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The effect of turmeric (*Curcuma longa*) supplementation on the performance and economic efficiency of local crossbred chickens

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Abstract

The experiment involving a total of 120 local crossbred chickens within the age range of 5 to 13 weeks old was systematically sorted into four treatments groups with three replicates per treatment group. This study aims to quantify the effect of turmeric powder supplementation in diets on the growth performance and economic efficiency of these chickens. A completely randomized design was used for this study wherein the birds had *ad libitum* access to feed and water in all the treatment groups. Different inclusion levels of turmeric were used in the diets, as follows: 0, 0.250, 0.500, and 0.750%. The result of the study showed that dry matter (DM), crude protein (CP), ether extract (EE), nitrogen-free extract (NFE), crude fiber (CF), ash, and metabolizable energy (ME) were lower in the 0.75% turmeric treatment group than in the other group. In addition, turmeric increased the daily weight gain (DWG), final live weight and improved the feed conversion ratio (FCR) in the group supplemented with 0.750% turmeric ($p < 0.05$). However, feed intake was lowest in the 0.750% turmeric treatment ($p < 0.05$). Furthermore, the 0.75% turmeric treatment was more profitable than the other treatments. It can be concluded that the inclusion of 0.75% turmeric in the experiment had strong effects on chicken performance and economic efficiency.

Keywords: Local Crossbred Chickens, Turmeric, Growth Performance, Economic Efficiency

1. Introduction

In Vietnam, indigenous chickens have increasingly become essential for farmers and are significantly distributed to meet Vietnamese nutrient requirement. In general, indigenous chickens of the tropical countries and of Vietnamese origin, in particular, are different from region to region and from communities to communities within a region [1]. The poultry industry has become an indispensable sector, not only for the economy but also for human nutrition [2]. Currently, to supply enough food for the increasing demand of humans and provide diverse poultry products for customers and consumers, meat from local chickens has become a solution [3]. Local crossbred chicken or “Noi Lai” chicken is a variant of local chicken in Vietnam that was crossbred from Noi chicken (native chicken) and a chicken breed from Binh Dinh province of Vietnam. The characteristics of these chickens are similar to that of the Noi chickens, but these have better performance [4]. More remarkably, Noi chickens have played an important role in rural areas because they can adapt well to harsh living conditions and have been raised in many ways, such as semi-intensive farm systems, semi-scavenging systems, backyard systems, and so on for the purpose of sales or consumption at households [5]. In addition, Noi chickens were selected as a potential chicken breed that can be grown under a sustainable poultry production system in Vietnam [5].

Turmeric supplementation in feed, as a feed additive, has brought numerous breakthrough that have significantly increased chicken performance and economic efficiency [6,7]. Turmeric, as a herbal feed additive, helped increase the average the daily weight gain (DWG), reduce feed costs of production [6] and had a beneficial effect on the DWG, the feed conversion ratio (FCR) and carcass characteristics of broiler chickens [7]. Turmeric is a Vietnamese culinary ingredient that is used to produce artificial color and special aroma for human food. It is readily found around household backyard or in the markets of Vietnam. In addition, turmeric contains one active

component known as curcumin [8] and various therapeutic properties such as: antibacterial, anticoccidial, antioxidant, hypercholesteremic and hypolipidemic properties [6,7,9-11]. It was also described that turmeric contains high amounts of crude protein (10.07%), ether extract (6.64%), crude fiber (4.87%), nitrogen-free extract (66.76%) and ash (2.76%) [12,13]. Moreover, turmeric contains essential minerals and nutrients that are essential for bone and muscle development [13].

