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Review Article

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PRESENCE OF PATHOGENIC PARASITES IN SALADS: A REVIEW

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ABSTRACT

Salads make up an important part of the diet of mankind, across the world. They are affordable and nutritious, and serve as good sources of dietary fibre, vitamins and minerals. However, they can also harbour a plethora of pathogenic microorganisms like various parasites, which may cause gut disorders. Studying these aspects of foods is very important from public health viewpoint.

KEYWORDS: Salads, parasites, entamoeba.

INTRODUCTION

Salads, often viewed as healthy, refreshing meals, are a staple in modern diets, especially due to the growing emphasis on plant-based and raw food consumption, and are good for health.[1] However, the rise in popularity of raw vegetables, fruits, and leafy greens as salad ingredients has brought attention to the potential risks of foodborne illnesses. One significant concern is the presence of pathogenic parasites in salads, which can lead to serious health problems if consumed. For example, Giardia oocysts frequently contaminate lettuce.[2] Other worms like eggs of *Taenia solium*, cysts of *Entamoeba* spp. and *Cryptosporidium* spp. may also be present in salads. Many types of salads are there, like green salad, lettuce salad, mixed salads, other salads containing egg and chicken meat etc. This review article aims to explore the various pathogenic parasites commonly found in salads, their sources, health impacts, and the methods of prevention to ensure food safety.

MATERIALS AND METHODS

Scientific, thorough literature search by using MeSH (medical subject headings) terms was used to search available information regrading parasites in salads and their public health importance. Our experience was also counted.

Parasites in salads

Pathogenic parasites frequently contaminate salads. They come mostly from the water used for washing, the soil used for growing the crops or from the contaminated hands of the handlers.

According to studies, lettuce is the most commonly contaminated vegetable type, harbouring parasites (29.5%), while tarragon leaves document the lowest level of contamination (2.3%).[3] The risk of contamination is significantly higher in lettuce samples when compared with the other samples studied. *Giardia duodenalis* is the most prevalent parasite detected (38.6%) and is abundantly found in lettuce isolates (23.5%).

Figures 1 and 2 below show illustrative examples of two different types of salads.

Fig. 1: Mixed salads (image:authors).

Fig. 2: Common green salads (source: authors).

Common Pathogenic Parasites in Salads

***Giardia intestinalis* (Giardiasis)**

Prevalence and Source: *Giardia intestinalis*, a protozoan parasite, is commonly found in contaminated water sources. Mostly cysts and rarely trophozoites can be found in salads.[4] If water used for irrigation or washing salad ingredients is contaminated, vegetables and leafy greens become susceptible to infestation.[5] This parasite can also be introduced by improper handling during harvesting, packaging, or distribution.

Health Impact: Infection with *Giardia* spp. causes giardiasis, which can result in diarrhea, abdominal cramps, nausea, and weight loss. The symptoms can range from mild to severe and may lead to dehydration, particularly in vulnerable individuals.

***Entamoeba histolytica* (Amebiasis)**

Prevalence and Source: *Entamoeba histolytica* is another protozoan parasite that can be transmitted through contaminated water or food.[6] Inadequate sanitation during agricultural practices, as well as improper hygiene among food handlers, increases the risk of contamination. Crops grown in regions with poor sanitation are particularly vulnerable. According to our experience, we found *E. histolytica*/*E. dispar* cysts, mostly in cucumber and carrot-based salads.

Health Impact: Amebiasis caused by E. histolytica can lead to dysentery, causing bloody diarrhea, abdominal pain, and fatigue. In severe cases, it can result in liver abscesses and other complications.

***Toxoplasma gondi*i (Toxoplasmosis)**

Prevalence and Source: *Toxoplasma gondii*, a protozoan parasite, is typically transmitted through ingestion of oocysts present in contaminated soil, water, or feces of infected animals, especially cats. Salad greens such as mint, spinach and lettuce grown in such environments can harbor this parasite if not adequately washed.[7]

Health Impact: Toxoplasmosis is usually asymptomatic in healthy individuals, but it can cause flu-like symptoms in some people. In immunocompromised individuals, pregnant women, and fetuses, it can lead to severe complications, including damage to the brain, eyes, or other organs.

***Cryptosporidium* spp. (Cryptosporidiosis)**

Prevalence and Source: Cryptosporidium is another protozoan parasite often found in contaminated water, which is commonly used for irrigation. It can also be transmitted through contact with contaminated surfaces or food. Salad vegetables, particularly those grown in areas with poor sanitation, are at high risk.[8]

Health Impact: Cryptosporidiosis manifests with symptoms like watery diarrhea, stomach cramps, nausea, and dehydration. The infection can be self-limiting in healthy individuals, but it poses significant risks to the immunocompromised.

