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The dietary supplement efficiency of essential oil of chive (*Allium macrostemon*) on the productivity and health performance of broilers

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ABSTRACT

This experiment was conducted to study the effect of chive essential oil (Allium macrostemon) (CEO) on the production and health of broilers. One-day -old roosters (Ross 308) were allocated to 4 treatments with 3 replications (10 birds/replication). The experiment consisted of control group (CT) with a basal diet and T1, T2 and T3 groups with the supplement in the basal diet by levels of CEO at 100, 300 and 500 mg/kg, respectively. In general, boilers supplemented with CEO had the better FCR compared to the CT. However, broilers in T2 group (300 mg/kg) showed the highest efficiency in terms of weight gain, FCR and PEI. In addition, the use of CEO in T2 and T3 group tended to reduce the incidence of respiratory and diarrhea syndrome in broilers by more than 50% of cases. It can be concluded that the supplement of CEO at the level of 300 mg/kg in the diet had improved the productive and health performance and may be a viable alternative to growth promoter in broiler production.

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1 INTRODUCTION

The main cost of broiler production comes from feed (about 80% of total costs) (Farooq *et al*., 2001). Feed additives are non-nutritive products that help improve feed efficiency and thus reduce feed costs. The use of antibiotic growth promoters (AGP) in feed was actually introduced several decades ago. However, the use of antibiotics is not only limited in broiler farming but also banned in many countries for many reasons such as increasing antibiotic resistance and reducing its effectiveness of antibiotic using for medical purposes (Kabir, 2009). Therefore, in order to replace AGP, natural growth stimulants such as prebiotics, probiotics, synbamel, enzymes, plant extracts etc. can be used in broiler production (Borazjaniz *et al*., 2011).

Chive is a popular crop in the hilly and sandy areas of the central provinces of Vietnam. Unlike other plants of the *Alliaceae* family such as garlic and onions, the antibacterial properties of chive, especially its essential oils, have not received much research attention. It is found that chive contains a lot of bioactive substances such as diallyl sulfide (diallyl monosulfide, diallyl disulfide, diallyl trisulfide, and diallyl tetrasulfide), which are sulfur compounds that are thought to help the antibacterial activities, antioxidant, immune-stimulating (Singh *et al*., 2008). Ethanol extraction from chive's bulb has antibacterial properties towards some negative gram isolated from diarrhea chicken (Hai *et al*., 2019). The most common of essential oil extracts is steam distillation, however, the negative effects may be caused by heat decomposition and the relatively large amount of residual oil in the water. In addition, the solvent used for extraction is usually a volatile solvent such as acetone, ethanol, methanol, ester, etc. which's residues may affect animal health. According to Staba *et al*. (2001), finely chopped chive bulbs are homogenized and slowly maculated in soybeans or other vegetable oils; this essential oil product contains vinyldithin, allyl sulfide, and ajoene. In this study, essential oils were extracted using vegetable oil solvents to assess their effect *in vivo* on growth, health, and economic efficiency in broilers.

2 MATERIAL AND METHOD

2.1 Research material

2.1.1 Essential oil extraction from chive

Fresh bulbs (4-5 months, planted in Hai Lang, Quang Tri) were washed, and crushed bulbs were rejected. Then, they were thinly sliced (2-3mm) with herbal slicers and dried at 50°C for 40 h to achieve 10 kg of chive's bulb. The identification results at the Institute of Biotechnology, Hue University showed that the chive sample is in the same branch and closely related to the *Allium macrostemon*.

Fig. 1: Chives (*Allium macrostemon*) with bulbs were used

The essential oil was extracted from the bulb by using a non-volatile solvent following the instructions of Nguyen Dinh Thuan (2006) with some minor changes. Two-hundred grams of raw material is extracted in solvent (Meizan gold vegetable oil - C. Meizan CLV Ltd.) with ratio 1/5 (w/v) at 60°C, 120 rpm shaking (Titertek Flow Laboratories - DSG 77-472-00) for 48 h. After filtering the residue, chive essential oil (CEO) was separated from the vegetable oil by ethanol (C_2H_5OH). The mixture then was distilled to recover C_2H_5OH under reduced pressure by IKA vacuum evaporator (RV10 Basic V) and then dry with sodium sulfate (Na_2SO_4) to get the pure CEO. The extraction was conducted simultaneously 5 times and carried out continuously to extract all the chive bulbs. The extraction efficiency was 2.03% of the CEO. CEO was kept at 4°C for *in vivo* studies.

2.1.2 Experimental animals and diets

A total of 120 one-day-old Ross 308 broilers (33.21±0.12g) were randomly assigned into four experimental treatments with three replications (10 chickens/replication). The broilers were fed with feed mixed with the main ingredients of corn, rice bran, anchovies, soybean meal 48%, oyster meal, vitamin premix, mineral premix, $CaCO_3$ powder, L-lysine, DL-methyonin to fully meet the needs of Ross strain according to Vietnamese standards (TCVN 2265: 2007) (Table 1). Feed and water are provided with *ad libitum*. Temperature and relative humidity are maintained within the optimal range.

