# PARASITIC CONTAMINATION OF COMMON EDIBLE FRESH VEGETABLES SOLD IN OMDURMAN CITY, KHARTOUM, SUDAN

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**Abstract.** Eating raw vegetables is one of the main ways that pathogens, such as internal parasites, are spread. The purpose of this study was to ascertain the frequency of parasite contamination of edible vegetables that were offered for sale in Omdurman, Khartoum State, marketplaces. 317 samples of commonly consumed vegetables in Sudan were gathered directly from the markets between June 2020 and May 2021 for this cross-sectional study. The samples were tested in a laboratory using sedimentation and flotation techniques for the presence of parasites. A questionnaire was also administered to 1619 vendors in the targeted locations to ascertain the association between parasite presence and health behaviours. According to the findings, 24 samples (7.6%) were contaminated, with Ascaris and Giardia accounting for the largest percentages of isolates (25% and 25%, respectively). Men made up 68.7% of the participants, 30.1% were between the ages of 48 and 58, and the majority had only completed primary school. Since supermarket samples were less contaminated than those from public markets, we conclude that safety regulations vary by market and that public health officials should emphasize proper health practices. We also found a correlation between some poor health behaviours and parasite contamination of vegetables.
**Keywords:** *intestinal, pathogen, marketing, vendor, Sudan*

## Introduction

Vegetables are a rich source of vitamins, minerals, and fiber (Kumar et al., 2020), but eating them raw or undercooked can make you sick due to food-borne parasites (Idahosa, 2011; Bekele et al., 2017). It has been proven that vegetables are an important part of the human diet. Eating them fresh significantly increases the risk of intestinal parasite transmission (Karshima, 2018).

A pathogenic intestinal parasite is one that feeds on or at the expense of a host. Intestinal parasitic infections are common worldwide and pose a serious threat to public health, economics, physical development, cognitive function, especially in children in developing countries such as Sudan. The reasons for the prevalence rate are sometimes poor personal hygiene, poor environmental conditions, and a weak health system


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(Punsawad et al., 2019). Foodborne worm parasites include tapeworms (cestodes) that larval forms, found in meat and fish, have the potential to mature into adults in the human gut. Although there are other species that have larval stages in fish muscles, the most well-known tapeworms are those found in beef and pig (*Taenia solium* and *T. saginata*, respectively). Fruits and vegetables that have been fertilized with human excrement or cleaned with tainted water may contain tapeworm eggs. When *T. solium* eggs are consumed by humans, the larvae that emerge from the eggs burrow out of the colon and move to the brain, muscles, and other areas of the body, where they can cause major issues (Balali, et al., 2020). Recently, it has been reported that there is an increasing number of cases of food-borne illness mainly linked to eating fresh vegetables (Amissah et al., 2020). In underdeveloped nations, parasitic diseases cause approximately 200,000 fatalities and 300 million serious illnesses. Both industrialized and developing nations have reported massive epidemics of intestinal parasite infections linked to raw vegetables; these were most likely caused by inadequate personal hygiene and poor sanitation (Alhabbal, 2015). To maintain flavor, vegetables are often consumed raw or barely cooked in many nations, which may increase the risk of contracting food-borne parasite infections (Naumova et al., 2003). When vegetables are contaminated during production, collection, transportation, preparation, and/or processing, they can become a potential source of human infections such as enteric bacterial, viral, and parasitic pathogens. Soil, human and animal feces, and water (for cleaning and irrigation) are the most common sources of contamination. Recently, it has been reported that there is an increasing number of cases of food-borne illness mainly linked to eating fresh vegetables (Duedu, et al., 2014). Parasites are living things that feed on other living things. Due to its long-term need on the host for a consistent food supply, a "good" or well-adapted parasite does not kill its host. Typically, parasites are smaller than their food supply, which sets them apart from tigers and other predators that consume other living things. Many parasites, especially worms, spend a portion of their lives developing asexually as larvae in an intermediate host of a different species and a portion of their lives reproducing sexually in a final or definitive host. However, other parasites solely live in one species of animal. Many parasitic infections are asymptomatic, others cause acute short- lived effects, and still others may persist in the body causing chronic effects (Heitman et al., 2002).

