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Prevalence of Parasites of Public Health Significance in Vegetables Sold in Jos Metropolis, Plateau State, Nigeria

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Abstract **BACKGROUND**: Vegetables are vital for good health but can serve as a means of transmission of parasitic pathogens to man. **JUSTIFICATION**: There is increase consumption of vegetables due to general awareness of the health benefits. This research intends to explore suggestive management strategies and control in handling vegetables to reduce or if possible eliminate food borne parasites. **AIM AND OBJECTIVE**: The study was to determine parasitic contamination of fresh vegetables with objective to determine the prevalence of parasites of medical importance in vegetables sold in Jos market. **METHODOLOGY**: A total of 575 samples of fresh vegetables; Lettuce, Cabbage, Carrot, Spinach, Green Pepper, Cucumber, Beetroot, Tomatoes, Garden egg, and Green bean; were bought from sellers from May-June 2016 and examined for helminthes eggs, larva and cysts using wet mount and concentration techniques. **RESULT**: Hookworm, *Ascaris lumbricoides, Trichuris trichuria, Strongyloides stercoralis*, cyst of *Entamoeba histolytica and Giardia lambia* accounted for 7.3%, 8.1%, 4.8%, 58.1%, 9.7% and 12.1% respectively. Cucumber, carrot, cabbage beetroot, spinach, lettuce, green pepper, green beans, garden egg and tomatoes had 0%, 26.7%, 31.7%, 5.7%, 40%, 53.3%, 6.7%, 6.7%, 13.3% and 25% respectively with overall prevalence of 21.6% and *strongyloides stercoralis* was most prevalent and *Trichuris trichiura* least prevalent found in cabbage and tomatoes. Lettuce has the highest contamination rate 32(53.3%), followed by spinach 24(40%) while beetroot had the least (5.7%). **CONCLUSION**: Vegetables in Jos Metropolis are contaminated with parasites. There should be proper washing as they could serve as source of transmission of parasites when eaten raw or undercooked.

Keywords: *fruits, vegetables, parasites, concentration techniques*

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1. Introduction

The consumption of fruits and raw vegetables are vital component to sound health. Vegetable is any parts of plants that is consumed by human as savory meal.[1] Vegetable can be eaten either raw or cooked and play an important role in human nutrition being mostly low in fat and carbohydrates but high in vitamins, mineral and fibre. [2]

Intestinal parasites associated with raw vegetables include; protozoan, cestodes, nematodes and trematodes. [3] Intestinal parasitic diseases still remain a major public health problem in developing countries probably due to poor sanitation and inadequate, personal hygiene. [4] In Nigeria, the transmission of intestinal parasitic infection has been considered to increase due to the frequent use of untreated human or animal dung as manure in cultivation by local farmers, which serve as a source of enhancement of Zoonotic parasitic infection. [5] The cultivation of vegetables and fruits for commercial and domestic purposes in Nigeria is mostly carried out by peasant farmers who depend on irrigation and or natural rainfall. Most farmers use untreated animal and human faeces as manure, which are known to contain various species of parasites that are of medical and veterinary importance. For the cultivation of these vegetables, the climate, vegetation and topography of the area have to be suitable. Vegetables are grown throughout the year in Plateau State, depending on rain during wet season and irrigation during dry season. Irrigation water is derived from two sources; River and mine ponds. These two sources may be highly polluted with animal and human excreta. [6] Vegetable sellers in most cases tend to wash with untreated water (stream, river) that may contain infective stage of parasites and the vegetables in most cases are displayed exposed in market places where they could get contaminated. Consumers may not care to wash these contaminated vegetables or properly cooked them before consumption. This negligence exposes them to high risk of acquiring infection.

