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Research Article

Prevalence of Parasitic Contamination in Lettuce Vegetables Sold in Public Markets in Davao City

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ABSTRACT

This study aims to assess parasitic contamination in lettuce (Lactuca sativa) from selected public markets in Davao City, Philippines. Using a quantitative cross-sectional design, a total of 60 samples were collected from Agdao, Bankerohan, and Toril Public Markets. Each sample was placed in sterile plastic bags and sent to the University of Mindanao Medical Technology Laboratory for examination. Using the method of Hoffman, Pons, and Janer, the samples were washed with saline, filtered, and examined using direct wet mount technique after overnight sedimentation. Four samples were positive for parasites, corresponding to a total prevalence of 6.67 percent. The parasites identified were *Strongyloides stercoralis, Balantidium spp.,* filariform larva, and a trematode egg. It was also found that there is no significant difference in parasitic contamination among the three public markets. The presence of parasites in commonly consumed raw vegetables like lettuce poses a significant threat to consumer safety. Hence, the researchers recommend that local health agencies in the community strengthen educational initiatives targeting vendors, food handlers, consumers, and the general public on proper vegetable handling and safe preparation practices. It is recommended that further research be conducted on effective methods for washing lettuce and other vegetables before consumption to safeguard the public from possible parasitic infections and outbreaks in the future.

Keywords: *Food-borne parasites, Food safety, Contamination, Lettuce, Public market*

Introduction

Vegetables are considered excellent sources of essential vitamins and minerals and are widely recommended for maintaining a healthy diet. Some vegetables are consumed raw or lightly cooked to preserve their flavor and protect heat-sensitive nutrients (Smith,

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2020). Additionally, raw vegetable consumption has been associated with improved digestion, enhanced mental health, and a reduced risk of developing cardiovascular and other chronic illnesses (Brown & Garcia, 2018; Lee et al., 2019). However, despite these benefits, studies have shown a strong link between the raw consumption of vegetables and the increased transmission of foodborne parasites and other microorganisms (Santos, 2021).

In the Philippines, vegetables make up a significant portion of the Filipino diet, and eating raw vegetables is a common practice. Lettuce (*Lactuca sativa*), a popular leafy vegetable often used in salads, is widely consumed due to its high nutritional value and ease of preparation. However, recent studies have reported a high prevalence of intestinal parasites in vegetables, raising increasing concerns about food safety (Cruz et al., 2020–2023).

Globally, intestinal parasitic infections are common but are especially prevalent in tropical and subtropical regions. Despite the interventions of public health agencies to control parasitic infections (Department of Health, 2019), it has been reported that 81 provinces in the Philippines remain endemic to at least one neglected tropical disease caused by parasites (World Health Organization [WHO], 2020). In the Davao Region, a 2011 study in Davao del Norte found that 34.1% of schoolchildren in indigenous communities were infected with at least one soil-transmitted helminth (STH), and 5.9% had heavy-intensity infections (Del Rosario et al., 2011). Due to the COVID-19 pandemic, infection control efforts targeting neglected tropical diseases were suspended, increasing the threat posed by parasitic infections (Gomez & Reyes, 2021).

Although several international studies have investigated parasitic contamination in fruits and vegetables, there is limited literature available from the Philippines, particularly in Davao City. Thus, there is a need to update local data on parasitic contamination in vegetables such as lettuce, especially in light of the COVID-19 pandemic, which has led to a diminished focus on intestinal parasitic infections.

Materials and Methods

Sampling

Twenty samples were purchased in three public markets, namely Agdao, Bankerohan, and Toril public markets. The samples were randomly selected regardless of size, appearance, or variety. Each sample was placed separately in sterile plastic bags and sent to the University of Mindanao Microbiology Laboratory for examination.

Processing and Analysis of Samples

Each lettuce sample was examined macroscopically for the presence of parasitic worms, including adult nematodes, cestode segments, and other ectoparasites. The samples were analyzed using the Hoffman, Pons, and Janer technique, commonly referred to as the spontaneous sedimentation method. This technique, as utilized in the study by Célio et al. (2014), demonstrated a high recovery rate of parasites in lettuce samples, with a reported recovery of 70%. For this procedure, each sample was fragmented and washed with 100 mL of physiological saline solution (0.9% NaCl) in a separate container to dislodge any parasitic ova, cysts, or larvae. The solution was continuously agitated for 30 minutes. Subsequently, the leaves were removed, and the wash water was filtered through sterile gauze. The resulting filtrate was placed in a sterile container and allowed to sediment overnight. The sediment was then gently resuspended, and 0.05 mL of the solution was mounted on four microscope slides—two for direct examination and two stained with Lugol's iodine. All slides were observed under 10x and 40x objectives, and parasite identification was confirmed by licensed medical technologists.

