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Review Article

Effect of Salmonella on Hatchability and Fertility in Laying Hen, an Assessment

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Abstract

Salmonella infection is not only infecting poultry but also emerging as a pandemic in public health. Salmonella affecting poultry are *S. pullorum*, *S. gallinarum*, *S. typhimurium*, which are collectively categorized under *S. enterica*. It causes a systemic infection in poultry birds primarily gastroenteritis with colonization of bacteria in liver, spleen, intestines, ovary, oviduct and vagina. Poultry eggs are more importantly contaminated with salmonella infection that originate from transovarian route (vertical route) or from contaminated hen house (horizontal route). In severe cases Salmonella causes a decrease in egg production, reduction in fertility and low hatchability of infected eggs. Albumin, yolk and other shell contents get contaminated with bacteria. They serve as source of nutrition for micro- organisms. Hatcheries and egg storing places also present risk of Salmonella contamination. They possess bacterial micro flora that may contaminate eggs before they are processed or set in the incubator. More simply the decrease in hatchability of eggs occurs due to persistence of Salmonella infection in hen reproductive tract. In this review, some of such features are discussed that included in manifestation of Salmonella infection.

Key Words: *Salmonella*, Hatchability, Fertility, Eggs, Route of transmission

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Introduction

Salmonella infections of poultry are categorized mainly as three types; *Salmonella pullorum*, *Salmonella gallinarum* and *Salmonella typhimurium*. *Salmonella* is transmitted by horizontal as well as vertical route. Bacterial transmission is reported may be due to transmission through ovule [1] and later by contamination of egg just after ovulation from salmonella excreting hens [2-7]. As egg once laid is wet, warm and prone to microbial transferring into shell [7]. *Salmonella* when passed in the egg shell and egg shell membranes it is rather difficult to restrict further entry of salmonella into the contents or developing embryo (8). It may be ingested by the embryo [9] or may grow and spread in the cabinet [8]. This leads to production of a bird that spreads the bacterial contamination to the body organs like intestines, feathers etc of other birds [10]. Simply a *Salmonella* contaminated egg is responsible for vertical transmission of infection to the chick [11] and hatching of that contaminated egg causes horizontal transmission of infection to the mates [9, 12]. However, ovary infection with motile *Salmonella* after systemic infection is rarely seen [13].

Salmonella is concerned contaminant in broiler breeder eggs [14]; however the outcomes may be affected by some characteristics like breed or line [15-17]. Salmonella infection signs may be shell-less, infertile eggs with early embryonic mortality [18, 19]. Persistent fecal shedding of S*almonella* is also seen in past after inoculation [20-24].

Infection susceptibility of chicks is age dependent, similarly day-old chicks are most susceptible due to their frail immune system [25-28]. The presence of cracked shelled eggs in those hatcheries brings problem of penetration of Salmonella into the eggs. In this way, single eggs causes contamination of whole batch at the time of hatching or whenever it is broken during incubation period. S*almonella* starts multiplication when it is inside an egg and keeps multiplying as long as there is integrity of vitelline membrane and it may die during the storage [29, 30]. However, it may survive if it is provided with high relative humidity [30] accompanied with low temperature [30-32] A mortality of 10-93% is observed in chicks [33], while morbidity may be much more than the mortality [1]

Routes of egg contamination by *Salmonella*

Many studies indicate that ovary is more often colonized by *S. enterica* than other parts of reproductive system e.g. oviduct [34]. *S. pullorum* and *S. gallinarum* also colonize in the ovary [35, 36]. Additionally S*almonella* can escape from the immune system of the hen by perhaps colonizing inside the cells of tract [37] and follicles as well [38]. *Salmonella* is found to colonize the oviduct tissue [38-40]. It is indicated that this is the area most frequently contaminated by *Salmonella*, while talking about oviduct colonization [41]. Vagina when experimentally inoculated by *Salmonella* caused high level of bacterial contamination because *Salmonella* has a great affinity for attachment to the vaginal epithelium [42]. *Salmonella* attachment to isthmus and magnum also showed problems of contamination by invading tissue cultures of these organ epitheliums [43]. It has special affinity for magnum as well, which reinforce the hypothesis that contamination of egg is by contamination of egg contents [albumin] [44].

However, experiments have showed that high levels of colonization do not give rise to high level of contamination [45]. It demonstrates that *Salmonella* when infects egg before it is laid, infection is transferred to the hatchling [46]. Some researchers claim that horizontal transmission to be most important [47, 48], meanwhile some call vertical transmission to be important [22, 42, 49]. Some researchers also suggested that *Salmonella* transmission to farms also took place by vertical transmission [50-52].

