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Research Article

Prevalence of Parasitic Contamination of Vegetables Sold in Dutsin-Ma Markets, Katsina State, Nigeria

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ABSTRACT
This study was carried out to determine the prevalence of parasitic contamination of vegetables sold in Dustin-Ma markets, Katsina State. A total of 270 vegetables including of lettuce, cabbage, spinach and sesame were obtained from three selected markets (Kasuwann Laraba, Kasuwann Aminu and Kasuwann Kadangaru), and examined for presence of parasitic eggs, cyst, larvae and worms by using using sedimentation method methods. This study found that of 88.9% of the vegetables sold in Dustin-ma markets tested positive for the presence of parasite contamination. The distribution of specific parasites among positive samples reveals the presence of *Ascaris* species 65(24.1%), hookworm 39(14.4%), *Trichuris* species 16(5.9%), *Taenia* species 23(8.5%), *Hymenolepsis* species 6(2.2%), *Enterobius vermicularis* 25(9.3%), *Fasciola* species 13(4.8), *Toxocara* species 4(1.5%) and *Strongyloides stercoralis* 49(18.1%). The lettuce, cabbage, spinach and sesame samples were contaminated with helminthic parasites with 27.1%, 28.8%, 27.1% and 17.1% respectively. Vegetable samples from Kasuwann Laraba had the highest prevalence of 85(31.5%), and Kasuwan Aminu with a total prevalence of 78(28.9%), while Kasuwann Kadangaru had the lowest prevalence with a total prevalence of 77(28.5%) at $P < 0.05$. Vegetables are important constituents of healthy diet and people have been encouraged to eat lots of raw (fresh) vegetables and these can serve as vehicles of transmitting enteric parasitic pathogens throughout the process of planting to consumption. Proper washing of vegetable is imperative, improve Sanitation and Hygiene Practices and Health Education are necessary for managing the prevalence of geohelminth parasites.

Keywords: Parasites; Vegetables; Market; Sanitation; Hygiene

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NTRODUCTION

An important element of healthy diet is fresh vegetables. Vegetables can become contaminated with enteric bacterial, viral and parasitic pathogens and this has been established to be vehicle for transmission of range of parasites (Ghimire *et al*., 2020). The level of contamination depends on several factors that include the use of untreated wastewater and water supplies contaminated with sewage for irrigation, post-harvest handling and unhygienic conditions of preparation in food service or home settings (Hotez *et al.*, 2008, WHO 2023). Soil-transmitted helminth (STH) infection is endemic in many parts of the world, especially in developing countries with poor environmental sanitation and personal hygiene. The mode of infection is mostly through faecal–oral, occurrence is high in individuals who live in areas contaminated with faeces (WHO, 2020). More than 1.5 billion people or 24% of the world's population are infected with soil transmitted helminthes infection worldwide. Moreover,

morbidity due to STH infections has primarily been associated to a range of complications, including gastroenteritis, malnutrition, anemia, intestinal obstruction, poor physical and cognitive development, nutrient absorption and iron loss (Hotez *et al*., 2008; Degarege *et al*., 2022). Although STHs can frequently evolve in a relative host-parasite balance, infections with a high parasitic burden can cause acute and life-threatening complications, including intestinal obstruction and perforation by *A. lumbricoides*, dysentery and rectal prolapse by *T. trichiura,* and several anemia caused by hookworm (WHO, 2023). High worm burdens are associated with reinfections due to constant exposure to environments contaminated with eggs (*A. lumbricoides and T. trichiura*) or larvae (hookworms) Ediau *et al.*, (2018). Although these infections are not among the big killers, they endanger human's health in a subtle and debilitating way. Chronic infections compromise healthy growth, cognitive development, physical fitness, and iron status, and affect the immune response of infected persons (WHO, 2012).

