**CHAPTER I**

**INTRODUCTION**

Poultry especially layers are essential to the national economy of Bangladesh. It fulfills the demand of protein sources of human being. Infections with bacteria of the genus salmonella are responsible for a variety of acute and chronic diseases in poultry (Gast, 1997). Salmonellosis has an increasing presence in both poultry and people. It often consists of colonization of the intestinal tract without any overt sings of diseases, and once infection has occurred many of the birds excrete salmonella and contaminate the environment (Poppe, 1996). Several constraints, the diseases, poor husbandry, low productivity and shortage of food affect, the optimal performance of this industry in Bangladesh (Haque *et al.,* 1991). With the great expansion of poultry rearing and farming, Salmonellosis is the most devastating disease in Bangladesh (Begum *et al*., 1993 and Haque *et al*., 1991).

 Whereas, fowl typhoid is a disease of mature chickens and causes either acute enteritis with greenish diarrhea or a chronic disease of the genital tract that reduces egg production (Proux *et al*., 2002). Poultry has high economic significance as commercial layers, breeder flocks and also as the local chickens (Douglas and Alice, 1993). The incidence of , Salmonellosis of Bangladesh was found to be 9.28% by ( Bhattacharjee *et al.,* 1996). Village chickens can act as a reservoir of Salmonellosis, and thus a prophylactic campaign must take them into account (Bouzoubaa *et al.,* 1992). The epidemiology of Salmonellosis in poultry, particularly with regard to transmission from one generation to the next is known to be closely associated with infected eggs (Wigley *et al*., 2001). Although more than 2300 serotypes of salmonella have been identified, only about 10% of these have been isolated from poultry (Gast, 1997). Salmonellosisis usually confined to the first 2-3 weeks of age and occasionally occurs in adults (Shivaprashad, 1997). With considering the above situations the present study carried out with the following objectives-

1.To estimate the prevalence of Salmonella in layer birds.

2.To determination of the rate of mortality due to the infection of salmonella.

**CHAPTER-II**

**REVIEW OF LITERATURE**

**Poultry background in Bangladesh:**

Poultry, namely domestic chickens, ducks, turkeys, gees and guinea fowls are kept throughout the world. In Bangladesh, Poultry production system is divided into two types, the traditional and commercial production system (Haque, 1991). The indigenous hens of the traditional system have small body size of around 1,149g and produce 45 eggs per hen per year. The commercial poultry production system is practiced mainly in urban areas (Haque *et al.,* 1991). The traditional chickens are kept by more than 80% of the rural people ( Hossain *et al*., 1992 ). The government poultry farms offer a pioneer model to the beneficiary for improving the poultry rearing by delivering day old chicks produced from cross bred, which is somewhat adapted to local climatic condition (Hossain *et al.,* 1992).

**History of Salmonella**:

The genus salmonella (of the family Enterobacteriaceae) named for The eminent United States Department of Agriculture (USDA) veterinarian and Bacteriologist Daniel E. Salmon, consist of more than 2300 serologically distinguishable variants (Gast, 1997). Towards the end of the 19th century, infectious Enteritis causing havvy mortality in chicken was described in Europe and North America Initially the causal agent was called *Bacillus gallinarum* and the name Fowl Typhoid was applied in 1902 (Shivaprashad, 1997*). Salmonella pullorum* was first isolated from chicks suffering from severe diarrhea and was described by Rettger and Stoneburn in 1909. The disease had been previously known as Bacillary White Diarrhea (BWD), but as white diarrhea is not always a clinical feature, it becomes known Pullorum Disease.

**Etiology of Salmonellosis in poultry:**

The disease is caused by Gram negative bacteria known as *Salmonella pullorum*. The organism belongs to a family known as enteribacteriaceae. Organism is non motile and Looks like slender rod measuring 0 .3-0.5 × 1-2.5 µm. It is non -liquefying, nonchromogenic, nonsporogenic facultative anaerobe.