***Ascaris lumbricoides* (Ascariasis)**

Prevalence and Source: *Ascaris lumbricoides*, a large intestinal roundworm, is prevalent in areas where open defecation and poor sanitation practices exist. The eggs of the parasite are often found in contaminated soil, which can contaminate vegetables and greens through direct contact during growth or harvesting.

Health Impact: Ascariasis can cause abdominal pain, nausea, vomiting, and in severe cases, intestinal blockage or damage. Chronic infections can impair growth and development in children.

As per our experience, *Entamoeba histolytica*/*E. dispar*, *Blastocystis hominis* and *Entamoeba coli* are common parasites found in urban areas in ready-to eat salads.

An image of cysts of *Entamoeba* spp. found from salad washings is shown below in figure 3.

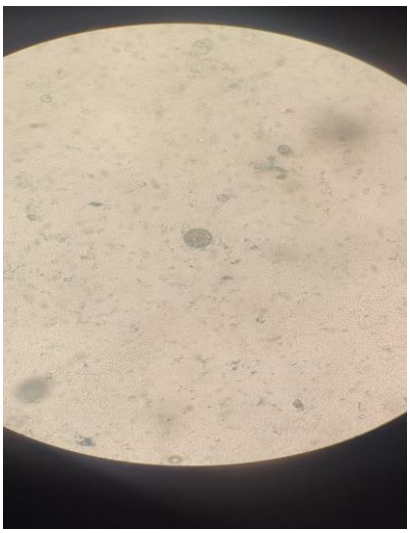

Fig. 3: Cyst of *Entamoeba* spp. found from salad washings (source:- authors)

Factors Contributing to Parasite Contamination

Several factors increase the likelihood of salad contamination with pathogenic parasites:

a. Irrigation Practices: Using untreated or contaminated water for irrigating crops is one of the main causes of parasitic contamination in salads. Use of human and animal excreta as natural fertilizer, and untreated waste water for irrigation purposes during cultivation are also main contributing factors.[9]
b. Soil Contamination: Crops grown in soil that is contaminated with fecal matter or wastewater are at high risk of harboring parasitic eggs or cysts.
c. Post-Harvest Handling: Contamination can also occur at various points during harvesting, transportation, storage, and processing. Improper handling by food workers can further introduce and spread parasites.
d. Poor Hygiene: Failure to practice proper hygiene during food handling, including inadequate washing of hands or kitchen surfaces, can significantly contribute to the transmission of parasites.

Detection methods for parasites present in salads

Microscopy by wet mount and ZN stain, and culture, are suitable methods to study parasites in stool. Newer molecular methods like PCR are also available. Nested-PCR and qPCR methods have been used to detect *G. duodenalis* and *Cryptosporidium* DNA in salad specimens.[4] As per our experience, mild washing of surfaces of salads by mild detergents may facilitate discovery of parasitic ova and cysts on salad surfaces. People have used othjer washing solutions to isolate these parasites, like phosphate-buffered saline, The glycine, sodium dodecyl sulfate, and Tween 80. Other rare solutions, like 10% formal saline and 0.1% peptone water are also reported to isolate the contaminating parasites.[10]

Prevention and Control Measures

To mitigate the risk of parasitic contamination in salads, several preventive measures must be taken at every stage of the food supply chain:

i) Proper Washing and Cleaning: Thoroughly washing salad ingredients under clean running water helps reduce contamination. However, washing does not guarantee complete removal of parasites, especially those that are deeply embedded in soil.
ii) Use of Safe Water: Irrigating crops with potable or treated water is crucial in reducing the risk of parasitic contamination. Water used for washing vegetables should also be treated to eliminate harmful microorganisms.
iii) Good Agricultural Practices (GAP): Farmers should implement good agricultural practices, such as avoiding the use of untreated sewage sludge and ensuring that soil and water sources are free from contamination.
iv) Consumer Education: Educating consumers on the importance of proper washing and handling of fresh produce, as well as the potential risks of eating raw vegetables, is essential to reduce the risk of foodborne parasitic infections.
v) Regulation and Inspection: Governments and food safety organizations should enforce regulations that require inspections of agricultural and food handling practices, especially in regions with a high incidence of parasitic infections

Common Food Safety Issues in Indian Restaurants

Indian restaurants face several food safety challenges, including:
Improper Food Handling: Cross-contamination between raw and cooked foods can occur if proper handling procedures are not followed.

Inadequate Temperature Control: Indian cuisine often involves dishes that need to be kept at specific temperatures to prevent bacterial growth.

Hygiene Practices: Maintaining high hygiene standards in busy kitchens can be challenging but is crucial for preventing food contamination.

Use of Contaminated Water: In some areas, access to clean water can be an issue, leading to the use of contaminated water in food preparation.