The prevalence and control of parasitic infection in vegetable is inextricably linked with water quality, sanitation, hygiene practices and socioeconomic status in the affected area (Strunz *et al*., 2014). Some of these parasitic pathogens are transmitted by eggs that are passed in the faeces of infected people. Adult worms live in the intestine where they produce thousands of eggs each day. In areas that lack adequate sanitation, these eggs contaminate the soil. Eggs that are attached to vegetables are ingested when the vegetable are not carefully cooked, washed or peeled. Several factors may contribute to contamination of crops. They become contaminated while still on the plant in fields, orchards, during harvesting, transport, processing, distribution and marketing or even at home. Other factors are waste water used for irrigating vegetables (Khalid *et al.,* 2018) and contamination of soil with animal and human wastes and increased application of improperly composted manures to soil in which vegetables are grown play a role in parasitic contamination of green vegetables (Damen *et al.,* 2006). Bad hygienic practices during production, transport, processing and preparation by handlers including consumers also contribute to vegetable contamination (Amoah *et al*., 2007; Kudah *et al*., 2018). Despite the recognized health risks associated with parasitic contamination and the importance of vegetables in a healthy diet, there is limited knowledge about the presence and prevalence of parasitic contamination in vegetables sold at the Dutsin-Ma Markets. This knowledge gap hinders the development of targeted interventions and preventive measures to reduce the risk of infection through contaminated leafy vegetables. Therefore, there is a need to investigate the extent of parasitic contamination in vegetables, identify potential risk factors associated to this contamination, and raise awareness among farmers, vendors, and consumers to ensure the safety and quality of leafy vegetables in the Dutsin-ma market.

MATERIALS AND METHODS

Study Area

The study was carried out in Dutsin-Ma Local Government Area in Katsina State. Dutsin-ma is located between latitudes 12°09'18"N to 12°30'44"N and longitudes 7°20'48"E to 7°37'18"E. Dutsinma is one of the oldest town in central part of Katsiná. It is bounded by Kankia, Charanchi and Matazu local government area to the East, Safana to the West and Dan-musa to the South as well as Kurfi to the North. For the most part of the year, the climate is hot and dry. Maximum day temperatures of over 38°C are frequent in the months of March, April, and May, with lowest temperatures of around 22°C in December and January with annual rainfall of 800 mm in DutsinMa. The people within this area are surrounded with dams, rivers, lakes, pond and stagnant water with several slow running water bodies. The main tribes in this area are Hausa, Fulani. The main occupations of the people in the area are farming, trading and cattle rearing occasionally.

Research Materials

The following materials were be used for the purpose of the laboratory analysis; Hand gloves, facemasks, test-tube, centrifuge, sterile nylon bags, microscope, pipette, sterile knife, beakers, Physiological saline solution and staining reagent.

Sample Collection

A total of 270 samples was collected from three selected markets within the metropolis in this study. Four different vegetables such as *Brassica oleracea* (cabbage), *Lactuca sativa* (lettuce), *spinacia oleracea (*spinach) and Sesame, were considered. The vegetables sample were purchased from vendors in kasuwa Kadangaru (FUDMA Market), kasuwa Aminu (Abuja Road) and kasuwa Laraba (Wednesday market). The samples were transported to the

Parasitology Laboratory in the Department of Biological Sciences Federal University Dutsin-Ma Katsna State for analysis.

Samples Analysis

The vegetables were analysed using sedimentation method, they were weighed and washed with physiological saline solution (0.90% NaCl) was used as solvents for the washing of vegetable samples. A total of 100 g of each fresh vegetable sample was chopped into small pieces, using a sterilized kitchen knife and put into a clean beaker containing 500 ml physiological saline solution to wash the sample. This was kept for 24 hours at room temperature to allow sedimentation to take place, after removing fragments of the samples from the washing saline using clean forceps. The top layer (supernatant) of the washing solvent was carefully discarded leaving 5 mL of the sediment, which was transferred into 5 mL test tube and centrifuged at 2000 revolutions per minute for 20 min. The supernatant was discarded and the residue mounted on slides, stained with Lugol's iodine solution and examined under the compound light microscope using x10 and x40 objectives for parasite stages (cysts, oocysts, eggs, larvae or worm) after adding a drop of Lugol iodine and the parasite stages identified. Positive samples were recorded and developmental stages recorded.

RESULT

A total number of 270 vegetables from three (3) markets each within Dutsin-Ma Local Government Area of Katsina State were examined for geohelminths contamination. Total number of contaminated samples was 240(88.9%). Highest contamination was detected in Kasuwan Laraba (Wednessday market), followed by Kasuwan Aminu (Abuja road market) while Kasuwan Kadangaru (FUDMA market) was the lowest prevalence.

Table 1 shows the Distribution and prevalence of Geohelminth Parasites in Different Vegetables sold in Kasuwan Kadangaru (FUDMA market). In Kasuwan Kadagaru (FUDMA market) a total of 90 vegetable samples were examined, out of which 77 samples were contaminated with 9 different parasites. A total of 25 lettuce samples were contamination with 24(90%) parasites. *Ascaris* spp was detected to be the most prevalent geohelminth parasite. A total number of 25 cabbage were sampled out of which 22(88%) samples were positive with 7 out of 9 different parasite. *Ascaris spp.* was also detected to be the most prevalence geohelminth parasite in cabbage. Spinach samples examined 25, out of which 19(76%) samples were positive with 7 out of 9 different parasite. *Ascaris spp.* was detected to be the most prevalent parasite. A total of 15 sesame were examined out of which 12(80%) were positive with 7 out of 9 different parasite.

