Efficacy of a commercial mixed botanical formula in treatment and control of coccidiosis in poultry

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ABSTRACT

Coccidiosis, a protozoal disease caused by a species of the *Eimeria* genus, causes tremendous economic damage to the poultry industry. Numerous natural remedies have been developed to combat emerging drug-resistant *Eimeria* species and mitigate public concerns about anticoccidial drug residues in poultry products. In the current study, the anticoccidial efficacy was evaluated of a commercial mixed botanical product, administered in two concentrations, in the treatment and control of a mixed coccidian infection. In this respect, 120 newly hatched broiler chickens were randomly allocated into five equal groups: Cox500, Cox1000, Positive control (PC), Negative control (NC), and Control (C). The first three groups were exposed to oocysts of several *Eimeria* species, Cox500 and Cox1000, and then received the two concentrations of a botanical blend (500 and 1,000 ml of formula per 1,000 L of drinking water, respectively) for five consecutive days. The positive control also received toltrazuril (7 mg/kg of live weight) through drinking water for two consecutive days. The negative control and control were the challenged-unmedicated and unchallenged-unmedicated groups, respectively. The chicks were monitored for clinical signs, intestinal lesions, performance indices, and oocyst shedding. The results indicated that the tested botanical formula in both concentrations improved the growth performance of the birds. However, the higher concentration prompted lower oocyst shedding and, likewise, toltrazuril in the positive control, healed cecal lesions more rapidly. In summary, the blended botanical formula, particularly in the higher concentration (1,000 ml per 1,000 L of drinking water), could successfully be incorporated into therapeutic strategies against coccidiosis in broiler flocks.

Key words: anticoccidial efficacy; botanical blend; broiler; oocyst shedding

Introduction

Coccidiosis is considered to be the most costly contagious disease in commercial poultry (MOHITI-ASLI and GHANAATPARAST-RASHTI, 2015) owing to the rapid multiplication of *Eimeria* protozoa within the intestinal epithelium and the destruction of host tissues. This disruption of the mucus integrity predisposes the intestine to secondary bacterial infections, such as necrotic enteritis, and leads to impaired feed intake, body weight gain (BWG), feed conversion ratio (FCR), or even mortality (ADHIKARI et al., 2020). Mainly due to the costs of medication and prophylaxis, the disease causes financial damage, which is even possible before the appearance of clinical signs

