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Anticoccidial efficacy of *Curcuma longa* (turmeric) and *Zingiber officinale* (ginger) in goats in central Kashmir

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Abstract
The present work was undertaken to evaluate the anticoccidial efficacy of *Curcuma longa* (turmeric) and *Zingiber officinale* (ginger) against *Eimeria* species of goats in central Kashmir. Although rhizomes of these herbs are potential alternatives to coccidiostats, their use has not been properly documented. For this purpose, 71 animals harbouring *E. arloingi*, *E. caprina*, *E. christenseni*, *E. ninakohlyakimovae* and *E.alijevi* with an overall OPG of above 6000 were randomly selected and divided into 5 groups (group A, group B, group C, group D and group E).Group A (n=15) received turmeric @ 300 mg/kg body weight/day, group B (n= 13) received turmeric @450mg/kg body weight/day, group C (n=15) received ginger @ 300mg/kg body weight, group D (n=13) received ginger@ 450mg/kg body weight, orally for 7 days in each group and group E (n=15) was kept as untreated infected control. Faecal samples from rectum were directly collected on '0' day before treatment and on 8th, 14th, 21st and 28thday after starting treatment. All treatments resulted in decreased oocyst counts post-treatment compared to before treatment. The maximum efficacy of turmeric@300mg/kg body weight was observed on day 21 as 63.53% while as turmeric@ 450mg/kg body weight had the maximum efficacy of 77.49% on day 21, after starting treatment.Ginger@300mg/kg body weight revealed the maximum efficacy on day 21 as 63.01% while as ginger@ 450mg/kg body weight showed the maximum efficacy of 60.44% on day 21 after starting treatment. Turmeric at both the doses and ginger at 300mg/kg b.wt showed significant difference of efficacy on day 8 with all other days (P<0.05). Ginger at 450mg/kg b.wt showed a significant difference (P<0.05) in efficacy on 8th day with that on day 21 and 28. Turmeric @ 450mg/kg b.wt showed a significant difference (P<0.05) with other treatment groups on day14 and 21.On day 28, both the turmeric-treated groups had a significant difference (P<0.05) with the ginger treated group @ 300mg/kg body weight.

Keywords: *Curcuma longa*, *Zingiber officinale*, *Eimeria*, efficacy, goats, Kashmir

1. Introduction
Protozoa infections are the major constraints in livestock production all over the world particularly developing countries like India where animals are generally reared in natural conditions and because of high animal density, reinfections occur more rapidly and effectiveness of drugs becomes poor. Coccidiosis is one of the most pathogenic infections responsible for considerable morbidity and mortality particularly in young animals. It is a serious disease of small ruminants in India as well as in various parts of the world and in different animal species (Hari *et al*., 2010) [15]. To date, it is customary to control coccidiosis by using anticoccidial drugs. Several drugs are licensed for control of coccidiosis in small ruminants. Undoubtedly this practice has played a crucial role in the growth of livestock industry; however it has increased the selection pressure against most anticoccidial drugs and increased the concern on potential toxicity of drug residues in edible tissues and milk. This worldwide and rapid development of drug resistance coupled with escalating costs of developing new drugs and public distrust of drug treated meat (Hur *et al*., 2005) [18] have greatly reduced the commercial incentive to develop new chemical anticoccidials (Chapman, 1997; Oluyemi and Roberts 2000; Peek and Landman, 2003) [8, 31, 34,]. Further, these anticoccidials are effective only against certain stages of parasite and require long period of treatment. Also resource-poor farmers find purchasing of synthetic drugs too expensive (Maria *et al*., 2015) [27]. Consequently, the development of alternative, safer and eco- friendly anticoccidial agents have become priority in most parts of the world. Some studies have reported the *in vivo* efficacy of natural plant extracts in the treatment of coccidiosis (Oviedo-Rondón *et al*., 2006; El-Khtam *et al*., 2014) [32, 13].

