Study on Poultry Coccidiosis in Different Production Systems in and Around Bishoftu, Oromia Region, Ethiopia

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Abstract: A cross sectional study was conducted in and around Bishoftu from November 2015 to May 2016 to determine the prevalence of poultry coccidiosis, identification of the circulating Eimeria species and identification of the associated risk factors in different poultry production systems. A total of 312 clinically sick and dead chickens of different age, sex and type were collected from small scale and large scale intensive poultry production systems. Direct examination of smears of intestinal scrapings and fecal specimens, floatation of intestinal content/ fecal samples, post mortem examination of the site and the nature of gross lesions and Histopathological examinations were conducted. The result revealed that out of 312 examined chickens 88 (28.2%) were found to be positive for poultry coccidiosis of which 46 (39.7%) were from small scale intensive production system and 42 (21.4%) were from large scale intensive production system. There was statistically significant difference ($\chi^2=11.95$, P-value<0.05) in the prevalence of poultry coccidiosis between the two production systems. Statistically significant difference ($\chi^2=4.034$, P-value<0.05) was also observed in the prevalence of poultry coccidiosis between the different age groups with high prevalence in young chickens than adults. There was no statistically significant difference (P-value>0.05) in the prevalence of poultry coccidiosis between the two sexes and type of chicken. Five Eimeria species namely, Eimeriatenella (33%), Eimerianecatrix (27.7%), Eimeria maxima (18.1%), Eimeriacervulina (15.9%) and Eimeriabrunetti (10.2%) were identified. Post mortem examination revealed that the cecum was severely affected by coccidia than other portions of the chicken intestine.

Key words: Bishoftu • Coccidiosis • Eimeria species • Post mortem • Floatation • Poult

INTRODUCTION

The world poultry population has been estimated to be about 16.2 billion, with 71.6% in developing countries, producing 67, 718,544 metric tons of chicken meat and 57,861,747 metric tons of hen eggs. The total poultry population in Ethiopia was estimated to be 42 million [1].

Three types of poultry production systems are identified in Ethiopia [2]. These are traditional (backyard) poultry production system, small scale and large scale intensive production systems. The main objective of rearing chicken in all production systems is concerned with egg and meat production, for income generation and home consumption.

In Ethiopia, poultry diseases are considered the most important factors responsible for reducing both the number and productivity of chickens [3]. Coccidia infection in chicken causes greater financial losses than in other domesticated birds[4]. In Ethiopia, the study conducted by Kinung’hi et al. [5] showed that coccidiosis contributes to 8.4% and 11.86% losses in profit in large and small-scale farms, respectively. Losses due to mortality following a severe outbreak may be devastating and incidence rates as high as 80% were sometimes observed in the country [6].

Poultry coccidiosis is an economically important disease in chicken caused by the intracellular protozoa parasite of Eimeriaspecies in the genus Eimeria, family Eimeridae, order Eucoccidiorida and phylum
Apicomplexa [7]. For many years, coccidiosis has been a major cause of poor performance and lost productivity in poultry and other farm animals [8].

Though nine species of *Eimeria* (E. tenella, E. necatrix, E. acervulina, E. maxima, E. mivati, E. brunetti, E. mitis, E. praecox and E. hagani) [9] have been identified as causative agents of poultry coccidiosis, only seven of them (except E. mivati and E. hagani) have been reported to be pathogenic [10]. *E. tenella* and *E. necatrix* are the most pathogenic species. *E. acervulina, E. maxima* and *E. mivati* are common and slightly to moderately pathogenic [9]. *Eimerianecatrix* has been reported as the most common pathogenic species causing intestinal coccidiosis in the domestic poultry among all the *Eimeriaspecies* [11]. *Eimeriaspecies* are omnipresent and can survive in infected birds and the environment for long times [4].

The species of *Eimeria* identified in Ethiopia are *E. tenella, E. necatrix, E. maxima, E. brunetti* and *E. acervulina* [12]. *E. mivati* was also reported [13].

