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The Effects of Pineapple Leaf Powder on Growth Performance and Carcass Traits of Noi Crossbred Broilers

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ABSTRACT: To meet the increasing demand of consumers on poultry products, poultry feed does not only improve the growth performance but also enhance meat quality. By this reason, the study was to evaluate the effects of pineapple leaf powder on growth performance and carcass characteristics of Noi broiler chickens from 5-12 weeks of age. The study was conducted at Tra Vinh University – experimental farm involving with 120 Noi crossbred broilers from 4 weeks of age. The study was a completely randomized design with 04 treatment and 03 replicates, consisting of 0% (control treatment, T0), 0.1% (treatment 1), 0.3% (treatment 2) and 0.5% (treatment 3) of pineapple leaf powder in the diet. Birds were fed *ad libitum* throughout the experiment. The results showed that body weight (1603 g/bird at 12 weeks of age), daily weight gain (21.90 g/bird/day) had the highest performance while feed intake (55.28 g/bird at treatment 2) and feed conversion ration (2.610) showed the lowest performance in the treatment 3 ($P<0.05$). However, the study did not record any significant changes in carcass traits, pH and cooking loss of broiler meat between treatments ($P>0.05$). It can be concluded that the inclusive of pineapple leaf powder on diets could improve growth rate of Noi crossbred chickens from 5-12 weeks of age.

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KEYWORDS: Broiler, Growth, Carcass, Nutrition, Pineapple leaf.

INTRODUCTION

Recently, the poultry industry in the world in general and in Vietnam in particular has been developing, in which the poultry production is increasing in both quantity and quality. To meet the growing demand of consumers, the raising of local chicken breeds is increasingly emphasized because of their high growth performance and ability to adapt to local conditions (Vo et al., 2019) and also their meat quality.

The poultry industry, on the other hand, faces many challenges, including the increasingly common overuse of antibiotics, resulting in antibiotic resistance, drug residues or weakened immune systems and indirectly affects the health of consumers. In recent years, there have been many studies on the use of herbs and plants from natural source that are highly safe and benign for pets and products from them. These dietary supplements have many biological functions such as anti-oxidation, improving immunity, and enhancing animal productivity (Bianchin et al., 2020; Mirzadeh et al., 2021) and specifically has the ability to replace antibiotics and act as growth stimulants (Dhana, 2015). The previous research shows that green tea, lavender, black cumin seeds, garlic, wildflower, turmeric... bring positive effects on the growth performance of livestock (Pliego et al., 2022). In addition, research on pineapples and enzymes inside pineapples is increasingly receiving attention internationally. Pineapple is grown in many tropical countries and used as a beverage in many countries around the world. Pineapple is highly appreciated because it contains many organic compounds, amino acids and large amounts of vitamins. Bromelain is considered the most important enzyme compound in pineapple that hydrolyzes proteins and enhances the absorption and metabolism of nutrients, thereby helping animals grow better (Yenice et al., 2019). It is rich in cysteine proteases of significant commercial importance (Feijoo-Siota & Villa, 2011) and its biological effects are related to proteolytic activity (Mazorra-Manzano et al., 2018). In addition to acting as a proteolytic enzyme to stimulate protein digestion, many studies have identified beneficial properties of bromelain for humans and animals, such as anti-inflammatory (Sahbaz et al., 2015), anti-edema. and cleaving (Hu et al., 2011), antioxidant (Yenice et al., 2019) and antibacterial (Begum et al., 2015) properties (Hossain & Rahman, 2011). In addition, there have been many studies on bromelain (Ni'matul Laili Nur

Mahfudhoh, 2023; Rahman & Yang, 2018; Van Doan et al., 2021) have proven its effects on the growth of poultry and poultry products such as eggs (Yenice et al., 2019).

However, research conducted on poultry is very limited and little is known about the effects on hybrid chickens. From the above reasons, the study was conducted to determine the level of pandan leaf powder supplementation on the growth ability and meat quality of hybrid Noi chickens.

RESEARCH METHODS

2.1. Research time and location

The experiment was conducted from September 2023 to December 2023 at the experimental farm of the Department of Animal Science and Veterinary Medicine, Tra Vinh University.

