International Journal of Agricultural Technology 2022Vol. 18(2):511-524
Available online http://www.ijat-aatsea.com
ISSN 2630-0192 (Online)

Effect of dietary supplementation with Vietnamese coriander (*Persicaria odorata*) extract on growth performance, carcass characteristics and meat quality of broilers

Glinubon, J.[1], Nopparatmaitree, M.[2], Chaiwang, N.[3], Bunmee, T.[4], Setthaya, P.[5], Suwanlee, S. [1], Lunpha, A.[1], Yeanpet, C.[1] and Siriboon, C.[1*]

[1]Department of Animal Science, Faculty of Agricultural, Ubon Ratchathani, University, Ubon Ratchathani, Thailand; [2]Faculty of Animal Sciences and Agricultural Technology, Silpakorn University, Phetchaburi IT Campus, Cha-am, Phetchaburi, Thailand; [3]Division of Agricultural Technology and Development, Faculty of Agricultural Technology, Chiang Mai Rajabhat University, Chiang Mai, Thailand; [4]Division of Animal Sciences, School of Agriculture and Natural Resources, University of Phayao, Phayao, Thailand; [5]Science and Technology Research Institute, Chiang Mai University, Chiang Mai, Thailand.

Glinubon, J., Nopparatmaitree, M., Chaiwang, N., Bunmee, T., Setthaya, P., Suwanlee, S., Lunpha, A., Yeanpet, C. and Siriboon, C. (2022). Effect of dietary supplementation with Vietnamese coriander (*Persicaria odorata*) extract on growth performance, carcass characteristics and meat quality. International Journal of Agricultural Technology 18(2):511-524.

Abstract The results indicated that the 600 mg/kg VCE and OTC supplemented groups had significantly greater weight gain and average daily gain than the 0, 200, and 400 mg/kg VCE supplemented groups ($P<0.05$). The feed conversion ratio significantly improved in the VCE and OTC supplemented groups compared with the control group ($P<0.05$). There were no significant differences in slaughter weight, carcass percentage, and dressing percentage among the treatment groups. The meat quality in terms of pH values determined at 45 minutes post-mortem was higher in the 600 mg/kg VCE than in other treatment groups ($P<0.05$). Broilers fed 600 mg/kg VCE had the lowest fat percentage ($P<0.05$). In addition, supplementation with VCE in the diet significantly decreased the TBARS value of breast meat during the storage time ($P<0.05$). In conclusion, broilers fed with 600 mg/kg VCE and Oxytetracycline supplemented diets had improved in growth performance and meat quality compared to the control group.

Keywords: Vietnamese coriander, Growth performance, Carcass characteristics, Meat quality

Introduction

The poultry industry is an important industrial sector for meat and meat products and has been developing rapidly. In particular, poultry feed ingredients are constantly being improved. It is managed effectively and hygienically to ensure that chickens are healthy and hygienic, to produce meat that is safe for the modern commercial poultry industry, and to meet the requirements of processors

[*] **Corresponding Author:** Siriboon, C.; **Email:** chawalit.s@ubu.ac.th

and consumers. Antibiotics, also known as antimicrobial drugs, are commonly used for the prevention and treatment of diseases, including growth promoters in the poultry industry (Petrolli *et al*., 2012). Meat production accounts for 73% of global antibiotic use. Forecasts on antibiotic consumption in relation to the manufacture of animal products anticipate growth of 11.5% by 2030 (Treiber and Beranek-Knauer, 2021). However, the misuse and overuse of antibiotics in animals causes an increase in antimicrobial resistance, decreases immune function, and the accumulation of residual antibiotics in meat products, which is an important public health problem and concerns the moment. (Boamah *et al*., 2016; Lekshmi *et al.*, 2017). Hosain *et al*. (2021) reported that antimicrobial residues in animal products can lead to various health risks, including hypersensitivity reactions, cancer, bacterial resistance, toxicity and teratogenicity. Therefore, The European Parliament has banned antibiotics as growth promoters in animal feed (Petrolli *et al*., 2012; Attia *et al.*, 2017). Several research studies have been carried out on the development of alternative substances to antibiotics that feed additives to growth promoters and reduce the use of antibiotics in poultry production. (Amouzmehr *et al*., 2012; Petrolli *et al*., 2012; Attia *et al.*, 2017). Phytogenic feed additives have received increasing attention as natural feed additives in livestock, which are appropriate potential alternatives to antibiotics for growth promoters. Phytogenics are defined as plant-derived natural bioactive compounds that are mixed into animal diets at an optimal level to improve feed conversion and growth performance by stimulating digestive activities, increasing gastric juice and enzyme secretion, modulating the immune system, changes in the intestinal morphology and improvements in nutrient utilization, which result in high performance. (Steiner and Syed, 2015; Madhupriya *et al.*, 2018). Attia *et al*. (2017) found that benefits may be linked to the presence of bioactive components or plant secondary metabolites that are supposed to promote growth, enhance feed intake, activate digestive enzymes and immune-stimulatory properties. The phytogenic feed additives that come from different botanical origins vary widely in composition and processing methods such as solid, dried and ground forms or as extracts or essential oils (Madhupriya *et al*., 2018). In recent years, plant extracts have attracted considerable attention as an alternative to antibiotics that can enhance growth performance and animal health. Lippens *et al.* (2005) reported that the addition of plant extract to broiler diets resulted in better feed conversion ratios and higher body weights than the control and avilamycin groups. These present a mechanism of plant extract that can be performed based on modifying the gut microflora, resulting in a decrease in the numbers of pathogenic and an increase in beneficial gut bacteria. There is also maintenance of intestinal morphology, enzyme secretion, immune response and antioxidant activity (Petrolli *et al.*, 2012). Paraskeuas *et al.* (2017) reported that broiler