*Eimeria* have direct life cycle, they are very site specific with reference to the development (intestine) and to cell types (epithelial cells of the intestinal villi or cells) [14]. The life cycle of coccidia involves sexual and asexual phases. The oocysts are extraordinary resistant to environmental stress and disinfectants, remaining viable in the litter for many months. Temperatures above 56°C and below 0°C are lethal but it seems to be impossible to decontaminate a previously contaminated poultry house or environment. Sporulated oocysts can be spread mechanically by wild birds, insects or rodents and via contaminated boots, clothing, equipment or dust. Direct oral transmission is the natural route of infection [4].

The infectious process is rapid (4-7 days) and is characterized by parasitic replication in host cells with extensive damage to the intestinal mucosa. Coccidia which are deep tissue invaders such as *E. maxima, E. necatrix* and *E. tenella* cause severe necrosis, hemorrhage of the intestinal mucosa and bloody diarrhea and many result in death. Signs include watery and bloody droppings, mortality (0-50%) and morbidity (0-100%), depression, poor weight gain and feed conversion and a drop in egg production [8].

Coccidiosis remains to be one of the major diseases problems of poultry in spite of the advancement made in prevention and control through chemotherapy, management and nutrition [15]. The disease is endemic in most of the tropical and subtropical regions where ecological and management conditions favour an all-year round development and propagation of the causal agent [16].

[17] has pointed out that coccidiosis to be one of the major diseases of poultry in commercial system than in backyard system. In all parts of the world where confinement rearing is practiced, coccidiosis represents a major disease problem demanding the attention of poultry producers, feed manufacturers and poultry disease experts, the occurrence of clinical Coccidiosis is directly related to the number of sporulated oocyst ingested by a bird at one time, the pathogenicity of the *Eimeria* species, the age of the infected chicken and the management system [18].

In large population of chicken kept confined together, the risk of acquiring sufficient dose of oocyst is more likely to occur and the risk factor is very high for young chicken than old age groups, which have developed immunity from pre exposure [19].

Preliminary studies on the prevalence of coccidiosis done in Ethiopia shows that both clinical and sub clinical coccidiosis have been occurring with low prevalence rate in the local strain chicken kept under the backyard production system than in the commercial oriented production systems [20].

Although several researches have been undertaken on poultry Coccidiosis in different parts of the country, the disease is still one of the major problems of the Poultry industry.

Therefore, the objectives of this study were:

- To determine the prevalence of poultry coccidiosis in the study area
- To identify the species of *Eimeria* circulating in the area
- To identify the associated risk factors

**MATERIALS AND METHODS**

**Description of Study Area:** The study was conducted in the Oromia regional state in and around Bishoftu town from November 2015 to May 2016. Bishoftu is located 45 Km southeast of the capital city Addis Ababa. The area is located at 9° N latitude and 40° E longitude. The altitude is about 1880 meter above sea level. The average annual rainfall is 866 mm with a bimodal distribution. The long rainy season extends from June to September (of which 84% of the rain is expected) followed by a dry season from...
October to February. The short rainy season lasts from March to May. The mean annual minimum and maximum temperatures are 14°C and 26°C, respectively. The mean relative humidity is 61.3% [21]. In Ada’aLiben district where Bishoftu is the center, there are about 191, 380 poultry [22].

Farmers in the vicinity of Bishoftu town use a mixed crop and livestock farming system. Moreover, Bishoftu and its surrounding have variable and yet representative agro-ecologies of the country. These agro-climatic zones are inhabited with different plant and animal species [1].

**Study Population:** The study was conducted on 312 clinically sick and dead chickens of different age, sex and type collected from small scale and large scale intensive production systems in and around Bishoftu town. The chickens were grouped in to sex (Male and Female), Age groups (young (2-8 weeks) and adult (above 8 weeks of age)) and Type (Layers and Broilers).

