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Parasitic Contamination of Common Fresh Fruits and Vegetables Sold in Markets within Dutsin-Ma Town, Katsina State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author TA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors JAB and CMS managed the analyses of the study. Author CMS managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The cases of parasitic diseases linked to consuming fresh fruits and vegetables are common in Northern Nigeria. This study assessed the parasitic contamination of common fruits and vegetables sold in markets within Dutsin-Ma town, Katsina State.
Place and Duration of Study: Sample: markets within Dutsin-Ma, Katsina State, North-Western Nigeria between April and June 2016.
Methodology: A total of 108 samples of fruits and vegetables were collected from three different markets in Dutsin-Ma town and assayed.
Methods Involved: Extraction of parasitic stages from the fruits and vegetables, sedimentation of the extract by centrifugation, staining to allow visualization of parasite eggs, cysts and larvae, and identification by microscopy.
Results: A total of 45 samples were found to be positive, 41.67% prevalence for parasites in this study. *Ascaris lumbricoides* was the most common parasite found, with prevalence of 11 (10.19%), while *Strongyloides stercolaris, Schistosoma* spp*, Giardia lamblia* and *Entamoeba hartmani* were least, with 1 (0.93%) each. Contamination had significant association with parasite type (p =

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0.0000). Contamination by type of fruits and vegetables showed spinach (vegetables) having the highest parasitic contamination 15 (83.33%), while cucumber and watermelon (fruits) had the least contamination, 2 (11.11%) eacha. Significant association was shown between prevalence and fruits/vegetable type (p = 0.0000).

Conclusion: *Ascaris lumbricoides* is the most prevalent parasite that contaminated fruits and vegetables sold in Dutsin-Ma markets. Vegetables, due to their rough/folded leaves are more contaminated with parasite cysts, eggs and larvae than fruits. Spinach showed the highest overall prevalence.

Keywords: Protozoans; Ascaris lumbricoides; geohelminthes; cysts/ova; Spinach; Roselle.

1. INTRODUCTION

Recently, there has been an increase in the number of reported cases of food borne illnesses linked to consuming fresh fruits and vegetables, especially in developing nations. The consumption of raw fruits and vegetables plays a major epidemiological role in the transmission of parasitic food borne diseases [1,2]. Many outbreaks of Protozoan infections in humans have been linked to raw fruits and vegetables. Previous studies have revealed that many types of vegetables and fruits purchased at markets in different regions from many developing countries were contaminated with Helminthes eggs as well as protozoan cysts [3-5].

In developing countries, the continued use of untreated waste water and manure as fertilizer for the production of fruits and vegetables is a major contributing factor to contamination, thereby causing numerous diseases [6]. Vegetables grown close to the soil may be contaminated with various food borne pathogens. Various factors contribute to increase in diseases associated with raw fruits and vegetables, which include globalization of food supply. Introduction of pathogens into new geographical areas through importation, use of untreated waste water and manure as fertilizers for crop production, irrigation and various agronomic practices, level of hygiene of food handlers *etc* [7]. It has been established that irrigation of vegetables using contaminated water or untreated wastewaters, environmental conditions such as the contamination of soil with human faeces, poor sewage disposal and the use of night soil as fertilizer contribute immensely to the contamination of vegetables. Some of these fruits and vegetables are eaten raw within the metropolis and sometimes in combination with cooked food [8].

Globally, parasitic infections affect millions of people. In some regions, they are a major cause of childhood diarrhoea and stunting of growth, and cause significant economic losses related to human health and to agriculture. Amongst the classes indicted are Protozoa, Cestodes, Trematodes and Nematodes. Previous studies have reported the presence of helminthes egg and protozoa cyst on fresh fruits and vegetables, which are agents of gastrointestinal infections [7, 9].

Some works have been reported on parasitic contamination of fruits and vegetables with geohelminths and protozoan cysts and ova in Nigeria [7,10-12]. But there is a dearth of information on the contamination of fruits and vegetables with such cysts and ova in some part of Northern Nigeria, especially Dutsin-Ma, Katsina State, where these vegetables are mostly cultivated and local farmers usually package and take their fruits and vegetables to the city markets in unhygienic condition. It is also a common practice among fruit and vegetable vendors in the study area to wash the fruits and vegetables with water from unknown sources. Hence, this study assessed the parasitic contamination of some common fruits and vegetables sold in markets within Dutsin-Ma town, Katsina State.

