Foodborne Pathogens in Poultry: A Public Health Concern

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ABSTRACT

Foodborne pathogens are one of the major risks in poultry meat industry due to its worldwide prevalence and public health significance. These infections, which come from the intestinal tracts of animals, contaminate chicken during processing and pose serious concerns when consumed. By identifying key control points and establishing safety thresholds, Hazard Analysis and Critical Control Points (HACCP) offer a systematic approach that is frequently used to manage these hazards across the food chain. However, different farm sizes and a lack of research provide challenges to the use of HACCP, particularly at the farm level, impeding its widespread acceptance. This chapter focus on these concerns that requires proactive measures within the meat sector. The use of antibiotics, especially gentamicin, successfully lowers the number of germs, but at high doses, it raises questions concerning fertility. Treatments like hydrogen peroxide and phenol dips show potential in reducing the number of bacteria in eggs. Reducing the spread of germs requires maintaining hygienic poultry facilities, strict disinfection procedures, and strong security measures. Using ingredients like sodium dodecyl sulphate, lactic acid, and citric acid throughout the meat processing process helps stop the spread of pathogens.

Multifaceted interventions are necessary to support poultry safety, even as HACCP standards and cleanliness measures do. Pre- and probiotics, organic acids, and essential oils can be used in conjunction with bacteriophages that target infections to potentially combat Salmonella and E. Coli. The goal of genetic engineering is to provide hens disease resistance. Germ transmission can be efficiently stopped by control techniques such as clean egg production, strict disinfection procedures, and avoiding semen contamination. To promote safer chicken production and reduce the significant hazards to the public's health presented by foodborne illnesses linked to the consumption of poultry, a comprehensive strategy incorporating HACCP principles, hygiene standards, antimicrobial treatments, and genetic interventions is essential. However, more study and coordinated work will be required to standardize and apply these controls to all aspects of chicken production.

Key words: Foodborne Pathogens, Salmonella, Campylobacter, Poultry Meat. HACCP, Antimicrobial Treatments

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1. INTRODUCTION

Foodborne pathogens pose a significant threat to public health, causing millions of cases worldwide each year (Pal and Ayele 2020). Among the various sources of foodborne diseases, poultry meat stands out as a major concern due to its potential to harbor and transmit pathogenic bacteria such as *Campylobacter*, *Salmonella*, and pathogenic *Escherichia coli* (Zhao et al. 2001). These bacteria colonize the digestive tracts of animals, including those raised for human consumption, and can contaminate poultry meat at multiple stages of processing along the food supply chain.

The transmission of foodborne pathogens from poultry to humans occurs through various routes. One of the primary pathways is the consumption of contaminated meat. During the slaughter process, the removal of the gastrointestinal tracts (GIT) can lead to the cross-contamination of carcasses with *Campylobacter* and *Salmonella* (Rasschaert et al. 2008; Zhang et al. 2018). Additionally, improper handling, processing, or storage of poultry meat can contribute to the transmission of these pathogens as well. Poor hygienic practices of workers, inadequate storage conditions, and lack of preventive measures further increase the risk of microbial contamination, particularly in regions with limited resources (Hafez 1999).

Moreover, direct contact with live birds, such as handling or cleaning their coops, can also result in the transmission of foodborne pathogens to humans (Nichols et al. 2018). *Salmonella*, for instance, can colonize the intestinal tracts of live birds without causing noticeable symptoms, posing a risk to those in close contact. Furthermore, eggs from infected poultry can serve as a potential source of foodborne pathogens, either through contamination of the eggshell or the presence of the pathogen in the yolk or white (Isa 2023). Nevertheless, proper food handling, adherence to hygienic practices during food processing and cooking, and effective prevention measures can significantly reduce the risk of transmission.

The transfer of *Salmonella*, *Campylobacter*, and *E. coli* from poultry meat to humans poses a significant and ongoing public health threat. These three foodborne pathogens are commonly found in poultry and can cause a range of illnesses with varying degrees of severity (Zhao et al. 2001).

