Clinico-epidemiological investigation on diseases of Sonali chicken in the northern part of Bangladesh.

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A Clinical Report Submitted as per approved styles and Contents

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List of Abbreviation

Abbreviation	Elaboration
BF	Bursa of Fabricius
CI	Confidence Interval
CIAs	Critically important antimicrobials
CPF	Central Poultry Farm
DOC	Day Old Chick
DVM	Doctor of Veterinary Medicine
et. al	and others
FDA	Food and Drug Administration
HPAI	High pathogenic avian influenza
IBD	Infectious bursal disease
LPAI	Low pathogenic avian influenza
N	Number
ND	Newcastle Disease
NE	Necrotic enteritis
No.	Number
OR	Odds ratio
P	Probability
PLDP	Participatory Livestock Development Project
PM	Postmortem
RIR	Rhode Island Red
SLDP	Smallholder Livestock Development Project
ULO	Upazila Livestock officer
UUVH	Ullahpara Upazila Livestock Office and Veterinary Hospital
UVH	Upazila Veterinary Hospital
WHO	World Health Organization
NGOs	Non-governmental organizations
e.g.	For the sake of example

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Abstract

Sonali chicken farming in the northern part of Bangladesh has been rapidly progressing. It meets the demands of the protein source of the people. One of the major problems in rearing Sonali chicken in this area is considered the occurrence of various diseases although there are no data. Therefore, the current research was designed to determine the prevalence of the diseases and their associated risk factors including the prescription of drugs against every diseased Sonali chicken case presented at Upazila Livestock Office and Veterinary Hospital, Ullahpara, Sirajgonj, Bangladesh for a period of 2 (two) months from February to April 2022. A total of 73 sick and dead Sonali chickens were examined for the diagnosis of different diseases based on history, clinical findings, and postmortem lesions of dead and sacrificed birds. This study revealed that most of the farmers were male (74.0%), middle-aged group (31 to 50 years) (49.3%), had poor education (34.3% secondary level), and were relatively new in farming (1-4 years) (72.6%). The flock size of most of the farms was medium (52.1%). Classic Sonali chicken dominated in the farms (60.3 %). Most of the farmers (91.8%) vaccinated their Sonali chickens. Results also demonstrated that the prevalence of viral diseases was the highest (39.3%) in Sonali chicken followed by protozoal (31.0%), and bacterial diseases (20.2%). Among the viral diseases, Newcastle Disease (14.3%), Infectious Bursal Disease (13.1%), and Low pathogenic Avian Influenza (4.8%) were more predominant. Coccidiosis (31.0%) was the highly prevalent disease among the protozoan diseases recorded in the Sonali birds. Bacterial diseases such as Colibacillosis (11.9%), and Necrotic enteritis (4.8%) were the most commonly occurring diseases observed in studied birds. However, Mycoplasmosis (3.6%), Brooder pneumonia (2.4%), and Ascariasis (2.4%) had also been found in Sonali chicken. The odds of coccidiosis positive were significantly higher in farms with flock size of 501 to 5100 than in farms with flock size with an odds ratio (OR) of 2.92 (95% CI: 1.0-8.7) (p=0.05) in Sonali chicken farm. Phytochemical/, herbal (Jingan®), levofloxacin, and immune stimulants were used as the main drugs, antibiotics, and supportive drugs for common viral diseases (ND and IBD). Amprolium with sulfa drugs and zinc or vitamin k was commonly used against coccoidal cases. Sulfa-quinoxaline (27.4%), Enrofloxacin (16.4%), Levofloxacin (13.7%), and Colistin (6.9%) were commonly prescribed

antibiotics for different Sonali chicken cases. Ciprofloxacin and gentamicin were included in the category of critically important for veterinary and human use. Proper farm management and good quality chicks should be taken into consideration for effective control of coccidiosis. More judicious consideration should be given to the use of critically important antibiotics first to curb the growing multi-drug resistance pattern in bacteria.

Keywords: Sonali chicken, disease, risk factor, coccidiosis, treatment, antibiotic.

Introduction

Poultry meat and egg production have boomed and predominantly crossed the expected production level over the past decades in the South East Asian countries, including Bangladesh (Davis et al., 2010). Bangladesh produced a substantial amount of protein sources through its improved poultry production channel during 2021 and 2022. About 150,000 farms across the country produced 3.76 billion poultry, 9.26 million tons of meat, and 233.5 billion eggs during this period (DLS 2022), contributing to animal source protein for the people. Among poultry species, 90% of the protein is derived from chickens, followed by ducks (8%) and other species, such as quail, pigeons, and geese (2%) (S. C. Das et al., 2008). Increased numbers of commercial farms, modern technology, and rearing high-yielding poultry varieties have been implemented to increase production in recent years. Hence, chicken production is increasing steadily in Bangladesh, from 261.47 million in 2014-15 to 311.8 million in 2021-22 (DLS, 2022). Despite the country's dramatic increase in poultry consumption over the past 30 years, current consumption is about 6.3 to 8.5 kg per person per year (World's Poultry Science Association, 2020). This sector can create opportunities for the Gross Domestic Product (GDP) to grow at a faster rate by promoting self-employment and nutritional production, and finally by reducing poverty (Talukdar et al., 2017). Bangladesh's main poultry products are chicken, duck, quail, pigeons, and turkey. In addition, there are four more diverse types of chickens- Broiler, Layer, Sonali, and local.

Along with different other poultry species, Sonali chicken has become an important part of poultry production in Bangladesh. This crossbred bird has to gain its popularity and acceptance over the broiler due to its phenotypic appearance with the local chicken. It is produced by crossing with the Rhode Island Red (RIR) cocks with Fayoumi hens. It is first introduced in 1996–2000 in the

northern part (e.g. Rangpur, Bogra, Dinajpur) of the country through some non-government organizations (NGOs) (PLDP; Participatory Livestock Development Project and SLDP; (Smallholder Livestock Development Project) funded by Danish Government (Uddin et al., 2015). The growth rate of Sonali is also far better than purebred Fayoumi and local chickens reared in intensive, semi-scavenging, and even in backyard rearing systems (Jahan et al., 2021). Due to the inbreeding depression of the Sonali classic chicken, production has decreased. As a result, some breeders in recent past years developed another type of Sonali chicken by crossing with other poultry breeds (SASSO, CPF-3, Tiger chicken), popularly known as "Sonali Hybrid Chicken". The performance (e.g., weight) of "Sonali Hybrid" is comparatively better than the traditional "Sonali Classic Chicken" developed earlier. A typical Sonali day-old chick weighs between 25 and 30 grams whereas it is 5–6 grams more in a Sonali hybrid chick. A standard or classic adult Sonali chicken weighs around 700–750 grams after 60 days, whereas the Sonali hybrid weights around 900 grams by that time period (Upazila livestock officer, Department of Livestock Service, Ullahpara, Personal communication, 2022). Sonali chickens are well adapted to the environmental conditions of the country because they need less care and attention in comparison to other poultry breeds (Saleque & Saha, 2013). The production records of this bird is better due to its higher disease resistance capability, minimum mortality, and fastest growth rate (more than 0.8kg by 60 days) (Howlader et al., 2022). Government and different NGOs use this breed of chicken as a tool for poverty alleviation as well as women empowerment in the country. By rearing this crossbred chicken, almost 76% of Sonali beneficiaries have improved their livelihood status (Hossen et al., 2012). Due to its high demand, the consumption rate soared by 45% in July 2019 compared to only 20% in July 2018 (Howlader et al., 2022).

The northern region of country is considered as an important poultry hub. Along with commercial poultry rearing (e.g. layer and broiler farming), rearing Sonali chicken (Sonali Classic and hybrid) for meat has gained its popularity in the regions over the last decade (Roy et al., 2020). The production of these birds is not only hampered by inappropriate managemental practices, incorrect breeding policies but also different infectious and non-infectious diseases. The outbreak of several devastating diseases that result in financial loss and discourage the rearing of the poultry (Das et al., 2004). Biswas et al., (2006b) reported about 28% mortality in Sonali chickens due to outbreaks of different infectious diseases on the southeastern coast of Bangladesh. Disease prevalence in a given location is influenced by several factors, including geo-climatic conditions, management

practices, immunization status, vaccine failure, production type, season, breed, age, sex, and social awareness (Das et al., 2018; Talukdar et al., 2017). The most prevalent diseases are determined to be Newcastle disease, Infectious bursal disease, Mycoplasma, Coccidiosis, Salmonellosis, Colibacillosis, Gangrenous dermatitis, Ascites, and Omphalitis during the period when chicks are being reared (Saleque & Saha, 2013). Sonali chickens were also affected by some other diseases such as fowl pox, low pathogenic avian influenza, infectious bronchitis, visceral gout, fowl cholera, necrotic enteritis, aspergillosis, mycotoxicosis, and parasitic infestation, etc. (Mamun et al., 2019; Haque & Gofur, 2020; Hasan et al., 2017; Tipu et al., 2021).

A single-celled protozoan parasite from the genus *Eimeria* (e.g. *E. tenella, E. necatirx*) causes the parasitic disease known as avian coccidiosis, associated with dysentery, enteritis, bloody diarrhea, including production loss (Dalloul & Lillehoj, 2005; Roy et al., 2020). The disease is more severe in Sonali birds because of their high morbidity and mortality rates (Shirzad et al., 2011). The most prevalent and pathogenic species that have an impact on the poultry business globally is *E. tenella*, which causes extensive damage to chickens' digestive tracts and has a 100% morbidity and high mortality rate (Ayaz et al., 2003; Mohammad et al., 2011). Young chick mortality rates are typically high because most Eimeria species affect birds between the ages of 3 and 18 weeks (Dakpogan & Salifou, 2013; Nematollahi et al., 2009). High levels of humidity and rainfall caused more oocysts to sporulate, which in turn increased the prevalence rate of coccidiosis (Sharma et al., 2013). Newcastle disease (ND) is a highly contagious and fatal viral disease in domestic fowl, Sonali chicken, broiler, and other bird species like turkey, pigeons, and parrots followed by acute respiratory problems, depression, nervous manifestations, or diarrhea may be the predominant clinical form (Haque et al., 2010; Haque & Gofur, 2020; Parvez et al., 2016). From mild to severe, the disease can vary. The virulence of the infecting virus and the host's susceptibility determine the severity. Most of Asia, Africa, and several North and South American nations have an endemic presence of highly virulent Newcastle disease virus (NDV) strains in poultry (Chang & Dutch, 2012). It was more prevalent in Sonali chickens reared in more northern districts than in local chickens (Biswas et al., 2005). Infectious Bursal Disease (IBD) is an acute, highly contagious viral disease of growing chickens especially chickens of 3-6 weeks of age, and severe damage of the Bursa of Fabricius (BF) followed by immunosuppression (Eterradossi et al., 2008; Pringle, 1999).