Addressing these issues by ensuring food safety standards is vital to maintaining the quality and safety of the food served.

Understanding HACCP for Indian Restaurants.

What is HACCP and Why It’s Important

HACCP, or Hazard Analysis and Critical Control Points, is a systematic approach to food safety that focuses on identifying and controlling potential hazards throughout the food production process. In the context of Indian restaurants, HACCP is crucial for several reasons:

Prevention Over Reaction: Instead of responding to food safety issues after they occur, HACCP emphasizes preventing them from happening in the first place.

Comprehensive Safety: It covers all aspects of food safety, from sourcing ingredients to serving the final dish, ensuring that every step of food handling and preparation is monitored.

Compliance and Confidence: Implementing HACCP helps Indian restaurants comply with food safety regulations, instilling confidence in customers that their food is safe to eat.

Ensuring food safety standards through HACCP is not just a regulatory requirement but also a vital practice to maintain the trust and health of customers.

Steps to Implement HACCP in an Indian Restaurant

Implementing HACCP in an Indian restaurant involves several key steps:

Conduct a Hazard Analysis
Identify potential hazards in the food preparation process, such as biological, chemical, or physical risks.
Common hazards in Indian cuisine might include contamination from spices, improper cooking temperatures, and cross-contamination between vegetarian and non-vegetarian foods.

Determine Critical Control Points (CCPs)
Identify stages where control measures can be applied to prevent or eliminate hazards, such as cooking, cooling, and reheating.
For example, ensuring that dishes like biryani reach the proper cooking temperature to kill harmful bacteria.

Establish Critical Limits
Set maximum or minimum limits for each CCP to prevent hazards, such as cooking chicken to at least 165°F (74°C).
Critical limits ensure that each step in food preparation meets safety requirements.

Monitor CCPs
Regularly check and record data at each CCP to ensure critical limits are met.
This can include using thermometers to check cooking temperatures or maintaining logs of storage conditions.

Establish Corrective Actions
Develop procedures to correct deviations from critical limits, such as discarding undercooked food or reheating it to the correct temperature.
These actions ensure that any potential hazard is addressed immediately.

Verify HACCP System
Regularly review the HACCP plan and procedures to ensure they are effective.
This can involve internal audits and testing to verify that food safety standards are consistently met.

Maintain Records
Keep detailed records of hazard analyses, CCP monitoring, corrective actions, and verification activities.
Documentation helps demonstrate compliance with food safety standards and supports continuous improvement.
By following these steps, Indian restaurants can effectively implement HACCP to ensure food safety standards are met at all times.

DISCUSSION

A number of pathogens are responsible for causing diarrheal diseases in man, of which intestinal protozoan parasites are important contributors which can be transmitted by ingestion of the contaminated food, particularly ready-to-eat salads.[11] The ingestion of raw vegetables and fruits seems to be a quick, easy, and healthy source of nutrients. However, these fresh vegetables and fruits can also be an important vehicle for transmission of some food-borne pathogenic microbes, if they are contaminated.[12] Common protozoan parasites which one may come across in salads include *Cryptosporidium* spp., *Giardia duodenalis*, *Cyclospora cayetanensis*, *Entamoeba* spp., *Toxoplasma gondii*, *Balantidium coli*, *Blastocystis* sp., *Cystoisospora belli* and *Enterocytozoon bieneusi*. The accidental ingestion of parasitic infective stages like ova, oocysts, cysts or spores with the contaminated raw vegetables or fruits causes a range of intestinal diseases and disorders in humans that may also lead to serious health issues. On many occasions, such contamination of vegetables and fruits produces outbreaks of parasitic infections. Globally, the occurrence of protozoan parasitic contamination in vegetables and fruits is said to range between 1.9% to 9.3%. However, such contamination with protozoans may be grossly underestimated, particularly in areas with poor sanitation protocols. These parasites originate from water and soil mostly. Many countries around the world have now realized the importance of studying the role of raw vegetables in the transmission of intestinal parasites.[13] High risk of diarrhea among raw vegetable consumers have been found in the Kathmandu valley of Nepal, mostly due to the use of river water by the farmers for washing vegetables.[14] This also suggests a need to avoid the use of river water for washing vegetables which are later used to prepare salads. These types of studies encompass human and animal health, and are really under the ambit of one health.

CONCLUSION

The presence of pathogenic parasites in salads poses significant public health risks, particularly when proper food safety measures are not followed. While the chances of parasitic contamination can be reduced through proper washing, hygiene, and safe agricultural practices, the responsibility lies with both food producers and consumers to mitigate the risks. As demand for raw and minimally processed foods continues to rise, ensuring that fresh produce is safe for consumption is critical to public health. More research, education, and stringent regulations are needed to address this persistent food safety issue and protect consumers from parasitic infections.

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