Consumption of un-hygienically prepared vegetables such as cabbage, tomatoes, cucumber, carrot, lettuce, garden egg, etc is considered to be a risk factor for human parasitic infections. Raw vegetables are relatively safe if peeled before eating. The presence of parasitic contamination in foods is of economic importance and may lead to disease condition. [7]

Intestinal parasitic infections are the most common infections worldwide, causing substantial intimidation to the public health, economy and physical and cognitive development in developing countries like Nigeria. The poor personal hygiene and poor health system commonly observed in developing countries makes the prevalence to the highest among the population. The protozoa (*Giardia lamblia, Entamoeba histolytica and Entamoeba coli)* are the most common protozoa to cause intestinal infection.[8] Parasites such as *Ascaris lumbricoides, Trichuris trichiura, Strongyloides stercoralis, Hookworms, Giardia lamblia, Entamoeba histolytica and Enterobius vermicularis* has been reported on vegetables in several parts of Nigeria and outside.[9,10] These parasites are known to infect human as a result of contaminated uncooked or improperly washed vegetables resulting to significant morbidity and mortality worldwide particularly in developing countries. [11] Intestinal parasitic infection may be acquired in different ways like through consumption of contaminated fruits, vegetables, other food stuff and water. [12,13]

Different parasitic stages can contaminate vegetables, the most likely contamination may occur before harvest while still on the plants in fields either by contaminated manure, sewage, Irrigation water and waste water from livestock operations or directly from wild and domestic animals. [14] Many pathogenic parasites spend part of their life cycle on soil and so vegetables consumption can lead to infection and spread intestinal parasitic disease to people. [15,16,17]

Epidemiology of Human Intestinal Parasites is traced to the consumption of raw vegetable which play a major epidemiological role in the transmission of parasitic food borne disease. [18] Many outbreaks of protozoan infections in humans have been linked to raw fruits and vegetables. In Nigeria, approximately 55 million people are infected with Ascariasis, 38 million with Hookworm infection and 34 million with Trichuriasis. [19]

Epidemiological studies carried out by Damen and colleagues [20] Alshaa & Mwafy [21] have also indicated that, in areas where parasitic diseases are endemic in the population and where waste water is used to irrigate vegetable which are eaten raw, the consumption of waste water irrigated fruits and vegetables without proper washing might have led to parasitic infection and is supported by Klapec and Borecka. [22]

Estimates suggest that *Ascaris lumbricoides* can infect over a billion. *Trichuris trichiura* can infect 795million and hookworms can infect 740 million people. [23] *Entamoeba histolytica* can infect 50 million [24] and *Giardia lamblia* 2.8 million. [24] Study conducted in Maiduguri Northeastern Nigeria have reported overall prevalence of 3.5% among which *Ascaris species, hookworm, Trichuris species, Taenia species, Echinococuss species and strongyloides stercoralis* were detected in 0.5%, 1.2%, 0.5%, 0.5 and 0.6% respectively. [16]

The most effective control program of intestinal parasitic infection is an integrated approach with community participation. The long-term objective is to reduce the prevalence, intensity of infections to levels at which they cease to be of public health significance. Theoretically, the infections can be controlled and prevented by improvement in environmental sanitation such as safe methods of faeces and waste disposal and provision of safe water supplies and health education on health promotion of personal and food hygiene such measures are usually slow to take effect, required considerable investment and need to be accompanied by social, economic and educational development. In recent years the availability of singlet dose broad-spectrum anthelminthics has helped in reducing the worm burden in endemic communities. Studies have shown that periodic chemotherapy strategy has successfully lowered the intensity of *Ascaris* and hookworm infections. [26]

The Justification of this research is based on the fact that intestinal parasites are known to cause significant morbidity and mortality worldwide particularly in developing countries such as Nigeria. The rate of consumption of unclean, raw, or undercooked fruits and vegetables which is one of the major means of transmission of intestinal parasitic infection to most people worldwide especially in Jos Nigerian facilitated this study to investigate the parasites associated with vegetables in Jos Plateau State, Nigeria. Notably, the diseases have socio- economic impact in terms of high treatment costs per disability adjusted life year (DALY). About 3.5million are infected with some kind of intestinal parasites causing diseases like ascariasis, trichuriasis, amoebiasis, giardiasis, schistosomiasis, and ancylostomiasis etc are responsible for about 2-3 million death annually worldwide.