Antimicrobial agents are essential drugs for the treatment of these diseases. In Bangladesh significant amount of antibiotics are used in poultry sector (Khan et al., 2018). Poultry farmers commonly administer antibiotics and sulpha medicines to their flocks for both therapeutic and non-therapeutic purposes, with or without a prescription from a licensed veterinarian (Islam, 2017; Rahman et al., 2018). If antibiotics are used indiscriminately, there will come a time when they are no longer useful for treating bacterial infections (Hamid et al., 2018; Luepke et al., 2017). Antimicrobial resistance is a global health (public and animal health) concern. The ability to treat common infectious diseases is at risk due to the emergence and global spread of new drug-resistance mechanisms, which can lead to a prolonged illness, disability, and death (Roy et al., 2020). There are many things can do better to control antimicrobial resistance. Most importantly, need to decrease overall antimicrobial use that includes usage in human and veterinary medicine (Collignon et al., 2016). Public and animal health organizations have developed competing lists of "critically important antimicrobials" (CIAs), which rank these compounds according to their importance in human and veterinary medicine, respectively. These lists are meant to help with navigating the complex set of medications involved and to ensure that the most crucial medications are used judiciously in both human and veterinary medicine (Scott et al., 2019). Due to the difficulty in distinguishing between sick and healthy birds, farmers rarely heed medical advice and routinely administer antibiotics to both sick and healthy poultry (Bhushan et al., 2017).

The prevalence of difference of diseases in Sonali chicken has been recorded in central and southern regions of the country although there less data in northern part of Bangladesh (Islam et al., 2021; Uddin et al., 2014). Moreover, the farming system, the disease surveillance data including the use of antibiotic in Sonali Chicken is poorly understood or recorded in the mentioned region. Therefore, the current study has been designed to determine the prevalence of different diseases in Sonali Chicken along with prescription patter in treating those drugs. The specific goal of the study was i) to characterize Sonali farmers and their farms along with management practices ii) to describe the clinical disease and disease conditions in Sonali chickens presented in the hospital and identify risk factors associated with commonly occurred diseases in Sonali chicken cases presented at the hospital assess drug prescription patterns against common Sonali chicken cases.

Materials and Methods

Study location and duration

The author completed 49 working days Doctor of Veterinary Medicine (DVM) internship clinical placement at the Ullahpara Upazila Livestock Office and Veterinary Hospital (UUVH) between the 17 February and 28 of April 2022 with the aim was to enhance clinical and epidemiological skills through hands-on learning coupled with field level activities.

Study area

The study was performed at Upazila Livestock Office and Veterinary Hospital, Ullahpara, Sirajgonj. In Bangladesh's Rajshahi Division, Sirajgonj is a district in the North Bengal area. It is a vital economic district in Bangladesh. It is flanked on the north by Bogra district, on the south by Pabna and Manikganj districts, on the east by Tangail and Jamalpur districts and on the west by Pabna, Natore and Bogra districts. Ullahpara Upazila area 414.43 sq. km, located in between 24°12' and 24°26' north latitudes and in between 89°24' and 89°38' east longitudes. In Ullahpara, the maximum average temperature is 36°C in April and the lowest is 26°C in January. A year's rainfall is around 1201 mm, with an average humidity of 66%. The concentration of poultry in this

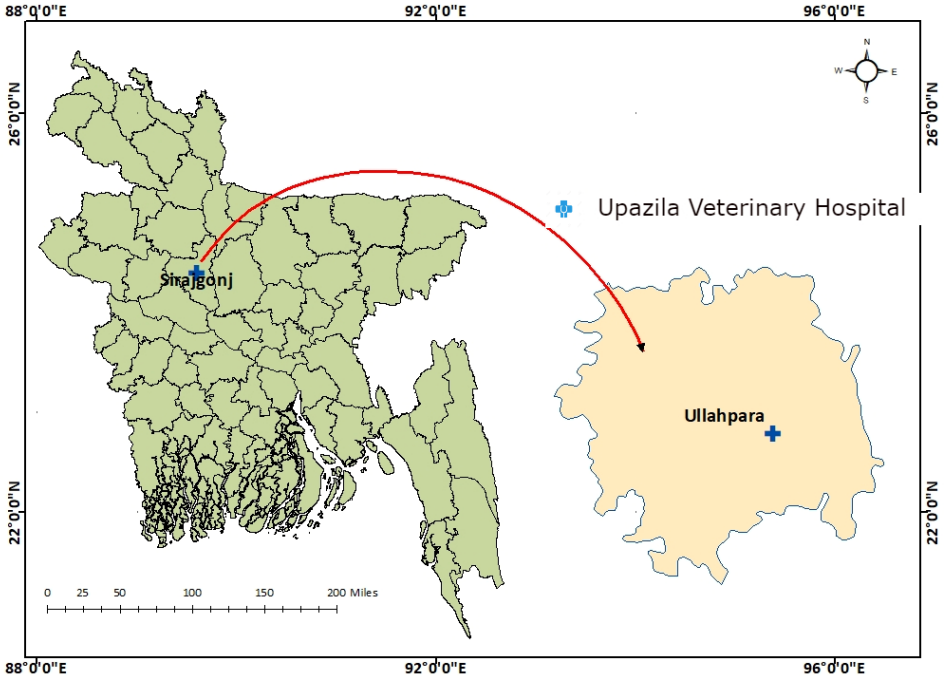

Figure 1. Map of Bangladesh (right), showing Sirajgonj District. The surrounding areas of Ullahpara veterinary hospital from which cases originated (left).

Upazila is quite high. The Upazila has 933 commercial farms (420 broiler, 12 layers, 365 Sonali, and 136 ducks), 1 Sonali Breeder farm. Among the total Sonali chicken farms, there are 50 small, 170 medium, and 145 large farms. (Upazila livestock officer, Department of Livestock Service, Ullahpara, Personal communication, 2022). Ullahpara Upazila Livestock Office and Veterinary Hospital was rebuilt in 2007 and this veterinary hospital has been providing efficient care to livestock animals for a long. Every day almost all species of livestock animals (cattle, sheep, goat, duck, and chicken) are brought in for treatment, including a significant number of Sonali chickens. Sonali chicken farms are increasing day by day in this Upazila and chicken cases are handled here within the UVH so most of the poultry farmers (backyard, small, medium, and large-scale farmers) brought their sick or dead poultry to the Veterinary hospital for clinical diagnosis, treatment, and advice.

Study design and cases

A descriptive study was conducted to describe clinical cases of chickens along with prescription pattern. During the placement, a total of 73 clinical cases were present in the hospital out of which 68 cases were dead chickens and 5 cases were live chickens. Experienced registered veterinarian (Upazila livestock officer) used the clinical history, clinical sign, and pathognomonic gross lesions to diagnosis the cases. In addition microscopic examination was applied to diagnose un-embryonated oocyst of *Eimeria sp.* by scraping from the inner layer of the ceca (Belal, 2018).

Clinical examination and data recording

Since the UUVH's existing recording system was unsatisfactory, sometimes it collects no data and sometimes it collects insufficient data. So, a structured record keeping sheet was developed for this study and used with the Upazila Livestock officer (ULO) approval. Before completing the data collection method, the ULO of the Veterinary Hospital and the participating poultry farmers both gave their verbal agreement. Clinico-epidemiological findings of each case were recorded in the structured record-keeping sheet by face-to-face questions with farmers and see ULO's prescription. After clinical examination and data recordings such as farmer demographic information (Name, address, sex, age, education profession, and Sonali rearing experience), farm demography (flock size, Sonali type, age of bird, credit farm, source of DOC), farm management (vaccination, deworming, the farmer received any treatment support before coming to UVH, disposed of a dead bird, sale pattern, marketing of and managed of litter material) clinical history

(previous disease, duration of illness, morbidity and mortality, etc.), observable post-mortem findings, tentative diagnosis, and prescribed drugs (M. Islam et al., 2021). A tentative diagnosis of cases was made based on clinical-epidemiological history, clinical signs, and post-mortem lesions (Swayne, 2013; Tipu et al., 2021). There was no dedicated room for poultry PM in the hospital. Poultry was PM with paper on the hospital balcony or outside table. Only hand gloves were used for personal protection. PM examinations were carried out by the ULO of the hospital or the intern veterinarian as per standard procedure or protocol described by the Atas of Avian Necropsy (Majó & Dolz, 2011). There was no dumping pit to dispose of the carcasses after PM. So, the owner was given the carcasses and advised not to leave it anywhere, but to bury it properly under the ground. PM specimens were not collected and sent to the "Field Disease Investigation Laboratory" or "Central Disease Investigation Laboratory" for confirmatory diagnosis and antimicrobial sensitivity testing. Here treatment was based on tentative diagnosis only. Not all PM information were an entry in the record book. So, passive disease surveillance report was not generated in the hospital for those who did not record correct information. Although passive disease surveillance report was very important because the number of poultry in this Upazila was high.