### *Health issues caused by intestinal parasites and control*

The types of intestinal parasites, how often they spread, and how they interact with other infections are some of the factors that contribute to the severity and spread of these infections. Intestinal parasite infections include amebiasis, which can cause dysentery and extraintestinal complications; giardiasis, which is linked to acute diarrhea, steatorrhea, and lactose intolerance; trichuriasis, which is linked to chronic diarrhea and rectal prolapse; ascariasis, which can cause intestinal blockage and frequently death; and hookworm infection, which can cause iron deficiency. *Cryptosporidium paroum* and *Blastocystis hominis* have been identified as the most prevalent opportunistic parasites that cause chronic diarrhea and severe enteritis in individuals with impaired immune systems. In both immunocompetent and immunocompromised individuals, *Cryptosporidium paroum* has also come to be recognized as a cause of diarrheal disease. Bile, carbohydrates, and low oxygen tension all promote Giardia growth in the small intestine.7. Blastocystis hominis is the most prevalent opportunistic parasite that causes severe enteritis and persistent diarrhea in immunocompromised individuals. It can also cause dyspepsia, malabsorption, and diarrhea. Blood loss is the main issue with infection. Hookworm is prevented by using an


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organic anticoagulant. In addition to the numerous difficulties that other parasite types may bring, it consumes roughly 0.25 mL of the host's blood per day (MacPherson, 1999). An integrated strategy with community involvement is the most successful intestinal parasite infection control program. with the intention of lowering the frequency and intensity of intestinal parasite infections by the improvement of environmental sanitation, including safe waste and fecal disposal techniques, the provision of clean water sources, and health education regarding food, personal, and health promotion. The diagnosis and prevention of parasite diseases will be enhanced by the establishment of comprehensive infection monitoring and preventive and control programs related to healthcare, as well as by efforts to accurately report parasitic disorders (Wutoh et al., 2004).

The goal of the study on intestinal parasites distributed by vegetables is to quantify the spread of these parasites to lessen the contributing variables.

## Materials and methods

### *Collection of samples and experimental setup*

Study area: A major social and cultural hub for Khartoum State in central Sudan, Omdurman is a sizable metropolis. One of the three cities that comprise the capital, Khartoum, the city is situated on the banks of the Nile River. The early Middle Ages saw the founding of the city of Omdurman. With 2.7 million residents, the city is thriving despite its hot and rather dry climate (Ibrahim, 2019).

Apart of the data collection process wase a pre-tested questionnaire was distributed that included factors related to vegetable contamination such as workers' health, work environment, and the way vegetables are sold.

In addition 317 from various types of raw vegetables, such as (-Armenian cucumber, hot pepper, radish, beet, watercress, green pepper, lettuce, carrot green onion, green bell pepper, coriander, mint, cabbage, turnip, cucumber, tomatoes), were randomly collected from the markets of Omdurman City, Khartoum State, at a rate of 250 grams per type, for a period of time from June 2020 to June 2021. Samples were collected using clean tools to avoid cross-contamination. The samples were placed in individual plastic bags, labeled, and placed in sterile containers. They were then transported to the laboratory for testing of the various stages of parasites, within 6 h of collection. The vegetables were washed with a quantity of distilled water, each type separately. The washing water was then filtered through a medical gauze to remove large and coarse materials. The precipitate was then allowed to gradually settle. The pure water was poured out, and 5 mL of the precipitate was taken and placed in test tubes. Then it was centrifuged for 5 min at a speed of 1000 mL 2111 rpm. The pure water was then poured out, and a portion of the precipitate was taken and placed on a glass slide. The preparation was examined under the microscope for parasites using x10 and x40 objectives.

The eggs/cysts were identified based on morphological details as described by (Soulsby, 1982).

The characteristics of those who included by the survey include all sellers present daily during working hours of all ages and genders who had previously agreed to participate, as participation is limited to one time only.

The Statistical Package for the Social Sciences (SPSS) Data analysis was done using SPSS 20.0. The Chi square test was used to analyze the data. Microscopic examination of samples and detection of different parasite stages were performed at Khartoum laboratories, and the results were recorded.