Salmonella transmission in humans can result in Salmonellosis, a gastrointestinal disease characterized by symptoms such as diarrhea, abdominal cramps, and fever. In severe cases, *Salmonella* infection can lead to hospitalization, especially in vulnerable populations, including young children and individuals with compromised immune systems (Wibisono et al. 2020). The potential for transmission is particularly high if poultry meat is not handled, stored, or cooked properly.

Similarly, *Campylobacter* is a leading cause of bacterial gastroenteritis worldwide, and poultry is a primary source of infection. Campylobacteriosis can result in diarrhea, abdominal pain, and fever. In some cases, the infection can lead to more severe complications such as Guillain-Barré syndrome (Acheson and Allos 2001). The transmission of *Campylobacter* to humans often occurs through the consumption of undercooked or cross-contaminated poultry meat.

E. coli, particularly certain strains such as toxin-producing *E. coli* can also pose a serious health risk when transmitted from poultry meat to humans. Infections with pathogenic *E. coli* can cause bloody diarrhea, abdominal cramps, and in some cases, progress to a severe condition called hemolytic uremic syndrome (HUS) which can lead to kidney failure (Stromberg et al. 2017). Poultry products contaminated with these strains can result in outbreaks of foodborne illnesses, underscoring the importance of preventing their transmission.

The public health threat associated with these foodborne pathogens from poultry meat to humans emphasizes the need for comprehensive control measures. These include strict adherence to food safety practices along the entire poultry production and supply chain, from farm to table. Proper cooking, storage, and handling of poultry meat are crucial to minimize the risk of infection. Additionally, robust surveillance, effective sanitation procedures, and appropriate vaccination strategies in poultry flocks can significantly reduce the prevalence of these pathogens (Dórea et al. 2010). By addressing the public health threat posed by these foodborne pathogens, we can protect individuals and communities from the debilitating effects of these infections and promote a safer food environment for all.

In this chapter, the transmission and control of foodborne pathogens in poultry is discussed. By understanding the routes of transmission and implementing effective control measures, we aim to enhance public health by reducing the incidence of foodborne illnesses associated with poultry consumption. Through comprehensive research and analysis, we explore various strategies to combat foodborne pathogens, highlighting the significance of good farming practices, vaccination, hygiene protocols, and other preventive measures. By combining these approaches, we can strive towards a safer and healthier poultry industry that safeguards consumer well-being.

2. FOODBORNE PATHOGEN TRANSMISSION

There are various ways that meat from animals or birds might spread foodborne diseases to people. Foodborne pathogens like *Campylobacter*, *Salmonella*, and pathogenic *E. coli* have colonized the digestive tracts of several wild and domestic animals, notably those produced for human consumption (Zhao et al. 2001). Along the whole food supply chain, these bacteria have the potential to contaminate food at many stages, including manufacturing, processing, distribution, retail marketing, and handling or preparation. According to several epidemiological studies, consuming foods obtained from animals is a significant risk factor for developing foodborne diseases (Petersen and James 1998).

Poultry is thought to be a major asymptomatic carrier of these pathogenic diseases. The removal of the GIT during slaughtering is one of the most significant causes of the cross-contamination of the carcass with *Campylobacter* and *Salmonella* (Mir et al. 2015). However, the predominant route of foodborne disease transmission from poultry to humans is through the ingestion of contaminated meat. The contamination can occur during slaughtering, processing, or storage of the meat (Hafez 1999). A study conducted in Africa discovered that poor hygienic practices of poultry meat handlers, as well as the sale of carcasses without cold storage or prevention from dust and flies, increased the risk of microbial contamination of meat, particularly with foodborne pathogens such as *Campylobacter* and *Salmonella* (Kagambèga et al. 2018). Moreover, factors like improper storage conditions, for example storage for prolonged period, also favors the microbial growth in meat and make it unsafe for human consumption (Taulo et al. 2008).

