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Coccidiosis in goats and its therapeutic management

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Abstract

Goats are a major source of income for rural families. Coccidiosis was one of the most common and fatal diseases in goats, causing large financial losses as the goat industry grew. Young goats were more susceptible to parasite. Coccidiosis is caused by protozoan parasites of the apicomplexan genus *Eimeria*. The most pathogenic coccidia species are considered to be *E. arloingi* and *E. ninakohlyakimovae*. Microscopy of faeces: Identification of coccidian spp depends on size and shape of oocysts and morphology of sporocyst, demonstration of the development stages of *Eimeria* spp. by Giemsa stain and haematoxylin eosin stain, molecular diagnosis using Polymerase chain reaction for detection of *Eimeria* spp. conventional control strategy is achieved by careful husbandry combined with in-feed anticoccidial drugs or vaccination with live or attenuated parasites. It is very urgent to develop safe and effective multivalent vaccines against mixed infection of all the economically important species of *Eimeria*.

Keywords: Coccidia, diarrhoea, eimeria, goat, kids, microscopic, molecular

Introduction

Goats are one of the first animals domesticated by man. Goats are contributing to the economically weak rural people's economy. Goats are used for its milk, meat, hide and manure. Goats are a major source of income for rural families (Chakrabarti *et al.*, 2014) ^[13]. Goats are easy to raise, require little capital, provide local food, and yield a more consistent income than other animals. In order to take advantage of the food supplies that are accessible in their area, goats may consume a variety of leaves that cattle and buffalo cannot (Celi *et al.*, 2022; Palomino-Guerrera *et al.*, 2024) ^[12, 46].

Coccidiosis was one of the most common and fatal diseases in goats, causing large financial losses as the goat industry grew. Young goats were more susceptible to parasites (Quyen *et al.* 2024) ^[48]. Coccidiosis is considered one of the most prevalent and economically important parasitic diseases in goat production systems worldwide (Yusof and Isa, 2016) ^[54]. The effects of coccidiosis usually extend from 4 to 10 weeks of age, and are especially important around weaning time due to changes in feeding and stress caused during this period (Singh *et al.*, 2014) ^[53]. Barba *et al.* (2022) ^[8] reported that India possesses 140.5 million goats accounting to 16.53% of the total global goat population and 18.97% of the total meat produced in the country. Goats are vulnerable to various parasitic diseases that not only undermine their health but also play a role in lowering the overall productivity and are responsible for causing heavy losses due to reduced production, morbidity and mortality in animals especially in developing countries (Lu *et al.*, 2021; Diao *et al.*, 2022) ^[18].

Etiology Coccidia in Goats

Coccidiosis is caused by protozoan parasites of the apicomplexan genus *Eimeria*. This disease is a major cause of mortality, poor performance and lost productivity in domestic livestock. The parasites have an oral-faecal life cycle involving three phases: schizogony (also known as merogony), gametogony and sporogony (or sporulation). The infective transmission stage is the oocyst which contains, when sporulated, four sporocysts each containing two sporozoites. Following ingestion, the sporozoites are released and penetrate epithelial cells of the intestine. This is followed by schizogony, an asexual phase of multiplication involving several repeated generations, and gametogony, which results in the

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production of a new generation of oocysts that are passed out in the faeces (Chapman *et al.* 2013; Duszynski *et al.* 2024) [14, 19].

