Review On: Food Chain Flow Diagram And Pathogen Control In Each Node

Hissa Dingeta Taressa and Asmamaw Aki

kondala Woreda Agriculture office, West Wollega Zone Oromia Regional State, Western Ethiopia
BGRS, BOA regional Animal Health Diagnostic Laboratory, P.O. BOX, 326. phone +251902330029,
asmamawaki@gmail.com

Summary: The presence of microorganisms in food poses a significant threat to public health, as it can result in foodborne illnesses with serious consequences for individuals and communities. The significance of food safety management, as demonstrated in this review, is paramount in the prevention and control of pathogenic microorganisms within the food supply chain, thereby ensuring public health. Food safety management is crucial for preventing and controlling pathogenic microorganisms in food. Collaboration across the food chain, from production to consumption, is essential for effective management strategies. Factors like temperature, pH, and water activity, alongside advanced identification techniques, play key roles in microbial control. Consumer education is essential in promoting safe food handling practices, thereby reducing foodborne illnesses and reinforcing confidence in the food system. In conclusion, the continuous evolution of practices, technologies, and regulations in this field drives the provision of safe, healthy, and high-quality food products, thus fulfilling the crucial mission of food safety management in contemporary society.
[Hissa Dingeta Taressa and Asmamaw Aki. **Review On: Food Chain Flow Diagram And Pathogen Control In Each Node.** *Biomedicine and Nursing* 2026;12(3):63-67]. ISSN 2379-8211 (print); ISSN 2379-8203 (online). http://www.nbmedicine.org. 06. doi:10.7537/marsbnj120326.06

Key words: Food; Food safety management; foodborne; food chain

1. Introduction

In current times, food security has emerged as one of the major global concerns, driven by the growing awareness of the health risks associated with consuming foods contaminated by pathogenic microorganisms (Vågsholm *et al.*, 2020). The presence of these microorganisms in food poses a significant threat to public health, as it can result in foodborne illnesses with serious consequences for individuals and communities (Bhunia, 2018).

This review article proposes a comprehensive approach to food safety management, highlighting its significance as a preventive and control strategy against pathogenic microorganisms in food. A profound understanding of these aspects becomes essential, as improper handling, inadequate processing, and incorrect storage of food can facilitate the proliferation of these harmful agents (Hammond *et al.*, 2015). In this context, it is crucial to study rigorous measures throughout the entire food chain, from production to consumption, in order to mitigate risks and ensure food safety.

This review study the key pathogenic microorganisms that can contaminate food, focusing on bacteria, fungi, parasites and virus that are often associated with outbreaks of foodborne diseases (Do Prado *et al.*, 2021). Additionally, it emphasizes the importance of utilizing advanced techniques for microbiological identification, such as Real-Time PCR, Next-Generation Sequencing (NGS), and MALDI-TOF mass spectrometry, to ensure early and accurate detection of these pathogens (Vidyadharani *et al.*, 2021).

The environmental and intrinsic factors affecting microbial growth in food are also explored in this review. Elements such as temperature, pH, water activity, and additives are they play a crucial role in inhibiting the proliferation of these pathogenic microorganisms (Peleg, 2022). Furthermore, the article underscores the importance of applying quality management systems, such as the Hazard Analysis and Critical Control Points (HACCP) system, as an effective approach to identify and control risks throughout the food chain (Nummer *et al.*, 2015).

The collaboration among various stakeholders, including regulatory bodies and international entities, is presented as a fundamental component in promoting global food safety (Karabasil. *et al.*, 2017). The synergy between different sectors and shared responsibility emerge as indispensable pillars to ensure that the food offered to consumers is safe and healthy (Meneguel *et al.*, 2022). Finally, consumer education is highlighted as a crucial element for the success of food safety strategies. Consumer awareness of safe food handling and storage practices plays a vital role in preventing foodborne illnesses and promoting healthy eating habits (Milton and Mullan, 2010).

Food safety is a complex global issue; this scientific article provides a comprehensive and detailed analysis of food safety management as a preventive and control strategy against pathogenic microorganisms in food. By

understanding and applying the measures and knowledge presented in this review, society will be better equipped to address the inherent challenges of food safety, ensuring a continuous supply of safe and high-quality food for human consumption (Karabasil. *et al.*, 2017).

2. Food and Micro-Organisms

Eating and digesting food will maximize the entropy of the consumed plant or animal. Food stabilizes the entropy of the consumer and facilitates the renewal of life. Food is thus essential to life but comes with the risk of other forms of entropy maximization. For humans, these (physical injury) risks do not arise from catching, harvesting, processing, or preparing food per se. Generally, food contains invisible micro-organisms; a term suggesting tiny living material with an autonomous nature. It can be debated whether this is completely true (Peleg, 2022).