**Sampling Method and Sample Size Determination:** The sampling technique employed was Simple random sampling method to collect all the necessary data from the study Chickens. However, effort has been made for proportional allocation of samples for the different variables (sex, age, type and production system). The sample size was calculated using the formula given by [23] by considering an expected prevalence of 71.7% from a previous report by [24] from the same study area as follows:

\[
N = \frac{1.96^2 \times P_{exp} (1-P_{exp})}{D^2}
\]

where

- \(N\) = required sample size
- \(P_{exp}\) = expected prevalence (71.7%)
- \(D\) = desired absolute precision
- 1.96 = \(z\)- value for 95% confidence interval

Accordingly the sample size of the present study was 312.

**Study Design:** A cross sectional epidemiological study design was employed to carry out the study.

**Study Methodology:** The study was conducted on randomly selected clinically sick and dead birds using fecal floatation and post mortem examination. The examination was conducted on daily basis. Information on different potential risk factors was collected by personal observation during the farm visit, farm records.

**Post Mortem Examination:** Clinically sick chickens were euthanized by cervical dislocation using the technique described by Zander [25]. Post Mortem examination was conducted on dead birds by opening their abdominal cavity and viscera according to the procedure described by Lobago et al. [26]. The exposed abdominal cavity and viscera was examined thoroughly for gross pathological changes. The intestinal portions were divided into 4 sections, the upper part (duodenum and jejunum), the middle part (ileum), lower part (distal ileum and rectum) and cecal pouches. The contents of different segments of the intestine were examined after rinsed in a running tape water to remove trace of blood. The serosal surfaces of the small and the large intestines were also examined for gross pathological changes. The intestine was opened at different positions (Duodenum, mid Intestine, the lower intestine and the caeca) using scissors according to the method utilized by Lobago et al. [26].

**Microscopic Examination:** Mucosal scrapings were taken from segments of the intestine with gross lesions for microscopic examination of developmental stages of coccidia. The scrapings were placed on microscopic slides and diluted with a drop of distilled water using Pasteur pipette, mixed thoroughly and covered with a cover slip and finally examined under light microscope according to the procedure utilized by Lobago et al. [26] and described by Luna [27].

**Fecal /Intestinal Content Floatation Technique:** The presence of coccidian oocyst was determined by using fecal flotation method. 3 gram of intestinal content was weighed using a digital balance and was put into a mortar and mixed with floatation solution (NaCl). By using a pistol, it was thoroughly mixed and strained using a sieve into another beaker. The filtrate was poured into test-tube of respective sample number and centrifuged at 1500 rpm for 3 minutes. Then the test tubes were placed in a test tube rack and each test tube was filled to the brim with the floatation solution, covered with a cover slip and left to stand for 10 minutes after which they are gently lifted up. The cover slips were then placed on microscopic slides and viewed under the microscope [28].
Histopathological Examination: Intestinal and cecal tissue samples of about 1-3 cm length were taken from the dead chickens having classical lesions and submitted to the National animal health diagnostic center (NAHDIC) Sebeta, Ethiopia for Histopathological examination. The samples were processed according to Luna [27]. In brief, the tissue samples were fixed in 10% neutral formalin for Histopathological examination, the tissues were trimmed to 3 to 5 µm thickness and then processed in an automatic tissue processor in different chambers containing different alcohol concentrations (70, 80, 95 and 100%). The processed tissues were cleared in xylene and embedded in paraffin for preparation into fine blocks. Blocks were sectioned with a microtome to a size of 5 µm; afterward, they were dewaxed and the tissues section was stained using haematoxylin and eosin (H and E) stain as described by Bancraft et al. [29]. The slides were mounted with xylene and allowed to dry and examined under a light microscope for any abnormality of tissue and detection of developmental stage of coccidia.