Moreover, the consumption of raw and poorly cooked vegetables is on the increase as a result of the general awareness of the health benefit of raw vegetables. Hence, this research intended to explore suggestive management strategies and control in handling vegetables in public health to reduce or if possible eliminate food borne parasites.

The aim of this study is to determine parasitic contamination of fresh green vegetables in Jos, Plateau State, Nigeria with the following Objectives:

i. To determine the prevalence of parasites of medical importance in vegetables sold in Jos market.
ii. To determine the rate of contamination by different groups of parasites in vegetables sold in selected market in Jos
iii. To determine the prevalence rate of vegetable contamination based on the social demographic characteristics of market sellers in Jos North Local Government Area
iv. To determine the prevalence rate of vegetable contamination in respect to Vegetable Sellers Knowledge of vegetable borne diseases and Practices For safety in Jos North Local Government Area.

2. Materials and Methods

The Study / Sampling Area is Farin Gada Market in Jos North Local Government Area of Plateau State; during the raining season from May to July 2016. This market was

considered because is a major market where majority of the farmers from different L.G.A of Plateau State, convey their farm products (carrot, spinach, cabbage, cucumber, beetroot, garden egg etc.) on daily basis for commercial purposes. Also, traders from other markets located in and around the metropolis likewise obtain vegetables from this market at relatively affordable prices.

The Study Sample of this research is ten (10) different types of vegetable were worked on which includes: Lettuce (*Eruca sativa*), Cabbage (*Brassica oleraca*), Carrot (*Daucus carota)*, Spinach *(Amaranthus* species), Green Pepper *(Capsicum* species) Cucumber (*Cucumis sativus)*, Beetroot (*Beta vulgaris*), Tomatoes (*Solanum lycopersicum*), Garden egg (*Solanum melongena*), and Green beans (*Phaseolus vulgaris*).

Vegetable Plates showing vegetables used:

Plate1: Cabbage (*Brassica oleraca*)

Plate2: Lettuce: (*Eruca sativa*)

Plate 3: Spinach (*Amarantus spp*

Plate 4: Green beans (*Phaseolus vulgaris*)

Plate 5: Cucumber (Cucumis sativus)

Plate 6: Green Pepper *(Capsicum* spp)

Plate 7: Beetroot (*Beta vulgaris*)

Plate 8: Carrot (*Daucus carota)*

Plate 9: Garden Egg (*Solanum Melongena*)

Plate 10: Tomatoes (*Solanum lycoperiscum*)

A well-structured questionnaire prepared in English and then translated to the local languages were used to investigate the perception of randomly selected retailers and whole sellers about transmission of intestinal parasites, personal and domestic hygiene before sales and consumption of vegetables. The variables include; Age, Sex, Educational status, religion, Type of toilet, Sources of water, Hand washing habit etc.

The Sample Size formular of Sarmukkadams and Gerald [27] was used to ascertain 575 different vegetable used in the study.

$$N = \frac{z^2 Pq}{L^2}$$

Where N is the sample size
Z is the statistical normal distribution at 95% confidence interval =1.96
P is the prevalence
L is the allowable error, which was taken at 5%=0.05
P= q-1.

Sample Collection: Fresh samples were randomly purchased from different spots within and around the market twice a week. The collection of vegetables was done in the early hour between 7.00am to 8.30am. To obtain a qualitative evaluation of parasite contamination of these vegetables; each vegetable sample was placed in a separate nylon bag and labeled appropriately. 60 (sixty) vegetables were selected from each category with the exception of beetroot 35(Thirty-five) to make up to a total of 575 samples for the purpose of this study.

Preparation of Samples and Examination of Eggs/Cysts and Larvae of Parasites and parasite identification was carried out in the Medical Laboratory Science Research Laboratory of Federal School of Medical Laboratory Science and Technology, Jos. The vegetables were analysed using both Direct wet mount technique (saline & iodine) and Concentration technique (Sedimentation & Floatation) in line with Cheesebrough, [7] Damen and colleagues, [20] Arora [28] and Nyarango and co-workers. [37]

Statistical Analysis was done using Chi-square to establish significant difference in prevalence rate of vegetable and fruit contamination sold by market sellers, and in respect to Demographics, knowledge and safety practices in Jos North local Government, using SPSS version 22.0.