Statistical analysis

Raw data were compiled into Microsoft excel professional 2020 (Microsoft corporation, USA). After coding and re-coding, data were checked for integrity and consistency, then entered into STATA 13 (Stata Crop, 4905, Lakeway Drive, College Station, Texas 77845, USA) for description, univariable and multivariable statistical analysis. Descriptive analysis was also performed on the epidemiological Sonali farmers and farms demographic with management data, the results were expressed as frequency number and percentage. The prevalence of different diseases and disease conditions was calculated using each category's number divided by the total number of cases of all categories according to disease pattern (disease type and disease group). We calculate prevalence taking the number of individual diseases divided by the total diseases according to pathogen type and individual distribution of diseases with considering mixed infection. Specific drugs, antibiotics, and supportive drugs data underwent descriptive analysis. Within all used antibiotics to have identified critically important antibiotics for veterinary and human use.

Risk factor analysis

Fisher's exact test was applied to assess the difference in the proportion of coccidiosis between or among the categories of different variables (Gender of rearing person, flock size, age of bird, Sonali type and source of DOC) in this study. Significant variables ($p \leq 0.2$) were forwarded to construct model by using multivariate logistic regression analysis. Factors with a trend toward significance ($p \leq 0.2$ in Fisher's exact testing) were initially considered for inclusion in the multivariable analysis. Backward stepwise logistic regression analysis was applied to fit the model. At first a full model was run and only variables with $p \leq 0.05$ in the likelihood ratio test were retained. Biologically plausible interactions among the main factors were also tested and retained in the final stage if significant ($p \leq 0.05$). The model outputs were presented as odds ratio, 95% Confidence interval and p-value. The probability value of $p \leq 0.05$ was considered as a cut off in evaluating the significant difference.

Results

Demography of Sonali chicken farmers, farms, and management practice

Characteristics of Sonali chicken farmers in surveyed area are shown in Table 1. Most of the farmers were male (74.0%), middle-age group (31 to 50 years) (49.3%), poor education (34.3% secondary level) and relatively new in farming (1-4 years) (72.6%). Agriculture as a profession was reported by 30.1% of the farmers. Flock size of most of the farms was medium (52.1%). Classic Sonali chicken dominated in the farms (60.3 %). Half of the farms had been credited by others including feed dealers (50.7%). Majority of the farmers sourced day old chicks directly from the hatchery (64.4%) (Table 2). The chickens presented to the UVH were vaccinated with at least Newcastle Disease Vaccine (91.8%). 64.4% of farmers received no treatment for their sick birds before coming to the UVH. Majority of farmers responded they had buried the dead birds (53.4%). 94.5% of farmers sold their birds at a time. Only 10.9% of farmers sold their birds through dealer (Table 3).

Table 1. Characteristics of Sonali chicken farmers in the Ullahpara Upazila, Sirajgonj, Bangladesh (N=73).

Variables	Categories	N (%)
Gender	Female	19 (26.0)
	Male	54 (74.0)
Age (Year)	Young (18 to 30)	16 (21.9)
	Middle (31 to 50)	36 (49.3)
	Old (51 to 67)	21 (28.8)
Education	Illiterate	18 (24.7)
	Primary (1 to 5)	11 (15.1)
	Secondary (6 to 10)	25 (34.3)
	Higher secondary (11 to 12)	9 (12.3)
	Hon's (>12)	10 (13.7)
Profession	Housewife	18 (24.7)
	Agriculture	22 (30.1)
	Poultry farming	10 (13.7)
	Job	17 (23.3)
	Student	6 (8.2)
Sonali rearing experience (Year)	Low (1 to 4)	53 (72.6)
	Medium (5 to 15)	18 (24.7)
	High (16 to 21)	2 (2.7)

Table 2. Characteristics of Sonali farms in the Ullahpara Upazila, Sirajgonj, Bangladesh (N=73).

Variables	Categories	N (%)
Flock size (no.)	Small (150 to 500)	28 (38.4)
	Medium (501 to 2500)	38 (52.1)
	Large (2501 to 5100)	7 (9.5)
Sonali (Type)	Classic	44 (60.3)
	Hybrid	29 (39.7)
Credit farm	No	36 (49.3)
	Yes	37 (50.7)
Day Old Chick source	Through feed and chick dealer	26 (35.6)
	Directly from Hatchery	47 (64.4)

Table 3. Sonali farm management and marketing of bird in the Ullahpara Upazila, Sirajgonj, Bangladesh (N=73).

Variables	Categories	(N (%)
Vaccination	Yes	67 (91.8)
	No	6 (8.2)
Birds received any treatment before coming to UVH	No	47 (64.4)
	Dealer	12 (16.5)
	Owner	7 (9.6)
	Private Vet	3 (4.1)
	Quack	2 (2.7)
	Neighbor farm owner	2 (2.7)
Disposal of dead bird	Throw	30 (41.1)
	Buried	39 (53.4)
	Buried and throw	4 (5.5)
Sale pattern	Single time	69 (94.5)
	Multiple times	4 (5.5)
Marketing of bird	Dealer	8 (10.9)
	Wholesale	39 (53.4)
	Wholesaler and retailer	16 (21.9)
	Retailer	10 (13.8)

Disease prevalence of Sonali chicken

In the present study, the majority of Sonali chickens were affected by infectious diseases (91.8%) and single disease (82.2%) followed by non-infectious diseases (8.2%) and mixed diseases group (17.8%). Viral (39.3%), Protozoal (31.0%), and Bacterial (20.2%) diseases were the most dominating clinical diseases among the Sonali chicken followed by mycoplasma (3.6%), fungal (2.4%), mycotoxin (1.2%) and Nematoda (2.4%) diseases presented in the study area (Table 4). This study estimated a wide range of Sonali chicken diseases by age categories (Table 5). Coccidiosis had the highest prevalence (31.0%) among Sonali chickens than any other disease(s) where chicken aged 29 to 70 days (17.9%) was more affected, followed by 15 to 28 days (7.1%) and 2 to 14 days (6.0%) aged birds. Within viral diseases, Newcastle Disease had the most prevalent (14.3%) clinical cases followed by Infectious Bursal Disease (13.1%) and Low Pathogenic Avian Influenza (4.8%). Newcastle Disease (10.7%) and Infectious Bursal Disease (7.1%) were relatively more prevalent in 29 to 70 days of chicken. Prevalence of Colibacillosis was 11.9% where chickens of 2 to 14 days (8.3%) were more affected. The prevalence of Necrotic

Enteritis was 4.8% where chickens of 29 to 70 days (3.6%) were commonly affected. Ascariasis prevalence was 2.4% in chickens of 29 to 70 days.

Table 4. Disease pattern in Sonali chickens in the Ullahpara Upazila, Sirajgonj, Bangladesh (73 cases).

Variables	Categories	N (%)
Disease type	Infectious	67 (91.8)
	Non-infectious	6 (8.2)
Disease group	Single	60 (82.2)
	Mixed	13 (17.8)
Pathogen type	Viral	33 (39.3)
	Bacterial	17 (20.2)
	Protozoal	26 (31.0)
	Mycoplasma	3 (3.6)
	Fungal	2 (2.4)
	Mycotoxin	1 (1.2)
	Nematoda	2 (2.4)

Table 5. Frequency distribution of diseases in Sonali chicken in the Ullahpara Upazila, Sirajgonj, Bangladesh (73 cases, 84 diseases).

Variables	Categories	Age (Day)			Overall N (%)
		2 to 14 N (%)	15 to 28 N (%)	29 to 70 N (%)	
Disease	Marek's Disease	3 (3.6)	0	0	3 (3.6)
	Newcastle Disease	0	3 (3.6)	9 (10.7)	12 (14.3)
	Infectious Bursal Disease	2 (2.4)	3 (3.6)	6 (7.1)	11 (13.1)
	Low Pathogenic Avian Influenza	1 (1.2)	0	3 (3.6)	4 (4.8)
	High Pathogenic Avian Influenza	0	0	1 (1.2)	1 (1.2)
	Fowl Pox	0	0	1 (1.2)	1 (1.2)
	Infectious Bronchitis	0	0	1 (1.2)	1 (1.2)
	Colibacillosis	7 (8.3)	2 (2.4)	1 (1.2)	10 (11.9)
	Necrotic Enteritis	1 (1.2)	0	3 (3.6)	4 (4.8)
	Salmonellosis	1 (1.2)	1 (1.2)	0	2 (2.4)
	Bamble Foot	0	0	1 (1.2)	1 (1.2)
	Coccidiosis	5 (6.0)	6 (7.1)	15 (17.9)	26 (31.0)
	Mycoplasmosis	2 (2.4)	0	1 (1.2)	3 (3.6)
	Brooder Pneumonia	1 (1.2)	1 (1.2)	0	2 (2.4)
	Mycotoxin	1 (1.2)	0	0	1 (1.2)
	Ascariasis	0	0	2 (2.4)	2 (2.4)

Distribution of Coccidiosis in Sonali chickens by space and other factors

Spatial distribution of coccidiosis of Sonali chicken in the study area based on union has been presented in Figure 1. Coccidiosis cases mostly originated from Ullahpara City Corporation (15.1%), Panchakrushi (6.8%), and Hatikumrul (6.8%).