Furthermore, the transmission of foodborne pathogens from poultry to humans can take place in several other ways. For example, direct contact with live birds, such as handling them or cleaning their coops can also lead to transmission of foodborne pathogens to humans. This is particularly relevant for *Salmonella*, which can colonize the intestinal tract of live birds without causing any symptoms (Contreras et al. 2016). Moreover, in addition to meat, eggs from infected poultry can also be a source of foodborne pathogens.

This can occur when the eggshell is contaminated with pathogens or pathogens are present in the yolk or white (Pui et al. 2011). However, by proper food handling, good hygienic practices during food processing and cooking can help to reduce the transmission risk of these foodborne pathogens.

3. SIGNIFICANCE OF PUBLIC HEALTH

Each year the increasing food borne diseases are causing a huge economic and health losses around the globe. The WHO states that annually 30% of the population of developed nations suffers from food-borne illnesses and it is estimated that up to 2 million people die from these illnesses each year in developing nations (Abebe et al. 2020). Moreover, majority of the milk and meat associated foodborne illness effects about 10 to 30% population of the world annually (Grace et al. 2020). While, the causalities associated with foodborne infections result in harmful consequences on the health of individuals, resulting in conditions including cancer, immune system damage, and even death (Gibb et al. 2019).

The necessity for the meat sector to pro-actively handle food safety concerns that might harm the perception of dairy products is highlighted by growing public knowledge regarding the safety of food. Poultry meat producers must assess every step of their processing processes, including the procurement of raw meat to increase the food safety of their products (Boor 2001).

The necessity of implementing a system at the farm level to guarantee the safety of the meat is indicated by the importance of raw meat to the meat industry (Valeeva et al. 2005). The acknowledged significance of an integrated chain strategy to enhance food safety throughout the whole chain is another problem that places a lot of focus on the farm level (Valeeva et al. 2004).

Practices used in agricultural production, such as enhancing food safety, have been affected by the General Food Law. Farmers must use a range of control methods that might improve the safety of meat to satisfy the needs of the meat business and the requirements of European laws. It is crucial for farmers to discover cost-effective methods to improve food safety because such measures have a cost that is typically not covered by a higher product price (Communities 2000). The few studies that have been conducted to estimate the cost of making poultry products safe to consume mainly focus on the entire meat industry. At the farm level, only a small number of animal hygiene operations' costs have been calculated (Sakamoto 2007).

One of the largest concerns about their implementation at the farm level is how cost-effective the majority of controls are for improving the safety of the farm. There are very few studies that assist farmers in selecting the most cost-effective set of control measures to achieve a specific level of food safety (Cullor 1997). Farms have the greatest size diversity among other significant chain members, which is particularly true for research looking at dairy farms as players in the complete chain, while, the previous research has looked into the costs associated with improving food safety in meat processing industries (Dorn and Bachmann 2000).

4. MICROBIAL THREAT

Several diseases have either been newly characterized or linked to foodborne pathogen transmission in the recent 20 years. For instance, Pink hamburger consumption was positively associated with sporadic *E. coli* O157 cases in an American matched case-control study, according to (Kassenborg et al. 2004). Acute gastroenteritis following consumption of raw or undercooked shellfish, invasive septicemia following consumption of raw or undercooked shellfish, primarily oysters, and necrotizing wound infections following marine exposures and injuries have all been linked to the highly virulent Vibrio vulnificus organism (Hiransuthikul et al. 2005; Finkelstein and Oren 2011; Diaz 2014).