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## Results

The results obtained from the analysis of demographic data indicate that 62.8% of the participants were men, the majority of them, 30.1%, were between 38 and 47 years old, and the majority of them, 37.7%, had intermediate education (*Table 1*). The results also indicate that 46.3% of participants washed their vegetables on open tables, and 31.3% used canal or river water to wash them. This means that 42% of them changed the water used to wash these vegetables twice daily. The collection of vegetable waste was poor, accounting for 19.7% (*Table 2*).

***Table 1.*** *Demographic characteristics of the participants (N = 1619) Appendix section 1*

| Variable | Frequency *n* (%) |
|---|---|
| Gender | |
| Male | 1112 (68.7) |
| Female | 507 (31.3) |
| Age | |
| 18-27 years | 281 (17.4) |
| 38-47 years | 288 (30.1) |
| 28-37 years | 421 (26) |
| 48-57 years | 253 (15.6) |
| >57 years | 176 (10.9) |
| Education level | |
| University | 201 (12.4) |
| Secondary | 611 (37.7) |
| Primary | 459 (28.4) |
| Non-school education | 247 (15.3) |
| Illiterate | 101 (6.2) |
| Years of experience in selling vegetables | |
| ≤3 years | 697 (43.1) |
| More than 3 years | 922 (56.9) |
| Place of work | |
| Public market | 1017 (62.8) |
| Supermarket | 253 (15.6) |
| Street selling | 149 (21.6) |

The environmental health in places that sell vegetables, where the general appearance was good, at a rate of 50.3%. As for the places where waste is collected, it was close to the places of sale, at a rate of 44.4%. Also, the majority of participants, 55.6%, reported that they use public toilets, and that 25.3% of them had their vegetables exposed to dust (*Table 3*). The health status of vegetable sellers, as a large number of them 42.2% do not have health cards, and 42.7% reported that there were visits by health inspectors, while 20.7% reported that there were no visits. Also, 19.7% reported that they had previously suffered from a parasite infection, and some of them, 13%, reported that they were currently suffering from it, and 19.8% reported that they had stopped working before for the same reasons (*Table 4*). Laboratory analysis results for the fresh vegetable samples collected showed that 7.6% of the total samples tested positive, with the majority (7.4%) coming from public markets, and the lowest percentage coming from vegetables offered in supermarkets.


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***Table 2.*** *Healthy practices with the sale of vegetables (N = 1619). Appendix section 2*

| Variable | Frequency *n* (%) |
|---|---|
| Vegetable display methods | |
| On the shelves | 409 (25.3) |
| On the floor | 385 (23.8) |
| On the top of tables | 751 (46.3) |
| Inside supermarket | 43 (2.7) |
| On the car | 31 (1.9) |
| Repeated spraying vegetables | |
| Yes | 619 (38.2) |
| No | 730 (45.1) |
| Sometimes | 270 (16.7) |
| Source of water for vegetables washing | |
| Pipe | 844 (52.1) |
| River | 507 (31.3) |
| Not sure | 268 (16.6) |
| Leftover vegetables management (if exists) | |
| It is disposed of | 120 (7.4) |
| Sold again the next time | 822 (50.8) |
| Dispose of damaged ones only | 677 (41.8) |
| How often is the washing water changed? | |
| Once a day | 320 (19.8) |
| Twice a day | 692 (42.7) |
| Not changed | 200 (12.4) |
| Nothing to wash | 407 (25.1) |
| Waste collection container | |
| Closed box | 790 (48.8) |
| Open box | 510 (31.5) |
| Not found | 319 (19.7) |

