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Bacteriological and Parasitological Assessment of Fruits and Vegetables Sold in Akoko South West Local Government Area of Ondo State Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study assessed the microbial and parasitic infestation of fresh fruits and vegetables sold in two major markets in Akungba Akoko and Ikare akoko, Ondo State Nigeria. A total of 10 fruits and 10 vegetables commonly consumed by dwellers of these communities were randomly purchased from the two markets. They were washed, and examined for microbial and parasitic organisms. The predominant bacteria isolated from both fruits and vegetables included*: Staphylococcus aureus, Micrococcus luteus, Bacillus cereus, Streptococcus lactis, Listeria monocytogenes, Escherichia coli and Enterococcus faecium.* The parasitic eggs observed included*: Capillaria hepatica, Fasciola sp., Ascaris lumbricoides, Enterobius vermicolaris and Taenia saginata* while the parasitic larvae included*: Trichuris trichiura, Strongyloides stercoralis, Taenia sp., Fasciola sp., Ascaris lumbricoides.* The parasites recovered from vegetables sold in Akungba market were more than those recovered from Ikare market. Findings from this study revealed that raw fruits and vegetables could be potential sources of microbial and parasitic

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infections, it is therefore essential to educate the populace on the need to inculcate the habit of thorough washing of these produce with clean water before consumption to avoid potential health risk.

Keywords: Parasitic; infestation; larvae; bacteria; microbial; markets.

1. INTRODUCTION

Fruits and vegetables are composed of different tranches of plant parts (leaves, roots, tubers, fruits, and flowers). The word "vegetable" was first recorded in English in the 15th century, and originally applied to any plant. The meaning of the term "vegetable" was specified to mean "plant cultivated for food, edible herb or root" [1]. In common language usage, "fruit" normally means the fleshy seeds associated structures of a plant that are sweet or sour and edible in the raw state, such as apples, oranges, grapes, strawberries, bananas, and lemons. On the other hand, the botanical sense of "fruit" includes many structures that are not commonly called "fruits", such as bean pods, corn kernels, wheat grains, and tomatoes. A fruit is a ripened ovary together with seeds of a flowering plant. Fruits are the means through which flowering plants disseminate seeds [2].

Fruits are cultivated in areas where the environmental factors are suitable for their growth. Pollination is a vital part of fruit culture, and in few species, they may develop in the absence of pollination/fertilization, a process known as parthernocarpy; such fruits are seedless (Mauser and James, 2003). Many foods are botanical lying fruits, but are treated as vegetables in cooking and food preparations. Examples are: Tomatoes, eggplant, pumpkin and pears etc [3].

Simple fruit can either be dry or fresh. For example, carrot, tomato, avocado, banana etc. [4]. The examples of aggregate fruits are pineapple, bread fruit, etc. Some Fruits have coat covered with Spikes or hooked burrs, either to prevent themselves from being eaten by animals, using them as dispersal agent, e.g. unicorn plant [5]. Many fruits are used to make beverages, such as fruit juice, (orange juice, apple juice, grape juice etc. or alcoholic beverages, such as wine or brandy. Apples are often used to make vinegar.

Infections acquired through directing espionage of invective egg or cyst is intimately linked with level of personal hygiene and sanitation in the community. Factors like the lack of latrine and adequate sewage disposal facilities have been known to contribute to the spread of the infection states of the parasites thereby bringing about a widespread contamination of foods. Infection can be acquired through contaminated unwashed fingers, insects, and circulation of currency and by wind during dry season items. Contamination of fruits with eggs and cyst especially those hacked by fruit vendors may also serve as a source of infection to consumers of such fruits items. These parasites includes*; Entamoeba histolystica, Guardia duodenace, Trichuris trichiura, Ascaris lumbricoides and Benterobius vermicularis* [6].

