**Direct Research Journal of Public Health and Environmental Technology**
Vol.9 (1), Pp. 47-52, April 2024
ISSN: 2734-2182
DOI: https://doi.org/10.26765/DRJPHET15014860
Article Number: DRJPHET15014860

https://journals.directresearchpublisher.org/index.php/drjphet

# Parasitic Contents of Prominent Fruits and Vegetables Sold in Different Markets in Lokoja Metropolis, Kogi State

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Received 13 February 2024; Accepted 7 April 2024; Published 11 April 2024

**ABSTRACT:** A cross-sectional study was undertaken from May to August 2021 to investigate the prevalence and predictors of contamination in fruits and vegetables sold in Lokoja's various markets. A systematic questionnaire was used to collect data on vendors' socio-demographic characteristics, as well as factors linked with fruit and vegetable contamination. A total of 192 samples of selected fruits and vegetables were collected from four (4) different markets in Lokoja metropolis. The samples were soaked in normal saline and shaken vigorously for 15 minutes. The sedimentation concentration technique was used to conduct microscopic examinations. The acquired results were analyzed with the SPSS version. Of the 192 samples tested, vegetables were the most polluted (60.4%), while fruits were the least (48.9%). The highest rate of contamination (36.2%) was found in Tomato (*Lycopersicon Esculentum*), while Guava (*Psidiumguajava*) was the least polluted (14.9%). For vegetables, African spinach (*Amaranthus Hybridus*) had the highest percentage of contamination (39.7%), while carrot (*Daucuscarota*) had the lowest (13.8%). A total of 105 (54.7%) were infected with at least one parasitic species. Hookworm spp. (28.6%) were the most commonly seen parasites, whereas *Taenia* spp. (1.9%) were the least prevalent. Increased parasite contamination was shown to be strongly linked with open market displays ($p<0.05$). The outcomes of this study show that there is a danger of contracting parasite illnesses by eating raw fruits and vegetables in Lokoja, Kogi state, Nigeria. It is recommended that vegetables and fruits be thoroughly washed before to ingestion.

Keywords: *Cross*-sectional, prevalence, contamination, vegetables, fruits

Citation: Olakunle, D. E., Audu, P. A., and Abovegodwin, G. O. (2024). Parasitic Contents of Prominent Fruits and Vegetables Sold in Different Markets in Lokoja Metropolis, Kogi State. Direct Res. J. Public Health and Environ. Technol. Vol. 9(1), Pp. 47-52. https://doi.org/10.26765/ DRJPHET15014860. 

## INTRODUCTION

Studies have linked parasitic illnesses to a lack of hygiene, poor sanitation, poverty, and overcrowding (Bekele et al., 2017; Bekele and Shumbej, 2019). According to Punsawad et al. (2019), intestinal parasitic infections have a global distribution with serious consequences for public health, physical and economic development. Environmental factors such as temperature, soil type, rainfall, geography, and climate influence this distribution. Intestinal parasite infections can be acquired in a variety of ways, including the intake of contaminated fruits, vegetables, other foods, and water. Furthermore, eating unwashed, uncooked, or undercooked fruits and vegetables contributes to parasite transmission (Punsawad et al., 2019). Fruits and vegetables are key components of the human diet; they are varied groupings of plant foods with varying nutrient and calorie content. They provide dietary fibre, vitamins, minerals, and phytochemicals, which act as antioxidants, phytoestrogens, and anti-inflammatory agents (Slavin and Lloyd, 2012). Fruits and vegetables come in a variety of forms, shapes, tastes, and, most importantly, nutritional components, such as berries, grapes, and pomegranates, which contain a high amount of procyanidins, anthocyanins, and flavonols (Jarvi et al., 2016, Habauzit et al., 2013), apples and citrus fruits, which are carotenoid-rich fruits, and cruciferous vegetables, which, according to research, have a high fibre content. Calcium and vitamins can also be found in specific fruits and vegetables, which when taken aid to reduce and make one less susceptible to various diseases and their effects (Park et al., 2011). According to Alhabbal (2015), gooseberry, curcumin, and soya are known to contain phyto-ingredients that protect against eye lens damage caused by hyperglycemia; and