There has been resurgence in the use of medicinal plants to treat cases of parasitism in ruminants and much of the success has been achieved in this direction against a variety of parasites. The herbal products with least side effects and low cost of production has attracted the attention of research workers. The use of seeds, stem, leaves and roots of some plants such as turmeric, mint, garlic, ginger have been exploited to treat animals that suffer from gastrointestinal parasitism as these have been shown to exhibit antimicrobial and anti-parasitic properties (Adeniji *et al*., 2017) [2]. Oxidative stress caused by excessive levels of reactive oxygen species that are induced under stressful environments such as coccidiosis has been regarded as one of the main factor in the pathogenesis (Kris-Etherton *et al*., 2004; Dalloul *et al*., 2006) [25, 12]. Naidoo *et al*. (2008) [29] demonstrated that antioxidant rich plant extracts have potential benefits in treating coccidial infections. Anticoccidial nature of certain herbal products has been reported by Hur *et al*., (2005) [18], Abbas *et al*, (2010) [1], Maria *et al*., (2016) [28] and Adeniji *et al*., (2017) [2]. *Curcuma longa* (turmeric) is a tropical plant native to southern and southeastern tropical Asia. Curcumin is the main important bioactive ingredient responsible for the biological activity of turmeric. Curcumin has been shown to have several biological effects, exhibiting anti-inflammatory, antioxidant and hypolipidaemic activities (El-Khtam *et al*., 2014) [13]. *Zingiber officinale* (Ginger) powder incorporation in the feed of small ruminants provides another alternative against helminth and coccidian load (Adeniji *et al*., 2017) [2]. Ginger powder is readily available in the tropics and subtropics and is environmentally friendly with no visible signs of chemical residues in the animal products. The significant biological properties of turmeric and ginger make them potential anti-coccidial feed additives. In Jammu & Kashmir only one study on the use of herbal drugs as anticoccidials has been carried out in Jammu region by Iqbal *et al*., (2013) [19] while no such study has been carried out in Kashmir valley.

2. Material and methods

2.1 Study area

This study was conducted on goats at Mountain Research Centre for Sheep and Goat (MRCSG), Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir (SKUAST-K), Shuhama, Srinagar located in central Kashmir. No coccidiostats had been used in any of the study animals during the initial examination.

2.2 Study design

First, faecal collection and analysis was performed to quantify the number of *Eimeria* oocysts per gram of faeces to identify and allocate animals randomly into control and experimental groups. For the study purpose, 71 goats naturally suffering from coccidiosis (OPG above 6000) were randomly assigned to 5 groups (group A-E), comprising 15 animals each in three groups and 13 animals each in two groups identified with ear tag numbers. Initially 75 animals were included but four shed less than 500 *Eimeria* oocysts per gram of faeces, thus were not used in the study. Group A (n=15) was treated with turmeric@ 300mg/kg body weight/day, group B (n=13) was treated with turmeric@ 450mg/kg body weight/day, group C (n=15)was treated with ginger@ 300mg/kg body weight/ day, group D (n=13) with ginger@ 450mg/kg body weight/ day, orally for 7 days for each group while group E (n=15) animals were kept as untreated infected control (positive control).The current study was approved by the Animal Ethical Committee of SKUAST Kashmir as per requirement. The complete schedule of treatment for drug trial, dosage and route of administration is presented in Table-1.

2.3 *Curcuma longa* and *Zingiber officinale*: To ensure purity, dried rhizomes of both plants were purchased from local commercial sources and cut into pieces before being pulverized with an electric grinder. The powder was stored in an air tight container till further use.

To determine the therapeutic efficacy of the drugs, faecal samples were collected from each animal of these groups on "0" day before treatment and on day 8th, 14th, 21st and 28thafter starting treatment and parasitic load quantification i.e OPG (oocyst per gram) was determined by modified McMaster technique. Briefly, the McMaster count was performed by adding 2 g of crushed faeces to 28 ml of floatation solution and mixed using magnetic stirrer dispersing oocysts into the solution and an aliquot pipetted onto a grid slide (ChalexLLC, USA) where the number of oocysts were counted.

2.4 The faecal oocyst count reduction test (*in vivo* test)

The percent efficacy of the drug was calculated from the arithmetic mean of the group OPGs as per the formula given below (Thrusfield, 2005) [41].

$$\text{Efficacy of drug treatment \%} = \frac{\text{Mean pre-treatment OPG- Mean post-treatment OPG}}{\text{Mean pre-treatment OPG}} \text{ X } 100$$

2.5 Speciation/ species identification

On day 0, pooled faecal samples obtained from kids were thoroughly mixed with an aqueous 2.5% (w/v) potassium dichromate solution, placed in thin layers in petridishes at 27±2°C for 5-7 days to allow sporulation. Then, using a sodium chloride floatation technique, oocysts were concentrated and evaluated at 40x magnification to determine the species based on characteristics previously described by Soulsby, (1982) [38]; Smith and Sherman (1994) [37] and Bhatia *et al*., (2004) [5]. An ocular micrometer was used to measure the size of sporulated oocysts.