Listeria monocytogenes is a foodborne pathogen that may be found in a variety of foods (Ryser and Marth. 2007). The condition known as listeriosis, which can manifest as sporadic infections or disease outbreaks with a large mortality rate of 20-30% worldwide (Buchanan et al. 2017), is consequently caused by L. monocytogenes, a prominent foodborne pathogen. Depending on the patient's age, immune system, the quantity of ingested bacteria, and the strain's virulence characteristics, human infection can take one of three different forms: severe moderate invasive listeriosis, non-invasive febrile gastroenteritis. A total of 1,876 confirmed cases of invasive listeriosis in humans were reported in the member states of the European Union in 2020, with a notification rate of 0.42 cases per 100,000 people and 97.1% hospitalisations, according to the most recent common report from the European Food Safety Authority (EFSA) and the European Centre for Disease Prevention and Control (ECDC) (EFSA and ECDC 2021).

Chicken and raw milk are frequent causes of intermittent outbreaks of *Yersinia enterocolitica*, which causes diarrhea (Rahman et al. 2011). It is also commonly linked to undercooked pork (Fosse et al. 2008). Although more than 40 microorganisms are known to cause food poisoning, there are still many cases that need to be answered in terms of the causative organism(s) and the pathways of contamination. Another significant characteristic of these diseases is their tendency for fast epidemic spread, leading to a pandemic scale and for reasons that are occasionally yet unknown (Baines et al. 2005).

5. FOOD SAFETY STRATEGY

Hazard Analysis and Critical Control Points (HACCP) represents an approach to food safety. Systematically employing preventive strategies to safeguard both food products and consumers against potential chemical, physical, and biological hazards, or contaminants. Its application is primarily observed during production and post-production stages, ensuring the absence of contaminants that could compromise the safety of the end products. Moreover, it devises measures to mitigate contamination risks to a safe level (Motarjemi et al. 2023).

The main foundation of HACCP methods to food safety is a rigorous study of supply chain risk. Since it can be used to a variety of supply scenarios, it is very simple to implement and popular as the most often used safety management method. It enables the pre-planning of food safety measures for the intended prevention, control, and reduction of possible issues in a range of settings. As a result, it has completely changed how developed and developing nations handle food safety (especially in food production). Some people view HACCP as the "gold standard" method to regulate food safety (Woteki et al. 2004). According to claimed cost-effectiveness, the HACCP is also favored by many in the food business as the best safety solution. HACCP has generally been endorsed by the government and regulators as the most effective risk-based prevention-focused system, but mostly outside the farm gate.

The linkage between HACCP and food safety is integral, as the correct implementation of HACCP is imperative to ensure the safety of food. Consequently, HACCP's core objective revolves around hazard prevention rather than post-production hazard detection or presence inspection; it's fundamentally a preemptive strategy for upholding food safety (Awuchi et al. 2021; Morya et al. 2022).

The HACCP framework finds application across all phases of the food supply chain, spanning initial food preparation, production processes, and subsequent post-production handling, encompassing aspects like sourcing raw materials, production, packaging, storage, distribution, and more. Various regulatory bodies governing food safety in different countries mandate the obligatory adoption of distinct HACCP programs tailored to specific food categories, such as meat, juice, dairy items, infant formula, seafood, canned goods, and others. This requirement seeks to ensure comprehensive food safety, safeguard public health, and mitigate the occurrence of foodborne illnesses (Njunina 2022).

To minimize possible contamination by *Salmonella* and *Staphylococcus* in particular, HACCP was pioneered in space initiatives in the 1960s to prevent microbial contamination in food needed for extended space flight. The Pillsbury Company raised awareness of it among the public in 1971 at the National Conference of Food Production in the United States (Woteki et al. 2004). The Food and Drug Administration was prompted by a botulism outbreak in the USA caused by tainted canned soup. HACCP for safety management was endorsed by the National Academy of Sciences (NAS) in the USA in 1985, and the Codex Alimentarius Commission subsequently started using it more often globally. HACCP requirements must be implemented as a mandated system in meat and poultry slaughter facilities. Later, it was used in the production of fruit juice (Minor et al. 2017).