Effect of *Salmonella* on hatchability

In freshly laid contaminated eggs there is small number of bacteria [53-57]. In contaminated eggs the most frequent site of contamination is outside of vitelline membrane [58]. When *Salmonella* infected eggs are incubated, there is an increase in proliferation of microorganism [59] but there is no change in color, consistency and smell of the infected egg when kept at room temperature [60]. *Salmonella* infection signs may be shell-less, infertile eggs with early embryonic mortality [19]. It has been observed that fowl typhoid or salmonellosis is associated with mortality, morbidity, decreased growth rate and poor hatchability and fertility in birds [61, 62]. Another study showed that a high mortality observed in young birds was associated with *Salmonella* [63]. If *Salmonella* is transmitted during incubation there may be unpipped or pipped with dead chick eggs [64]. Horizontal transmission of *Salmonella enteritidis* occurs during hatching, it cause infection from dust, litter, fecal of chicks [65].

Bruce and Johnson reported that infection increases as the flock hatching age increases [66]. But susceptibility of chicks to *Salmonella* colonization decreases post 1 week of hatching [26, 67]. Kim et al reported that *Salmonella enteritidis* was recovered from yolk of contaminated eggs and ovary of breeder hens [13]. But small number of micro-organisms does not start multiplication inside the albumin [68].

The newly hatched chicks are gnotobiotic and are vulnerable for *Salmonella* infection [69]. Research has shown contamination of ovaries, dead embryos, hatched chicks with high mortality can be due to other serovars of *Salmonella* other than *Salmonella gallinarum-pullorum* [70]. Similarly a study on *Salmonella* serotypes showed that *Salmonella harder* and *Salmonella Kentucky* which are adapted in the intestinal environment are also found in hatcheries. They contaminate the hatcheries and horizontal transmission is followed by their contamination. This study also reveals that an infection from these serotypes is found in day-old chicks when they hatched from contaminated eggs [71] it can initiate during hatching [9]. Bacteria can be isolated from hatchery fluffs and meconium of day old chicks [72].

Erbeck et al suggested *Salmonella* infection as systemic disease with signs and symptoms and drop in egg production, decreased fertility and reduced hatchability of eggs in pullorum disease [PD] and Fowl typhoid (FT) all depending on severity [73]. Usually the infection originating in hatcheries is not coming from egg shells but contamination of hatchery environment after the hatching of infected egg is thought to be most acceptable. As the fan driven air in hatchery causes movement of *Salmonella* from infected eggs to the non-infected eggs [9, 74]. When these infected chicks become pullet, they also produce infected eggs [75].

Effect of S*almonella* infection on fertility

Salmonella enteritis is not always associated with effecting badly on fertility in hens rather infection of *S. enteritidis* may support its vertical transmission [76, 77]. *Salmonella* is recovered from the ovaries and oviduct in the layer flock [75]. A study to understand the causes of early embryo and chick mortality in Nigeria was conducted, which concluded Omphalitis is associated with infection, probably *Salmonella* or *E.coli* [71]. According to study conducted by Seneviratna [1969] and Okoaeme [1983] concluded that *S. pullorum* infection is a cause of unfertile eggs [78].

The birds infected with *Salmonella* serotypes such as *S. enterica* serovar *pullorum* and *S.enterica* serovar *gallinarum* are characterized by weight loss, decrease in egg production and high mortality [79, 80]. The production of egg by infected bird is said to descend infection from ovarian tissue. Experimental infection of poultry birds showed that if egg production was depressed, then the eggs produced were also contaminated [24]. Wigley *et al* showed by experimental inoculation that *Salmonella pullorum* contaminated eggs when reached maturity, they produced *Salmonella* contaminated eggs. Some studies regarding susceptibility of *Salmonella* infection showed brown shelled egg layer hens are more susceptible than white egg shell producing hens [16, 17]. Erbeck et al suggested *Salmonella* infection in hens as drop in egg production, decreased fertility of eggs in pullorum disease and Fowl typhoid all depending on severity [73].

Conclusion

Salmonella is a cause of many serious infections in poultry as well as other avian species involved in heavy economic losses to the industry causing decrease in

production by poultry industry through illness and mortality. There is a need of *Salmonella* screening in poultry farms and hatcheries as *Salmonella* presents potential hazard to the industry. There is a need of *Salmonella* monitoring of eggs using a system by which layer birds are to be tested for any infection. Also hatcheries play a role as the check point in avoiding infection in production cycle [81]. Leaving the floor eggs and strict hygiene of the nests at the farm is necessary to reduce the bacterial load which is a hazard for personal and equipment safety [82, 83]. Secondly hatcheries should show compliance with rules as described in appendix 3.1.4 of the *OIE Terrestrial Animal Health Code* (1) (or equivalent) so that hazards from *Salmonella* can be minimized that will assure the health of flock [84].

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