Table 1: Complete schedule of treatment, dosage and route of administration in goats

Group	No. of animals	Drug used	Dosage mg/kg body weight	Route of administration
A	15	Turmeric	300mg/kg body weight	Orally for 7 days
B	13	Turmeric	450mg/kg body weight	Orally for 7 days
C	15	Ginger	300mg/kg body weight	Orally for 7 days
D	13	Ginger	450mg/kg body weight	Orally for 7 days
E	15	Control	-	-

2.6 Statistical analysis

The results were subjected to standard statistical analysis as per Snedecor and Cochran (1994) [40].

3. Results

This study describes the anticoccidial activity of *Curcuma longa* and *Zingiber officinale* (family Zingiberaceae) rhizome which are normally used as spices in human food as well as in traditional ethnoveterinary medicine**.**The species identified in the culture of pooled faecal samples were *E. arloingi*, *E. caprina*, *E. christenseni*, *E. ninakohlyakimovae* and *E. alijevi*.

3.1 Efficacy of turmeric @ 300 mg/kg b.wt (Table 2, 3; Fig. 1, 2)

Group A animals were treated with turmeric at the dose rate of 300 mg/kg body weight orally for 7 days. Pre-treatment

mean oocyst per gram (OPG) of faeces on day 0 was 7870.0±407.3 (6350-12000). Mean OPG count on 8th, 14th, 21stand 28th day after starting treatment was 4060.0±289.3 (2550-6500), 3236.7±210.2 (1900-5050), 2870.0±168.4 (1550-4000) and 2896.7±171.1 (1400-3900), respectively. It was found that the efficacy of drug was 48.41 percent against *Eimeria* species on 8th day, 58.87 percent on day 14, 63.53 percent on day 21 and 63.19 percent on 28th day after starting treatment. All animals except two had normal faecal consistency during whole study period.

Table 2: Mean oocyst per gram (OPG) counts in different treatment groups observed on different days in goats in central Kashmir

Group	Drug	Pre-treatment mean OPG	Post-treatment mean OPG at days			
			8	14	21	28
A (n=15)	Turmeric (300mg/kg bw)	7870.0±407.3^{a} (6350-12000)	4060.0±289.3^{a} (2550-6500)	3236.7±210.2^{a} (1900-5050)	2870.0±168.4^{a} (1550-4000)	2896.7±171.1^{a} (1400-3900)
B (n=13)	Turmeric (450mg/kg bw)	8200.0±554.2^{a} (6650-14050)	3638.5±311.2^{a} (2050-6850)	2173.1±127.2^{b} (1550-3350)	1846.2±158.7^{b} (850-2900)	2130.8±214.4^{a} (600-3600)
C (n=15)	Ginger (300mg/kgbw)	8693.3±525.1^{a} (6150-13000)	5076.7±394.7^{a} (3100-8600)	4000.0±311.0^{a} (1600-6150)	3215.3±210.7^{a} (1800-4900)	3780.0±277.2^{b} (1750-5900)
D (n=13)	Ginger (450mg/kgbw)	8138.5±385.5^{a} (6350-11200)	4088.5±347.5^{a} (2800-7000)	3507.7±258.9^{a} (2600-5650)	3219.2±295.7^{a} (2350-5800)	3346.2±266.6^{ab} (2300-5700)
E (n=15)	Control	8426.7±488.1^{a} (6500-12650)	12763.0±501.7^{b} (9800-16500)	16543.0±610.9^{c} (13000-20150)	15547.0±600.6^{c} (10500-20200)	18993.0±509.4^{c} (14500-22000)

Values in the same column bearing similar superscript letters are statistically non-significantly different (P>0.05) (mean ± SE)

Table 3: Efficacy of turmeric and ginger against *Eimeria* species of goats in central Kashmir

Group	Drug	Efficacy (%) of drugs on days			
		Day 8	Day 14	Day 21	Day 28
A	Turmeric@300mg/kg bw for 7 days	48.41^{a}	58.87^{b}	63.53^{b}	63.19^{b}
B	Turmeric@450mg/kgbw for 7 days	55.63^{a}	73.50^{b}	77.49^{b}	74.01^{b}
C	Ginger@300mg/kgbw for 7 days	41.60^{a}	53.99^{b}	63.01^{b}	56.52^{b}
D	Ginger@450mg/kgbw for 7 days	49.76^{a}	56.90^{ab}	60.44^{b}	58.88^{b}

