Dietary inclusion of *Achyranthes japonica* extract to corn-soybean meal-wheat-based diet on the growth performance, nutrient digestibility, cecal microflora, excreta noxious gas emission, and meat quality of broiler chickens

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ABSTRACT This research was conducted to determine the effects *Achyranthes japonica* extract (**AJE**) supplementation to corn-soybean meal-wheat-based diet on the growth performance, nutrient digestibility, cecal microflora, excreta noxious gas emission, and meat quality of broiler chickens. A total of 432 one-day-old male Ross 308 broiler chickens, having initial body weight (**IBW**) of 41.11 ± 1.65 g were randomly allotted to 4 dietary treatments. Each treatment had 6 replicates cages with 18 broilers per cage. Dietary treatments composed of corn−wheat−soybean meal−based diets along with the addition of 0, 0.025, 0.05, and 0.1% of AJE. Bodyweight gain (**BWG**) and average daily feed intake (**ADFI**) were linearly influenced by the supplementation of AJE duringphase1 and 2 and the overall trial period. Inclusion of increasing levels of AJE linearly improved the digestibility of dry matter (**DM**) on d 35. Dietary supplementation of increasing levels of AJE failed to show significant effects on cecal Lactobacillus, coliform, and Salmonella counts, excreta noxious gas ammonia, hydrogen sulfide, total mercaptans, carbon dioxide, acetic acid and propionic acid emission, meat quality, and relative organ weight. Therefore, we concluded that supplementation of 0.1% of AJE in diets could improve BWG and ADFI, dry matter digestibility in broilers.

Key words: *Achyranthes japonica*, broilers, bodyweight gain, intestinal microorganism, nutrient utilization

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INTRODUCTION

The intensive raising methods of poultry by commercial farms causes different stresses, exposes the chickens to different diseases, lowers the immunity, reduces meat quality and carcass traits, and compromises the antioxidant ability of broilers, which leads to higher mortality rate and high economic losses (Xing et al., 2015; Long et al., 2020). Antibiotic growth promoters (**AGPs**) have been widely applied in poultry diets to increase performance, improve health status and reduce incidence of mortality of broilers (Cervantes, 2015; Liu et al., 2021). However, the use of AGPs in broiler feed has been banned in the European Union, South Korea, China, and United States, and other countries because of the risk of drug-resistant bacteria and antibiotic residues in broilers products (Barug et al., 2006; Long et al., 2020; Liu et al., 2021). Therefore, a need to develop natural and environmentally friendly alternative substances to promote general health and growth in broiler production became urgent and prompted the animal scientists for the investigation of suitable alternatives (Cervantes, 2015). Different alternatives for in-feed antibiotics including organic acids (Nguyen and Kim, 2020), plant extracts (Dang and Kim, 2020), probiotics (Wang et al., 2021), and yeast (Sampath et al., 2021) have been studied by the research team of our lab. Among the different alternatives medicinal herb plants extract is one such alternative that has a lot of bioactive compounds and their application in the diet have been demonstrated to increase performance, nutrient digestibility, antioxidants status, antimicrobial activities, anti-inflammatory, and immune function of broilers (Upadhaya and Kim, 2017; Liu et al., 2020, 2021). Medicinal herb plant extracts are potential replacement for antibiotics. The A*chyranthes japonica* (**AJ**) plant (Amaranthaceae) is a perennial plant abundant in East Asian countries including China, Korea, and Japan. The active compounds of A*chyranthes japonica* extract (**AJE**) mainly contain triterpenoids, inokosterone, saponins, oleanolic acid, ecdysterone, and bisdesmoside which may have scavenging effects against free radicals (Park and Kim, 2020). A few biological

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activities of AJE have been reported; antiallergic, antioxidant, anti-inflammatory, hepatoprotective, arthritis alleviation, and anticancer properties of AJ roots (Jang et al., 2012; Sureshkumar et al., 2022). Thus, AJE whose main component is triterpenoid saponins, might well influence broilers production. For the last several years, some studies have found that supplementing AJE to diets could improve growth performance, nutrient digestibility, meat quality, gut microbiota to benefit the health of broilers (Park and Kim, 2020; Sun et al., 2020), mice (Tahiliani and Kar. 2000), and pigs (Dang et al., 2020).

