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REVIEW ARTICLE

An Overview of the Prevalence of Avian Coccidiosis in Poultry Production and Its Economic Importance in Nigeria

[†‡]Balarabe Rabiu Mohammed and [†]Obeta Sylvester Sunday

[†]Department of Veterinary Parasitology and Entomology, Faculty of Veterinary Medicine, University of Abuja-Nigeria.
[‡]School of Science, Engineering and Technology (SET), Abertay University, Dundee, DD1 1HF, United Kingdom.

*Corresponding Author:

Balarabe Rabiu Mohammed

Email:
balarabemohammed161@yahoo.co.uk

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Abstract

Coccidiosis is one of the most devastating diseases with a substantial economic impact to the poultry industry. Several reports on the prevalence of avian coccidiosis in a number of states across Nigeria have been documented. However, there is no published data on the overall prevalence of this disease on the poultry industry. In this paper review, the prevalence of coccidiosis in the 6 geographical zones and its economic consequences was enumerated. The aetiological agents, signs, treatment and control strategies were also highlighted. Prevalence of 14.2%, 36-43%, 12% and 23.42% (North West zone); 9.5% and 11.4% (North east zone); 36-43%, 69% and 36.6% (North central zone); 12%, 51.5-07.6%, 3.5%, and (South west zone); 35.5% and 14% (South east zone); 36-43% and 15.14% (South south zone) were reported. An overall prevalence of 52.9% coccidiosis across the 6 geopolitical zones has been recorded. Losses associated with coccidiosis both direct and indirect components include; the cost of control measures, production losses and potential consequences to poultry health from resistance to chemoprophylaxis in the region of millions of Naira. Control is by good sanitary measures, avoiding water spillage, overcrowding, the use of prophylactic anticoccidials “shuttle programme” and vaccination. This has implication to the poultry production industry.

Keywords: Anticoccidials, Coccidiosis, Naira, Nigeria, Poultry, Prevalence.

1. Introduction

Poultry refers to domestic birds such as chickens, turkeys, ducks, guinea fowl, peasants, pigeons and more recently ostriches kept for meat or egg production (Muazu *et al*., 2008; Ugwu, 2009; Getu, 2014). Those that are of economic importance given the trade in poultry, however are chicken, guinea fowls and turkeys among which the chickens predominate (Adene and Oguntade, 2006; Ugwu, 2009; Kamani *et al*., 2010; Omodele and Okere, 2014). The poultry industry occupies an important position in the provision of animal protein (meat and egg) to man as well as manure for crops and generally plays a vital role in the national economy as a revenue provider and provides employment (Eduvie, 2002; Nnadi and George, 2010). In 1998, the poultry meat represented 28 % of the world total meat consumption compared to 26.5% for beef (Nnadi and George, 2010; Quiroz-Castañeda and Dantán-González, 2015). It is also estimated that poultry provides 12kg of protein needs per inhabitants per year whereas cattle provides 5.3 kg (Nnadi and George, 2010; Roy, 2013; Nghonjuyi *et al*., 2014). Moreover, compared to a number of other livestock species, fewer social and religious taboos are related to the production, marketing and consumption of the poultry products. For these reasons, poultry products have become one of the most important protein sources for man throughout the world (Radfar *et al*., 2012; Beyene *et al*., 2014). Other important factors in the continuing growth of the poultry industry in many countries include; the ease and efficiency of poultry to convert vegetable protein into animal protein, the attractiveness and acceptability of poultry meat, its competitive cost and the relative ease with which new technologies, such as health care systems, can be passed on to other countries and farmers (Moges, 2009; Roy, 2013). Poultry is one of the most intensively reared of the domesticated species and one of the most developed and profitable animal production enterprises (Al-Jamaien *et al*., 2013, Opara *et al*., 2014). It’s importance in improving the nutritional status and income of many small farmers and those with small land holdings has been recognized by various scholars and rural development agencies in the last two decades (Nnadi and Goerge, 2010; Al-Jamaien *et al*., 2013; Letebrhan *et al*., 2015). Chickens also fulfil other functions such as pest control and sacrifice in special festivities (Maikai *et al*., 2007; Sahlu *et al*., 2015). Poultry production in Africa and parts of Asia is still distinctively divided into commercialized and village enterprises subsector each with its peculiarities. The former comprises of strains specifically developed on the basis of primary products into parent stocks, layers and broilers each with its specialized equipment and management apparatus. The latter however, consists of indigenous domestic fowls (*Gallus domestica*) variously referred to as local chicken, backyard poultry or village chickens and/or free range chickens (Njue *et al*., 2001; Al-Jamaien *et al*., 2013). The total number of poultry in the world has been estimated by the Food and Agriculture Organization of the United Nations (FAO, 1987) to be 14.718 million, with 1.125 million distributed throughout the African continent, 1.520 million in South America, 6.752 million in Asia, 93 million in Oceania, 3.384 million in North America and 1.844 million in Europe. For most African countries, backyard (traditional) poultry accounts for more than 60% of the total national flocks (TNF) with an asset value of more than 5.75 billion US $ (Biu *et al*., 2012; Garbi *et al*., 2015). In Nigeria, the poultry population is estimated to be 160 million; comprising of 72.4 million chickens, 11.8 million ducks, 4.7 million guinea fowls, 15.2 million pigeons, and 0.2 million turkeys million which is estimated at US $250. Backyard poultry constitute about 60% (Fig 1A), and thus the most important form of poultry production (Onyeagocha *et al*., 2010; Akintunde *et al*., 2015; Barde *et al*., 2015; Omokaro, 2015).