3. Results

Out of 575 samples of fruits and vegetables examine for parasitological contamination, 124 were contaminated with parasites. The stages and species of helminthes parasites, detected include larvae of *strongyloides stercoralis*, ova of *Ascaris lumbricoides*, hookworm, *Trichuris trichiura*, and cysts of protozoa parasites include *Entamoeba histolytical* and *Giardia lamblia*.

Table 1 indicates the load of vegetables borne parasites of public health importance recovered from Farin Gada markets in Jos metropolitan area of Plateau State. Significant difference was observed across the occurrence of 6 parasites recovered from 9 out of 10 vegetables sampled within study area, the most prevalent parasite was *Strongyloides stercoralis* 72(58.1%) which occur on all vegetables except Cucumber and Beetroot, and the least prevalent was *Trichuris trichiura* 6(4.8%) occurred only on Cabbage and Tomatoes. Vegetables with the highest load of parasite was Carrot 16(100.0%), Green Pepper 4(100.0%), Green beans 4(100.0), Garden egg 8(100.0%) with *Strongyloides stercoralis* been the major contaminant. Beetroot 2(100.0%) with *Ascaris lumbricoides* being the major contaminant, while the least contaminated vegetable was Lettuce 3(9.4%) with *Entamoeba histolytica* being the major contaminants. No parasites were recovered on Cucumber.

Table 2 indicates the load of parasitic contamination on vegetables sold in selected markets in Jos North LGA, where Lettuce had the highest contamination 32(53.3%) while Beetroot had the least 2 (5.7%).

Table 3 indicates the Prevalence of vegetable contamination in Jos North LGA based on some social demographic characteristics of vegetable sellers. There was no significance (P>0.05) difference in the level of contamination of these vegetables based on Gender and Age. However a significant (P<0.05) difference was observed in respect to Educational Level with Market Sellers with SSCE 4(28.6%) recording the highest contamination on their vegetables while those who have attained a Tertiary level recording the least 3(17.6%)

Table 4 shows the level of Knowledge of Fruits/Vegetable sellers about parasitic borne disease. In respect to level of contamination, there was no Significant (P>0.05) difference in their knowledge of fruits/vegetables borne disease. In respect of "Awareness of vegetable borne disease", "awareness of ability of unsafe vegetable to transmit disease through faecal oral route", "Frequency of sanitation in markets", "Frequency of cleaning surrounding before selling", "Frequency of hand washing during sales", "Awareness of unsafe vegetables to cause food poison". However a significant (P< 0.05) difference was observed in the level of parasitic contamination of vegetables in respect of "Regular plans of sellers to keep surrounding environment clean", those who Agreed (YES) had the highest prevalence 91(23.4%) while those who responded No had the least 33(17.3%), also "on availability of a clean schedule those who said YES had the highest prevalence 20(23.3%) while those who opted NO had the least 99 (20.8%). Regarding to the invitation of sanitary officials for inspection of their selling environment" those who responded No had the highest prevalence 75(21.7%) while YES had the least 37(19.7%).

Table 5 shows vegetable seller's practices for safety in respect of contamination with parasites. There was no significance (p>0.05) difference in contamination in respect to source of water, type of toilet used. However, significant (p< 0.05) difference was observed in their practices such as "Quality of water in market" with those who opted for water been rarely available showing the highest prevalence 50(23.7%) while those who opted for readily available showing the least 61(19.9%). In respect to "Replacement of water used for washing fruits/vegetables" those who rarely replace water had the highest prevalence 60(23.1%) while those who replace once per basket had the least 12(15.8%).

