PARASITIC CONTAMINATION OF VEGETABLES CULTIVATED IN IRRIGATION SITES ALONG THE KUBANNI RIVER IN ZARIA, NIGERIA

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ABSTRACT
Background: The unsanitary state of the environment can expose vegetables to parasite contamination before they are harvested. This will pose a serious health threat to consumers of the vegetables.
Aim: This study aimed at examining the presence of intestinal parasite in irrigated vegetables grown throughout the Kubanni irrigation area.
Methodology: A total of 125 vegetable samples were examined in the laboratory using sedimentation method. The selected vegetables include tomatoes, spinach, onions, lettuce, and cabbage.
Result: The parasites found in this investigation include *Entamoeba coli, Hookworm, Toxocara, Fasciola Hepatica, Ascaris lumbricoides,* and *Strongyloides*. It shows that *Ascaris lubroicodes* is the most prevalent parasite 28 (40%) while *Entamoeba coli* had the lowest prevalence rate (7%). Cabbage hosts the largest number of intestinal parasites 18 (25%) while tomatoes had the lowest parasitic contaminants 9 (13%).
Conclusion: In order to guarantee that vegetables produced in the study area are free of parasite contamination, safe agricultural methods in addition to enhanced environmental sanitation should be maintained.
Key Words: Parasite; Contamination; Vegetable; Irrigation; Kubanni

INTRODUCTION

In our everyday meals, vegetables like lettuce, spinach, cabbage, tomatoes, and onion play a crucial role because they are packed with numerous nutrients (Samuel and Sani, 2019). They are known to lower the risk of cancer, heart disease, diabetes, and other illnesses; therefore they have a big impact on our health (Mohammed *et al*., 2020). Some vegetables have shown to benefit human health, but they are also known to carry a number of risks because of various pollutants they contain. Mohammed *et al*. (2020) claim that ingestion of contaminated vegetables can result in foodborne illnesses such as diarrhea, constipation, dysentery and other related illness.

Many urban and peri-urban locations of most countries in the world during the dry season, vegetables are mostly cultivated along river valleys, urban farms, home gardens, and fallow plots (Irfan *et al*., 2017). According to estimates, between 2009 and 2010, fresh vegetable consumption in Europe contributed to 4.4% to 10% of illnesses (Nzamouhe and Omar, 2020). Because of the climate conditions and other environmental factors, illness caused by contaminated vegetables may be more common in Africa including Nigeria. Vegetable contamination can come from different sources which include soil, irrigation water, and techniques (Joep, 2017).

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Intestinal parasites (helminthes), which can infect both humans and animals, are good examples of pollutants that may be present in fresh vegetables. Raw meals from fruits and vegetables are the main way that intestinal worms enter people. Use of fresh, unclean, and partially cooked vegetables is regarded as a risk factor for transmission of intestinal parasites due to continuous exposure of vegetables to parasitic ova, larvae, or oocyst during cultivation (Honorine *et al*., 2022).

The existence of intestinal worms in vegetables and their possible effects on human health are causes for increasing concern. Poor agricultural practices alongside with unhygienic nature of the environment are some of the leading factors contributing to parasitic contamination of fresh vegetables. Vegetables contaminated with parasites may cause foodborne illnesses that could seriously endanger consumers' health. According to Lesa and Wageh, (2019), numerous of vegetable pollutants are absorbed at their harvest sites. Many studies have been carried out to assess parasitic contamination of vegetables across different market areas in Zaria. However, none of those studies was able to analyze vegetables in the farms along the Kubanni irrigation site. This study has examined the current situation of intestinal parasite pollution of vegetables from irrigated farms, the hazards connected with it, and possible solutions. This will assist in knowing the real contamination route as those vegetables sold in the market have higher chance of cross contamination from non-vegetable items sold in the same area.

MATERIALS AND METHODS

The Study Area

The Kubanni irrigation area lies between 5° 34' 0" and 7° 48' 0" East and Latitudes 11° 2' 0" and 11° 12'0" North. There are around six to seven months of rain from March/April to October/November, and five to six months of dry weather from November to March (Ismail *et al*., 2018). Temperature in January is around 22 degrees Celsius while April, just before the rainy season begins, is approximately 28 degrees Celsius. The average temperature is high all year long. The average daily low temperature during the dry season is around 11 ^{o}C, and the average high temperature is around 33 ^{o}C. The temperature in the area is suitable for irrigation farming, allowing farmers to cultivate a variety of crops, such as tomatoes, carrots, peppers, cabbage, lettuce, and spinach.