***Table 3.*** *Environmental health in vegetable sales areas (N = 1619)*, *Appendix section 3*

| Variable | Frequency *n* (%) |
|---|---|
| Environmental cleanliness level | |
| Good | 810 (50.0) |
| Not good | 509 (31.4) |
| Poor | 300 (18.5) |
| The distance of the place where vegetables are sold from the garbage dump | |
| < 150 m | 590 (36.4) |
| ≥ 150 m | 712 (44.0) |
| < 150 m | 317 (19.6) |
| Having a suitable toilet | |
| There is a suitable toilet | 510 (31.5) |
| There is no toilet | 209 (12.9) |
| Public toilets | 900 (55.6) |
| Exposure to the environmental dust | |
| Yes | 410 (25.3) |
| No | 602 (37.2) |
| Sometimes | 607 (37.5) |
| The presence of rodents and insects | |
| Yes | 511 (31.6) |
| No | 803 (49.6) |
| Sometimes | 305 (18.8) |
| Method of waste disposal | |
| Dispose of waste immediately | 745 (46.0) |
| Dispose of waste at the end of the day | 340 (18.8) |
| Dispose of waste at the beginning of the next day | 570 (35.2) |


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***Table 4.*** *Health of vegetable sellers (N = 1619), Appendix section 4*

| Variable | Frequency *n* (%) |
|---|---|
| Validity of the health card | |
| Valid | 611 (37.8) |
| Not valid | 324 (20.0) |
| Not found | 684 (42.2) |
| Visit health inspectors | |
| One day a week | 691 (42.7) |
| Day per month | 335 (20.7) |
| No visits | 393 (24.2) |
| Not sure | 300 (12.3) |
| Staying away from work due parasite illness | |
| Yes | 310 (19.2) |
| No | 711 (43.9) |
| Not sure | 598 (36.9) |
| Receiving advice from health inspectors | |
| Yes | 432 (26.7) |
| No | 525 (32.4) |
| Not sure | 662 (40.9) |
| Currently suffering from any parasitic disease | |
| Yes | 211 (13.0) |
| No | 656 (40.4) |
| Not sure | 752 (46.6) |
| Suspension by health authorities | |
| Yes | 321 (19.8) |
| No | 712 (44.0) |
| Not sure | 586 (36.2) |

The results also show that most of the positive samples were in public markets, at 7.4%, and the lowest were vegetables displayed in supermarkets (*Table 5*), Most of the positive samples were among leafy vegetables such as radishes at 5.4%, watercress at 16%, and green onions at 12.5% (*Table 6*). The results also showed that the isolation rate of parasites/positive samples was higher among Ascaris and Giardia lamblia at 25%, followed by Amoeba coli and threadworms at 12.5% each (*Table 7*). *Tables 8* and *9* show the relationship between the seller receiving health advice and infection with parasites, as well as the relationship between the places where vegetables are sold and the validity of the health card, where it indicates statistical significance $p < 0.001$.

The study also demonstrated a relationship between the validity of vendor health cards and parasitic infection, as well as the relationship between the locations where vegetable samples were taken and positive sample results, indicating a statistical significance of $p < 0.001$ (*Tables 10* and *11*).


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***Table 5.*** *Number of positive samples/fresh vegetables in three different places for sale—Omdurman*

| Vegetable type | Total number of samples examined and frequency of positivity | | Public markets (Sabreen, Shabi, central) | | Supermarkets | | Street selling | |
|---|---|---|---|---|---|---|---|---|
| | Number examined | Frequency of positivity, *n* (%) | Number examined | Number positive | Number examined | Number positive | Number examined | Number positive |
| Armenian cucumber | 14 | 2 (14.3) | 8 | 1 | 2 | 0 | 4 | 1 |
| Hot pepper | 13 | 0 (0.0) | 6 | 0 | 2 | 0 | 5 | 0 |
| Radish | 27 | 4 (15.4) | 16 | 2 | 4 | 1 | 7 | 1 |
| Beet | 16 | 0 (0.0) | 10 | 0 | 2 | 0 | 4 | 0 |
| Watercress | 25 | 4 (16.0) | 15 | 2 | 3 | 1 | 7 | 1 |
| Green pepper | 23 | 1 (4.4) | 14 | 1 | 3 | 0 | 6 | 0 |
| Lettuce | 19 | 2 (10.5) | 9 | 1 | 4 | 0 | 6 | 1 |
| Green onion | 32 | 4 (12.5) | 18 | 2 | 5 | 1 | 9 | 1 |
| Green bell pepper | 18 | 1 (0.3) | 9 | 0 | 3 | 0 | 6 | 1 |
| Coriander | 6 | 0 (0.0) | 3 | 0 | 1 | 0 | 2 | 0 |
| Mint | 15 | 1 (6.7) | 8 | 0 | 2 | 0 | 5 | 1 |
| Cabbage | 8 | 0 (0.0) | 4 | 0 | 1 | 0 | 3 | 0 |
| Turnip | 8 | 0 (0.0) | 4 | 0 | 1 | 0 | 3 | 0 |
| Cucumber | 31 | 2 (6.4) | 17 | 1 | 5 | 0 | 9 | 1 |
| Tomatoes | 39 | 2 (5.1) | 21 | 2 | 4 | 0 | 14 | 0 |
| Carrot | 23 | 1 (4.4) | 13 | 1 | 3 | 0 | 7 | 0 |
| Total | 317 | 24 (7.6) | 175 | 13 | 45 | 3 | 97 | 8 |