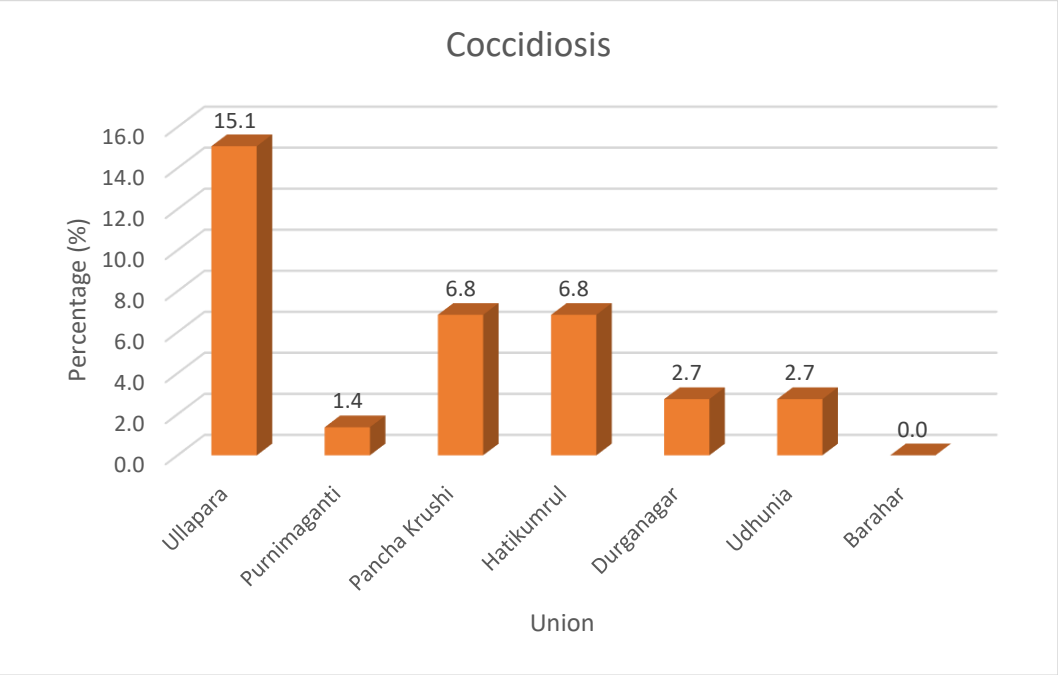

Figure 2: Spatial distribution of Coccidiosis of Sonali chicken farm in the Ullahpara Upazila, Sirajgonj, Bangladesh (73 cases).

Risk factors for Coccidiosis in Sonali Chickens

Univariate analysis:

Farms operated by male farmers, flock size of 501 to 5100, classic Sonali and DOC sourced from feed dealers had higher prevalence of Coccidiosis 44.5%, 44.4%, 43.2% and 46.8% respectively than that of their counterparts 10.5%, 21.4%, 24.1% and 15.4%, respectively ($p \leq 0.2$) (Table 6).

Table 6: Univariate association between each of factors and Coccidiosis in Sonali chicken in the Ullahpara Upazila, Sirajgonj, Bangladesh (73 cases).

Variables	Categories	Coccidiosis		
		+ (%)	-(%)	P
Gender of rearing person	Female	2 (10.5)	17	0.006
	Male	24 (44.5)	30	
Flock size (no.)	150 to 500	6 (21.4)	22	0.039
	501 to 5100	20 (44.4)	25	
Age of bird (Day)	2 to 14	5 (22.7)	17	0.318
	15 to 28	6 (42.9)	8	
	29 to 70	15 (40.5)	22	
Sonali (Type)	Classic	19 (43.2)	25	0.078
	Hybrid	7 (24.1)	22	
Day Old Chick source	Directly from Hatchery	4 (15.4)	22	0.006
	Through feed and chick dealer	22 (46.8)	25	

Multivariate analysis:

The flock size of 501 to 5100 had significantly 2.92 times higher occurrence (odds) of Coccidiosis in Sonali chickens than the flock size of 150 to 500 (p=0.05) (Table 7).

Table 7. Multivariable association between potential factors with the prevalence of Coccidiosis in Sonali chicken farms in the Ullahpara Upazila, Sirajgonj, Bangladesh (73 cases). (Logistic regression model output)

Variables	Categories	OR[a]	95% CI[b]	P
Flock size	150 to 500	1.0		
	501 to 5100	2.92	1.0 -8.7	0.05
Sonali (Type)	Classic	1.0		
	Hybrid	0.42	0.1-1.2	0.11

a= Odds ratio; b= Confidence Interval

Common treatment regimens against the Sonali chicken diseases

Drugs that were prescribed against different Sonali chicken cases were categorized into three groups, which were specific drugs, antibiotic, and supportive drugs (Table 8 and 10). Amprolium and Sulfa-quinoxaline, and Sulfadimidine and Sulfa-dimethoxine were used as the specific drugs in 23.8% and 7.1%, respectively for protozoal cases. The most supportive drugs used in Coccidiosis were zinc (8.33%) and zinc with vitamin k (7.14%) (Table 10). Phytochemical/ herbal (Jingan®) and Andrographis paniculate were used as the main drugs in 16.7% and 2.4%, respectively for viral cases. Enrofloxacin and Enrofloxacin and colistin were used as the specific

drugs in 8.3% and 3.6%, respectively for bacterial diseases. Piperazine citrate was used as the specific drugs in 2.4% for Nematoda cases. A wide range of antimicrobials was prescribed against different Sonali chicken cases in the present study. Sulfa-quinoxaline (27.4%), Enrofloxacin (16.4%), Levofloxacin (13.7%), Sulfadimidine (8.2%), Sulfa-dimethoxine (8.2%) and Colistin (6.9%) were commonly prescribed for different Sonali chicken cases without considering disease types (Table 9). Levofloxacin was prescribed for ND (11.0%) followed by IBD (4.1%) (Figure 3). Enrofloxacin was prescribed for Necrotic Enteritis (5.5%) and Colibacillosis (4.1%). All antibiotics prescribed in the treatment of Sonali chickens were divided into three categories. Ciprofloxacin and gentamicin were included in the category of critically important for veterinary and human use. Doxycycline, enrofloxacin, levofloxacin, sulfa-dimethoxine, sulfadimidine, and sulfa-quinoxaline were included in the critically important for veterinary use category. Colistin, tylosin, and tilmycosin were included in the critically important for human use category.

Table 8. Specific drugs used for Sonali chicken cases in the Ullahpara Upazila, Sirajgonj, Bangladesh (73 cases).

Specific drugs	Viral N (%)	Bacterial N (%)	Protozoal N (%)	Mycoplasma N (%)	Fungal N (%)	Mycotoxin N (%)	Nematoda N (%)
Amprolium and Sulfa-quinoxaline**	0	0	20 (23.8)	0	0	0	0
Andrographis paniculata	2 (2.4)	0	0	0	0	0	0
Ciprofloxacin ***	0	2 (2.4)	0	0	0	0	0
Enrofloxacin**	0	7 (8.3)	0	0	0	0	0
Enrofloxacin and colistin*	0	3 (3.6)	0	0	0	0	0
Gentamicin***	0	1 (1.2)	0	0	0	0	0
Levofloxacin**	0	1 (1.2)	0	0	0	0	0
Levofloxacin** and colistin*	0	2 (2.4)	0	0	0	0	0
Phytochemical/ herbal (Jingan®)	14 (16.7)	0	0	0	0	0	0
Piperazine citrate	0	0	0	0	0	0	2 (2.4)
Sulfadimidine** and Sulfa-dimethoxine**	0	0	6 (7.1)	0	0	0	0
Tilmycosin*	0	0	0	1 (1.2)	0	0	0
Nystatin+ toxin neutralizer	0	0	0	0	2 (2.4)	1 (1.2)	0
Tylosin*	0	1 (1.2)	0	2 (2.4)	0	0	0
No	17 (20.2)	0	0	0	0	0	0

*** Critically important antibiotics for veterinary and human use; ** Critically important antibiotics for veterinary use; * Critically important for human use (WHO, 2018.; OIE, 2018)

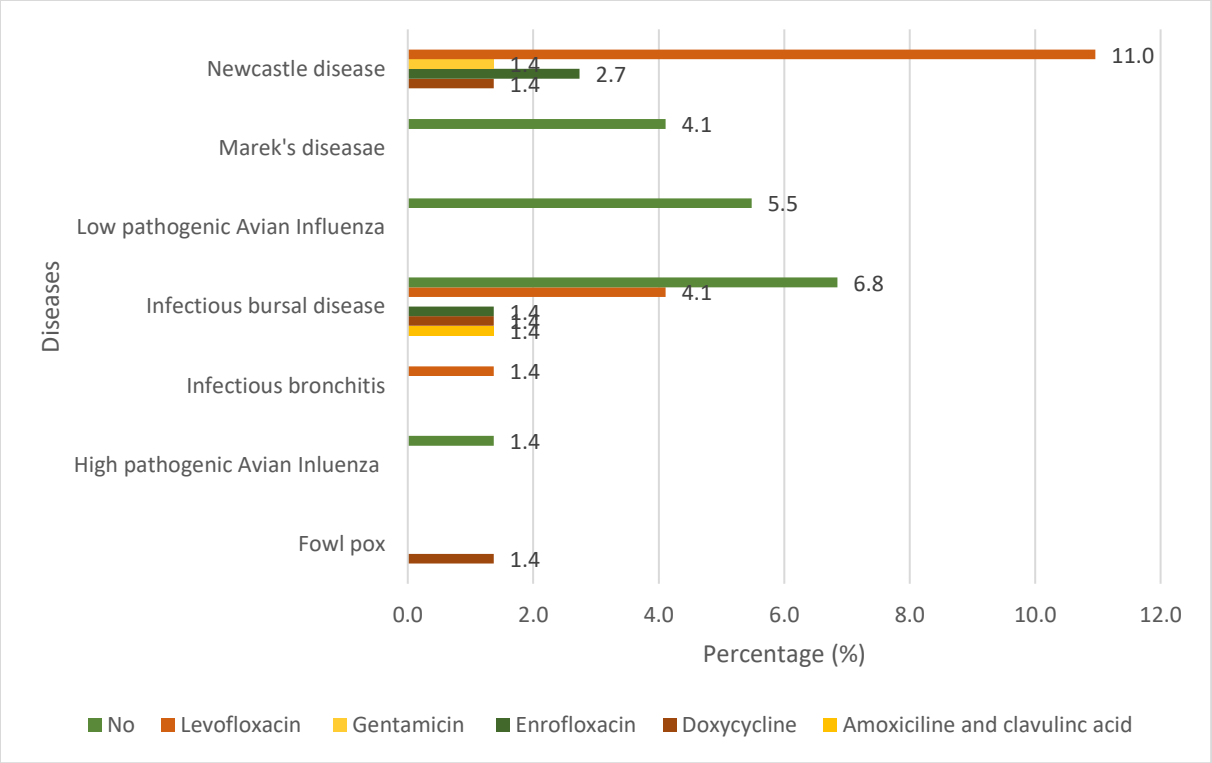

Figure 3: Antibiotics used against distinct viral diseases of Sonali farm in the Ullahpara Upazila, Sirajgonj, Bangladesh (73 cases).

