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Research Article
Effects of Herb Residue Supplementation on Growth Performance, Economic Return, Carcass Quality and Ammonia Nitrogen of Broiler Chickens

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Abstract

Background and Objective: Herb residues, residues from herbal medicine processing in pharmaceutical plants, were evaluated for their nutrient quality when added to broiler feed. An experiment was conducted to evaluate the growth performance, economic return, carcass quality and ammonia nitrogen of broiler chickens fed three herb residues. **Materials and Methods:** A total of 160 7-day-old Ross 308 broiler chicks were allocated to 4 treatments with 4 replications for 5 weeks. All birds were raised under the same conditions. The dietary treatment groups were the commercial diet for the control (CT) and the commercial diet supplemented with *Zingiber cassumunar* (ZC) residues, *Kaempferia galangal* (KG) residues or *Curcuma aromatic* (CA) residues (CA) at 3 g kg^{-1} feed. **Results:** The CA group displayed a better body weight gain (BWG), average daily gain (ADG) and salable net return (SBR) than the other treatment groups ($p<0.01$). The ZC, KG and CA groups had higher productive indices (PI) than the control group ($p<0.01$), while the ZC, KG and CA groups had lower feed conversion ratios (FCR) compared to the control group ($p<0.01$). Moreover, the CA group had significantly increased abdominal fat, ($p<0.05$) but the KG group had significantly increased total visceral organ weight ($p<0.05$). Shear force value of the breast from KG chickens was higher than that of the other treatment groups ($p<0.05$) but the shear force value of the thigh from the ZC, KG and CA chickens was higher than that of the control group ($p<0.01$). The CA group showed lower ($p<0.01$) moisture in the broiler feces than the control group. Fecal ammonia nitrogen had no significant differences. **Conclusion:** CA at 0.3 g kg^{-1} diet may be used as a potential growth enhancer for broilers in an open house from 7-42 days.

Key words: Herb residue, growth performance, economic return, carcass quality, ammonia nitrogen

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Continuous increases in population have increased the demand for animal proteins, especially poultry, because of its low price compared to other animals. Therefore, poultry production is increasing significantly worldwide[1]. Restrictions on the use of in-feed antibiotics have affected animal production in many countries. Supplementation with antibiotics has a risk of inducing not only cross-resistance but also multiple resistances[2]. The uncontrolled and unlimited use of antibiotics also leads to the accumulation of residues, which is harmful for animals and their products[3]. Consumed antibiotics residue can cause allergies, poisoning and pathogen resistance[4].

Researchers have great interest in identifying natural growth promoters to enhance poultry production[5]. Natural growth promotors, such as prebiotics, probiotics, symbiotic, enzymes, spices, herbs, plant extracts, etc., can be extensively used to feed broiler chickens without any adverse effects on the performance of the birds[6]. Some plants containing various essential oils have been used as alternative remedies by some researchers[7]. Plant extracts can improve the feed conversion ratio, increase carcass quality, decrease the market age of the broiler and reduce their rearing cost[8]. For example, curcumin extracted from turmeric has biological functions such as anti-inflammation, anticoagulant and hypolipidemic[9] and antibacterial activities[10] and it can destroy bacterial cell membranes[11].

Residues from herbal medicine processing in pharmaceutical plants creates a large amount of waste (herb residues), which consists mainly of environmental pollution and medicinal waste[12]. The active ingredients of traditional Chinese herbal medicine are the secondary metabolites of plants and the low decoction efficiency leaves approximately 30-50% of the medicinally active substances in their herb residues[13]. In addition, herb residues are mostly disposed of through stacking in the open, sanitary burials, or burning, causing serious environmental pollution, especially affecting water quality[14]. The huge amounts of herb residues produced by the continuous development of the herbal medicine industry have become a serious problem for large pharmaceutical companies[12].