To the best of our knowledge, studies that focused on the effects of AJE supplementation to corn-SBM-wheat-based diet on broilers growth performance, nutrient digestibility, and health status are limited. Thus, this experiment was conducted to assess the effects of AJE supplementation to corn-SBM-wheat-based diet on growth performance, nutrient digestibility cecal microbiota, excreta noxious gas emission, and meat quality in broilers.

MATERIALS AND METHODS

All the experimental procedures were agreed by the Institutional Animal Care and Use Committee of Dankook University (Cheonan, South Korea; Ethics Approval Number: DK-1-1903).

Experimental Samples

The *Achyranthes japonica* (AJ) is derived from a climbing plant widely distributed in South Korea. The dried root of *Achyranthes japonica* was purchased from Synergen Company (Bucheon, South Korea). In brief, dried root of AJ were ground to powder (100 g) extracted with 500 mL 80% methanol, sonicated for 2 h, filtered, and extracted twice (500 mL each time). The filtrates were combined and dried by rotary vaporization (Büchi, Rotavapor R-124, Flawil, Switzerland). The AJE contains active constituents of total flavonoid (1.15 mg/g), total polyphenol (4.26 mg/g), and saponin (0.47 mg/g).

Research Design, Birds, and Diets

A total of 432 one-day- old male Ross 308 broiler chickens, initial body weight (41.11 ± 1.65 g) were randomly divided to 4 treatments, 6 replicate pens per treatments, and 18 broilers per pen. Dietary treatments composed of corn−wheat−soybean meal−based diets along with the addition of 0, 0.025, 0.05, and 0.1% of AJE. The trial period lasted for 35 d. All diets were formulated to meet or exceed the nutrient requirements recommended by the National Research Council (National Research Council 2012) and fed in mash form (Table 1). D 28 to 35, Chromium oxide (Cr2O3, 0.2%) was added to all diets as an indigestible marker.

Broilers were fed according to their growing stages; phase 1 (d 1−7), phase 2 (d 8−21), and phase 3 (d 22−35). All broilers were housed in a temperature-controlled room with 3 floors of stainless-steel battery cages (1.75 × 1.55 m^2). Brooding house temperature was 33°C, and it was reduced by 3°C for per week until it reached 22°C and then remained constant. The broilers had free access to feed and water during the trial.

Table 1. Composition and nutrient levels of basal diets (%, as-fed basis)[1].

Ingredients, %	Phase 1 (d 1−7)	Phase 2 (d 8−21)	Phase 3 (d 22−35)
Corn	44.10	45.42	51.46
Wheat	10.00	10.00	10.00
SBM	30.494	28.591	19.14
Rapeseed meal		3.00	
DDGS	5.00	2.41	5.00
Tallow	3.21	6.00	6.00
Soy oil	0.50		
Limestone	1.42	1.06	1.31
MDCP	1.88	1.66	1.58
Sodium bicarbonate	0.10	0.10	0.10
DL-Methionine, 99%	0.506	0.421	0.51
Threonine 98.5%	0.21	0.16	3.26
Choline,50%	0.13	0.10	0.10
Mineral premix[1]	0.10	0.10	0.10
Copper sulfate		0.03	0.038
Salt	0.27	0.26	0.23
Lysine 50%	2.00	0.62	0.71
Tryptophan,10%			0.01
Vitamin premix[2]	0.06	0.06	0.45
Vitamin E,10%	0.02		
Calculated value			
Dry matter	87.31	87.53	87.57
Crude protein, %	22.00	20.50	18.50
Crude fat, %	5.74	7.85	8.05
Crude fiber, %	2.46	2.45	2.22
Crude ash, %	6.32	5.85	5.31
Metabolizable energy, kcal/kg	3030	3140	3250
Calcium, %	1.05	0.90	0.90
Available phosphorus	0.50	0.45	0.42
Lysine	2.04	1.34	1.09
Methionine	0.72	0.65	0.66
Cysteine	0.34	0.34	0.27
Threonine	0.97	0.91	3.79
Tryptophan	0.24	0.23	0.17
Methionine + cysteine	1.06	0.99	0.93
Digestible lysine	1.87	1.17	0.95
Digestible methionine	0.68	0.60	0.62
Digestible cysteine	0.26	0.26	0.21
Digestible threonine	0.83	0.76	3.65
Digestible tryptophan	0.20	0.20	0.15
Digestible methionine and cysteine	0.94	0.87	0.83