Table 2 shows the distribution and prevalence of parasitic contamination in different vegetables sold in Kasuwan Aminu (Abuja Road Market). A total of 90 vegetable samples were examined, 25 vegetable each were sampled from lettuce, cabbage and spinach and sesame. Out of 78(86%) were contaminated with 9 different geohelminth parasites. A total of 25 lettuce samples were examined and 17 (68%) samples were contaminated with 7 out of 9 different parasite. *Strongyloides stercoralis spp.* was found to be the most prevalence parasite in this vegetable. Cabbage samples were 25, out of which, 22[88%] were positive with 9 out of 9 different parasite. *Strongyloides stercoralis spp.* was also noted to be the most prevalence parasite in the vegetable. The spinach sample had the highest prevalence of parasitic contamination at 25(100%), with 7 out of 9 different parasite examined. Out of 15 sesame sampled, 14(93%) were positive with 6 out of 9 different parasite detected in this study. *Ascaris spp.* was detected to be the most prevalent parasite with 20(80%) while spinach 25(100%) is the most prevalence infected vegetable sold in Kasuwan Aminu (Abuja road market).

Table 3 shows the distribution and prevalence of arasitic contamination in different vegetables sold in KasuwanKasuwan Laraba (Wednesday market). A total of 90 vegetable samples were examined, out of which 85 (84%) samples were contaminated with 9 different geohelminth parasites. Out of 25 lettuce sampled 24(96%) samples were contaminated with 7 out of 9 different parasite detected in this study. *Ascaris spp* was found to be the most prevalence parasite in lettuce. Cabbage examined were 25, and 25(100%) were positive with 9 out of 9 different parasite detected from this study. *Ascaris spp.* was also detected to be the most prevalence parasite in this vegetable. Spinach had the highest prevalence of parasite contamination with 21(84%) positive contamination parasite. *Ascaris spp.*, *Hookworm spp.* and *Tapeworm* was detected to be the most prevalence parasitic contamination in the vegetables samples. Out of 25 Sesame sampled, 15(60%) samples were positive for parasite contamination,

Ascaris spp. and Strongyloides stercoralis spp. were the most prevalence parasite present in the vegetable, *Hymenolepis spp.* and *Hookworm spp* were not detected. *Ascaris spp. was* detected as the most prevalent parasite with 24(96%) while cabbage 25(100%) is the most infected vegetable sample sold in Kasuwan Laraba (Wednesday market).

Table 4 shows that the total number of contaminated samples was 240(88.9%). Highest contamination was observed in cabbage 69(28.8%), lettuce and spinach was same 65(27.1%), while sesame had the lowest contamination 41(17.1%). However, there was no statistical difference between levels of contamination among the vegetables (P< 0.05).

Table 5 presents prevalence of parasitic contamination of vegetables according to the three markets where the samples were purchased. Kasuwan laraba had the highest prevalence and a total prevalence of 85(31.5%), followed by Kasuwan Aminu with a total prevalence of 78(28.9%), while Kasuwan Kadangaru had the lowest prevalence with a total prevalence of 77(28.5). However there was no significance difference (P<0.05).

Table 1. Distribution and Prevalence of Parasites Contamination in Different Vegetables Sold in Kasuwan Kadangaru (FUDMA Market)

Parasitic Vegetables	*Ascaris spp* (%)	*Trichuris spp* (%)	*Hymenolepis spp* (%)	*Enterobius vermicularis* (%)	*Strongyloides stercoralis (%)*	*Toxocara spp* (%)	*Fasciola spp* (%)	Hookworm (%)	Tapeworm (%)	Total
Lettuce N=25	5[20]	0[0]	1[4]	2[6]	4[16]	1[4]	3[12]	6[24]	2[6]	24[96]
Cabbage N=25	9[36]	2[6]	0[0]	1[4]	6[24]	1[4]	1[4]	0[0]	2[6]	22[88]
Spinach N=25	5[20]	2[6]	0[0]	1[4]	4[16]	0[0]	1[4]	2[6]	4[14]	19[76]
Sesame N=15	2[13]	2[13]	0[0]	2[13]	2[13]	0[0]	1[7]	2[13]	1[7]	12[80]
Total= 90	**21[23.3]**	**6[6.7]**	**1[1.1]**	**6[6.7]**	**16[17.8]**	**2[2.2]**	**6[6.7]**	**10[11.1]**	**9[10.0]**	**77[85]**