The industry contributes up to 15% to the country’s gross domestic product (GDP) and accounts for 36% of total protein intake of the country (Akintunde *et al*., 2015. Historically, poultry diseases remain one of the major threats to boosting poultry production in Nigeria (Laseinde, 2002; Etuk *et al*., 2004; Akintunde and Adeoti, 2014). These diseases are of particular importance because of their high incidence in poultry occasioned by the tropical environmental conditions under which the farmer operates (Seifert, 2006; Adewole, 2012). With the continued increase in poultry production in Nigeria (FAO, 2000) evidenced by the proliferation of farms, it is pertinent to continually evaluate the prevalence and management issues associated with common poultry diseases. Coccidiosis, as one of the most significant diseases of poultry, costs the world's commercial chicken producers at least US$ 1.5 billion every year (Arabkhazaeli *et al*., 2011; 2013; 2014). It is a major parasitic disease of poultry with a substantial economic impact to the poultry industries in Nigeria (Etuk *et al*., 2004; Musa *et al*., 2010; Usman *et al*., 2011). Although previous studies have reported the prevalence of this disease in a number of states across the six geographical zones, there is no published data on the prevalence and impact of avian coccidiosis on poultry production in Nigeria. The objective of this study therefore is to investigate the prevalence of coccidiosis and its economic importance in Nigeria.