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(KOSTADINOVIĆ et al., 2015; POP et al., 2019). Substantial efforts have been exerted over the past few decades to control the disease through better sanitation, flock management, vaccine exploitation, and the development of various chemotherapeutics. Nevertheless, emerging *Eimeria* species, resistant to anticoccidial drugs such as ionophores, costly vaccine production, public concerns about chemical residues in livestock products, and demands for more organic foods necessitate novel and safe therapeutic strategies, particularly for organic poultry production, where medical intervention is banned or not affordable (ABBAS et al., 2012; ALMEIDA et al., 2012; QUIROZ-CASTAÑEDA and DANTÁN-GONZÁLEZ, 2015; POP et al., 2019). In this respect, concerning their antimicrobial and antioxidant impacts, broad dosage range, along with capabilities of improving gut microflora and feed intake (ARCZEWSKA-WŁOSEK and ŚWIĄTKIEWICZ, 2013), botanical products have become an area of interest and promise success against coccidiosis (QUIROZ-CASTAÑEDA and DANTÁN-GONZÁLEZ, 2015). In this context, artemisinin, the active ingredient of annual wormwood (*Artemisia annua*) with a considerable margin of safety in poultry (FATEMI et al., 2017), is efficacious against all *Eimeria* strains in pure dietary form (KOSTADINOVIĆ et al., 2015). It impairs the *Eimeria* life cycle, kills its developing oocysts, suppresses the oocyst sporulation rate, and promotes the apoptosis of both the parasitized host cells and the second-generation merozoites of *Eimeria* (MO et al., 2014; MUTHAMILSELVAN et al., 2016; JIAO et al., 2018). Organic acids provide specific antimicrobial properties through decreasing the pH during digestion, enhancing pancreatic secretion, and positively affecting the gastrointestinal mucosa. Despite conflicting results about the influence of these compounds on performance enhancement of chickens (ARAUJO et al., 2019), the presence of dietary organic acids promotes the lactic acid bacteria population, including the number of *Lactobacillus* species, which may decrease during a coccidian infection. Through producing lactic acid, this type of bacteria prevents the growth of various pathogens in the chicken's gut content (HUANG et al., 2018; ROYAN, 2019; ADHIKARI et al., 2020). Consistently, the efficacy of an organic acid blend with immunoprotective impact, including lactic acid, has been reported to help against a coccidian infection (ABDULLAHI et al., 2020). Combining organic acids with essential oil also provides a synergic advantage in favour of intestinal health and productive performance (STEFANELLO et al., 2020). Recently, a blend of organic acids combined with essential oils proved promising in controlling necrotic enteritis following a coinfection with *Eimeria* species and *Clostridium perfringens* by enhancing growth performance and gut health (PHAM et al., 2020). Among essential oils, thyme oil is one of the most beneficial to extirpate *Eimeria* oocysts in vitro, at low concentrations. It is also palatable and cost-effective along with fewer residues and lower toxicity (REMMAL et al., 2011). The dietary essential oil of oregano (OEO) enhances antioxidative defense and intestine quality. It also ameliorates FCR, probably through promoting the absorptive surface area and digestive enzymatic activity (BOZKURT et al., 2016). Besides, in a specific dose, it is beneficial against the detrimental effects of coccidiosis in broiler chickens (MOHITI-ASLI and GHANAATPARAST-RASHTI, 2015). Garlic and, more specifically allicin, contains some active components which play a role in promoting digestion and absorption efficiency by regenerating and healing the intestinal epithelium. Also, it causes the death of *Eimeria,* and its sporozoites by acting on the cytoplasmic membrane and inducing an immune response (ALI et al., 2019). Betaine plays a protective role against osmotic stress resulting from coccidian infection, which is even enhanced by using ionophores, including salinomycin (BARBOUR et al., 2015). This osmoprotectant also enhances nutrient digestibility and growth performance in multiple bird species, and improves carcass quality when added to poultry diets (METZLER-ZEBELI et al., 2009).

In the present study, assessment was attempted of the efficacy of two different concentrations of a commercial blend of the substances reviewed above, with potential synergistic impacts in protecting broiler chickens against an experimental mixed coccidian infection.

Materials and methods

Birds housing and feeding. One hundred and twenty day-old broiler chickens (ROSS® 308) were purchased from a local hatchery (Dizbad Breeder Company, Mashhad, Iran) and transferred to an experimental facility at the Veterinary Polyclinic of Ferdowsi University of Mashhad, Mashhad, Iran. The birds were raised on deep litter until day 14. All pens and equipment were thoroughly cleaned, disinfected, and fumigated with ammonium hydroxide in advance to kill any existing oocysts. On day 14, the 120 birds were randomly divided into five groups, each consisting of three replicates of 8 birds, and transferred to separate wired floor cages to avoid cross-contamination with *Eimeria*. All birds were kept in the standard environmental conditions suggested by the ROSS broiler management handbook (AVIAGEN, 2018). The temperature was set at 33°C during the whole first week. Following a gradual decline to 21° C until the end of week 3, the temperature remained constant during the rest of the trial period. All groups had free access to water during the whole trial period, and received standard coccidiostat-free broiler diets (super starter, starter, grower, and finisher) provided from Gohar Daneh Shargh Corporation, Mashhad, Iran.

Eimeria oocysts preparation. A mixture of sporulated oocysts of the *Eimeria* species was provided by the Faculty of Veterinary Medicine of Tehran University, Tehran, Iran. Briefly, following the standard procedures (ARABKHAZAELI et al., 2011), sporulated oocysts were propagated in broiler chicks via the oral passage. The recovered oocysts were then detected and preserved in 2.5% potassium dichromate solution. The estimated infective dose was based on the infective inoculums that caused the most lesions but the least mortality in these chicks. Subsequently, sporulated oocysts in a smear of the mixture were counted by the hemocytometer method. 1 ml suspension of 200,000 sporulated oocysts of *Eimeria* species, comprising *E. tenella* (50%), *E. maxima* (25%), and a combination of *E. acervulina*, *E. mitis,* and *E. necatrix* (25% in total), were determined as the challenge dose per bird.