Vegetables are eaten in a variety of ways, as part of main meals and as snacks. The nutritional content of vegetables varies considerably, though generally they contain little protein and fat; and varying proportions of vitamins (such as Vitamin A, Vitamin B6), pro vitamins, dietary minerals and carbohydrates. Production practices, growth conditions and the location of the edible part during growth (soil, soil surface, aerial part) will in combination with intrinsic, extrinsic, harvesting and processing factors affect their microbial status at the time of consumption [7]. Pathogens from human and animal reservoir as well as other environmental pathogens can be found at the time of consumption. Insects, rodents and birds have also contributed to faecal contamination of maturing fruits and berries, and this has created several health hazards on consumption of these fruits and vegetables.

Soil is also another source of contamination, the land under cultivation may receive increased exposure to faecal contamination because of regular visitation of wild animals and through the application of manure [8]. Almost any ready-to-eat fruit or vegetables that have been contaminated with pathogens either from the environment or from human or animal faeces or through storage, processing and handling could potentially cause diseases. Vegetables are essential part of a healthy human diet due to their nutritional value. Raw vegetables are great source of vitamins, dietary fiber and minerals;

and the irregular consumption is associated with the risk of cardiovascular diseases, stroke and certain cancers [9]. Some vegetables are eaten raw as salad to retain the natural taste and preserve heat labile nutrients. Diets containing recommended amounts of fruits and vegetables may help lower the risk of heart diseases, type 2 diabetes, protect against some cancers, bone loss and formation of kidney stones [10]. The consumption of raw vegetables without proper washing is an important route in the transmission of parasitic diseases [11].

The objectives of the research are to isolate bacteria and parasites of medical importance from fruits and vegetables sold in Akungba and IkareAkoko market areas in Ondo state; and to assess the safety of eating these fruits and vegetables without washing.

2. MATERIALS AND METHODS

2.1 Sample Collection

A total of 10 samples comprising fresh fruits and vegetables which include; Water-melon (*Citrullus lanatus)*, Carrot (*Daucus carota*), Bitter leaf (*Vernonia amygdalina*), Cucumber (*Cucumis sativus*), Water leaf (*Hydrophyllum triangulare),* Ewedu *(Corchorus olitorius*), ugwu *(Telfairia occidentallis), spinach (Amaranthus hybridus*), green peas (*Pisum sativum*), apple (*Malus pumila*) were collected from two different sources; Akungba and Ikare-Akoko, Ondo State. The samples of each fruit and vegetable were purchased from different sellers at different locations in the market.

2.2 Bacteriological Examination of Fruits and Vegetables

2.2.1 Total viable bacterial count

Ten (10) g of each sample was weighed and washed in sterile distilled water, thereafter, 1 ml of the sample water was introduced into sterile test tubes containing 9ml of sterile distilled water for serial dilution to 10^3 using sterile syringes, and 1 ml of 10^2 for each sample was pipette into sterile petri dishes. Nutrient agar was allowed to cool to 45°C and poured into plates and swirled, then allowed to solidify and incubated in an inverted position at 37°C for 24 hours; the colonies on the plates were counted with a colony counter. Each colony was isolated in a pure form by sub culturing for further studies and identification [12]. The pure cultures of bacterial isolates were subjected to various morphological and biochemical characterization tests to determine the identity of the bacteria isolates with reference to Bergey´s Manual of Determinative Bacteriology.

2.2.2 Total coliform count

The total count was determined by pour plates method, serial dilution were made to 10^2 in test tubes, and labeled. MacConkey agar was used as primary choice of medium. The agar was allowed to cool to 45°C and then poured into Petri dishes aseptically. The plates were rocked and allowed to set and incubated at 37°C for 24 hours. The colonies on the plates were then counted with a colony counter. The pure cultures of bacterial isolates were subjected to various morphological and biochemical characterization tests to determine the identity of the bacteria isolates with reference to Bergey´s Manual of Determinative Bacteriology [13].