Sample Collection and Processing

Using a random sampling technique, 125 vegetable samples were collected from farmlands around the study area. The samples were sealed in a clean polythene bag instantly taken to the microbiology laboratory at Ahmadu Bello University Zaria for preparation and analysis. Tomatoes, spinach, cabbage, lettuce, and onions were among the vegetables that were chosen. This is because they are the most widely grown vegetables in the research region. Vegetable samples were analysed using floating and sedimentation method. Each fresh vegetable sample (25g) was weighed and transferred into 200mL of normal saline. After carefully shaking the mixture, the vegetables were removed, and the water was left in place overnight. After discarding the top layer, the sediments were further concentrated by centrifugation for five minutes at a speed of 2000 revolutions per minute (rpm).

The supernatant were discarded. A cover slip was used after the residue has been transferred to a clean, grease-free glass slide. Light microscope using 10x and 40x objectives was used to examine the wet mount in order to find and identify parasite eggs and larvae according to (Abubakar *et al*., 2024).

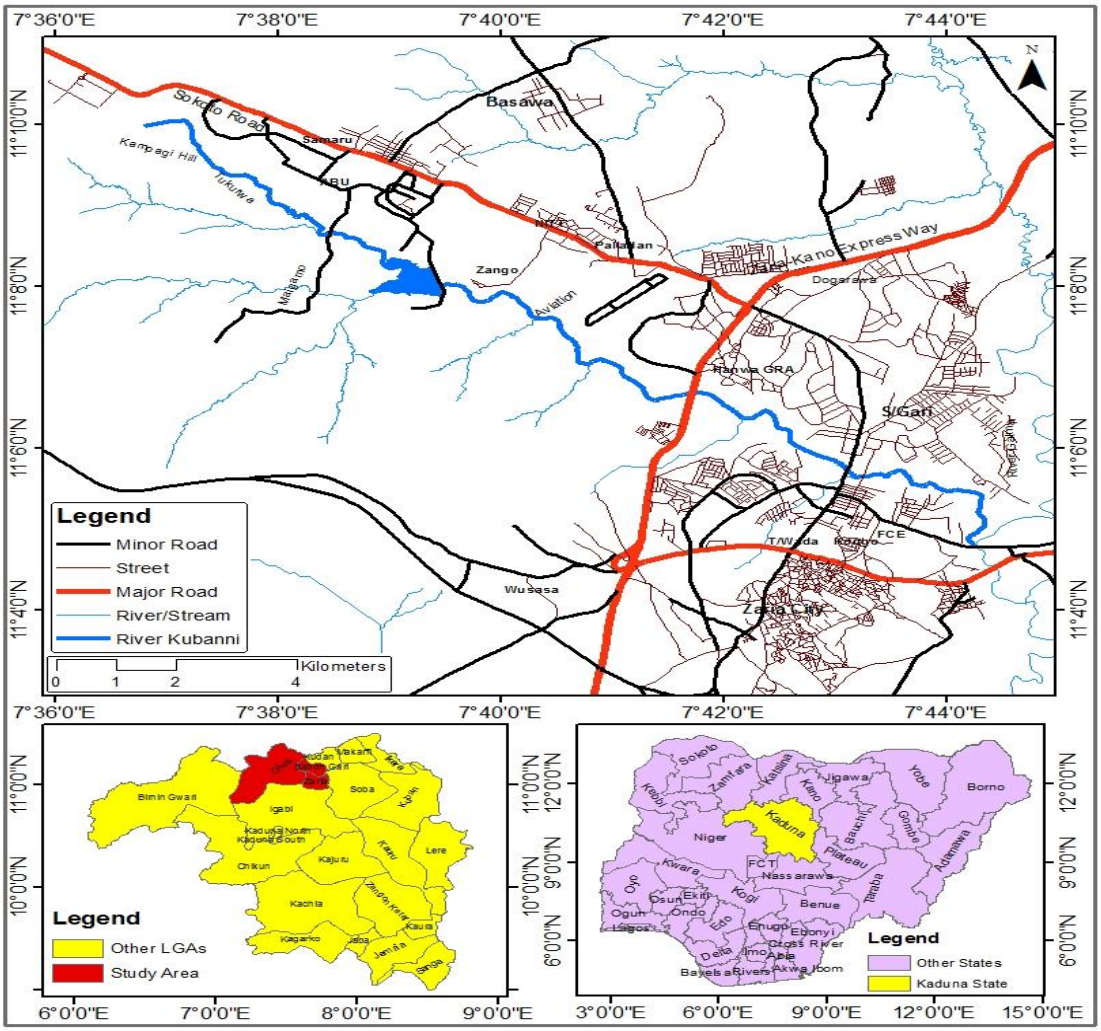

Figure 1: Zaria showing the Kubanni River

Source: Adapted and modified from the administrative map of Nigeria.

Data Analysis

For this study, a descriptive statistics (charts) were used for presentation and analysis of data from Microsoft Excel 2007.

RESULTS

Overall and Individual Prevalence of Intestinal Parasites

Overall Prevalence of Intestinal Parasites

From Figure 1, it shows that *Ascaris lubroicodes* is the most prevalent parasitic contaminant in all the selected vegetables cultivated along the Kubanni irrigation site which had 28 (40%). *Hookworm* is the second most prevalence parasite representing 17 (23%) of all the intestinal parasites from vegetables within the study area. The third most prevalent parasite was *Toxocara* and *Fasciola hepatica* with 8 (11%) prevalence rate each. The fourth most prevalent parasite is *Strongyloides* with 6 (8%) prevalence rates while *Entamoeba coli* are the least parasitic contaminants within the study region with only 5 (7%) prevalence rate.