In respect of "Hand washing practices after toilet use," the highest prevalence was recorded in those who

occasionally wash their hands, 108(23.0%) while those who wash Regularly recorded the least 16(15.2%), in respect of "Means of vegetable display", those who display on the Floor recorded the highest prevalence of contamination 111(22.4%) while those who display on table recorded the least 13(16.3%).

Table 1. Vegetables borne parasites of public health importance recovered from Farin Gada Markets in Jos Plateau State

Vegetables	Number Observed	*Strongyloides*	*E.histolytica*	*Ascaris*	*G.lamblia*	*Trichuris*	Hookworm
Cabbage	19	8(42.1)	3(15.8)	2(10.5)	-	3(15.8)	3(15.8)
Carrot	16	16(100.0)*	-	-	-	-	-
G.Pepper	4	4(100.0)*	-	-	-	-	-
G.Beans	4	4(100.0)*	-	-	-	-	-
Lettuce	32	16(50.0)*	3(9.4)	4(12.5)	3(9.4)	-	6(18.8)*
Garden egg	8	8(100.0)*	-	-	-	-	-
Spinach	24	12(50.0)	6(25.0)*	-	6(25.0)	-	-
Cucumber	-	-	-	-	-	-	-
Tomatoes	15	4(26.7)	-	2(13.3)	6(40.0)	3(20.0)*	-
Beetroot	2	-	-	2(100.0)*	-	-	-
TOTAL	124	72(58.1)	12(9.7)	10(8.10)	15(12.1)	6(4.8)	9(7.3)

χ^2=101.859, df= 45, P=0.001(P<0.05).
*Parasites with significantly higher contamination, P < 0.05.

Table 2. Prevalence of parasites on vegetable sold in Farin Gada Markets in Jos North Plateau State

Vegetables	No. Observed	Prevalence (%)
Cabbage	60	19(31.7)
Carrot	60	16(26.7)
G.pepper	60	4(6.7)
G.Beans	60	4(6.7)
Lettuce	60	32(53.3)
Garden egg	60	8(13.3)
Spinach	60	24(40.0)
Cucumber	60	-
Tomatoes	60	15(25.0)
Beetroot	35	2(5.7)
TOTAL	**575**	**124(21.6)**

χ^2=92.660, df=9, p=0.001(p<0.05).

Table 3. Prevalence of parasites on vegetable sold in Farin Gada market based on some social demographic characteristics of sellers

		No. Observed	Prevalence (%)	p=value
Gender	Male	272	59(21.7)	
	Female	303	65(21.5)	**0.945**
	Total	**575**	**124(21.6)**	
Age	18-25	44	9(20.5)	
	26-33	87	14(16.1)	
	34-41	141	30(21.3)	**0.808**
	42-49	201	48(23.9)	
	50-57	88	20(22.7)	
	58-65	14	3(21.4)	
	TOTAL	**575**	**124(21.6)**	
Education level	None	400	89(22.3)	
	FSLC	144	28(19.4)	
	SSCE	14	4(28.6)*	**0.007**
	Tertiary	17	3(17.6)	
	TOTAL	**575**	**124(21.6)**	

Result is significant where P<0.05; *Demographic with significantly higher prevalence.

Table 4. The Knowledge of Fruits/Vegetable sellers about vegetable borne disease in respect to prevalence of contamination

Knowledge of Fruits/Vegetable sellers on borne disease	No. Observed	Prevalence (%)	P-value
Have you heard of vegetable borne disease?			
YES	286	65(22.7)	**0.500**
NO	289	59(20.4)	
Do you know that Transmission of vegetable? disease are through faecal oral route			
YES	286	60(21.0)	
NO	289	64(22.1)	**0.734**
Regular plan of sellers to keep environment clean			
YES	389	91(23.4)*	
NO	186	33(17.7)	**0.023**
Frequency of sanitation in Market			
Daily	129	32(24.8)	
Weekly	87	19(21.8)	**0.569**
Monthly	359	73(20.3)	
Frequency of cleaning surrounding before selling			
Daily	345	88(19.7)	
Twice	216	51(23.6)	**0.235**
Monthly	14	5(35.7)	
Frequency of Hand Washing			
Once	157	32(20.4)	
Twice	389	84(21.6)	**0.613**
Do you have clean schedule			
YES	86	20(23.3)*	
NO	475	99(20.8)	**0.037**
Do you know unsafe vegetable can cause food poison?			
YES	347	72(20.7)	
NO	214	49(22.9)	**0.548**
Do you invite sanitary officials for inspection?			
YES	188	37(19.7)	
NO	345	75(21.7) *	**0.044**

Result is significant where P<0.05; *Response is significantly higher.