The broiler industry in Thailand is one of the most important industries in the country. One of the problems in this broiler industry is the spread of diseases, resulting in an increase in morbidity and/or mortality[15]. Moreover, increasing levels of broiler production are causing many environmental problems. Chicken manure can be a source of ammonia (NH_3) emissions, which impact both animal and human health[16]. The study of Roberts *et al.*[17] found that dietary fiber lowered NH_3 emissions from laying hens. Lokaewmanee[18] studied the effects of chili pedicle meal on the ammonia nitrogen of broiler chickens. Their results also demonstrated that dietary fiber reduced ammonia nitrogen production by poultry. However, these studies did not undertake any investigation of the effects of herb residues on growth performance, economic return, carcass quality, fecal moisture or ammonia nitrogen of broilers.

Therefore, the possibility of utilizing herb residues for feeding broilers is promising. The present study was carried out to investigate the effect of using herb residues as an unconventional feedstuff in broiler diets on growth performance, economic return and fecal ammonia nitrogen levels.

MATERIALS AND METHODS

This study was conducted at the Animal Farm of the Kasetsart University Chalermprakiat Sakon Nakhon Province Campus from August to September 2019.

Preparation of the herb residues: The herb residues were collected from the Laboratory of Chemistry, Department of Science, Faculty of Science and Engineering, Kasetsart University Chalermprakiat Sakonnakhon Province Campus, Thailand. *Zingiber cassumunar*, *Kaempferia galangal* and *Curcuma aromatic* were extracted by solvent extraction of 95% ethyl alcohol and evaporating by rotary vacuum evaporator. Essential oils from the solvent extraction were used for cosmetics, while all of the herb residues were dried for 1 day in an oven at 65°C and then ground and passed through a 2 mm screen. The dry matter, crude protein, crude fiber, crude fat, crude ash and gross energy contents of the herb residues were determined using the standard methods according to the Association of Official Analytical Chemists and are shown in Table 1. The herb residues were stored in plastic bags at ambient temperature before being mixed into the feed.

Experimental design, birds and management: The animal care and protocol was approved by Kasetsart University, Thailand. The experiment was performed using 160 individual broilers (Ross 308 strain), which were divided into four treatment groups with four replicates (10 birds in each replicate). A corn and soybean meal-based diet (Table 2) formulated to meet nutrient requirements was left unmodified

Table 1: Chemical composition of herb residues[a]

Chemical analysis	*Zingiber cassumunar* residues	*Kaempferia galangal* residues	*Curcuma aromatic* residues
Dry matter (%)	99.67	93.03	89.74
Crude protein (%)	9.66	6.40	5.27
Crude fiber (%)	1.56	2.31	0.22
Crude fat (%)	2.75	2.32	1.49
Crude ash (%)	5.82	7.68	2.76
Gross energy (kcal kg^{-1})	4,286.60	4,022.33	4,280.35

[a]Dry matter

Table 2: Ingredients and nutrient composition of starter diet and grower diet

Ingredients	Starter diet (7-21 days)	Grower diet (22-42 days)
Maize	513.00	620.00
Soybean meal	328.00	250.00
Fish meal	61.00	34.00
Rice bran oil	64.00	63.00
Oyster shell	11.00	11.00
Dicalcium phosphate	9.00	8.00
Salt	4.00	4.00
DL-methionine	2.00	2.00
Concentrate mixture[a]	8.00	8.00
Nutrient composition (g kg^{-1})		
Crude protein	230.00	200.00
Crude fiber	40.00	40.00
Crude fat	40.00	60.00
Calcium	10.00	8.00
Available phosphorus	5.00	4.00
ME (g kg^{-1})	13.40	13.40

[a]Concentrate mixture including (per kg of diet): Trans-retinyl acetate: 12,000 IU, Cholecalciferol: 2,000 IU, DL-α-tocopheryl acetate: 12 IU, Menadione: 1.50 mg, Thiamine: 1.50 mg, Riboflavin: 4 mg, Pyridoxine: 2 mg, Cyanocobalamine: 15 μg, Biotin: 0.30 mg, Pantothenic acid: 10 mg, Folic acid: 0.5 mg, Nicotinic acid: 60 mg, Copper: 6 mg, Manganese: 60 mg, Zinc: 60 mg, Iron: 20 mg, Preservative: 6.25 mg and Feed supplement: 25 mg

in the control group (CT). In the ZC group, a diet containing 3 g kg^{-1} *Zingiber cassumunar* residues was provided. In the KG and CA groups, *Kaempferia galangal* and *Curcuma aromatic* residues comprised 3 g kg^{-1} of the diet, respectively.

