

Comparative effects of butyric acid blend with valeric acid and tributyrin on growth performances and carcass quality of broiler chicken

Theerawit *Poeikhampha**¹, Sombat *Prasongsook*¹, Savek *Kiatsomphob*¹, Panatda *Bungsrisawat*¹ and Warod *Buranasiri*¹

¹Department of Animal Science, Faculty of Agriculture, Kasetsart University, Bangkok 10900, Thailand

Abstract. The use of alternative feed additives as a replacement for antibiotic growth promoters has been focused on increasing the growth efficiency of broiler. This study was conducted to compare the effects of butyric acid blend with valeric acid and tributyrin on growth and carcass in broiler. A total of 630 male broiler chickens (ROSS 308) was divided into 3 groups and distributed into 6 pens with each pen consisting of 35 birds following a Completely Randomized Design. Throughout the 35 days of the feeding trial, all birds received diets: 1) Control diet, 2) +Butyric acid blend with Valeric acid and 3) +Tributyrin. The results indicated that birds received butyric blend with valeric acid or tributyrin showed significantly improved feed conversion ratio ($p < 0.05$). Birds receiving butyric blend with valeric acid tend to increase daily weight gain. Feed intake seems to be decreased by tributyrin. Conversely, the birds received butyric blend with valeric acid or tributyrin supplementation not influenced carcass yield and foot-pad score. Therefore, the supplementation of butyric blend with valeric acid or tributyrin results in improved growth performance without the negative effect on carcass quality in broiler chicken.

* Corresponding author: agrtrw@ku.ac.th

1. Introduction

Recently, the use of feed additives in stimulating the growth and improving carcass quality of chickens has been increasingly studied because of the rapid development of broiler breeds and broiler farming management. Since 2006, the European Union had banned antimicrobial growth promoter (AGP) because antimicrobial resistance (AMR) problems in human food safety. The withdrawing of AGP from routine production and seeking for AGP replacer have become a worldwide target for sustainable industry development [2]. Withdrawal of AGP significantly increases the incidence of diseases and reduces animal growth performance and efficiency. Due to such consequences, it is very important in finding the optimal alternatives for AGP.

Butyric acid is known to be involved in the mucosal immune response, and it has an anti-inflammatory effect in animals. Butyrate can increase the rate of tight junction which suggests butyrate helps to maintain gut integrity [9]. Another study observed increasing of machine production, a secreted component of intestinal mucosal barriers, in human intestinal epithelial cells incubated with SCFA, including butyrate [13]. Butyrate supplementation for broiler chickens is known to have beneficial properties such as reducing *Salmonella* colonization and increasing antimicrobial peptide transcription [3,12]. Moreover, in healthy broilers, butyrate supplementation leads to reduced weight gain that is caused by a lower nutrient diet [1].

Valeric acid is a straight-chain saturated fatty acid containing five carbon atoms. It is a short-chain fatty acid and a straight-chain saturated fatty acid. The valeric might give the positive effects when supplementation in the diet, however, Effects of valeric acid on intestinal health have been poorly investigated [7]. This study was conducted to compare the effect of butyric acid blended valeric acid and tributyrin on the growth performance and the carcass quality of broiler chicken. To find out a suitable guideline for selecting animal feed additives which focus on improving growth performance and carcass yield for broiler industry.

2. Materials and Methods

This study was conducted at the Animal Research Farm, Department of Animal Science, Faculty of Agriculture, Kasetsart University, Thailand. The experimental animals were kept, maintained, treated and handled in adherence and accordance with accepted standards for the humane treatment of animals. The number of Approval for Animal Care and Use of Scientific Research, Kasetsart University is ACKU65-AGR-016.

2.1 Animal and management

Six hundred- and thirty-day-old male chicks (ROSS 308 strain) were obtained from a commercial hatchery. The birds were randomly assigned according to their initial body weights to one control group and 3 treatment groups. Each group was replicated

into 6 pens with each pen consisting of 35 birds. The birds were given the same management and vaccination program as those done in commercial farms. Water and feed were provided *ad libitum* throughout the experiment. The water supply in each pen was equipped with a water bell from 1-10 days and nipple from 11-42 days. The birds in a control group received the basal diet and water (without any supplementation) (T1). Basal diet supplemented with butyric and valeric acid dosages 500 g/ton in starter, 500 g/ton in grower and 250 g/ton in finisher (T2) and Basal diet supplemented with tributyrins dosages 500g/ton in starter, 250 g/ton in grower and 250 g/ton in finisher (T3).

Table 1. Feed ingredients and nutrients composition of the basal diet (control diet).