feeding with phytogenic feed additive including menthol, anethol and eugenol at 100 and 150 mg/kg resulted in a significant increase in digestibility, improved serum total antioxidant capacity that enhanced the growth performance of broilers.

Persicaria odorata (Polygonum odoratum) is one of the natural plant parts that have been traditionally used worldwide in medicine, cuisines, pharmacy and cosmetics. It is a native plant of Southeastern Asia and also known as Vietnamese coriander. Basit *et al*. (2019) reported that Vietnamese coriander is a potent antioxidant that contains polyphenols and a high concentration of essential oils. The prominent antioxidant activity of Vietnamese coriander extract may be due to the presence of polyphenols like gallic acid, quercetin, ferulic acid and apigenin. Bioactive compounds, especially polyphenols provide an important role in human health by countering oxidative stress mediated diseases caused by free radicals (Somananda, 2014). Volatile compounds of Vietnamese coriander extract contain aldehydes such as decanal (28%), dodecanol (44%), as well as decanol (11%). Moreover, it contained sesquiterpenes such as beta-caryophyllene and alpha-humulene, which comprised around 15% (Sasongko *et al.*, 2011). These have various medicinal properties such as antioxidant, antimicrobial, anti-inflammatory and anticancer activities. (Ridzuan and Wan Salleh, 2019). Moreover, the Vietnamese coriander extract was compared with the essential oils from coriander (*Coriandrum sativum L.*) essential oil and similar aldehyde compositions (Shavandi *et al.*, 2012). Hosseinzadeh *et al.* (2014) found that broilers fed coriander oil had improved performance indices and ileum microflora. It also stimulates immune responses, reducing pathogenic bacteria in the digestive tract will improve the intestinal health and general well-being of broilers. Coriander powder or extract may potentially be used as an antibiotic alternative in poultry production. Few studies have been conducted on coriander extract as an antibiotic supplement for monogastric animals. However, there are no studies repoerted that have evaluated the Vietnamese coriander extract added to broiler diets. In addition, the active principles of Vietnamese coriander leaf meal *in vivo* have not been fully clarified yet and the research literature is still small. Therefore, the purpose of this study was to investigate the effect of dietary supplementation with Vietnamese coriander extract on growth performance, carcass characteristics and meat quality of broilers.

Materials and methods

Plant materials

The *Persicaria odorata* or Vietnamese coriander fresh were purchased from a local vegetable and fruit market in the Warin Chamrap District, Ubon

Ratchathani, Thailand. The whole plants were cleaned, chopped and dried in an oven dryer at 40 ℃ for 24 h. The dried leaves were mashed and mixed with material in 50% ethanol (1:5 w/v ratio). Extraction was carried out at room temperature over five days. The mixtures were filtered through Whatman filter paper (No.1). The solvents were removed with a rotary vacuum evaporator. 20% maltodextrin (MD) with a DE value of 10–12 was used as the drying agent and remained constant throughout the drying process at the Scientific Equipment and Laboratory Center, Ubon Ratchathani University. The Vietnamese coriander extract was stored in a reagent bottle until it was prepared in the broiler diet of the experiment.