The chicken was illuminated 23 hours/day during the experiment. The control group fed on a basal diet (recommended by Ross) and test groups were fed on a basal diet with the CEO at 100, 300, and 500 mg/kg (T1, T2, and T3 respectively). The CEO is mixed in the carrier (soybean oil), then added to the baseline diet. The feed is mixed weekly in powder form. Experimental chickens were vaccinated against Marek, Newcastle, Fowl pox, and Gumboro.

Table 1: Ingredient and nutrient composition of the experimental diets

Nutritional ingredients	1-21 days old	22-42 days old
Metabolizable energy (kcal kg^{-1})	2850.00	2950.00
Crude Protein (%)	22.50	20.00
Calcium (%)	1.00	0.96
Phosphorus (%)	0.48	0.43
Lysine (%	1.20	1.10
Methionine (%)	0.46	0.44

2.2 Experimental indicators

Chicken productive performance: Feed intake and weight gain were measured at 10, 24, and 42 days of age; and feed conversion ratio (FCR) was feed intake per kg weight gain.

Chicken health: Mortality is monitored daily. Incidence of diarrhea syndrome (DS) or respiratory syndrome (RS): number of chickens suffering from diarrhea or respiration/total number of chickens observed daily.

PEI (Performance Efficiency Index) = Body weight at the end (g) x Survival rate (%) / Number of days raised (days) * FCR (Andrade *et al*., 2006)

2.3 Statistical analysis

Data were statistically analyzed with ANOVA analysis using SPSS (version 26.0) according to the general linear correlation model (GLM). Statistical algorithm: $y_{ij} = \mu + C_i + e_{ij}$; Where: yij = dependent variable; Ci = effect of CEO supplementation; eij = random error. The confidence interval is set at 95% confidence.

3 RESULTS AND DISCUSSION

3.1 The effect of adding the CEO on broiler production

In the starter stage (1to10 day-old), the results in Table 2 showed that feed intake in T3 with the highest CEO supplementation (500 mg/kg) was significantly lower than control groups (P<0.01), meanwhile, fewer CEO groups (100 and 300 mg/kg) and control group were similar. During the finishing period (25-42 day-old) and the whole period (1-42 day-old) the amount of feed intake did not differ significantly among the experimental groups. It is consumed that the flavor of CEO at the high level could affect the palatability of the feed at the beginning period. Chicken weight in T2 groups supplemented with 300 mg/kg of CEO was increased significantly compared to the control group (P<0.05). In general, FCR was significantly improved in all groups with CEO compared to control groups (P<0.001) within 42-day period. Using CEO at 500 mg/kg (T3) caused weight loss (P<0.01), so FCR was improved for T2 group compared to T3 group (P<0.05). In this study, weight gain improvement was not linear. Chickens in T3 group had lower feed intake and as consequence the improved overall FCR (1-42 day-old) was observed in comparison to the control group.

Similarly, Agostini *et al*. (2012) found that chicken growth supplemented with a diet of clove essential oil at 100 and 200 mg/kg when fed a diet with different levels of clove oil (0; 100; 200; 1,000 and 2,500 mg/kg). Ertas *et al*. (2005) found better growth results in broilers fed 100 or 200 mg/kg of essential oil mixture (marjoram, clove and star anise) compared to the 400 mg/kg group.

PEI is a general evaluation index of economic and technical indicators. The higher the PEI, the greater the economic efficiency, normally the PEI in industrial chicken production should be greater than 70 (Andrade *et al*., 2006). In this experiment, PEI of 296,15 in T2 group (300 mg/kg CEO) was significantly higher than that in the remaining groups (P<0.05) showing highest economic efficiency.

In general, the supplement of CEO with the level of 300 mg/kg in T2 group showed the best efficiency with regards to FCR, weight gain and PEI.

Table 2: Effect of CEO supplemented on daily diet in the broiler production

	Days old	Control group	T1 (100 mg/kg)	T2 (300 mg/kg)	T3 (500 mg/kg)	SEM	P-value
Feed intake (g/bird)	1-10	305[a]	304[a]	293[ab]	278[b]	5.10	0.007
	11-24	1316	1301	1290	1289	14.3	0.213
	25-42	2436	2362	2361	2352	36.0	0.092
	1-42	4081[a]	3968[ab]	3966[ab]	3941[bc]	37.5	0.021
Weight gain (g/bird)	1-10	173[b]	183[ab]	199[a]	187[ab]	6.52	0.025
	11-24	748[a]	735[ab]	756[a]	689[bc]	16.6	0.005
	25-42	1201[b]	1236[ab]	1292[a]	1223[ab]	25.7	0.044
	1-42	2121[b]	2158[b]	2259[a]	2131[b]	34.6	0.004
FCR	1-10	1.78[a]	1.66[a]	1.48[b]	1.50[b]	0.04	0.0004
	11-24	1.75[ab]	1.77[ab]	1.71[b]	1.88[a]	0.04	0.031
	25-42	2.03	1.91	1.82	1.95	0.04	0.072
	1-42	1.92[a]	1.84[b]	1.74[c]	1.84[b]	0.02	0.0006
PEI		253.71[b]	260.81[b]	296.15[a]	265.21[b]	7.95	0.018

