Effect of quaternary benzophenantridine and protopine alkaloids on growth response and gut health of broiler under hot climate management

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ABSTRACT

The aim of this experiment was to investigate the effect of quaternarybenzophenantridine (QBA) and protopine alkaloids (PA) mixture supplementation on growth response and gut health of broilers under hot climate management. One thousand and six hundred, one-day-old male broiler chicks (Ross 308) were divided into 4 treatments. Treatment 1 (T1) served as the control group, T2, T3 and T4 were fed with 0, 30, 60 and 100 ppm of QBA and PA mixture, respectively. Each treatment consisted of 8 replications with 50 birds per replication. All diets were formulated with out growth promoter supplementation. All birds were raised in evaporative cooling house. Feed and water were provided *ad-libitum* and vaccinated for coccidiosis prevention at 4 days of age. There was no significant effect of QBA and PA mixture supplementation on body weight gain of broilers . However, feed intake and feed conversion ratio were significantly decreased with an increase of QBA and PA mixture levels in the diets ($P<0.05$). Broilers fed diet containing QBA and PA mixture had a significant reduction in mortality rate. The lowest mortality was observed in birds fed 100 ppm QBA and PA mixture ($P<0.05$). The supplementation of QBA and PA mixture significantly improved gut health by increasing villi height, villi width, villi height:crypt depth ratio and surface area of jejunum, especially at 100 ppm in the diet ($P<0.05$). Feeding high dose of QBA and PA mixture without the addition of growth promoter has a potential to improve growth performance and gut histology of broilers under hot climate management.

Keywords : broiler, villi height, protopine alkaloid, quarternary benzophenanthridine alkaloid

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INTRODUCTION

Due to the ban on using of antibiotic growth promoters, to prevent occurrence of new antibiotic resistance bacteria, it is necessary to look for alternatives to these production enhancing compounds. Plant extracts are increasingly being used in animal production industry. It has multiple name such as poppy plant, plume-poppy and tree celandine. It has been widely used for centuries as alternative medicine. *Macleaya cordata* contains several alkaloids. Sanguinarine and chelerythriene are the major alkaloids found in leaves. Sanguinarine and chelerythriene belong to quaternary benzophenantridine (QBA) and protopine alkaloids (PA) group (Shamma and Guinaudeau, 1986). They possess antimicrobial (Mitscher *et al.,* 1980) and anti-inflammatory effects (Lenfeld *et al.,* 1981). Another biological effect of sanguinarine and chelerythriene is to improve endogenous digestive enzyme secretion, activate of the immune system and improve protein retention of farm animals (Mellor, 2001). Therefore, *Macleaya cordata* could be used as an alternative to antibiotic growth promotors for animals. The objective of this study of to evaluate the effect of quarternary benzophenanthridine alkaloid (QBA) and protopine alkaloid (PA) from Phytobiotics (Thailand) Co.,Ltd on growth response and gut histology of broilers under hot climate management fed practical corn-soy-rice bran diets.

MATERIALS AND METHODS

Animal and Diets

The study was conducted at Poultry Research and Development Center, Kasetsart University, Kamphaengsaen Campus, NakhonPathom, Thailand. All chicks were housed in a 12 m × 30 m curtain-sided, evaporative cooling system house with rice hull as litter. The building housed 40 identical pens separated by wire. One thousand six hundred, one-day-old, male broiler chicks of Ross 308 were divided into 4 dietary treatments as shown in table 1.

Table 1 Description of treatments

Treatment	Description
T1	Positive control (Corn-Soy- Rice bran diet)
T2	T1 + QBA & PA Mixture 30 ppm
T3	T1 + QBA & PA Mixture 60 ppm
T4	T1 + QBA & PA Mixture 100 ppm

The tested products were stored in a cool (<20 °C), dry place, protected from moisture and light until mixed with the trial diets. Each treatment consisted of 8 replications with 50 birds per replication. All diets were formulated to be isocaloric and isonitrogenous. Diets were formulated according to Thai industrial standards. All diets were corn-soy basal diet containing rice bran. Feed in mash form and water were provided *ad-libitum* throughout the experiment.The trial was conducted for 35 days.

The tested product were mixed with premix and then added to the total feed in the mixer. The total amount of feed manufactured for the trial will be 200 kg/batch. Representative samples of experimental diets were collected from each batch, pooled together at kept in the freezer pending for nutrient composition analysis (AOAC, 1990).