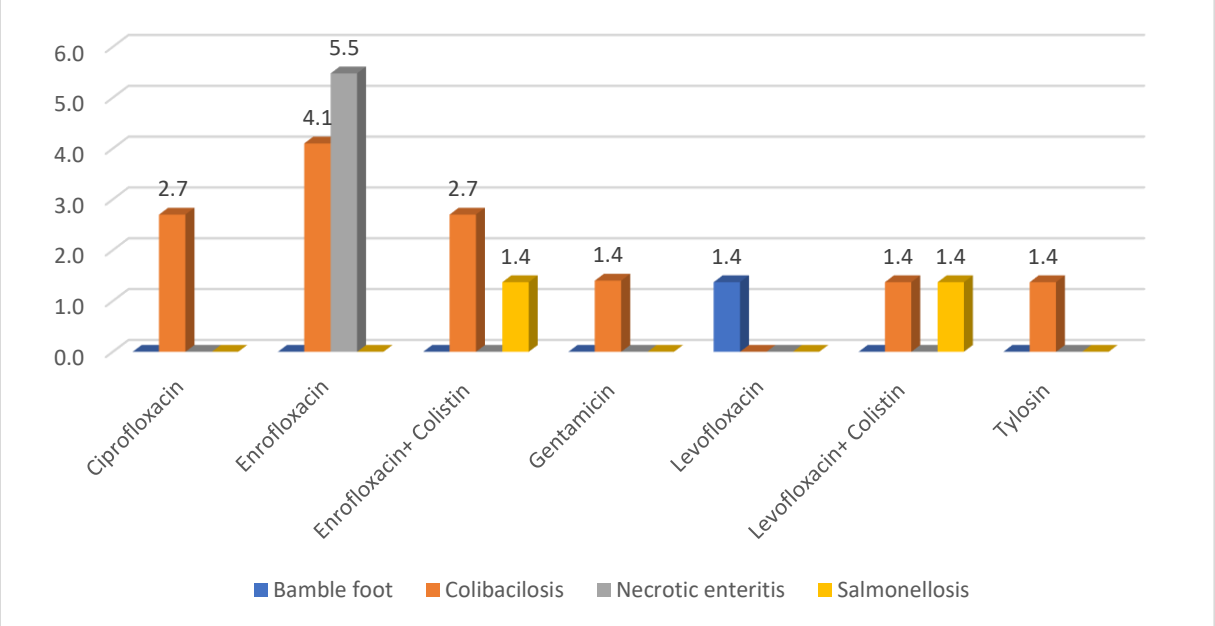

Figure 4: Antibiotics used against distinct bacterial diseases of Sonali farm in the Ullahpara Upazila, Sirajgonj, Bangladesh (73 cases).

Table 9. Frequency distribution of antibiotics prescribed for Sonali chicken cases presented to the hospital (73 cases).

Antibiotics	Frequency (N)	Percentage (%)
Amoxicillin	1	1.4
Amoxicillin and clavulanic acid	2	2.7
Ciprofloxacin***	2	2.7
Colistin*	5	6.9
Doxycycline**	3	4.1
Enrofloxacin**	12	16.4
Gentamicin***	3	4.1
Levofloxacin**	10	13.7
Sulfa-dimethoxine**	6	8.2
Sulfadimidine**	6	8.2
Sulfa-quinoxaline**	20	27.4
Tilmycosin*	1	1.4
Tylosin*	2	2.7

*** Critically important antibiotics for veterinary and human use; ** Critically important antibiotics for veterinary use; * Critically important for human use (WHO, 2018; OIE, 2018).

Table 10. Supportive drugs used against different diseases of Sonali farm in the Ullahpara Upazila, Sirajgonj, Bangladesh (73 cases).

Diseases	Supportive or other drugs.												
	Electrolyte N (%)	Electrolyte and Zinc N (%)	Immuno-stimulant N (%)	Immuno-stimulant and Respiratory stimulant N (%)	Immuno-stimulant and Vitamin C N (%)	Liver tonic N (%)	Multi-vitamin N (%)	Respiratory stimulant N (%)	Vitamin C N (%)	Vitamin K N (%)	Zinc N (%)	Zinc and Vitamin K N (%)	No N (%)
Marek's Disease	0	0	3 (3.57)	0	0	0	0	0	0	0	0	0	0
ND*	1 (1.19)	0	3 (3.57)	3 (3.57)	1 (1.19)	0	0	2 (2.38)	0	0	0	0	2 (2.38)
IBD**	1 (1.19)	0	2 (2.38)	1 (1.19)	1 (1.19)	0	1 (1.19)	1 (1.19)	0	0	0	0	3 (3.57)
LPAI ***	0	0	1 (1.19)	2 (2.38)	0	0	0	1 (1.19)	0	0	0	0	0
HPAI****	0	0	1 (1.19)	0	0	0	0	0	0	0	0	0	0
Fowl pox	1 (1.19)	0	0	0	0	0	0	0	0	0	0	0	0
Infectious bronchitis	0	0	0	1 (1.19)	0	0	0	0	0	0	0	0	0
Colibacillosis	0	0	1 (1.19)	1 (1.19)	0	0	4 (4.76)	1 (1.19)	0	0	0	0	3 (3.57)
Necrotic enteritis	0	0	0	0	0	0	1 (1.19)	0	0	0	1 (1.19)	0	2 (2.38)
Salmonellosis	0	0	0	0	0	0	0	1 (1.19)	0	0	1 (1.19)	0	0
Bamble foot	0	0	0	1 (1.19)	0	0	0	0	0	0	0	0	0
Coccidiosis	0	1 (1.19)	2 (2.38)	0	0	0	0	1 (1.19)	1 (1.19)	2 (2.38)	7 (8.33)	6 (7.14)	6 (7.14)
Mycoplasmosis	0	0	0	0	0	0	0	1 (1.19)	0	0	0	0	2 (2.38)
Brooder pneumonia	0	0	0	0	0	1 (1.19)	0	0	0	0	0	0	1 (1.19)
Mycotoxin	0	0	0	0	0	1 (1.19)	0	0	0	0	0	0	0
Ascariasis	0	0	0	0	0	0	1 (1.19)	0	0	0	0	0	1 (1.19)

*ND= Newcastle Disease; **IBD= Infectious bursal disease; ***LPAI= Low pathogenic avian influenza; ****HPAI= High pathogenic avian influenza

Discussion

Demography of Sonali chicken farmers, farms, and management practice

Farmers' access to agricultural loans, adoption of farming practices, and farm profit have all been influenced by their characteristics of socioeconomic status, scale of farms, and management practice (Akpan et al., 2013; Nouman et al., 2013). Majority of Sonali farmers middle-aged male in this study which reflects young and energetic people being involved with this farming and this result is supported by an earlier study (Howlader et al., 2022) who reported that the highest number of Sonali chicken farmers within the male (92.2%) and middle-aged (31 to 50 years, 52.2%). Majority of farmers (60%) had good/very good level of education (secondary to hon's) which is very much suitable for reading materials related to farm management and others in order to improve farm practices and thus income. As 40% farmers had no education/minimum education, we need to have special arrangement to educate farmers on improve farm management. In this study 44% farmers were involved with agriculture and poultry farming and 25% farmers were housewife. These are indicative of the national picture of small to medium scale poultry farmers (Islam et al., (2015). Job holders and students having Sonali farms are turned as new pattern in the study area. Major portion of the Sonali chicken farmers were low experienced (72.6%) which is true scenario as Sonali farming is relatively new avenue and lot of promise to generate income. However, there is potential risk of being failed for farmers as they start farming without any prior training. These farmers need proper education and training on Sonali farming to make their farming sustainable. Small to medium scale farmers (90%) dominated over large scale in this study. Biosecurity standard of small-to medium-scale famers are generally poor (Rimi et al., 2017) and thus frequent occurrence of infectious diseases and overuse of antibiotics (Parkhi et al., 2022). Farmers in the study area reared both Sonali classic chicken (60.3%) and Sonali hybrid (39.7%). Farmers claimed that Sonali classic chickens had a relatively lower incidence of disease and were easily available. However, farmers reported or it is reported that Sonali hybrid gains better weight. Most of the farmers procured DOC directly from the hatchery (64.4%) and 35.6% of the farmers procured DOC from feed and chick dealers. Farmers also claimed hatchery-collected chicks were of much better quality than dealer-collected chicks. As poverty farmers did not have the means to procure chicks directly from the hatchery, they are forced to buy outstanding from feed and chick dealers. Most of the farmers (91.8%) vaccinated their Sonali chickens. They usually vaccinate birds against Newcastle Disease, Infectious Bronchitis, and Infectious Bursal Diseases (M. B.

Uddin et al., 2010). This is a good practice to prevent infectious diseases. However, diseases still occurs due to poor chick quality, poor farm hygiene, poor vaccination practices, poor management on farm, and non-adherence to biosecurity (Abbas et al., 2015). To reduce production costs and due to a lack of awareness of the importance of vaccination, the rest of the farmers do not vaccinate chickens regularly. Majority of farmers had buried the dead birds (53.4%) which is a very good practice to prevent the spread of diseases. Throwing dead birds (41.1%) in open places (like crop field, pond, lake) is very risk to spread out infectious diseases to neighboring farms which should be stopped and for this farmers' education is needed. Similar result was reported by (Belgrad et al., 2018) who found that 47.2% farmers buried their dead bird. Dead birds are always a potential source of infectious agents. Proper disposal of dead birds had a significant protective factor in the poultry farm (Mustafa et al., 2018). The present study identified that the maximum farmers (94.5%) sold their bird at single time, which is a desirable farm management practice, but few farmers (5.5%) sell chickens several times because more DOC is raised on the farm in proportion to the space and when the chickens grow up the flock density increases. Then the farmers sell the chickens in several stages to bring the balance to the farm. This results in more stress on the chickens and a greater tendency for germs to enter the farm. So, with the 'all in, all out' system one looks forward to the best chicken farming with minimal chances of disease problems because effectively stops the carry-over of fragile pathogens on a site. This effect is further enhanced by modernized facilities and effective cleaning and disinfection.