Table 5. Prevalence of parasitic contamination in respect of vegetable sellers' safety practices

Vegetable sellers practices for safety	No. Observed	Prevalence (%)	P-value
Availability of water in Market			
Readily	306	61(19.9)	**0.048**
Rarely	211	50(23.7)	
Source of water			
Tap	128	30(23.4)	**0.750**
Borehole	346	71(20.5)	
Well	101	23(22.8)	
Replacement of water used for washing fruits			
Once per Basket	76	12(15.8	**0.003**
Twice per Basket	239	52(21.8)	
Rarely Replaced	260	60(23.1)	
Type of Toilet Used			
Pit	86	18(20.9)	**0.987**
Water Closet	416	90(21.6)	
Bush	73	16(21.9)	
Hand washing After Toilet use			
Occasionally	470	108(23.0)	**0.008**
Regularly	105	16(15.2)	
Means of vegetable display			
Floor	495	111(22.4)	
Table	80	13(16.3)	**0.021**

Result is significant where P<0.05; *Practice with significantly higher prevalence.

The Hypothesis for testing are:

1. Ho; There is no significant difference in the prevalence of parasites of medical importance in vegetables sold in Jos market.

Ha; There is a significant difference in the prevalence of parasites of medical importance in vegetables sold in Jos market.

2. Ho; There is no significant difference in the rate of contamination by different groups of parasites on vegetables sold in selected market in Jos

Ha; There is significant difference in the rate of contamination by different groups of parasites on vegetables sold in selected market in Jos

Based on the these hypothesis and results from the statistical analysis;

1. We reject H_0, since there was a significant difference $P< 0.05$in the prevalence rate of parasites of medical importance on vegetables sold in Jos market (Table 1).
2. We reject H_0, since there was significant difference $P< 0.05$ in the rate of contamination by the different groups of parasites in vegetables sold in Jos North Market (Table 1 & Table 2).

4. Discussion

The study of parasites of public health significance in fruit, and vegetables sold in Farin Gada market in Jos, Plateau state is helpful in accessing the prevalence of helminthes eggs and protozoa in a population which may pose a public health problem to consumers who stand the chance of ingesting the infected part of the vegetable. The contamination of fruits and vegetable could be from several sources, such as the atmosphere, during storage, usage, handling or production. [29]

Parasites isolated from this study differ from those isolated in other parts of Nigeria. [3,20,30,31] The variation in parasites observed may be due to geographical location of the study. Despite the variations in isolated parasites, ova of *Ascaris lumbricoides* and that of hookworm were common to all the fruits and vegetables in the studies. This could be due to the fact that these parasites can withstand a wide variety of adverse environmental conditions which could serve as an indication of water pollution as a result of indiscriminate defecation which give rise to water pollution and farmland as observed by Damen and colleagues.[20] Parasite infestations are most abundant in Nigeria not only because of tropical environment with climate conditions suitable for easy parasite growth and spread but also as consequence of unsanitary environments with constant encountered pollution of soil and drinking water. [30]