Experimental design. On day 21 of the trial, all groups, excluding the Control (C), were infected with the challenge dose of mixed *Eimeria* oocysts, given by means of individual oral gavage. On day 26, when bloody droppings first appeared, the treatment was initiated, as El-BANNA et al. (2005) did. Two of the challenged groups, including Cox500 and Cox1000, received a blended botanical formula, Coxmarin Esex (Marino Ibericamed S.L., Spain), containing artemisinin (*Artemisia annua*'s extract; 8 mg/ml), essential oils of oregano (*Origanum vulgare L.*; 16 mg/ml) and thyme (*Thymus vulgaris L.*; 15 mg/ml), garlic (*Allium sativum L.)* oil (4 mg/ml), betaine HCl (49 mg/ml) and lactic acid (99 mg/ml), in different concentrations of 500 and 1,000 ml of formula per 1,000 L of drinking water, for five consecutive days (according to the manufacturer's instructions for use). On the same day, Toltra-K® (Karizoo S.A., Spain) in a dosage of 7 mg/kg of live weight, was given to the Positive Control (PC) through drinking water for two successive days. Notably, one challenged group, namely the Negative Control (NC), and the unchallenged group, the Control (C), remained untreated.

Monitoring of clinical signs and intestinal lesions scoring. During the experiment, clinical symptoms, particularly those attributable to coccidiosis, were monitored in all birds. These signs included reductions in appetite or daily feed intake, decreased water consumption, weight loss, lethargy, and bloody diarrhoea. Also, to investigate the etiology of mortality cases, the carcasses were immediately necropsied, and the lesions were recorded. Intestinal lesion examination was performed upon completion of the period of administration of toltrazuril and the botanical blend (days 28 and 31, respectively). At each time point, two birds from each replicate were randomly selected and humanely euthanized following the guidelines of AVMA (AVMA, 2020), and their intestinal lesions were investigated by the same blinded expert. On the basis of the cecal lesions observed, a specific grade from 0 to +4 on the scale, indicating the rate of severity of the damage, was given to each carcass, in accordance with the work done by JOHNSON and REID (1970), and subsequently the average score for each group was assessed at each of the time points.

Average body weight and feed conversion ratio assessment. Following grouping, the mean body weight (BW) of each replicate was registered weekly from day 21 onwards to calculate the groups' average BW. The mean feed intake of each replicate was also recorded weekly from day 28 onwards to assess the groups' average FCR values.

Oocyst count in faecal samples. Following the standard McMaster method (HAUG et al., 2006), on four occasions (on days 26, 28, 30, and 33), fecal sampling and Eimeria oocyst counting in the replicates of all the groups were performed. Subsequently, the average oocyst per gram (OPG) number in each group was calculated.

Ethical approval. This experiment was approved by the Ethics Committee of Ferdowsi University of Mashhad, Iran, and performed according to the relevant guidelines and regulations.

Statistical analysis. The data on all parameters were analyzed using SPSS® Software version 25 (IBM® Corp., Armonk, NY, USA). ANOVA coupled with post hoc Tukey HSD and Kruskal-Wallis, followed by the Mann Whitney U-test were employed for normally distributed (BW, FCR, and OPG) and non-normally distributed data (LS), respectively. The discrepancy was considered statistically significant at the P-value < 0.05 for all the analyzed data.

