items traveling between flocks, appropriate building location and structure) is an asset in the capacity to endure economically. Biosecurity should be viewed as an insurance premium for a more predictable future, not as an unnecessary expense.

Before the poultry building is constructed, planning for an efficient biosecurity program begins by choosing a location that is distant from other poultry farms, public roads, hatcheries, feed mills, rivers, and lakes that attract wild ducks and shorebirds. Vehicles and equipment used to transport feed, pullets, or dead hens between farms and poultry houses should also be cleaned and sanitized. The exterior of the cars, including the vehicle wells and wheels, should get special attention. Moving between chicken buildings should require both employees and visitors to wash their hands, use disinfectant footbaths, and wear clean apparel and boots. Animals such as wild birds, cats, and other wildlife should not be allowed inside poultry farms.

Rodent control: Rats and mice are the main reservoir and source of infection for laying hens and are biological vectors that can spread and increase the amount of Salmonella in chicken houses. Because food, water, and shelter are all easily accessible, rats find chicken houses to be the ideal places to dwell, and high rodent populations in chicken houses have regularly been linked to laying hens with *Salmonella* infections. *Salmonella enterica* infection is more common in laying hens on farms with high rodent densities when compared to hens on farms with low rodent densities. Even after cleaning and disinfecting the home, *Salmonella enterica* may remain in rat populations on a farm for at least 10 months. Rodent infestation and inadequate cleaning procedures have been linked to *Salmonella enterica* infection of consecutive flocks of chickens. Because they move around, mice and rats can transfer Salmonella from one flock to another, to the adjacent homes on the same property, and neighboring farms.

Minimizing environmental exposure: An important step to avoid infection of replacement pullets going into a previously infected house and the production of *Salmonella* affected eggs is the timely cleaning and disinfection of contaminated laying hen houses after the removal of spent chickens. The proportion of eggs contaminated with *Salmonella* and the related human illness is directly correlated with the extent of environmental contamination in poultry houses.

Salmonella contamination in chicken houses that have not been properly cleaned and disinfected may infect the following flocks that enter the houses, and the farm environment may be the main contributor to the infection of laying flocks. Salmonella in poultry buildings must be considerably reduced by cleaning before disinfection. The first step in disinfecting a layer hen house is to remove all eggs, dead and alive chickens, and moveable equipment to provide room for deep cleaning. Old feed that remains in hoppers, troughs, and feed bags, as well as feed that has caked-on troughs, should be removed by scraping since feed that is left within a building can offer food for insects and rats. If moist cleaning is employed, homes should be given plenty of time to completely dry before being disinfected. Houses need to be disinfected after cleaning with a high pressure spray, foam, aerosol, or fumigation. All disinfectant safety, dilution, and application directions provided by the manufacturer should be carefully followed.

Probiotics: Probiotics can be utilized to alter the gut's environment to prevent *Salmonella* from colonizing, invading, multiplying, and shedding. Young fowl, in which stable gut flora has not yet been established, are especially in need of this. These advantageous bacteria can occupy the intestine and actively compete with pathogen colonization, preventing it (or at least reducing it), by being added to feed or water. Probiotics are preparations or products that contain living, predetermined microorganisms in sufficient quantities to change the host's gastrointestinal micro flora and so have a beneficial effect on their health.

By competing for attachment sites on the luminal surface of enterocytes, competing for nutrients, and creating antibacterial substances, beneficial microorganisms in probiotics may prevent enteric infections (volatile fatty acids, low pH, and bacteriocins). Additionally, probiotic bacteria may impair pathogen metabolism by altering the activity of enzymes and enhancing or suppressing immunity by elevating antibody levels and macrophage activity.

Vaccination

Chickens are immunized using live, attenuated, and dead *Salmonella* vaccine. Although less frequently than might be anticipated in flocks that have not had vaccinations, flock illness and the generation of contaminated eggs may nevertheless happen. Although it has been demonstrated that immunization greatly reduces the number of chickens infected with *Salmonella* and the rate of egg transfer, these problems are not completely resolved. Additionally, maternal antibodies found in the yolk of infected eggs may inhibit the development of *Salmonella*. No vaccine is 100% effective, and poor Salmonella vaccine efficacy has been associated with inadequate rodent control, poor cleaning, and disinfection, a lack of feed or water, or environmental conditions like extreme heat. Infections with

Salmonella in humans have significantly decreased in the UK as a result of vaccination of laying flocks against the disease.

Following a challenge with Salmonella Infection, live vaccinations diminish intestine colonization, infection of internal organs (spleens, livers, ovaries, and oviducts), and quantities of contaminated eggs. Live vaccines promote cell mediated immunity, which is crucial for eliminating *Salmonella* from internal organs, as well as mucosal immunity in the digestive system. Live *Salmonella* vaccinations establishing attachment sites in a chick's digestive tract may prevent later *Salmonella* colonization because Salmonella strains can actively compete with one another for survival. In edible liquid egg contents, *Salmonella bacterins* may significantly reduce the amount of *Salmonella* cells. High quantities of circulating antibodies are induced by *Salmonella bacterins*, and both complete protection and opsonic action supplied by antibodies as well as immunity mediated by T cells and macrophages are required.