11 species of the genus *Eimeria* in goats are *E. arloingi*, *E. christiensi*, *E. jolchijevi*, *E. alijevi*, *E. ninakohlyakimovae*, *E. capina*, *E. caprovina*, *E. hirci*, *E. apsheronica*. The most pathogenic coccidia species are considered to be *E. arloingi* and *E. ninakohlyakimovae* (Nguyen-Ho-Bao *et al.*, 2022; Nunes *et al.*, 2015) [44, 45]. Goats are resistant to adverse environmental conditions, and endure semi-arid and dry areas far better than other farm animals. Moreover, they have more modest food requirements than other ruminants. Factors that increase the risk of prevalence of coccidiosis in goats are a warm and rainy summer (from July to October), a mild winter and a cool spring (Balicka-Ramisz *et al.*, 2012; Carvalho Junior *et al.*, 2023) [6, 11]. Intestinal coccidiosis is one of the most important parasitic diseases of small ruminants' worldwide affecting kids of 2-4 months old causing kid mortality leading to economic losses (Meena *et al.*, 2023; Rout *et al.*, 2015; Akgul and Akgul, 2021) [2, 40, 49].

Transmission

Bangoura and Bardsley (2020); Lianou *et al.* (2022) [7, 35] reported that the oocysts from the environment are transmitted directly by faecal-oral infection route, the susceptible hosts ingesting contaminated feed, drinking from contaminated water sources, licking on surfaces contaminated with faecal material, and so forth. According to Deshmukh (2022) [16] the parasites' life cycle, coccidiosis is a self-limiting infection because there are no stages left inside the gut after the life cycle is completed and the oocysts are excreted. Clinical disease occurs when young non-immune animals are exposed to massive challenges with sporulated oocysts. Coccidiosis is common in four to six months old age kids and lambs and they manifest higher prevalence under conditions of intensive husbandry system (Etsay *et al.*, 2020; Hashemnia *et al.*, 2015) [24, 29].

Pathogenesis of coccidiosis in goats

Mohammed *et al.* (2021) [42] and Kheirandish *et al.* (2014) [34] mentioned that *Eimeria* spp parasites that obligate development in epithelial cells for the cytoplasm and produce cell death from infection with parasite and hyperplasia. The severity infection has a relation with number of oocyst take by the animal and on the location of the parasite in the epithelial lining of the intestines *Eimeria* species Immune status and age of host and the stages of development in the various intestinal regions (Nahavandi *et al.*, 2016; Karimzadeh *et al.*, 2022) [32, 43]. Coccidia cause changes in the intestinal mucosa of infected animals causing localized haemorrhage and atrophy which results in decreased intestinal absorption. Pathogenic species and sites of infection are *E. arloingi* small intestine, *E. christiensi* small intestine, *E. ninakohlyakimovae* small and large intestine (Elazazy, 2023; Keeton and Navarre (2018) [20, 33]. Many factors affect on the pathogenicity of *Eimeria* such as the dose of oocysts ingestion, host cell destruction, location of parasite in host tissues, stage of infection, general condition and age of host, and degree of immunity which may be acquired or natural. *Eimeria* spp. infections resulted in superficial development with villi atrophy, which might be due to a decrease in epithelial cell life time and the surface area accessible for absorption,

resulting in a lower feed efficiency (Shaheed and Al-Aziz, 2023) [52]. Severe damage to the intestinal mucosa is caused by the second generation meronts and sexual stages of *Eimeria*. Destruction of capillaries in the intestinal mucosa may lead to hypoproteinemia and anaemia. Secondary bacterial infection can occur and cause severe enteritis (Engidaw *et al.*, 2015) [23].

Clinical symptom of coccidiosis in goats

de Macedo *et al.* (2020) [15] observed that sub clinical infection is the most common manifestation of the disease, which has a significant impact on herd health and production. One of the first signs is a delay in development, especially in young animals. However, when clinical infection occurs, signs such as diarrhoea, anorexia, weight loss and dehydration can be noted. The initial clinical symptom of *Eimeria* infection includes the abrupt acute diarrhoea with bad odours and stools including mucus and blood, as well as an increasing loss of body weight. Remarkable pale mucous membranes, weakness, staggering, dyspnoea, dehydration, and recumbency were also reported appetite, dullness, pale mucous membranes, and minor pyrexia as clinical indications of acute *Eimeria* leading to a disruption of the digestive system resulted in the release of water, electrolytes, and protein (Acharya *et al.*, 2020) [1]. As explained by Zainalabidin *et al.* (2015) [55] protozoa usually cause acute invasion and destruction of intestinal mucosa, they invade and destroy intestinal cells, resulting in loss of blood and electrolytes and poor absorption of nutrients. The most common sign of infection is diarrhoea, which may be severe and the faeces may contain blood.