2.2.3 Parasitic examination

As soon as the samples were brought into the laboratory, 10 g of each fruit and vegetable type was weighed and washed in sterile beakers separately containing sterile distilled water and saline solution for the removal of parasitic ova, cysts and larva using the centrifugal sedimentation technique a method described by Gaspared and Schwartzboad [14].

The protocol involved soaking the vegetables and fruits in the sterile distilled water and saline solution and agitating 5 times within 30 minutes, this is to dislodge eggs, larvae and cysts from the vegetables. The suspension was strained through a clean and sterile sieve to remove larger particles. The filtrate was centrifuged at 5,000 rpm for 5 minutes, supernatant was discarded into disinfectant jar, and the deposit fluid was examined carefully and systematically for ova, larvae and cysts of parasites. The ova, larvae and cysts of parasites were compared with and identified in line with known features according to Gaspared and Schwarzboad, [14].

2.3 Morphology and Biochemical Characterization of the Bacterial Isolates

The following tests were carried out on the isolated bacteria to determine their cellular morphology and biochemical characteristics to confirm their identities.

2.3.1 Gram staining

The isolated organisms were Gram stained in order to determine their Gram staining reaction. A thin smear of each of the bacteria isolated was prepared on clean grease-free slides by dissolving a minute portion of the colony obtained from a young culture (48hours old) of each of the bacteria isolated in one drop of distilled water on the slide. This was subsequently air dried and heat fixed by passing over gentle flame. Each heat-fixed smear was stained by addition of 2 drops of crystal violet solution for 60 sec and rinsed with water. The smear were again flooded with Gram's iodine for 30 sec and rinsed with water, decolorized with 70% alcohol for 15 sec and were rinsed with distilled water. They were then counter stained with 2 drops of Safranin for 60 sec and finally rinsed with water, then allowed to air dry. The smears were mounted on a Microscope and observed under oil immersion objective lens. Gram negative cells appeared pink or red, while Gram positive organisms appeared purple [12].

2.4 Biochemical Characterization of the Bacterial Isolates

2.4.1 Indole test

Tryptone broth (5 mL) was placed into different test tubes after which a loopful of the bacterial isolates was inoculated into the test tubes, leaving one of the test tubes uninoculated to serve as control. The test tubes were then incubated at 37°C for 48 hrs. After incubation, 3 drops of Kovac's reagent was added and shaken gently; it was allowed to stand for 20 min to permit the reagent to rise. A red colour at the top surface of the tube indicates a positive result while yellow coloration indicates a negative result [13].

2.4.2 Citrate test

This test detects the ability of an organism to use citrate as a sole source of carbon and energy. About 2.4 g of citrate agar was dissolved in 100 mL of distilled water. About 9 mL of citrate medium was dispensed into each tube and covered, then sterilized and allowed to cool in a slanted position. The tubes were inoculated by streaking the organisms once across the surface. A colour change of the medium from green to blue indicates utilization of the citrate.

2.4.3 Oxidase test

A piece of filter paper was soaked with few drops of oxidase reagent. Sterile inoculating loop was used to pick a colony of the test organism and smeared on the filter paper. If the organism is oxidase producing, the phenylenediamine in the reagent will be oxidized to a deep purple colour [13].

2.4.4 Sugar fermentation

Sugar fermentation test was carried out to determine the ability of organisms to ferment sugars with production of acid and gas. Sugar indicator broth was prepared using peptone water medium containing 1% fermentable sugar and 0.01% phenol red. About nine millimeters of sugar broth was dispensed into each of the test tubes, durham tube which would trap the gas if produced was inverted carefully. The test tubes were autoclaved and inoculated with a loopful of 24 hrs old culture of the test organisms after then incubated for 2-7 days at 36°C and observed daily for acid and gas production. Yellow coloration indicates acid production while gas production was indicated by displacement of the medium in the durham tube [12].

2.4.5 Catalase test

A small quantity of 24 hrs old culture was transferred into a drop of 3% Hydrogen peroxide solution on a clean slide with the aid of sterile inoculating loop. Gas seen as white froth indicates the presence of catalyze enzyme [13].