Values in the same row bearing similar superscript letters are statistically non-significantly different (P>0.05)

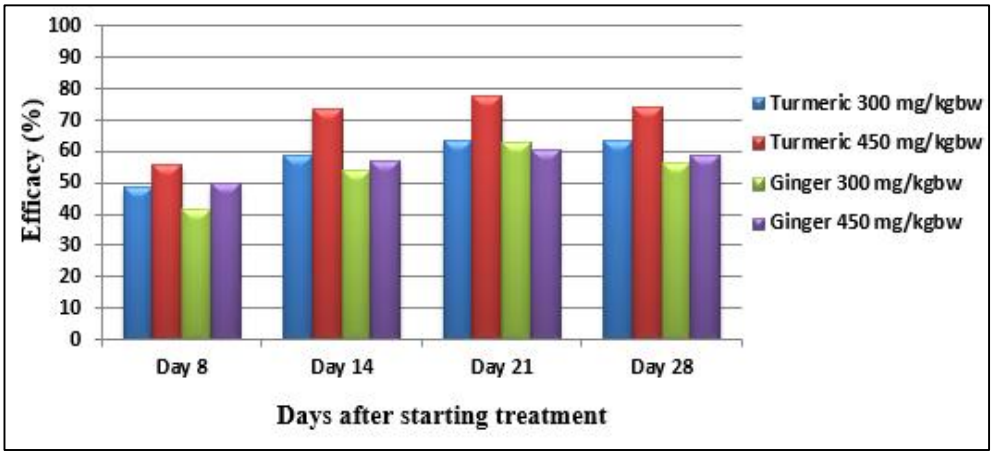

Fig 1: Efficacy of turmeric and ginger observed on different days

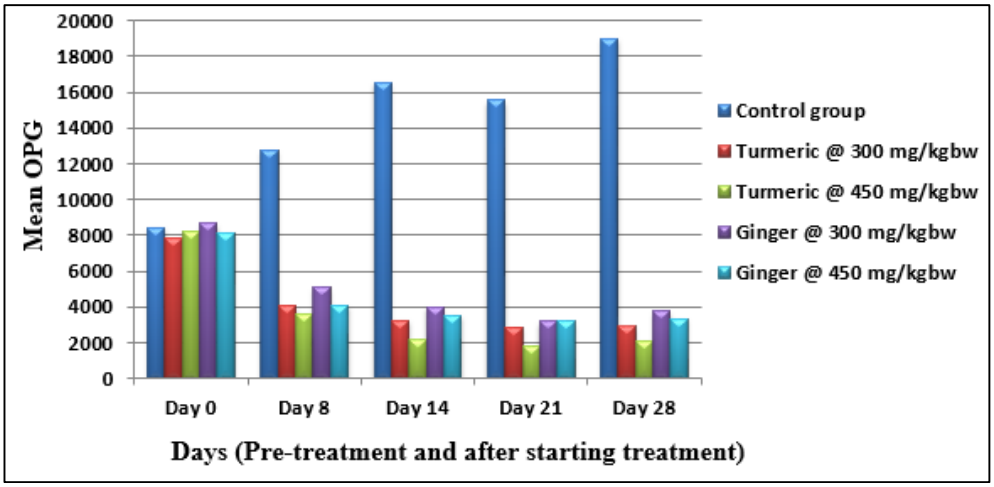

Fig 2: Mean OPG counts of control group and treatment groups on different days

3.2 Efficacy of turmeric @ 450 mg/kg b.wt (Table 2, 3; Fig. 1, 2)

Group B animals were treated with turmeric at the dose rate of 450 mg/kg body weight orally for 7 days. Pre-treatment mean oocyst per gram (OPG) of faeces on day 0 was 8200.0±554.2 (6650-14050). Mean OPG count on 8th, 14th, 21st and 28th day was 3638.5±311.2 (2050-6850), 2173.1±127.2 (1550-3350), 1846.2±158.7 (850-2900) and 2130.8±214.4 (600-3600), respectively. It was found that the efficacy of drug was 55.63 percent against *Eimeria* species on 8th day, 73.50 percent on day 14, 77.49 percent on day 21st and 74.01 percent on 28th day after starting treatment. Out of four animals of which one had pasty and three had semi-solid faecal consistency up to 14th day, two showed normal consistency on 21st day and onwards.