As defined by the European Commission, MOs compromise bacteria, viruses, yeasts, molds, algae, parasitic protozoa, microscopic parasitic helminthes, and their toxins and metabolites. So, not all MOs are living materials and autonomous. MOs are part of biogeochemical cycles, are highly adaptable, can survive anywhere and in all facets of life. Most MOs are "friendly" and many have closed a pact with plants, animals, and humans. In particular symbiotic bacteria protect and support our skin and gut, and help to convert certain food components while also producing e.g., vitamin K. In reality, microbes in the gut are essential for a healthy person stimulating the immune system. Beneficial MOs ferment (unpalatable) matters into favorable and enjoyable food products. Besides adding taste and quality, MOs can spoil food products and/or form a health threat for food workers and consumers (Janssen *et al.*, 2008).

Following the invasion of a host, some MOs can replicate and cause infectious diseases. Pathogenic MOs can be harmful even without invasion of the eater by leaving toxins in the food and causing so-called toxic infections. In other cases, not only the injurious action of the MO but also the consumer's immune response to the MO leads to health damage. For example, although rare and affecting only approximately in 1 out of 1,000 infected individuals, different reactive (autoimmune) diseases are possible consequences of a Campylobacter infection (Janssen *et al.*, 2008).

Annually, 1,400 cases of reactive arthritis, 60 cases of Guillain-Barré syndrome, and 10 cases of inflammatory bowel disease as a result of campylobacteriosis are estimated in the Netherlands alone. Here, Campylobacter is an example of bacterial zoonosis, i.e., a pathogen transmitted from animal to human. Microbial hazards, like zoonoses, can enter the food-chain at any point: water, soil, in the growing, weaning, fattening phase up to the preparation of a meal. Water and soil are listed not without reason. They may contain harmful bacteria, parasites, and viruses which infect or contaminate plant or animal. For example, cows may contract zoonotic cysticercosis from feeding on tainted grass (Mangen *et al.*, 2020).

Pet food is a part of that food-chain as well and also requires high hygienic standards. In several surveys, disease-causing agents, such as Salmonella, Listeria, toxin-producing Escherichia coli, Mycobacterium spp., Sarcocystis spp. and many other parasites were found in, predominantly raw, cat and dog food, not only diseasing companion animals but also transmitting the pathogens to (juvenile) humans. Besides the indirect route, remind that pet food is consumed occasionally by people who cannot afford other food (Overgaauw, 2000).

A subject often forgotten, is that food safety does not only concern the final consumer, but also the professionals coming into contact with infected or contaminated animals, plants, and food products, namely the butcher, (spouse and children of) farmers, fishermen, inspector, processor, retailer, slaughterer, veterinarian, etc (Greig *et al.*, 2007), and residents close to farms and slaughterhouses. Many risks, such as hepatitis E virus (HEV), Salmonella, Streptococcus suis, Vibrio sp. (fish products), have been underestimated and underreported for food-workers for a long time (Rabozzi *et al.*, 2012).

3. Prevention and Control of Microbial proliferation

Microbial proliferation is influenced by optimal growth conditions, such as temperature, humidity, pH, and nutrient availability in food. Contamination occurs during various stages of the production process, including cultivation, harvesting, processing, improper storage, and handling. Cross-contamination is another common source of microorganism spread, where bacteria or other pathogens are transferred from one food to another (Abatenh *et al.*, 2018).

Prevention and control of microbial spoilage are essential to ensure food safety. Measures of personal hygiene and sanitation are crucial to prevent food contamination by unwanted microorganisms. This includes practices such as frequent hand washing, wearing clean and appropriate attire, as well as maintaining facilities and equipment

properly sanitized. The personal hygiene of food handlers is one of the primary pillars in contamination prevention. Regular and proper hand washing, the use of clean clothing, and being mindful of coughing and sneezing near food are critical practices to avoid the transmission of unwanted microorganisms Abdel *et al.*, 2016).

Correct sanitation of facilities, equipment, and utensils is also paramount. Regular cleaning and proper sanitization ensure the elimination of potential sources of cross-contamination, minimizing the proliferation of microorganisms in food. Proper storage is another critical factor in preventing microbial spoilage. Keeping raw and processed foods at appropriate temperatures, such as refrigeration and freezing, slows down the growth of microorganisms, preventing them from reaching dangerous levels. Additionally, controlling humidity and using suitable packaging helps prevent the entry of microorganisms (Salgado *et al.*, 2021).