2.4.6 Methyl red test

5 mL of glucose phosphate broth (1g glucose, 0.5% KH_2PO_4, 0.5% peptone and 100mL distilled water) were dispensed in clean test tubes and sterilized. The tubes were then inoculated with the test organisms and incubated at 37°C for 48hrs. At the end of incubation, few drops of methyl red solution were added to each test and colour change was observed. A red colour indicates a positive reaction [15].

2.5 Statistical Analysis

The difference among the groups were analyzed by the one way analysis of variance test using SPSS 25.0, software (SPSS Inc., Chicago, IL,USA) and descriptive and inferential statistics for this analysis. The results were expressed as

Mean± Standard Deviation (SD), where the level of significance was considered at P<0.05.

3. RESULTS

Pathogenic parasites and bacteria were isolated from some of the fruit and vegetable samples examined. Parasitic organisms isolated from the vegetables included; *Fasciola sp, Ascaris lumbrcoides, Capillaria hepatica, Taenia saginata, Enterobius vermicularis, Strongyloides stercoralis and Trichuris trichiura*.

A total number of 4 parasitic eggs and 3 larvae were recovered from the vegetable samples from Akungba market as shown in Table 1; while 2 parasitic eggs and 1 larva were recovered from the samples from Ikare market as shown in Table 2.

The mean total viable bacterial and coliform counts of the assessed fruits and vegetables from Akungba Market are shown in Table 3. The mean total bacterial count of the various assessed samples varied from 4.03 × 10^4 CFU/g, (greenpeas) to 0.73× 104 CFU/g (Ugwu); while the mean total coliform count ranged from 3.67 ×10^4 CFU/g (greenpeas) to 0.59 x 104 CFU/g (Ewedu).

Table 1. Parasitic eggs and larvae observed in samples obtained from Akungba market

Common names of vegetables	Botanical Names	Eggs	Larvae
Ugwu	*Telfairia occidentallis*	*Fasciola sp*	*Strongyloides*
Spinach	*Amaranthus hybridus*	*Ascaris lumbricoides*	*Trichuris trichiura*
Bitterleaf	*Vernonia amygdalina*	Nill	*Taenia saginata*
Waterleaf	*Hydrophyllum triangulare*	*Capillaria hepatica*	Nill
Ewedu	*Corchorus olitorie*	*Taenia saginata*	Nill

Legend: Nill = Not detected

Table 2. Parasitic eggs and larvae observed in samples obtained from Ikare market

Common names of vegetable	Botanical name	Eggs	Larvae
Ugwu	*Telfairia occidentallis*	*Enterobius vermicularis*	*Taenia saginata*
Spinach	*Amaranthus hybridus*	Nill	Nill
Bitterleaf	*Vernonia amygdalina*	Nill	Nill
Waterleaf	*Hydrophyllum triangulare*	*Ascaris lumbricoides*	Nill
Ewedu	*Corchorus olitorie*	Nill	Nill

Legend: Nill = Not detected

Table 3. Total viable bacteria and coliform counts of the fruits and vegetables samples from Akungba

Common names of fruits and vegetables	Botanical name	Mean total bacterial counts	Mean total coliform count
Cucumber	*Cucumis sativus*	1.47±0.85^{a}	3.53±2.04^{d}
Carrot	*Daucus carota*	2.83±1.63^{c}	1.95±1.13^{c}
Greenpeas	*Pisum sativum*	4.03±2.32^{cd}	3.67±2.12^{d}
Watermelon	*Citrullus lanatus*	1.46±0.84^{a}	1.45±0.84^{a}
Apple	*Mallus domestica*	2.90±1.64^{c}	1.83±1.06^{a}
Waterleaf	*Hydrophyllum triangulare*	2.20±1.27^{c}	1.98±1.14^{c}
Bitterleaf	*Vernonia amygdalina*	3.67±2.12^{d}	1.10±0.64^{a}
Ugwu	*Telfairia occidentallis*	0.73±0.42^{b}	1.96±1.13^{c}
Spinach	*Amaranthus hybridus*	1.47±0.85^{a}	1.83±1.06^{c}
Ewedu	*Corchorus olitorius*	1.07±0.62^{b}	0.59±0.34^{b}