The herb residues were first mixed with a premixture, subsequently mixed with the other dietary ingredients and then stored in plastic bags before feeding. The experimental diets were prepared every week. The diet was offered to the broiler chickens twice daily *ad libitum* and all birds had free access to water. The light program consisted of 24 h light and the birds were reared in open-sided houses with the temperature maintained at 33°C during the rainy season in northeastern Thailand.

Growth performance and economic return: The initial weights of the birds were taken at the start of the study and live weight measurements were subsequently recorded on a weekly basis. The feed intake was determined on a daily basis as the difference between the quantity of feed administered the previous day and the quantity left the next morning. The feed conversion ratio was calculated as the ratio of the feed intake to the body weight gain. All pens were checked for viability daily. The feed cost per gain, salable net return, net profits return per bird and return of investment of each group were calculated and compared with those of the control group.

Determination of carcass quality: On day 42, a total of 20 male chickens randomly selected from each treatment were slaughtered. The dressing weight, eviscerated weight, abdominal fat weight, breast muscle, wing muscle, thigh muscle and drumsticks muscle were weighed according to Chen *et al.*[19]. The shear force was determined using a texture analyzer (TA.XT Plus, Stable Micro System Ltd., United Kingdom). Meat samples were manually trimmed, 45 min after the muscles had been separated, into 1.0 cm (width) ×0.5 cm (thickness) ×2.5 cm (length) strips parallel to the muscle fiber from the main portion of the muscle and sheared vertically[20]. Each sample was measured three times along the muscle fiber.

Determination of ammonia nitrogen: Ammonia nitrogen was measured during the last week of the feeding period. The birds were randomly allocated to the four dietary treatment groups (four birds/group) of similar mean body weight and then moved into individual cages. The feces were subsequently collected over three consecutive 24 h periods on plastic trays placed within each cage. The feces from each of the 24 h periods were pooled within groups and stored at -20°C until analysis. Fecal ammonia nitrogen was analyzed by the AOAC method[21].

Data analysis: Data collected were subjected to one-way analysis of variance (ANOVA) following the general linear model procedure[22]. Differences between treatments were tested using Duncan's new multiple range test at the 5% significance level[23]. The results of the statistical analyses are shown in the tables as the mean with standard errors.

RESULTS AND DISCUSSION

The number of studies investigating the impact of herb residues on broiler chickens is limited. The results showed that the CA treatment significantly ($p<0.05$) increased the body weight gain, average daily gain, feed conversion ratio and productive index (Table 3). These results agree with the finding of González-Alvarodo *et al.*[24] and Jiménez-Moreno *et al.*[25], who reported that dietary supplementation with oat hull, soy hull and sugar beet pulp improved the productive performance of broilers. However, Lokaewmanee[18] found that the addition of 0.5-1.5% chili pedical meal reduced the body weight gain and average daily gain of broilers and Sklan *et al.*[26] reported that adding increasing levels of dietary fiber (80-90 g kg^{-1}) to turkey diets showed a negative effect on growth rate and feed efficiency. There was no significant difference in feed intake or viability among the CT, ZC, KG and CA groups at 42 days of age. The crude fiber of *Zingiber cassumunar* residues, *Kaempferia galangal* residues and *Curcuma aromatic* residues were 1.56, 2.31 and 0.22%, respectively. This finding correspond with the fact that no adverse effects were observed on feed intake