In this study, larvae of *Strongyloides stercoralis* (58.1%) was most prevalent parasite contaminating virtually all the vegetable samples with the exception cucumber (0%).This might be due to the fact that the parasite have both parasitic and free living state and does not require a host for its proliferation. [30] And *Trichuris trichiura* was the least prevalent parasite contaminating tomatoes only (4.8%). *Ascaris lumbricoides* was the second prevalent parasites in vegetables (8.1%). The highest contamination was detected in lettuce sample (12.5%).This may be due to the strong adhesion thereby successfully evading the effect of washing and disinfection. In surveys done in Kenya Urban School children revealed a high prevalence of intestinal parasitic infection with Ascaris lumbricoides (82%), Trichuris trichiura (60%), Entamoeba histolytica (41%) and Giardia lamblia (30%). Also at various locations in Kisii Highlands, western Kenya showed high prevalence of many intestinal parasites such as Ascaris. lumbricoides (10%) hookworm (4%) and Trichris trichuria (0.1%). [32]

Studies conducted in and around Chennai India reported the prevalence of intestinal parasitic diseases ranging from 60–91%. Among which Ascaris lumbricoides was the most common helminthic parasite detected (52.5%) followed by Trichuiris trichuria (45.6%). [33]

The prevalence of *Gairdia lamblia* cysts detected in this study was (12.1%). The highest contamination was found in tomatoes (40%), followed by spinach (25%) and lastly lettuce (9.4%). And the prevalence of *Entamoeba histolytica* was (9.7%), with the highest contamination occurring in spinach (25%) followed by cabbage (15.8%).

The presence of helminth eggs and protozoa cysts in different vegetables may be related to either contamination of soil or contamination of irrigated water (kishk and Allam, 2000). [34]

In the study, Lettuce(53.3%) was found to be the most frequently contaminated produce followed by spinach (40%), cabbage(31.7%), carrot(26.7%), Tomatoes (25%), Garden egg(13.3%), Green pepper(6.7%), Green beans (6.7%) and beetroot (5.7%) was the least contaminated, while cucumber(0%) is free of contamination.

This variation in contamination rates may be due to differences in shape and surface of vegetables. Vegetables such as lettuce, spinach, cabbage and carrot have uneven surfaces that probably facilitate sticking of parasitic eggs, cysts and ocysts more easily, either at the farm or when washed with contaminated water. However, vegetables with smooth surface such as Cucumber, Tomatoes, Garden egg, Green pepper and Green beans had the lowest prevalence rates of contamination. [17,20] The result of this study shows slightly lower level of contamination of green vegetables with intestinal parasite (21.6%), when compared with the study recent one reported by Ettehad [35] which shows slight high level of contamination of consumed vegetable with intestinal parasite (29%) in Ardabil city, Iran.

High level of contamination of vegetables was observed in Ghana with overall parasitic contamination of the vegetables as 36%. [36] Parasite contamination of the vegetables in another study in Jos, Nigeria was also 36%. [20] Higher rate of contamination of green vegetables was detected in wholesale and retail market in Tripoli, Libya in the study carried out by Abougraina [18] where the study detected 58% positive samples for intestinal parasites. Examination of vegetables sample in Kenya by Nyarango [37] in 2008 revealed also higher rate of contamination (75.9%), and the highest rates was detected in Khorramabad, Iran (79%). [38] Lower rate of contamination in the Middle-East were detected in Riyadh, Saudi Arabia (16.2%) [39] and Turkey (6.3%). [40] However several other factors may contribute to the differences observed in the contamination rate these may

include geographical location, types and number of samples examined, methods used for detection of the intestinal parasite, type of water used for irrigation, post-harvesting handling methods of such vegetables which are different from one country to another.

The use of questionnaire interview gave a clue on some of the basic ways by which fruits and vegetables are contaminated from the vendors. These vendors serves as intermediary between the producers, farmers, and final consumers, they play a vital role in the chain of distribution of fruits and vegetables produce and also in the contamination and distribution of contaminants. [31,41]

The study showed that there was a significant difference ($P< 0.05$) among vegetables handlers in relation to their educational status, Non formal educators food handlers had the highest prevalent 22.3% while the tertiary vegetables vendors had the least 17.6% prevalence parasites. The level of education is very important in understanding simple hygienic practices towards prevention of parasitic infections.