2. Aetiology of Avian Coccidiosis in Nigeria

Coccidiosis is generally a disease of animals but predominantly chickens which are highly susceptible to about 11 different species of this single celled obligate intracellular parasite of almost exclusively the genus *Eimeria* (Phylum Apicomplexa). *Eimeria* is an intracellular protozoan parasite in the epithelial cell of the intestine (Alberta, 2007; Patrick and Mgbere, 2010; Lai *et al*., 2011). About 1800 *Eimeria* spp affect the intestinal mucosa of different animals and birds (Nematullahi *et al*., 2008; Muazu *et al*., 2008). In Nigeria, the disease is caused by *Eimeria tenella, E. necatrix, E. bruneti, E. acervulina, E. mitis* and *E. praecox* (Owai and Gloria, 2010; Jatau *et al.*, 2012). The two most pathogenic species however are *E. tenella* and *E. necatrix*, but mixed infections are commonly observed resulting in lower meat and egg productions (McDougald and Reid, 1997; Maikai *et al*., 2007). Infection with a single species of coccidian are rare in natural conditions, mixed infection being the rule but nevertheless in many outbreaks, the clinical entity can be ascribed principally to one species occasionally a combination of two or three (Macmullin, 2001; Patrick and Mgbere, 2010). The disease spreads from bird to bird through eating or drinking contaminated food or water, litter or other materials containing coccidian oocysts (Patrick and Mgbere, 2010; Owai and Gloria, 2010). Similarly, recent studies highlighted the role of the common house fly in the mechanical spreading of the coccidian, thus predisposing even birds in new houses to outbreaks. Alternatively, equipment, personnel, rodents and wild birds have also been incriminated in the spread of coccidiosis (Abdu *et al*., 2008; Musa *et al*., 2010).

3. Clinical Signs

Coccidiosis in poultry is divided into caecal and intestinal. Caecal coccidiosis may produce bloody droppings and anaemia that is often followed by death. Intestinal coccidiosis is more chronic in nature (Muazu *et al*., 2008; Ali *et al*., 2014). Sub clinically, it is manifested by poor performance, impaired feed conversion, poor flock uniformity and poor growth.

Coccidia can damage the immune system and leave poultry more vulnerable to pathogens like *Clostridium*, *Salmonella* and *E. coli* (Yu-wen, 2009). In Zaria, studies indicated *E. tenella* and *E. necatrix* to be the most pathogenic *Eimeria* species causing bloody and caecal coccidiosis respectively (Musa *et al*., 2010) (Fig 2).

4. Epidemiology

Coccidiosis is a disease common in intensively managed farms especially where management or hygiene standards are compromised (Musa *et al*., 2010). Damp litter that has high moisture content and warmth of 25-30^{o}C, favour oocysts sporulation (David, 2000). It was also observed that oocyst sporulation is delayed or not even occur at 10 ^{o}C in dry conditions, while at 45-50 ^{o}C oocysts could sporulate within a day and under optimal conditions of temperature (21-30^{o}C), adequate moisture and oxygen, oocysts could sporulate and become infective within 1-2 days or could get destroyed at 56^{0}C for one hour (Trees, 1999; Etuk *et al*., 2004; Musa *et al*., 2010). Sudden outbreak of coccidiosis occurs following the ingestion of high doses of the sporulated oocysts over a short period of time by non-immune young (3-8 week old) birds (Musa *et al*., 2010). Birds of any age are susceptible to coccidiosis but most birds get infected in the early few weeks of life (Chookyonix *et al*., 2009). Coccidiosis has been reported about 3 days following ingestion of large numbers of sporulated oocysts (Urquhart *et al*., 1996) and under field condition, the incubation period for intestinal coccidiosis was reported to be 5 days while that of caecal coccidiosis was 5-6 days (Chookyonix *et al*., 2009; Musa *et al*., 2010). Furthermore, clinically infected and recovered adult birds have been shown to shed oocysts in their faeces thereby contaminating feed, water and soil (Trees, 1999; Musa *et al*., 2010). Additionally, oocysts have been practically shown to survive outside the host for up to 2 years and resisted low temperatures, dry conditions and many forms of disinfectants (David, 2000).