***Table 6.*** *Parasitic load in different types in vegetables*

| Types of fresh vegetables | Number of samples being examined | Positivity *n* (%) |
|---|---|---|
| Edible leafy vegetables | 132 | 15/132 (11.4) |
| Edible peeled vegetables | 185 | 9/185 (4.9) |
| Total | 317 | 24/317 (7.6) |

***Table 7.*** *Frequency of isolated parasites/positive samples (N = 24)*

| Parasite | Frequency n (%) |
|---|---|
| Cryptosporidium spp | 1 (4.2) |
| Ascaris lumbricoides | 6 (25.0) |
| Entamoeba coli cyst | N (12.5) |
| Taenia egg | 2 (8.3) |
| Hymenolepis nana egg | 2 (8.3) |
| Pin worms | 3 (12.5) |
| Giardia lamblia cyst | 6 (25.0) |
| Hookworms egg | 1 (4.2) |
| Total | 24 (100.0) |


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***Table 8.*** *Description of parasites eggs / oocyst isolated from vegetables*

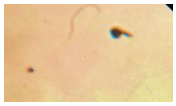
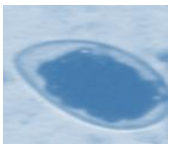
| | |
|---|---|
| Cryptosporidium oocyst: Under the microscope, the eggs appear as small, round or oval-shaped structures, usually 4-6 µm in diameter. They often exhibit a distinct red or pink color when dyed with modified acid-fast techniques |  |
| Ascaris Lumbricids egg cyst: Fertilized eggs are typically oval to round in shape, with a thick, mammillated outer layer that often appears brown due to bile staining. Unfertilized eggs are elongated and larger than fertilized eggs |  |
| Entamoeba coli cyst: Entamoeba coli cysts appear spherical or slightly oval and are typically 10-35 µm in diameter |  |
| Entamoeba histolytica cyst: Entamoeba histolytica cysts appear spherical and typically measure 10-20 µm in diameter |  |
| Taenia Pin worm egg: elongated oval shape with one flattened side. They are typically transparent and range in size from 50-60 µm |  |
| Hymenolepis nana egg: appear oval or subspherical and are smaller than those of H. diminuta. They typically measure 30-50 µm in diameter |  |
| Giardia lamblia cyst: appear as oval to ellipsoid structures, typically ranging from 8 to 19 µm in length |  |
| Hookworms egg: Hookworm eggs, typically found in stool samples, are oval-shaped and thin-shelled, with a clear space surrounding a cluster of cells in the center. They are colorless and measure roughly 60-75 µm by 35-40 µm |  |

***Table 9.*** *Relationship between seller's receiving health advices and parasitic infection*

| **Sellers receive advice in health practices** | **Parasitic infection** | | | | **Approx. Sig** |
|---|---|---|---|---|---|
| | **Yes** | **No** | **Not sure** | **Total** | |
| Yes | 20 | 300 | 112 | 432 | .000 |
| No | 110 | 106 | 309 | 525 | .000 |
| Not sure | 81 | 250 | 331 | 662 | |
| Total | 211 | 656 | 752 | 1619 | |

Chi-square test sig .000 (approx.sig0.000)