[1]Provided per kg of complete diet: 12 mg Cu (as $CuSO_4 \bullet 5H_2O$); 85 mg Zn (as $ZnSO_4$); 8 mg Mn (as MnO_2); 0.28 mg I (as KI); 0.15 mg Se (as $Na_2SeO_3 \bullet 5H_2O$).

[2]Provided per kg of complete diet: 11,025 IU vitamin A; 1,103 IU vitamin D3; 44 IU vitamin E; 4.4 mg vitamin K; 8.3 mg riboflavin; 50 mg niacin; 4 mg thia mine; 29 mg d-pantothenic; 166 mg choline; 33 μg vitamin B12.

Broiler Performance

On d 0, 7, 21, and 35, chickens were weighed by pen, and feed intake was recorded to calculate body weight gain (**BWG**), average daily feed intake, and feed conversion ratio (**FCR**).

Apparent Total Tract Digestibility

From d 33 to 35, clean fecal samples were collected (without feather and feed in feces) from each pen every day, and mixed together, dried in an oven (65°C) for 72 h, and ground to pass through a 1-mm sieve. Feed and fecal samples were analyzed for dry matter (**DM**) and nitrogen (**N**) according to the methods of AOAC International, 2000. The gross energy (**GE**) was determined using an automatic adiabatic oxygen bomb calorimeter (Parr 6300 Calorimeter, Moline, IL). Chromium concentration was determined by UV absorption spectrophotometry (UV-1201, Shimadzu, Kyoto, Japan).

The equation for calculating digestibility was as follows:

ATTD (%) = (1−((Nf × Cd)/ (Nd × Cf))) × 100, where Nf = nutrient concentration in feces (% DM), Nd = nutrient concentration in diet (% DM), Cf = chromium concentration in feces (% DM), and Cd = chromium concentration in diet (% DM).

Cecal Microflora Counts and Excreta Noxious Gas Emission

At termination of the trial, the left ceca were excised from slaughtered 2 chickens per pen (12 birds per treatment), collected in airtight bags, and stored at −18 °C. At the time of investigation, the content of each ceca was thawed and squeezed into sterile bottles and serially diluted in 0.85% sterile saline solution. An aliquot (0.1 mL) of each diluted sample was cultivated on a Lactobacilli MRS agar (Difco Laboratories, Detroit, MI), MacConkey agar (Difco Laboratories), and Salmonella −Shigella agar (Difco Laboratories) and incubated at 37 °C for 24 h. After the incubation periods, colonies of the respective bacteria were counted and expressed as the logarithm of colony-forming units per gram (log10 CFU/g).