Table 2 Composition of the experimental diets

Ingredient	Starter	Grower
Corn	51.90	55.46
Rice bran	3.00	5.00
Soybean oil	1.67	1.93
Full fat soybean	10.00	12.50
Soybean meal 49% CP	28.69	20.99
L-lysine	0.25	0.14
DL-methionine	0.35	0.24
Choline chloride (60%)	0.04	0.02
Monodicalciumphosphate 21	1.92	1.65
Calcium carbonate	1.55	1.43
Salt	0.41	0.41
Premix	0.25	0.25
Total	100	100

MEARSUREMENT

1. Performance

Body weight of all birds was recorded at 1, 18 and 35 days of age. From these data, periodically gain in weights of the birds was calculated. The feed offered and the feed refused were recorded periodically for each replicate. On the basis of these data, periodically feed consumption

and feed conversion ratio were calculated. Numbers of dead bird were recorded for mortality calculation.

2. Gut histology

At 14 and 35 DOA, 2 birds from each replication were killed by cervical dislocation. The gastrointestinal morphometric variables evaluated were villus height, villus width, crypt depth, villus height/crypt depth and villus surface area from the jejunum (Brunnsgaard, 1998).

STATISTICAL ANALYSIS

Analysis of variance of all data was conducted using the completely randomized design: CRD. Treatment effect was considered to be significantly different at $P<0.05$. Tendencies ($0.05<P<0.1$) were also reported. Variables having a significant F-test were compared using the Duncan's new multiple range test function of statistical package.

RESULTS AND DISCUSSION

1. Performance

The effect of QBA and PA mixture on growth performance of broiler chicken is shown in Table 3. There was no significant effect of QBA and PA mixture supplementation on body weight gain of broiler throughout the experimental period. However, feed intake and feed conversion ratio were significantly decreased with an increase of QBA and PA mixture levels in the diets ($P<0.05$). Broiler fed diet containing QBA and PA mixture had a significant reduction in mortality rate. The lowest mortality was observed in birds fed 100 ppm QBA and PA mixture ($P<0.05$). These results indicate that dietary QBA and PA mixture may exert growth-promoting effects on broiler chicks. In another study, chicks fed with sanguinarine at 50 and 25 ppm had improved FCR (Pickler et al., 2013)

Table 3 The dietary effects of QBA and PA mixture on growth performance in broiler chicken.

	T.1	T.2	T.3	T.4	P-value	SEM
Initial BW. (g)	42.08	41.85	41.94	42.03	0.6747	0.0690
Starter period BW. (g)	564.65[a]	547.61[b]	553.24[ab]	559.91[ab]	0.1027	2.4829
Final BW. (g)	2,125.44	2,110.94	2,073.14	2,132.69	0.1525	9.6232
Feed intake (g/bird)						
1-17 d	723.10	729.55	710.08	703.45	0.1809	4.5093
18-35 d	2,598.92[a]	2,525.95[b]	2,462.05[c]	2,459.80[c]	0.001	8.6687
1-35 d	3,322.02[a]	3,255.50[b]	3,172.13[c]	3,163.25[c]	0.001	10.0187
BW. Gain (g/bird)						
1-17 d	512.81	505.76	511.30	517.89	0.3412	2.3131
18-35 d	1,612.63	1,605.18	1,598.09	1,614.80	0.9001	8.6467
1-35 d	2,083.36	2,069.09	2,067.45	2,090.66	0.7339	8.5846
FCR						
1-17 d	1.410[ab]	1.443[a]	1.389[ab]	1.359[b]	0.0267	0.0094
18-35 d	1.613[a]	1.575[ab]	1.541[b]	1.523[b]	0.0158	0.0097
1-35 d	1.595[a]	1.574[ab]	1.534[bc]	1.514[c]	0.0011	0.0069
Mortality (%)						
1-17 d	0.75	0.25	0.50	0.50	0.8243	0.1860
18-35 d	2.50[a]	1.25[ab]	1.00[ab]	0.25[b]	0.1582	0.3423
1-35 d	3.25[a]	1.50[ab]	1.50[ab]	0.75[b]	0.1487	0.3824

[a-c] Mean values in a same row with no common superscripts are significantly different (P<0.05).

