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TECHNICAL NOTE

Influence of *Houttuynia Cordata* Powder on The Growth Performance of Ducks and The Impact of $AlCl_3$ Treatment on Ammonia flux in Duck Litter

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Abstract

The effects of *Houttuynia cordata* powder on the growth performance of ducks were investigated. Ninety ducks were assigned into one of three dietary treatments as a completely randomized design for 6 weeks: feeds supplemented with 1% or 2% *H. cordata* and a control group. No significant difference was observed in feed conversion among the three groups ($p > 0.05$), but addition of *H. cordata* had a significantly positive effect ($p < 0.05$) on initial and final body weight, weight gain, and feed intake of the ducks. Furthermore, the effects of chemical treatment (comprising 50 g and 100 g aluminum chloride [$AlCl_3$] per kilogram litter) on the ammonia (NH_3) flux in duck litters were also investigated. Duck litter was treated with $AlCl_3$ at a depth of 8 cm by top-dressing; this resulted in a significant difference on NH_3 flux ($p < 0.05$) during the experimental period (but not at 2 weeks). NH_3 flux at 6 weeks were reduced by 25.4% and 37.5% by treatment with 1% and 2% H. cordata, respectively, compared with the control groups. In conclusion, enriching the diets of the ducks with 2% *H. cordata* and adding 100 g $AlCl_3$ to their litter has beneficial effects on increasing their growth performance and reducing NH_3 flux in their environment.

Key words : *Houttuynia cordata* powder, Aluminum chloride, Growth performance, Ammonia, Duck litter

1. Introduction

Antibiotic growth promoters (AGPs) are used in animal diets to enhance livestock production and economic viability, as well as to prevent subclinical diseases. However, the use of antibiotics in animal feed has been prohibited in many countries due to the rise of pathogen resistance to antibiotics. In January 2006, the European Union banned the use of AGPs in animal feed except for three antibiotics (salinomycin-Na, flavophospholipol, avilamycin) (Wenk, 2003; Catalá-Gregori et al., 2008). Consequently, many alternative approaches that have the potential to maintain animal health and productivity in the livestock industry have been investigated. Among these, medicinal herbs are considered a potential candidate for antibiotic alternatives.

Houttuynia cordata (*H. cordata*) is traditionally used as an aromatic medicinal herb because of its antioxidant, antimicrobial, antiviral, and anti-inflammatory activities. It is distributed widely in China, Korea, India, and Taiwan (Hayashi et al., 1995; Chen et al., 2003; Lu et al., 2006). *H. cordata* is known to have beneficial effects on livestock productivity,

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nutrient digestibility, and mast cell-mediated inflam -mation (Kim et al, 2007; Yan et al., 2011). In addition, the major components in *H. cordata* are essential oils, alkaloids, and flavonoids that possess antioxidant properties and free radical scavenging capacities (Fu et al., 2013).

Another challenge faced by the livestock industry is the regulation of ammonia (NH_3) levels in poultry litter. The buildup of NH_3 in the environment has inevitably provoked various concerns about environ -mental, human, and poultry health. However, litter is a valuable resource for improving crop production. Thus, recognizing and understanding its significance is central to good litter management in poultry houses. Management practices could be refined to mitigate potential negative environmental impacts of litter on air and soil. For example, chemical amendments to animal manure or litter have been shown to reduce NH_3 levels effectively; a study by Smith et al. (2001) demonstrated that swine manure treated with $AlCl_3$ emitted less NH_3.

Therefore, the objective of the present study was to evaluate the beneficial effects of H. cordata on the growth performance in ducks and furthermore examine how ammonia emissions are affected by addition of $AlCl_3$ to duck litter?

2. Material and methods

2.1. Leaf preparation

H. cordata leaves and stems were obtained from a herbal medicine market (Daegu, South Korea). They were initially air-dried for 12 h at room temperature and then oven-dried at 50°C for two consecutive days and subsequently ground to a fine texture. The resulting powder was stored in airtight plastic bags until further processing.

2.2. Experimental design and birds

All experimental protocols were performed in compliance with the animal care guidelines of animal policy at Gilhong farm (Geochang, South Korea). Ninety ducks (one-day-old pekin, 45 male and 45 female) were assigned to one of three dietary treat -ments in a completely randomized design for a 6-week experimental period: two treatment groups (T1 [1% *H. cordata*] and T2 [2% *H. cordata*]) and one control group (Control). After a brooding period of 1 week, each treatment group was subdivided into three replicates of 10 ducks (5 male and 5 female) per pen. Starter diets were provided from day 1 to 21 and comprised 21% crude protein, 2.5% crude fat, 8% crude fiber, 9% crude ash, 0.40% Ca, and 1.50% P. Finisher diets provided from day 22 to 42 consisted of 17% crude protein, 2.5% crude fat, 8% crude fiber, 9% crude ash, 0.40% Ca, and 1.0% P. A feeder and a drinker were placed in each pen and the ducks had access to feed and water filled *ad lib*. Approximately 8 cm of litter comprising rice hulls and duck manure was deposited over concrete flooring. Ventilation and temperature in the duck houses were automatically regulated. Ducks were weighed at 8 and 42 days of age, and the average weights were recorded to determine growth performance. Feed intake was also recorded at each feed change interval during the experimental period. Body weight gain and feed intake were used to calculate feed conversion ratio (FCR).

2.3. Chemical treatment and ammonia measurement

The duck litter with rice hulls was chemically treated by top-dressing. The three treatments consisted of control, T1 (50 g $AlCl_3$/kg litter) and T2 (100 g $AlCl_3$/kg litter). Aluminum chloride ($AlCl_3 \cdot 6H_2O$) was purchased from Samchun Chemicals Company (Pyeongtaek, South Korea). Ammonia emissions from duck litter with rice hulls were measured weekly (2 weeks through 6 weeks) at 4 random sites in each pen by using a multi-gas analyzer (Yes Plus LGA, Critical Environment Technologies Canada

Inc., Delta, Canada).