Results

Not all the animals showed changes in appetite, abnormal fecal excretes, and specific clinical signs on the challenge day. From day 23 to 27, symptoms, including lethargy, deficiency in feed intake and bloody diarrhoea, gradually appeared in all infected groups. On day 27, one chicken from the negative control group died. During the post-mortem examination, pathognomonic signs of coccidiosis were found in the bird's intestine, particularly in the cecum. No more mortalities were observed until the end of the trial period. From day 30 to 31, clinical signs and bloody diarrhoea gradually disappeared in the challenged groups. The negative control, however, suffered more prolonged lethargy until day 34. Intestinal lesions examination at each time point revealed more severe lesions in members of the negative control than those in Cox500, Cox1000, positive control and control groups. Members of the latter two never experienced any lesions. More details about lesions, recorded at each time point, are presented in Table 1. At the first time point on day 28, no cecal lesion score was recorded for either the Control or Positive Control, while the Negative Control reached the highest score. Concerning the groups treated with the botanical blend at this time point, Cox1000 registered a lower cecal score than Cox500. At the second time point on day 31, the recorded cecal score for the Negative Control saw a reduction, but it was significantly higher than for any other group. Furthermore, not unlike the previous time point, no cecal lesion score was registered for the Control and Positive Control. Also, the groups treated with the botanical blend experienced similar cecal lesion scores, lower for both groups compared to the previous time point (Table 1).

During the whole trial period, the unchallenged, untreated group recorded the highest mean body weight of all the groups. The mean body weights of the groups treated with the botanical blend were in the same range until day 28. From this time point onward these two groups, more specifically Cox500, registered significantly higher mean body weights than the other challenged groups. The Positive Control successively had the lowest mean body weight, except on day 35, when the Negative Control's weight was lower (Fig. 1). On day 28, the Positive and Negative Controls had approximate FCR values significantly higher than the roughly comparable records of the groups treated with the botanical blend. Otherwise, on this day, the lowest FCR value was registered for the Control. On day 35, the highest FCR value was recorded for the Negative Control, followed by the Control, whereas the Positive Control and Cox500, recorded the lowest values, respectively. On Day 42, the lowest FCR value was recorded for Cox500, followed by the Control. Also, while Cox1000 and the Positive Control had approximate the same values, the Negative Control registered the highest FCR record (Fig. 2).

Table 1. Intestinal lesions (prevalence) and cecal scores (mean ± SD) in chickens treated with two concentrations of the blended herbal formula (Coxmarin Esex) in comparison with the controls at two various time points

		Day 28	Day 31
Groups	Site of lesions	Intestinal lesions (Prevalence)	Intestinal lesions (Prevalence)
Cox500	Duodenum	Absent	Few scattered petechiae (66%)
	Jejunum	Few scattered petechiae (66%)	Absent
	Ileum	Absent	Absent
	Ceca	Few scattered petechiae (33%) Noticeable blood in cecal contents (16/5%) Cecal cores (33%) Cecal Score: 1.66 ± 1.21 ^{a,c}	Few scattered petechiae (33%) Cecal Score: 0.33 ± 0.51 ^{a}
Cox1000	Duodenum	Few scattered petechiae (33%)	Absent
	Jejunum	Few scattered petechiae (33%)	Absent
	Ileum	Absent	Absent
	Ceca	Few scattered petechiae (33%) Noticeable blood in cecal contents (16/5%) Cecal Score: 0.66 ± 0.81 ^{a,b}	Few scattered petechiae (33%) Cecal Score: 0.33 ± 0.51 ^{a}
Positive control (PC)	Duodenum	Absent	Absent
	Jejunum	Absent	Absent
	Ileum	Absent	Absent
	Ceca	Absent Cecal Score: 0 ± 0 ^{b}	Absent Cecal Score: 0 ± 0 ^{a}
Negative control (NC)	Duodenum	Ecchymosis (16.5%)	Absent
	Jejunum	Absent	Absent
	Ileum	Absent	Absent
	Ceca	Noticeable blood in cecal contents (50%) Thickened cecal walls (50%) Distended cecal walls (50%) Blood and caseous cores (50%) Cecal Score: 3 ± 1.09 ^{c}	Few scattered petechiae (33%) Noticeable blood in cecal contents (33%) Thickened cecal walls (66%) Blood cores (33%) Cecal Score: 2 ± 0.89 ^{b}
Control (C)	Duodenum	Absent	Absent
	Jejunum	Absent	Absent
	Ileum	Absent	Absent
	Ceca	Absent Cecal Score: 0 ± 0 ^{b}	Absent Cecal Score: 0 ± 0 ^{a}

^{a,b,c} Distinct superscripted lowercase letters indicate significant differences ($P < 0.05$) between groups on each day, Cox500, and Cox1000, challenged and treated respectively with concentrations of 500 and 1,000 ml of the blended herbal formula per 1,000 L of drinking water; Positive Control (PC), challenged and treated by toltrazuril (7 mg/kg of live weight); Negative Control (NC), challenged and untreated; Control (C)), unchallenged and untreated.