At the termination of the trial, fresh excreta samples (300 g) were collected from each cage for 4 d for determining ammonia, hydrogen sulfide, total mercaptan, carbon dioxide, acetic acid, and propionic acid. The subsamples of excreta were taken and stored in 2-L sealed plastic containers in duplicate for 5 d at ambient temperature (20−24°C). One hundred milliliters of headspace air was sampled at approximately the upper 2 inches of the excreta surface. After the fermentation period, a gas sampling pump kit (model GV-100S, Gastec Corp., Tokyo, Japan) was used for gas detection. The concentrations of ammonia, hydrogen sulfide, total mercaptan, acetic acid, and propionic acid were measured by a detector tube within the scope of 0.5 to 78 ppm (No. 3 L, detector tube; Gastec Corp.), 0.1 to 4 ppm (No. 4LT, detector tube; Gastec Corp.), and 0.1 to 8 ppm (No. 70 L, detector tubes; Gastec Corp.), respectively.

Meat Quality and Viscera Percentage

On d 35, the collected viscera of 2 chickens per pen (12 birds per treatment) were weighed to determine the viscera percentage, including the breast meat, abdominal fat, gizzard, liver, spleen, and bursa of Fabricius percentages, according to the following formula:
Viscera percentage (expressed as % of body weight) = viscera weight / final body weight × 100.

Breast meat colour was measured using a Minolta CR-410 Chromameter (Konica Minolta Sensing Inc., Osaka, Japan) and expressed as (L∗ = lightness, a∗ = redness, and b∗ = yellowness) values. The pH values of each breast meat sample were measured via a glass-electrode pH meter (WTW pH 340-A, WTH Measurement Systems Inc., Ft. Myers, FL). To estimate the cooking loss, raw meat samples were packed into Cryovac Cook-In Bags after weighing and cooked in a water bath at 100° C for 30 min. Samples were cooled at room temperature for 1 h and weighed again. Cooking loss was calculated as the weight difference between the initial raw and final cooked samples. Drip loss was measured using approximately 4 g of meat sample hung in a zipper bag and stored at 4°C. After storage, moisture on the surface of the meat slice was carefully removed and weighed at d 1, 3, 5, and 7 after the sample was taken. The initial and final weight of each sample was used to calculate drip loss. To analyze water-holding capacity (**WHC**), 0.2 g chicken meat sample was taken and placed in a filter paper 125-mm diameter and pressed for 3 min at 26°C. The moisture exposure of the compressed areas was determined using a digitalized area-line sensor (MT-10S, M.T. Precision Co. Ltd. Tokyo, Japan). The ratio of water in the meat area was then calculated (a smaller ratio indicates increased WHC).

Statistical Analysis

All data were analyzed by linear, quadratic, and polynomial contrasts test for unpaired data with cage as an experimental unit using SAS software (version 9.2; SAS Inst. Inc., Cary, NC). Data are showed as mean ± SD. For all tests, $P < 0.05$ was considered as significant difference, while $0.05 < P < 0.10$ as a tendency.

RESULTS

Broiler Performance

Increasing dietary levels of AJE linearly increased the BWG and ADFI of broilers at phase 1, 2, and overall (d 1−35 d). However, there were no differences in FCR among all groups (Table 2).

Apparent Total Tract Digestibility

On d 35, ATTD of DM increased in broiler fed on diets supplemented with increasing levels of AJE. No treatment effects were observed on the N and GE (Table 3).

Table 2. The effect of *Achyranthes japonica* extract supplementation on growth performance in broilers[1].

Items	AJE 0%	AJE 0.025%	AJE 0.05%	AJE 0.1%	SEM[2]	P-value Linear	P-value Quadratic	P-value Cubic
IBW	41.83	41.80	41.95	41.70				
Phase 1 (d 1 to 7)								
BWG, g	123	126	131	128	1.69	0.0215	0.1491	0.2007
ADFI, g	160	163	167	166	2.23	0.0483	0.4049	0.5468
FCR	1.299	1.294	1.275	1.292	0.007	0.2645	0.1567	0.1350
Phase 2 (d 7 to 21)								
BWG, g	647	651	663	660	3.51	0.0058	0.3238	0.2260
ADFI, g	899	905	916	914	5.48	0.0376	0.4956	0.4747
FCR	1.390	1.389	1.382	1.384	0.004	0.2766	0.7392	0.4036
Phase 3 (d 21 to 35)								
BWG, g	963	976	985	981	8.85	0.1373	0.3757	0.8394
ADFI, g	1,787	1,806	1,822	1,816	14.46	0.1381	0.4073	0.7924
FCR	1.856	1.852	1.850	1.852	0.007	0.6623	0.7007	0.9882
Overall period								
BWG, g	1,733	1,753	1,778	1,769	10.4	0.0118	0.1935	0.4036
ADFI, g	2,846	2,874	2,904	2,896	15.27	0.0194	0.2507	0.5685
FCR	1.642	1.640	1.633	1.637	0.003	0.1550	0.3801	0.3899