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***Table 10.*** *Relationship between vegetable sales locations and validity of the health card*

| Place selling vegetables | Validity of the health card | | | | Approx. Sig |
|---|---|---|---|---|---|
| | Valid | Not valid | Not found | Total | |
| Public market | 306 | 200 | 511 | 1017 | .000 |
| Supermarkets | 205 | 24 | 23 | 253 | .000 |
| Different streets | 100 | 100 | 149 | 349 | |
| Total | 611 | 324 | 683 | 1619 | |

Chi-square test sig .000 (approx.sig0.000)

***Table 11.*** *Relationship between valid health card and sellers parasitic disease*

| Validity of the health card | Parasitic disease | | | | |
|---|---|---|---|---|---|
| | Yes | No | Not sure | Total | Approx. Sig |
| Valid | 41 | 488 | 82 | 611 | .000 |
| Not valid | 74 | 39 | 212 | 324 | .000 |
| Not sure | 96 | 129 | 458 | 684 | |
| Total | 211 | 656 | 752 | 1619 | |

Chi-square test sig .000 (approx.sig0.000)

***Table 12.*** *Relationship between the places of vegetables samples taken and positive samples results*

| Places where vegetables samples were taken | Positive samples results | | | |
|---|---|---|---|---|
| | Positive | Negative | Total | Approx. Sig |
| On the shelves | 10 | 195 | 205 | .000 |
| On the floor | 11 | 36 | 47 | .000 |
| On the top of tables | 2 | 41 | 43 | |
| On car | 1 | 21 | 22 | |
| Total | 24 | 293 | 317 | |

Chi-square test sig .000 (approx.sig0.000)

## Discussion

The most common way parasites spread is through food, drink, or other contaminated food, as well as through unsafe handling practices in markets and unfavorable environmental conditions. Intestinal parasites are more common in people living in developing countries, and consuming raw vegetables is one of the most common ways of the parasites spread. For this reason, this study was conducted to shed light on and determine the prevalence of these parasites and the factors that contribute to them. It was conducted among 1619 vendors selected from 3 marketing area, the majority of whom were from public markets (62.8%), of whom 68.7% were men. Analysis of the questionnaire data revealed differences in safety requirements between good and bad. This study also included several questions, some of which addressed how different vegetable display techniques affect their safety. Many participants frequently spray vegetables with water to restore their freshness, which also contributes to other study about vegetables parasitic contamination conducted in Gezira, Sudan (Alnor and Younis, 2020) and 55.6% of people use public toilets exclusively. In addition, there is


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a scarcity of tap water, which has led people to wash vegetables with water repeatedly and sometimes not change it until the end of the day. This study also showed that there is a relationship between the parasitic load and the method of displaying vegetables, as there was a relationship between displaying directly on the ground and the high positive results, which is consistent with the results of some other studies on the microbial environment of food commodities Roberts et al. (2005).

This study is also revealing that sellers lack cards and that the majority of them are in temporary places markets which are frequently distant from visiting health inspectors ($p < 0.001$). Despite the small percentage of positive results (7.6%), there is evidence that contaminants are linked to certain environmental factors and the way vegetables are handled and sold. The highest percentage (11.4%) was found in leafy vegetables, indicating the need to increase emphasis on thorough washing. The results showed variations in the amount of parasites and their eggs, including cryptosporidium parasites. The *Ascaris lumbricoides, Hymenolepis nana* eggs, taenia eggs, and entamoeba coli cysts eggs of giardia lamblia cyst hookworms, ascaris had the greatest percentage followed by giardia the findings are comparable to a research that found that 48% of people in Gezira state, Sudan, had Giardia (Mohamed et al., 2016). Another study conducted in yamen founded that out of 216 vegetable samples, 166 (76.9%) were contaminated with one or more parasites (Muqbel et al., 2023). Other investigations in ethiopia and other countries revealed a higher percentage of vegetables contaminated with parasites, 58.7% (Othman et al., 2014). This study demonstrated a correlation between several elements, including the arrangement of vegetable materials, such as those placed close to the ground and those situated distant from contaminants. Health authorities must step in and instruct vendors in all marketplaces to retain uncontaminated produce because there is a correlation between the health status of vegetable merchants and the existence of health cards, which was approximately ($p < 0.001$). This study also shares similar findings to another study assessing food safety, hygiene, and the environment in Sudanese schools in Khartoum Bahri, which found a relationship between the food presentation environment and food consumption in schools and food contamination. This highlights the importance of environmental health ($p < 0.001$ (Abuagla and Omer, 2025).

