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Protozoa and Helminth Parasites of Some Freshly Cultivated Vegetables from Some Irrigated Farms within Kaduna Metropolis, Kaduna State, Nigeria

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Abstract

The parasitic (protozoa and helminthes) infestation of some freshly cultivated vegetables from some irrigated farms within Kaduna metropolis, Kaduna State, Nigeria were assessed. A total of 300 vegetables comprising 12 each of cabbage, carrot, cauliflower, cucumber and lettuce from 5 different farms were used for this study. The vegetables were processed using sedimentation and floatation techniques for parasites identification. Results revealed that out of the 300 vegetable samples examined, 26 (8.67%) were positive for the presence of parasites. Of the 26 vegetables that had parasites, 9 (15.00%) were cabbages, 3 (5.00%) were carrots, 5 (8.33%) were cauliflowers, 3 (5.00%) were cucumbers and 6 (10.00%) were lettuces. No significant (X^2 = 5.222, P = 0.265) association existed between the prevalence of parasites and the various vegetables. The parasites encountered included Hookworms (26.92%), *Teania* ssp. (11.54%), *Ascaris lumbricoides* (42.31%), *Trichuris trichuria* (3.85%), *Fasciola hepatica* (3.85%), *Strongyloides stercoralis* (7.69%) and *Entamoeba histolytica* (3.85%). Hookworm (33.33%) and *Strongyloides stercoralis* (22.22%) were more prevalent in cabbage while *Ascaris lumbricoides* (60.00%) was most prevalent in cauliflower. There was no significant association between the parasites identified and the different types of vegetable. Significant association existed between parasite infestation and the different farms with the highest prevalence was recorded in Farm D (11.67%) and lowest prevalence (3.85%) in Farms A and C. Seasonal occurrence of parasites in the vegetables showed higher prevalence of parasites during the rainy season (73.08%) in all farms than in the dry season (26.92%).

Keywords

Protozoa, Helminth, Vegetables, Irrigated, Kaduna Metropolis, Farms

1. Introduction

Vegetables are of great importance to human health and development, as they are essential for a normal balanced diet [1]. Vegetables are generally reported to have low protein and fat contents, but contained varying proportions of vitamins such as vitamin A, K, B_6, C and D. Vegetables such as lettuce, cabbage, water melon, and cucumber have high water contents and are good sources of vitamin C, carotene, mineral elements, iron and fiber [2]. Carrots, tomatoes and garden eggs are good antioxidant that neutralizes free radicals which are harmful molecules that damage the body cells and cause inflammation [2, 3]. Some other vegetables have high caloric values and glycemic index and are recommended to be taken in moderation [4].

Parasites may be transmitted from animals to humans, from humans to humans, from food to humans or even from

humans to animals [5]. Several parasites have emerged as significant causes of food-borne and water-borne diseases in the world. These are contracted through the consumption of contaminated food, and water or by eating raw vegetables that are contaminated with parasites ova or cysts [6]. The use of human faeces and animal dung in enriching the soil for cultivation of crops such as fruits and vegetables are on the increase [7]. The peasant farmers in Nigeria who are mainly in charge of the cultivation of vegetables depend on irrigation when there is no rainfall for the cultivation of their crops all year round [8]. Many of them use untreated human faeces and animal dung as manure, which may contain various species of parasites that are of medical and veterinary importance [9].

In Nigeria, the incessant increase in the number of reported cases of food borne illnesses are more often linked to consumption of fresh fruits and vegetables [10, 11]. It has been established that most protozoan infections in humans caused by helminthes have been linked to consumption of fresh vegetables hence consumption of fresh vegetables plays a major epidemiological role in the transmission of food borne helminthic diseases [9, 11]. The climate, vegetation and topography of Kaduna State in Nigeria favours the cultivation of various vegetables using rain water during the wet season and the method of irrigation during the dry season [12]. This study, therefore aims at investigating the occurrence of protozoa and helminthes parasite in some freshly cultivated vegetables from some irrigation farms within Kaduna metropolis.