It grows on beef agar or broth very readily. MacConkey agar can be used for growth. The organism is non - lactose fermenter. The organism is resistant to heat and many chemicals. Unsuitable environment the organism can survive for couple of years. The organism contains a thermostable toxin**.** *S. gallinarum - Pullorum*, other Salmonellae such as *S. enteritidis, S. panama* and *S. dublin* also belong to the serogroup D1. The various motile and non-host adapted highly invasive serotypes such as *Salmonella enteritidis* and *Salmonella typhimurium* are commonly referred to as paratyphoid salmonellae (Gast, 1997).

**Epidemiology and Geographical distribution:**

Salmonellosis is a serious systemic disease of domestic poultry which may cause large scale economic losses through mortality, morbidity and reduction in egg production. The disease occurs sporadically or enzotically in most countries of the world including Bangladesh. It causes severe economic loss of the poultry with morbidity and mortality varying. In chicken, from 10-12% or more. Salmonellosis is distributed in many countries of the world and economic significance. They are mainly distributed in Latin America, the Middle East, the Indian subcontinent, Africa and perhaps other parts of the world (Shivaprashad, 1997, Bouzoubaa *et al.,* 1992). Salmonellosis has also been reported in many countries of South – East Asia including Bangladesh. (Bhattacharjee *et al.,* 1996 and Begum et al., 1993 ) and Nepal (Jha *et al.,* 1994). Salmonellosis is a common in both backyard chickens and in commercial poultry (Fricker, 1987).

**Mode of transmission of Salmonella spp**:

The infection spreads in two ways (a) Vertical Transmission and (b) Horizontal transmission. The vertical transmission takes place through the infected eggs. extensive dissemination of infection may occur during hatching from infected embryos to non infected chicks. The horizontal transmission takes place through contaminated utensils, contaminated water, contaminate feed, diseased pullets, dead embryos, dead chicks, infected eggs, of infected birds, egg eating, visitors rodents and Flies etc **(**Shivaprasad, 1997).

**Host affected:**

Almost all outbreaks in the UK have been chickens but in countries, notably the USA, serious incidences with heavy mortality have occurred in turkey flocks. Salmonella enteric is a facultative intracellular pathogen that is capable of causing diseases in a wide range of hosts . Although more than 2300 serotypes of Salmonella have been identified, only about 10% of these have been isolated from poultry (Gast, 1997). Strains of non-host adapted serovars result in intense colonization and invasion of the host than simultaneously administered adapted serovar (Steinbach *et al*., 2000). It can also promote adherence and spreading of the agent in the adequate host and is therefore of little public health significance **(**Shivaprasad,1997).

 **Age of birds those are more prone to Salmonella infection:**

Salmonellosis is a peracute, acute or chronic form of disease affecting mostly adult chickens, whereas affects the very young chickens, mostly 2-3 weeks of age. In the adult it tends to be chronic (Shivaprasad, 1997). Salmonellosis is frequently referred to as a disease of adult birds. Still, there are also reports of high morbidity and mortality in young chickens (Hall *et al*., 1949). *Salmonella gallinarum* can produce lesions in chicks, which are indistinguishable from those associated with pullorum disease (Shivaprasad, 1997). A certain percentage of chickens that survive from the initial infection become carriers with or without presence of clinical signs and pathological lesions.

**Mortality rate due Salmonellosis:**

Salmonella is a poultry pathogen of considerable economic importance. (Lowry *et al.,*1999) reported that approximately 68% mortality might occur as a result of horizontal transmission in non-treated contact chicks. One of the characteristic features of salmonella infection is that it can persist for prolonged periods in absence of clinical disease and mortality from Salmonellosis may vary from 0-100%, depending on the severity of infection, age, strain susceptibility, nutrition, flock management and characteristics of exposure (Wigley *et al.,* 2001, Shivaprashad, 1997). Mortality may also vary from 10-93% due to salmonellosis (Hall *et al.,* 1949). Embryo mortality increases by 16.18% (Tran and Dao, 2000) Which mainly occurs between 7 and 14 days of incubation. Salmonella was isolated from 8.33% of the chickens that died at a young age (Tran and Dao, 2000).