In previous studies, turmeric had been widely used in commercial broiler chickens and laying hens. Significant results were recorded, as well. Supplementation with 0.750% turmeric in feed increased the body weight and improved the FCR of commercial broiler chickens and eventually the increasing the gross profit [14]. The in-feed inclusion of turmeric has also resulted to the improvement of the growth performance and egg production of poultry animals through its natural antibiotics effects [15]. Additionally, turmeric helped broiler chickens improve their antioxidant capacity, feed conversion ratio and carcass characteristics [16]. Furthermore, the 3% inclusion of turmeric that was applied in broiler chicken feed resulted in the lowest feed intake while also improving the FCR [17].

However, only few studies have used turmeric powder for local chickens or indigenous chickens. Therefore, the application of turmeric in diets is necessary to diversify feed ingredients and feed resources in rural areas. Furthermore, exploring new feed compositions aims to maintain the sustainable local poultry production system in Vietnam. This study was conducted for the above-mentioned reasons. This study also aims to determine the influence of turmeric powder on the growth parameters and economic efficiency of chickens. It will also study further the most suitable percentage of turmeric supplementation that can be used on the farm.

2. Materials and methods

2.1 Experimental place

This study was conducted at Tra Vinh University, particularly at the experimental farm of the School of Agriculture and Aquaculture, from December 2020 to February 2021.

2.2 Preparation of turmeric powder

Raw turmeric was used for this study, and this was sourced from the local wet market. After buying a fresh one, it was cut finely without its peel and dried completely under the sun. After drying, the turmeric was chopped and ground until it achieved a powdery consistency. Turmeric powder was stored in plastic containers and preserved in room condition. Prior to usage, turmeric powder was mixed with feed, one day prior.

2.3 Animal and experimental design

Local crossbred chickens or “Noi Lai” chickens is a result of the cross between the Noi chickens from Ben Tre province and the chickens from Binh Dinh province. The resulting breed is raised for meat processing purposes.

A total of 120, one-day-old, chickens were purchased from Ben Tre Province with an average weight of 41 g/bird. These are allotted in experimental pens made from wood and covered by a net (3 m²/10 heads). Chicks were raised on the first three weeks without treatments to adapt to the local environment. Balasa bioyeast was used to cover the floor of the cages. The compositions of feed and nutrients in feed are shown below:

Table 1 The feed compositions of basal diet used for chickens.

Items	Basal diet
Ingredients (%)	
Corn	12.5
Broken rice	23.0
Rice bran	43.5
Soybean meal	11.0
Fish meal	9.2
Dicalcium phosphate	0.5
Vitamin and mineral-premix*	0.3
Total	100
Nutrient analysis (%dry matter (DM))	
Crude Protein	19.0
Ether Extract	7.8
Nitrogen Free Extract	61.0
Crude Fiber	4.7
Ash	7.6
Calcium	0.9
Phosphate	1.0
Metabolizable Energy (MJ/kg DM)	12.7

*Mineral premix and vitamin used in this study followed the growth period of chickens.

The experiment was started on the fifth week until the thirteenth week. A completely randomized design (CRD) was used to allocate the birds into four treatments (T1, T2, T3, T4) with three replicates per treatment (5 females and 5 males for each). The birds had ad libitum access to water and feed, in mash form. At 2-3 weeks of age, all chickens in the study were vaccinated against some basic diseases, such as: duck plague and avian influenza. The experimental design is shown below:

The control treatment (T0): basal diet without turmeric powder

The first treatment (T1): basal diet with 0.250% turmeric powder

The second treatment (T2): basal diet with 0.500% turmeric powder

The third treatment (T3): basal diet with 0.750% turmeric powder

Growth performance and economic efficiency: Chickens were weighed individually to determine the initial weight during allotment. Birds were weighed every week during the trial (in the morning and before feeding). After determining their initial weight, chickens were randomly distributed into four treatment groups. The data on feed intake and leftovers were gathered daily in the morning. All costs of raising birds were recorded throughout the experiment.

2.2 Statistical analyses

The data in the experiment were calculated and analyzed by using the General Linear Model (GLM) procedure in ANOVA mode of Minitab 16.0. The Tukey test was used to compare the variable means of the data. The results with $p < 0.05$ were considered significantly different.