6. IMPLEMENTATION OF HACCP FOR FOOD SAFETY MANAGEMENT

The initial step is to initiate a hazard analysis, encompassing the development of a strategy to assess potential hazards to food safety. This requires the identification of preventive actions to manage these hazards effectively (Vu-Ngoc et al. 2018; Mureşan et al. 2020). A food safety hazard is defined as a tangible, biological, and/or chemical characteristic capable of rendering food unfit for consumption.

A critical control point (CCP) refers to any stage, process, or juncture within the production process where intervention is viable to avert or eradicate food safety risks, or at the very least, curtail them to an acceptable threshold. To establish a critical control point, the subsequent query proves valuable: during this preparation phase, is there potential for food contamination, or does the likelihood of contamination rise exist? (Mureşan et al. 2020; Maina et al. 2021).

The critical limit signifies the lowest or highest point to which a chemical, biological, or physical peril needs to be regulated at a critical control point (CCP) for the purpose of averting or eradicating the hazard, or, at the very least, diminishing it to a level deemed acceptable Supervision is essential to ensure that the process remains regulated at each critical control point (CCP). It might also be necessary to outline the monitoring procedures and their frequencies within the HACCP plan. Elements that could be considered when formulating monitoring prerequisites for CCPs comprise: the volume of products susceptible to adverse effects if a deviation arises at a critical control point; the permissible divergence from the critical limit (Lithuania 2020; Maina et al. 2021).

There are obvious indications that certain governments, such as Australia (Baines et al. 2005) and the European Union (EFSA and ECDC, 2021), view the implementation of whole chain HACCP, including primary production, as the preferred method to identify food hazards, preventing, and subsequently managing food risks. However, it should be noted that Australia and New Zealand have yet to implement required HACCP for primary production. Furthermore, the Deputy Head of Animal Nutrition, DG26 has stated that the political will to implement this in the EU appears to be under growing pressure. It is said that basic manufacturing will not be covered by HACCP. Regardless of where HACCP should start in the food chain, many countries believe that the food sector is ultimately responsible for adopting HACCP, with regulatory inspection serving at most as a means of consumer monitoring or supervision. Some governments, including those in the USA, are worried about food security because of potential terrorist operations (Azevedo 2003).

7. TREATMENT PROTOCOLS

During various handling phases, food is regularly contaminated with different pathogens. The contamination of foods by pathogens can result food poisoning which range from mild symptoms to more

significant consequences. To the best of the world's knowledge, red meats, poultry, and seafood have been observed to be more likely to result in illness than fruits and vegetables (Noor 2019).

Symptomatic treatment may be used to alleviate symptoms like pain, fever, vomiting and diarrhea. In adults with uncomplicated acute diarrhea, symptomatic therapy with bismuth subsalicylate and loperamide may be taken into consideration (Riddle 2019). Despite the fact that loperamide drug is more efficient than that of bismuth subsalicylate; it may not be advised for patients suffering from hematochezia due to the possibility of invasive illness.

Antiemetics drugs can minimize the severity and symptoms of the illness and can avoid need for hospitalization in patients who have been diagnosed with substantial vomiting (Decamp et al. 2008). Numerous studies back the administration of one dosage of ondansetron to kids experiencing vomiting due to gastroenteritis (Ramsook et al. 2002). It is reasonable to use antiemetics in adults with gastroenteritis; however, there is a lack of information on potential side effects.

Oral rehydration therapy has been shown to be successful in treating diarrhea-related dehydration. Dehydration may be prevented and treated in individuals of all ages, according to research (Guerrant et al. 2001). World Health Organization and the American Academy of Pediatrics have released guidelines that advise using rehydration treatment for mild level to severe dehydration in newborns. A combination of electrolytes and carbohydrates are present in oral rehydration solutions. Sports drinks and soft drinks can make diarrhea worse since they have a high osmolality.