2.2. Experimental design

The experiment utilized a total of 120 Noi crossbred chickens, starting at 5 weeks of age. The experiment was conducted using a completely randomized design, consisting of 4 treatments and 3 replications for each treatment. Each experimental unit consists of 10 birds (balanced male and female birds). The feed composition utilized for the experiment was computed based on the methodologies of the NRC (NRC, 1994) and AOAC (AOAC, 1990). The pen was constructed with two roofs and featured excellent ventilation. Additionally, it was intentionally designed to be elevated one meter above the ground. The floor was coated with rice husks and Balasa bio-yeast. The dimensions of the pen were 1 x 1 meter. The trial utilized diets composed of feed procured from a nearby retail store. Table 1 provided an analysis of the nutritional composition of the substances. Besides, the chickens were provided with feed consisting of corn, broken rice, rice bran, soybeans, fish meal, dicalciphosphate (DCP), and premix-vitamins (as shown in Table 2).

Table 1: Chemical composition of ingredients (% DM)

Ingredients	DM	OM	CP	EE	ME (Kcal/KgDM)
Corn	87,2	99,4	7,30	1,80	3,699
Broken rice	86,2	99,7	7,98	0,91	3,488
Rice bran	88,7	92,6	13,2	8,25	2,608
Soybean meal	87,2	94,2	43,5	1,73	2,628
Fish meal	91,6	85,8	53,7	10	3,138
DCP	100	14,8	-	-	-
Stone	100	-	-	-	-
Mineral - vitamin premix	100	-	-	-	-

DM: dry matter, OM: organic matter, CP: crude protein, EE: crude fat, ME: Metabolizable energy (kcal/kg DM).

Chemical composition of feed: dry matter (DM), organic matter (OM), crude protein (CP), analyzed according to AOAC (AOAC, 1990). ME values of feed ingredients were estimated according to the recommendations of NRC (NRC, 1994). The experiment used 4 levels of pineapple leaf powder (PA) in the diet including 0% (T0), 0.1% (T1), 0.3% (T2) and 0.5% (T3) of PA in the diet.

Table 2: Formula and nutritional ingredients in the diet of the chickens

Ingredients (%)	Treatments			
	T0 (0%)	T1 (0.1%)	T2 (0.3%)	T3 (0.5%)
Corn	32.0	32.0	32.0	32.0
Broken rice	8.00	8.00	8.00	8.00
Rice bran	36.1	36.1	36.1	36.1
Soybean meal	14.0	14.0	14.0	14.0
Fish meal	7.50	7.50	7.50	7.50
Salt	0.30	0.30	0.30	0.30
DCP	0.30	0.30	0.30	0.30
Mineral – vitamin premix	0.30	0.30	0.30	0.30
Stone	1.50	1.50	1.50	1.50
Total	**100**	**100**	**100**	**100**

DM	88.0	88.0	88.0	88.0
OM	92.5	92.5	92.5	92.5
CP	18.0	18.0	18.0	18.0
EE	4.51	4.51	4.51	4.51
ME	**3,005**	**3,005**	**3,005**	**3,005**

DM: dry matter, OM: organic matter, CP: crude protein, EE: crude fat, ME: Metabolizable energy

2.3. Growth performance

At the beginning of the experiment, measure the weight of the chickens, and subsequently measure their weight every week on the same day. Take the weight of the chickens in the early morning before supplying them with feed. Feed consumption was assessed by measuring the weight of the feed given each day and the weight of the remaining feed the next morning. The feed conversion ratio is determined by dividing the total amount of feed consumed during a particular duration by the amount of weight gained during that same period.

2.4. Carcass quality

At the end of the experiment, broiler chickens were reared under standard conditions, given access to water. The following morning, their live weight was measured, and a survey was conducted to evaluate the quality of the meat. Birds were slaughtered to access to various parameters, including carcass weight (g), weight of breast meat and thigh meat (g), weight of heart and gizzard (g), liver weight (g), length of small intestine (cm), length of large intestine (cm), and length of cecum (cm). Following the slaughter, samples of breast and thigh meat were collected to measure pH levels and cooking loss. Pulverize 5 grams of breast meat using 50 ml of distilled water. Utilize the pH pH/ORP/Temperature Laboratory Bench Meter Mi 151, manufactured by Milwaukee in Brookfield, WI, USA, to assess the pH of the breast meat sample. Wait until the pH indicator reaches a stable position, then record the data. Furthermore, breast and thigh meat samples were utilized to measure cooking loss, with around 5 g recorded for each sample. The meat was boiled and allowed to rest for 5 minutes, then measure its weight.