Quercetin, which contains flavonoids capable of preventing oxidative stress in glaucoma pathogenesis (Miyamoto et al., 2014). Research has also shown that a high prevalence of cardio-vascular illness, osteoporosis, lung issues, chronic obstructive pulmonary disease, hypercholesterolemia, and blood pressure disorders is connected with low vegetable and fruit consumption (Payne et al., 2012). A major public health challenge is the transmission of medically important intestinal parasites through the consumption of contaminated raw fruits and vegetables. Many studies have been conducted, and the role of unwashed and consumed raw vegetables and fruits has been demonstrated (Said et al., 2012, Abougrain et al., 2010, and Tefera et al., 2014). The research examines the degree of parasite contamination in fruits and vegetables sold in various markets in Lokoja metropolis, Kogi state, Nigeria.

## MATERIALS AND METHODS

### Study area

The study was conducted in Lokoja, the capital of Kogi state, Nigeria. Lokoja is a city located at the North-Central Nigeria which lies at the confluence of the Niger and the Benue rivers with a GPS coordinate of latitude $7^0$48 59.99 N and longitude $6^0$44 59.99 E. It is well accessible through State and Federal highways. The area is sandwiched between a water body and a hill, that is River Niger and Mount Patti respectively, which has streamlined the settlement into a linear one and has a modifying effect on the climate. The climate of Lokoja is characterized by the wet and dry season. The annual rainfall is between 1016mm and 1524mm, with the mean annual temperature of $27^0$C.

### Collection of fruit and vegetable samples

The fruits and vegetables were acquired from four (4) selected markets in Lokoja namely: International market, Old market, Lokongoma market and Mami market. These markets are considered the major ones because majority of farmers, business men and women in and out of Lokoja, Kogi state convey their products for sales with large population of buyers to complete the circle of buying and selling. A total of 192 samples were collected. The fruits and vegetables were purchased randomly from the different market to obtain qualitative estimation of parasitic contamination of these fruits. A total number of twenty-four (24) of fruits and vegetables (eight each) were purchased at each of the four selected markets in a neat, newly bought, labelled polythene bags respectively (for each sample) and were, gently transported to the Department of Biological Sciences laboratory for examination.

### Administration of questionnaire and data collection

A simple re-tested and semi- structured questionnaire through dialogue were used to obtain information on factors related to the contamination of fruits and vegetables such as: Produce freshly collected or not, Status of the produce and Fingernail status of the vendors. Data on means of display and type of market was recorded by simple observation. Then, in each market, each sample was collected under normal purchase conditions from randomly selected sellers. A total of eighty-two vendors participated.

### Preparation and examination of samples

The samples were soaked and washed in 500ml of normal saline to separate the parasitic stages (ova, larvae, oocysts, and cysts) of protozoans and helminthes parasites, then let to stand for 24 hours. Using a cheesecloth, the sample liquid and sediment were sieved to remove unwanted materials. The parasitic stages were then concentrated by centrifuging 15mls of sediment at 3000 revolutions per minute for five minutes. The supernatant was carefully decanted without shaking, after which the sediment was gently stirred by hand to redistribute the parasite stages before being prepared for microscopic analysis. The samples were examined under light microscope (10X and 40X) objectives to determine the parasite stage (Omowaye and Audu, 2015). The parasites were detected using the WHO's bench aids for intestinal parasite diagnosis (2012).