Table 3: Effect of herb residues meal on growth performance of broilers

Traits	CT	ZC	KG	CA	SEM	p-value
7-14 days						
BWG (g)	266.43^{b}	294.68^{a}	289.53^{a}	298.63^{a}	3.810	0.0034
FI (g)	367.47	386.89	379.27	368.01	4.200	0.3924
ADG (g)	36.67^{d}	42.10^{b}	41.37^{c}	42.66^{a}	0.610	0.0001
FCR	1.38^{a}	1.31^{b}	1.31^{b}	1.23^{c}	0.020	0.0002
PI	277.41^{c}	318.78^{b}	318.97^{b}	342.15^{a}	6.360	0.0001
Viability (%)	100.00	100.00	100.00	97.50	0.630	0.4363
15-21 days						
BWG (g)	483.76^{b}	448.52^{d}	491.65^{a}	480.95^{c}	4.260	0.0001
FI (g)	600.00^{c}	600.00^{c}	619.08^{b}	638.04^{a}	4.250	0.0001
ADG (g)	69.07^{b}	64.07^{d}	70.24^{a}	68.71^{c}	0.610	0.0001
FCR	1.24^{b}	1.34^{a}	1.26^{b}	1.33^{a}	0.010	0.0001
PI	551.89^{a}	479.74^{c}	555.65^{a}	517.59^{b}	8.010	0.0001
Viability (%)	100.00	100.00	100.00	100.00	-	-
22-28 days						
BWG (g)	603.79^{b}	610.80^{a}	589.03^{c}	598.64^{b}	2.220	0.0002
FI (g)	758.16^{a}	767.00^{a}	729.14^{b}	741.10^{b}	4.150	0.0004
ADG (g)	86.76^{b}	87.26^{a}	84.15^{d}	85.52^{c}	0.310	0.0001
FCR	1.26	1.26	1.24	1.24	0.010	0.1598
PI	669.54	694.38	679.75	692.81	6.490	0.4867
Viability (%)	97.50	100.00	100.00	100.00	0.630	0.4363
29-35 days						
BWG (g)	631.89^{b}	646.22^{a}	646.91^{a}	655.41^{a}	2.830	0.0140
FI (g)	970.09^{a}	865.52^{b}	877.49^{b}	880.57^{b}	11.050	0.0001
ADG (g)	89.84^{b}	92.32^{a}	92.42^{a}	93.63^{a}	0.450	0.0081
FCR	1.54^{a}	1.34^{b}	1.36^{b}	1.34^{b}	0.020	0.0001
PI	549.38^{b}	675.24^{a}	630.92^{ab}	628.43^{ab}	18.090	0.1204
Viability (%)	92.50	97.50	92.50	90.00	1.980	0.6887
36-42 days						
BWG (g)	356.61^{b}	442.54^{a}	443.13^{a}	435.72^{a}	9.460	0.0001
FI (g)	1016.71	1008.95	1038.32	1080.01	12.240	0.2620
ADG (g)	50.94^{b}	63.22^{a}	63.30^{a}	62.25^{a}	1.350	0.0001
FCR	2.85^{a}	2.28^{c}	2.34^{bc}	2.48^{b}	0.060	0.0003
PI	178.04^{b}	272.25^{a}	268.72^{a}	254.34^{a}	10.560	0.0001
Viability (%)	100.00	97.50	100.00	100.00	0.630	0.4363
7-42 days						
BWG (g)	2336.36^{d}	2450.14^{c}	2461.20^{b}	2472.91^{a}	14.160	0.0001
FI (g)	3712.43	3628.36	3643.30	3707.73	30.830	0.1288
ADG (g)	66.43^{c}	69.79^{b}	70.29^{b}	70.55^{a}	0.430	0.0001
FCR	1.66^{a}	1.51^{b}	1.50^{b}	1.52^{b}	0.012	0.0001
PI	450.89^{b}	488.08^{a}	49.08^{a}	487.06^{a}	5.250	0.0188
Viability (%)	98.00	99.00	98.50	97.50	0.400	0.7205