The initial infection usually occurs in the first weeks of life, when goat kids ingest oocysts attached to the udders of their dams but generally acquire low numbers to trigger clinical signs. Several immunocompetent cells have been found within the mucosa of goat kids experimentally infected with *Eimeria ninakohlyakimovae*, including polymorphonuclear cells, mast cells, eosinophils, globular leukocytes, and lymphocytes (Ruiz and Molina, 2019) [50].

Diagnosis of coccidiosis in goats

Many laboratory tests are there that can be performed to confirm the diagnosis of coccidiosis. Microscopy of faeces: Identification of coccidian spp depends on size and shape of oocysts and morphology of sporocyst, demonstration of the development stages of *Eimeria* spp by Giemsa stain and haematoxylin eosin stain, molecular diagnosis using Polymerase chain reaction for detection of *Eimeria* spp (Mohammed *et al.*, 2021; Premaalatha *et al.*, 2016) [42, 47]. El-Shahawy (2016) [21] stated that the coccidial infection of each faecal sample was examined by flotation technique using saturated saline; with coccidian oocysts per gram (OPG) quantified using modified McMaster technique. Furthermore, identification of oocysts was done by incubating faecal samples in 2.5% (wt./vol) potassium dichromate at room temperature for 2-5 days.

Identification was based on the morphological features of the oocyst and sporocysts. Faecal sample collected directly from the rectum, for the diagnosis of infection with coccidia protozoan parasite (*Eimeria* spp.). Direct smear, flotation in saturated salt solution, and culturing with 2.5% and 5% Potassium Dichromate (wt./vol.) methods at room temperature are used for the diagnosis and classification of

various *Eimeria* spp (Al-Bayati *et al.*, 2016; Bawm and Htun, 2021) ^[3,9].

Purified oocyst samples from goat feces were frozen and thawed to break the oocyst walls mechanically, thereby releasing the genomic DNA. The freeze-thawing process was carried out by storing the sample in a freezer at -20°C for 15 minutes, followed by transferring it to a heater at 60°C for 15 minutes until it melted. The sample was then spun down, and this cycle was repeated five times. DNA was extracted using the Geneaid GT100 Genomic DNA Mini Kit (Geneaid, Taiwan) (Dewi *et al.*, 2025) ^[17].

DNA was extracted by Phenol Chloroform Isoamyl protocol using 0.2mm glass bead and freeze thawing method (Carvalho *et al.*, 2011) ^[11].

Molecular characteristics of caprine-derived *Eimeria* spp. using a combination of 18S rRNA and COI. Molecular techniques can be used to identify *Eimeria* spp. in goat faecal samples, specifically through characterization at 18S locus and other gene loci when used in parallel. Molecular techniques offer some advantages over microscopy for identification of *Eimeria* species, particularly with respect to precision (Al-Habsi *et al.*, 2017; Makawi, 2024) ^[4,38].

Treatment of coccidiosis in goats

Iqbal *et al.* (2013); Awasthi *et al.* (2022) ^[5,30] reported that goats were treated with toltrazuril @ 20 mg/kg b.wt once orally and other goats treated with amprolium @ 50 mg/kg b.wt for 5 days orally. Goats treated with toltrazuril gained 2.67 kg over a period of four weeks, while those treated with amprolium gained 1.87 kg over the same period. Toltrazuril was shown to be safe and effective in the prevention and control of caprine coccidiosis.

Gibbons *et al.* (2016) ^[27] suggested that Amprolium with a dosage of 50 mg/kg orally for 5 days resulted in a significant decrease in faecal oocyst counts and improved clinical appearance.