### Data analysis

The data was entered, cleaned, and analyzed using the Statistical Package for the Social Sciences (SPSS) software Windows version 16.0 (IBM, Chicago, IL, USA). Pearson's Chi-square (X2) test was used to access the categorical variables (that is, to compute the difference in parasitic contamination among the different categories and to determine the prevalence of parasites in the various categories of fruits and vegetables). Values were considered statistically significant when their computed P-value was less than or equal to 0.05. Univariate and multivariate logistic regression analysis were used to determine factors related to parasite contamination of fruits and vegetables.

## RESULTS

### Parasite contamination of the selected fruits and vegetables

A total of 192 fruits and vegetables samples were collected from 82 vendors, of which 42 (51.2%) were

**Table 1:** Distribution of parasitic contamination among fruits and vegetables sold at the selected markets.

| Type of Produce | Category | Number examined | Number Positive | % value | Number of Parasite Detected per Produce | | |
|---|---|---|---|---|---|---|---|
| Fruits | | | | | 1 | 2 | 3 |
| | Soursop | 24 | 9 | 19.1 | 9(37.5) | 0 | 0 |
| | Mango | 24 | 14 | 29.8 | 14(58.3) | 0 | 0 |
| | Guava | 24 | 7 | 14.9 | 7(29.2) | 0 | 0 |
| | Tomatoes | 24 | 17 | 36.2 | 13(54.3) | 4(16.7) | 0 |
| | Total | 96 | 47 (48.9%) | 100 | 43(44.8) | 4(4.2) | 0 |
| Vegetables | | | | | | | |
| | Carrots | 24 | 8 | 13.8 | 8(33.3) | 0 | 0 |
| | Cabbage | 24 | 13 | 22.4 | 13(54.3) | 0 | 0 |
| | Spinach | 24 | 23 | 39.7 | 18(78.0) | 3(12.5) | 2(8.3) |
| | Fluted Pumpkin | 24 | 14 | 24.1 | 14(58.3) | 0 | 0 |
| Total | | 96 | 58 (60.4%) | 100 | 53(55.2) | 3(3.1) | 2(2.1) |
| Overall Distribution | | 192 | 105 (54.7%) | | 96(50.0) | 7(3.65) | 2(1.04) |

**Table 2:** Distribution of Parasites from Type of Produce at the Different Markets in Lokoja.

| Detected Parasites | Mango | Sour Sop | Guava | Tomatoes | Carrot | Cabbage | Spinach | Fluted Pumpkin | Total Value% |
|---|---|---|---|---|---|---|---|---|---|
| *Ascarislumbricoides* | 3 | 0 | 0 | 3 | 0 | 1 | 5 | 2 | 14(13.3) |
| *Toxocara spp.* | 1 | 0 | 2 | 1 | 2 | 0 | 3 | 1 | 10(9.5) |
| *Hymenolepis spp.* | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 3 (3.1) |
| Hook worm | 2 | 4 | 0 | 6 | 0 | 6 | 7 | 5 | 30 (28.6) |
| *Strongyloides* | 7 | 2 | 2 | 2 | 2 | 3 | 0 | 3 | 23 (21.5) |
| *Giardia lamblia* | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 (1.9) |
| *Entamoeba spp.* | 0 | 0 | 2 | 3 | 2 | 2 | 2 | 2 | 13 (12.4) |
| *Cryptosporidium spp.* | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 2 (1.9) |
| *Idamoebabutschlii* | 0 | 0 | 1 | 0 | 0 | 0 | 5 | 0 | 6 (5.7) |
| *Taenia spp.* | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 (1.9) |
| Total | 14 | 08 | 08 | 17 | 08 | 13 | 23 | 13 | 105(54.7) |