Thermal treatment, such as cooking, pasteurization, and sterilization, is one of the key measures to eliminate pathogenic microorganisms and reduce microbial load in processed foods, making them safer for consumption. pH and water activity control are also important to prevent the growth of unwanted microorganisms. Adjusting these parameters creates a less favorable environment for the development of bacteria and fungi, extending the shelf life of foods (Chiozzi *et al.*, 2022). Adding additives, such as preservatives and natural or artificial antioxidants, is a common strategy to inhibit microbial growth and ensure the preservation of processed foods for a longer period. Regularly monitoring and analyzing the presence of pathogenic microorganisms and indicators of spoilage are essential to identify potential issues before they become a threat to food safety. Traceability is also an important tool in preventing food safety-related issues (Salgado *et al.*, 2021).

The ability to trace the origin of foods facilitates the rapid identification and resolution of potential contamination cases. Furthermore, education and training of staff on good practices for food handling and storage are crucial for the correct adoption of these preventive measures It is important to emphasize that, during food transportation, it is essential to ensure proper conditions to preserve their safety (Vitória *et al.*, 2022).

Temperature and hygiene during this stage must be rigorously controlled to prevent the growth of microorganisms and product deterioration. Adequate packaging and protection against contamination are essential to maintain the integrity of food throughout its journey to the consumer. In addition to ensuring food safety at all stages of the supply chain, it is necessary to inform consumers about the necessary precautions to maintain food safety in their homes. This includes guidance on proper food hygiene before consumption, appropriate storage and handling to avoid cross-contamination, and recognizing signs that the product may be compromised (Young *et al.*, 2022).

4. Food Safety Management

Food contamination arises from a multitude of sources, resulting in the introduction of harmful substances or pathogens that undermine the safety and quality of food products. A comprehensive understanding of these sources is essential for the implementation of effective food safety measures. Pathogenic microorganisms, encompassing bacteria, fungi, parasites, and viruses, can infiltrate food during various stages of production, processing, handling, and storage For this reason, efficient food safety management is a shared responsibility among producers, industry, distributors, retailers, and regulatory authorities. One of the key aspects to be considered is hygiene in production. In the field, it's essential to adopt good agricultural practices that minimize the presence of contaminants in food (Bhunia, 2018). This includes the responsible use of pesticides, proper pest and disease control, ensuring the personal hygiene of workers involved in production, and protecting planting areas against potential external contaminations (Waring *et al.*, 2020). In food processing industries, it's crucial to follow good manufacturing practices (GMP). These guidelines encompass various aspects, such as strict equipment and facility hygiene, precise control of temperature and processing time, proper training of employees for safe food handling, and product traceability, which enables the identification of the origin and destination of each batch, facilitating corrective actions in case of issues. Another crucial point is quality control carried out throughout the entire food chain. It's important to also verify the presence of pesticide residues and other chemicals that could be harmful to health. Additionally, microbiological testing and laboratory analyses are essential to monitor the presence of pathogens and other contaminants in food (Varghese *et al.*, 2022).

5. Conclusion

Pathogen control is essential at every step of the food chain to prevent foodborne illnesses. Regular testing, monitoring, and proper handling practices are key to controlling pathogens and ensuring food safety.

6. Recommendations

- ✓ Implement regular testing and monitoring protocols for water sources, feed, and food products.
- ✓ Ensure proper sanitation practices in animal housing and food preparation areas.
- ✓ Educate individuals on safe cooking and handling practices to prevent contamination.

- ✓ Implement strict health monitoring programs for animals and humans in the food chain.
- ✓ Stay informed of current food safety guidelines and regulations to ensure compliance.

7. References

Abdel-Aziz SM, Asker MMS, Keera AA, Mahmoud MG. Microbial food spoilage: Control strategies for shelf life extension. In: *Microbes in Food and Health. Cham*: Springer; 2016.

Bhunia AK. Introduction to Foodborne Pathogens. In: Foodborne Microbial Pathogens. *New York, NY, Springer New York*; 2018: 1-23.

Bhunia AK. Introduction to Foodborne Pathogens. In: Foodborne Microbial Pathogens. *New York, NY, Springer New Yor*k; 2018: 1-23.

Chiozzi V, Agriopoulou S, Varzakas T. Advances, applications, and comparison of thermal (pasteurization, sterilization, and aseptic packaging) against non-thermal (ultrasounds, UV radiation, ozonation, high hydrostatic pressure) technologies in food processing. *Appl Sci (Ba*sel). 2022; 12(**4**): 2202

Da Vitória AG, de Souza Couto Oliveira J, de Almeida Pereira LC, de Faria CP, de São José JFB. Food safety knowledge, attitudes and practices of food handlers: A cross-sectional study in school kitchens in Espírito Santo, Brazil. *BMC Public Health*. 2021; 21(**1**): 1-10.

Do Prado PC, Matias CL, Goulart JQ, Pinto AT. Most involved microorganisms in foodborne diseases outbreaks: A systematic review. *Braz J Dev*. 2021; 7(11): 106900-106916.

