



FOOD SAFETY AND PARASITE CONTROL IN PLANT-BASED FOODS: A REVIEW OF HOUSEHOLD SANITIZATION METHODS

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Thematic Axes: Epidemiology; Public Health; Collective Health.

ABSTRACT

The contamination of plant-based foods by cysts and eggs, and larvae of parasites represents a significant public health concern, particularly in developing countries. This review evaluated the effectiveness of household sanitization methods in removing these parasitic forms from plant-derived foods. The findings indicate that the chlorinated solution (sodium hypochlorite) is the most efficient method, achieving over 90% elimination of protozoan cysts such as *Giardia lamblia* and *Entamoeba histolytica*, as well as helminth eggs such as *Ascaris lumbricoides* and *Strongyloides stercoralis*. However, the use of vinegar (acetic acid) shows limited efficacy, particularly against helminth eggs and larvae, due to the high structural resistance of these parasitic forms. The saline solution (sodium chloride), although still commonly used by the population, has demonstrated low disinfection efficiency and may even compromise food quality. Washing with running water alone reduces the superficial load of contaminants but is insufficient for the complete parasite removal, and its effectiveness depends on the quality of the water used. Therefore, combining washing under running water followed by immersion in a chlorinated solution represents the most effective household sanitization approach for raw vegetables, contributing to the prevention of parasitic infections and the assurance of food safety.

Keywords: Household sanitization; Eggs; Cysts; Food safety.

Funding agencies: Universidade Federal de Pernambuco, Fundação de Amparo à Ciência e Tecnologia de Pernambuco (FACEPE)

INTRODUCTION

Food as fruits and vegetables have a rich and diverse nutritional composition, providing vitamins, minerals, dietary fiber, and bioactive compounds that contribute significantly to the promotion of human health (WORLD HEALTH ORGANIZATION, 2003). However, for these nutritional and functional benefits to be fully realized, it is essential that such foods are free from biological, chemical and physical contaminants. The presence of pathogenic agents, pesticide residues, heavy metals or foreign materials can compromise food safety, negatively affect consumer health and reduce product quality. Therefore, appropriate practices in cultivation, handling, storage and transportation are indispensable to ensure the integrity and safety of these foods. In this regard, the National Food and Nutrition Security System (SAN) highlights that food and nutrition security encompasses access to food that is safe in terms of biological, sanitary, nutritional and technological quality, being a



determining factor in the promotion of public health (BRASIL, **2006**). Despite advances in ensuring food and nutrition security, challenges such as foodborne parasitic diseases remain an important public health concern. These diseases, often associated with inadequate hygiene and food-handling practices, demand continuous surveillance, health education, and effective regulatory control to protect public health.

Horticultural products, particularly leafy vegetables, are grown in direct contact with the soil, which is often contaminated, and in many cases irrigated with untreated water, conditions that favor the presence of pathogenic agents (OSAFO *et al.*, 2022; MAIA *et al.*, 2023). The prevalence of intestinal parasitic infection tends to be higher in developing countries due to socioeconomic inequality, limited access to safe drinking water, poor sanitation, inadequate hygiene conditions and low educational levels (HAJARE *et al.*, 2022). The consumption of raw fruits and vegetables without effective hygienization therefore represents a significant health risk, acting as vehicles for the transmission of intestinal parasites (OSAFO *et al.*, 2022; MAIA *et al.*, 2023).

According to Maia *et al.* (2023), even after industrial washing and packing processes, leafy vegetables may still reach consumers harboring viable parasitic forms. Examples include the presence of *Giardia duodenalis* and *Entamoeba histolytica* cysts, *Ascaris lumbricoides* eggs and *Strongyloides stercoralis* larvae. Regarding the impact of these parasites, giardiasis alone is a globally reported infection, being particularly prevalent among children. Detection rates range from 2% to 5% in developed countries, 20% to 30% in developing nations and may reach up to 95% in regions with poor sanitation, such as Mexico and Russia. A study conducted in Malaysia associated infection with protein-energy malnutrition and vitamin A deficiency in children (HAJARE *et al.*, 2022).