female and 40 (48.8%) were male. Of all the samples, 21, 20, 20, 21 were from the International, Old, Lokongoma and Mami markets respectively (Table 1). On average, each vendor displayed two to four items of fruits and vegetables for selling. The samples were made of 96 each of fruits and vegetables. A total of 105 samples were contaminated with at least one parasite species. The contamination of fruits alone was 47 (44.8%), while those of vegetables were 58(55.2%). Out of the 105 contaminated samples, 96(50.0%) was contaminated with one parasite species, while 7(3.65%) and 2(1.04%) had more contaminations with two and three parasite species respectively. The level of contamination was higher in the vegetables compared to fruits. Among the fruits, tomatoes were the most contaminated with 36.2%, followed by mango with 29.8% and sour sop with 19.1%, then guava with 14.9% showed the least contaminated item. Among the vegetables, spinach showed the highest contamination with 39.7%, followed by fluted pumpkin with 24.1% and cabbage with 22.4%, then carrot with 13.8% as the least contaminated item; vegetables showed statistically significant higher contamination rate than fruits (Table 1).

## Detection of parasites on the fruits and vegetables

Out of the 105 contaminated samples, Hook worm eggs (28.6%) and *Strongyloides (21.9%)* were the most commonly detected parasites on the fruits and vegetables followed by *Ascarislum bricoides, Entamoebaspp* and *Toxocaraspp* with 13.3%, 12.4% and 9.5% respectively. Others showed less than 9.0% and the lowest of 1.9% frequency as seen in *Giardia lamblia* and *Iodamoeba Butschlii* (Table 2). Chi-square test revealed that the Old market showed the highest number of contamination frequency, followed by International market and Lokongoma, then Mamimarket with the lowest contaminations (Table 3).

## Factors associated with parasitic contamination of fruits and vegetables

Vendors of the fruits and vegetables who were unable to read and write (43.9%) had higher contamination rate, followed by those who attended primary school (31.7), then those with secondary school education (24.4) as the lowest. However, the difference in the contaminations is not statistically significant (P value= 0.09161). Displaying place (0.0002) and Means of display (0.04913) was statistically significantly (P value=<0.05) in association with parasitic contamination; as Open market (100%) for those washed before displayed and those displayed in bucket without water (35.4%) had the highest rate of contamination (Table 4).

**Table 3:** Distribution of Parasite Species on Fruits and Vegetables Based on the Market Location.

| Market Location | Parasite Species | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | *Total* |
| International | 5(4.8) | 0(0) | 0(0) | 9(8.5) | 5(4.8) | 0(0) | 4(3.8) | 0(0) | 4(3.8) | 0(0) | 35(33.3) |
| Old | 3(2.9) | 5(4.8) | 3(8.5) | 8(7.6) | 7(6.6) | 1(0.9) | 6(6.7) | 2(1.8) | 0(0) | 0(0) | 27(25.7) |
| Lokongoma | 1(0.9) | 5(4.8) | 0(0) | 7(6.6) | 6(5.7) | 1(0.9) | 0(0) | 0(0) | 0(0) | 2(1.8) | 22(21.0) |
| Mami | 5(4.8) | 0(0) | 0(0) | 6(5.7) | 5(4.8) | 0(0) | 3(2.9) | 0(0) | 2(1.8) | 0(0) | 21(20.0) |
| | 14(13.4) | 10(9.6) | 3(2.9) | 30(28.6) | 23(21.9) | 2(1.8) | 13(12.4) | 2(1.8) | 6(5.6) | 2(1.8) | 105(100% |

1= *Ascarislumbricoides* 2=*Toxocara*spp 3=*Hymenolepis*spp 4=Hook worm 5=*Strongyloides*6=*Giardia lamblia* 7=*Entamoeba*spp 8=*Cryptosporidium*spp 9=*Idamoebabutschlii*10=*Taeniaspp*
International Market = $X^2$= 16.296, df = 12, p-value = 0.178
Old Market= $X^2$= 14.114, df = 15, p-value = 0.5169
Lokongoma Market= $X^2$= 14.545, df = 13, p-value = 0.3366
Mami Market= $X^2$= 8.7619, df = 12, p-value = 0.7231

**Table 4:** Binary Logistic Analysis of Factors Associated with Parasite Contamination of Fruits and Vegetables Sold at the Selected Markets of Lokoja, Kogi State.