Gemen R, Breda J, Coutinho D, Fernández Celemín L, Khan S, Kugelberg S, et al. Stakeholder engagement in food and health innovation research programming - key learnings and policy recommendations from the in pro food project. Nutr Bull. 2015; 40(1): 54-65.

Hammond ST, Brown JH, Burger JR, Flanagan TP, Fristoe TS, Mercado-Silva N, et al. Food spoilage, storage, and transport: *Implications for a sustainable future. Bioscience*. 2015; 65(8): 758-768.

Karabasil N, Bošković T, Dimitrijević M, Vasilev D, Đorđević V, Lakićević B, et al. Food safety - the roles and responsibilities of different sectors. *IOP Conf Ser Earth Environ Sci.* 2017; 85(**1**): 012023.

Marriott NG, Gravani RB, Schilling MW. Principles of food sanitation. *New York: Springer*; 2006.

Meneguel CR de A, Hernández-Rojas RD, Mateos MR. The synergy between food and agri-food suppliers, and the restaurant sector in the World Heritage City of Córdoba (Spain). *J Ethn Foods*. 2022; 9(**11**): 1-13.

Milton A, Mullan B. Consumer food safety education for the domestic environment: a systematic review. *Br Food J. 2010*; 112(**9**): 1003-1022.

Nummer B, Gump D, Wells S, Zimmerman S, Montalbano A. Hazard analysis and critical control points (HACCP). In: Regulatory Foundations for the Food Protection Professional. New York, NY, *Springer New York*; 2015: 163-178.

Peleg M. A new look at models of the combined effect of temperature, pH, water activity, or other factors on microbial growth rate. *Food Eng Rev*. 2022; 14(1): 31-44.

Salgado PR, Di Giorgio L, Musso YS, Mauri AN. Recent developments in smart food packaging focused on biobased and biodegradable polymers. *Front Sustain Food Syst*. 2021; 5: 1-30.

Tuglo LS, Agordoh PD, Tekpor D, Pan Z, Agbanyo G, Chu M. Food safety knowledge, attitude, and hygiene practices of street-cooked food handlers in North Dayi District, Ghana. *Environ Health Prev Me*d. 2021; 26(**54**): 1-13.

Vågsholm I, Arzoomand NS, Boqvist S. Food security, safety, and sustainability - getting the trade-offs right. *Front Sustain Food Syst*. 2020; 4: 1-14.

Varghese SM, Parisi S, Singla RK, Begum ASA. Food safety and quality control in food industry. In: Trends in Food Chemistry, Nutrition and Technology in Indian Sub-Continent. Cham: Springer; 2022.

Vidyadharani G, Vijaya Bhavadharani HK, Sathishnath P, Ramanathan S, Sariga P, Sandhya A, et al. Present and pioneer methods of early detection of food borne pathogens. *J Food Sci Technol*. 2022; 59(**6**): 2087-2107.

Waring B, Neumann M, Prentice IC, Adams M, Smith P, Siegert M. Forests and decarbonization - roles of natural and planted forests. *Front For Glob Chang*. 2020; 3: 1-6.

Young I, Waddell L, Harding S, Greig J, Mascarenhas M, Sivaramalingam B, et al. A systematic review and meta analysis of the effectiveness of food safety education interventions for consumers in developed countries. *BMC Public Health*. 2015; 15(**1**): 1-14.

Janssen, R.; Krogfelt, K.A.; Cawthraw, S.A.; Van Pelt, W.; Wagenaar, J.A.; Owen, R.J. Host-pathogen interactions in Campylobacterinfections: The host perspective. *Clin. Microbiol. Rev.* 2008, 21, 505–518.

Mishu Allos, B.; Iovine, N.M.; Blaser, M.J. Campylobacter jejuni and Related Species. In Mandell, Douglas, and Bennett's Principles and Practice of Infectious Diseases, 8th ed.; Bennett, J.E., Dolin, R., Blaser, M.J., Eds.; W.B. Saunders: Philadelphia, PA, USA, 2015;Chapter 2018, Volume 2, pp. 2485–2493.

Mangen, M.J.J.; Havelaar, A.H.; de Wit, G.A. Campylobacteriosis and Sequelae in the Netherlands—Estimating the Disease Burden and the Cost-of-Illness, National Institute for Public Health and the Environment, Centre for Prevention and Health Services Research (RIVM), *RIVM Report* 250911004/2004.

Overgaauw, P.A.M. Parasite risks from raw meat-based diets for companion animals. *Companion Anim*. 2020, 25, 261–267.

Greig, J.D.; Todd, E.C.D.; Bartleson, C.A.; Michaels, B.S. Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 1. Description of the problem, methods, and agents involved. *J. Food Pro*t. 2007, 70, 1752–1761.