Therefore, ensuring that vegetables are properly sanitized before consumption and during storage is of paramount importance. Domestic hygienization represents an essential additional barrier against enteroparasitic infections. Typically the cleaning of raw vegetables begin with rising under running water to remove visible dirt. Subsequently, immersion in sanitizing solutions such as sodium hypochlorite is recommended to eliminate microorganisms. For firmer vegetables, the use of brushes can assist in mechanical cleaning. Finally, vegetables should be dried and stored in clean, refrigerated environments to maintain quality and prevent contamination. Even so, the hygienization of raw vegetables faces challenges, including the incomplete removal of microorganisms when using running water of uncertain sanitary quality, potential toxic residues from sanitizing solutions and possible mechanical damage caused by brushes, as well as inadequate drying and storage conditions. Thus, the present study aimed to analyze the efficacy of commonly used household sanitization methods applied to fresh horticultural products.

STUDY DESIGN AND METHODOLOGICAL STRATEGY

This study adopted a narrative literature review design, conducted between September and October 2025. The search was carried out in recognized online scientific databases: PUBMED (National Library of Medicine), SCIELO (Scientific Electronic Library Online), BVS (Biblioteca Virtual em Saúde) e LILACS (Latin American and Caribbean Literature in Health Sciences). Descriptors were used in Portuguese, English, and Spanish, including the terms “home sanitization,” “parasites,” “eggs,” “cysts,” and “disinfection methods.” Only articles published within the last five years were considered. Original and review articles were considered eligible, initially selected through a critical reading of titles and abstracts. Subsequently, the full texts of the selected studies were analyzed in detail. The objective was to identify, describe, and discuss the effectiveness of household hygienization methods applied to raw vegetables in the removal of parasite cysts and eggs, from the perspective of nutrition and food safety, thereby contributing to the understanding of the implications of these practices in controlling foodborne parasitic diseases.

RESULTS AND DISCUSSION

The parasites that contaminate leafy vegetables generally share similar transmission mechanisms. In their resistant forms such as cysts, eggs, or larvae, they can reach food primarily through contaminated irrigation water, contact with previously contaminated soil and inadequate transportation, handling and storage practices (OSAFO *et al.*, 2022; MAIA *et al.*, 2023). In this context, the adoption of alternative household techniques for the disinfection of fruits, vegetables and especially leafy greens is of great importance for the promotion of public health and the prevention of foodborne diseases. Because these foods are frequently consumed raw, they are more susceptible to contamination by pathogenic microorganisms such as bacteria, viruses and parasites. The *Manual of Good Practices for Food and Services* emphasizes that this stage is essential for the reduction of microorganisms and parasites and should be performed before consumption or processing.

Regarding foodborne parasites, the protozoa *G. lamblia* e *E. histolytica* are noteworthy. Both are transmitted via the fecal-oral route through the ingestion of cysts present in contaminated water or food. In the case of *G. lamblia*, the ingested cysts release trophozoites in the small intestine, where they multiply and adhere to the mucosa, causing gastrointestinal symptoms. Similarly, *E. histolytica* releases trophozoites that can invade the intestinal mucosa, leading to diarrhea, dysentery or hepatic abscess (WESEL *et al.*, 2021; HAJARE *et al.*, 2022). Among helminths, *A. lumbricoides* and *S. stercoralis* stand out for their global medical importance. *A. lumbricoides* occurs through the fecal-oral route via the ingestion of embryonated eggs present in the contaminated soil, water or food. The larvae hatch in the intestine, migrate to the lungs, and return to the intestine, where they mature into adults. *S. stercoralis* has a more complex life cycle, involving transcutaneous infection or autoinfection, which favors its persistence in the host. Both parasites may cause abdominal pain, diarrhea, and, in severe cases, malnutrition and pulmonary complications (CAI *et al.*, 2024; MUSLIM *et al.*, 2024).

Although few studies have specifically evaluated the effectiveness of household sanitization methods in reducing or removing parasitic forms from raw vegetables, the available research provides relevant findings for food safety. According to the meta-analysis by Maia *et al.* (2023), the main procedures evaluated involve the use of chlorinated solutions, vinegar (acetic acid), and running water, applied either by immersion or direct washing. The chlorinated solution, at concentrations between 100 and 200 ppm, was identified as the most effective method for eliminating parasite cysts and eggs, showing reduction rates above 90% in several studies included in the review. Vinegar is widely used as a household method for sanitizing fruits and vegetables due to its easy availability and low cost. Even though it exhibits some antimicrobial activity, mainly attributed to the presence of acetic acid, its effectiveness is considered variable. Studies indicate that vinegar can partially inhibit the growth of certain microorganisms, including some protozoa such as *G. lamblia* and *E. histolytica*, suggesting a potential benefit in controlling mild contamination by these parasites. Nevertheless, its action is limited against helminths, since their eggs and larvae possess highly resistant external structures that hinder the penetration of simple disinfecting agents such as vinegar. Therefore, despite being a practical alternative, vinegar should not be regarded as a fully effective method (MAIA *et al.*, 2023).