2. Gut histology

The dietary effect of QBA and PA mixture on relative jejunum and ileum morphology at 17 days and 35 days of age in broiler chickens are shown in Table 4 and 5 respectively. At 17 days of age the supplementation with QBA and PA mixture significantly increased villi width and villi surface area of jejunum and significant increased villi height, villi:crypt depth ratio and villi surface area of ileum as compared with control group (P<0.05). At 35 days of age the supplementation of QBA and PA mixture significantly improved gut health by increasing villi height, villi width, villi height:crypt depth ratio and surface area of jejunum, especially, when supplement at 100 ppm in the diet (P<0.05) and significant increased villi height:crypt depth ratio of ileum (P<0.05). This result is partly in accordance with the reports of Chang (2008). That supplemental QBA & PA mixture positively influenced villi height, villi:crypt depth ratio and villi surface area in this study may

suggest an enhanced rate of nutrient digestion, absorption and utilization leading to improved growth performance. Satin et al. (2001) reported that the correlation of a higher villi height with a higher surface area for nutrient absorption and better broiler performance was observed.

Table 4 The dietary effects of QBA and PA mixture on Jejunum and Ileum morphology in broiler chicken at 17 days of age.

	T.1	T.2	T.3	T.4	P-value	SEM
Jejunum						
Crypt depth (μm)	98.91	99.19	101.80	104.42	0.9533	3.8723
Villi height (μm)	718.95	857.88	913.53	883.03	0.1489	31.6679
Villi width (μm)	88.27^{b}	102.52^{ab}	104.83^{ab}	115.80^{a}	0.1218	3.9895
Villi height : Crypt depth ratio	6.93	7.98	8.35	8.47	0.3123	0.3181
Villi surface area (mm^2)	0.0679^{b}	0.0939^{a}	0.1018^{a}	0.1085^{a}	0.0024	0.0038
Ileum						
Crypt depth (μm)	102.39	111.95	107.34	101.64	0.7755	3.9508
Villi height (μm)	673.37^{b}	741.88^{ab}	844.47^{ab}	891.00^{a}	0.0527	29.8744
Villi width (μm)	107.55	107.78	106.63	110.09	0.9926	4.1951
Villi height : Crypt depth ratio	6.26^{b}	6.26^{b}	7.44^{ab}	8.33^{a}	0.0315	0.2834
Villi surface area (mm^2)	0.0774^{b}	0.0856^{ab}	0.0965^{ab}	0.1045^{a}	0.0876	0.0039

$^{a-b}$ Mean values in a same row with no common superscripts are significantly different ($P<0.05$).

Table 5 The dietary effects of QBA and PA mixture on Jejunum and Ileum morphology in broiler chicken at 35 days of age.

	T.1	T.2	T.3	T.4	P-value	SEM
Jejunum						
Crypt depth (μm)	135.27	120.27	116.13	112.06	0.1894	3.9534
Villi height (μm)	1,182.97^{b}	1,376.30^{ab}	1,293.86^{ab}	1,385.70^{a}	0.1181	32.9307
Villi width (μm)	203.06^{b}	177.95^{b}	265.72^{a}	289.16^{a}	0.0002	9.3445
Villi height : Crypt depth ratio	9.55^{b}	11.56^{a}	10.70^{ab}	12.45^{a}	0.0219	0.3322
Villi surface area (mm^2)	0.2407^{b}	0.2463^{b}	0.3686^{a}	0.4043^{a}	0.0001	0.0148
Ileum						
Crypt depth (μm)	121.39	116.44	102.83	105.47	0.2279	3.6227
Villi height (μm)	1,101.69	1,199.33	1,251.63	1,251.45	0.3545	33.6171
Villi width (μm)	248.88^{a}	252.59^{a}	195.19^{b}	201.59^{b}	0.0126	7.6612
Villi height : Crypt depth ratio	8.83^{b}	10.48^{ab}	10.64^{ab}	11.94^{a}	0.0312	0.3593
Villi surface area (mm^2)	0.2936	0.3008	0.2937	0.2537	0.2933	0.0104

$^{a-b}$ Mean values in a same row with no common superscripts are significantly different ($P<0.05$)

CONCLUSION

The supplementation of 60 ppm of QBA and PA mixture without the addition of growth promoter has a potential to improved growth performance but more beneficial in gut health can observed when supplement 100 ppm of QBA & PA mixture in the diet under hot climate management.

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