3.3 Efficacy of ginger @ 300mg/kg b.wt (Table 2, 3; Fig. 1, 2)

Group C animals were treated with ginger at the dose rate of 300 mg/kg body weight orally for 7 days. Pre-treatment mean oocyst per gram (OPG) of faeces on day 0 was 8693.3±525.1 (6150-13000). Mean OPG count on 8th, 14th, 21st and 28th day was 5076.7±394.7 (3100-8600), 4000.0±311.0 (1600-6150) and 3215.3±210.7 (1800-4900), 3780.0±277.2 (1750-5900), respectively. It was found that the efficacy of drug was 41.60 percent against *Eimeria* species on 8th day, 53.99 percent on day 14, 63.01 percent on day 21 and 56.52 percent on 28th day after starting treatment. All animals had normal faeces except two with semi-solid faecal consistency upto 14 and 21stday of study period, respectively.

3.4 Efficacy of ginger @ 450 mg/kg b.wt (Table 2, 3; Fig. 1, 2)

Group D animals were treated with ginger at the dose rate of 450 mg/kg body weight orally for 7 days. Pre-treatment mean oocyst per gram (OPG) of faeces on day 0 was 8138.5±385.5 (6350-11200). Mean OPG count on 8th, 14th, 21stand 28th day was 4088.5±347.5 (2800-7000), 3507.7±258.9 (2600-5650), 3219.2±295.7 (2350-5800) and 3346.2±266.6 (2300-5700), respectively. It was found that the efficacy of drug was 49.76 percent against *Eimeria* species on 8th day, 56.90 percent on day 14, 60.44 percent on day 21 and 58.88 percent on 28th day after starting treatment. Three animals of the group were mildly diarrhoeic at the start of study among which two had semi-solid faeces by day 21st and 28, respectively while other showed no improvement during the whole study period.

3.5 Control group (Table 2; Fig. 2)

In the control group (positive control; Group-E), mean OPG of faeces for *Eimeria* species was found to be 8426.7±488.1 (6500-12650) at '0' day which increased to 12763.0±501.7 (9800-16500), 16543.0±610.9 (13000-20150), 15547.0±600.6 (10500-20200) and 18993.0±509.4 (14500-22000) at 8th, 14th, 21st and 28th day, respectively.

On day 0, difference was not significant ($P>0.05$) in mean OPG values of goats among different groups. On the other hand, significant difference was observed among groups on day 8th, 14th, 21st and 28th ($P<0.05$). In group A, B, C and D mean OPG count decreased on subsequent days, while the mean OPG of group E increased significantly ($P<0.05$). On day 8, the difference was statistically significant between group E verses all other groups ($P<0.05$) while the treated groups varied non-significantly among themselves ($P>0.05$). On days 14 and 21, the difference was statistically significant between Group E verses all other groups and Group B verses all other groups ($P<0.05$). On day 28, the difference was statistically significant between Group E verses all other groups ($P<0.05$). Also group A and B showed a significant difference with group C ($P<0.05$).

Turmeric at both the doses and ginger at 300mg/kg b.wt showed significant difference of efficacy on day 8 with all other days ($P<0.05$). Ginger @450mg/kg b.wt showed a significant difference ($P<0.05$) of efficacy at 8th day with that on day 21 and 28.

4. Discussion and conclusion

This study investigated treatment of animals with greater than 5000 eimerian oocysts per gram of faeces as OPG over 5000 is considered significant for clinical coccidiosis in ruminants (Radostits *et al*. 2007) [35]. In the present study, it was found that the efficacy of turmeric@300mg/kg body weight was 48.41 percent on 8th day, 58.87 percent on day 14, 63.53 percent on day 21 and 63.19 percent on 28th day after starting treatment while turmeric@ 450mg/kg body weight showed the efficacy to be 55.63 percent on 8th day, 73.50 percent on day 14, 77.49 percent on day 21st and 74.01 percent on 28th day after starting treatment. Ginger@300mg/kg body weight showed the efficacy of 41.60 percent on 8th day, 53.99 percent on day 14, 63.01 percent on day 21 and 56.52 percent on 28th day after starting treatment while as the efficacy of ginger@450mg/kg body weight was 49.76 percent on 8th day, 56.90 percent on day 14, 60.44 percent on day 21 and 58.88 percent on 28th day after starting treatment. Therefore, the maximum efficacy of turmeric between the two doses was found to be on 21st day @ 450mg/kg body weight as 77.49%. Similarly, between the two doses, maximum effect of ginger was @ 300mg /kg body weight as 63.01% on day 21.