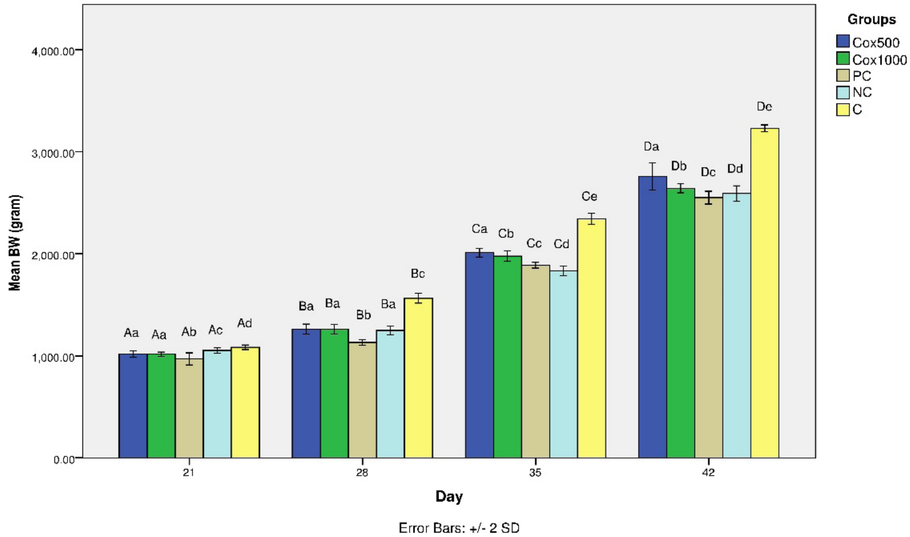

Fig. 1. Body weight (gram, mean ± SD) of chickens treated with two concentrations of a blended herbal formula (Coxmarin Esex) in comparison with the controls. ^{a,b,c,d,e} Distinct superscripted lowercase letters indicate significant differences (P<0.05) between groups on each day. ^{A,B,C,D} Distinct superscripted uppercase letters indicate significant differences (P<0.05) within each group over days. Cox500, and Cox1000, challenged and treated respectively with concentrations of 500 and 1,000 ml of the blended herbal formula per 1,000 L of drinking water; Positive Control (PC), challenged and treated by toltrazuril (7 mg/kg of live weight); Negative Control (NC), challenged and untreated; Control (C)), unchallenged and untreated.