2. METHODOLOGY

2.1 Study Area

This study was carried out within Dutsin-Ma town, Dutsin-Ma Local Government Area, Katsina State. Dutsin-ma Local Government Area of Katsina state, lies on the latitude $12^0$26N and longitude 07°29E. It is bounded by Kurfi and Charanchi LGAs to the north, Kankia LGA to the east, Safana and Dan-Musa LGA to the West, and Matazu LGA to the southeast. Dutsin-ma has a size of about 552.323 km^2 with a population of 169 829 as at 2006 national census [13]. The people are predominantly farmers, cattle rearers and traders. The climate of Katsina

state is a tropical wet and dry type (tropical continental climate). Rainfall is between May and September with a peak in August. The average annual rainfall is about 700 mm. The pattern of rainfall in the area is highly variable. This can result to severe and widespread droughts that can impose serious social- economic constraints [14]. The mean annual temperature ranges from 29℃ – 31℃. The highest air temperature normally occurs in April/May and the lowest in December through February. Evapo-transpiration is generally high throughout the year. The highest amount of evaporation occurs during the dry season. The vegetation of the area is the Sudan savannah type which combines the characteristics and species of both the Guinea and Sahel Savannah [15,16].

2.2 Sampled Markets and Samples Collection

Three major markets; kasuwan laraba (Wednesday market), kasuwan yaradole and kasuwan yara where vegetables are usually sold within Dutsin-Ma town were selected for this research. Samples of three fruits (cucumber, orange and watermelon) and three vegetable (spinach, cabbage and roselle), frequently available fruits and vegetables were purchased from shed sellers for a period of six weeks, between April and June 2016. A total of 108 fruits and vegetable samples were collected from the three major markets within the metropolis during the study period, 18 of each fruit and vegetable.

2.3 Laboratory Analysis

The leafy vegetables were processed and examined according to the methods of [11] with slight modifications. 250 g aliquot of each vegetable sample were weighed aseptically and hand washed by shaking vigorously for 2 minutes in 500 ML of normal saline (0.85% NaCl). Non-leaf vegetables and fruits were washed directly in 500 ML of normal saline. The suspension was strained through sterile 0.4 mm^2 standard sieve to remove undesirable materials. The filtrate was left to stand for 24 hours. 480 mL aliquots of the supernatant was decanted and kept aside while the sediments in the remaining 20 mL were resuspended by votexing for 10 second. Aliquot 10 mL was then centrifuged at 2000 rpm for 20 minutes. Roughly 90% of the supernatant was decanted after centrifugation and the deposits votexed for another 10 seconds. Two drops of the suspension were placed on clean microscope slide. A drop of lugols iodine was added, covered with a clean cover slip and observed under binocular compound light microscope at x10 and x40[14].

2.4 Data Analysis

Chi-square (χ^2) test was used to determine whether any relationship exists between parasite ova/larvae and contamination of different fruits and vegetables, type of produce and location of markets. Significance was considered at $p < 0.05$.

3. RESULTS

In this study, results revealed fruits and vegetables to be contaminated with parasite cysts, eggs or larva. A total of 45 (41.67%) samples were found to be positive for parasites during the study. Parasites found included *Ascaris lumbricoides, Trichuris trichiura,* Hookworm*, Strongyloides stercoralis, Schistosoma* spp*, Fasciola* spp*, Entamoeba coli, Giardia lamblia, Entamoeba histolytica, Taenia* spp and *Entamoeba hartmanni*. Results from the study showed highest parasitic contamination of fruits and vegetables with *A. lumbricoides,* 11 (10.19%), while *S. stercolaris, Schistosoma* spp*, G. lamblia* and *E. hartmanni* least contaminated the fruits and vegetables 1 (0.93%) each. Prevalence of contamination had significant association with parasite type ($p = 0.0000$) (Table 1).