Plants produce a broad–spectrum variety of phytochemicals such as phenolics, polyacetylenes, alkaloids, polysaccharides and essential oils with large number of antimicrobial and anti-parasitic activities. Safe alternative to chemical anticoccidial drug is herbal products because they do not result in tissue residues and drug resistance. One potentially well accepted alternative to chemical additives is *Curcuma longa* that has been recognised to possess an important potential as anticoccidial preparation (Khalafalla *et al*., 2011) [22]. Anticoccidial effect of turmeric crude powder may be attributed to its curcumin content which is a natural polyphenolic compound abundant in the rhizome of *Curcuma longa*. Depending on geographical and seasonal conditions *Curcuma longa* extracts usually contain 60-70% carbohydrate, 8.6% protein, 5-10% fat, 2-7% fiber, 3-5% curcuminoids (50-70% curcumin) and up to 5% essential oils and resins (Chinedum *et al*., 2015; Jiang *et al*., 2014 and Trujillo *et al*., 2013) [9, 21, 42]. *Curcuma longa* has been used as an additive to decrease the harmful effects of coccidiosis in broilers (Khalafalla *et al*., 2011; Kim *et al*., 2013) [22, 23], having positive effects against coccidiosis. It reduces coccidiosis lesion scores and oocyst shedding (Peek *et al*., 2013) [33]. Results obtained in the present study also show that *Curcuma longa* significantly reduced oocyst production in kids. As far as we know, this is the first report of *Curcuma longa* used to treat *Eimeria* spp. infection in goats. The action mechanism was not determined; however, it is reasonable to speculate that its effects are similar to the ones already mentioned i.e., through a direct toxic effect on coccidian (Ramsewak *et al*., 2000) [36], inducing apoptosis by presence of precipitates on sporozoite surface affecting its morphology and viability and adhesion ability (Chattopadhyay *et al*., 2004) [7]. Additional to its antiprotozoal effects, anti-

inflammatory and antioxidant properties have also been demonstrated and considering that oxidative stress is a hallmark of intracellular infections (Hering *et al*., 2012) [16], these actions can complement the anticoccidial activity observed. It exerts its antioxidant effect by interacting with different signalling pathway or interacting with enzymes or genes implicated in oxidative stress. Such effects are relevant if the main characteristics of coccidiosis are considered. For example: alterations in the quantity of physiological antioxidants such as vitamins A, C and E in sheep suffering from coccidiosis (Georgieva *et al*., 2006) [14]; intestinal epithelial inflammation and increased tissue and blood concentrations of reactive oxygen species (Hõrak *et al*., 2004 and Nweze and Obiwulu, 2009) [17, 30]. Added up, all these effects can counteract the damage *Eimeria* spp. induces in epithelial cell integrity and impairment of mucosal recovery due to cellular oxidative injury (Cornelissen *et al*., 2009) [10].