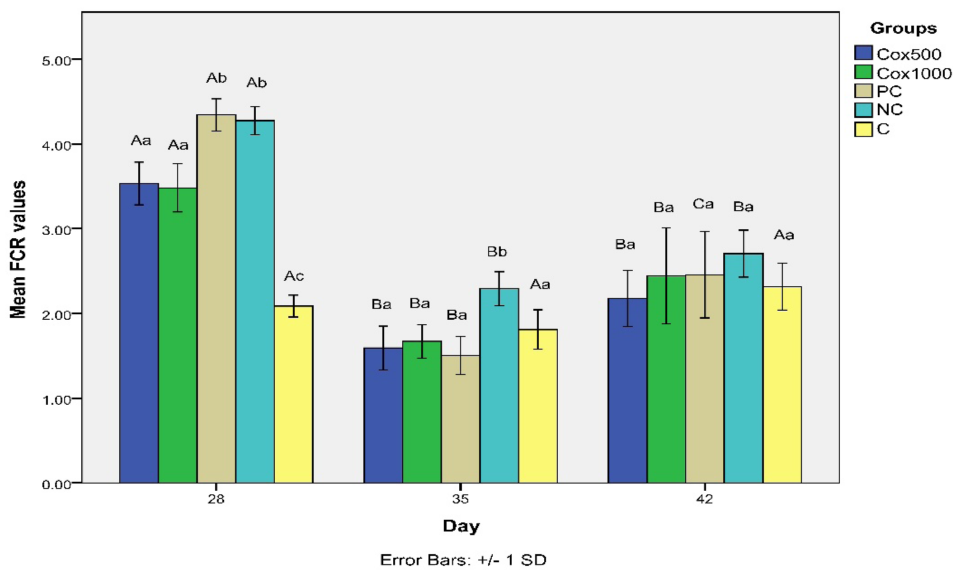

Fig. 2. Feed conversion ratio (FCR, mean ± SD) in chickens treated with different concentrations of a blended herbal formula (Coxmarin Esex) compared to the controls. ^{a,b,c} Distinct superscripted lowercase letters indicate significant differences (P<0.05) between groups on each day. ^{A,B} Distinct superscripted uppercase letters indicate significant differences (P<0.05) within each group over days. Cox500, and Cox1000, challenged and treated respectively with concentrations of 500 and 1,000 ml of the blended herbal formula per 1,000 L of drinking water; Positive Control (PC), challenged and treated by toltrazuril (7 mg/kg of live weight); Negative Control (NC), challenged and untreated; Control (C)), unchallenged and untreated.

On day 26, Cox1000, followed by the Positive Control, registered the highest OPG values, whereas Cox500 and the Negative Control had approximate the same records. Days 28 and 30 saw the highest OPG records for all challenged groups. More specifically, while the highest OPG level observed for the Positive Control was on day 28, which was significantly higher than for the other groups, the groups treated with the botanical blend and the Negative Control had their highest OPG peak on day 30. Cox1000, followed by Cox500 had the highest OPG value on day 33. On each sampling day, the Negative Control's OPG value was the lowest of all groups, apart from the Control, which was never exposed to *Eimeria,* and also Cox1000 but only on day 30 (Fig. 3).

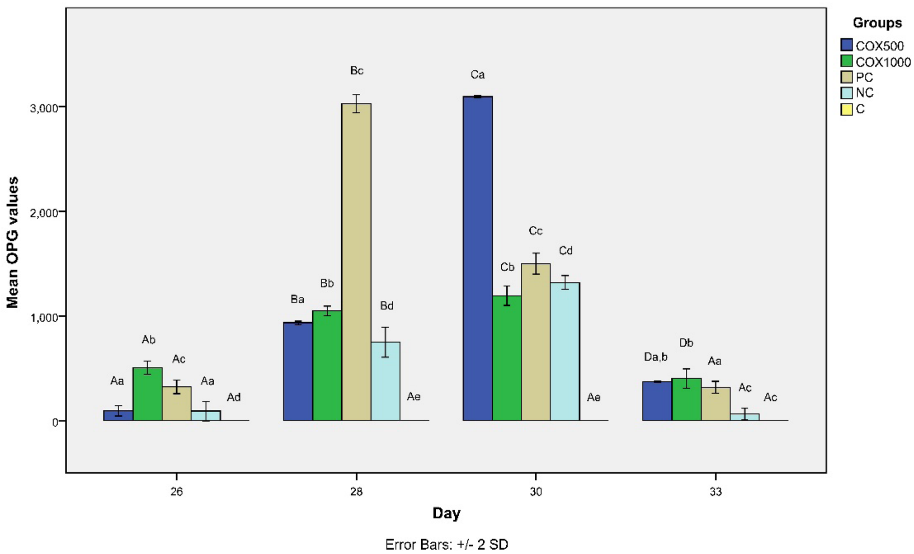

Fig. 3. Oocyst shedding (OPG, mean ± SD) by chickens treated with two concentrations of a blended herbal formula (Coxmarin Esex) compared to the controls. ^{a,b,c,d,e} Distinct superscripted lowercase letters indicate significant differences (P<0.05) between groups on each day. ^{A,B,C,D} Distinct superscripted uppercase letters indicate significant differences (P<0.05) within each group over days. (Cox500, and Cox1000, challenged and treated respectively with concentrations of 500 and 1,000 ml of the blended herbal formula per 1,000 L of drinking water; Positive Control (PC), challenged and treated by toltrazuril (7 mg/kg of live weight); Negative Control (NC), challenged and untreated; Control (C)), unchallenged and untreated.