Disease prevalence of Sonali chicken

A wide range of diseases or disease conditions with single or concurrent occurrence in Sonali chickens was estimated through the present study. The present study revealed the overall prevalence of coccidiosis was 31.0% in Sonali chickens which is coincided with the study conducted by Belal, (2018) in Sirajgonj district of Bangladesh (35.5%). However, Hasan et al., 2017 and Tipu et al., (2021) reported slightly lower prevalence of Coccidiosis (21.1% in Joypurhat) and (21.3% in Kishoreganj). Haque & Gofur, (2020) and Olanrewaju & Agbor, (2014) reported a lower (15.5%) and higher (65%) prevalence of coccidiosis in the Naogaon district of Bangladesh and Abuja of Nigeria, respectively compared to that recorded in the current study. The variation in the findings might be due to different factors, such as sampling periods, sample size, diagnostic procedures, geographical area, management, density of the population, season, and climatic conditions prevailing in the study area. In the present study, we calculated the overall

prevalence of ND as 14.3% in Sonali chickens. The result was strongly supported by (Tipu et al., 2021) who reported the prevalence of ND as 14.64% in Sonali chickens in the Kishoreganj district. Similar result was reported by Talukdar et al., (2017) who reported 11.24% prevalence of ND in Sonali chickens in the Bogura district. On the contrary, 19.39% of ND cases were recorded in Sonali chickens in the Joypurhat district (Hasan et al. 2017). Chickens of all ages are susceptible to ND (Abdisa & Tagesu, 2017). The present study showed the overall prevalence of infectious Bursal disease (IBD) in Sonali chicken was 13.1%. The result was strongly supported by (M. N. Haque & Gofur, 2020) who reported 13.7% prevalence of IBD in Sonali chickens in the Naogaon district. Contrastingly, Talukdar et al., (2017) and Hasan et al., (2017) who reported 14.72% and 25.51% prevalence of IBD, respectively in Sonali chickens of the different regions in Bangladesh. These estimates may be influenced by poor farm biosecurity, non-vaccination, and inadequate vaccination protocols (Sharif & Ahmad, 2018). About 4.8% prevalence of Low pathogenic avian influenza (LPAI) was recorded in our study. There are very limited studies on LPAI even not in Sonali Chickens. According to (M. Z. Rahman et al., 2020), 7.78% seroprevalence of LPAI in Sonali chickens of Joypurhat district. LPAI viruses are circulating in poultry farms of Bangladesh (Parvin et al., 2014). The overall prevalence of High pathogenic avian influenza (HPAI) in the current study was 1.2% and all chickens died in this Sonali chicken farm. According to (Rimi et al., 2019) highly pathogenic avian influenza (HPAI) which causes generalized rather than respiratory disease with flock mortality as high as 100%. The present study revealed a 11.9% overall prevalence of Colibacillosis in Sonali chickens. This estimate was close to the findings of Islam et al., (2021) and Talukdar et al., (2017) who reported 13.6% and 14.72% prevalence of Colibacillosis in Sonali chickens in the Kishoregonj and Bogra district, respectively. The prevalence of colibacillosis might be due to unhygienic management of the farm, and the supply of contaminated water and feed (Mamun et al. 2019). The present study revealed that Necrotic Enteritis (NE) attributed to 4.8% of total cases in Sonali chickens. This estimate agreed with the findings of Mamun et al., (2019) and Aktar et al., (2022) who reported 2.56% and 6.2% prevalence of NE in Sonali chickens in the Kishoregonj and Rajshahi district of Bangladesh, respectively. It has been shown that physical, environmental, and feeding changes can predispose birds to NE (M'Sadeq et al., 2015). According to the present investigations, the prevalence of Ascariasis was 2.4%. However, Islam et al., (2020) reported a considerably higher prevalence of Ascariasis (7.6%) in Sonali chickens, than the estimate of the present investigation.

Risk factors for Coccidiosis in Sonali Chickens

The multivariable association model showed that the most significant factor for coccidiosis was flock size of 501 to 5100 birds (OR=2.92). The present finding also revealed significantly higher prevalence of coccidiosis in the farms with flock size of 501 to 5100 birds. This agrees with (Kalita et al., 2018) who reported higher incidence of coccidiosis in the farms with flock size of more than 1000 birds. Yunus et al., (2008) further reported the incidence of coccidiosis in chickens increased with increase in flock size. Because larger farms require more water, feed, litter and generate greater volumes of feces, they might represent more potential sources of infection (Razmi & Kalideri, 2000). Most of the farmers could not manage properly due to keeping a large number of chickens in a small space. According to Hafez, (2008), coccidiosis is generally regarded as a management-related disease. However, (Al-Natour et al., 2002) recorded no the such difference according to flock size. According to (Wondimu et al., 2019), the poor management farm had significantly 4.2 times higher occurrence (odds) of coccidiosis in chicken than good management farm. Management of poultry houses plays a significant role in the spread of coccidiosis, because coccidian oocyst has high sporulation potential and easily spread in the poultry house environment (Adhikari et al., 2008). Higher prevalence of avian coccidiosis has been attributed to period of rainfall primarily because it positively influences the warm and humid environmental conditions needed for oocysts sporulation (Ola-Fadunsin, 2017).

Common treatment regimens against the Sonali chicken diseases

This study explored the pattern of drugs prescribed for different diseases or disease condition in Sonali chickens. Specific drugs prescribed for protozoal diseases in Sonali chicken were Amprolium and Sulfa-quinoxaline, and Sulfadimidine and Sulfa-dimethoxine. These results are close to the findings of Islam et al., (2021). The most supportive drugs prescribed for Coccidiosis were zinc or vitamin k. Similar result was reported by (Stephens & Tugwell, 1960) who reported vitamin K supportive drugs were effective in preventing prolonged blood clotting time and excessive mortality from cecal coccidiosis in chickens. The zinc was also efficacious to improve intestinal integrity and reduce gut damage caused by *Eimeria* spp. (Santos et al., 2020). Specific antiviral drugs prescribed for the viral diseases (ND, IBD) were Phytochemical (Jingan®) and Andrographis paniculate. Antibiotics were prescribed in the viral diseases (ND and IBD) to check

the secondary bacterial infections. Commonly prescribed antibiotics were Levofloxacin, Enrofloxacin, Doxycycline. These are critically important antibiotics which should be used judiciously; otherwise, antibiotic resistance would be developed. Immune stimulants were the most prescribed drugs for ND and IBD because of increasing immunity against the virus and this is an effective practice for managing viral diseases. Enrofloxacin was prescribed for NE. Contrastingly, Paiva & McElroy, (2014) reported NE has been treated by administering lincomycin, bacitracin, oxytetracycline, penicillin, and tylosin in water. Enrofloxacin, Enrofloxacin and Colistin, Ciprofloxacin, Gentamicin, Levofloxacin and Colistin, and Tylosin were prescribed most frequently for Colibacillosis. These findings are in line with the findings of Hossain et al., (2015) reported gentamicin, neomycin, oxytetracycline, amoxicillin, enrofloxacin and ciprofloxacin were commonly used for the treatment of colibacillosis. Kempf et al., (2016) further reported the main indications for colistin are the prevention and treatment of Enterobacteriaceae infections. According to the World Health Organization (WHO), Colistin is a "reserve" antibiotic, which means it is supposed to be considered a "last-resort" option in the treatment and used only in the most severe circumstances when all other alternatives have failed. Therefore, it is not advisable to use colistin in the first place. Asambe et al., (2018) reported ciprofloxacin was found to be potent against *Escherichia coli* infection. But it was a critically important antibiotic for veterinary and human use. The FDA (U.S. Food & Drug Administration) has approved this drug for use in humans, but it is not officially approved for use in animals. The FDA allows veterinarians to prescribe products containing this drug in limited cases for critical situations. Piperazine citrate was used as the specific drugs for Nematoda cases (*A. galli*) at the present study which supported by Sukhapesna, (1990). This study recorded 13 different types of antibiotics prescribed against various cases of Sonali chickens. The hospital has no set protocol for drug administration and is therefore using the drugs indiscriminately. With increased pathogen antibiotic resistance to animal infections and the close relationship between food animals and people in Bangladesh, people will soon come into contact with antibiotic resistant strains of bacteria (M. S. Khan et al., 2014). The most frequent used of these were sulfa drugs, enrofloxacin, levofloxacin, and colistin which are supported by Rahman et al., (2019). It was further reported development of proper treatment protocols and the use of antimicrobial sensitivity testing are of paramount importance going forward in the treatment of the poultry diseases. To decrease the development and spread of antimicrobial resistant foodborne bacteria, we must reduce the injudicious use of antimicrobials in

veterinary and human medicine. This is of greatest importance for drugs that are "critically important" to human medicine, and the WHO list of critically important antimicrobials is an important tool at the country level for member states to use in development and implementation of risk management strategies in food production animals. Strategies that control the use of critically important antimicrobials in food animals have been shown to be associated with lower resistance rates, not only in bacteria from animals but also in bacteria carried by humans.

Conclusion and recommendation

This study estimated a wide range of diseases or disease conditions with single to concurrent occurrence of diseases. The prevalence of ND, IBD, LPAI, HPAI, Coccidiosis, NE, Colibacillosis, and Ascariasis were also recorded. The overall prevalence of coccidiosis was the highest among these infectious diseases, though the results of overall prevalence by their causal pathogens showed that most of cases were attributed by viruses. Larger flock was identified as a significant risk factor for Coccidiosis. Poor management, high stocking density and poor chicks' quality was significant factor for higher prevalence of coccidiosis. Ionophore and Sulfa drugs were used as the specific drugs for protozoal diseases. Zinc and vitamin k were used as the supportive drugs for coccidiosis. Phytochemical/ herbal (Jingan®), levofloxacin, and immune stimulant were used as the main drugs, antibiotics, and supportive drugs, respectively for common viral diseases. Antibiotic was prescribed indiscriminately in the treatment of Sonali chicken disease. Reserve and critically important antibiotics were prescribed in the first choice. Chick quality evaluation, proper farm management, and antibiotic use training programs should be offered to poultry farmers in the study areas and surrounding areas. Not all poultry diseases can be accurately diagnosed based on clinical signs and PM lesions. Therefore, laboratory support is essential for confirmatory diagnosis and antibiotics sensitivity tests. So, a field diagnostic laboratory for poultry disease should be developed and introduced at each Government Veterinary Hospital in Bangladesh. Further microbiological and molecular diagnoses are suggested for detailed studies of these diseases and their pathogens.