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Individual Prevalence of Parasites in the Selected Vegetables

Figure 2 contained the individual distribution of parasitic worms in vegetables, it indicated that Cabbage had the highest number of *Hookworm* 6 (24%) while spinach is second with 5 (20%), followed by lettuce 4 (16%), tomatoes with 2 (8%) and onion with 0% prevalence rate. Onion had

the highest prevalence rate for *Toxocara species* 4 (16%) followed by spinach with 2 (8%) rate. Tomatoes and lettuce recorded 1 (4%) prevalence rate each while cabbage recorded 0%. Tomatoes are most affected by *Fasciola hepatica* with 4 (16%) prevalence rates. This is followed by onion with 2 (8%) while cabbage and lettuce had 1 (4%) each. Spinach recorded 0% contamination with *Fasciola hepatica*. Onion is most contaminated by *Strongyloides* parasite with 3 (12%) prevalence rate followed by lettuce 2 (8%) and cabbage 1 (4%). Spinach and tomatoes are free from *Strongyloides species* contamination within the Kubanni irrigation site. *Entamoeba coli* were observed in Cabbage and lettuce each having 2 (8%) prevalence rate followed by onion with 1 (4%). Spinach and tomatoes are free from *Entamoeba coli* contamination. *Ascaris* is most prevalent in cabbage with 8 (32%) followed by spinach 7 (28%), lettuce 6 (24%) then onion 5 (20%). The least vegetable contaminated with *Ascaris* species is tomatoes which recorded only 2 (8%).

Contamination Level in the Selected Vegetables

Figure 3 shows that cabbage host the largest number of intestinal parasites 18 (25%) within the Kubanni irrigation site followed by lettuce 16 (22%), onion 15 (21%), spinach 14 (19%) and the least is tomatoes with 9 (13%) prevalence rate.