Identification of Species of Eimeria: Identification of the different species of Eimeria was achieved by considering the location of the gross lesions on the chickens intestine, nature and characteristics of the gross lesions and Histopathological findings. The information from these findings was combined and compared with identification key given by Long and Reid [30].

Data Analysis: All collected raw data that were recorded from the study were entered to a Microsoft Excel database system and imported to be analyzed descriptively by using SPSS Version 20. The data that are imported to database system, include, age, sex, breed, type of production system, type of chicken and laboratory results. Variation of infections, prevalence between age, sex, type of chicken and production systems were determined by using a chi-square test. A p-value of less than 0.05 at 95% confidence interval (CI) was considered statistically significant.

RESULTS

Overall Prevalence of Poultry Coccidiosis in the Study Area: In this study, out of 312 dead chickens studied from the two production systems (small scale intensive and large scale Intensive farms) 88 chickens were found positive for poultry coccidiosis. Accordingly the overall prevalence of poultry coccidiosis in the study was 28.2%.

Prevalence of Poultry Coccidiosis Within Different Production Systems: Both small scale and large scale intensive poultry farms were included in the study. 116 and 196 dead chickens were examined from both production systems respectively. The prevalence of poultry Coccidiosis in the two production systems was 39.7% (46) and 21.4% (42) respectively. The difference in the prevalence of poultry coccidiosis between the two production systems was found statistically significant ($x^2=11.95$, $P<0.05$) (Table 1).

Prevalence of Poultry Coccidiosis by Age: In this study, out of 312 dead chickens examined 149 of them were young and 163 were adult. It was observed that 33.6% of the young were positive and 23.3% of adult chickens were positive for Poultry Coccidiosis. The difference in the prevalence of the two age groups was found statistically significant ($x^2=4.034$, $P<0.05$). Higher prevalence of Poultry Coccidiosis was observed in young chickens than adult chickens (Table 1).

Prevalence of Poultry Coccidiosis by Sex: Among the totally examined dead chickens 126 of them were male from which 31.7% of them were found positive for poultry Coccidiosis and from 186 examined female chickens 25.8% of them were found positive. Chi square test revealed that there was no statistically significant difference between the two sexes ($P$-value$>0.05$).

Prevalence of Poultry Coccidiosis by Type of Chickens: From the total of 312 chickens examined in this study 150 of them were Broilers from which 32.0% of them were found positive and 162 of the total chickens examined were Layers from which 24.7% of them were found positive for poultry coccidiosis. However, no statistically significant difference was found in the prevalence of poultry coccidiosis between the two types of chickens ($x^2=2.054$, $P$-value$>0.05$).

Identified Eimeriaspecies by Site of Infection and Gross Lesions: In this study from the totally examined dead chickens 88 (28.2%) of them have showed different types of gross lesions at different sites of the intestine. The majority of the lesions observed were Petechial Hemorrhage and clotted blood in the intestine mainly on the cecum, thickening of the intestinal wall, ballooning of the small intestine and mucus and bloody secretion from the mucosal surface of the intestine. The majority of the lesions were found on the cecum followed by the
Table 1: Prevalence of poultry coccidiosis by different risk factors

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Category</th>
<th>No examined</th>
<th>No Positive</th>
<th>Prevalence</th>
<th>$x^2$</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production system</td>
<td>Small scale intensive</td>
<td>116</td>
<td>46</td>
<td>39.70%</td>
<td>11.955</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Large scale intensive</td>
<td>196</td>
<td>42</td>
<td>21.40%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>Young</td>
<td>149</td>
<td>50</td>
<td>33.60%</td>
<td>4.034</td>
<td>0.045</td>
</tr>
<tr>
<td></td>
<td>Adult</td>
<td>163</td>
<td>38</td>
<td>23.30%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td>Male</td>
<td>126</td>
<td>40</td>
<td>31.70%</td>
<td>1.309</td>
<td>0.253</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>186</td>
<td>48</td>
<td>25.80%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Types of chicken</td>
<td>Broiler</td>
<td>150</td>
<td>48</td>
<td>32.00%</td>
<td>2.054</td>
<td>0.152</td>
</tr>
<tr>
<td></td>
<td>Layer</td>
<td>162</td>
<td>40</td>
<td>24.70%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>312</td>
<td>88</td>
<td>28.20%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: The species of *Eimeria* identified from chickens