$^{a-d}$Values bearing different superscripts within the same row are significantly different ($p<0.05$), BWG: Body weight gain, FI: Feed intake, ADG: Average daily gain, FCR: Feed conversion ratio, PI: Productive index

Table 4: Effect of herb residues on economic return of broilers

Traits	CT	ZC	KG	CA	SEM	p-value
FCG (baht bird^{-1})	54.65	52.78	54.26	56.29	0.71	0.8100
SBR (baht bird^{-1})	93.55^{d}	97.86^{c}	98.38^{b}	98.85^{a}	0.55	0.0001
NPR (baht bird^{-1})	38.90	45.08	44.12	42.57	0.85	0.2910
ROI (%)	71.56	85.54	81.82	76.03	2.47	0.6150

$^{a-d}$Values bearing different superscripts within the same row are significantly different (p<0.05), FCG: Feed cost per gain, SBR: Salable net return, NPR: Net profits return, ROI: Return of investment compared with the control group

Table 5: Effect of herb residues on carcass quality of broilers

Traits	CT	ZC	KG	CA	SEM	p-value
Dressing (%)	85.23	83.71	84.23	84.46	0.35	0.38100
Breast weight (% BW)	33.34	32.98	31.39	33.15	0.29	0.07090
Wing weight with bone (%BW)	10.76	10.75	10.65	10.63	0.08	0.94360
Thigh weight with bone (%BW)	18.19	18.28	17.16	17.53	0.18	0.10210
Drumsticks weight with bone(%BW)	14.20	14.29	13.99	14.06	0.09	0.06230
Abdominal fat weight (%BW)	1.61^{b}	1.79^{b}	1.57^{b}	2.26^{a}	0.07	0.00620
Total eviscerated weight (%BW)	9.38^{c}	9.94^{c}	12.89^{a}	10.31^{b}	0.25	0.0380
Shear force value						
Breast (N)	42.64^{b}	43.43^{b}	49.91^{a}	42.52^{b}	1.07	0.0001
Thigh (N)	43.76^{b}	54.35^{a}	58.93^{a}	54.35^{a}	2.04	0.00740

^{a,b,c}Means in the same row with different superscripts differ significantly (p<0.05)

among broilers fed dietary fiber[27]. These results were supported by Nakhon *et al.*[28], who found that supplementing the diets of broiler chickens with 10 mg kg^{-1} dietary rice hull silicon did not alter feed intake.

Table 4 shows the economic return of the broiler chickens. No previous information is available about the impact of dietary herb residues on the economic characteristics of broilers. The results of economic return indicated that feeding herb residues did not significantly affect the feed cost per gain, salable net return or the return of investment compared with the control group but the salable net return was significantly increased (p<0.05) by adding *Curcuma aromatic* residues. The improvement in salable net return with the addition of *Curcuma aromatic* residues could be due to their essential oils and their main component, which stimulates the digestive process in animals[29], resulting in increased body weight gain and salable net return. On the other hand, Lokaewmanee *et al.*[18] indicated that feed cost per gain, salable net return, net profit return per bird and return of investment showed non-significant differences for broilers fed chili pedicle meal. These differences in the results could be due to the type of substance used in the experiments.

The effects of herb residues on the carcass quality of broilers are described in Table 5. We found that by adding *Curcuma aromatic* residues (the CA group), the highest percentage of abdominal fat was significantly (p<0.05) produced compared to that in the CT, ZC and KG groups. Our results agree with those reported by Sundari *et al.*[3], who suggested that nanocapsule levels significantly (p<0.01) increased abdominal fat. However, when adding *Kaempferia galangal* residues (the KG group), the highest percentage of total eviscerated weight was significantly (p<0.05) produced compared to that in the CT, ZC and CA groups. Previous researchers stated that the use of turmeric powder reduced the level of abdominal fat[30]. Ejaz *et al.*[31] reported that curcumin was able to inhibit the expression of $PPAR_{\gamma}$ and C/EBPα as the main transcription factors involved in adipogenesis and lipogenesis in subcutaneous adipose.