Experimental design and treatments

The present study was conducted at the poultry farm, laboratory and farming office, Faculty of Agricultural, Ubon Ratchathani University, Ubon Ratchathani, Thailand. A total of 300-one-day old Ross 308 broilers of mixed gender were assigned into five groups. Each group was represented by four replicates (15 broilers/replication) according to a completely randomized design (CRD). The dietary treatments consisted of T1 was an unsupplemented basal diet (CON), T2 was basal diets supplemented with 500 mg/kg of Oxytetracycline (OTC), and T3–T5 were basal diets supplemented with Vietnamese coriander leaf extract (VCE) at levels of 200, 400, and 600 mg/kg of diet, respectively. The broilers were reared in an evaporative cooling house, provided with *ad libitum* of feed and water during the whole experiment period. A two-phase feeding program was applied including starter diets (1 to 21d) and finisher diets (22 to 35d). The ingredients and nutrient composition by laboratory of the two-phase experimental diets are shown in Table 1.

Measurements

Growth performance

The broliers weight were recorded individually on arrival and then once a week until 35 days. The feed intake was recorded at the same time point for determination of the average BW, average daily gain (ADG), average daily feed intake (ADFI) and feed conversion ratio (FCR). Broilers were checked for mortality once daily to estimate the liveability percentage, according to the method described by Marcu *et al.* (2013).

Carcass characteristics

At 35 days of age, four birds per experimental unit (two males and two females). The broilers were pre-slaughter fasting for eight hours, transported to

the slaughterhouse for slaughtered, exsanguinated, dehaired and eviscerated according to commercial practices. The carcasses were dissected retail cut into commercial parts: breast, thighs, drumsticks, wings, skeleton, shank, head, and the weights of each was recorded. Carcass percentages were calculated as their weight relative to live weight. The breast muscles were collected and weighed individually, vacuumed in plastic bags for further meat analysis, which was stored at -20 ℃.

Meat quality

The PH-value was measured directly on the breast muscles at 45 min post-mortem by using a pH-meter. Meat color was measured at 48 h post-mortem on the surface area of the breast muscles. The data were recorded L* (Lightness), a* (redness) and b* (yellowness) by using a Minolta Chroma Meter. After being packed in plastic bags, meat samples were hung on hooks for overnight storage at 4±2 ℃. The weights of before and after were recorded and revealed as the drip loss percentage. Chemical composition of the breast muscles (protein, moisture and fat) was determined according to the Association of Official Analytical Chemists (AOAC, 1995). The breast muscles were defrosted overnight at 4 ℃ and reweighed to measure thawing loss percentage. They were suspended in a plastic bag and immersed in a water bath until the endpoint temperature of 78℃ that was directly measured by the thermocouple tester. The difference between uncooked and cooked weights were recorded and the cooking loss was calculated as the weight loss expressed as a percentage of the uncooked sample weight. The cooked samples were cut into cubes (1 cm^3) for shear force measurements using a texture analyzer with a Warner Bratzler blade. There were five replicate measurements for each sample and the maximum force required to cut the slices was determined. Moreover, the lipid oxidation changes were determined by the TBARS assay, which ground meat are stored in a refrigerator at 4℃ to be analyzed at d 0, 3, 6 and 9.

Statistical analysis

SAS was used to perform a one-way analysis of variance (ANOVA) on the data. Duncan's multiple range test was used for multiple comparisons among means, in which the statistical significance was regarded as $P<0.05$ and $P<0.01$.

Results

Growth performance

Body weight gain, feed intake, and feed conversion rate of broilers were recorded at 1-21, 22-35 and 1-35 days of age. The results showed that broilers

receiving OTC and 600 mg⁄kg VCE had significantly (P<0.05) greater BWG, ADG and FCR compared to other treatments during the starter period (1-21 days), except for the 400 mg⁄kg VCE in diets, where the weight gain did not differ (P<0.05) from that of the control. During the total period (1-35 days), the highest BWG, ADG and lowest FCR were obtained in birds fed with OTC and 600 mg⁄kg VCE. Furthermore, the 400 mg⁄kg VCE had significantly (P<0.05) higher BWG, ADG and greater FCR than the control group, but there was no significant difference between those fed the 400 mg⁄kg VCE (P>0.05). However, the VCE supplementation had no significant effect on the growth performance indices of broliers during the finisher period (22-35 days), and also had no affect on ADFI during the experimental period (P>0.05).