Toltrazuril was shown to decrease oocyst counts and increase growth rates in goats at both 1 and 2 mg/kg when given once at 3 weeks or at three and five weeks of age. Toltrazuril resulted in a complete reduction in faecal oocyst counts by seven days after treatment compared with 21 days for amprolium treatment for coccidia in goats (Fraquelli *et al.*, 2015) ^[25].

Goats treated with 10% oxytetracycline intramuscularly daily for five days and treated four goats with Sulfadimidine 33.3% subcutaneously daily for five days and reported that oxytetracycline can effectively be used in treating caprine coccidiosis (Garba *et al.*, 2020) ^[26].

Three anticoccidial drugs used to treat the experimental animals; sulphadimidine 33.3% powder (100mg/kg. B.W. given orally daily for 4 days) amprolium 20% powder (50mg /kg. B.W given orally daily for 4 days) and diclazuril 1% solution (1mg/kg. B.W given orally daily for 4 days). Using of sulphadimidine in treatment of coccidiosis, induced a gradual decrease in oocyst count with an efficacy 97.6% and 85.3% in goats respectively, while amprolium has an efficacy 95.6% and 87.6% in goats respectively but, there is a sharp decrease in oocyst count with an efficacy 95.2% and 100% in goat respectively in case of using of diclazuril (Mahmoud *et al.*, 2018) ^[37].

Prevention and Control of coccidiosis in goats

For controlling coccidiosis in goat kids Bélanger-Naud and Vasseur (2021) ^[10] recommended adding an anticoccidial drug to the kids' feed starting at 15 to 30 days of age,

depending on the recommendation source. Feeding 1 mg of decoquinate (a quinolone coccidiostat) per kg of kid BW per day for 30 days was found to be efficient at preventing coccidiosis in dairy goat kids around weaning.

According to Emanfo *et al.* (2017) ^[22] in goat rearing, a mixture of *Azadirachta indica* leaves (Neem plant) and fresh seeds of this plant reduced oocyst excretion in kids of 2 months of age. The leaves of the plant are most concentrated in medicinal substances and this plant may control coccidia of the genus *Eimeria*. Mohamed *et al.* (2022) ^[41] reported that conventional control strategy is achieved by careful husbandry combined with in-feed anticoccidial drugs or vaccination with live or attenuated parasites. It is very urgent to develop safe and effective multivalent vaccines against mixed infection of all the economically important species of *Eimeria*.

Pens should not be overcrowded. They should be kept dry and well-bedded. No feed should be fed on the ground or the floor of a pen. Feeders should be elevated or located on the outside of the pen (Matos *et al.*, 2017) ^[39]. Water receptacles should be kept clean and free from faecal matter. Good nutrition is essential to maintaining high levels of immunity in the flock or herd. Balanced rations, with proper vitamin and mineral supplementation, should be fed (Gonzaga *et al.*, 2021) ^[28]. Colostrum will provide immunity to coccidiosis for the first several weeks of the neonate's life. An adequate intake of colostrum will help kids cope with coccidial infection. Washing and drying the female's udder before colostrum consumption may further help to limit infection (Schoenian, 2016) ^[51].

Conclusion

Coccidiosis is one of the major parasitic diseases affecting goats worldwide, especially young kids during early growth and the weaning period. The disease is mainly transmitted through the faecal-oral route, and factors such as poor hygiene, overcrowding, environmental contamination, and stress increase the risk of infection. Early diagnosis using faecal examination, microscopic analysis, and molecular techniques is essential for proper disease management. Anticoccidial drugs including toltrazuril, amprolium, diclazuril, and sulphadimidine are effective in reducing oocyst shedding and improving the health and productivity of affected animals. Therefore, proper awareness, good husbandry practices, timely treatment, and preventive measures are necessary to control coccidiosis, improve animal welfare, and enhance the economic benefits of goat farming.

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