**Pathogenesis and Pathogenecity:**

The pathogenecity of salmonella depends on the invasive properties and the ability of the bacteria survive and multiply within the cells, particularly macrophages (Humbert and Salvat, 1997). The principal site of multiplication of these bacteria is the digestive tract, which may result in widespread contamination of the environment due to bacterial excretion through feces. Following invasion through the intestinal mucosa, caecal tonsils and peyer”s patches, the organisms are taken up by macrophages, and through the blood stream and/or lymphatic systems, they spread to organs rich in reticuloendothelial tissues (RES), such as liver and spleen, which are the main sites of multiplication (Barrow et al., 1994). In case of inadequate body defense mechanism, they may lead to second invasion and be localized in other organs, particularly ovary, oviduct, myocardium, pericardium, gizzard, yolk sac and/or lungs (Barrow, 1993).

**Clinical signs:**

Clinical signs in chicks and poults include anorexia, diarrhea, dehydration, weakness, and high mortality. In mature fowls, Salmonellosis is manifested by anorexia; drop in egg Production, increased mortality, reduced fertility and hatchability. Salmonellosis infected adult birds may or may not exhibit any clinical signs, or they cannot be detected by their physical appearance. In growers and adults, watery to mucoid yellowish diarrhea is the most characteristic clinical signs in the phase of the disease. In addition to these , progressive loss of body weight reduced feed consumption and egg production, ruffled feathers, shrunken pale combs and wattles are the characteristic signs (Wray, 1996). The chicks exhibit lassitude, huddle together, have droopy wings, pasted vent, labored breathing and distorted body appearance Shivaprasad, 1997).

**Post mortem lesion:**

Salmonellosis can produce lesions in chicks which are indistinguishable from those associated with pullorum disease (Pomery and Nagaraja, 1991). In per acute cases, the birds usually die without showing the pathological lesions, and in acute cases, The most common changes are septicemia, enlarge liver and spleen with necrotic Foci. Liver usually turns into bronze colored shiny appearance of the surface (Pomery and Nagaraja. 1991). Pullorum disease established in adult birds seldom Produces signs of an acute infection. Gross lesions due to Salmonellosis in chicks and poults include hepatitis, splenitis, typhilitis, omphalitis And peritonitis (Shivaprasad, 1997). In mature fowls, lesions include Oophoritis, salpingitis, Orchitis, peritonitis and perihepatitis (Shivaprasad, 1997). Misshapened, discolored, pedunculated, cystic ova with various forms of pericarditis and peritonitis, swelling of the hock joints and nodular heart muscles resembling the neoplastic disease, Are frequently evident in chronic cases (Wray *et al*., 1996). Yolk sac contents may be of creamy or caseous consistency (Wray *et al*., 1996). Grey nodules in one or more of the following sites: lungs, liver, gizzard wall, heart, intestinal wall, peritoneum etc. along with bronze discoloration (Samad, 2005). On necropsy, muscle degeneration or necrosis, hepatomegaly, spleno-megaly, airsacculitis, gastroenteritis and nephropathy. Numerous yellow necrotic foci are often present in organs (Altman *et al*,. 1997).

**Diagnosis:**

 Fowl typhoid and pullorum disease cannot be differentiated clinically or pathologically From other systemic diseases. Serological findings are not adequate for definitive diagnosis, but can play a major role in detecting the disease (Snoeyenbos, 1991). And are valuable for tentative diagnosis (Wray  *et al.,* 1996). Definitive diagnosis depends on the isolation and identification of organisms.

**Treatment:**

 Rahman (1995) Observed 100% efficacy followed furaltadone administration against salmonellosis in chicks. Numerous reports have indicated the effectiveness nitrofurans in the treatment of Salmonellosis. Sulphaquinoxaline at 0.1% in the feed can be used for 2-3 days, and 0.05% in feed for 10 days, chlorotetracycline at a 200 mg/kg level in the feed, the aminoglycoside apramycin for a 5 days treatment at either 150-225 mg/L in drinking water was effective In reducing in morbidity and mortality.