Similarly, ginger contains several compounds as gingerol, gingerdiol, shogaols and gingerdione that are again described to posess anti-oxidant and anti-coccidial properties. Fresh ginger root and alcoholic extracts of ginger have established antioxidative capacities *in vitro* and in whole animals (Anonymous, 2012) [4]. The main pungent constituents, 6-gingerol and 6-shogaol, appear to be the main antioxidants. The anti-inflammatory effects of ginger root are at least partly derived by inhibiting the induction of genes encoding cytokines and chemokines (arachidonic acid metabolism *via* the COX-2 and lipoxygenase products pathways) that are synthesised and secreted at sites of inflammation. Various studies on anticoccidial efficacy of turmeric and ginger have been conducted in poultry, while only a few studies on sheep have been conducted and no such previous study has been done on goats against coccidiosis. Lambs treated orally for 14 days with 50, 100 and 200 mg/kg body weight of *Curcuma longa* showed 100% efficacy @ 200mg/kg b.wt on day 42 against coccidiosis in Mexico (Maria *et al*. 2016) [28]. Similarly, efficacy of the aqueous extract of curcumin (*Curcuma longa*) @ 40 mg/kg body weight on the excretion of oocysts of *Eimeria* spp. in 24 New Zealand white rabbits was 80.1, 63.7 and 64.9% for day 28, 35 and 42, respectively (Maria *et al.* 2015) [27]. El-Khtam *et al*. (2014) [13] evaluated the anticoccidial effect of turmeric powder in broilers and revealed anticoccidial activity comparable with that of the anticoccidial drug evidenced by prevention or reduction of mortality, lowering gut lesion scores and reduced faecal oocyst shedding of the infected chickens as compared to the infected non treated group. Similarly, Abbas *et al*. (2010) [1] in Pakistan observed a comparable efficacy of turmeric (3%) crude powder with salinomycin sodium against coccidiosis in broilers. Adeniji *et al.* (2017) [2] reported the anticoccidial efficacy of crude powder of ginger rhizome as 100,100, 98.83 and 100 percent on 28th day @5g/kg, 10g/kg, 15g/kg and 20g/kgof feed to Yankasa rams of Nigeria. Adeniji *et al*., (2017) [2] reported that at the level of 5g/kg ginger inclusion in feed, there was a high percent reduction in faecal egg count (94.13, 86.73, 87.93 and 100.00%) at days 7, 14, 21, and 28 respectively in Yankasa rams of Nigeria. In contrast, Iqbal *et al*., (2006) [20] observed a dose and time-dependent anthelmintic effect in sheep and revealed that crude ginger powder was 25.6% effective on day 10 of post-treatment. Ali *et al*. (2019) [3] revealed efficacy of ginger to be more in comparison to amprolium on coccidiosis in broiler chickens in Pakistan. The discrepancy among these studies is likely due to the different animals, physiological stages, diet compositions, and the drug source and its application level. Although curcumin and gingerol present in turmeric and ginger may increase anti-oxidant properties, it is proposed that the decrease in oocyst shedding in this short term study was more likely to have been due to direct effects of turmeric and ginger on different stages of parasites life cycle rather than *via* anti-oxidant action. Moreover, the herbs had no visible signs of chemical residues in the animals since no adverse effect was physically observed throughout the duration of treatment.

Of the many species of *Eimeria* that are known to infect goats, three are considered most pathogenic, *E. christenseni*, *E. ninakohlyakimovae*, and *E. arloingi* (MAFF, 1971) [26]. The identified species from the goats in this study were *E. arloingi*, *E. caprina*, *E. christenseni*, *E. ninakohlyakimovae* and *E. alijevi*. Clinical signs of coccidiosis including diarrhoea and weight loss and histological evidence of proliferative enteritis in the colon have been found in goat kids experimentally infected with *E. ninakohlyakimovae* oocysts (Dai *et al*., 2006) [11]. *E. arloingi* has been reported in outbreaks of coccidiosis in goats and disease associated with this species has also been experimentally reproduced (Senthilvel *et al*., 2004) [39].

In the present study, OPG count with progressive decline in turmeric and ginger groups and highest in control group, indicate the substantial effect of herbal drugs in reducing the oocyst count At the same time, although, turmeric and ginger treated animals started showing clinical improvement on 14th day onwards, oocysts continued to be in faeces upto 28th day of observation indicating that the herbs were less efficacious against small ruminant coccidiosis compared to allopathic drugs. Many of the scientists are of the view that prophylactic medication need not be administered in coccidiosis affected kids and lambs e g. Borgsteede and Dercksen (1996) [6] have expressed that it is better to set natural infection and allow immunity to build up natural immunity. The similar view has been expressed by Kusiluka *et al*., (1998) [24] according to whom low coccidial output do not call for chemoprophylaxis or therapeutic intervention. However, the above two observations were expressed in context when oocyst output was low and not of clinical grade.

Some scientists advocated medication in the form of preventive treatment. Although only a few cases in present study showed clinical signs, the presence of moderate to high number of oocysts is indicative of sub-clinical disease state which has adverse effects on small ruminants. Therefore prophylactic measures are desirable where young stock is at risk of contracting infection from high stock concentration. Therefore, in the present study it can be concluded that *Curcuma longa* and *Zingiber officinale* can be used as natural prophylactic alternatives for controlling coccidian infection in goats but further studies are clearly needed both to determine the minimum dose of *Curcuma longa* and *Zingiber officinale* required to keep coccidiosis under control and effects of feeding these herbal drugs on the productive performance of goats needs to be worked out because both these herbs have also antimicrobial as well as immune booster properties.

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6. References

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