Table 2. Distribution and Prevalence of Parasites Contamination in Different Vegetables Sold in Kasuwan Aminu (Abuja road market)

Vegetables	*Ascaris spp. (%)*	*Trichuris spp. (%)*	*Hymenolepis spp (%)*	*Enterobius vermicularis* (%)	*Strongyloides stercoralis* (%)	*Toxocara spp. (%)*	*Fasciola spp.* (%)	Hookworm (%)	Tapeworm (%)	Total
Lettuce N=25	4[16]	1[4]	0[0]	2[8]	5[20]	0[0]	1[4]	3[12]	1[4]	17[68]
Cabbage N=25	4[16]	1[4]	1[4]	4[16]	5[20]	1[4]	2[16]	3[12]	1[4]	22[88]
Spinach N=25	7[28]	2[8]	0[0]	5[20]	3[12]	0[0]	1[4]	4[16]	3[12]	25[100]
Sesame N= 15	5[20]	1[4]	0[0]	1[4]	4[16]	0[0]	0[0]	2[8]	1[4]	14[93]
Total= 90	**20[22.3]**	**5[5.6]**	**1[1.1]**	**12[13.3]**	**17[18.9]**	**1[1.1]**	**4[4.4]**	**12[13.3]**	**6[6.7]**	**78[86]**

Table 3. Distribution and prevalence of Geohelminth Parasites in Different Vegetables sold in Kasuwan Laraba (Wednesday market)

Items	*Ascaris spp. (%)*	*Trichuris spp. (%)*	*Hymenolepis spp. (%)*	*Enterobius vermicularis spp. (%)*	*Strongyloides stercoralis spp. (%)*	*Toxocara spp. (%)*	*Fasciola spp. (%)*	*Hookworm (%)*	Tapeworm *(%)*	Total
Lettuce N= 25	8[32]	1[4]	1[4]	2[8]	6[24]	0[0]	0[0]	4[16]	2[8]	24[96]
Cabbage N=25	7[28]	1[4]	2[8]	2[8]	4[16]	1[4]	2[8]	5[20]	1[4]	25[100]
Spinach N=25	5[20]	2[8]	1[4]	1[4]	2[8]	0[0]	0[0]	5[20]	5[25]	21[84]
Sesame N=15	4[8]	1[4]	0[0]	2[8]	4[8]	0[0]	1[4]	3[12]	0[0]	15[100]
Total= 90	**24[26.7]**	**5[5.6]**	**4[4.4]**	**7[7.8]**	**16[17.8]**	**1[1.1]**	**3[3.3]**	**17[18.9]**	**8[8.9]**	**85[94]**

Table 4. Prevalence of Parasitic Contamination According to Vegetables Sold in Dutsin-ma

Vegetables	**Leaves**	**Number examined**	**Number positive**	**(%) Prevalence**
Lettuce	*(Letuca sativa)*	75	65	27.1
Cabbage	*(Brassica oleracae)*	75	69	28.8
Spinach	*(Ipomoea aquatica)*	75	65	27.1
Sesame	*(sesamum indicum)*	45	41	17.1
Total		**270**	**240**	**100%**

Table 5. Prevalence of Parasite found on vegetables According to Selected Markets within Dustin-Ma, Katsina State

Market	**Number Examined**	***Ascaris spp.***	***Trichuris spp.***	***Hymenolepis spp***	***Enterobius vermicularis spp.***	***Strongyloides stercoralis spp.***	***Toxocara spp.***	***Fasciola spp.***	**Hookworm**	**Tapeworm**	**Total%**
Kasuwan Kadagaru	90	21[23.3]	6[6.7]	1[1.1]	6[6.7]	16[17.8]	2[2.2]	6[6.7]	10[11.1]	9[10.0]	77[28.5]
Kasuwan Aminu	90	20[22.2]	5[5.6]	1[1.1]	12[13.3]	17[18.9]	1[1.1]	4[4.4]	12[13.3]	6[6.7]	78[28.9]
Kasuwan Laraba	90	24[26.7]	5[5.6]	4[4.4]	7[7.6]	16[17.8]	1[1.1]	3[3.3]	17[18.9]	8[8.9]	85[31.5]
Total (%)	**270(100)**	**65(24.1)**	**16(5.9)**	**6(2.2)**	**25(9.3)**	**49(18.1)**	**4(1.5)**	**13(4.8)**	**39(14.4)**	**23(8.5)**	**240[88.9]**