In our current study, differences in shear force among broilers fed CT, ZC and CA residues were found. The data showed that the breast in the KG group had a higher shear force than that in the CT, ZC and CA groups (p<0.05). In addition, the ZC, KG and CA groups had higher shear forces than that in the CT group (p<0.05). Meat characteristics, including shear force, water-holding capacity, pH and meat color, are important indices for meat quality[32]. Shao *et al.*[33] reported that shear force is considered the most important by consumers, with higher quality meat having a lower shear force. The lower the shear force, the more tender the meat[34]. In this experiment, a higher shear force was detected in the ZC, KG and CA groups, which suggests that ZC, KG and CA residues could be used to promote meat quality in special markets.

Table 6 shows that chicks fed diets supplemented with 3 g kg^{-1} CA residues had the lowest (p<0.05) fecal moisture. However, a non-significant effect was observed in the production of fecal ammonia nitrogen of broilers consuming ZC, KG and CA residues. The reduction in fecal moisture may be due to the composition of the CA residues. In this study, the CA residues comprised dry matter (89.74%),

Table 6: Effect of herb residues on fecal moisture and ammonia nitrogen of broilers

Traits	CT	ZC	KG	CA	SEM	p-value
Moisture (%)	78.68[a]	77.39[ab]	76.57[ab]	73.70[b]	0.88	0.01
Ammonia nitrogen (mg g^{-1})	0.30	0.30	0.30	0.29	0.02	0.98

[a-b]Values bearing different superscripts within the same row are significantly different ($p<0.05$)

crude protein (5.27%), crude fiber (0.22%), crude fat (1.49%), crude ash (2.76%) and gross energy (4,280.35 kcal kg^{-1}) (Table 1), which confirmed the suitability of the composition of the CA residues for lowering fecal moisture in the broilers manure. Dietary nutrient composition can affect excreta moisture content through nutrient digestibility and the passage rate of digesta through the gastrointestinal tract (GIT)[35].

Increasing the dietary crude protein level has been shown to result in an increased amount of uric acid, nitrogen and moisture excreted on an excreta DM basis[36]. Increased protein content of the digesta in the hind gut can, therefore, affect microbial composition in the hind gut and affect water reabsorption. However, in this experiment, we did not observe any relationship between microbial composition and excreta moisture content. Further studies are needed to investigate the effect of dietary CA residues on microbial composition and excreta moisture content.

CONCLUSION

Results from this study suggest that supplementation of the diet with *Curcuma aromatic* residues at 0.3 g kg^{-1} feed may improve body weight gain and average daily gain and consequently, the productive index and salable net return could be increased.