Value is a mean ± SD, n=3 Values along the same column with different superscripts are significantly different (P<0.05)

The different bacterial isolates identified from the examined fruits and vegetables included; *Staphylococcus aureus, Bacillus cereus, Escherichia coli, Micrococcus luteus, Listeria monocytogenes, Alcaligenesparadoxus, Enterococcus faecium, Streptococcus lactis, Enterococcus mundtii and Bacillus pumilis.*

4. DISCUSSION

The results obtained from this study revealed that pathogenic microorganisms are associated with the fruits and vegetables examined; bacteria, parasitic eggs and larvae were observed to be high in the samples. Previous studies revealed that many types of vegetables purchased at markets in different regions were contaminated with helminth eggs, as well as protozoan oocysts [16].

This research focused on commonly consumed raw fruits and vegetables locally. It was observed that certain Vegetables like *Vermonia amygdalina, Corcohorus olitorius, Telfairia occidentalis, Amaranthus hybridus* have similar surface bacteria. Fruits like *Citrullus lanatus*, *Daucus carota, Cucumis sativus, Pisum sativum and Malus pumila* have more variable surface bacterial communities from two or three different groups. This is in agreement with the work of Jonathan et al. [17] who reported that vegetables have similar bacteria and fruits have more variable surface bacteria. Fierer [18] also found differences in surface bacteria between produce grown using different farming practices. He suggested that several factors may contribute to the differences he observed; including farm locations, storage temperature or time, and transport conditions. These surface bacteria on produce can impact the rate at which food spoils. Previous studies have shown that although such microbes do not necessarily cause disease, they may still interact with, and perhaps inhibit the growth of disease-causing microbes. The results of this new research suggest that people may be exposed to substantially different bacteria depending on the types of produce they consume.

All organisms isolated are capable of causing different kinds of human diseases, some of which may lead to death. *Listeria monocytogenes* isolated from this work, has been reported in food samples particularly in fruits and vegetables (Kuhn *et al.,* 2011). *Listeria monocytogenes* causes listeriosis, it affects the pregnant women, newborns and immune-compromised individual, listeriosis can also lead to septicemia or meningitis. The symptoms include; headache, confusion, loss of balance, fever, chills, muscle ache and so on.

Escherichia coli, Micrococcus luteus, Enterococcus species, Bacillus cereus, Streptococcus lactis and Alcaligenes paradoxus, which were isolated, are well established pathogens or opportunistic pathogen of public health significance. *E. coli* is a well-established index of fecal contamination, the presence of these isolates in the samples may be indication of faecal contamination due to poor hygiene and sanitation of people handling the fruit and vegetable products. *E. coli* has been implicated in human diarrheal particularly type 0157:H7 [19]. *Staphylococcus aureus* is known to produce enterotoxin and usually are often able to cause infection once they gain entry into damage skin or deeper body. Staphylococcal infections can

Table 4. Total Viable Bacteria and Coliform counts of the fruits and vegetables samples from Ikare

Common names of fruits and vegetables	Botanical name	Mean total bacterial counts	Mean total coliform count
Cucumber	*Cucumis sativus*	1.20 ± 0.10^{b}	2.35 ± 2.04^{c}
Carrot	*Daucus carota*	1.73 ± 0.84^{b}	0.91 ± 0.00^{a}
Greenpeas	*Pisum sativum*	2.67 ± 1.32^{c}	2.90 ± 1.00^{c}
Watermelon	*Citrullus lanatus*	1.11 ± 0.95^{b}	1.22 ± 0.76^{b}
Apple	*Mallus domestica*	2.33 ± 1.50^{c}	1.35 ± 0.17^{b}
Waterleaf	*Hydrophyllum triangulare*	1.20 ± 0.89^{b}	1.00 ± 1.19^{b}
Bitterleaf	*Vernonia amygdalina*	2.41 ± 0.00^{c}	0.66 ± 0.15^{a}
Ugwu	*Telfairia occidentallis*	0.48 ± 0.12^{a}	1.23 ± 1.00^{b}
Spinach	*Amaranthus hybridus*	1.30 ± 0.31^{b}	0.88 ± 0.07^{a}
Ewedu	*Corchorus olitorius*	0.85 ± 0.19^{a}	0.42 ± 0.22^{a}