Limitation

The greatest limitations of the study were little time for sample collection. The sample size was rather small and not representative of a large population. Furthermore, the veterinary hospital receives patients from only a certain radius that may not be representative of the entire country of

Bangladesh. Similarities among postmortem findings for different diseases might have created misclassification bias. Farmers may have withheld information producing information and response biases (missing information like litter material information). However, the local veterinarian used his experience along with PM lesions to differentiate the poultry diseases in this study. Seasonal variation is an important issue for Bangladesh. The relationship of seasonality with disease prevalence of Sonali chickens was not mentioned in this study. Therefore, future studies should discuss such relationships with importance.

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Appendix I: Breeder and commercial Sonali farm

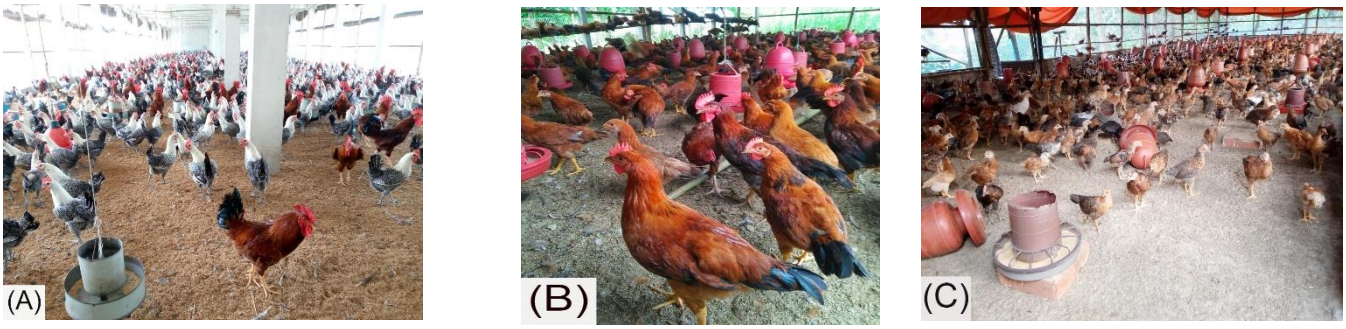

Figure 5: Breeder and commercial Sonali farm in Ullahpara Upazila, Sirajgonj, Bangladesh. (A) Road Island Red (RIR♂) cocks and Fayoumi hens (♀). (B) Classic Sonali chicken. (C) Hybrid Sonali chicken.

Appendix II: Postmortem finding of Sonali chicken

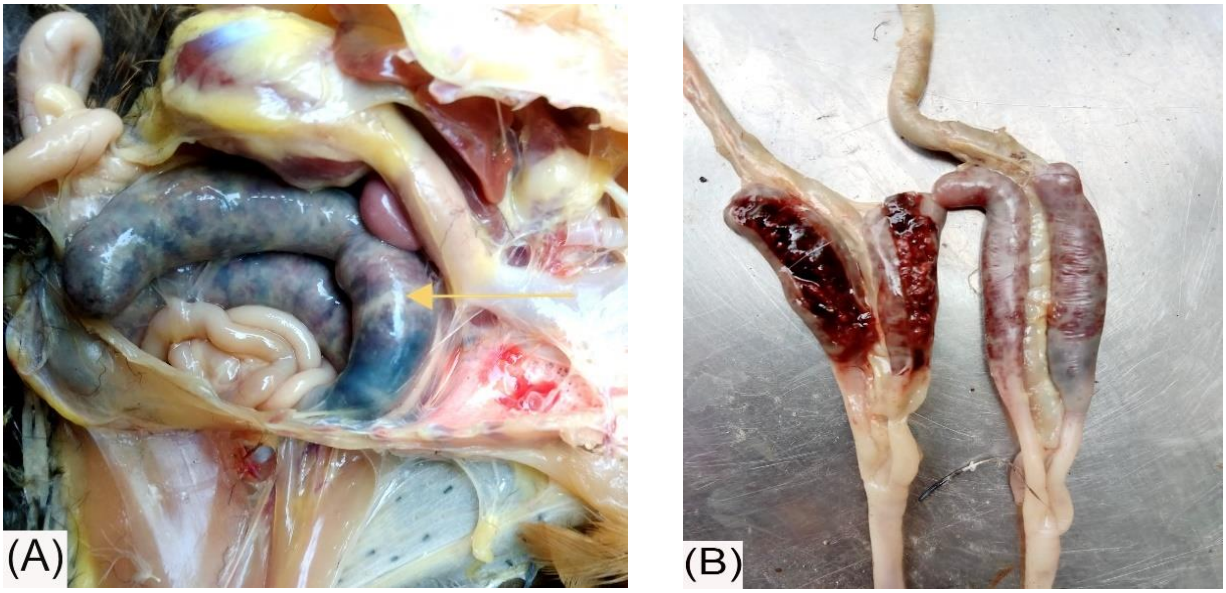

Figure 6: PM of findings of Coccidiosis. (A) swollen and distended of caeca, (B) clotted blood in the caeca.

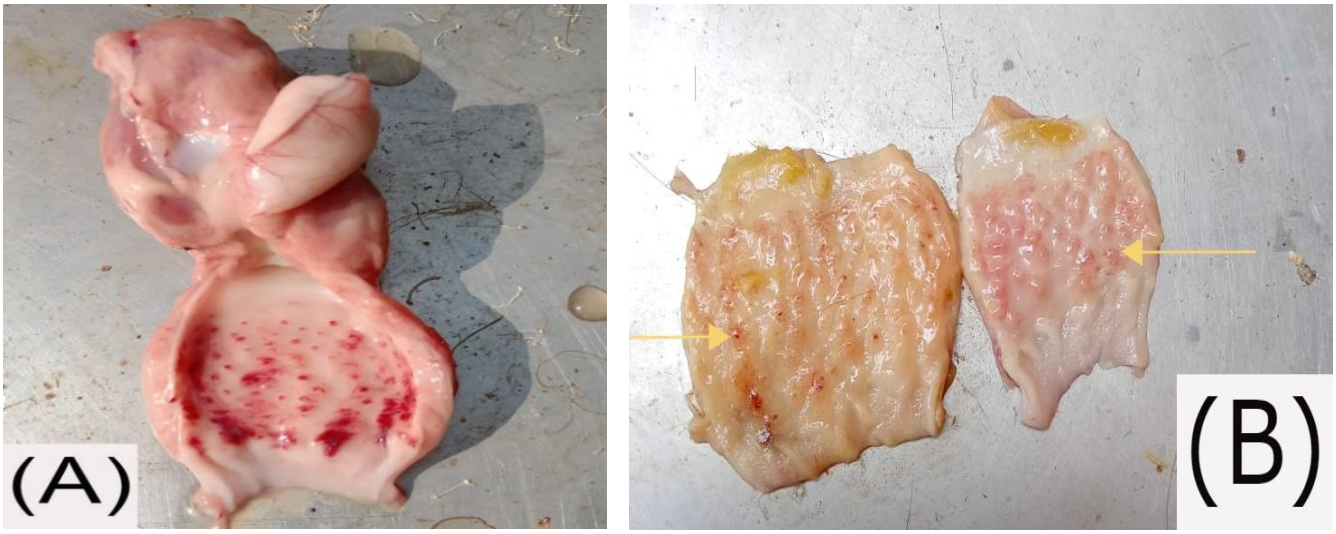

Figure 7: PM of finding of ND. (A, B) pin point hemorrhage at the tip of the proventricular gland.