2. Materials and Methods

2.1. Study area

The study was conducted in Kaduna Metropolis, Kaduna State, Nigeria. Kaduna is the capital of Kaduna State and within latitudes 100 23'N to 100 38'N of the equator, and longitudes 70 21'E to 70 31'E of the Greenwich Meridian. It is located in the central area of what used to be called the Northern Region of Nigeria. It has interstate boundaries with Niger state to the West, Zamfara, Katsina and Kano states to the North, Bauchi and Plateau states to the East while FCT and Nasarawa state are to the South. The metropolis comprises four local government area councils namely; Kaduna north and south with segments of Chikun and Igabi. The four councils have a combined population of about 6,113, 503 people [13].

2.2. Vegetable sample collection

A total of 300 vegetable samples were collectedfrom five randomly selected farms in Kaduna metropolis. The vegetables collected were cabbage (*Brassica oleracea*), lettuce (*Lactuca sativa*), carrot (*Daucus carota*), Cucumber (*Cucumis sativus*) and Caulifiower (*Brassica oleraceavar botrytis*). The vegetables were purchased from Kawo Market of Kaduna State, in the early hours of the morning between 6:00 am and 9:00 am. Sixty vegetable samples comprising 12 each of the different vegetables listed above were collected from each farm. The vegetables were collected using labeled sterile polythene bags and later transported to the laboratory of the Department of Biological Science, Nigerian Defence Academy, Kaduna for analysis.

2.3. Laboratory analysis

Vegetables were weighed using simple laboratory weighing balance and washed appropriately. One hundred grams (100 g) of each vegetable was washed in 250 mL of 0.9% sodium chloride solution. Floatation technique was further employed in the preparation of the resulting wash water [6].

For sedimentation technique, about 25 g of the each vegetable sample was weighed and washed in distilled water to remove parasite ova/cysts. The suspension was drained through a sterile sieve to remove undesirable materials. The filtrate was centrifuged at 3000 rpm for 15 minutes. The supernatants were discarded into a clean container. The sediment was mixed up and a drop of it placed on the centre of a clean grease-free microscope slide followed by gently placing a clean cover slip on the slide to avoid air bubbles. Iodine was added through the cover slip into the preparation for easy identification of the parasite [14]. Parasite ova/cysts were identified with the aid of Atlas of Medical Parasitology [6].

3. Data Analyses

Data were analyzed using IBM SPSS (26.0 version, Armonk, NY: IBM) and presented using tables. The overall prevalence of the parasites was calculated. Chi-square (X^2) test was used to determine the relationship between parasite contamination of vegetables and the different vegetable types, type of parasites, the different farms and season. Values of $P \leq 0.05$ were considered significant.

4. Results

4.1. Prevalence of Helminth and Protozoa Parasites in Vegetable Samples

The results on the overall prevalence of parasites in freshly cultivated vegetables from some farms within Kaduna Metropolis are presented in Table 1. Out of the 300 vegetable samples examined, 26 (8.67%) were positive for the

presence of parasites. Of the 26 vegetables that were positive, 9 (15.00%) were cabbages, 3 (5.00%) were carrots, 5 (8.33%) were cauliflowers, 3 (5.00%) were cucumbers and 6 (10.00%) were lettuces.

The highest percentage of parasite infestation was found in cabbage (34.61%), followed by lettuce (23.08%) and least in carrot (11.54%) and cucumber (11.54%). The percentage parasitization of 19.23% was recorded for cauliflower. There was no significant association ($X^2 = 5.222$, $P = 0.265$) between prevalence of parasite contamination and the various vegetables.

The occurrences of each parasite in freshly cultivated vegetables from some farms within Kaduna Metropolis are presented in Table 2. The parasites encountered included Hookworms, *Teania* spp, *Ascaris lumbricoides*, *Trichiuris trichiura*, *Fasciola hepatica*, *Strongyloides stercoralis* and *Entamoeba histolytica*.

From the 300 vegetables examined, 26 parasites were identified. Out of the 26 parasites identified 7 (26.92%) were Hookworms, 3 (11.54%) were *Teania* spp, 11 (42.31 %) were *Ascaris lumbricoides*, 1 (3.85%) was *Trichiuris trichiura*, 1 (3.85%) was *Fasciola hepatica*, 2 (7.69%) were *Strongyloides stercoralis* and 1 (3.85%) was *Entamoeba histolytica*. There was significant difference ($X^2 = 24.077$, $P = 0.001$) in the prevalence of the various parasites identified.

