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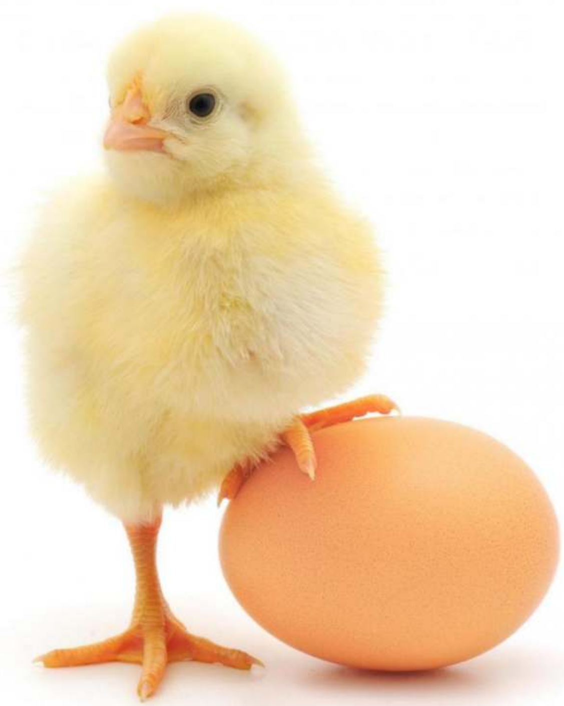

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Research Article
Effect of Chili Pedicle Meal Supplementation on Growth Performance, Economic Return and Ammonia Nitrogen of Broiler Chickens

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Abstract

Background and Objective: Chili pedicle meal, a byproduct of chili powder production, was evaluated for its nutrient quality in broiler feed. A trial was conducted to investigate the effects of chili pedicle meal on broiler chickens in terms of their growth performance, economic return and ammonia nitrogen levels. **Materials and Methods:** The study was conducted using 160 individual Ross 308 broilers at the age of 7-42 days. The animals were randomly distributed into four equal groups. Chili pedicle meal was added to the diets at different concentrations of 0, 0.5, 1.0 and 1.5% of the weight of diet, which corresponded to treatments T1, T2, T3 and T4, respectively. The growth performance, economic return and ammonia nitrogen were tested. **Results:** Body weight gain, average daily gain and fecal ammonia nitrogen decreased as the concentration of chili pedicle meal increased with no change in economic return. **Conclusion:** The chili pedicle meal administration decreased fecal ammonia nitrogen, which could be beneficial for broiler production. However, more studies are needed to detect the meat quality, sensory evaluations and mechanisms involved.

Key words: Ammonia nitrogen, growth performance, chili pedicle, poultry production, broiler feed

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

INTRODUCTION

Researchers have great interest in identifying natural growth promoters to enhance poultry production and reduce feed costs[1]. Agro-industrial by-products that are produced as a result of diverse agricultural species represent one of the most important and promising energy and protein sources[2]. Antibiotic growth promoters (AGPs) are used to improve the productive performance and increase the general health of chickens[3,4], although the excessive use of antibiotics may have negative effects on the development of antibiotic resistance and human health[3,5]. Natural growth promotors, such as prebiotics, probiotics, synbiotics, enzymes, spices, herbs, plant extracts etc., can be extensively used to feed broiler chickens without any hostile effects on the performance of birds[6].

Phytobiotics are of interest due to their high content of pharmacologically active ingredients[7]. Animal scientists are now turning their attention to safe and natural additives, such as plants, for use in animal nutrition. Thailand is an agricultural country, especially Sakon Nakhon Province, which grows many chilis[8]. The production and processing of chili into different products, such as chili powder and chili sauces, results in the production of a large number of chili processing byproducts, such as pedicles[9]. Consequently, most chili pedicles are not used effectively and are dumped into fields, resulting in environmental contamination.