DISCUSSION

The findings of this study have shown the presence of helminthes eggs, larvae and worm on vegetable samples from retail market sold for public consumption in Dustin-Ma, Katsina State. The rate of contamination varies with the nature of the vegetable surface depending on whether it is smooth or (lettuce, spinach, cabbage). In this study, Out the 270 samples of vegetable that were collected and examined, 240(88.9%) were contaminated with helminth parasites. Ogunleye *et al.,* (2010) reported lower prevalence rates of 30.3% and 68.8% in western part of the country while Damen *et al.,* (2007) reported a 36.0% in the North central part of Nigeria. Ghimire *et al*. (2020) and Alemu *et al*. (2020) also reported a high prevalence of diverse parasitic pathogen in raw vegetable sampled. The nine different parasites identified in this study (*Ascaris* spp*.,* hookworm*, Trichuris* spp*., Taunia. S. Stercoralis, Toxocara* spp*., Fasciola spp., E. vermicularis* spp*.* and *Hymenlopsis* spp), might be attributed to be the medium these parasites were introduced. This is in agreement with report of Abougrain *et al*. (2010a) unhygienic water used by fruit sellers is a source of parasitic helminthes found in vegetables. Soil transmissible helminthes were among the parasites detected indicative of poor socio-economic condition, as well as poor environmental and sanitation practices. Abougrain *et al*. (2010b) also reported the presence of soil transmitted helminthes vegetables from the farms where animal dungs were used as fertilizer. Geographical location, type of water used for irrigation, post-harvesting handling methods of such vegetables and level of development of various countries have been shown to modulate prevalence of helminthic infections associated with consumption of vegetables (Abougrain *et al.,* 2010a; Kozan *et al.,* 2005). *Ascaris* spp. were detected in all the infected samples and had the highest prevalence. Presence of *Ascaris spp.* and hookworm is an indication that the canalization system as well as the toilet habits in this area are not up to the required standards. *Toxocara spp.* was only detected in cabbage and lettuce which was the lowest prevalence while *S. stercoralis* were found in various vegetable samples. *S. Stercoralis* and *Acaris spp*. were also detected as co-parasites in some samples. This findings corroborates the report of Dillard *et al.,* (2007) who stated that *S. stercoralis* is a zoonotic parasite as well as co-parasites of dogs, cats and primates that can cause cutaneous larva in humans contaminated vegetables. Ohaeri and Unogu (2011) also reported that *A. lumbricoides* (80.6%) was the most prevalent helminthes observed on vegetables in Umuahia, Abia State, likewise Dada *et al.,* (2015) reported 24.00% for *A. lumbricoides* and people consuming vegetables irrigated with drainage and waste water are exposed to the risk of infection with *A. lumbricoides*. *Ascaris lumbricoides* eggs are known to withstand a wide variety of adverse environmental conditions (Damen *et al.,* 2007) so that large numbers of eggs voided in feces could be viable in exposed soil or manure used for vegetable production in the study area. The presence of *Ascaris* sp*,* hookworm, *S. stercoralils* and *T. trichiura* reported in the present study points to the fact that when hygienic standards are compromised during planting and harvesting of vegetables, there is a great potential of acquiring geohelminth infections by consuming such raw vegetables.

CONCLUSION

This study recorded the high prevalence of parasitic contamination among vegetables sold in the different markets studied in Dutsin Ma. Nine different parasitic pathogens were identified in the different vegetable sampled. Cabbage had the highest contamination of parasitic pathogens while Ascaris spp was found to be the most prevalent parasite. Proper washing of raw vegetables before sale and subsequent consumption is crucial to both human and animal health because they are important vehicles of transmission of pathogenic helminthes. A lot of irrigation activities go on around the Markets and farmlands in Dustin-Ma with the absence of proper drainage and sewage system linked to farmlands and markets areas results in , as a result hygienic standards are compromised right from planting to consumption leading to greater risk of acquiring intestinal helminthes infection from consuming raw plant products.

Contributions: NCE and EOO conceptualized the study, NCE and EOO designed the study. EOO participated in fieldwork and data collection. NCE and EOO performed the data analysis; NCE, EOO and JDB interpreted the data. EOO prepared the first draft of the manuscript, reviewed by NCE and JDB. All authors contributed to the development of the final manuscript and approved its submission.

Conflicts of Interest: The authors declare np conflict of interest

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