Results of parasitic contamination by type of fruits and vegetables showed spinach (vegetables) having the highest parasitic contamination 15 (83.33%) each, while cucumber and watermelon (fruits) had the least contamination, 2 (11.11%). Significant association was shown between prevalence and fruits/vegetable type ($p = 0.0000$) (Table 2).

Results of prevalence of parasitic contamination of fruits and vegetables according to the different markets revealed highest prevalence in Kasuwan Yaradole 18 (50.00%), out of 36 total samples while the lowest prevalence contamination of 36.11% was observed in Wednesday market (Table 3). No significant association was established between prevalence of parasitic contamination and markets in Dutsin-Ma town ($p = 0.449$).

Table 1. Prevalence of parasitic contamination according to parasite type

Parasite	Number of sample examined	Number positive	Prevalence	χ^2	p-value
T. trichiura	108	2	1.85	108.000	0.000*
Taenia spp	108	3	2.78		
A. lumbricoides	108	11	10.19		
Fasciola spp	108	3	2.78		
Hookworm	108	5	4.63		
E. coli	108	9	8.33		
S. haematobium	108	1	0.93		
S. stercoralis	108	1	0.93		
E. hartmanni	108	1	0.93		
E. histolytica	108	6	5.56		
G. lamblia	108	1	0.93		

Table 2. Prevalence of parasitic contamination according to fruit and vegetable types

Vegetables and fruits	Number examined	Number positive	Prevalence (%)	X^2	p-value
Orange	18	3	16.67	41.486	0.000*
Cucumber	18	2	11.11		
Spinach	18	15	83.33		
Cabbage	18	9	50.00		
Roselle	18	14	77.78		
Water Melon	18	2	11.11		
Total	108	45	41.67		

Table 3. Prevalence of parasitic contamination of both fruits and vegetables according to markets

Market	Number of vegetables and fruits screened	Number contaminated	Prevalence	X^2	p-value
K/Yaradole	36	18	50.00	1.600	0.449
Wednesday Market	36	13	36.11		
K/Yara	36	14	38.89		
Total	108	45	41.67		

Table 4. Types of parasite prevalent according to markets

Parasites	Market			X^2	p-value
	K/Yaradole (n = 36)	Wednesday market (n = 36)	K/Yara (n = 36)		
T. trichiura	1(2.78)	0	1(2.78)	26.206	0.452
Taenia spp	3(8.33)	0	0		
A. lumbricoides	5(13.89)	2(5.56)	4(11.11)		
Fasciola spp	1(2.78)	2(5.56)	0		
Hookworm	1(2.78)	3(8.33)	1(2.78)		
E. coli	2(5.56)	3(8.33)	4(11.11)		
S. haematobium	1(2.78)	0	0		
S. stercoralis	0	1(2.78)	0		
E. hartmanni	0	0	1(2.78)		
E. histolytica	3(8.33)	2(5.56)	1(2.78)		
G. lamblia	0	0	1(2.78)		

Table 5. Type of parasite contamination according to type of fruits and vegetables

Parasites	Fruits and vegetables						X^2	p-value
	Orange (n = 18)	Cucumber (n = 18)	Spinach (n = 18)	Cabbage (n = 18)	Roselle (n = 18)	Water melon (n = 18)		
T. trichiura	0	0	2(11.11)	0	0	0	112.395	0.000*
Taenia spp	0	0	0	2(11.11)	1(5.56)	0		
A. lumbricoides	0	1(5.56)	6(33.33)	0	4(22.22)	0		
Fasciola spp	0	0	0	0	3(16.67)	0		
Hookworm	0	0	3(16.67)	1(5.56)	1(5.56)	0		
E. coli	2(11.11)	1(5.56)	1(5.56)	2(11.11)	1(5.56)	2(11.11)		
S. haematobium	0	0	1(5.56)	0	0	0		
S. stercoralis	0	0	0	1(5.56)	0	0		
E. hartmanni	0	0	1(5.56)	0	0	0		
E. histolytica	1(5.56)	0	1(5.56)	3(16.67)	1(5.56)	0		
G. lamblia	0	0	0	0	1(5.56)	0		

When the types of parasites prevalent were considered according to markets, *Ascaris lumbricoides* was highest (13.89%) in Kasuwan yaradole and lowest (5.56%) at Wednesday market, *Taenia* spp (8.33%) and *S. haematobium* (2.78%) were only present in Kasuwan yaradole. *Entamoeba hartmanni* and *G. lamblia* were only present in samples from Kasuwan yara (Table 4). No significant association between types of parasites that contaminate fruits and vegetables with market ($p = 0.452$).