| Variables | Categories | Number examined | Percentage contamination rate % | $X^2$ test | P value |
|---|---|---|---|---|---|
| Sex of Vendors | Male | 40 | 48.8 | 0.04878 | 0.8252 |
| | Female | 42 | 51.2 | | |
| Educational Level | Not Educated | 36 | 43.9 | 4.7805 | 0.09161 |
| | Primary | 26 | 31.7 | | |
| | Secondary | 20 | 24.4 | | |
| Fingernail Status | Trimmed but neat | 26 | 31.7 | 2.7317 | 0.2552 |
| | Trimmed but dirty | 22 | 26.8 | | |
| | Not trimmed | 34 | 41.5 | | |
| Source of Produce | Farmer | 35 | 42.7 | 1.7561 | 0.1851 |
| | Middle Men | 47 | 57.3 | | |
| Displaying Place | Grocery | 0 | 0 | 82 | 0.0002 |
| | Open Market | 82 | 100 | | |
| Washed before Display | Yes | 37 | 45.1 | 0.780 | 0.3770 |
| | No | 45 | 54.9 | | |
| Means of Display | In a bucket with water | 16 | 19.5 | 7.850 | 0.04913 |
| | In a bucket without water | 29 | 35.4 | | |
| | On the floor | 13 | 15.8 | | |
| | On the table/shelf | 24 | 29.2 | | |
| Means of Transportation | Human | 21 | 25.6 | 2.2915 | 0.03296 |
| | Truck | 31 | 37 | | |
| | Car | 30 | 36.6 | | |

## DISCUSSION

The current study has revealed an overall parasitic contamination of 54.7% by parasites on some fruits and vegetables sold at different markets in Lokoja metropolis. This observed contamination of fruits and vegetables in the area might be attributed to favorable climatic conditions that enhance fecal pollution of water, soil and foodstuffs (Wegayehu *et al.,* 2013, Sia *et al.,* 2012). One might also speculate that the market chain activities contribute as the fruits and vegetables pass through different hands and might have been contaminated with parasitic pathogens, including enteric bacteria and virus (Cheesbrough, 2009). In this study, spinach was the most frequently contaminated item (39.7%), while guava was the least contaminated item (14.9%). Vegetables are more prone to contamination than fruits due to the fact that vegetables like spinach, cabbage and fluted pumpkin have rough and uneven surfaces which enhance easy attachment of parasites to them and therefore overcome the effects of washing (Ismail, 2016; Said, 2012). The fragile nature of vegetables make them easily prone to damages which might explains why most vendors do not wash them thoroughly or do not wash them at all before display (Duedu *et al., 2014*). In contrast to fruits, the smooth and even surface of fruits like tomato, mango and guava makes them to be washed easily and then reduce the number of attachment points for parasites. The higher contamination of vegetables by parasites recorded in the current study may also be attributed to the fact that the edible parts of vegetables are known to grow closer to soil than fruits. Most of the soil utilize organic fertilizer in the form of human and other animal excreta (Tomas and Kidane, 2012) which in most cases contains parasite cysts and eggs capable of contaminating the vegetables because of the closeness to soil (Nasiru *et al., 2015*).

Hookworm eggs (28.6%) were the most frequently detected parasites. This observation might be due to contaminated soil during harvest and the use of human and animal wastes as natural fertilizer during pre-harvest phase, thereby contaminating the fruits and vegetables (Adenusi *et al.,* 2015). Larva of *Strongyloides spp.* (21.9%) was also detected with high frequency. The observed high frequency might be due to the fact that some parasites have a free-living state making it abundant in the environment, hence, contaminating fruits and vegetables easily. The infections of animal reservoirs could also contaminate the environment (Tefera *et al.,* 2014 and Dankwa *et al.,* 2018). *Ascaris Lumbricoides spp.* (mainly eggs) with contamination rate of 13.3% was the third most common parasite detected in the study. The next most prevalent parasite were the *Entamoeba spp.* (12.4%) and this contamination rate might be attributed to the long periods of survival of cysts under cool and moist conditions and variations in geographical distribution of the region (Etewa *et al.,* 2017, Luz *et al.,* 2017). Cyst of *Giardia lamblia, Cryptosporidium spp.* and *Taenia spp.* were the least detected parasites according to the present study with 1.9% rate of contamination.