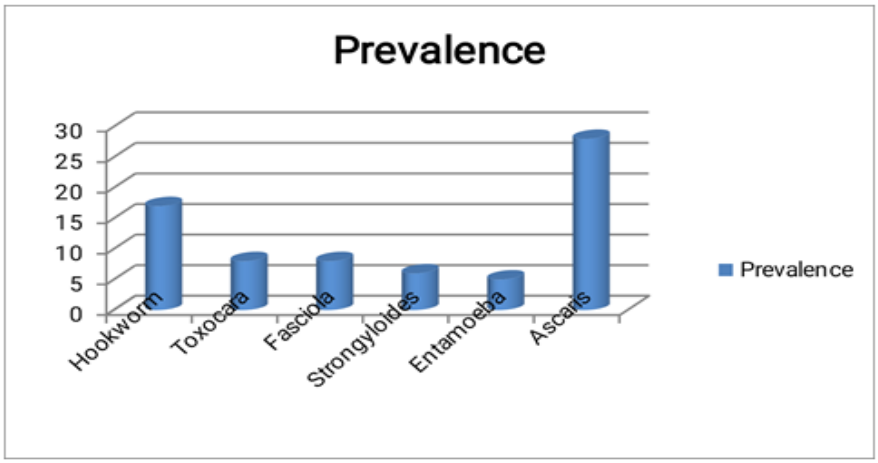

Figure 1: Overall Prevalence of Parasites

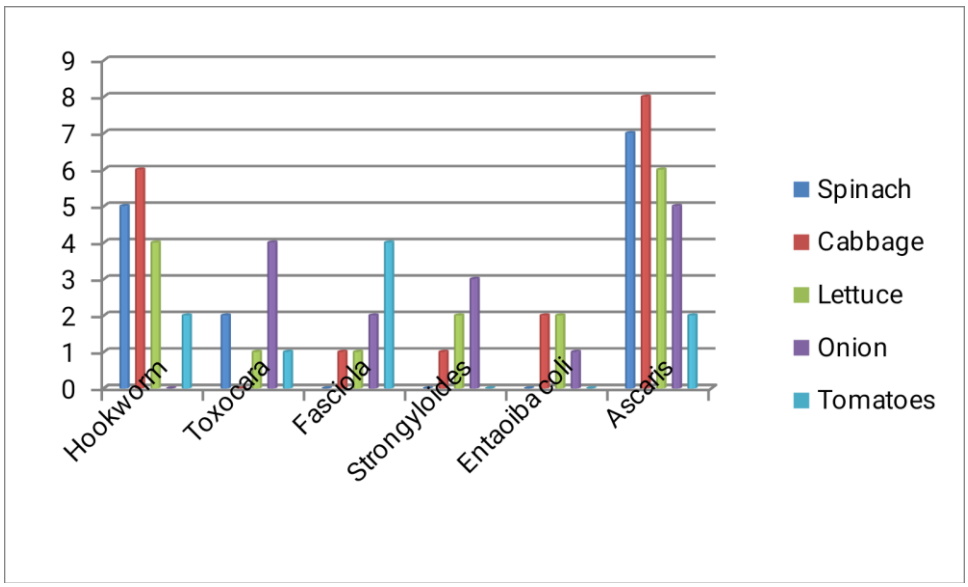

Figure 2: Individual Prevalence of Parasites in the Selected Vegetables

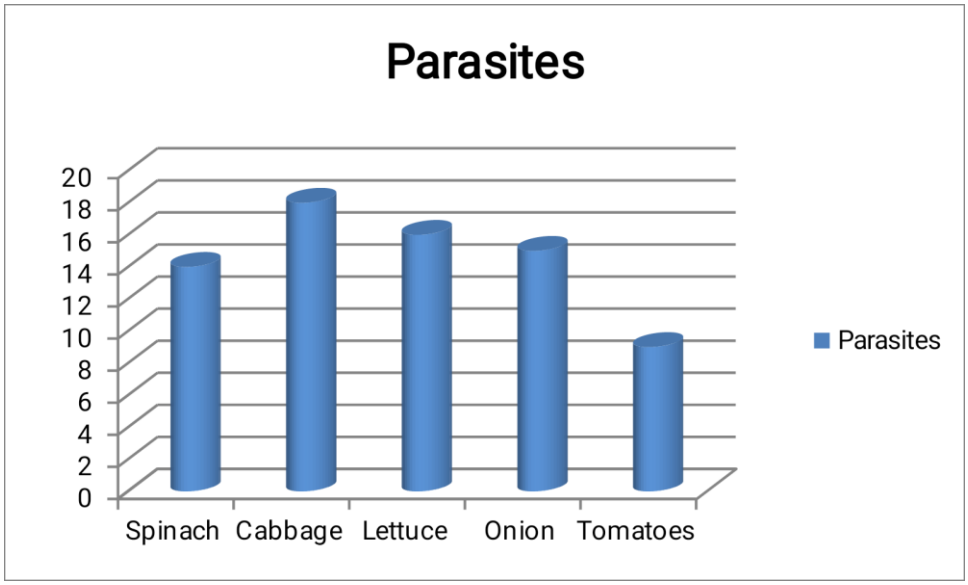

Figure 3: Contamination Level

DISCUSSION

The overall prevalence which represents the total number of positive samples shows that *Ascaris lubroicodes* emerged as the most prevalent parasitic contaminant in all the selected vegetables with 40%. This is contrary with the findings of Chuchard *et al*., (2019) in their assessment of parasitic contamination of vegetables in Nakhon Si Thammarat province, southern Thailand. They reported that *Hookworms* were the most predominant parasite with a 42.9% prevalence rate. In the study of (Abubakar *et al*., 2024), *Ascaris* also recorded highest prevalence rate in vegetables from Keffi, Nassarawa state, Nigeria. In another study by Yahaya and Gabriel, (2022) who analyzed the parasitic contamination of vegetables sold in some markets and farms in Zaria, *Strongyloides stercoralis* was the most occurring parasite (9.5%), followed by *Ascaris lumbricoides* (6.9%), *Hookworms* (6.1%), *Trichuris trichiura* (1.7%). High level of *Ascaris* in vegetable samples could be due to abundance of their eggs in the soil which are transferred to vegetables in the study area. Finding of this study is similar with that of Karshima, (2020) in their analysis of parasitic contamination of vegetables who also observed that *Ascaris lubroicodes* had the widest geographical distribution in Nigeria.

The individual distribution of parasites by Species in the selected vegetables shows that parasitic ova of five different species which include *Hookworm, Toxocara, Fasciola Hepatica, Strongyloides, Entamoeba coli* and *Ascaris* were observed in different proportion from vegetable samples within the study area. It shows that cabbage is more contaminated with *Hookworm* than other vegetables considered in this study. *Hookworm* is a parasitic roundworm that infects the small intestine of humans and animals. Two major species of Hookworm include *Ancylostoma duodenale* and *Necator americanus. Hookworm* requires a moist and fertile soil with abundant organic matter contents to strive (Chuchard et al., 2019). The continuous use of organic manure and regular application of irrigation water could be the reason for higher levels of *Hookworm* ova in the vegetables within the study area. *Hookworm* can be transmitted through direct transfer from contaminated soil and consumption of raw or partially cooked vegetables that host the parasites. Few health effects of *Hookworm* on human include malnutrition, anaemia and impaired growth in children (Chuchard et al., 2019). They continue to be