[abc]: Means on the same row followed by different superscripts are significantly different (P<0.05)

3.2 The effect of adding a CEO to the health of broilers

The two most common syndromes that occur in broilers are DS and RS. The results in Fig. 2 showed that chickens with DS and RS were quite high, about 17.4-20.69%, especially at the age of 21-42 days, the prevalence of DS was 37.93%. The high mortality rate (10%) in the control group was also occurred during this period. On the whole, the use of CEO in the diet had tended to reduce the incidence of DS and RS at 300 mg/kg (T2) and 500 mg/kg (T3) by more than 50% of infected broilers. A statistically significant difference (P<0.05) was found only at the period of 21-42 days old (6.9% in T3 and 10.2% in T2 compared to 37.93% in the control group) for DS. Besides, the mortality rate in T2 and T3 was lower than the control group but the difference was not statistically significant (P<0.05). Most broilers were infected due to the winter weather in Hue City, especially during periods of cold air and high humidity. Therefore, adding the CEO had a positive sign in preventing DS and RS in this period. It is likely that adverse weather is associated with the possible presence of bacteria such as *E. coli* and *Salmonella* caused high DS in broilers and the CEO had an antibacterial effect towards these bacteria.

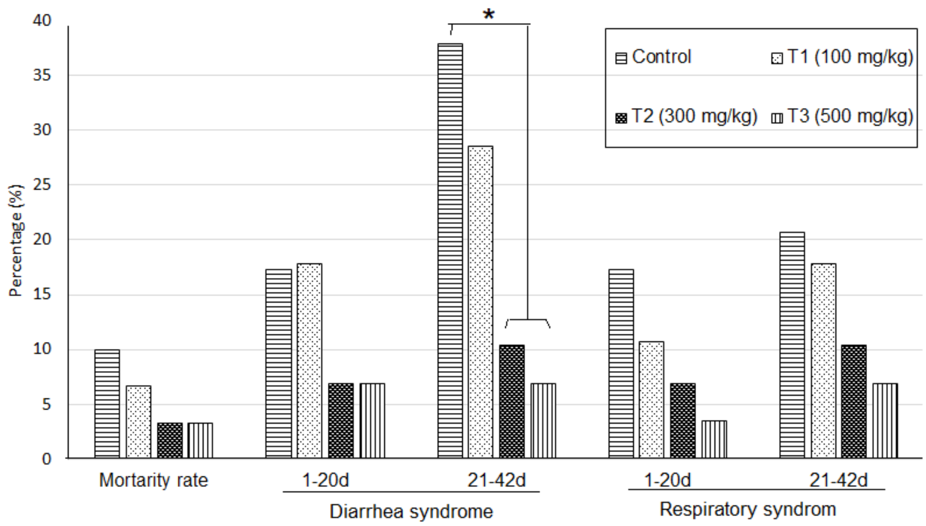

Fig. 2: Effect of CEO supplementation on the health of experimental chickens

**statistical differences (P<0.05)*

Bacteria are the main cause of respiratory and digestive diseases in poultry species that cause heavy economic losses of broiler production worldwide (Samy and Naguib, 2018). Possible pathogens are *Escherichia coli* (Murthy *et al*., 2008), *Ornithobacterium rhotracheale* (Lister and Barrow, 2008) associated with respiratory tract infection, or by *Mycoplasma gallisepticum* that causes chronic respiratory disease (CRD) in poultry (Levisohn and Kleven, 2000). With the gastrointestinal tract, the main pathogenic bacteria are *E. coli* and *Salmonella* and to an increasingly difficult to control level (Azam *et al.*, 2019). On the previous study (Hai *et al.*, 2019) we found that ethanol extract of chive had potential antibacterial activities against pathogens/Gram-negative bacteria (*E. coli* and *Salmonella* spp.) isolated from diarrhoea chickens. Besides, Mnayer *et al*. (2014) evaluated the antibacterial activity of chive's oil against different gram-negative and gram-positive bacterial strains. According to the author, the high compound of sulfur in the oil effects on the high susceptibility to bacteria. In addition to antibacterial properties, the pharmacological ingredients in CEO have the ability to stimulate the animal digestive system, antioxidants, antifungal, anti-parasitic and anti-inflammatory; thereby improving the growth and health of the chickens.

4 CONCLUSIONS

The groups of CEO supplements at 100, 300 and 500 mg/kg showed a better production efficiency, especially the FCR compared to the control treatment. The level of 300 mg/kg showed the highest efficiency. The CEO supplementation at 300 and 500 mg/kg had a positive effect on the health of the experimental broilers, as shown by the improvement in the survival rate and the incidence of DS and RS. The results of this study show that the CEO extracted with the vegetable oil solvent at a supplement of 300 mg/kg in feed may be a viable alternative to growth promoter in chicken production.

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