[1]Abbreviations: AJE, *Achyranthes japonica* extract; ADFI, average daily feed intake; BWG, body weight; FCR, feed conversion ratio; IBW, initial body weight.
[2]Standard error of means.

Table 3. The effect of *Achyranthes japonica* extract supplementation on nutrient digestibility in broilers[1].

Items, %	AJE 0%	AJE 0.025%	AJE 0.05%	AJE 0.1%	SEM[2]	P-value Linear	P-value Quadratic	P-value Cubic
Finish								
Dry matter	70.12	72.10	73.27	72.48	0.64	0.0097	0.0445	0.6944
Nitrogen	68.74	69.43	70.60	70.37	0.96	0.1761	0.6416	0.6639
Energy	71.94	72.88	73.59	73.36	0.72	0.1391	0.4264	0.8312

[1]Abbreviation: AJE, *Achyranthes japonica* extract.
[2]Standard error of means.

Cecal Microflora Counts and Excreta Noxious Gas Emission

On d 35, the inclusion of increasing levels of AJE diets had no effects on *Lactobacillus*, coliform, and *Salmonella* as well as excreta noxious gas ammonia, hydrogen sulfide, total mercaptans, carbon dioxide, acetic acid, and propionic acid emission (Tables 4 and 5).

Meat Quality and Viscera Percentage

As shown in Table 6, the dietary AJE supplementation had no differences on the meat quality parameters such as pH, WHC, color, cooking loss, and drip loss. Relative organ weight (breast muscle, liver, spleen, gizzard, and bursa of fabricius) were also not affected by increasing levels of AJE supplementation

DISCUSSION

In the current study, demonstrated that that supplementing AJE to broilers diets could improve BWG and ADFI during phase 1, 2, and overall period and ATTD of dry matter on d 35. The improvement in growth performance of broilers might be due to the AJE, AJE has been proved to have antioxidant capacities and anti-inflammatory activities (Sureshkumar et al., 2021; Liu and Kim, 2021). In addition, it has been reported that AJE was beneficial to the gut health of animals (Liu et al., 2018). Sun et al. (2020) showed that 0.10% of AJE supplementation to broilers diets could significantly increase BWG and ADFI during phase 1, 2, and overall period ATTD of dry matter and nitrogen at d 35. Previously, Park and Kim (2020) also reported that broiler fed AJE had improved the growth performance and ATTD of dry matter and nitrogen at da35. Similarly, Dang et al. (2021a,b) reported that AJE at level of

Table 4. The effect of *Achyranthes japonica* extract supplementation on cecal microbial counts in broilers[1].

Items, log_{10}cfu/g	AJE 0%	AJE 0.025%	AJE 0.05%	AJE 0.1%	SEM[2]	P-value Linear	P-value Quadratic	P-value Cubic
Lactobacillus	7.02	7.11	7.12	7.12	0.05	0.2089	0.3298	0.7584
E.coil	6.26	6.23	6.21	6.23	0.06	0.6632	0.6488	0.9104
Salmonella	2.99	2.88	3.00	2.96	0.05	0.8938	0.5686	0.1496

[1]Abbreviation: AJE, *Achyranthes japonica* extract.
[2]Standard error of means.