a significant health challenge in most developing countries. Continuous use of human and animal waste as manure in irrigation farms within the Kubanni area means the parasite will continue to infect consumers of vegetables within the study area. Periodic deworming, soil treatment, improved hygiene, washing and well cooking of vegetables are some of the good ways to minimize the spread of *Hookworm* in the study area.

In this study, *Toxocara* species are more in Onion 16% followed by spinach with 2 (8%) rate. Tomatoes and lettuce recorded 1 (4%) prevalence rate each while cabbage recorded 0%. This is lower than the level observed by Healy *et al*., (2023) in their analysis of *Toxocara* contamination of spinach grown in the south of England, UK who reported 23.0% prevalence rate in spinach. *Toxocara* species infects both human and animals, two main species that infect human include *Toxocara canis (T. canis)* and *Toxocara cati (T. cati). Toxocara* eggs may survive in moist soils for up to seven years while larva may survive for several months in moist environment Karshima, (2020). The Kubanni irrigation site is a wetland environment and could be the reason why they are found in vegetables within the study area. Infection with *Toxocara* is common in unhygienic areas. The release of wastewater from areas surrounding the Kubanni River alongside with continuous use of human and animal waste as well as municipal solid waste (see Plate I, II, III and IV) are some of the few reasons why *Toxocara* were observed in vegetables within the study area. Their transmission route is through contaminated soil, water or uncooked vegetables. They can also be transmitted through contact with infected dog or cat and their symptoms include coughing, wheezing, abdominal pain, diarrhoea and sometimes skin rashes (Healy et al., 2023). Infection with *Toxocara* species may cause severe health challenges like loss in vision and respiratory failure. Proper washing and cooking of vegetables, regular deworming of pet animals are some of the ways to reduce the rate of *Toxocara* infection (Chuchard *et al*., 2019).

