activities of some enzymes and histopathology of selected tissues of albino rats. *Slovak Journal of Food and Sciences,* 270 – 275.

Akinseye, J. F, Ayuba, S. B, Adewuyi, I. K. and Agunlejika R. A. (2017). Isolation of intestinal parasites in vegetables sold in major Markets in Akure, Ondo State, *Nigeria. International Journal of Health Sciences and Research,* (6): 78 – 83.

Aleke, C. G. and Nwachukwu, C. M. (2018). Assessment and characterization of the basement aquifer at Idu–Karmo, area of FCT-Abuja, Nigeria, for drinking and irrigation. *Environmental Earth Sciences,* 1(1), 777 – 789.

Al-Mekhlafi, H. M., Nasr, N. A., Lim, Y. A. L. and Elyana, F. N. (2019). Prevalence and risk factors of *Strongyloides stercoralis* infection among Orang Asli schoolchildren: new insights into the epidemiology, transmission and diagnosis of strongyloidiasis in Malaysia. *Parasitology,* 146(12), 1602 – 1614.

Al-Megrin, W. A. I. (2010). Prevalence of intestinal parasites in leafy vegetables in Riyadh, Saudi Arabia. *International Journal of Zoological Research,* 5(2): 20 – 23.

Amaechi, E. C., Ohaeri, C. C., Ukpai, O. M. and Adegbite, R. A. (2016). Prevalence of parasitic contamination of salad vegetables in Ilorin, North Central, Nigeria. *Memona International Journal of Science,* 8(2), 1 – 10.

Auta, T., Bawa, J. A. and Suchet, C. M. (2017). Parasitic contamination of common fresh fruits and vegetables sold in Markets within Dutsin-Ma Town, Katsina State, Nigeria. *Journal of Advances in Biology and Biotechnology* 14(2): 1 – 8.

Balogun, I. O., and Olatidoye, O. P. (2012). Chemical composition and nutritional evaluation of velvet beans seeds for domestic consumption and industrial

utilization in Nigeria. *Pakistan Journal of Nutrition* 11(2), 116 – 122.

Dankwa, K., Siaw, D. O., Obboh, E. K. and Singh, B. (2018). Parasitic profile of fresh vegetables sold in selected Markets of the Cape Coast Metropolis in Ghana. *Annual Research and Review in Biology*, 28(6), 1 – 7.

Darchenkova, N. N., Romanenko, N. A. and Chernyshenko, A. I. (2006). Current ascariasis situation in the Russian Federation. *Medical Parasitology*, 4: 40 – 43.

Ehimemen, N. H., Mukhtar, M. F. and Salisu, N. (2018). Prevalence of bacterial loads on some fruits and vegetables sold in Kaduna central Market, Northwestern Nigeria. *Journal of Applied Sciences,* 19(1): 20 – 24.

Eze, O. C., Tukura, B. W., Atolaiye, B. O., Opaluwa, O. D. and Ubani, K. I. (2018). Proximate compositions and health risk evaluation of heavy metal uptake by vegetables grown at a Waste –water irrigated site in FCT, Abuja, Nigeria. *International Journal of Advances in Scientific Research and Engineering,* 4(5), 160 – 170.

Gimba, A. S. and Madueke, S. N. (2015). Bacteriological and parasitological assessment of fresh vegetables and fruits sold in two major Markets in Lokoja, Kogi State, Nigeria. *American Journal of Nutrition and Food Science,* 1(2), 32 – 37.

Haddeland I, Heinke J, Biemans H, Eisner S, Flörke M, Hanasaki N, Konzmann M, Ludwig F, Masaki Y, Schewe J, and Stacke T. (2014). Global water resources affected by human interventions and climate change. *Proceedings of National Academy of Science*, U S A, 111(9): 3251 – 3256.

http://nona.net/features/map-regional and 3d topo map of Kawo, Nigeria. Retrieved on 22nd February, 2020.

http://www.parasitesinhumans.org/. Parasites in Humans. Find the Nastiest Parasites in Humans-2015. Retrieved on 25th March, 2020.

Inyinbor, A. A., Olugbenga, S. B., Bello, S., Oluyori, A. P., Oluyori, A. P., Inyinbor, E. and Fadiji, E. (2019). Wastewater conservation and reuse in quality vegetable cultivation: Overview, challenges and future prospects. *Food Control,* 98(1), 489 – 500.

Ma, C., Liwanag, S. J. and Soriano, G. P. (2018). Bacterial load of fresh vegetables sold in a selected public Market and their susceptibility to commonly used antibiotics, 10(3) 18 – 25.

Maikaji, F. S., Inabo, H. I., Samuel, F. U., Bello, T. K. and Hassan, R. (2015). Efficacy of some sanitizing agents on *salmonella* species detected in rinsed water of vegetables eaten raw in Samaru, Zaria. *Journal of Animal Production Research,* 27(1), 1 – 9.

Mary, C., Kayombo, A. and Mayo, W. (2018). Assessment of microbial quality of vegetables irrigated with polluted waters in Dar es Salaam City, Tanzania. *Environment and Ecology Research*, 6(4): 229 – 239.

Nyarango, R. M., Aloo, P. A., Kabiru, E. W. and Nyanchong, B. O. (2008). The risk of pathogenic intestinal parasite infections in Kisii Municipality, Kenya. *BMC Public Health*, 8: 237.

Oliveira, C. A. F. and Germano, P. M. L. (1992). Estudo da ocorrência de enteroparasitas em hortaliças comercializadas na região metropolitana de São Paulo, SP, Brasil. I – Pesquisa de helmintos. Revista de Saúde Pública, S. Paulo, 26 (4): 283 – 289.

Olokun, A. L., Ajide, A. B. and Ihuma, J. O. (2019). Gram Negative Bacteria Associated with Spoilage of Tomatoes Sold at Mararaba and Masaka Market, New Karu Local Government Area, Nasarawa State. *International Journal of Pathogen Research,* 2(3), 1 – 7.

Pozio, E. (2003). Foodborne and waterborne parasites. *Acta Microbiological Pollution*, 52: 83 – 96.

Slater, S. L., Sågfors, A. G., Pollard, D. J., Ruano-Gallego, D. and Frankel, G. (2018). The Type III secretion system of pathogenic *Escherichia coli, a Versatile Pathogen*, 51 – 72.

Truchado, P., Hernandez, N., Gil, M. I., Ivanek, R. and Allende, A. (2018). Correlation between *E. coli* levels and the presence of foodborne pathogens in surface irrigation water: Establishment of a sampling program. *Water Research*, 128(1): 226 – 233.

Vuong T, Martin L, and Matar C. (2006). Antioxidant activity of fermented berry juices and their effects on nitric oxide and tumor necrosis factor-alpha production in macrophage 264.7 gamma NO (-) cell line. *Journal of Food Biochemistry*. 30: 249 – 268.