Table 1. Ingredients and nutrient composition by laboratory of experimental diets

Ingredients (%)	**Starter (1-21 days)**	**Finisher (22-35 days)**
Maize	44.6	49.2
Soybean meal	33.5	30.2
Rice bran (Oil extracted)	15.0	15.0
Palm oil	5.50	4.20
Dicalciumphosphate 18%	0.60	0.60
DL-Methionine	0.20	0.20
Premix, Broiler	0.50	0.50
Salt	0.10	0.10
Total	100	100
Nutrient composition by laboratory (%)		
Crude protein	23.10	21.52
Ether extract	5.10	6.06
Crude fiber	3.65	3.39
Dry matter	90.35	92.25
Ash	6.12	6.37
Calcium	1.26	1.24
Phosphorus	0.79	0.85
Gross energy (Kcal/kg)	3,705.20	3,894.87

Carcass characteristics

The values and statistical analysis of the carcass characteristics are shown in Table 3. Dietary treatments did not induce any significant (P>0.05) effect on live weight, dressing percentage and the retail cut percentage including breast, thigh, drumsticks, wings, skeleton, shank, head and also had no effect on evisceration during the experimental period.

Table 2. Effect of Vietnamese coriander extract in diet on Average body weight gain (BWG), average daily feed intake (ADFI), average Daily Gain (ADG) and feed conversion ratio (FCR) during the entire trial period

Parameters	CON	OTC	VCE[1] (mg/kg)			SEM	P-value[2]
			200	400	600		
0-21 days							
BWG (g/bird)	901.3^{b}	1081.6^{a}	929.8^{b}	991.5^{ab}	1092.2^{a}	22.32	0.003
ADFI (g/bird)	65.87	66.97	64.48	67.16	68.55	0.73	0.725
ADG (g/bird/day)	42.92^{b}	51.50^{a}	44.28^{b}	47.21^{ab}	52.01^{a}	1.06	0.003
FCR	1.54^{a}	1.31^{b}	1.47^{ab}	1.43^{ab}	1.32^{b}	0.03	0.018
22-35 days							
BWG (g/bird)	775.9	870.9	827.1	834.1	844.1	16.54	0.514
ADFI (g/bird)	102.1	110.9	106.3	108.9	112.7	1.51	0.188
ADG (g/bird/day)	55.42	62.21	59.08	59.58	60.29	1.18	0.514
FCR	1.85	1.79	1.80	1.84	1.87	0.03	0.958
0-35 days							
BWG (g/bird)	1677.2^{c}	1952.4^{a}	1757.0^{bc}	1825.6^{b}	1936.3^{a}	26.88	0.0001
ADFI (g/bird)	82.54	84.53	82.18	83.87	85.60	0.61	0.396
ADG (g/bird/day)	47.92^{c}	55.79^{a}	50.20^{bc}	52.16^{b}	55.32^{a}	0.77	0.0001
FCR	1.72^{a}	1.52^{c}	1.64^{ab}	1.61^{bc}	1.55^{bc}	0.03	0.003
Mortality rate (%)	1.67	1.67	1.67	0.00	0.00	1.29	

[1]/ Vietnamese coriander extract
[2]/ ^{ab}Mean with symbol with in same row differ significantly (P<0.05)

Table 3. Effect of Vietnamese coriander extract in diet on carcass characteristics

Parameters	CON	OTC	VCE[1] (mg/kg)			SEM	P-value[2]
			200	400	600		
Live weight (g)	1731.7	1855.9	1794.0	1821.7	1897.0	28.37	0.444
Carcass (%)	77.28	76.42	77.65	77.80	78.90	0.61	0.792
Retail cut percentage (%)							
Breast	30.96	31.29	31.09	31.87	32.23	0.45	0.632
Thighs	14.47	15.08	14.45	14.78	14.50	0.32	0.966
Drumsticks	12.81	13.26	12.94	13.18	12.96	0.12	0.798
wings	9.95	10.08	10.14	9.58	10.05	0.13	0.704
Evisceration (%)							
Liver	2.56	2.77	2.69	2.41	2.36	0.05	0.956
Heart	0.49	0.60	0.45	0.47	0.57	0.02	0.107
Gizzard	3.05	3.33	3.22	3.31	3.45	0.08	0.541
Abdominal fat	1.88	1.42	2.13	1.51	1.55	0.13	0.404

[1]/ Vietnamese coriander extract
[2]/ ^{ab}Mean with symbol with in same row differ significantly (P<0.05)