**Prevention and control:**

Effective prevention requires that breeding stock is free of salmonella infection to prevent vertical transmission through the egg to progeny. Exposure must be preventedIn the hatchery and throughout the flock by high standards of management and flocksecurity. The best efficacy in a salmonella control programme may be expected by a simultaneous implementation of monitoring, biosecurity, vaccination and the correct choice in feed additives. The dead birds need to be well disposed. Adequate precautions are needed to prevent infections from mechanical carriers like footwear, human clothing, hatchery displines,equipments, litters, crates, trucks and processing plants (Christensen  *et al.,* 1994).Wray *et al.,* (1996) Described that the birds need to be tested at the age of 16 weeksdue to immunologic maturity, at the point of lay due to stress and two consecutive times one month apart to provide the acceptable evidence that the flock is free from Salmonellosis (Barrow, 1993).

**CHAPTER-III**

**MATHODOLOGY**

**A. Study area and Location:**

The study was carried out at Shahedul Alam Quaderi Teaching Veterinary Hospital (SAQTVH), Chittagong Vaterinary And Animal Sciences University(CVASU), Chittagong.

**B. Study Population:**

The total sample size was 5220 based on the previous case, record sheet from SAQTVH Chittagong Vaterinary And Animal Sciences University(CVASU), Chittagong.

.  **Clinical Data Profile:**

The cases were defined in the study of salmonellosis by observing clinical signs such as drowsiness, inappetance, weakness, diarrhea (white feces), ruffled feather, pale comb and wattle.

**D. Postmortem data profile:**

After postmortem Examination, the cases were defined by observing postmortem Lesions such as unabsorbed yolk, Misshapen ova, greenish coloration of liver, hemorrhage in intestine, enlargement of liver.

**E. Data Entry and Analysis:**

The obtained data were imported and stored in the Microsoft Excel-2007 and analyzed by STATA 11.

**CHAPTER IV**

**RESULTS**

**Estimation of total birds suspected as Salmonella brought in SAQTVH:**

Overall statistics of birds brought in SAQ teaching Veterinary Hospital for treating as Salmonella suspected cases during 2010-2013 shown in table 1. The birds were assigned in three groups based on the age in months (1-4 months, >4-8 months >8-12 months). Total 5220 birds were enrolled for examination and after examining clinical signs and postmortem lesions 255 birds were tentatively diagnosed as a Salmonella infection. In brief, the number of birds enrolled for treatment as 2500 at 1-4 months , 1560 at >4-8 months, 1220 at > 8-12 months and the number of birds treated as suspected salmonella cases were 115 at 1-4 months, 85 at >4-8 months and 55 at >8-12 months of age respectively.

**Table-1: Overall statistics of affected birds treated in SAQ teaching Veterinary Hospital from 2011-2013**

|  |  |  |
| --- | --- | --- |
| **Group (Age in Months )** | **Number of birds enrolled for treatment** | **Number of birds treated as suspected salmonella case** |
| I (1-4) | 2500 | 115 |
| II (>4-8) | 1560 | 85 |
| III (>8-12) | 1220 | 55 |
| Total | 5220 | 255 |

**Rate of mortality among suspected cases:**

Out of 255 Suspected salmonella cases 92% was confirmed based on clinical, post-mortem and laboratory tests represented in table 2. Among these groups, 43 % of birds placed in group II which was higher than group I and II.