5. Prevalence of Coccidiosis in Nigeria

Coccidia prevalence has been reported in all flocks worldwide (Yu-wen, 2009; Muazu *et al*., 2010; Györke *et al*., 2013; Gharekhani *et al*., 2014). The global prevalence of *Eimeria*-infected flocks has been estimated at more than 50% in countries throughout Asia, Europe, the Middle East, and South America (Haug *et al*., 2008; Sun *et al*., 2009; Nemaollahi *et al*., 2009; Lee *et al*., 2010; Brooks-Pollock *et al*., 2015). Previous studies also revealed the mortality rate of 54.3% in Turkey (Karaer *et al*., 2012), 92% in Romania (Györke *et al*., 2013), 88.4% in Argentina (McDougald and Mattiello, 1997), 31.7% and 39.6% in India (Sharma *et al*., 2013; Nikam *et al*., 2012), 71.9% in Pakistan (Khan *et al*., 2006), 78% in Jordan (Al-Natour *et al*., 2002), 70.9% in Ethiopia (Gari *et al*., 2008; Oljira *et al*., 2012). Muazu *et al*. (2008) reported an overall 52.9% prevalence of coccidiosis across the 36 states and the federal capital territory Abuja in Nigeria (Fig 3; Table 1).

The prevalence rate of coccidiosis is higher during the rainy season, primarily because it is positively influenced by the warm and humid weather, which characterizes the rainy season period by providing favourable conditions for the growth and development of the infective oocysts (Etuk *et al*., 2004; Alawa *et al.*, 2010). Coccidiosis is also most prevalent among young chicks of 1-5 weeks of age as oocysts could appear in faecal samples of birds as early as 7 days of age with the clinical disease manifesting by the 4th week (Majero *et al*., 2001; Obasi *et al*., 2001). Obasi *et al*. (2001) reported that exposure potential of chicken to coccidian parasites in warm humid tropical condition is high, since environmental conditions favour an all year round development of the coccidian organisms. Coccidiosis should therefore be regarded as ubiquitous in poultry management. Since even under extreme conditions of experimental work it is difficult to avoid infection completely for any length of time (Owai and Gloria, 2010; Pavlović *et al*., 2012). Birds managed on deep litter show higher incidence of coccidiosis due perhaps to their close contact with the infective oocysts in the litter (Etuk *et al*., 2004). Similarly, high stocking density was reported to facilitate coccidiosis (Trees, 1999; David, 2000; Etuk *et al*., 2004).

6. Economic Impact of Coccidiosis

An outbreak of coccidiosis has a very high negative and economic impact on the flock as well as for the poultry producer as treatment alone cannot prevent the economic losses (Majero, 1980; Barksh, 1989). The disease results overall in 51.38% mortality in the poultry industry worldwide (Cocciforum, 2007). The global cost of coccidiosis to the poultry industry has been estimated to exceed \$2 billion per annum (Fornace *et al*., 2013). It is also estimated that the economic losses due to the disease is about US \$ 450 million with additional US \$ 100 million due to medication in the united states alone (Pakissan.com 2005; Maikai *et al*., 2007). In Nigeria where poultry farming is less developed, the disease is more serious and causes heavy economic losses. The losses associated with coccidiosis include both direct

Table 1: Prevalence of avian coccidiosis across the six geopolitical regions states and Abuja in Nigeria

State	City	Zone	%	References
Kaduna	Zaria	North west	36 - 43	Uza *et al*. (2001); Etuk *et al*.(2004)
Katsina	Katsina	North west	23.42	Ukashatu *et al*. (2012)
Sokoto	Sokoto	North west	12	Adamu *et al*. (2009)
Borno	Maiduguri	North east	9.5	Balami *et al*. (2014)
Gombe	Gombe	North east	11.4	Grema *et al*. (2014)
Abuja	Gwagwalada	North central	69	Olarenwaju *et al*. (2014)
Benue	Makurdi	North central	36-43	Uza *et al*. (2001); Etuk *et al*. (2004)
Plateau	Vom	North central	36.6	Muazu *et al*. (2008)
Ekiti	Ekiti	South west	3-5	Adewole (2012)
Ogun	Ogun	South west	3-5	Adewole (2012)
Oyo	Ibadan	South west	51.5- 97.6	Adene and Oluloyode (2004)
Enugu	Nsukka	South east	35.5	Nnadi and George (2010)
Imo	Owerri	South east	14	Opara *et al*. (2012)
Akwa Ibom	Abak	South south	29.36	Majero (1981); Etuk *et al*. (2004)
Cross river	Calabar	South south	15.14	Owai and Gloria (2010).

and indirect components; including the cost of control measures, production losses and potential consequences to animal health from resistance to chemoprophylaxis could be in the region of millions of Naira (Maikai *et al*., 2007; Fornace *et al*., 2013). The disease therefore carries losses for the farmer in the form of mortalities, reduced market value of the affected birds and sometimes culling or delayed slaughter time (Yu-Wen, 2009).