Treatment

Salmonella related gastroenteritis is often a self-limiting illness, with fever and diarrhea subsiding within 72 hours and 3 days-7 days, respectively. Therefore, the main goal of therapy should be to replace fluid and electrolyte losses. Antimicrobials should not be routinely used to treat NTS gastroenteritis that is not complex or to lower convalescent stool excretion. However, any systemic illness should be thought about receiving antibiotic medication (Kasper, 2005). At high levels, antibiotics help to prevent disease in exposed animals and to treat diseases. For the treatment of salmonellosis gentamicin (22.22%), neomycin (17.28%), oxytetracycline (11.11%), amoxicillin (6.17%), enrofloxacin (25.93%) and ciprofloxacin (17.28%) were used in poultry farms (Hossain et al, 2015).

The global overview of salmonellosis

Despite improvements in sanitation and hygiene NTS sickness continues to have a considerable negative impact on human health in both industrialized and developing nations. According to estimates, there are 93.8 million gastrointestinal illnesses caused by Salmonella species worldwide each year, resulting in 155,000 fatalities. *Salmonella enteritidis* was the most prevalent serotype globally (65% of the isolates), followed by *Salmonella typhimurium* (12%) and Newport (4), and according to data collected by Salmonella surveillance (a WHO supported food-borne disease monitoring network) between 2001 and 2005. *Salmonella Enteritidis* was the most prevalent isolate in Asia, Europe, and Latin America (38%, 87%, and 31%, respectively).

Salmonella Typhimurium was the most commonly reported Salmonella species in North America (29%) followed by *Salmonella Enteritidis* (21%) and other Salmonella species (21%), according to Majowicz (2010). *Salmonella Typhimurium* and *Salmonella Enteritidis* comprised 26% and 25%, respectively, of the isolates in Africa. Bloodstream infections with *Salmonella* species, particularly *Salmonella Enteritidis* and *Salmonella Typhimurium*, are more frequently linked to NTS in Sub-Saharan Africa than with Salmonella typhi or paratyphi, according to hospital-based studies.

Status of salmonellosis in Ethiopia

About 56 million chickens exist in Ethiopia, the majority of which (95%) are kept in low input, low output village chicken farming systems. Together with providing eggs and meat, chickens are a significant source of income for poor smallholder households. Ethiopia consumes 0.5 kg of eggs annually per capital, which is significantly less than the average sub-Saharan African country consumption of 2.3 kg.

Salmonella isolates in Ethiopia may have similar phenotypic and genotypic characteristics to isolates elsewhere in the world. NTS enteric infection in Ethiopia is a major health problem and is caused by similar serovars to those reported from elsewhere in Africa. Different studies indicated the widespread occurrence and distribution of Salmonella in Ethiopia and the resistance of the isolates to antimicrobial agents. In recent years the number of outbreaks of *Salmonella* in humans has increased considerably in the country (Table 1).

Table 1. Prevalence of *Salmonella* from different poultry samples in different sites of Ethiopia.

Sample type	Site	Prevalence
Chicken carcasses	Addis Abeba	14%
Egg contents and egg shells	Kombolcha	11.50%
Poultry	Jimma town	41.90%
Eggs	Addis Abeba	4.69%

Egg contents and egg shells	Alage, Ziway, and Shashemene	13.30%
Egg shell	Haramaya	0%
Cloacal swabs, fresh feces, litter, and poultry drinking water	Modgo, Centeral Ethiopia	19.40%
Cloacal swab, personnel hand swab, bedding	Northern Ethiopia	16.70%
Poultry	In and around Addis abeba	14.60%
Cloacal swab	Jimma town	2.41%
Chicken cloacal swab	Asosa	22.65%
Poultry	Kafa zone	9.27%
Feces, eggs, and meat	Central Ethiopia	16.15%
Poultry	Addis Ababa	15.50%

Public and veterinary health importance of chicken eggs

Chicken eggs are a good source of protein. All age groups consume them, either alone or combined with other foods like fried potatoes (chips). Despite their nutritional values they can as well cause health problems through consumption of contaminated eggs with pathogenic Salmonella spp. In developing countries cracked and fecal contaminated eggs are being sold at a low price and consumed which can act as risk factors to acquire Salmonella illness. Eggs are of economic importance based on poultry industry production which can rise farmer`s income worldwide. The intact egg has natural physical and chemical barriers which inhibit pathogens from entering into egg contents. Eggs contain antimicrobial components, however various bacteria, including Salmonella, can infect them, having adverse effects on both animal and human sectors. Salmonellosis, a zoonotic infection, is thought to be mostly transmitted between chickens and humans.