The economic efficiency was calculated through Excel computations. The profit analysis was calculated by comparing total revenue (from selling the chickens) and total costs incurred (chickens, feed, water, electricity, labor, animal health service and turmeric).

3. Results

3.1 Proximate compositions and metabolizable energy content

The dry matter, crude protein, ether extract, nitrogen-free extract, crude fiber, ash and metabolizable energy are shown in Table 2. Dry matter was lowest in the 0.750% turmeric treatment ($p < 0.05$). The proximate compositions and metabolizable energy illustrated different values between the diets, which were lowest in the 0.750% turmeric treatment ($p < 0.05$). The control treatment had the highest proximate values as compared to the other treatment groups.

Table 2 Proximate compositions and metabolizable energy content with turmeric in the diet (g/bird/day).

Criteria	Treatment				SEM	P
	T0	T1	T2	T3		
Dry Matter	52.35 ^a	51.43 ^a	49.64 ^{ab}	47.87 ^b	0.706	0.0090
Nitrogen Free Extract	28.3 ^a	27.7 ^a	26.7 ^{ab}	25.8 ^b	0.3800	0.0070
Proximate compositions as percent of DM						
Crude Protein	8.82 ^a	8.64 ^a	8.34 ^{ab}	8.03 ^b	0.1100	0.0070
Ether Extract	3.62 ^a	3.56 ^a	3.43 ^{ab}	3.30 ^b	0.0400	0.0080
Crude Fiber	2.19 ^a	2.14 ^a	2.06 ^{ab}	1.99 ^b	0.0200	0.0060
Ash	3.54 ^a	3.46 ^a	3.34 ^{ab}	3.22 ^b	0.0400	0.0070
Metabolizable Energy (MJ/bird/week)	0.59 ^a	0.58 ^a	0.56 ^{ab}	0.54 ^b	0.0100	0.0070

^{a,b} Means within a row with different superscripts differ significantly ($p < 0.05$).

3.2 Growth performance of the chickens

Table 3 shows the growth performance of the chickens. Initial weight was not statistically significant, which proves that the weight of chickens in the experiment was balanced, and bias was removed in this experiment. Final live weight and daily weight gain was higher in the 0.75% turmeric treatment than in all the other treatments ($p < 0.05$). In contrast, feed intake and feed conversion ratio were lowest in the same group, treatment with 0.750% turmeric ($p < 0.05$).

Table 3 Growth parameters of the chickens in the diets with turmeric powder.

Criteria	Treatment				SEM	P
	T0	T1	T2	T3		
Live weight						
Initial weight*, g	430	432	428	425	12.420	0.9820
Final weight, g	1366 ^b	1394 ^{ab}	1423 ^{ab}	1448 ^a	15.560	0.0270
Daily weight gain, g	14.86 ^b	15.80 ^{ab}	15.80 ^{ab}	16.24 ^a	0.2320	0.0140
Feed intake, g/d	52.35 ^a	51.43 ^a	49.64 ^{ab}	47.87 ^b	0.7060	0.0090
Feed conversion ratio	3.50 ^a	3.40 ^{ab}	3.20 ^{bc}	2.90 ^c	0.0600	0.0010

^{a-c} Means within a row with different superscripts differ significantly ($p < 0.05$).

* Initial weight is weighted at 5-week-old.

3.3 Economic efficiency of the chickens

Table 4 shows the economic efficiency of the chickens in the four treatment groups. Basing on the data from the table, the revenue and profit in all diets with turmeric were higher than those in the control treatment. There is an increasing trend in profit from 0.250% turmeric to 0.750% turmeric. Furthermore, there was highest profit in the treatment of 0.750% turmeric, which was 2.18%, compared to the treatment without turmeric.

Table 4 Economic efficiency of the chickens in the experiment.