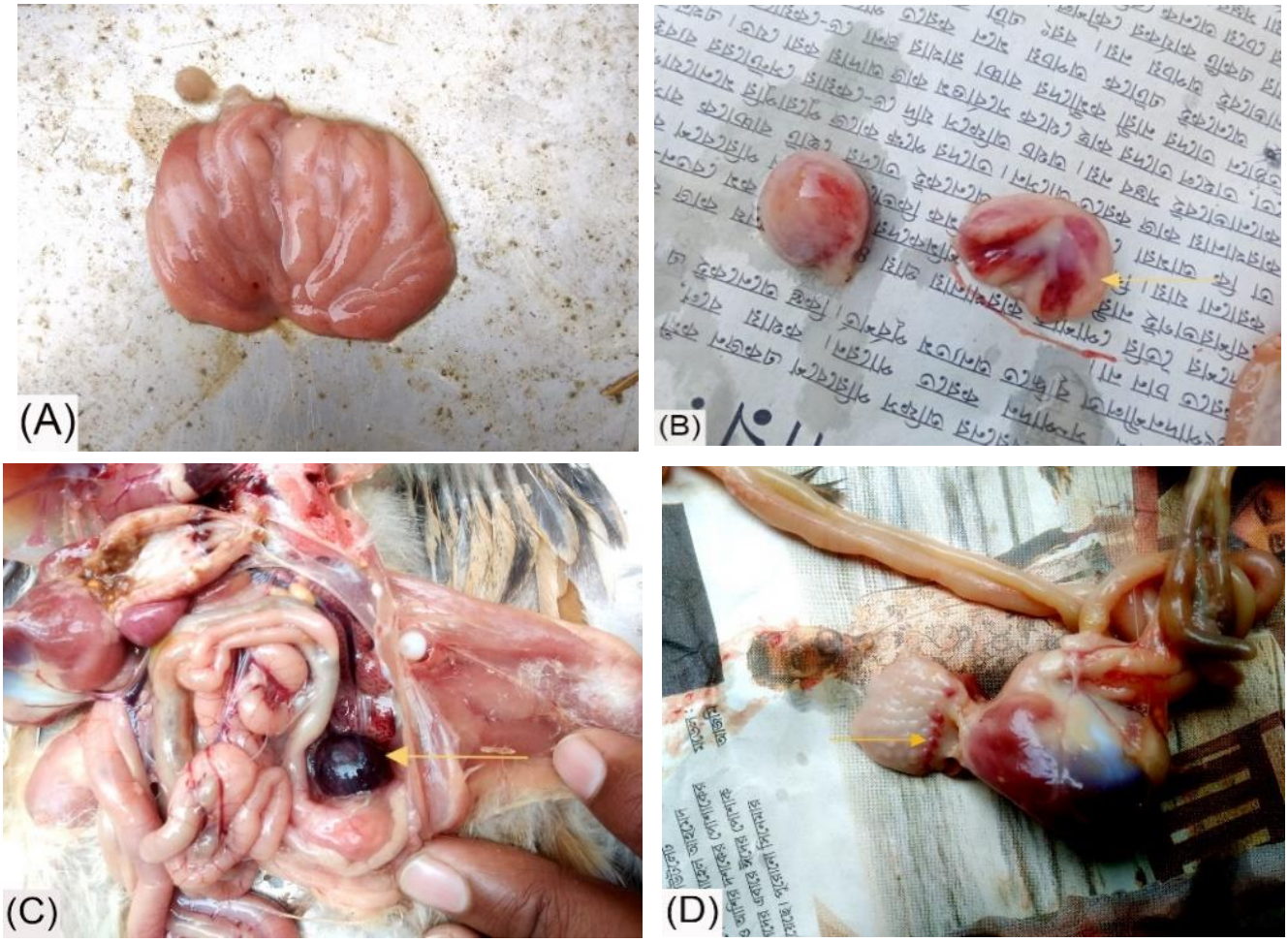

Figure 8: PM finding of IBD. (A, B, C) swollen, hemorrhagic, and edematous bursa, (D) hemorrhage in the junction between gizzard and proventriculus.

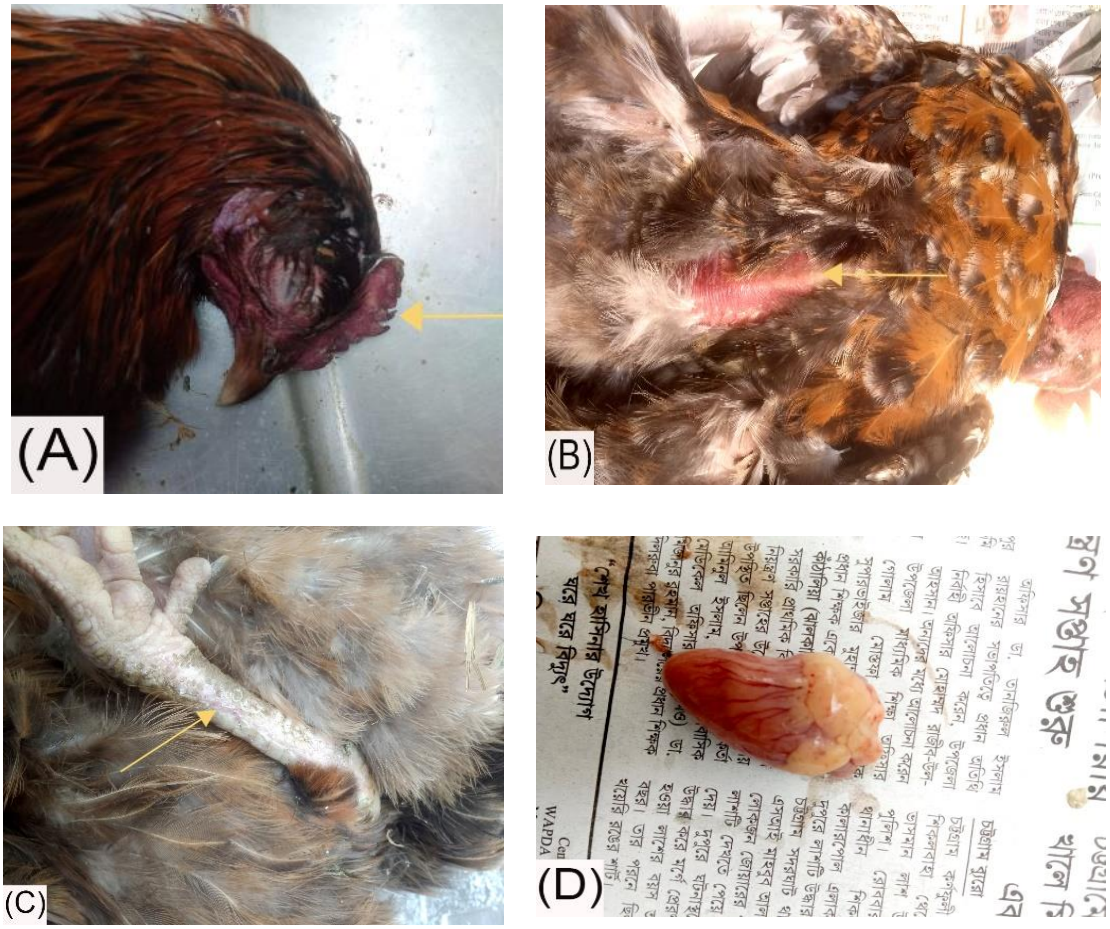

Figure 9: PM finding of Avian Influenza. (A) cyanosis in comb and wattles, (B) subcutaneous hemorrhages, (C) hemorrhage on the shank, (D) petechial hemorrhages on coronary fat.

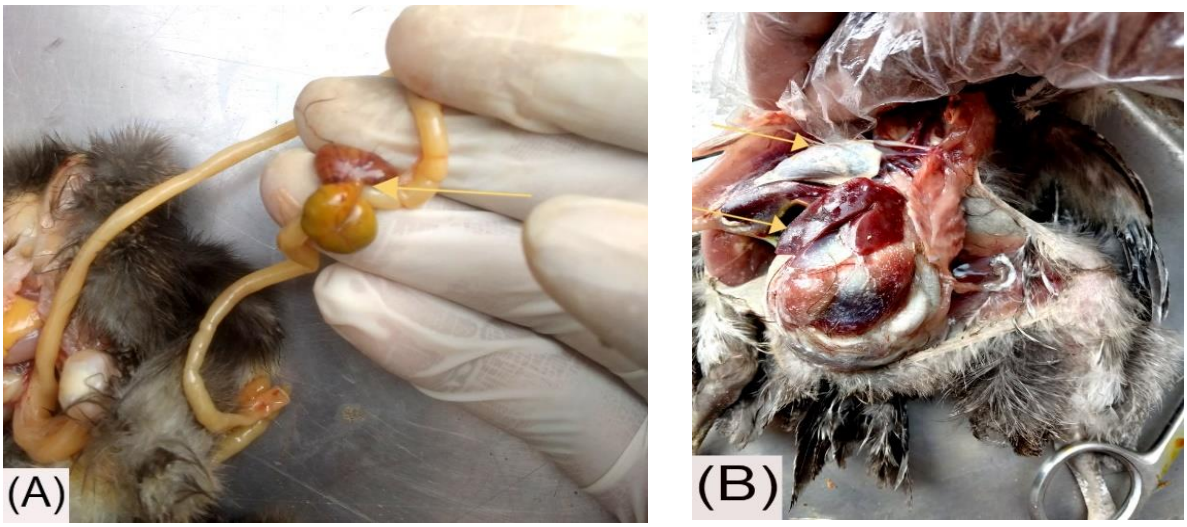

Figure 10: PM finding of Colibacillosis. (A) omphalitis, (B) diseased heart and liver covered with yellowish-white fibrinous exudates.

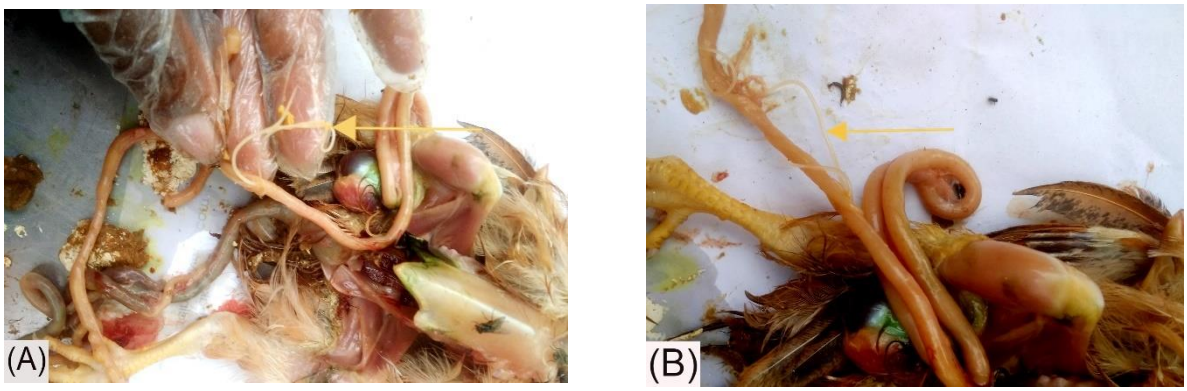

Figure 11: PM finding of Ascariasis. (A, B) *A. galli* is found in the intestine.

Biography

I am Md. Rasel Prank. I was born in Boropangashi, a remote area of the Sirajgani district. I passed my Secondary School Certificate (SSC) examination from Ullapara Adharsha High School, Sirajganj in 2013, and my Higher Secondary Certificate (HSC) examination from Govt. Akbar Ali Collage, Ullapara, Sirajganj in 2015. I enrolled for a Doctor of Veterinary Medicine (DVM) degree at Chattogram Veterinary and Animal Sciences University (CVASU), Chattogram, Bangladesh in the 2016-2017 session. In the near future, I would like to work and have a massive interest in Epidemiology.