7. Strategies to Control Avian Coccidiosis

7.1 Immunoprophylaxis

A coccidian free environment is not likely achieved; chicks that become infected may develop acquired immunity or succumb to diseases if the balance is in favour of the parasite (Chookyinox *et al*., 2009). Immunity to coccidiosis in chickens is *Eimeria* specific (Urquhart *et al*., 1996; David, 2000). Birds that survive severe coccidiosis may never be productive which while survivors of one strain of *Eimeria* may become infected with another different strain thereby requiring further treatment (Chookyonix *et al*., 2009). Resistance to the diseases usually increases with age of birds (Chapman, 1997; Uza *et al*., 2009). Davis (1981) reported maternal immunity against coccidiosis occur at the height of serum antibody production, unfortunately serum antibodies have been found to be very essential for prevention against coccidiosis. Prophylactic administration of anti-coccidial drugs such as amprolium is a common practice in Nigeria (Abdu *et al*., 2008).

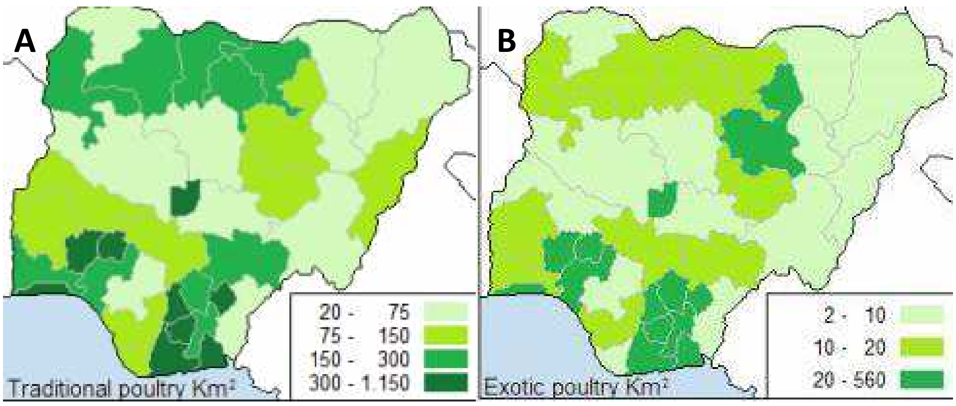

Fig 1: A. Geographical distribution of traditional poultry stated in Km^2 in Nigeria B. Distribution of exotic breed of poultry stated in Km^2 in Nigeria. Distances are stated in Km^2. This distribution does not take into account the fact that there are commercial poultry farms based on exotic birds operated on a backyard poultry basis and that subsistence household poultry rearing can be based on exotic birds. Adapted from Pagani *et al*. (2008). http://www.fao.org/3/a-ak778e.pdf

Fig 2: Caecal coccidiosis caused by *Eimeria* spp can cause severe enteric disease. Ballooning and hemorrhages (Arrows) of the intestine. Adapted and modified from Jatau *et al*. (2012). http://scialert.net/qredirect.php?doi=ajpsaj.2012.79.88&linkid=pdf