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REFERENCES

1. Al-Tawash, A.S.A., W.S.J. Al-Bachry and S.A.M. Al-Khaikani, 2020. Effects of canola oil on fatty acids and biochemical traits of blood plasma in broiler chickens Int. J. Poult. Sci., 19: 37-41.
2. Wachira, W.M., A. Shitandi and R. Ngure, 2011. Determination of the limit of detection of penicillin G residues in poultry meat using a low cost microbiological method. Int. Food Res. J., 18: 1203-1208.
3. Sundari, Z., T. Yuwanta and R. Martien, 2014. Effect of nanocapsule level on broiler performance and fat deposition. Int. J. Poult. Sci., 13: 31-35.
4. Okocha, R.C., I.O. Olatoye and O.B. Adedeji, 2018. Food Safety Impacts of Antimicrobial Use and their Residues in Aquaculture. Public Health Rev., 10.1186/s40985-018-0099-2
5. Alshukri, A.Y., N.A.L. Ali, R.J. Abbas, A.M. Alkassar and Y.J. Jameel, 2018. Effect of dietary supplementation with differing levels of moringa oleifera leaf meal on the productivity and carcass characteristics of broiler chickens. Int. J. Poult. Sci., 17: 536-542.
6. Borazjanizadeh, M., M. Eslami, M. Bojarpour, M. Chaji and J. Fayazi, 2011. The effect of clove and oregano on economic value of broiler chickens diet under hot weather of Khuzestan. J. Anim. Vet. Adv., 10: 169-173.
7. Abbas, R.J., 2010. Effect of using fenugreek, parsley and sweet basil seeds as feed additives on the performance of broiler chickens. Int. J. Poult. Sci., 9: 278-282.
8. Javed, M., F.R. Durrani, A. Hafeez, R.U. Khan and I. Ahmad, 2009. Effect of aqueous extract of plant mixture on carcass quality of broiler chicks. ARPN J. Agric. Biol. Sci., 4: 37-40.
9. Anand, P., A.B. Kunnumakkara, R.A. Newman and B.B. Aggarwal, 2007. Bioavailability of curcumin: Problems and promises. Mol. Pharm., 4: 807-818.
10. Okoro, I.O., A. Osagie and E.O. Asibor, 2010. Antioxidant and antimicrobial activities of polyphenols from ethnomedicinal plants of Nigeria. Afr. J. Biotechnol., 9: 2989-2993.
11. Bhawana, R.K. Basniwal, H.S. Buttar, V.K. Jain and N. Jain, 2011. Curcumin nanoparticles: Preparation, characterization and antimicrobial study. J. Agric. Food. Chem., 59: 2056-2061.
12. Meng, F., T. Chen, D. Ma, X. Wang and X. Zhao *et al*., 2017. Reclamation of herb residues using probiotics and their therapeutic effect on diarrhea. Mediators Inflamm, Vol. 2017 10.1155/2017/4265898
13. Zhou, Y., A. Selvam and J.W.C.Wong, 2016. Effect of Chinese medicinal herbal residues on microbial community succession and anti-pathogenic properties during co-composting with food waste. Bioresour. Technol., 217: 190-199.
14. Zeng, X., R. Shao, F. Wang, P. Dong, J. Yu and G. Xu, 2016. Industrial demonstration plant for the gasification of herb residue by fluidized bed two-stage process. Bioresour. Technol., 206: 93-98.