Value is a mean ± SD, n=3 Values along the same column with different superscripts are significantly different (P<0.05)

Table 5. Morphological and Biochemical Characteristics of Bacterial isolates from Fruits

Sample	Maltose	Sucrose	Lactose	Glucose	Fructose	Indole	Citrate	Oxidase	Methyl red	Catalyse	Gram staining	Probable organisms
NA Cucumber	_g	+g	_g	+g	+g	_	+	_	_	+	+rod	*Listeria monocytogenes*
NA W. melon	+g	+g	_g	+g	+g	+	+	_	_	+	+cocci	*Staphylococus aureus*
NA G. peas	+g	+g	_g	+g	+g	+	+	_	_	+	+rod	*Bacillus cereus*
NA Carrot	+g	+g	+g	+g	+g	+	+	+	_	+	+rod	*Bacillus pumilis*
NA Apple	+g	+g	+g	+g	+g	+	+	_	_	+	+rod	*Bacillus cereus*
MAC W. melon	+g	+g	+g	+g	+g	+	+	_	_	+	+cocci	*Micrococcus luteus*
MAC Cucumber	+g	+g	_g	+g	+g	+	+	_	_	+	+cocci	*Micrococcus luteus*
MAC G. peas	+g	+g	+g	+g	+g	+	+	_	_	+	+cocci	*Streptococcus lactis*
MAC Carrot	+g	+g	+g	+g	+g	+	+	+	_	_	+cocci	*Enterococcus faecium*
MAC Apple	+g	+g	+	+	+	+	+	+	_	_	_cocci	*Escherichia coli*

Legend: +g= Acid gas production + = Acid only + = Positive - = Negative

Table 6. Morphological and Biochemical Characteristics of Bacterial Isolates from Vegetables

Sample	Maltose	Sucrose	Lactose	Glucose	Fructose	Indole	Citrate	Oxidase	Methyl red	Catalyse	Gram staining	Probable organisms
Ns AB.Leaf	+g	+g	_g	+g	+g	+	+	_	_	+	+cocci	*Micrococcus luteus*
NA W. leaf	+g	+g	+g	+g	+g	+	+	_	_	_	+cocci	*Enterococcus mundtii*
NA Ugwu	+g	+g	+g	+g	+g	+	+	_	_	+	+rod	*Bacillus cereus*
NA Spinach	+g	+g	+g	+g	+g	+	+	_	_	+	+cocci	*Micrococcus luteus*
NA Ewedu	+g	+g	+g	+g	+g	+	+	_	_	+	+rod	*Bacillus cereus*
MAC B. leaf	+g	+g	+g	+g	+g	+	+	_	_	+	+rod	*Bacillus cereus*
MAC Ugwu	+g	+g	+g	+g	+g	+	+	_	_	+	+rod	*Bacillus cereus*
MAC Ewedu	+g	+g	+g	+g	+g	+	+	_	_	_	_cocci	*Alcaligenes paradoxus*

Legend: +g= Acid gas production + = Acid only + = Positive - = Negative

Table 7. Morphology and cultural characteristics of bacterial isolates from vegetables samples obtained from Akungba market