Vegetables handlers that do not observe regular principle of washing their hands after using the toilet had the highest contamination (23%) of vegetables compared to 49.4% for those that regularly washed their hands after using the toilet. Our finding justified the emphasis by WHO [42] on hand washing as a simple but very important method in preventing infections. Majority (22.4%) of the vegetable produce were displayed for sale on the floor. where it is exposed to dusts and flies. It is a well-known fact that flies can act as vectors for a number of microbial pathogens including parasites like *Cryptosporidium parvum* and *Toxoplasma gondii.*[43] Insects such as flies and cockroaches can significantly contribute to the spread of vegetable borne parasitic disease in both developing and developed countries. [44,45]

5. Conclusion

The findings in the present study show the important role of raw vegetables in the transmission of human intestinal parasites to new hosts, and need to improve the sanitary conditions in many areas where these vegetables are grown. The use of night soil as a fertilizer on farms may be made safe by its chemical disinfection or other types of sterilizing treatment. The present study has also revealed that *Entamoeba histolytica* and *Giardia lamblia* as common protozoa, while *Ascaris lumbricoides, Strongyloides stercoralis,* hookworm and *Trichuris trichiura* as the common helminthes that cause parasitic infection with varying magnitude in Jos Metropolis. Risk factors such as low economic statue and low hygienic habits like lack of hand washing after defecation and eating improperly washed vegetables were significantly associated with intestinal infection among the vendors. The control of insect vectors of zoonotic disease whether blood sucking or non-blood sucking insects will improve the environmental health conditions by minimizing risk factors. The finding could help to better practices in handling, washing and preparation of vegetables to protect the consumers against gastrointestinal parasitic infection.

In conclusion few types of fresh vegetables in Jos metropolis were moderately contaminated by intestinal parasites than other areas. This is suggestive that human are at risk of getting infections from contaminated fresh vegetables eaten on daily basis. These findings raised concern of public health being at high risk of infection with Amoebiasis, Giardiasis, Strongyloidiasis, Ascariasis and others. Effective and comprehensive preventions and treatment measures should be taken to ensure vegetable safety. Washing procedure before eating raw vegetables regardless of the providers. Sanitation should be performed to avoid transmission of intestinal parasites in addition to strict personal hygienic practices, and safe disposal of excreta which plays a significant role in the epidemiology and control of Giardiasis and Amoebiasis.

This study having noted that vegetables cannot be excluded from human diet, but can be removed from the cycle of transmission and dispersion of parasites do recommend a simple personal and environmental hygiene by sellers and consumers; avoidance of using untreated human and animal wastes as manure, soaking of vegetable for 10 minutes in vinegar or saturated salt solution which will plasmolise the parasites if present by farmers or consumers; adequate cooking of vegetables before serving them as meal and avoidance of indiscriminate defecation within the market and vegetable farms.

The findings also highlight the need for effective health education, enforced health policy, clear vegetable production regulation and supervision, empowerment, capacity building and creating partnership for better healthy and safer food production marketing.

Media programs can be used to inform the community about good sanitation hygiene and potential health risk of raw vegetables to prevent transmission of food borne diseases. In addition, health education programme regarding food safety and food protection should be directed towards producers and vendors of food local markets.

Farmers and people should be educated and motivated to use only fully digested or properly composted human excreta and not to apply the raw or partially digested excreta to the field. Fully digested excreta are taken from a latrine pit where it has been sufficiently stored for one to two years during which disease pathogens and worms eggs must have died out completely. An integrated de-worming program should also be included in the health education to the people.

Farmers and vegetables vendors should be subjected to routine checks by food safety officers from community and environmental health departments of the local government or Non-governmental organizations who are working on food safety.

Finally, edible raw vegetables are better to be washed after harvest and protect from public touching, coughing or sneezing in the displayed area in the markets since there is tendency of trying, testing and eating products by customers as previous study in other developing countries[46] regarding food hygiene that policy marker should address and implement more safety and hygiene measurement and policy to promote healthy and safe food. [47]

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Conflicts of Interest

There are no conflicts of interest in this study known to the Researchers

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