Efficacy of essential oils in managing coccidiosis in broilers subject to Eimeria challenge

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Dietary essential oils (EO) are reported to enhance growth performance, modulate immunity and manage coccidiosis of broilers, however, the mechanism behind these benefits remains to be determined. The objective of this study was to evaluate the effect of EO in managing coccidiosis in broilers subject to *Eimeria* challenge. The study consisted of 3 dietary treatments – positive control (PC) without *Eimeria* challenge, negative control (NC), and EO (NC plus 30 g/ton of EO, encapsulated blend of thymol and carvacrol, NEXT ENHANCE®150, Novus International Inc.), each with 12 replicates of 11 birds. All birds in NC and EO treatments were orally gavaged with a coccidiosis vaccine (mixed species of *E. acervulina*, *E. tenella*, and *E. maxima*) at 20× the recommended dose on d 14. Birds were raised in battery cages and fed corn-SBM-based diet with DDGS (5-7.5%) and meat bone meal (3%) as mild dietary challenge. Diets were provided in crumbled form in start phase and pelleted form in grower phase. Growth performance was determined on d 14, 20, and 26. On d 20 and 21, one bird per pen was sacrificed to collect serum to measure cytokines by ELISA. On d16, 19, 20, 21 and 22, fecal samples were collected to count oocyst number per gram feces (OPG). Data were subjected to one-way ANOVA and means were separated by Fisher's protected LSD test. *Eimeria* challenge caused coccidiosis with decrease of serum coloration ($P<0.001$) and systemic inflammation as indicated by an increase of serum alpha-1-acid glycoprotein (AGP) on d20 ($P=0.02$) and interferon gamma (IFNγ) on d21 ($P<0.01$), increased fecal OPG at all time points post challenge ($P<0.01$), and increased FCR during d21-26 by 4.7 points ($P = 0.01$). Compared to NC, EO reduced serum AGP ($P= 0.06$) on d20, IL10 ($P=0.01$) and IFNγ ($P = 0.03$) on d21, fecal OPG ($P=0.04$) on d20, the peak time point of oocyst shedding, and area under the curve of fecal OPG during d16-22 ($P =0.11$), and numerically improved FCR during d21-26 by 2.5 points ($P=0.13$). To determine the effect of EO on *Eimeria* oocysts *in vitro*, oocysts from *Eimeria* vaccine were incubated overnight at 41°C with EO at 0-15.36 mg/mL or monensin (COBAN®90), a commercial coccidiostat as positive control, at 0-16 mg/mL. Live oocysts after incubation were counted and analyzed by one-way ANOVA and separated by Fisher's protected LSD test. Both EO and monensin reduced live oocyst counts in a dose-dependent manner with LC50 of 3.20 and 4.94 mg/ml, respectively. In summary, under the experimental conditions, dietary EO could manage coccidiosis of broilers by reducing host inflammation and fecal oocyst shedding, the latter could be due to direct killing of *Eimeria* oocysts based on *in vitro* results, which was comparable to monensin.

Key words: *Eimeria*, inflammation, essential oil, monensin, broiler