Item	Starter (1-10 days)	Grower (11-24 days)	Finisher (25-35 days)
Corn	55.10	41.62	40.99
Wheat	-	10.00	15.00
Rice bran defatted	-	5.00	5.00
Corn DDGs	-	8.00	8.00
Palm oil	2.78	4.97	5.99
SBM 48%	37.63	21.13	15.94
Rape seed Meal	-	4.00	4.00
Feather meal	-	2.00	2.00
L-Lysine HCL	0.19	0.35	0.35
L-Threonine	0.09	0.08	0.06
Salt	0.35	0.35	0.35
Calcium carbonate	1.21	1.02	1.08
MDCP 21%	1.80	0.73	0.53
Vitamin and Mineral Premix+	0.24	0.24	0.24
Choline chloride 60%	0.28	0.27	0.25
Phytase and Xylanase	-	0.01	0.01
Total	100.00	100.00	100.00
Nutrient (Calculation)	Starter (1-10 days)	Grower (11-24 days)	Finisher (25-35 days)
Metabolize energy for Poultry (kcal/kg)	3,000.00	3,100.00	3,200.00
Protein (%)	23.00	21.50	19.50
Fat (%)	5.27	7.81	8.82
Fiber (%)	2.56	3.58	3.47
Calcium (%)	0.96	0.81	0.78
Total Phosphorus (%)	0.72	0.58	0.52
Avail. P for Poultry (%)	0.48	0.44	0.39

Salt (%)	0.34	0.34	0.34
Animal acids (Digestible, %)			
Arginine	1.44	1.22	1.08
Histidine	0.58	0.50	0.45
Isoleucine	0.90	0.79	0.70
Leucine	1.81	1.67	1.53
Lysine	1.28	1.15	1.02
Methionine	0.63	0.53	0.48
Methionine +Cysteine	0.95	0.87	0.80
Phenylalanine	1.05	0.95	0.86
Phenylalanine +Tyrptophan	1.77	1.36	1.20
Threonine	0.86	0.77	0.68
Tryptophan	0.25	0.21	0.19
Valine	0.98	0.92	0.83
Choline (mg/kg)	1,700.00	1,600.00	1,500.00

+The vitamin and mineral premix contained in the diet: vitamin A, 8,820 kIU/kg; vitamin D, 3,528 kICU/kg; vitamin E, 13,230 IU/kg; menadione, 1,166 mg/kg; B12, 11 mg/kg; folic acid, 441 mg/kg; choline, 835 mg/kg; d-pantothenic acid, 14,112 mg/kg; riboflavin, 4,410 mg/ kg; niacin, 70,560 mg/kg; thiamine, 2,205 mg/kg; d-biotin, 66 mg/kg; pyridoxine, 1,600 mg/kg; manganese, 68 g/kg; zinc, 68 g/kg; iron, 48 g/kg; copper, 6 g/kg; iodine, 0.6 g/kg; selenium, 0.24 g/kg.

All birds were fed a starter diet until 10 days of age, followed by grower and finisher diet from 11-24 days and 25-42 days of age, respectively. The feed ingredients used, and nutritional composition of experimental diets are shown in Table 1. The diets were formulated to meet the recommended nutritional contained 23% CP and 3,000 ME kcal kg⁻¹ during the starter period, 21.50% CP and 3,100 ME kcal kg⁻¹ during the growing period and 19.50% CP and 3,200 ME kcal kg⁻¹ during the finisher period. The experiment was conducted during the month of June to October 2022 in Bangkok, Thailand. Throughout the duration of the experiment, house temperature and humidity readings were taken and recorded once a day at 13.00.

2.2 Growth performance

Body weight, feed intake and flock mortality in each pen were recorded during all the feeding stages. Mean body weight, weight gain and feed intake were computed to determine feed conversion ratio (FCR).

2.3 Carcass quality measurements

When the experiment ended in the 42 days, 12 birds were randomly chosen from each group and were asphyxiated using CO₂ under atmosphere of less than 2% oxygen (air displaced by CO₂). The hot carcasses were manually eviscerated and weighted thereafter. Abdominal fats were manually removed and weighted. The weight of

carcass weight, abdominal fat, wing, inner breast, outer breast, drumstick and thighs were recorded. Footpad lesions score were assigned to one of three classes: score 0 = no lesions, no or very small superficial lesions, slight discoloration on a limited area of the footpad, mild hyperkeratosis (thickening of the outer layer of the skin) or healed; score 1 = mild lesion, discoloration of the footpad, superficial lesions, dark papillae and hyperkeratosis; score 2 = severe lesions, epidermis is affected, ulcers and scabs, sign of hemorrhages or swollen footpads according to [8]

Statistical analysis: All the data was statistically analyzed using ANOVA. The differences between the means of each group were separated by Duncan's Multiple Range Test. Statements of statistical significance are based on $p < 0.05$. All statistical analyses were computed in accordance with the Steel and Torrie (1980) in accordance with the following model:

$$Y_{ij} = \mu + A_i + \varepsilon_{ij}$$

Where;

Y_{ij} is the observation from the i treatment in the j replication (where $i = 1, 2, 3$ and $j = 1, 2, 3, \dots, 6$)

μ is the overall mean of the experiment

A_i is the effect of the i treatment (where $i = 1, 2, 3$)

ε_{ij} is the experimental error \sim NID $(0, \sigma^2)$.