Indicators	Treatment*			
	T1	T2	T3	T4
Total costs	77000	76000	74000	71000
Total revenue	88000	90000	92000	95000
Profit	11000	14000	18000	24000
Profit/bird	11000	14000	18000	24000
Comparison	-	1.27%	1.63%	2.18%

*Unit: VND per treatment.

1 USD is approximate 23000 VND.

4. Discussion

All the proximate compositions and dry matter in the 0.750% turmeric treatment were lower compared to those in the control treatment and even lower than those in the other treatment groups. The inclusion of turmeric in the diets, treatment with 0.750% turmeric, resulted to a lower proximate composition value compared to all the other treatments. This can be explained by the fact that the nature of turmeric contained high proximate compositions, which helped increase the nutrients and quality of feed in the experiment. So, chickens did not need to consume high amount of feed. It was also analyzed that turmeric contains an appreciable amount of proximate compositions and minerals [12,13].

In the experiment, body weight gain was highest in the 0.750% turmeric treatment. In contrast to body weight gain, feed intake and feed conversion ratio were highest in the control treatment without turmeric and lowest in the treatment of 0.750% turmeric. Based on these results, we can infer that turmeric helped chickens increase their daily weight gain, decrease their feed intake, and improve their feed conversion ratio. The results were in line with many previous studies [14-16]. Turmeric in diets acted as a growth stimulant to promote the growth of chickens, particularly increasing the final live weight and body weight gain [6]. Turmeric has therapeutic properties, such as: antibacterial, anticoccidial, antioxidant, hypercholesteremic and hypolipidemic properties [6,7,9-11]. Turmeric also contains curcumin, which could help improve the liver function of chickens against some diseases, especially diseases of the digestive system. Thus, the digestive function of birds was not physiologically challenged, and the birds was able to digest the feed efficiently.

The feed intake results showed that chickens in the treatment groups fed with turmeric consumed a lower amount of feed than the control group. Since the turmeric-infused feed is highly digestible, the chickens do not need to consume high amounts of feed. Remarkably, the chickens had a better body weight gain and feed conversion ratio performance. Moreover, turmeric in the diets increased the absorption of nutrients in feed and improved the digestive process of chickens through the therapeutic properties, enhanced lipolysis, and body metabolism by curcumin, which was found in the turmeric powder and had a positive effect on increasing intestine villus width [18]. In addition to therapeutic properties and highly essential nutrients, turmeric is a natural promoter that might be used as an alternative to antibiotics [15].

The economic efficiency of chickens is determined not only by the costs of raising chicken productively but also on the growth performance of chickens, which is mostly affected by the feed nutrient composition. The economic efficiency increased in the diets with turmeric powder. Turmeric helped chickens improve its growth performance and eventually increasing the profit, as well. As previously explained, turmeric contains curcumin and therapeutic properties which are known as natural remedies that can prevent diseases and improve the growth rate and the feed conversion ratio of chickens [6]. In summary, chickens had outstanding growth performance,

especially the final live weight, which affects the selling price of chickens. The result gathered was similar to the results of the previous study; the inclusion of 0.750% turmeric can improve gross profit [14].

5. Conclusion

The study showed that the inclusion of 0.750% turmeric was the optimum inclusion level in feed, among other treatments, which fostered the performance increase and economic efficiency of chicken production. The most cost-effective in-feed inclusion of 0.750% turmeric yielded the best performance. The inclusion of turmeric in the diets helped chickens increase their final live weight and daily weight gain. In addition, turmeric in the diet-assisted chickens improved feed conversion and decreased the feed intake of chickens in the experiment. Proximate analysis and metabolizable energy contents mostly reflected the feed consumption of chickens.

6. Ethical approval

To avoid all unnecessary discomfort to the experimental animals, all procedures were checked and approved by ethical approval from the Department of Veterinary and Animal Husbandry of Tra Vinh University with the approval reference number 163/KH-NNTS.

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