As presented on Table 5, *E. coli* were the only parasite that contaminated all types of fruits and vegetables. Roselle had the highest number (9) of parasites types. Only water melon had a single type of parasite, *E. coli.*

4. DISCUSSION

Contamination of fruits and vegetables with human pathogenic species of parasite as recorded in this study revealed 45 (41.67%) of the samples to be contaminated out of the one hundred and eight (108) total samples of fruits and vegetables examined. This result is similar to the findings of [17] and [5], where they reported 36.0% and 31.7% cases of parasitic contamination of fresh vegetables in Jos, Nigeria and Alexandria, Egypt respectively. It is quite higher than the reports of [18] who screened fruits sold in Calabar, Nigeria for parasites. The works of [19] and [20] were also lower, where they recorded 13.5% and 14% positive cases of parasites on fruits and vegetables sold in Kaduna and Zaria respectively, all in Nigeria. The variation in prevalence of contamination with other reports corroborates the point that prevalence of specific parasites in food supplies varies between countries and regions and show that the pattern of quality could be improved for fruits and vegetables sold in places where contamination is still high [21]. The highest prevalence found of *A. lumbricoides* may be as a result of the viability of their eggs in the soil for months and being the commonest parasite in the tropics [22-24]. This corroborated the works of [25] and [7] who reported that *A. lumbricoides* was the most prevalent helminth observed on fruits and vegetables (80.6% and 65.8%) in Umuahia, Abia State and Gusau, Zamfara State respectively, all in Nigeria. Also, it is in line with the work of [20], who reported 24% for *A. lumbricoides*. He also reported that people consuming vegetables irrigated with raw waste water are exposed to the risk of infection with *Ascaris lumbricoides*, *Entamoeba histolytica* and *Giardia lamblia*. Ascariasis and Gardiasis diseases are among the commonest parasitic infections associated with raw fruits and vegetables, which causes considerable morbidity in pregnant women, children and adults. The detection of these geohelminth and protozoan cysts, ova/ larvae on fruits and vegetables in the three studied markets, has a significant public health implication. Some of the vegetables and fruits are processed and eaten uncooked, which could lead to infection and disease especially when served to the public [26].

The highest prevalenkce of parasitic contamination on spinach (vegetables) compared to fruits is similar to what [7,10,27] reported. This may be due to the rough surface and leaf folds of this vegetable which may retain dirt that cannot be easily washed off [28]. Highest prevalence in Kasuwan Yaradole among the three markets could be attributed to the differences in personal hygiene, source of water and other environmental factors. *Entamoeba coli* were the only parasite that contaminated all types of fruits and vegetables, their very small size most have been an advantage. The variation of this result and findings of previous researches could be due to the fact that areas of study differ in geographical location, climatic, environmental conditions, general behavioural attitude to hygiene and the socio-economic activities of producers, sellers and consumers.

5. CONCLUSION

In conclusion, most fruits and vegetables sold within the metropolis were contaminated with parasitic cysts/eggs. Vegetables, due to their rough/folded leaves are more contaminated with parasite cysts, eggs and larvae than fruits. *Ascaris lumbricoides* is the most prevalent parasite that contaminated fruits and vegetables sold in Dutsin-Ma markets. Variations in the percentage positive samples are a reflection of the poor sanitary conditions of the locality.

The need for health education and intensive advocacy by both governmental and nongovernmental organizations cannot be over emphasised. Also, organic manure should be sterilized or properly treated before use for cultivation of vegetables and other ready-to-eat farm produce. The need for the improvement of sanitary facilities in markets where fruits and vegetables are sold is quite necessary. There should be media programs to inform the consumers on the potential health risks

associated with consumption of unwashed or improperly washed raw fruits and vegetables, and the need for proper washing and disinfecting of fruits and vegetables before consumption. Government or market management authorities should make provision of safe water for washing of fruits, vegetables and other farm produce.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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