<table>
<thead>
<tr>
<th>Site of infection</th>
<th>Observed gross lesions</th>
<th>Identified <em>Eimeriaspecies</em></th>
<th>Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cecum</td>
<td>Hemorrhage, thickening of cecal wall, Ballooned cecum, clotted blood</td>
<td><em>E. tenella</em></td>
<td>33.0% (29)</td>
</tr>
<tr>
<td>Small Intestine</td>
<td>Hemorrhage, mucus secretion in the lumen, thickening of the wall</td>
<td><em>E. necatrix</em></td>
<td>27.7% (20)</td>
</tr>
<tr>
<td>Mid small intestine</td>
<td>Hemorrhagic intestine with bloody contents,</td>
<td><em>E. maxima</em></td>
<td>18.1% (16)</td>
</tr>
<tr>
<td>Duodenal loop</td>
<td>Watery exudates, white mucosal streaks</td>
<td><em>E. acervulina</em></td>
<td>15.9% (14)</td>
</tr>
<tr>
<td>Lower small intestine</td>
<td>Hemorrhage</td>
<td><em>E. brunetti</em></td>
<td>10.2% (9)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>28.2% (88)</td>
</tr>
</tbody>
</table>

Histopathological Findings: Histopathologically examined intestinal tissue samples showed different developmental stages of coccidia including, Schizonts and Merozits. The epithelial cells, the villi and the crypts were highly necrotized and invaded with developmental stages of coccidia and high number of inflammatory cells. High number of inflammatory cells were also seen in the lamina propria. The mucosal layer was sloughed and eroded. Hemorrhages and congestion was also observed. Histological examination has revealed that the cecum was severely affected than other portions of the intestine by coccidian (See Annexes).

**DISCUSSION**

In the present study the overall prevalence rate of poultry coccidiosis in the examined 312 chickens from the two different production systems (large scale and small scale intensive production systems) was 28.2%. This finding is relatively comparable to the reports of Ashenafi et al. [20] who reported 25.5% in local strain chickens, [31] who reported 22.3% [32] who reported 23.1% [33] who reported 20.57% in different parts of the country. However, the present finding is relatively lower than the findings of Dinka and Yakob [24] who reported 71.7% in Fayoumi chickens at DZARC and Alamargot [17] who reported 80% in and around Bishoftu. The variation for this difference could be associated with the study time, breed and management system differences and possibility of drug resistance. Furthermore, the lower prevalence rate in the present study could indicate the efficacy of the control and prevention measures taken by the stockholders in the poultry industry.

Higher prevalence was recorded in chickens studied from small scale intensive production systems than large scale intensive production systems which was statistically significant (P-value<0.05). This may be attributed to the relatively lower sanitation management and lower level of biosecurity in the small scale intensive poultry farms compared to large scale intensive poultry production system. High level of stocking density due to lack of enough land space, relatively poor ventilation in the poultry houses that leads to suffocation and the feed and water management in which the feed and water spreads on the ground could also contribute for the higher prevalence of coccidiosis in this farms by creating favorable conditions for sporulation of oocysts and its ingestion by the chickens. In addition, the personnel in these farms are not well trained hence, there could be inappropriate use of coccidiostats that leads to the occurrence of drug resistance.

In this study, young chickens were found to be more exposed to coccidiosis than adult chickens and this was statistically significant (P-value<0.05). This could be due...
to the lower level of immunity of young chickens. Whereas, adult chickens have develop a better immunity due to previous exposure to coccidiosis compared to young chickens which are usually susceptible to initial infections. This finding was inline of agreement with the finding of Gadise[34] who reported statistically significant difference in the prevalence of poultry coccidiosis between the two age categories.