3. Results and Discussion

3.1 Growth performance

The birds received feed supplemented butyric blend with valeric acid or supplemented with tributyrin significantly decreased average feed conversion ratio 1.37 ± 0.03 and 1.36 ± 0.04 when compared with the control group ($p < 0.05$). Birds received feed supplemented butyric blend with valeric acid tended to increase average daily weight gain 74.53 ± 1.88 g. The birds received feed supplemented with tributyrin were shown average feed intake 3467.16 ± 59 g. which tended to decrease in feed intake when compared to the other groups (Table 2).

Table 2. Effects of Butyric Acid blend with Valeric Acid and Tributyrin on growth performances of broiler chickens.

Items	Control	Butyric blend with Valeric acid	Tributyrin	p-value	SEM
Initial body weight (g)	46.91 \pm 0.47	47.11 \pm 0.54	46.87 \pm 0.25	0.60	0.10
Initial Uniformity (%)	91.63 \pm 1.21	90.84 \pm 2.82	90.48 \pm 0.95	0.56	0.42
Uniformity (%)	88.90 \pm 1.43	90.37 \pm 0.75	90.47 \pm 1.77	0.12	0.35
Average daily weight gain (g)	72.42 \pm 0.74	74.53 \pm 1.88	73.09 \pm 1.95	0.10	0.42
Feed intake (g)	3598.82 \pm 110.63	3580.55 \pm 100.87	3467.16 \pm 59.80	0.06	24.98
Feed conversion ratio	1.42 \pm 0.04 ^a	1.37 \pm 0.03 ^b	1.36 \pm 0.04 ^b	<0.05	0.01
Feed cost per gain (baht/g)	24.08 \pm 0.69	23.94 \pm 0.75	24.02 \pm 0.74	0.94	0.16

Data is Mean \pm SD, a,b Means with different superscripts in the same row are significantly different ($p < 0.05$)

This study affirmed the findings of [4] that the birds received tributyrin significantly improved feed conversion ratios (FCR, $p < 0.05$) and shown not statical differences in feed intake. Moreover, this study also affirmed the findings of Sizmaz et al. (2022) that the birds received tributyrin supplementation in the feed can reduce feed conversion ratios ($p < 0.05$). As a result of the finding of [5] that supplementation of tributyrin in the feed may lead to increasing nutrition absorption in broiler by improved the intestinal morphology as indicated by higher villus height and the ratios of villus height/crypt depth in broilers.

3.2 Carcass quality

The birds received feed supplemented butyric blend with valeric acid or tributyrin shown not different in carcass weight, abdominal fat, wing weight, inner breast weight, drumstick weight, thighs weight and foot-pad score (Table 3).

Table 3. Effects of butyric acid blend with valeric acid and tributyrin on carcass quality of broiler chickens.

Items	Control	Butyric blend with Valeric acid	Tributyrin	<i>p</i> -value	SEM
Carcass weight (g)	2124.92±69.52	2148.33±84.95	2130.17±72.80	0.84	12.37
Abdominal fat (g)	31.92±12.94	32.58±24.34	30.33±17.37	0.96	3.05
Wing (g)	193.17±11.49	193.75±16.07	190.92±11.78	0.86	2.16
Inner breast (g)	104.25±5.93	108.58±14.18	103.17±10.10	0.43	1.76
Outer breast (g)	580.17±40.08	565.25±59.46	556.00±99.74	0.70	11.60
Drumstick (g)	246.58±14.13	247.00±16.45	240.92±17.78	0.59	2.66
Thighs (g)	337.83±52.40	328.83±38.26	340.92±22.67	0.74	6.48
Foot pad score	0.67±0.78	0.67±0.65	1.17±1.27	0.33	0.16

Data is Mean±SD

The result of this study in terms of carcass yield was contradicted with the findings of [6] that birds given tributyrin supplementation in the feed can increase eviscerated carcass rate and reduce abdominal fat yield ($p < 0.05$). Therefore, the supplementation of butyric acid, blended with valeric acid, and tributyrin improved feed utilization, but did not affect carcass yield when compared to those fed the control diet.

4. Conclusion

It can be concluded that butyric acid blended valeric acid and tributyrin can improve feed conversion ratio (FCR) and tended to increase average daily weight gain when fed in the diet and it could be used as feed additives for broiler without the negative to the carcass of broiler.

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