Meat quality

The present experiment showed the effect of Vietnamese coriander extract in the diet on meat quality (Table 4). Meat pH at 45 min post-mortem was found to be higher in 600 mg/kg VCE compared to other treatments (6.72 vs 6.20, 6.20, 6.30), except for the 400 mg/kg VCE (6.52) supplementation in diets. However, the pH value in all treatments was within the normal range. Birds fed 600 mg/kg VCE had lower fat content in their breast muscles compared with those fed CON, OTC and 200 mg/kg VCE. There was no significant difference with 400 mg/kg VCE. Moreover, the lipid oxidation changes of breast muscles were measured by TBARS values, which are expressed as μM/kg meat. The results of lipid oxidation showed a significant difference among dietary treatments at 0, 3, 6 and 9 days after storage. Breast muscles from broilers fed a diet supplemented with 600 mg/kg VCE had the lowest TBARS value ($P<0.05$) compared with other groups at 6 and 9 days after storage. But the meat color, moisture, protein and water holding capacity (drip loss, cooking loss, and thawing loss) were observed to be non-significant ($P>0.05$) in all the treatments.

Table 4. Effect of Vietnamese coriander extract in diet on meat quality

Parameters	CON	OTC	VCE[1] (mg/kg)			SEM	P-value[2]
			200	400	600		
pH 45 min	6.20^{b}	6.20^{b}	6.30^{b}	6.52^{ab}	6.72^{a}	0.06	0.007
Meat color							
L*	49.04	46.10	49.67	47.08	47.26	0.66	0.429
a*	1.96	3.27	1.68	2.96	2.65	0.23	0.154
b*	13.85	15.62	14.73	15.58	17.50	0.56	0.350
Chemical composition (%)							
Moisture	74.37	74.80	75.24	75.44	75.45	0.14	0.059
Protein	22.33	22.14	21.40	21.90	22.16	0.15	0.391
Fat	1.67^{a}	1.69^{a}	1.66^{a}	1.45^{ab}	1.24^{b}	0.04	0.0009
Water holding capacity (%)							
Drip loss	3.32	3.15	3.12	2.73	2.93	0.11	0.561
Cooking loss	3.48	4.89	3.60	3.41	3.97	0.31	0.590
Thawing loss	18.78	19.93	17.17	19.36	21.44	0.64	0.329
Shear force (N)	40.83	43.80	50.95	45.27	51.30	4.12	0.380
TBARs value, μM/kg meat sample							
Day 0	0.062	0.057	0.058	0.064	0.068	0.04	0.225
Day 3	0.273^{a}	0.271^{a}	0.252^{a}	0.189^{b}	0.178^{b}	0.01	0.0001
Day 6	0.440^{a}	0.457^{a}	0.408^{a}	0.300^{b}	0.239^{c}	0.02	0.0001
Day 9	0.917^{a}	0.936^{a}	0.903^{a}	0.774^{b}	0.724^{c}	0.02	0.0001

[1]/ Vietnamese coriander extract

[2]/ ^{ab}Mean with symbol with in same row differ significantly ($P<0.05$)

Discussion

Phytogenic compounds have received attention as an alternative to antibiotic growth promoters. Plant extracts as phytogenic additives are known to have antimicrobial, antiviral, anticoccidial, fungicidal, and/or antioxidant properties that can improve nutrient utilization in the gastrointestinal tract by enhancing production of digestive secretions and enzymatic activity. This increases nutrient digestibility and absorption, which improves the growth performance and feed efficiency of broliers. The present study investigated the use of VCE as a phytogenic feed additive in the broiler diet. The study demonstrated that the inclusion of 600 mg/kg in the broiler diet significantly improved ($P<0.05$) growth performance parameters such as BWG, ADG and FCR in comparison to the control group. These results may be related to an extract from Vietnamese coriander has been known as source of polyphenols like gallic acid, quercetin, ferulic acid, and apigenin. Bioactive compounds, especially polyphenols, play an important role in animal health (Somananda *et al.*, 2014). They increase growth performance and serum total antioxidant capacity, and also improve digestibility. Basit *et al*. (2019) reported that the supplementation of flavonoids in the diet has been reported to enhance the growth performance of broilers. The plant extract recovered leaves of Vietnamese coriander, which were extracted by ethanol a yield of 4.49% and was evaluated for the total phenolic content and antioxidant activities of VCE. The study found that VCE has a total phenolic content of 19.23 mg GAE/g sample and the antioxidant capacity of the plant was determined by an inhibiton percentage value of 88.75%. This is in accordance with Somananda *et al.* (2014) who reported that the phytochemical study showed a high amount of total phenolics and flavonoids present in the ethanolic extract of VCE. The total phenolic was determined as 13.03 mg GAE/g and DPPH was determined by showed prominent IC_{50} value of 190.19 µg/ml. The use of plant extracts in the diet had a positive effect on health through stimulation of appetite and feed intake. Previous studies have reported that the coriander oil and antibiotic improved broilers growth performance, they had a better average daily gain and FCR compared with the control group. The improvement in FCR was a result of differences in feed intake, and possibly due to higher feed digestibility. The dietary addition of coriander extract may be an appropriate alternative to antibiotics for improving performance of broilers (Ghazanfari *et al*., 2015). Jang (2011) found that the supplementation of coriander oil to the diet of broilers could improve feed intake and weight gain of broilers. In this study, there were no treatment effects ($P>0.05$) on ADFI during the experimental period and these results were in agreement with other studies (Hernandez *et al.,* 2004; An *et al.,* 2015; Farahat *et al*., 2016). However, there