The distributions of parasites in the different vegetable types from some farms within Kaduna Metropolis are presented in Table 3. Out of the 9 parasites identified in cabbages, 3 (33.33%) were Hookworms, 1 (11.11%) was *Teania* spp, 2 (22.22%) were *Ascaris lumbricoides*, 1 (11.11%) was *Fasciola hepatica* and 2 (22.22%) were *Strongyliodes stercoralis*. From the 3 parasites identified in carrots, 1 (33.33%) was *Teania* spp and 2 (66.67%) were *Ascaris lumbricoides*.

Out of the 5 parasites identified in cauliflowers, there were 2 (40.00%) Hookworms and 3 (60.00%) *Teania* spp. In cucumbers, 2 (66.67%) of the parasites identified were *Ascarislum bricoides* and 1 (33.33%) was *Trichiura trichiura*. The parasites identified in lettuces were 2 (33.33%) Hookworms, 1 (16.67%) *Teania* spp, 2 (33.33%) *Ascaris lumbricoides* and 1 (16.67%) *Entameoba histolytica*. There was no significant association ($X^2 = 23.309$, $P = 0.502$) between the parasites identified and the different types of vegetable.

Table 1. Prevalence of parasite in freshly cultivated vegetables from some farms within Kaduna Metropolis, Nigeria

Vegetables	Number examined	Number positive	Prevalence (%)	% infestation	X^2	P value
Cabbage	60	9	15.00	34.61	5.222	0.265
Carrot	60	3	5.00	11.54		
Cauliflower	60	5	8.33	19.23		
Cucumber	60	3	5.00	11.54		
Lettuce	60	6	10.00	23.08		
Total	300	26	8.67	100.00		

Table 2. Occurrence of each parasite in freshly cultivated vegetables from some farms within Kaduna Metropolis, Nigeria

Type of Parasites	Number of parasites identified (n = 26)	(%) Occurrence	X^2	P value
Hookworm	7	26.92	24.077	0.001*
Teania spp	3	11.54		
Ascarislum bricoides	11	42.31		
Trichuris trichuria	1	3.85		
Fasciola hepatica	1	3.85		
Strongyliodes stercoralis	2	7.69		
Entameoba histolytica	1	3.85		
Total	26	100.00		

*significant at $P < 0.05$

Table 3. Distribution of the parasites in vegetable types from some farms within Kaduna Metropolis, Nigeria

Parasite identified	Cabbage	Carrot	Cauliflower	Cucumber	Lettuce	X^2	P value
Hookworm	3(33.33)	0(0.00)	2(40.00)	0(0.00)	2(33.33)	23.309	0.502
Teania spp	1(11.11)	1(33.33)	0(0.00)	0(0.00)	1(16.67)		
Ascarislum bricoides	2(22.22)	2(66.67)	3(60.00)	2(66.67)	2(33.33)		
Trichiuris trichiuria	0(0.00)	0(0.00)	0(0.00)	1(33.33)	0(0.00)		
Fasciola hepatica	1(11.11)	0(0.00)	0(0.00)	0(0.00)	0(0.00)		
Strongyliodes stercoralis	2(22.22)	0(0.00)	0(0.00)	0(0.00)	0(0.00)		
Entameoba histolytica	0(0.00)	0(0.00)	0(0.00)	0(0.00)	1(16.67)		

4.2. Prevalence of Parasites in Vegetables from Different Farms

4.2.1. Overall prevalence of parasites in the different farms

The occurrence of parasites in vegetables in the different farms within Kaduna Metropolis is presented in Table 4. The prevalence of parasites in vegetables recorded in Farm A was 6.67% while Farm B had 10.00%. Also Farm C had 6.67% parasite occurrence while Farm D and Farm E had 11.67% and 8.33% parasitic occurrence respectively. The percentage distribution of parasite was highest in Farm D (26.92%) followed by Farm B (23.08%), Farm E (19.23%) and least in Farms A (15.38%) and C (15.38%). There was significant association (X^2 = 113.869; P = 0.000) between parasite occurrence and the different farms.