A sodium chloride solution (table salt) is often used domestically for cleaning plant-based foods due to its easy availability and low cost. However, its effectiveness against cysts, eggs, and larvae of parasites is limited. Salt can aid in removing surface debris and, to some extent, inhibit the growth of certain microorganisms, but it lacks sufficient disinfectant action to eliminate resistant parasitic forms, such as protozoan cysts or helminth eggs. Therefore, saline solution should not be considered an effective method on its own for disinfecting raw vegetables and should preferably be combined with other techniques, such as immersion in chlorinated solutions. However, this method is widely criticized in the literature, as it can cause irreversible damage to the quality of plant-based foods.

Similar results were reported by Osafo *et al.* (2022), who emphasized that the use of simple and accessible domestic hygiene methods is essential, particularly in developing countries where there is high exposure to intestinal parasites due to food contamination. The study reinforces that the use of disinfectant solutions, such as sodium hypochlorite, vinegar, and saline solutions, combined with an appropriate immersion time (between 10 and 30 minutes) significantly enhances the removal of viable parasitic forms from vegetables.

These findings are consistent with the guidelines of the Agência Nacional de Vigilância Sanitária (ANVISA), which recommends the sanitization of fruits and vegetables through washing under running water followed by immersion in a chlorinated solution prepared with one tablespoon of sodium hypochlorite (2–2.5%) per liter of water for 10 to 15 minutes, and subsequent rinsing with potable water (BRASIL, 2004).

The chlorinated solution is widely recognized as the most effective household method for disinfecting raw vegetables. According to Maia *et al.* (2023), when used at concentrations between 100 and 200 ppm, sodium hypochlorite can eliminate more than 90% of *Giardia* and *Ascaris* cysts and eggs. The mechanism of chlorine action involves the oxidation of cellular structures and the denaturation of proteins, leading to the inactivation of parasites and microorganisms. According to ANVISA, the immersion protocol using sodium hypochlorite solution is considered the gold standard for domestic and institutional sanitization, being the safest and most accessible method to ensure the sanitary quality of food (BRASIL, 2004). Osafo *et al.* (2022) further report that chlorine acts by altering the pH and destabilizing the cell membranes of protozoa; however, it is less effective against helminth eggs and larvae, whose resistant structures prevent the penetration of acetic acid. Despite its mild antimicrobial activity, vinegar cannot replace the use of chlorinated solutions.

Washing under running water is the simplest and most commonly adopted method among the population, yet it is also the least effective in eliminating parasites. Rinsing with potable water reduces the superficial parasitic load by removing dirt, soil, and part of the adhered cysts; however, it does not ensure complete removal of infective forms (MAIA *et al.*, 2023). This method is useful as an initial step, as it facilitates the penetration of the sanitizing agent and enhances the effectiveness of subsequent disinfection (OSAFO *et al.*, 2022). Although running water is indispensable for cleaning, it should not be used alone as a parasitic control measure but rather as part of a combined process that includes immersion and final rinsing, as recommended by ANVISA (BRASIL, 2004). Nonetheless, a major limitation in removing disinfectant residues with running water lies in the quality of the water itself, which, in many cases, is not adequately ensured by the available supply systems.

CONCLUSION

Domestic sanitization of leafy vegetables is essential to prevent infections caused by parasites such as *Giardia lamblia*, *Entamoeba histolytica*, *Ascaris lumbricoides*, and *Strongyloides stercoralis*. The chlorinated solution stands out as the most effective method, eliminating more than 90% of cysts and eggs, while vinegar shows limited efficacy, particularly against helminths. Washing under running water is important but insufficient on its own and depends on the quality of the available water. Therefore, the proper combination of these techniques, along with sanitary education, is crucial to ensure food safety and reduce public health risks.

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