Statistical Analysis

The researchers used a one-way ANOVA test as a statistical tool to determine if there is a significant difference in the prevalence of the parasitic contamination of lettuce vegetables collected from the three selected markets in Davao City. A p-value of less than 0.050 was deemed significant.

Inclusion and Exclusion Criteria

Lettuce *(Lactuca sativa)* vegetables were purchased from three public markets in Davao City: Bankerohan Public Market (District 1), Agdao Public Market (District 2), and Toril Public Market (District 3). The research location was chosen because these three public markets are central and open-air public markets where vegetables are purchased directly from farmers or producers. The lettuce samples utilized in this investigation were collected regardless of size, variety, cultivation method, vendor, suppliers, or other criteria that may contribute to parasitic contamination. The study did not include lettuce vegetables sold at supermarkets, stalls, and marketplaces other than Agdao, Bankerohan, and Toril public markets.

Results and Discussion

In this study, four out of 60 lettuce vegetables tested positive for intestinal parasites – two from Agdao and two from Toril Public Market. Meanwhile, all samples obtained from Bankerohan were negative for parasitic contamination. The parasites identified were *Strongyloides stercoralis, Balantidium spp.,* filariform larvae, and a trematode egg. The study's findings revealed no significant difference in the prevalence of parasitic contamination between the three public markets. Table 1 shows the frequency of detected parasites per market.

Public Markets in Davao City	No. of Samples (n=60)	Frequency of Positive Samples
Agdao	20	2 (10%)
Bankerohan	20	0
Toril	20	2 (10%)

Notably, the lettuce samples obtained from Agdao and Toril public markets were prewashed with water at the time of purchase. In contrast, samples from the Bankerohan market were unwashed but tested negative for parasitic contamination. Monterde et al. (2020) reported that some vendors in Davao City reuse water for washing vegetables due to the large volume of water required for proper cleaning. In contrast, a study conducted in Southern Ethiopia indicated that unwashed vegetables were 3.6 times more likely to be contaminated compared to those washed before display (Abdissa et al., 2019). Similarly, a study conducted in Laguna, Philippines, revealed that using water from mountain springs can lead to contamination of vegetables and soil with animal-borne pathogens, while tap water supplies were found to be safer and free of waterborne parasites (Delos Reyes et al., 2018). These findings highlight the critical importance of washing vegetables in public markets, while also emphasizing that the quality of water used is a significant factor in reducing the risk of parasitic contamination.The parasites identified in lettuce vegetable samples collected from three public markets in Davao City are listed in Table 2. *Strongyloides stercoralis* larvae and *Balantidium spp.* were recovered from lettuce samples obtained from Agdao Public Market. One trematode egg and one filariform larva were also identified from samples in Toril Public Market. Because the filariform larvae of *S. stercoralis* and hookworms have similar morphologies, it is difficult to differentiate them using the detection method.

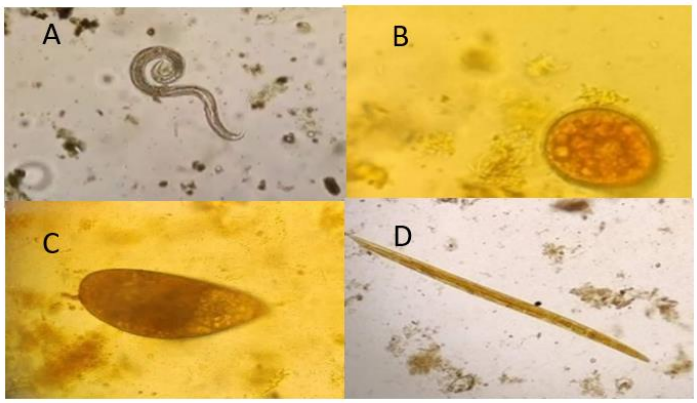
Consistent with the findings of this study, numerous international investigations have documented high levels of *Strongyloides stercoralis* contamination in lettuce and other vegetables such as cabbage, spinach, carrots, watercress, and spring onions (Célio et al., 2015; Santos et al., 2018). *S. stercoralis* is transmitted via contaminated soil and possesses a complex life cycle that enables the parasite to adopt a free-living form. This adaptability may contribute to the heightened risk of contamination in soil-grown produce. Additionally, *Balantidium* spp. was detected in the current analysis. This protozoan parasite is primarily transmitted through the fecal-oral route, with pigs and other animals serving as its main reservoirs.

Elevated levels of contamination, as reported in earlier studies (Santos et al., 2018; Yilma & Malone, 1998; Célio et al., 2015), may be attributed to the use of pig or human fecal-contaminated water for irrigating vegetables.