The broiler industry in Thailand is one of the most important industries in the country. The import of broiler meat in Thailand has increased consistently throughout recent years and reached 6.17% in 2016. One of the problems in the broiler industry is the spread of diseases resulting in an increase in morbidity and/or mortality[10]. Therefore, the broiler industry has consistently searched for ways to reduce morbidity and/or mortality and for ways to reduce the odor from broiler manure. Increasing levels of broiler production are causing many environmental problems. Chickens manure can be a cause of ammonia (NH_3) emission, which impacts both animal and human health. The nitrogen (N) content in feces, containing undigested N, endogenous N and microbial nitrogen[11], can lead to NH_3 emission into the atmosphere or can be converted to nitrate during storage[12]. NH_3 emissions contribute to acid rain and nitrogen deposition that damage natural ecosystems. Interestingly, dietary fiber has been shown to lower NH_3emission from laying hens[13].

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

MATERIALS AND METHODS

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

Preparation of the chili pedicle meal: The chili pedicle meal was collected from the Laboratory of Food Technology and Nutrition, Faculty of Natural Resources and Agro-Industry, Kasetsart University Chalermprakiat Sakon Nakhon Province Campus, Thailand. It was 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 chili pedical meal were determined using methods according to the Association of Official Analytical Chemists and are shown in Table 1. The chili pedicle meal was 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 in the control group (T1). In the T2 group, a diet containing 0.5% chili pedicle meal by weight was provided. In the T3 and T4 groups, chili pedicle meal comprised 1.0 and 1.5% of the diet was provided.

The chili pedicle meal was first mixed with a premixture, subsequently mixed with 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 birds

Table 1: Chemical composition of chili pedicles meal[a]

Chemical analysis	Chili pedicles meal
Dry matter (%)	98.87
Crude protein (%)	13.31
Crude fiber (%)	15.65
Crude fat (%)	1.81
Crude ash (%)	1.06
Gross energy (kcal kg^{-1})	4,014.04

[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

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. Feed cost per gain, salable net return, net profits return per bird and return of investment were calculated and compared with those of the control group.

Determination of ammonia nitrogen: Ammonia nitrogen was measured during the last week of the feeding period. The birds were randomly allotted into the four dietary treatment groups (four birds/group) of similar mean body weight and then moved to the individual cages. The feces were subsequently collected over three consecutive 24 h periods on plastic trays 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[14].

Data analysis: Data collected were subjected to one-way analysis of variance (ANOVA) and the general linear model procedure[15]. Differences between treatments were tested using Duncan's new multiple range test at the 5% significance level[16]. 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 chili pedical meal on broiler chickens is limited. The results obtained in this study suggested that incorporation of 0.5-1.5% chili pedical meal in the diet of broilers showed beneficial promotion of the viability of broilers because there was no mortality in these groups. Feed intake, feed conversion ratio, productive index and viability did not show a significant difference after feeding chili pedical meal to the broilers (Table 3). This corresponded with the fact that no adverse effects were observed in feed intake and feed conversion ratio in broilers fed dietary fiber[17]. These results were also supported by Nakhon *et al*.[18], who found that supplementing the diets of broiler chickens with 10 mg kg^{-1} dietary rice hull silicon did not alter body weight, feed intake or the feed conversion ratio. In this study, the inclusion of 0.5-1.5% chili pedical meal reduced the body weight gain and average daily gain of broilers ($p<0.05$; Table 3). These results are in agreement with those of Sklan *et al*.[19], who reported that increasing levels of dietary fiber (80-90 g kg^{-1}) in turkey diets showed a negative effect on growth rate and feed efficiency. Conversely, some researchers have reported that dietary supplementation with oat hull, soy hull and sugar beet pulp improved the productive performance of broilers[20,21]. This finding could be partly explained by the increased dietary