**Table-2: Prevalence estimation based on clinical and postmortem findings:**

|  |  |  |
| --- | --- | --- |
| **Group (Age in Months )** | **Salmonella infected case** | **Mortality %** |
| I (1-4) | 36 | 39.14 |
| II (>4-8) | 43 | 46.73 |
| III (>8-12) | 13 | 14.13 |
| Total | 92 | 100.00 |

**Estimated value for making relationship among age, clinical signs and postmortem manifestations:**

A total of 40 cases were found positive for salmonella infections among 100 suspected cases based on white feces which is shown in table 3. Of them, 23% of birds were in group I. The least percentage was estimated for group III, which was 4%. There was found significant relationship between age and disease (white feces) (p<0.05). Besides, 48 cases were treated as Salmonella infections after post mort examination and special emphasis given on yolk (Unabsorbed yolk) which is presented in table 4. Unlike white feces in group I most of the birds tabulated in group II in case of unabsorbed yolk, that accounted for 30% among >4 to 8 months of birds. There was also found statistical significant (p<0.05).

**Table-3: Estimation of probable relationship between age and Salmonella positive case (white feces) of the diseases:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Group (Age in month)** | **White faces** | **Total (%)** | **Chi2 test** | **P value** |
| **Yes** | **No** | 7.50 | 0.023\* |
| I (1-4) | 23 (23.00) | 18 (18.00) | 41 (41.00) |
| II (>4-8) | 13 (13.00) | 32 (32.00) | 45 (45.00) |
| III (>8-12) | 4 (4.00) | 10 (10.00) | 14 (14.00) |
| Total | 40 (40.00) | (60.00) | 100 (100.00) |

Figure in the parenthesis indicate percentage, \* Significant at p<0.05

**Table-4: Estimation of probable relationship between age and Salmonella positive case (Unabsorbed yolk) of the diseases:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Group (Age in month)** | **Unabsorbed yolk** | **Total (%)** | **Chi2 test** | **P value** |
| **Yes**  | **No**  | 11.49 | 0.003\* |
| I (1-4) | 13 (13.00) | 28 (28.00) | 41 (41.00) |
| II (>4-8) | 30 (30.00) | 15 (15.00) | 45 (45.00) |
| II (>8-12) | 9 (9.00) | 5 (5.00) | 14 (14.00) |
| Total | 52 (52.00) | 48 (48.00) | 100 (100.00) |

Figure in the parenthesis indicate percentage, \* Significant at p<0.05

**CHAPTER-V**

**DISCUSSION**

Concerning to the prevalence depending on the ages, The birds were assigned in three groups based on the age in months (1-4 months, >4-8 months >8-12 months). Among these groups, 46.73 % mortality found in group II which was higher than group I and II. There was also found statistical significant (p<0.05).

 Sikder *et al*., (2005) who reported the highest *Salmonella* infection was 30.8% at 39 weeks of age and the lowest was 13.3% at 32 weeks of age and Truong *et al*. (2003) reported that the prevalence *of* Salmonella infection increased with the increase of age.

Mdegela *et al.,* (2000) also recorded that the higher prevalence of Salmonella infection in commercial flocks (18.4%) than in scavenging chickens (6.3%) and infection rate increased with the increase of flock size. . Lowry *et al.,* (1999) reported that approximately 68% mortality might occur as a result of horizontal transmission in non-treated contact chicks.

However the relationship among age, clinical signs and the postmortem manifestations was 23% in group I, 13% and 4% in group II and III respectively and P<0.023\* ( Significant at p<0.005). So the Salmonella positive case highest at 1-4 months of age and lowest at >8-12 months of age. Similar report was demonstrated by Hall *et al*.,( 1949). Where they reported that the high morbidity and mortality in young chickens due to Salmonella infection and Paiva *et al.,* (2009) reported that the Mortality caused by SG may be higher than 80% in broilers and may reach almost 100% in inoculated young brown layers Shivaprasad, (1997) reported that the *Salmonella gallinarum* can produce lesions in chicks, which are indistinguishable from those associated with pullorum disease

**CHAPTER-VI**

**CONCLUSION**

 From the above discussion, we can conclude that, salmonellosis is a disease of major economic importance or significant cause of mortality in the national poultry flock. *Salmonella enteritis* has given cause for concerned to the industry because of the loss of consumer confidence and legislation. It is an alarming situation for poultry farms in the whole country.