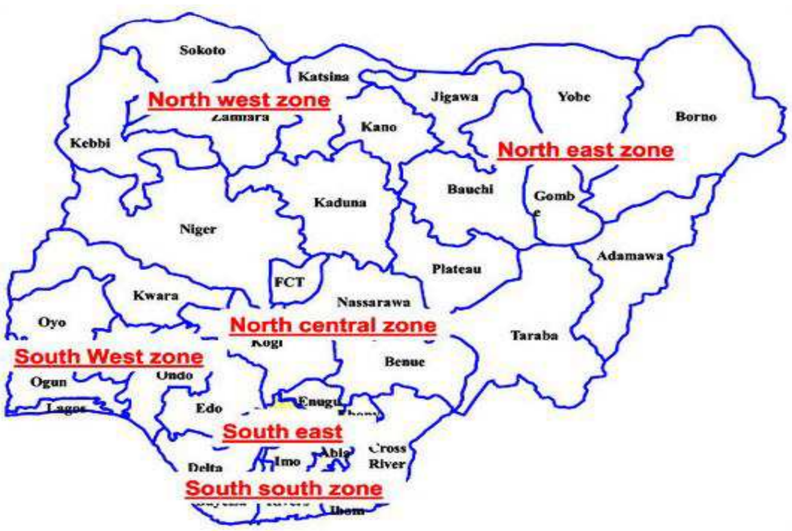

Fig 3: Shows a map of Nigeria indicating the six geopolitical regions and the federal capital territory (FCT), Abuja**.** Adapted from Dineen *et al*., (2008).http://openi.nlm.nih.gov/imgs/512/24/2572038/2572038_1471-2415-8-17-1.png

7.2 Anticoccidial Treatment and Coccidiostats

The disease is controlled mainly by hygiene and use of chemical anti-coccidial agents (Chapman, 2000; Nwosu *et al*., 2011; Elkhtam *et al*., 2014). Coccidiosis though highly prevalent in Nigeria can be successfully managed using a combination of chemoprophylaxis and good hygienic practices (Chapman, 2000; Etuk *et al*., 2004; Adewole, 2012). However, cost and indiscriminate use of anti-coccidial drugs including monensin, ionospheres and nicarbazin have resulted in the emergence of resistant strains of *Eimeria*. These have cut short the usefulness of successive commercial drugs thereby prompting the exploration of new areas for appropriate medicinal relief (Patrick and Mgbere, 2010; Nwosu *et al*., 2011).

8. Alternative Control Strategies

Such medicinal relief include; *Melia Azadirachta* (National Research Council, 1993; Biu *et al*., 2006) in Neem leaves which has been reported to produce antiprotozoal, antibacterial and antifungal effects (Schmutterer, 1990). Other aqueous stem back extracts used for the treatment of coccidiosis include; *Khaya senegalensis, and Anona senegalensis*, *Aloe excels, Camellia sinensis*, *Curcuma longa*, *Echinacea purpure*, *Origanum vulgare*, *Saccharum officinarum, Triticum aestivum*, *Yucca schidigera* (Abbas *et al*., 2012). Their photochemical analysis reveals that tannins, terpenes, anthraquinones, phlobitaminans, alkaloids, cardiac glycosides and steroids were present in various concentrations (Nwosu *et al*., 2011). Other alternative control measures across the globe mentioned in (Table 2).

Genetic studies have also revealed that resistance to avian coccidiosis is linked with microsatellite markers LEI0071 and LEI0101 on the gene chromosome and associations between parameters of resistance to coccidiosis and single nucleotide polymorphisms (SNP) in 3 candidate genes located between LEI0071 and LEI0101 [*zyxin*, *CD4*, and tumor necrosis factor receptor super family 1A (*TNFRSF1A*)] have also been determined (Hong *et al*., 2009; Tewari and Maharana, 2011). Therefore, an improved knowledge of natural genetic resistance can pave the way towards effective chemotherapeutic and prophylactic control of avian coccidiosis.