Statistically significant difference was not observed (P-value>0.05) in the prevalence of coccidiosis between the two sexes.

In this study, no statistical difference was observed (P-value<0.05) in the prevalence of poultry coccidiosis in the two types of chickens. However, higher prevalence of coccidiosis was observed in broiler chickens compared to layers. This could be associated with the difference in management systems of the two types of chickens. Broilers are reared in confinement on the ground and this increases the chance of getting oocyst but layers are reared in a cage system. Additionally, age differences of the two types of chickens in which layers who are kept for longer period in the farm can develop more resistance to coccidiosis than broilers who leave the farm at early age.

The biological characteristics of coccidia of chickens are well known and can be used in the identification of Eimeria species [4]. In this study, in the attempt made to identify the species of Eimeria circulating in the study area, five species of Eimeria namely E.tenella, E.necatrix, E.maxima, E.acervulina and E. brunetti were identified with descending order of occurrence. These Eimeria species were previously reported in Ethiopia by Methusela et al. [35] and Ashenafi et al. [20] and Dinka and Yakob [24] and Amareet al.[31] and Luu et al. [36] and abroad in Nigeria [37], Iran [38] and Pakistan [39]. This indicates wide spread of these species in many countries [40].

In the present study E.tenella was the predominant species (33.0%) followed by E.necatrix (22.7%). This finding is consistent with the finding of Gari et al. [6] and Dinka and Yakob [24]. However, previous reports from Ethiopia [20] and Iran [42] revealed dominance of E.acervulina while E.brunetti was reported as the most prevalent species in Kombolcha Ethiopia [26]. This is likely due to drug resistance and very few drugs are equally effective against all Eimeriaspecies [4].

Both gross and microscopic pathological changes observed for each species in the current study were quite similar to previous findings and descriptions [4, 40, 43, 44]. Destruction of host tissue as a result of parasite development and multiplication leads tothe various clinical manifestations.

Grossly observed pathological lesions and changes in different intestinal parts were consistent with findings of Ashenafi et al. [20] and Adamu et al. [45], in which transverse whitish band on the loop of duodenum, ballooning, hemorrhage, mucoid-blood filled exudates, thickened intestinal wall, necrotic white spots and clotted and unclotted blood were observed.

Coccidiosis is known to produce different Histopathological features depending on the Eimeriaspecies [9]. Histopathological examination of intestinal tissue samples with classical lesions revealed that cecum was the most severely affected organ than other intestinal parts. Severity of E. tenellais similar with finding of [45] in which high numbers of oocysts, schizonts and severe tissue damage in the ceca were observed. Less severity of other species is inline of agreement with report of Adamu et al. [45], who reported less severity of E. brunetti than E. tenella. However Ashenafi et al. [20] reported densely parasitized duodenum with E.acervulina.

CONCLUSION

The results of this study indicated that poultry coccidiosis is still one of the major problems of the poultry industry in the study area in both small scale and large scale production systems. This problem is demonstrated by high economical lose due to high mortality rate, cost of treatment and vaccination, cost of restocking and lose of production. There was statistically significant difference between the prevalence of poultry coccidiosis in the two poultry production systems and age categories. Although, statistically insignificant differences was recorded in the prevalence of poultry coccidiosis in the two sex groups and types of chickens high prevalence rate was detected in male and broiler chickens. In this study, five Eimeria species namely, E.tenella, E. necatrix, E.maxima, E.acervulina and E.brunetti were identified. Among the identified Eimeria species E.tenella and E.necatrix were found to be the predominant Eimeria species while E.acervulina and E.brunetti were lower prevalent in the study area. Postmortem examinations showed that the cecal pouch was severely affected by coccidia than other portions of the chickens intestine.

REFERENCES