Discussion

Coccidiosis typically occurs as an infection caused by multiple *Eimeria* species in poultry flocks. Therefore, in this study several prevalent *Eimeria* species were considered in the field for experimental infection (MORRIS and GASSER, 2006; DE GUSSEM, 2007). Against this infection, different parameters were employed, including intestinal lesion scoring, performance indices, and OPG count, however, lesion scoring was based on cecal lesions. Attributing the macroscopic intestinal lesions found on intestinal lesions examination to any specific *Eimeria* species could be inaccurate since, except for *E. tenella* causing more distinct gross lesions, the species used here for bird infection may have overlapped in sites of infection (MORRIS and GASSER, 2006; DE GUSSEM, 2007). Besides, half of the infective oocysts per bird were of the *E. tenella* species, and lesions were primarily found in the ceca (Table 1). These facts collectively explain why lesion scoring was based on cecal lesions.

According to the results, mortality was only observed in the negative control. This group also recorded the highest scores at both time points. These findings possibly correlate with the lack of treatment, as well as the high pathogenicity (POP et al., 2015) and amplification of *E. tenella* oocysts in the infective dose employed. The lack of lesion scores for the Positive Control at both time points demonstrated the capability of toltrazuril to rapidly alleviate cecal lesions attributable to the coccidian infection. The comparison of Cox500 and Cox1000 groups revealed a lower score for the latter at the first time point. Thus, in this study the efficacy of the higher concentration of the botanical blend appeared more comparable to toltrazuril in the rapid healing of cecal lesions resulting from coccidiosis.

During the trial period, the Negative Control registered deficient FCR and body weight records. These observations were possibly due to the disruption of intestinal integrity, reflected in the high lesion scores, which impaired feed utilization efficiency (MOHITI-ASLI and GHANAATPARAST-RASHTI, 2015). Besides, the groups treated with the botanical blend mostly recorded both the highest body weight and the lowest FCR records among the challenged groups. These findings suggest that the botanical blend could efficiently improve the performance indices of coccidia-infected broiler flocks.

The oocysts per gram number probably represents the aspect of the parasite's replication cycle that may not be reflected merely through lesion scores or body weight gain records. The oocyte shedding rate is more dependent on the parasite's capability of multiplication within the gut epithelium than the infection level. This so-called crowding effect probably indicates the role of intestinal healing in promoting oocyst output (CHASSER et al., 2020). In this sense, the earlier OPG peak observed in the Positive Control on day 28 compared to that observed in the other challenged groups on day 30, might again demonstrate that the intestinal epithelium healed more rapidly in the members of the Positive Control. Nevertheless, this group and Cox500 witnessed much higher oocyst shedding than Cox1000 during their OPG peaks. Regardless of intestinal status, this discrepancy may be explained by more over-replication of uninhibited parasites in the members of the Positive Control and Cox500 groups (POP et al., 2019), indicating that the concentration of the herbal formula utilized for Cox1000 was more optimal to stop parasite replication.

Apart from Cox1000 on day 30 only, the Negative Control surprisingly experienced the lowest oocyst shedding rate of all the challenged groups on each sampling day. Consistently, multiple studies have reported higher OPG numbers in challenged groups treated with herbs compared to the challenged untreated groups (ARCZEWSKA-WŁOSEK and ŚWIĄTKIEWICZ, 2013; POP et al., 2015; POP et al., 2019; CHASSER et al., 2020). This finding may be ascribed to the reduced damage to enterocytes, or the promotion of cell renewal in the treated groups, which provided more surface for parasite multiplication (POP et al., 2019). Therefore, owing to the probable excessive damage to enterocytes, reflected in the relevant high lesion scores, the parasite replication and subsequent oocyst shedding was massively suppressed in the Negative Control. Moreover, excreted oocysts are unsporulated after release, and require proper environmental conditions to sporulate. In this respect, at specific concentrations, artemisinin can inhibit sporulation, and deform or inactivate infective sporocytes (DEL CACHO et al., 2010; FATEMI et al., 2015; POP et al., 2015). Thus, despite the higher level of oocyst shedding observed in the groups treated by the botanical blend, a more considerable proportion of excreted sporocytes and oocysts from these groups probably lacked the ability for sporulation and infection compared to the Negative Control. Nevertheless, the oocyst sporulation rate was not considered here to support the validity of this hypothesis further.