was an increasing trend in ADFI from broilers fed with an increased supplementation of VCE being higher (P>0.05) value.

In this experiment, VCE and OTC dietary supplementation did not affect the carcass characteristics of broilers compared with the CON group. These results are the same as the findings of Carlos *et al.* (2014) who reported that the carcass yield of broilers supplemented with plant extract during the finisher phase was not different when the broilers fed plant extracts during the finisher phase were compared with those fed the diet with antibiotics. Amouzmehr *et al.* (2012) showed that broilers were fed on diet supplemented with garlic and thyme extract did not affect on performance and carcass composition such as carcass weight, breast, thigh, and abdominal fat. The results of the present study are also in agreement with the results of Attia *et al.* (2017) that showed dietary in take of the plant extract mix did not improve the carcass characteristics of broiler chickes. In contrast, Erener *et al.* (2011) found that use of 0.1-0.2 g/kg green tea extract resulted in an improvement in carcass weight and dressing percentages of broilers compared with the CON group.

The effect of dietary Vietnamese coriander extract in diet on meat quality compared with control and antibiotic treatments are presented in Table 4. The pH value at 45 minutes post-mortem was found to be higher in 600 mg/kg VCE compared to other treatments (6.72 vs 6.20, 6.20, 6.30), except for the 400 mg/kg VCE (6.52) supplementation in diets. However, the pH value in all treatments was within the normal range and was the same as the findings of the previous trial reported by Džinić *et al*. (2015) which found that meat samples with a pH at 45 minutes post-mortem more than 5.8 were considered as normal meat. The color values of meat consisting of the L*, a*, and b* values did not differ significantly between groups. Bostami *et al.* (2018) reported that the color value of meat, L* is linked with the color appearance of meat surfaces, the a* value is related to oxidation state, intramuscular fat and pigment content and the b* value is associated with oxidative rancidity and intramuscular fat content. For chemical composition in our study, fat content was lowest (1.24%) in broliers fed with high VCE in this experimental, and there was no significant difference in protein and moisture content, due to VCE contain a polyphenol compound that could inhibit the formation and accumulation of fat by condensing polyphenols with bile salts as a fat solvent in the digestive tract of broliers. Therefore, the absorption process of fat in the digestive tract was disrupted and reduced, so that the production of abdominal fat was small. Yang *et al.* (2020) reported that plant extract was supplemented in the diets, showed beneficial effects on the nutritional composition and ability to increase the nutritive value of breast meat.

Meat and meat products are composed of nutritional composition, which makes them very susceptible to oxidation reactions, especially lipid oxidation which is primary cause of meat spoilage that affects on the color, flavor, texture and nutritional value of meat. Generally, lipid oxidation increased with storage time at 4 ℃. According to this study, the TBARS value showed a significant linear increase ($P<0.05$) in all treatment groups at 3-9 days after storage time. Breast meat from broilers fed a diet supplemented with 600 mg/kg VCE had a lower TBARS value ($P <0.05$) compared with CON, OTC and 200 mg/kg VCE during storage time. Plants contain several compounds, mainly polypehnols, that have antioxidant activities which prevent oxidative damage by delay free radicals in meat, so they can be used as natural antioxidants in meat products. Similarly, Jang *et al.* (2008) found that broilers fed a diet containing medicinal herb extract mix of mulberry leaf, Japanese honeysuckle, and goldthread can increase the antioxidative activity that inhibits the lipid oxidation of breast meat. The antioxidant potential of phenolic compounds, which delay or inhibit the initiation step or interrupt the propagation step of lipid oxidation. Thereby reducting the formation of volatile decomposition products such as aldehydes and ketones that cause rancidity. However, the shelf life of breast meat is short because of rapid microbial growth and lipid oxidation (Yang *et al*., 2020).