DISCUSSION

Public health significance of salmonellosis

One of the most commonly seen outbreaks of a food borne illness, salmonellosis is especially prevalent in developing countries such as India, Asia, and Africa. Due to its large morbidity and fatality rates, high endemicity, difficulties in adopting controls, and other factors, salmonellosis poses a concern to public health. There are approximately 93.8 million occurrences of gastroenteritis worldwide each year, making it the most prevalent type of NTS infection. Since outbreaks of salmonellosis have frequently been linked to poultry, including chicken products like eggs, the disease's major cause is usually recognized to be poultry.

Salmonella Enteritidis phagotype 4 was implicated in several outbreaks of food-borne illness in England during the 1980’s, which were brought on by the consumption of foods containing poultry ingredients. This raised concerns about the presence of *Salmonella* species in foods derived from poultry, which led to an increase in awareness of the problem. Typhoid, paratyphoid, and NTS are the three different infections that can be caused by the infectivity of *Salmonella* in humans. Typhoid and para typhus fever are caused in humans by this illness. *Salmonella* Typhi and *Salmonella* Paratyphi is a pathogen that causes fever as well as symptoms in the form of leukopenia, septicemia, and immunological and neurological abnormalities. Complications from typhoid and paratyphoid may result in death. In the reverse, *Salmonella enterica* serovar Typhimurium, *Salmonella enterica* serovar enteritidis, *Salmonella enterica* serovar Newport, and *Salmonella enterica* serovar Heidelberg, cause gastroenteritis-limited, non-typhoidal infections of Salmonella, with clinical sign of nausea, vomiting, diarrhea, and bacteremia, but not lethal.

The chicken industry now places a high priority on preventing the spread of *Salmonella* spp. through food because of the potential effects on public health. Salmonella contamination in eggs and poultry is the main cause of salmonellosis, a common intestinal disease in humans. Salmonella is one of the diseases that have the most effect on population health, according to WHO, and is linked to outbreaks and sporadic occurrences of food borne illness. According to data from the Brazilian ministry of health, 43% of the 6,602 food borne disease outbreaks that were observed between 1999 and 2008 had Salmonella spp. as the etiological agent.

Economic significance of Salmonellosis

The modern world is interconnected and dependent on one another. As a result, localized outbreaks of food-borne illness are now a potential global concern. A contaminated food item can have an impact on people's health

simultaneously in numerous nations due to globalization, trade, and distribution. One contaminated food ingredient may cause the destruction of literally tons of food, significant financial losses for the industry that produces it, trade restrictions, and negative consequences on the travel and tourism sector.

Salmonellosis is a significant socioeconomic issue in many countries, especially poor countries, where it is believed that this etiological agent is mostly to responsible for outbreaks of food-borne illness. The bacteria can have an immediate negative impact on producers or farmers, either directly or indirectly. These illnesses have a number of negative effects as well, such as productivity losses for poultry farms (such as production losses, treatment costs, market disruptions, and loss of income from activities involving poultry resources), infection of humans (morbidity, food safety and quality), prevention or control costs (public expenditure), and less than optimal use of production potential. In 2010 alone, the annual costs associated with salmonellosis were estimated at US$2.71 billion for 1.4 million cases. Similarly, in the US, the estimated costs of medical expenses, sick leaves and loss of productivity related to the high incidence of salmonellosis ranged from US$1.3 to US$4.0 billion a year.

CONCLUSION

The NTS especially serovars Typhimurium, Enteritidis, Heidelberg and Newport have been reported in many outbreaks of human salmonellosis around the globe and these outbreaks have been linked with consumption of *Salmonella* contaminated foods of animal origins such as poultry. NTS like many other enteropathogenic bacteria has evolved in utilizing a variety of virulence markers and other cellular machinery to colonize the host by attaching, invading and bypassing the host's gastrointestinal defense mechanisms. The spread of *Salmonella* is very widespread and persistent in the environment, it increases the difficulty in reducing the spread of *Salmonella* spp. it can even cause death in humans and animals. Apart from this, the emergence of antibiotic resistance in Salmonella is a major challenge in terms of effective treatment for the Salmonella infection. Limiting the use of antibiotics in feed is an effective measure to stop the spread of antibiotic resistance in poultry production.

RECCOMENDATION

Therefore, based on the above conclusions, the following recommendations are forwarded:

- It is recommended that Intervention tools that help prevent introduction of *Salmonella enteritidis* in to the poultry production facility include biosecurity, procurement of *Salmonella enteritidis* free replacement flocks, and keeping disease vectors out of the houses should be made
- Factors related to flock contamination are generally linked to biosecurity measures and the design of the premises where they are controlled, thus preventing the introduction, survival, and multiplication of germs or their vectors in poultry should be embraced
- The public should be made aware of risks associated with consumption of raw chicken eggs and raw eggs cracked during storage and transportation.
- Awareness creation for chicken farmers about improving farming practices and the risks of antimicrobial resistance demands special attention.

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