To our knowledge, a few mixed herbal extracts with multiple and similar constituent components to the botanical blend employed here, have been successfully tested and reported against coccidiosis. ARCZEWSKA-WŁOSEK and ŚWIĄTKIEWICZ (2012, 2015) reported twice that a herbal extract combination, including garlic, sage, echinacea, thyme, and oregano, improved OPG output and performance parameters. However, in the earlier study, the herbal blend was not effective to prevent cecal lesions and mortality in broiler chickens, which were not observed with both concentrations of the herbal formula tested here. Pajic et al. (2018) also reported the capability of a blend of essential oils of thyme, oregano, and coriander, coupled with organic acids, dextrose, and sodium chloride, in providing both defence against oxidative stress and anticoccidial responses. Recently, a study by POP et al. (2019) suggested various herbal combinations as advantageous measures against mixed coccidian infection. Also, of three blended herbal formulas tested against mixed experimental coccidiosis in their study, only one, comprising extracts of nine various herbs with synergistic impacts, was capable of collectively improving the OPG output, total lesion score, body weight gain, and FCR records, which is comparable to our findings for the higher concentration of the blended herbal formula tested in the present study.

Conclusion

To conclude, the botanical blend showed promising efficiency in the treatment and control of coccidian infection in broiler chickens. No noticeable discrepancy in the impact of the two applied concentrations of the blended botanical formula on growth performance enhancement was observed. However, the higher concentration prompted lower OPG output and, like toltrazuril for the Positive Control, acted more potently in improving the intestinal lesions. Therefore, supplementation of the botanical blend, particularly with in a concentration of 1000 ml of formula per 1,000 L of drinking water, could effectively promote the protection of broiler flocks against coccidian infection.

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Conflict of interest

No conflict of interest is declared.

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SAŽETAK

Kokcidioza, protozoarna bolest uzrokovana vrstom parazita iz roda *Eimeria,* uzrokuje veliku gospodarsku štetu u peradarskoj industriji. Razvijen je niz prirodnih pripravaka za borbu protiv novih vrsta *Eimeria* otpornih na lijekove i ublažavanje zabrinutosti javnosti u pogledu rezidua antikokcidijskih lijekova u proizvodima od peradi. U ovom istraživanju procijenjena je antikokcidijska djelotvornost komercijalne biljne mješavine, primijenjene u dvije koncentracije, za liječenje i kontrolu miješane infekcije kokcidijama. S tom svrhom, 120 novoizvaljenih brojlera nasumično je raspoređeno u pet jednakih skupina: Cox500, Cox1000, pozitivna kontrola (PC), negativna kontrola (NC) i kontrola (C). Prve dvije skupine, Cox500 i Cox1000, bile su izložene oocistima nekoliko vrsta *Eimeria,* a zatim su primile dvije koncentracije biljne mješavine (500 odnosno 1000 ml formule na 1000 L vode za piće) tijekom pet uzastopnih dana. PC skupina također je dobivala toltrazuril (7 mg/kg žive tjelesne mase) putem vode za piće, dva uzastopna dana. NC skupina je poslužila kao skupina s izazvanom-neliječenom kokcidiozom a C skupina kao skupina s neizazvanom-neliječenom kokcidiozom. Kod pilića su nadzirani klinički znakovi, crijevne lezije, pokazatelji proizvodnosti i izlučivanje oocista. Rezultati su pokazali da je testirana biljna formula u obje koncentracije poboljšala pokazatelje rasta pilića. Veća koncentracija potaknula je manje izlučivanje oocista, dok je toltrazuril u PC skupini ubrzao cijeljenje lezija crijeva. Istražena biljna mješavina mogla bi se, posebno u višoj koncentraciji (1000 ml na 1000 L vode za piće), uspješno ugraditi u terapijske strategije protiv kokcidioze u jatima brojlera.

Ključne riječi: djelotvornost protiv kokcidija; biljna mješavina; brojler; izlučivanje oocista

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