Empiric antibiotics can be used if the patient is suspected for having a foodborne illness and shows symptoms of a similar disease. Inappropriate use of empiric antibiotics may increase morbidity. The standard recommendation for empiric antibiotic therapy is fluoroquinolone or sulfamethoxazole/ trimethoprim in pediatrics. Traveler's diarrhea exists globally and can be caused mostly by E. coli; it is mostly treatable using ciprofloxacin. However, the use of azithromycin can be proven to be a better option when fluoroquinolone-resistance is present (Adachi et al. 2003).

Once the laboratory findings about stool culture, bacterial toxin and microscopy are available, specific and targeted antibiotic should be recommended. In older adults, neonates, and patients with impaired immune systems, the use of targeted antibiotic therapy may reduce the severity of disease and hence bacteremia can be prevented.

8. ONE HEALTH APPROACH

There are several foodborne pathogens that contaminate poultry, but *Salmonella*, *Campylobacter* and *E. coli* are commonly known pathogens. These disease-causing pathogens are often carried in the animal's intestine asymptomatically, but they can be passed into feces and transmit to other animals, products, or humans via vectors. These vectors include birds, vermin, insects, humans handling the animals, contaminated feed and water sources, and direct contact with droppings. Through a variety of interventions including the genetic selection of animals resistant to colonization, application of various treatment protocols to prevent vertical transmission of enteric pathogens, sanitation practices to minimize the risk of contamination on the farm, disinfection of transportation vehicles, elimination of pathogens contaminating the food and water sources, food additives that make it difficult for the pathogen to colonize, and biological treatments, the contamination with foodborne pathogens in poultry has been reduced (Doyle and Erickson 2006).

9. USE OF ANTIMICROBIALS

To reduce bacterial cell count, without having an adverse effect on fertility, several antibiotics can be effective including gentamicin. However, the concentration of specific antibiotics required to prevent

bacterial growth can be harmful for fertility. To control pathogen contamination of chicks to be hatched, antimicrobial dips can be used to sanitize egg surfaces. *Salmonella* positive eggs can be treated with a single dip in the solution of hydrogen peroxide and phenol; however, three dips in the same solution could be more efficacious. The incidence of contamination with pathogens in poultry can be minimized by ensuring clean housing and proper disinfection of water supply lines and other utensils. Minimizing exposure of flocks to wild animals, restriction of traffic at farms, implementation of personal sanitation protocols and clean transport of equipment are the precautionary measures that can decrease the chances of pathogen attack. Decontamination treatment protocols can be applied on poultry transport containers, but they should be validated for their efficacy before use. Immersion of transport containers in water at 60 to 70°C temperature for 30 seconds is effective in reducing coliforms rather than using high pressure jet spray treatments (Ramesh et al. 2004).

Cross-contamination of chicken carcasses during poultry slaughter can happen because of insufficient disinfection and direct contact with infected tools. The usage of disinfectants is a popular method for lowering the danger of cross-contamination during meat processing. The disinfectants such as citric acid, lactic acid, and sodium dodecyl sulphate are tested for their efficacy against *Salmonella* and *Campylobacter* and proved highly effective, especially when used in combination (Bai et al. 2022).

10. GOOD MANAGEMENT PRACTICES

In addition to good farming and meat processing practices, strict adherence to HACCP principles, regular testing and monitoring, training of workers and consumer awareness can result in pathogen free poultry products and decreases the incidences related to foodborne infections. Strict biosecurity controls might prevent the disease from entering commercially raised flocks (Fraser Robert et al. 2010). Because *Campylobacter* is abundant in wild and domestic animals and the environment, it is critical to limit the contamination of chicken-raising units from such sources. Installing hygienic roadblocks between the outside and the inside, such as controlling farm personnel entry and strict hygienic routines such as hand washing and sanitizing, and changing boots and coveralls before entering, has been shown to be effective, but these barriers are frequently breached (Humphrey et al. 2007). Keeping optimal environmental conditions within the poultry house (air quality, temperature, or stocking density), as well as maintaining an excellent health status and implementing a novel vaccination strategy, reduce the danger of predisposing variables that often trigger E. coli infections (Barnes et al. 2008).