## Conclusion

We conclude that many studies have indicated that raw vegetables are more susceptible to contamination, which leads to the spread of many foodborne diseases caused by microbes, especially in developing countries due to poor environment. This study has proven that vegetables, especially raw leafy vegetables, which are commonly consumed, are one of the sources of parasitic contamination in vegetable markets, which exposes consumers to the risk of infection with various types of parasites. Based on the results of this study, we recommend that health inspectors visit all vegetable sales locations and emphasize the importance of sellers obtaining health cards, monitoring sales strategies through a presentation style on several websites, and emphasizing the importance of environmental health and the factors that may contribute to vegetable contamination. The public health sector should also urge the public not to consume vegetables without thoroughly washing or cooking them. Finally, we call for further studies that consider all factors that contribute to the spread of parasites among vegetables.


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# APPENDIX

**Date ----------No ( )**

## PARASITIC CONTAMINATION OF COMMON EDIBLE FRESH VEGETABLES SOLD IN OMDURMAN CITY, KHARTOUM, SUDAN

***Market place ----------***

***I hope you can answer the questions so that everyone can benefit***

***Section 1***

*Demographic characteristics of the participants*

| Variable (question) | Answer |
|---|---|
| Gender | |
| Male<br>Female | |
| Age | |
| 18-27 years<br>38-47 years<br>28-37 years<br>48-57 years<br>>57 years | |
| Education level | |
| University<br>Secondary<br>Primary<br>Non-school education<br>Illiterate | |
| Years of experience in selling vegetables | |
| ≤3 years<br>More than 3 years | |
| Place of work | |
| Public market<br>Supermarket<br>Street selling | |


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## *Section 2*

*Healthy practices with the sale of vegetables*

| Variable (question) | Answer |
|---|---|
| Vegetable display methods | |
| On the shelves<br>On the floor<br>On the top of tables<br>Inside supermarket<br>On the car | |
| Repeated spraying vegetables | |
| Yes<br>No<br>Sometimes | |
| Source of water for vegetables washing | |
| Pipe<br>River<br>Not sure | |
| Leftover vegetables management (if exists) | |
| It is disposed of<br>Sold again the next time<br>Dispose of damaged ones only | |
| How often is the washing water changed? | |
| Once a day<br>Twice a day<br>Not changed<br>Nothing to wash | |
| Waste collection container | |
| Closed box<br>Open box<br>Not found | |


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## *Section 3*

*Environmental health in vegetable sales areas*

| Variable (question) | Answer |
|---|---|
| Environmental cleanliness level | |
| Good | |
| Not good | |
| Poor | |
| The distance of the place where vegetables are sold from the garbage dump | |
| <150 m | |
| ≥150 m | |
| <150 m | |
| Having a suitable toilet | |
| There is a suitable toilet | |
| There is no toilet | |
| Public toilets | |
| Exposure to the environmental dust | |
| Yes | |
| No | |
| Sometimes | |
| The presence of rodents and insects | |
| Yes | |
| No | |
| Sometimes | |
| Method of waste disposal | |
| Dispose of waste immediately | |
| Dispose of waste at the end of the day | |
| Dispose of waste at the beginning of the next day | |


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***Section 4***

*Health of vegetable sellers*

| Variable (question) | Answer |
|---|---|
| Validity of the health card | |
| Valid | |
| Not valid | |
| Not found | |
| Visit health inspectors | |
| One day a week | |
| Day per month | |
| No visits | |
| Not sure | |
| Staying away from work due parasite illness | |
| Yes | |
| No | |
| Not sure | |
| Receiving advice from health inspectors | |
| Yes | |
| No | |
| Not sure | |
| Currently suffering from any parasitic disease | |
| Yes | |
| No | |
| Not sure | |
| Suspension by health authorities | |
| Yes | |
| No | |
| Not sure | |

Prepared by researcher Dr. Mona Abuagla (food hygiene researcher)


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