15. Abdullah, F.K., A.Y. Al-Nasser, A. Al-Saffar, A.E. Omar and G. Ragheb, 2019. Impact of dietary supplementation of different levels of black seeds (*Nigella sativa* L.) on production performance, mortality and immunity of broiler chickens. Int. J. Poult. Sci., 18: 467-474.
16. Julio, R. and F.D. Berrocoso, 2016. Dietary fiber and protein fermentation in the intestine of swine and their interactive effects on gut health and on the environment: A review. Anim. Feed Sci. Technol., 212: 18-26.
17. Roberts, S.A., H. Xin, B.J. Kerr, J.R. Russell and K. Bregendahl, 2007. Effects of dietary fiber and reduced crude protein on ammonia emission from laying-hen manure. Poult. Sci., 86: 1625-1632.
18. Lokaewmanee, K., 2020. Effect of chili pedicle meal supplementation on growth performance, economic return and ammonia nitrogen of broiler chickens. Int. J. Poult. Sci., 19: 270-276.
19. Chen, X., J. Niu and Z. Geng, 2017. Gene expression and plasma lipid content in relation to intramuscular fat in Chinese indigenous Wuhua chicken. J. Applied Poult. Res., 26: 391-400.
20. Molette, C., H. Remignon and R. Babile, 2003. Maintaining muscles at a high post-mortem temperature induces PSE-like meat in Turkey. Meat Sci., 63: 525-532.
21. AOAC., 2000. Association of Official Analytical Chemists of Official Methods of Analysis. 17th Edn., AOAC International, Washington, DC., USA., ISBN-13: 978-093558467-7.
22. Steel, R.R.D. and J.H. Torrie, 1980. Principles and Procedures of Statistics. 3rd Edn., McGraw-Hill International Book Co., London, Pages: 633.
23. Duncan, D.B., 1955. Multiple range and multiple F tests. Biometrics, 11: 1-42.
24. González-Alvarado, J.M., E. Jiménez-Moreno, D. González-Sánchez, R.Lázaro and G.G. Mateos, 2010. Effect of inclusion of oat hulls and sugar beet pulp in the diet on productive performance and digestive traits of broilers from 1 to 42 days of age. Anim. Feed Sci. Technol., 162: 37-46.
25. Jiménez-Moreno, E., J.M. González-Alvarado, D. González-Sánchez, R. Lázaro and G.G.Mateos, 2010. Effects of type and particle size of dietary fiber on growth performance and digestive traits of broilers from 1 to 21 days of age. Poult. Sci., 89: 2197-2212.
26. Sklan, D., A. Smirov and I. Plavnik, 2003. The effect of dietary fibre on the small intestines and apparent digestion in the Turkey. Br. Poult. Sci., 44: 735-740.
27. S.D. Santos, C. Laosutthipong, K.e. Yamauchi, N. Thongwittaya and J. Sittiya. 2019. Effects of dietary fiber on growth performance, fecal ammonia nitrogen and gastrointestinal tract pH in broilers from 1 to 21 days of age. Proceeding of International Conference on 4th Industrial Revolution and Its Impacts. March 27-30, 2019 Walailak Procedia 1-5.
28. Nakhon, S., S. Numthuam, R. Charoensook, W. Tartrakoon, P. Incharoen and T. Incharoen, 2019. Growth performance, meat quality and bone-breaking strength in broilers fed dietary rice hull silicon. Anim. Nutr., 5: 152-155.
29. Cabuk, M., A. Alicicex, M. Bozhutr and N. Lmre, 2003. Antibacterial properties of the essential oils isolated from aromatic plants and using possibility as alternative feed additives. Proceedings of the 11th National Animal Nutrition Congress, September 18-20, 2003, Turkey, pp: 184-187.
30. Zainali, A., A. Riasi, H. Kermanshahi, H. Farhangfar and dan H. Ziaie, 2009. Effect of sodium selenite and turmeric powder on growth performance, carcass quality and blood antioxidant metabolites of heat stressed broiler chickens. J. Anim. Sci. Res., 19: 69-85.
31. Ejaz, A., D. Wu, P. Kwan and M. Meydani, 2009. Curcumin inhibits adipogenesis in 3T3-L1 adipocytes and angiogenesis and obesity in C57/BL mice. J. Nutr., 139: 919-925.
32. Tong, H.B., J. Cai, J. Lu, Q. Wang, D. Shao and J.M. Zou, 2015. Effects of outdoor access days on growth performance, carcass yield, meat quality and lymphoid organ index of a local chicken breed. Poult. Sci., 94: 1115-1121.
33. Shao, D., Q. Wang, Y. Hu, S. Shi and H. Tong, 2019. Effects of cyclic heat stress on the phenotypic response, meat quality and muscle glycolysis of breasts and thighs of yellow-feather broilers. Ital. J. Anim. Sci., 18: 301-308.
34. Wolcott, M.L., D.J. Johnston, S.A. Barwick, C.L. Iker, J.M. Thompson and H.M. Burrow, 2009. Genetics of meat quality and carcass traits and the impact of tenderstretching in two tropical beef genotypes. Anim. Prod. Sci., 49: 383-398.
35. Hoeven-Hangoor, V.d., N.D. Paton, V.d.IB. Linde, M.W. Verstegen and W.H. Hendriks, 2013. Moisture content in broiler excreta is influenced by excreta nutrient contents. J. Anim. Sci., 91: 5705-5713.
36. Namroud, N.F., M. Shivazad and M. Zaghari, 2010. Impact of dietary crude protein and amino acids status on performance and some excreta characteristics of broiler chicks during 10-28 days of age. J. Anim. Nutr., 94: 280-286.