Table 3: Effect of chili pedicles meal on growth performance of broilers

Trait	T1 (control)	T2 (0.5%)	T3 (1.0%)	T4 (1.5%)	SEM	p-value
7-14 days						
BWG (g)	248.85	247.44	245.97	239.14	3.35	0.78
FI (g)	309.44	318.11	312.11	300.84	5.71	0.80
ADG (g)	35.54	35.35	35.14	34.16	0.48	0.78
FCR	1.25	1.28	1.27	1.26	0.03	0.98
PI	410.27	394.51	397.19	391.87	11.37	0.96
Viability (%)	100.00	100.00	100.00	100.00	-	-
15-21 days						
BWG (g)	320.15	301.50	322.76	312.38	8.70	0.86
FI (g)	510.57	496.90	452.84	525.42	13.97	0.31
ADG (g)	45.74	43.07	46.11	44.63	1.24	0.86
FCR	1.60	1.67	1.58	1.70	0.05	0.82
PI	402.05	379.28	429.65	381.73	22.44	0.87
Viability (%)	97.50	100.00	100.00	100.00	0.63	0.43
22-28 days						
BWG (g)	573.08	602.13	557.11	576.31	13.43	0.74
FI (g)	884.63	900.00	900.00	900.00	3.84	0.43
ADG (g)	75.56	86.02	75.06	80.06	1.70	0.15
FCR	1.55	1.51	1.64	1.57	0.04	0.69
PI	713.21	806.94	631.58	733.08	29.28	0.21
Viability (%)	97.50	100.00	100.00	100.00	1.35	0.55
29-35 days						
BWG (g)	484.31	464.23	498.55	507.51	9.20	0.40
FI (g)	915.25	900.00	887.95	900.00	5.02	0.31
ADG (g)	69.19	66.32	65.78	72.50	1.76	0.55
FCR	1.90	1.95	1.80	1.78	0.04	0.32
PI	524.54	490.97	496.16	585.75	24.62	0.55
Viability (%)	100.00	100.00	100.00	100.00	-	-
36-42 days						
BWG (g)	595.20	563.24	610.64	560.72	16.44	0.69
FI (g)	1260.50	1300.00	1313.05	1181.72	31.43	0.50
ADG (g)	83.13	80.47	80.35	80.10	2.66	0.98
FCR	2.13	2.33	2.15	2.13	0.08	0.97
PI	560.30	504.00	507.40	561.50	34.94	0.91
Viability (%)	100.00	100.00	100.00	100.00	-	-
7-42 days						
BWG (g)	2321.13^{a}	2173.53^{b}	2181.75^{b}	2184.19^{b}	22.39	0.04
FI (g)	3880.50	3915.00	3864.95	3807.97	30.83	0.71
ADG (g)	66.31^{a}	62.24^{b}	62.33^{b}	62.40^{b}	0.64	0.04
FCR	1.67	1.79	1.77	1.74	0.02	0.25
PI	392.97	346.47	347.88	359.11	8.23	0.15
Viability (%)	98.50	100.00	100.00	100.00	0.40	0.48

$^{a-b}$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 chili pedicles meal on economic return of broilers

Traits	T1 (control)	T2 (0.5%)	T3 (1.0%)	T4 (1.5%)	SEM	p-value
FCG (baht/bird)	59.55	61.72	57.95	56.15	1.23	0.21
SBR (baht/bird)	93.20	87.14	87.91	87.37	0.89	0.07
NPR (baht/bird)	33.65	31.43	29.97	25.22	1.46	0.44
ROI (%)	56.86	50.98	50.85	43.01	2.98	0.44

FCG: Feed cost per gain, SBR: Salable net return, NPR: Net profits return, ROI: Return of investment compared with the control group

insoluble fiber increasing the rate of feed passage, resulting in an increased feed intake and, hence, greater growth performance[22,23], a situation that was not observed in the present study.

The economic return of broiler chickens, measured from 7-42 days of age, did not vary among treatments (Table 4). No information is available about the impact of dietary chili pedicle meal on the economic characteristics of broilers.