Table 2. Parasites Identified from Lettuce samples

Parasites Identified	Public Markets			TOTAL
	Agdao	Bankerohan	Toril	
Balantidium spp.	1	0	0	1
Filariform larva	0	0	1	1
Trematode egg	0	0	1	1
Strongyloides stercolaris	1	0	0	1
Negative	18	20	18	56
Total	20	20	20	20

A trematode egg was detected in one of the lettuce samples collected from Toril Public Market. However, due to limitations in the detection method employed in this study, the researchers were unable to accurately identify the specific species of the trematode. Nonetheless, previous studies on vegetable contamination have frequently reported the presence of *Fasciola* spp. in lettuce and other produce (Célio et al., 2015; Santos et al., 2018; Yilma & Malone, 1998). *Fasciola* spp. is primarily transmitted through contaminated water sources and is commonly associated with aquatic vegetation.



A. Strongyolides stercoralis; B. Balantidium coli; C. Trematode egg; D. Filariform larva

Figure 1. Parasites Identified from Lettuce Samples Collected from Selected Public Markets in Davao City

Table 3 shows the total prevalence rate of parasites detected from *L. sativa* samples taken in three public marketplaces in Davao City. Two samples tested positive for parasite contamination in Agdao and Toril Public Markets, with a prevalence of 3.3 percent in each market. The cumulative prevalence of parasite infestation in the sixty lettuce samples examined is 6.7 percent.

Table 3. Prevalence of Parasitic Contamination in Lettuce

Public Markets		Parasitic Contamination		TOTAL
		Positive	Negative	
Agdao Public Market	**Count**	2	18	**20**
	% of Total	3.3%	30.0%	**33.3%**

Public Markets		Parasitic Contamination		TOTAL
		Positive	Negative	
Bankerohan Public Market	**Count**	0	20	**20**
	% of Total	0.0%	33.3%	**33.3%**
Toril Public Market	**Count**	2	18	**20**
	% of Total	3.3%	30.0%	**33.3%**
TOTAL	**Count**	**4**	**56**	**60**
	% of Total	**6.7%**	**93.3%**	**100.0%**

Table 4. Summary of ANOVA for Prevalence of Contamination between Markets

ANOVA						
	Sum of Squares	**df**	**Mean Square**	**F**	***p* value**	**Conclusion**
Between Groups	.133	2	.067	1.056	.355	**No significant Difference**
Within Groups	3.600	57	.063			
Total	3.733	59				

Table 4 The p-value obtained in this study was greater than 0.05, indicating that there is no statistically significant difference in the prevalence rate of parasitic contamination among the markets examined. Compared to earlier research on parasitic contamination of lettuce (Célio et al., 2015; Monterde et al., 2020; see also references 4–25), the overall prevalence identified in this investigation was relatively low. Several factors may have contributed to this finding. One possible explanation is the sanitary conditions of the markets and geographic variation. Another factor may be the differing food-handling practices across countries. In this study, the lettuce samples had been washed several times prior to display to enhance freshness, which may have influenced the presence or absence of parasites. However, it remains inconclusive whether washing effectively reduces parasitic contamination, as this same practice may have led to the detection of parasites in samples from Agdao and Toril Public Markets.

Additionally, differences in laboratory procedures could have contributed to the lower prevalence observed. For instance, a study by Célio et al. (2015) used a double saline washing method to improve parasite recovery. In contrast, the current study utilized only a single saline wash. Furthermore, unlike previous research, this study did not employ the Modified Ziehl–Neelsen staining technique, which is essential for identifying coccidian oocysts (Célio et al., 2015). This omission may explain the absence of coccidian oocysts in the samples examined.

Parasitic contamination does not appear to be solely dependent on the market location; rather, it may occur at various stages, including production, collection, transportation, preparation, or processing. This observation contrasts with the findings of Célio et al. (2015), who reported significant differences in parasitic contamination of lettuce samples collected from Maxixe City, Mozambique. To reduce the incidence of contamination in leafy green vegetables and mitigate the associated risk of parasitic infections among consumers, effective preventive measures must be implemented.

Conclusion

The findings of this study revealed that the total prevalence of parasitic contamination of lettuce vegetables obtained from Agdao, Bankerohan, and Toril Public Markets is 6.67 percent. Parasitic contamination of lettuce vegetables may have occurred during harvesting, transportation, or may be due to the handling practices of vendors. The prevalence of these parasites in lettuce, a commonly consumed raw vegetable, poses a high risk to public health and consumers' safety. Because of this, the researchers conclude that there is an urgent need to implement simple and scalable protocols to safeguard the public from parasitic infections. Hence, the researchers recommend that health agencies in the community improve efforts in

educating vendors, food handlers, and consumers. It is recommended that further research be conducted on effective methods for washing lettuce and other vegetables before consumption to prevent possible parasitic infections and outbreaks in the future.

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