Sisolates	Colour of colony	Surface of colony	Edge of colony	Shapes of colour	Gram stained reaction	Arrangement
NA B. leaf	Yellow	Smooth	Irregular	Cocci	Purple	Clusters
NA W. leaf	Yellow	Smooth	Irregular	Cocci	Purple	Chains
NA Ugwu	Light Yellow	Rough	Irregular	Rod	Purple	Chains
NA Spinach	Golden Yellow	Smooth	Circular	Cocci	Purple	Chains
MAC B. leaf	Light Yellow	Smooth	Circular	Rod	Purple	Chains
MACUgwu	Golden Yellow	Rough	Irregular	Rod	Purple	Chains
MAC Ewedu	Light Yellow	Smooth	Irregular	Cocci	Pink	Clusters

Table 8. Morphology and cultural characteristics of bacterial isolates from fruits samples obtained from Akungba market

Isolates	Colour of colony	Surface of colony	Edge of colony	Shapes of colour	Gram stained reaction	Arrangement
NA W. melon	Yellow	Smooth	Circular	Cocci	Purple	Clusters
NA G. peas	Golden Yellow	Smooth	Irregular	Rod	Purple	Clusters
NA Carrot	Light Yellow	Rough	Irregular	Rod	Purple	Chains
NA Apple	Yellow	Smooth	Circular	Cocci	Purple	Clusters
NA Cucumber	Light Yellow	Smooth	Circular	Cocci	Purple	Chains
MAC Carrot	Light Yellow	Rough	Irregular	Cocci	Purple	Clusters
MAC Apple	Light Yellow	Smooth	Irregular	Rod	Pink	Clusters

range from minor skin problems to endocarditis, a life-threatening infection of the inner lining of the heart (endocardium). As a result, signs and symptoms of Staphylococcal infections vary widely, depending on the location and severity of the infection. Symptoms includes; Nausea and vomiting, diarrhea, dehydration and low blood pressure.

Bacillus cereus identified in the fruits and vegetables have been found to be associated with plants [20]. *Bacillus cereus* has the ability to grow at varying temperatures and pH. Two types of illnesses arise as a result of consumption of food contaminated with *B. cereus* and the two illnesses are: emesis and diarrheal. Symptoms include: abdominal pain, rectal tenesmus, seldom vomiting and no fever [21]. Most isolated microorganisms from this research work are probably opportunistic pathogen and not indigenous microorganisms; their enterotoxigenic strains are popular for causing severe food borne illness [22]. The Microorganisms are present in contaminated water and when ingested, causes diarrhea, vomiting and abdominal cramps. This study has established a secondary source of constant occurrence of food borne diseases among the villagers.

Parasites observed in this study have been elucidated by many researchers, notably are: *Fasciola sp, Ascaris lumbrcoides, Capillaria hepatica, Taenia saginata, Enterobius vermicularis, Strongyloides stercoralis and Trichuris trichiura.*These parasites have been reported to reduce food absorption by causing inflammation of the intestinal wall [23], symptoms caused by these parasitic infections include: anorexia, chills, cough, diarrhea, dysuria, fatigue, fever, headache, hematochezia, hemoptysis, itching, joint pain, muscle pain and spasms, nausea or vomiting, rash, rectal hemorrhage, rectal, shortness of breath, stomach pain, swelling, sweating and grinding teeth while sleeping.

5. CONCLUSION

The study has established that fresh vegetables and fruits in Akungba major markets harbor higher number of parasitic and pathogenic contaminants than Ikare market. Consumption of unwashed raw fruits and vegetables from these markets could be hazardous to human health. The presence of pathogenic micro flora on the surface of fresh fruits and vegetables emphasize the necessity for observing hygienic conditions during production, as contamination can occur from water, soil, waste and humans.

6. RECOMMENDATION

Before consumption, proper washing of raw fruits and vegetables with clean water to decrease the density of microbial contaminants from the surface of the fresh produce should be encouraged. Government intervention is also required to protect the consumer and to safeguard the quality of the produce. In addition, it is essential to educate the public about the need for proper washing of fruits and vegetables using clean water before consumption to avoid microbial and parasitic infections.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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