A comparative analysis has revealed that contaminations of fruits and vegetables observed in current study were higher than findings recorded insimilar studies in Oyo state (35.4%), Plateau, (36.0%), Ibadan City (11.6%) in Nigeria, Tarcha town of Ethiopia (39.0%), Southern Thailand (35.1%) and Sharkyia governorate of Egypt (39%).

The differences might be attributed to variations in the number and items of samples collected, processed and laboratory methods used. The difference might be due to the time of samples collection. For instance, in the study from Brazil, the vegetable samples were collected between February and July (Luz *et al.,* 2017), while sample collection for the present study was between May-August. Variations in geographical distribution of parasites, sanitary and socioeconomic status of communities could be another factor.

Fruits and vegetables displayed without washing (54.9%) by vendors were higher and more likely to be contaminated with parasites compared to those washed before displayed (45.1%) but was not statistically significant ($p>0.05$). The type/cleanliness of the water might bring such discrepancies. It was noted from a dialogue with one of the vendors that river water was used mainly during the dry season, but when rain became more abundant, they store and use rain water for the washing of the fruits and vegetables, and not the river water (Month of June). Though, it is justifiable that washing before display removes parasites (Endale *et al.,* 2018; Bekele *et al.,* 2017; Tefera *et al.,* 2014). The number of illiterate vendors (43.9%) was higher than those who had primary school (31.7%) and secondary school education (24.4%). Vendors with untrimmed fingernails (41.5%) were higher compared to those who had trimmed fingernails that was neat (31.7%) and those that was trimmed but dirty (26.8%). It is known that untrimmed finger nails are more likely to collect dirt and parasites, which in turn, contaminate everything touched, hence, leading to the spread of food borne parasitic infection. Fruits and vegetables supplied to vendors by middlemen (57.3%) were more than the ones supplied directly by farmers (42.7%) as shown in the current study. However, those directly supplied by farmers were more likely to contain contaminated fruits and vegetables. Middlemen receive fruits and vegetables from the farmers and transport them using vehicles, store properly and distribute to the vendors; in contrast, vendors who received fruits and vegetables directly from farmers,and transport them directly from the farm as the fruits and vegetables have higher contamination rate.

## Conclusion

The current study has shown that the prevalence of parasites in the selected fruits and vegetables sold at the selected markets in Lokoja metropolis indicating that a source of parasitic infections among the public is the foodborne source. Leafy vegetables are more prone to contamination than fruits. Hookworm, *Strongyloides spp* and *Ascaris Lumbricoides* were the common contaminants of fruits and vegetables with comparable distribution. Fruits and vegetables sold by vendors who displayed their items in bucket without water, those without washing and those who displayed them in an open market were at higher risk of parasitic contamination. Hence, the public health sector should create awareness among farmers, vendors and consumers about safe cultivation, transportation, handling and consumption of fruits and vegetables, and proper hygienic practices, especially among consumers. Studies targeting fruits and vegetables in large scale both at pre-harvest and post-harvest phases using molecular detection methods are recommended to best identify the various sources of contamination and to detect various pathogenic contaminants. Proper washing of fruits and vegetables, improved hygienic practices of produce handlers and improvement in sanitation standards are measures believed to prevent contamination and infections.

## Acknowledgement

The authors acknowledge with thanks the technical assistance rendered by the technologists in the Department of Biological Sciences, Federal University Lokoja., kogi State.

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