Table 5. The effect of *Achyranthes japonica* extract supplementation on meat quality in broilers[1].

	AJE					*P*-value		
Items, ppm	0%	0.025%	0.05%	0.1%	SEM[2]	Linear	Quadratic	Cubic
Finish								
Ammonia	13.5	13.8	13.8	13.7	0.41	0.8048	0.6637	0.9688
Hydrogen sulfide	2.5	3.2	3.3	2.6	0.45	0.8945	0.1616	0.9711
Acetaldehyde	3.2	2.9	3.2	3.7	0.75	0.6095	0.6179	0.9249
Carbon dioxide	1,935	1,891	1,880	1,733	193.9	0.4963	0.7970	0.8483
Acetic acid	1.3	1.4	1.2	0.9	0.18	0.1105	0.2196	0.7747
Propionic acid	3.2	4.7	2.5	4.3	0.89	0.7619	0.8706	0.0938

[1]Abbreviation: AJE, *Achyranthes japonica* extract.
[2]Standard error of means.

0.015 and 0.030% increased the BWG and reduced FCR, and ATTD of nitrogen in broiler chickens.

The gastrointestinal tract of broilers is the major position of feed digestion and nutrient absorption, which comprised over 900 species of bacteria (Wei et al., 2013). The cecum is the main site of microbial fermentation in the distal intestine and plays important roles in preventing pathogen colonization, removing harmful substances, circulating nitrogen, and absorbing additional nutrients (Yan et al., 2017). It was reported that the individual intestinal compartment owns the unique physical and chemical properties and was occupied with specialized microbiome composition (Dethlefsen et al., 2007). Therefore, stimulating beneficial bacteria such as lactic acid bacteria could be helpful to the gut microbiota balance, and this consequently affects the host growth, immunity, and well-being positively. In an in vitro study conducted by Jung et al. (2008), it was indicated that AJE received high antimicrobial effects against Clostridium difficile; furthermore, the efficiency of antimicrobial activity increased with the combination of lactic acid bacteria. Recently, Sun et al. (2020) and Park and Kim (2020) reported a linear increase in lactobacilli count and linear reduction in coliform and Salmonella count in the excreta of broiler chickens fed dietary AJE supplementation. Moreover, Liu and Kim (2021) and Sureshkumar et al. (2021) reported a linear reduction in coliform count and linear increase in lactobacilli count of pigs fed dietary AJE supplementation. However, with Dang et al., 2021a who reported no effects on coliform count, lactobacilli count in the cecal digesta of broiler chickens fed dietary AJE supplementation. Similarly, Reis et al. (2018) reported no difference in the cecal microbial count in broiler fed phytogenic feed additive. The results of the present study indicated that the addition of AJE did not exert significant difference on coliform, lactobacilli and Salmonella counts in the cecal digesta of broiler chickens. Furthermore, microbiota balance also could be an explanation for the no affect nitrogen digestibility in this experiment.

The result of present study showed that the inclusion of AJE had no difference on carcass quality in broilers. Similarly, Dang et al. (2021a) reported no effects on the carcass quality of broiler chickens fed dietary AJE supplementation. Similarly, Park and Kim (2020) found that dietary inclusion of 0.02, 0.05, and 0.10% AJE had no difference on the meat quality in broilers. However, another study reported that supplementation of the

Table 6. The effect of *Achyranthes japonica* extract supplementation on meat quality in broilers[1].