11. ROLE OF BACTERIOPHAGES IN FOOD SECURITY

Bacteriophages' primary role is to replicate bacteria by utilizing the genetic material and bacterial structures that they have introduced to create copies of themselves. Bacteriophages also connect to bacteria through surface receptors on the cell membrane. This permits the phage to invade the bacterial cell, causing the replication, transcription, and translation machinery to malfunction (Janez Nika and Catherine Loc-Carrillo 2013). Bacteriophages are, therefore, parasitic viruses that may be employed to target and destroy specific bacterial pathogens while leaving the surrounding microbiota unharmed. Phages have been proposed as potentially effective solutions for controlling foodborne pathogens such as *Campylobacter* (Moye Zachary et al. 2018).

12. USE OF PRO AND PREBIOTICS

However, the use of prebiotics and probiotics, such as complex polysaccharides and lactic acid bacteria strains, has shown some potential (Hariharan et al. 2004). The use of bacteriocin-producing bacteria (e.x.

Paenibacillus polymyxa) or bacteriocins has demonstrated certain potential and requires further investigation (Stern Norman et al. 2005). Probiotics and prebiotics have been shown to be effective against *E. coli* (Patterson and Burkholder 2003). Certain essential oils have also been shown to lower the amount of *E. coli* in the gut (Hammer et al. 1999). A study investigated the antibacterial activity of 16 essential oils against *E. coli* isolates derived from chicken and found that at least 5 oils had excellent activity (Ebani et al. 2018).

13. USE OF ORGANIC ACIDS

Acidifiers or organic acids can reduce the amount of *E. coli* by modifying the intestinal pH to limit the metabolism of intestinal pathogens, as well as by regulating the population of helpful bacteria (Khan and Javid 2016). Another study found that the use of a mixture of formic, acetic, and propionic acids helped to reduce the amount of *E. coli* that was resistant to the antibiotic's ampicillin, tetracycline, ciprofloxacin, and sulfamethoxazole. The risk of new hatched birds is significantly reduced by good hygienic practices in the hatchery. A basic step in reducing hatchery infections is to reject dirty eggs with a high number of coliforms on their outer shell. Spraying disinfectants over hatched eggs lowers *E. coli* contamination of the egg surface (Roth Nataliya et al. 2017).

14. GENETICISTS APPROACH

Genetic alterations were discovered in chicken after *S. Enteritidis* vaccination. To get genetic resistance against enteric pathogen infections, genetic lines have been suggested that targets genes to regulate the host's response to pathogens (Malek et al. 2004). The discovery of unique genetic procedures that regulate bacterial burden in the spleen and cecum, however, complicates this objective. *Salmonella* and *Campylobacter* have both been proved to transmit vertically from parent flocks to offspring. During semen collection, semen can be contaminated with debris, and insemination with this affected semen can transmit the pathogens in chicken and their eggs (Donoghue et al. 2004).

15. CONCLUSION

Foodborne pathogens can cause foodborne illness outbreaks in humans and pose serious threats to poultry. To stop and limit the spread of diseases along the production and processing chain, the poultry sector must put strict measures in place. To combat the spread of foodborne pathogens in chicken products, it is important to implement effective monitoring, sanitation, and hygiene procedures. To further ensure the protection and quality of chicken products before they reach consumers' plates, regular testing and adherence to food safety rules are essential. In order to remain abreast of changing foodborne risk factors, further research and breakthroughs in pathogen detection and mitigation techniques are required. The chicken business can greatly lower the occurrence of foodborne illnesses and protect public health by implementing proactive measures and remaining diligent in resolving food safety concerns.

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