4.2.2. Prevalence of parasites in the different farms based on vegetable type

The distribution of parasites on vegetable types in the different farms within Kaduna Metropolis is presented in Table 5. In Farm A, parasite infestation was highest in cabbage (50.00%) followed by cauliflower (25.00%) and lettuce (25.00%), and absent (0.00%) in carrot and cucumber.

In Farm B, parasite infestation of 33.33% was recorded for cabbage, and 16.67% each for carrot, cauliflower, cucumber and lettuce. In Farm C, parasite infestation of 25.00% was recorded each for cabbage, carrot, cauliflower and cucumber.

In Farm D, parasite infestation was highest in cabbage (42.86%), followed by lettuce (28.57%), carrot (14.29%) and cucumber (14.29%) but was absent in lettuce (0.00%). In Farm E, cauliflower and lettuce each had parasite infestation of 40.00% and cabbage had 20.00% while carrot and cucumber had no (0.00%) parasite infestation. There was no significant (X^2 = 8.903, P = 0.917) association between parasite infestation of the vegetable types and the different farms.

The seasonal distribution of parasites among the vegetables in the different farms within Kaduna Metropolis is presented in Table 6. The overall prevalence of parasite contamination of vegetables was significantly higher (X^2 = 5.538, P = 0.019) during the rainy season (73.08%) in all farms than in the dry season (26.92%). The occurrence of parasites among the vegetables in the farms was 75.00% in the rainy season and 25.00% in the dry season in Farm A; 66.67% in the rainy season and 33.33% in the dry season in Farm B. There was also 75.00% parasite occurrence in the rainy season and 25.00% parasite occurrence in the dry season in Farm C; 71.43% parasite occurrence in the rainy season and 28.57% occurrence in the dry season in Farm D. In farm E, there was 80.00% parasite occurrence in the rainy season and 20.00% occurrence in the dry season.

Table 4. Distribution of parasites among vegetables of some farms in Kaduna Metropolis, Nigeria

Farms	Number examined	Number positive	Prevalence (%)	% distribution	X^2	P value
Farm A	60	4	6.67	15.38	113.869	0.000*
Farm B	60	6	10.00	23.08		
Farm C	60	4	6.67	15.38		
Farm D	60	7	11.67	26.92		
Farm E	60	5	8.33	19.23		
Total	300	26	8.67	100.00		

*significant at P < 0.05

Table 5. Prevalence of parasites in vegetables of each farm within Kaduna Metropolis, Nigeria

Vegetable	Farm A	Farm B	Farm C	Farm D	Farm E	X^2	P value
Cabbage	2(50.00)	2(33.33)	1(25.00)	3(42.86)	1(20.00)	8.903	0.917
Carrot	0(0.00)	1(16.67)	1(25.00)	1(14.29)	0(0.00)		
Cauliflower	1(25.00)	1(16.67)	1(25.00)	0(0.00)	2(40.00)		
Cucumber	0(0.00)	1(16.67)	1(25.00)	1(14.29)	0(0.00)		
Lettuce	1(25.00)	1(16.67)	0(0.00)	2(28.57)	2(40.00)		

Table 6. Seasonal distribution of the parasites among vegetables of some selected farms within Kaduna Metropolis, Nigeria

Farms (n = 60)	Rainy Season (%)	Dry Season (%)	X^2	P value
Farm A	3(75.00)	1(25.00)	5.538	0.019*
Farm B	4(66.67)	2(33.33)		
Farm C	3(75.00)	1(25.00)		
Farm D	5(71.43)	2(28.57)		
Farm E	4(80.00)	1(20.00)		
Overall prevalence	19(73.08)	7(26.92)		