**CHAPTER-VII**

REFERENCES

**Altman, R.**B., Clubb, S.L., Dorrestein G.M., and Qvesenberry K. (1997). Avian Medicine & Surgery, 1st Edition, W.B. Saunders Company, Philadelphia, pp.269-273.

**Bouzoubaa, K.; Lemainguer, K. and Bell, J.G. 1992.** Village chickens as a reservoir of Salmonella pullorum and Salmonella gallinarum in Morocco. Preventive Veterinary Medicine. 12: 95-100.

**Barrow, P.A 1993.** Salmonella control- past, present and future. Avian Pathology. 22: 651-669.

**Begum, F.; Khan, M. S. R.; Choudhury, K. A.; Rahman, M.M. and Amin, M.M. 1993.** Studies on immune response of chickens to fowl typhoid vaccines. *Bangladesh Journal of Microbiology. 10: 51-56.*

**Barrow, P.A.; Huggins, M.A and Lovell, M.A. 1994.** Host specificity of salmonella infection in chickens and mice is expressed in vivo primarily at the level of the reticuloendothelial system. Infection and immunity. 62:4602-4610.

**Bhattacharjee, P.s. ; Kundu, R.L.; the Mazumder, J.U.; Hossain, E. and Miah, A.H. 1996.** A retrospective analysis of chicken diseases diagnosed at the Central Disease Investigation Laboratory, Dhaka, Bangladesh. Bangladesh Vet. Jr. 30: 105-113.

**Christensen, J.P.; Skov, M.N.; Hinz, K.H. and Bisgaard, M. 1994.** Salmonella enteric biovar gallinarum in layers: epidemiological investigations of a recent outbreak in Denmark. Avian Pathology. 23:489-501.

**Douglas, W.W. and Alice, M.H. 1993.** Isolation of Salmonella from chickens reacting in the pullorum typhoid agglutination test. Avian Diseases. 37: 805-810.

**Fricker, C.R. 1987.** Isolation of Salmonella and Campylobacter. Journal of Applied Bacteriology. 63: 99-116.

**Gast, R.K. 1997. Paratyphoid Infections. In:Calnek, B.W., Barnes, H.J., Beard, C.W., McDoughald, L.R., and Saif, Y.M., (eds).** Diseases of Poultry, 10th ED. Lowa State University Press. Ames, la. Pp: 97-121.

**Haque, M.E.; Hamid, M.A.; Howleder, M.A.R. and Haque, Q.M.E. 1991.** Performance of native chicks and hens reared together or separately under rural condition in Bangladesh. Bangl. Vet. 8:11-13.

**Hossain, M.B.; Islam, M.B. and Hossain, M.A. 1992.** Introduction of chick rearing unit among the rural household of Bangladesh*. Bangladesh Journal of Animal Science*. 21: 15-19

**Hall, W.J, Legenhausen, D.H. and Macdonald, A.D. 1949.** Studies on fowl typhoid. 1. Nature and dissemination. Poultry Science. 28:344-362.

**Humbert, F. and Salvat, G. 1997.** Risques de transmission des Salmonelles en aviculture: detection et prevention en Europe. [The risk of transmission of salmonellae in poultry farming: detection and prevention in Europe]. Rev. Sci. Tech. 16:83-90.

**Jha, V.C., Thakur, R.p., Chand-Thakuri, K. and Yadav, J.N. 1994.** Prevalence of salmonellosis in chickens in the eastern Nepal. Veterinary review Kathmandu. 9:4-6.

**Lowry, V.K., Tellez, G.I., Nisbet, D.j., Garcia, G., Urquiza, O., Stanker, L.H. and Kogut, M.H 1999.** Efficacy of Salmonella enteritis- immune lymphokines on horizontal transmission of *Salmonilla arizonae* in turkeys and *Salmonella gallinarum* in chickens. *Int J Food Microbiol. 48: 139-48.*

 **Mdegela, R. H., Yongolo, M. G. S., Minga, U. M., & Olsen, J. E. (2000).** Molecular epidemiology of *Salmonella gallinarum* in

chickens in Tanzania, *Avian Pathology*, 29, 457-463

**Pomery, B.S. and Nagaraja, K.V. 1991.** Fowl typhoid. In: Calnek, B.W., Barnes, H.J., Beard, C.W., Reid, W.M., and Yoder, H.W. Jr., (eds). Diseases of Poultry. 9th ED. Pp: 87-99 (London, Wolfe publishing Ltd).