The results showed that broilers fed with 600 mg/kg VCE and antibiotic supplemented diets had improved in growth performance and meat quality compared to the control group.

Acknowledgements

The authors gratefully acknowledge financial support from the Research Development Profect of Ubon Ratchathani University grant and the poultry farm of the office of laboratory and farming, Faculty of Agricultural, Ubon Ratchathani University. The authors extend thanks to Khwanrudee Boonsri, Thipsuda Khotbandit, Supatra Thanee, Sitthiporn Lalun, Sithipong Budtegak and Issaya Boonchado for assistance during the laboratory work.

References

Amouzmehr, A., Dastar, B., Nejad, J. G., Sung, K. I., Lohakare, J. and Forghani, F. (2012). Effects of garlic and thyme extracts on growth performance and carcass characteristics of broiler chicks. Journal of Animal Science and Technology, 54:185-190.

An, B. K., Kim, J. Y., Oh, S. T., Kang, C. W., Cho, S. and Kim, S. K. (2015). Effects of onion extracts on growth performance, carcass characteristics and blood profiles of white mini broilers. Asian-Australasian Journal of Animal Sciences, 28:247-251.

AOAC (1995). Official methods of analysis 16th Ed. Association of official analytical chemists. Washington DC, USA.

Attia, G., Hassanein, E., El-Eraky, W. El-Gamal, M., Farahat, M. and Hernandez-Santana, A. (2017). Effect of dietary supplementation with a plant extract blend on the growth performance, lipid profile, immune response and carcass traits of broiler chickens. International Journal of Poultry Science, 16:248-256.

Basit, A. M., Kadir, A. A., Chwen, L. T., Aziz, S. A., Salleh, A., Kaka, U. and Idris, S. B. (2020). Effects of graded dose dietary supplementation of Piper betle leaf meal and Persicaria odorata leaf meal on growth performance, apparent ileal digestibility, and gut morphology in broilers, Saudi Journal of Biological Sciences, 10:1209.

Boamah, V. E., Agyare, C., Odoi, H. and Dalsgaard, A. (2016). Practices and factors influencing the use of antibiotics in selected poultry farms in Ghana. International Journal of Antimicrobial Agents, 2:2-8.

Bostami, A. B. M. R., Mun, H. S. and Yang, C. J. (2018). Loin eye muscle physico-chemical attributes, sensory evaluation and proximate composition in Korean Hanwoo cattle subjected to slaughtering along with stunning with or without pithing. Meat Science, 145:220-229.

Carlos, T. C. F. I., Barbosa, L. C. G. S. I., Polycarpo, G. V. I., Afonso E. R. I., Utimi, N. B. P. I., Bortolato, C. I. I. and Araújo, C. S. S. I. (2014). Performance and carcass yield of broilers supplemented with plant extract during the finisher phase. Brazilian Journal of Poultry Science, 16:443-448.

Džinić, N., Puvača, N., Tasić, T., Ikonić, P. and Okanović, Đ. (2015). How meat quality and sensory perception is influenced by feeding poultry plant extracts. World's Poultry Science Journal, 71:673-82.

Erener, G., Ocak, N., Altop, A., Cankaya, S., Aksoy, H. M. and Ozturk, E. (2011). Growth performance, meat quality and caecal coliform bacteria count of broiler chicks fed diet with green tea extract. Asian-Australasian Journal of Animal Sciences, 24:1128-1135.

Farahat, M., Abdallah, F., Abdel-Hamid, T. and Hernandez-Santana, A. (2016). Effect of supplementing broiler chicken diets with green tea extract on the growth performance, lipid profile, antioxidant status and immune response. British Poultry Science, 57:714-722.

Ghazanfari, S., Mohammadi, Z. and Adib Moradi, M. (2015). Effects of coriander essential oil on the performance, blood characteristics, intestinal microbiota and histological of broilers. Brazilian Journal of Animal Science, 17:419-426.

Hernandez, F., Madrid, J., Garcá, V., Orengo, J. and Megías, M. D. (2004). Influence of two plant extracts on broilers performance, digestibility, and digestive organ size. Poultry Science, 83:169-174.