*significant at $P < 0.05$

5. Discussion

In this study, the overall prevalence of 8.67% was reported for parasite contamination of freshly cultivated vegetables from farms within Kaduna Metropolis in Kaduna State. This prevalence is lower than the 36.0% reported in Jos, Plateau State [15] and the 11.6% in Ibadan, Oyo State [16]. Also it was lower than the 40.0% reported in Ilorin, Kwara State [17]; 73.5%in Abeokuta, Ogun State [18]; and 29.5% in Port-Harcourt, Rivers State [19]. The prevalence in this study is however higher than the 3.5% reported in Maiduguri, Borno State [20]. The variations in the overall prevalence of parasite in these studies might be due to differences in the number and types of vegetables collected in the geographical locations and practices of the farmers/traders from where the vegetables were collected. It might also be due to methods of collection, season in which the vegetables were collected and nature of the soil and water used in the cultivation of the vegetables. The vegetables examined in this study were cabbage, carrot, cauliflower, cucumber and lettuce, and the parasites identified in the vegetables were Hookworm, *Teania* spp, *Ascarislum bricoides*, *Trichiuris trichiuria*, *Fasciola hepatica*, *Strongyloides stercoralis*, *Entamoeba histolytica*. The highest prevalence of parasite contamination was reported in cabbage (15.00%) followed by lettuce (10.00%). This might be because Cabbage and lettuce are leafy vegetables which are close to the ground thus predisposing them to contamination with helminth parasites during flooding and heavy rain. This is consistent with the findings of other researchers [15, 16, 21] who reported highest parasite contamination in cabbage. In contrast Amaechi et al. [17], reported the highest parasite contamination in lettuce while Tchounga et al. [19], reported the least parasite contamination in cabbage. Also, it was reported that flooding occurs in farms leading to the submerging of these vegetables in water that may contain cysts or ova.

Ascarislum bricoides constituted the most prevalent parasite and this is consistent with the findings of other researchers [16-19, 22, 23]. This might have result5d from the fact that eggs of *Ascarislum bricoides* can withstand extreme environmental conditions due to the presence of ascaroside membrane resulting in prolonged viability of their eggs in the soil for months [24]. Also *Ascarislum bricoides* is a common parasite in the tropic, its presence might have resulted from poor socio-economic conditions, and unhygienic environmental and sanitation practices as well as favourableweather and climatic condition, such as high temperature, high humidity and rainy season.

The presence of *Strongyloides stercoralis* indicated there was faecal contamination of vegetables with the parasite and other extrinsic bacterial and viral agents that can cause serious infection. This is of public health significance due to the ability of *Strongyloides stercoralis* to exist in a freeliving state and proliferate in the absence of a host.

There was high parasite prevalence in vegetables from Farm D (11.67%) in this study. This might be due to the fact that Farm D used water from River Kaduna for the irrigation of their vegetables. River Kaduna being a major river in Kaduna State is prone to great contaminations from open defecation and indiscriminate dumping of refuse, organic fertilizers and manure, as well as run-off water from pit latrines and sludge. This similar observation was made by Dauda et al. [25]. The Farm B had the second highest parasite prevalence of 10.00%. This could be attributed to indiscriminate

dumping of refuse on water ways and run-off water from pit latrines and sludge from domestic environment [26]. These contaminations might be the possible reasons for the prevalence of parasite contamination in vegetables from these farms. Also, the physicochemical properties of the water and soil in these farms might have favoured the development of these parasites [25].

The helminth parasite contamination between dry and rainy seasons on the vegetables in the different farms showed that the rainy season had the highest parasite prevalence while dry season had the lowest parasite prevalence. This is in agreement with the reports of other researchers [19, 27, 28]. This might be due to the fact during heavy rainfall, the rain splashes, irrigation water or river flush of contaminated soil or poor sewage deposited on contaminated soil on the surface of leaves of vegetables. Also, this can be associated with warm temperature in the rainy season which supports the embryonation and development of helminthes eggs [29]. In contrast, high prevalence of parasite contamination during the dry season was reported in South Western Saudi Arabia [30]. The difference in geographical location might be responsible reason for the variation in these sets of observations.

In conclusion, the results of this study confirm the contamination of vegetables collected from selected farms within Kaduna Metropolis, Kaduna State, Nigeria. Vegetables with rough/folded leaves (cabbage and lettuce) were more contaminated with parasite cysts, eggs and larvae than others. *Ascarislum bricoides* and hookworm were the most prevalent helminth parasites that contaminated the vegetables. This showed undoubtedly, that vegetables consumed within Kaduna metropolis were contaminated with parasites hence there is need for proper decontamination of these vegetables before consumption.

Authors' contributions

R.I.O. conceived, designed and performed the study. O.O. wrote the paper. M.C.E. and D.M.B. supervised and approved the design of the study, critical revision of the manuscript and final approval for paper submission.

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