**Poppe, C. 1996.** Salmonellosis in poultry and people, influencing factor of its presence are often similar. World Poultry. Special salmonellosis. Nov. Pp. 13-14.

**Paiva JB, Penha Filho RAC, Argüello YMS, Silva MD, Gardin Y, Resende F, Berchieri Jr. A, Sesti L.** Efficacy of several Salmonella vaccination programs against experimental challenge with Salmonella Gallinarum in commercial brown layer and broiler breeder hens. *Brazilian Journal of Poultry Science 2009*; 11(1):65-72.

**Proux, K., Humbert, F., Jouy, E., Houdayer, C., Lalande, F., Oger, A., & Salvat, G. (2002).** Improvements required for the detection of *Salmonella pullorum* and *gallinarum*. *Canadian Veterinary Research*, 66(3), 151-157.

**Shivaprasad, H.L. 2000.** Fowl typhoid and pullorum disease. Revue-Scientifique-et-Technique-Office-International-des-Epizooties. 19: 405-24.

 **Samad, M**.A. 2005. Poultry Science and Medicine. LEP Publication, Mymensing,

Bangladesh. pp: 504-528.

**Steinbach, G.; Lauterbach, L. and Methner, U. 2000.** Studies of the Phenomenon of host adaptation in salmonella. J-Vet-Med-B-Infect-Dis-Public-Health. 47:707-19.

 **Shivaprasad, H.L. 1997.** Pullorum disease and fowl typhoid. In:Calnek, B.W., Barnes, H.J., Beard, C.W., Mc Doughald, L.R., and Sail, Y.M., (EDS). Diseases of poultry, 10th ED. Lowa State University press. Ames, la, Pp: 82-96.

**Snoeyenbos, G.H. 1991**. Pullorum disease. In: Calnek, B.W., Barnes, H.J., Beard. C.W. Reid, W.M. and Yoder, H.W. Jr. 9th (EDS). Pp: 87-99. (London, Wolfe publishing Ltd).

**Sikder, A. J., Islam, M. A., Rahman, M. M., & Rahman, M. B. (2005).** Seroprevalence of *Salmonella* and

*Mycoplasma gallisetpticum* infection in the six model breeder poultry farms at Patuakhili district in Bangladesh.

*International Journal of Poultry Science*, 4 (11), 905-910.

**Tran, Q.D. and Dao, T.H. 2000.** Performance of ISA parent stock fowls infected with *Salmonella gallinarum* (Theo doi mot so chi tieu san xuat cua dan ga bo me going thit isa bi nhiem *Salmonella gallinarum –pullorum*). Khoa- Hoc- Ky- Thuat- Thu- Y- Veterinary- Science- and- Techniques. 7:21-26.

 **Truong, Q., & Tieu, Q. A. (2003).** Prevalence of *Salmonella gallinarum* and *pullorum* infection in the Luong

Phuong chickens reared in the household sector. *Khoa-Hoc-Ky-Thuat-Thu-Y-Veterinary Science and Technology*,

10, 15-19.

**Wray, C., Davies, R.H. and Corkish, J.D. 1996.** Enterobacteriaceae. In: Jordan, F.T.W., and Pattison, M., (Ed.) Poultry Diseases, 4th ( ed.) Pp: 9-43. (London, Wolfe publishing Ltd).

**Wigley, P.; Berchieri, A. Jr.; Page, K.l.; Smith, A.L. and Barrow, P.a. 2001.** Salmonella enterica serovar pullorum persists in splenic macrophages and in the reproductive tract during persistent, disease free carriage in chickens. Infect immune. 69: 7873-7879.