Hosain, M. Z., Kabir, S. M. L. and Kamal, M. M. (2021). Antimicrobial uses for livestock production in developing countries. Veterinary World, 14:210-221.

Hosseinzadeh, H., Qotbi, A. A. A., Seidavi, A., Norris, D. and Brown, D. (2014). Effects of different levels of coriander (*Coriandrum sativum*) seed powder and extract on serum biochemical parameters, microbiota, and immunity in broiler chicks The Scientific World Journal. Retried from http://dx.doi.org/10.1155/2014/628979

Jang, A., Liu, X., Shin, M., Lee, B., Lee, S., Lee, J., Lee, H. and Jo, C. (2008). Antioxidative potential of raw breast meat from broiler chicks fed a dietary medicinal herb extract mix. Poultry Science, 87:2382-9.

Jang, J. P. (2011). Effect of different levels of coriander oil on performance and blood parameters of broiler chickens. Annals of Biological Research, 2:578-583.

Lekshmi, M., Ammini, P., Kumar, S. and Varela, M. F. (2017) The food production environment and the development of antimicrobial resistance in human pathogens of animal origin. Microorganisms, 5:11.

Lippens, M., Huyghebaert, G. and Cerchiari, E. (2005). Effect of the use of coated plant extracts and organic acids as alternatives for antimicrobial growth promoters on the performance of broiler chickens. European Poultry Science, 6:48-56.

Madhupriya, V., Shamsudeen, P., Manohar, G. R., Senthilkumar, S., Soundarapandiyan, V. and Moorthy, M. (2018). Phyto feed additives in poultry nutrition-a review. International Journal of Science, Environment and Technology, 7:815-822.

Marcu, A., Vacaru-Opriș, I., Dumitrescu, G., Ciochina, L. P., Marcu, A., Nicula, M., Dronca, D. and Kelciov, B. (2013). The influence of genetics on economic efficiency of broiler chickens' growth. Animal Science and Biotechnologies, 46:339-346.

Paraskeuas, V.; Fegeros, K.; Palamidi, I.; Hunger, C. and Mountzouris, K. C. (2017). Growth performance, nutrient digestibility, antioxidant capacity, blood biochemical biomarkers and cytokines expression in broiler chickens fed different phytogenic levels. Animal Nutrition, 3:114-120.

Petrolli, T. G., Albino, L. F. T., Rostagno, H. S., Gomes, P. C., Tavernari, F. de C. and Balbino, E. M. (2012). Herbal extracts in diets for broilers. Brazilian Journal of Animal Science, 41:1683-1690.

Ridzuan, P. M. and Wan Salleh, W. M. N. (2019). *Persicaria Odorata* as a Potential Medicinal Plant-Mini Review. Journal of Natural and Ayurvedic Medicine, 3:000174.

SAS (1996). SAS Procedures Guide, Release 6.3 Edition. SAS Institue Inc., Cary. NC.

Sasongko, P., Laohankunjit, N. and Kerdchoechuen, O. (2011). Evaluation of physicochemical properties of plant extracts from *Persicaria odorata*. Thai Journal of Agricultural Science, 42:333-336.

Shavandi, M. A., Haddadian, Z. and Ismail, M. H. S. (2012). Eryngium foetidum *L. Coriandrum sativum* and *Persicaria odorata L.*: a review. Journal of Asian Scientific Research, 2:410-426.

Somananda, K. A., Shantibala devi, G. A. and Chattopadhyay, S. (2014). Bioactive compounds and antioxidant activity of *Polygonum odoratum Lour*. International Journal of Basic and Applied Biology, 2:94-97.

Steiner, T. and Syed, B (2015). Phytogenic feed additives in animal nutrition. In: Máthé Á. (eds) Medicinal and aromatic plants of the world, vol 1. Springer, Dordrecht, pp.403-423.

Treiber, F. M. and Beranek-Knauer, H. (2021). Antimicrobial Residues in Food from Animal Origin—A Review of the Literature Focusing on Products Collected in Stores and Markets Worldwide. Antibiotics, 10:534.

Yang, E. J., Seo, Y. S., Dilawar, M. A., Mun H. S., Park, H. S. and Yang, C. J. (2020). Physico-chemical attributes, sensory evaluation and oxidative stability of leg meat from broilers supplemented with plant extracts. Journal of Animal Science and Technology, 62:730-740.

(Received: 10 August 2021, accepted: 15 February 2022)