Plate I: Wastewater Drained into Kubanni River

Plate II: Human Waste from Soak Away

Plate III: Sac containing Animal Waste (cow Dung)

Plate IV: Solid Dumpsite

Source: Field Survey, 2024

High level of *Fasciola hepatica* observed in tomatoes and other vegetables may expose consumers to greater health risk. *Fasciola hepatica* is also known as a liver fluke; it belongs to the flatworm group and can infect liver bile duct of mammals including man. The parasite is common in places where livestock such as cattle and sheep are raised (Renato *et al*., 2022). The presence of Fulani herders in nearby communities like Hayin Malam and Hanwa could be the main reason for high level contamination of vegetables with *Fasciola hepatica* in the Kubanni irrigation site. The use of cow dung as manure is a common practice among irrigation farmers in the study area (see plate III). Symptoms of infection with *Fasciola hepatica* include: abdominal pain, diarrhoea, fatigue, jaundice, loss of body weight, liver enlargement and dark urine. Infection with *Fasciola hepatica* can have both economic and health effects in the study area as it affect both man and livestock which are considered as a very important industry within the Kubanni irrigation area.

High level of *Strongyloides* parasite observed in onion which recorded 12% prevalence rate, lettuce with 8% and cabbage with 4% calls for concern. Tomass and Kidane, (2012) in their analysis of geohelminthes in vegetables prior to harvest at the Mekelle City and Tigray, Ethiopia observed that *Strongyloides stercoralis* are the most prevalent parasites followed by *Taenia* and *Entamoeba* species.

Strongyloides are considered as an important health challenge affecting people and animals within the tropical and sub-tropical areas. Symptoms include abdominal pain, weight loss, and diarrhoea, body itching, fever, headache, fatigue, anaemia and sometimes coughing. Immuno-compromised individuals are at high risk of *Strongyloides* infection when in contact with contaminated soil and water (Robert *et al*., 2022). The cyst of *Entamoeba* observed in the result is an indication of unhygienic condition of the study area.

The result shows that cabbage had 32%, spinach 28%, lettuce 24%, onion 20% while tomatoes had 8% prevalence rate for *Ascaris*, this is very close to the value reported by Benti and Gemechu, (2014) in their analysis of pre-harvest contamination of vegetables with Helminthes in Eastern Showa, Ethiopia; they observed that *Ascaris* recorded 22.2% in spinach, 16.7% in lettuce and 23.61% in cabbage. However, Karshima, (2020), observed that *Ascaris lumbricoides* is most common in lettuce (51.5%) than other vegetables.

The result for contamination level shows that cabbage accommodates highest level of intestinal parasites representing 25% while tomatoes are the least contaminated vegetable in the study area. This is not the same with the study of Falohun *et al*. (2018) in Ibadan, the Southwest Nigeria who reported that Spinach had the highest level of parasites 20 (35.1%). In the study of Obebe *et al*. (2020), also in south western Nigeria, Jute recorded highest level of parasites with 32.1% prevalence rate while lettuce was the lowest with 3.5% prevalence rate. According to Yahaya and Gabriel, (2022), leafy vegetables, such as spinach, lettuce, and cabbage, have a much higher number of parasites due to their vast surface area, which allows parasites to adhere and attach. This could be the reason why there are more parasitic contaminants in leafy vegetables analyzed in this study like lettuce, cabbage and spinach than in tomatoes.

CONCLUSION

Due to the unsanitary conditions of the Kubanni irrigation area, it was discovered that every vegetable chosen for this study have been contaminated with various parasite pathogens. According to the study, eating raw vegetables that have not been properly cleaned can expose consumers to parasite infestation.

RECOMMENDATIONS

Based the findings from this study, the following recommendations are made:

1. Alternative source of irrigation water like borehole should be provided in the study area.
2. Effective treatment of irrigation water can reduce the risk of parasitic contamination.
3. Appropriate sanitation and waste management should be put in place across the study site
4. Use of sanitized and clean instruments or equipment during farming is recommended
5. Hygienic training to farmers and handlers of vegetables within the Kubanni irrigation area is recommended
6. Regular testing of soil and irrigation water is another way to control parasitic contamination of irrigated vegetables in the study area.

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