9. Prevention and Control

Although coccidiosis is controllable under most circumstances, the cost of control makes the disease one of the most expensive parasitic diseases encountered in the poultry industry. Good sanitary measures, avoiding water spillage, overcrowding, and the use of prophylactic anti-coccidia "Shuttle programme" are essential to control the menace of coccidiosis (Musa *et al*., 2010). Litter should always be kept dry and special attention given to litter near fonts or feeding troughs. Good ventilation also reduces the humidity in the house and helps to keep litter dry. Coccidial oocysts are extremely resistant to environmental conditions and disinfectant agents, so eradication of coccidiosis from chicken houses by litter removal, cleaning and disinfection is not feasible (Carvanates, 2008; Ajao *et al*., 2010). Recent advancement has shown that characterisation of the infective *Eimeria* species transcriptome may provide a better understanding of the biology of the parasite and aid in the development of a more effective control for coccidiosis (Amiruddin *et al*., 2012).

10. Conclusions

Profitable poultry production demands efficient management as well as effective coccidiosis control measures since diseases remain and will continue to remain a major profit limiting factor in the poultry industry. The potentials for increasing poultry population and its product such as meat, eggs can only be met and fully realized if birds are adequately protected against coccidiosis. Recent advances in

Table 2: Some dietary modulators of immunity as anticoccidial dietary additives commercially available

Feed additive	Functions	References
Mushroom and herb extracts	Enhancement of both cellular and humoral immune responses in *E. tenella* infected chickens	Guo *et al*. (2004)
Fish oils, flax seed oil	Reduce the lesion caused by *E. tenella* causes ultra-structural degradation of both asexual and sexual stages by inflicting oxidative stress	Allen *et al*. (1997a, b) Danforth *et al*. (1997)
Dietary plum	Promote protective immunity against coccidiosis	Lee *et al*. (2008)
Artemisinin	Effective in reducing oocyst output from both *E. acervulina* and *E. tenella* infections	Allen *et al*. (1997a, b)
Probiotic Mitomax	Prophylactic drug for controlling poultry coccidiosis caused by *E. acervulina* and *E. tenella*.	Lee *et al*. (2007)
Immunobiotics, particularly lactic acid bacteria	Act as useful as immunomodulators to stimulate the gut-associated immune system in neonatal chicks, and thereby protect them from disease without decreasing growth performance as a possible substitution of antibiotics	Sato *et al*. (2009)
Antioxidants (Gamma tocopherol)	Reduces the severity of infection of upper and middle part of small intestine caused by *E. acervulina* and *E. maxima*	Tewari and Maharana (2011)
Sugar beet containing betaine and salinomycin	Reduces cell invasion *by E. acervulina* by directly affecting the development of the parasite	Augustine and Danforth (1999); Augustine *et al*. (1997)
Mycobacterium phlei	Prevents enteric pathogens during a critical phase in their lifespan Also act as immunostimulant agents and have beneficial roles against caecal coccidiosis	Bera *et al*. (2010); Quiroz-Castañeda and Dantán-González (2015).

molecular genetics and functional genomics are now allowing for rapid progress in understanding the molecular mechanisms of disease resistance against major infectious agents of poultry. It is anticipated that identifying the nature of host-pathogen interactions will facilitate the development of novel vaccines and therapeutics. Recent advances in molecular genetics and functional genomics are now allowing for rapid progress in understanding the molecular mechanisms of disease resistance against major infectious agents of poultry. It is anticipated that identifying the nature of host-pathogen interactions will facilitate the development of novel vaccines and therapeutics.

11. Recommendations

Government should organize continued education on the advantages of vaccination and adoption of integrated approach involving good hygienic practices and the use of both drugs and vaccines to prevent the disease. Additionally, regular extension services to poultry farmers on the menace of coccidiosis in particular and poultry diseases in general will ensure sustainability in the control strategies. A further study on the genetic basis of survival of the coccidian parasite within the avian host and the key molecules associated with the disease is quintessential as a recent technique in disease control. The regulatory mechanisms involved in the host for the expression of key molecules is equally important for better understanding of the pathogenesis as well as help in devising strategies for their amelioration. Such approach as applied in some developed countries if applied in Nigeria will help ameliorate the menace of avian coccidiosis.

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