	AJE					*P*-value		
Items	0%	0.025%	0.05%	0.1%	SEM[2]	Linear	Quadratic	Cubic
pH value	7.71	7.84	7.76	7.76	0.06	0.7931	0.2853	0.3013
Breast muscle color								
Lightness	34.07	33.24	33.92	33.59	0.49	0.7420	0.6218	0.2745
Redness	37.65	35.01	35.92	36.33	0.99	0.5066	0.1518	0.3790
Yellowness	15.60	14.84	14.40	14.42	0.66	0.2104	0.5681	0.9567
WHC, %	45.36	43.98	44.75	44.26	4.08	0.8925	0.9150	0.8548
Cooking loss	18.24	18.95	17.42	17.38	1.85	0.6285	0.8404	0.6603
Drip loss, %								
d 1	4.76	4.42	4.33	4.38	0.14	0.0834	0.2024	0.8797
d 3	7.68	7.38	7.64	7.47	0.21	0.7134	0.7793	0.3207
d 5	10.35	10.25	10.00	10.42	0.16	0.9525	0.1461	0.2899
d 7	12.67	12.08	12.57	12.49	0.28	0.9730	0.3975	0.2203
Relative organ weight, %								
Breast muscle	18.48	18.67	19.47	18.67	0.95	0.7555	0.6111	0.6152
Liver	2.99	2.80	2.88	2.57	0.30	0.4092	0.8571	0.6426
Bursa of Fabricius	0.13	0.14	0.16	0.13	0.01	0.7617	0.2888	0.3704
Abdominal fat	2.92	2.71	2.92	2.85	0.40	0.9836	0.8674	0.7000
Spleen	0.13	0.13	0.14	0.12	0.16	0.9382	0.6049	0.5895
Gizzard	1.74	1.67	1.62	1.77	0.12	0.9210	0.3911	0.7344

[1]Abbreviation: AJE, *Achyranthes japonica* extract.
[2]Standard error of means.

same product (AJE) no effects in broilers (Sun et al., 2020), and finishing pigs (Liu and Kim 2021). The dietary inclusion of AJE had linearly reduced drip loss in finishing pigs (Dang et al., 2020; Sureshkumar et al., 2021). Furthermore, Park and Kim (2020) found that dietary inclusion of 0.02, 0.05, and 0.10% AJE had improved the relative weight of the bursa of Fabricius in broilers Rezar et al. (2017). reported that quality of meat is affected by lots of factors, including breed, husbandry conditions, nutrition, and handling before, and after slaughter. The reason may also be related to the antioxidant and anti-inflammatory properties of AJE.

Ammonia, total mercaptans, hydrogen sulfide, acetic acid, and carbon dioxide are the main noxious gas emissions from broilers farm, which categorized as air pollutants posing serious health problems both to animals and workers (Lesschen et al., 2011). Therefore, for sustainable broiler production, the emission of such odorous gaseous must be decreased by proper management and dietary modification Park and Kim. (2020). and Sun et al. (2020) reported that the dietary supplementation of 0.1% AJE in the broiler's diets linearly reduced excreta noxious gas ammonia emission. Similarly, Dang et al. (2021a) suggested that dietary supplementation of 0.03% AJE decreased ammonia emission from broiler excreta. Moreover, Dang et al. (2020) and Sureshkumar et al. (2021) found that dietary inclusion of AJE could reduce ammonia gas emission from pig's feces. However, in this study, we observed that supplementing the diets with 0.05% and 0.10% of AJE supplementation had no effect on the noxious gases emission in broilers. These results are in agreement with Dang et al. (2021b) who reported that the dietary supplementation of AJE had no difference on ammonia, hydrogen sulfide and methyl mercaptans in broilers. However, excreta gas emissions correlated with nutrient digestibility. Considering that AJE did not influence nitrogen digestibility, as shown in the present study, theoretically, the no effect of gas emission levels should be easily understood. Therefore, we expect that supplemental AJE cannot affect odors in broiler housing due to did not affect excreta ammonia gas emission in growing broilers.

CONCLUSIONS

Supplementation with increasing levels of AJE improved growth performance during phase 1 and 2 and overall period, enhanced the dry matter digestibility in broilers fed corn−wheat−soybean meal diet. Among the 3 levels of AJE, addition of 0.1% had the best performing in broilers. This study provided a basis for future research on AJE as a feed additive in broilers.

DISCLOSURES

The author declares that there is no conflict of interest.

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