2.4. Statistical Analysis

Data were analyzed by analysis of variance using the general linear model procedure (SAS Institute Inc., 2002), with the pen defined as the experimental unit. Differences among all treatments were analyzed using Duncan's multiple range test at a probability level of <0.05 (Duncan, 1955).

3. Results and discussion

3.1. Growth performance

The effects of *H. cordata* powder on the growth performance in ducks were examined (Table 1). No significant difference was observed in feed conversion among the groups ($p > 0.05$), but addition of *H. cordata* had a positive effect ($p < 0.05$) on the initial and final body weight, weight gain, and feed intake. When the groups treated with *H. cordata* powder were compared, the 2% *H. cordata* groups (T2) showed a slightly higher weight and feed intake than the 1% *H. cordata* groups (T1). This finding suggests that a growth promoter from *H. cordata* could exert an indirect effect on duck growth performance. These results could be explained by the herbal components' stimulatory effects on digestion and their gastropro-tective effects, as reported by Abdulla *et al*. (2010).

Herbal feed additives not only enhance the flavor of animal diets but also stimulate eubiosis of the microflora in the digestive tract, which results in the secretion of digestive fluids. This leads to more efficient nutrient utilization and absorption and plays a major role in the early growth process of animals. Digestion processes in the later stages can be specifically optimized and adapted to the available feedstuffs (Wenk, 2003). However, Yan et al. (2012) reported that using *H. cordata* (1g/kg) did not influence ($p > 0.05$) the average daily gain (ADG) of the pigs in their study.

To the best of our knowledge, limited research has been carried out on duck nutrition and production using *H. cordata* as a feed additive.

3.2. Ammonia fluxes

The effects of $AlCl_3$ on NH_3 flux in the litters were analyzed (Table 2). Treatment of duck litter with $AlCl_3$ had a significant effect on NH_3 flux during the experimental period ($p < 0.05$). However, no signi-ficant differences in NH_3 flux were observed among the various groups at 2 weeks. Overall, NH_3 fluxes significantly decreased ($p < 0.05$) in T1 and T2 compared with the control group for 6 weeks. In addition, NH_3 flux at 6 weeks decreased by 25.4% and 37.5% in T1 and T2, respectively, compared with

Table 1. Effect of *Houttuynia cordata* (*H. cordata*) powder on growth performance in ducks after 42 days

Item	Treatment[2]			Statistics	
	Control	T1	T2	SEM[1]	*P-value*
Initial body weight (at 8d, g)	181.96^{ab}	186.23^{a}	177.33^{b}	2.57	0.0293
Final body weight (at 42d, g)	3166.67^{b}	3330.33^{a}	3425.67^{a}	75.63	0.0054
Weight gain (g)	2984.71^{b}	3144.10^{b}	3248.34^{a}	25.57	0.0059
Feed intake (g)	5419.20^{b}	5466.53^{b}	5647.10^{a}	61.33	0.0158
Feed conversion (feed:gain ratio, 8 to 42d)	1.82	1.74	1.74	0.04	0.0651

$^{a-b}$Mean values within rows with different superscripts are significantly different ($P < 0.05$).
[1]Mean values are expressed as means ± SEM.
[2]Control = basal diet; T1 = 1.0% *H. cordata*; T2 = 2.0% *H. cordata*.

Table 2. Effect of aluminum chloride on ammonia fluxes (ppm) in litter after 42 days

Time (week)	Treatment[2]			Statistics	
	Control	T1	T2	SEM[1]	*P-value*
2	1.74	1.67	1.43	0.09	0.5054
3	6.99[a]	4.18[b]	3.55[b]	1.06	0.0277
4	14.64[a]	10.67[b]	9.57[b]	1.54	0.0021
5	24.83[a]	17.53[b]	13.90[c]	3.21	P<0.0001
6	29.57[a]	22.05[b]	18.48[c]	3.27	P<0.0001

[a-c]Mean values within rows with different superscripts are significantly different (P < 0.05).
[1]Mean values are expressed as means ± SEM.
[2]Control = basal diet; T1 = 50 g $AlCl_3$/kg litter; T2 = 100 g $AlCl_3$/kg litter.

the control group. This result was expected because addition of $AlCl_3$ to duck litter creates an unfavour-able acidic environment for pathogen and enzyme activity that contributes to NH_3 formation (Pokharel, 2010). As shown in Table 1, this result supports the hypothesis that an $AlCl_3$-induced decrease in NH_3 flux could affect duck growth performance, regard-less of the use of H. cordata additives. Similar findings have been reported by Lee et al. (2013), who found that using a combination of anhydrous $AlCl_3$ and $CaCO_3$ as litter additives reduces NH_3 flux by 55.3%, 56.4%, 40.1%, and 35.8% for 1, 2, 3, and 4 weeks, respectively, in comparison with the control groups. Choi et al. (2011) reported a 67%, 57%, and 35% reduction in NH_3 flux by the application of 300 g, 200 g, and 100 g liquid $AlCl_3$/kg rice hulls, respectively.

4. Conclusion

The addition of *H. cordata* powder in the feed influenced the initial and final body weight, weight gain, and feed intake of the ducks studied. The inclusion of up to 2% *H. cordata* in diets had a positive effect on duck growth performance. More-over, the addition of 100 g $AlCl_3$ to duck litter has the potential to reduce NH_3 flux, which may help decrease environmental pollution in duck housing facilities.

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