Table 5: Effect of chili pedicles meal on fecal moisture and ammonia nitrogen of broilers

Traits	T1 (control)	T2 (0.5%)	T3 (1.0%)	T4 (1.5%)	SEM	p-value
Moisture (%)	21.57	20.98	20.13	18.52	0.88	0.60
Ammonia nitrogen (mg g^{-1})	0.94[a]	0.72[b]	0.58[c]	0.11[d]	0.02	0.01

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

Onyimonyi *et al.*[24] reported that a decreased cost of feed consumed by using neem leaf meal increased the economic benefit of farmers. Lokaewmanee *et al.*[25] indicated that feed cost per gain, salable net return, net profit return per bird and return of investment were increased when broiler feed was supplemented with 0.5% mao pomace. These differences in the results could be due to the type of substance used in the experiments. Moreover, chili pedicle meal has no value in the market or industry and is added in the small amounts of 0.5-1.5%; thus, its supplementation did not increase production costs.

Compared with that in the control group, the NH_3 nitrogen was significantly lower in the 1.5% chili pedicle meal group at 42 days of age (p<0.05) (Table 5). The total NH_3 nitrogen decreased with increasing levels of chili pedicle meal supplementation. Fecal moisture tended to decrease with increasing levels of chili pedicle meal supplementation (Table 5). Many researchers have used diet composition improvement methods to decrease manure pollutants. Interestingly, NH_3 emission has been reported to be decreased by dietary fiber[26,27]. In this study, chili pedicle meal, as a byproduct of making chili powder, had 98.87% dry matter, 13.31% crude protein, 15.65% crude fiber, 1.81% crude fat and 1.06% crude ash and 4,014.04 kcal kg^{-1}gross energy (Table 1). This confirmed the suitability of fiber in chili pedicle meal for lowering ammonia emissions from broilers manure. A portion of the unabsorbed intestinal content was excreted as NH_3 nitrogen[28]. This observation was supported by the finding of Tran *et al.*,[29] who reported positive effects on ammonia reduction, weight gain and feed conversion in turkeys in their work with dietary supplementation of 0.02% silicon. Duke[30] also found that the undigested feed in the gizzard induced the secretion of hydrochloric acid in the proventriculus, causing a reduction in pH in this organ. Therefore, the reduced gizzard pH of chickens can be beneficial for reducing ammonia nitrogen levels. Dos Santos *et al.*[17] found that the fiber inclusion of 2.5% rice hulls and 5.0% soybean hulls reduced the fecal NH_3 nitrogen. This finding was anticipated because dietary fiber extends the fermentation of microbes in the large intestine and therefore confirms the suitability of fiber diets to lower NH_3 emissions from broiler manure. In contrast, Sittiya *et al.*[28] reported that the average NH_3nitrogen level from 64-72 weeks of age tended to increase with increasing levels of wood charcoal vinegar supplementation but tended to decrease with hen age. The variable effects of dietary fiber supplementation may be induced by other factors such as the type of fiber, chemical components and concentration of dietary fiber. This study will help researchers uncover critical information regarding the dietary fiber in chili pedicle meal that had not yet been reported. Moreover, this study confirmed that1.5% chili pedicle meal to broiler chickens can reduce NH_3nitrogen by 88.29%.

CONCLUSION

In this study, chili pedicle meal administration resulted in a significant decrease in body weight gain, average daily gain and fecal ammonia nitrogen but showed no significant differences in economic return. This most likely occurred due to the use of a byproduct that could reduce the fecal ammonia nitrogen of broiler chickens. In future, we hope to determine the effect of chili pedicle meal on broiler meat quality and sensory evaluation.

SIGNIFICANCE STATEMENT

This study discovered that a high level of chili pedicle meal administration in the diet caused a decrease in both body weight gain and average daily gain with no effect on economic return. The fecal ammonia nitrogen could be reduced by dietary chili pedicle meal supplementation in the diets. This study will help researchers uncover critical information regarding chili pedicle meal application in poultry diets that has not been explored previously.

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