2.5 Data analysis

Data were preprocessed using Microsoft Excel software (2013) and analyzed by ANOVA method using Minitab 16.1.0 software (2010). Tukey test was used to compare treatment means with 95% confidence. Mean values are considered statistically different when $P < 0.05$.

RESULTS AND DISCUSSION

3.1 Growth performance of chickens at 5-12 weeks of age

Table 3. Body weight of chickens (g/bird)

Week	Treatments				SEM	P
	T0	T1	T2	T3		
Week 5	458.1	476.1	485.1	478.4	9.781	0.31
Week 6	574.7	610.2	631.8	633.5	14.62	0.06
Week 7	689.0^{b}	734.2^{a}	757.5^{a}	763.2^{a}	9.270	0.01
Week 8	838.9^{b}	848.9^{b}	940.4^{a}	962.1^{a}	15.56	0.01
Week 9	1031^{b}	1061^{ab}	1108^{ab}	1162^{a}	25.78	0.03
Week 10	1173^{b}	1213^{ab}	1299^{a}	1310^{a}	24.33	0.01
Week 11	1310^{b}	1354^{ab}	1461^{a}	1497^{a}	33.25	0.01
Week 12	1474^{b}	1548^{ab}	1568^{ab}	1603^{a}	23.61	0.02

Note: *T0, control treatment; T1, 0,1% supplement; T2, 0,3% supplement; T3, 0.5% supplement; SEM, standard error of mean; P, statistical significance.*

Mean values with different letters in the same row are statistically different (P<0.05).

The initial weights of the chickens in the experiment were similar, demonstrating their consistency at the start of the study (Table 3). At 5 weeks of age, there was no significant difference in the weight of birds (P>0.05). By the end of the 12-week trial, the weight of the chickens varied significantly (P<0.05). The highest weight was observed in the T3 group, with an average of 1603 g per bird, while the lowest weight was recorded in the T0 group, with an average of 1474 g per chicken. This finding aligns with the research conducted by (Rahman & Yang, 2018), which indicated that incorporating 1% pineapple leaf powder into the diet has the potential to alter the growth performance of birds, including enhancing body weight (BW). Pineapple contains several chemical components,

one of which is bromelain. Bromelain is a protease enzyme that functions similarly to trypsin or pepsin. It aids in digestion by breaking down proteins in the intestines. Oral administration of this substance enhances intestinal permeability and mitigates the adverse effects commonly linked to antibiotics like penicillin and tetracycline (Maurer, 2001; Neubauer, 1961). Adding bromelain derived from pineapple leaves greatly enhances the thickness of the mucosal lining in the ileum. This, in turn, indirectly promotes the growth and fortification of cells in the intestinal mucosa, leading to improved mucosal thickness and absorption capacity in the intestines. The cohesion among intestinal epithelial cells plays a crucial role in preserving the integrity of the intestinal absorptive barrier. This barrier helps to minimize the contact with harmful microbes, bacterial substances, toxins, and antinutrients (Kogut et al., 2018). Supplementing enzymes in the meal not only enhances digestion but also enhances nutrient absorption, hence enhancing the ability of poultry to absorb nutrients. This enhances the bird's capacity to increase their BW.

Table 4. Feed intake of chickens (g/bird)

Criteria	Treatments				SEM	P
	T0	T1	T2	T3		
Average of 5-8 weeks	38.20	38.35	39.71	40.06	0.490	0.06
Average of 9-12 weeks	77.83^{a}	77.23^{a}	70.85^{b}	70.57^{b}	0.540	0.01
Average of 5-12 weeks	58.02^{a}	57.79^{a}	55.28^{b}	55.31^{b}	0.390	0.01

Note: *T0, control treatment; T1, 0,1% supplement; T2, 0,3% supplement; T3, 0.5% supplement; SEM, standard error of mean; P, statistical significance.*
Mean values with different letters in the same row are statistically different (P<0.05).

There was a statistically significant difference (P<0.05) in the amount of feed consumed by chickens between 9 and 12 weeks of age, with the lowest amount consumed in T3 group (Table 4). The findings align with previous research conducted by (Gebert et al., 1999; Kogut et al., 2018), which indicated that dietary herbal growth boosters did not have a substantial impact on chicken FI consumption. Besides, inclusive of pineapple into broiler diets resulted in a considerable decrease in feed consumption (Cross et al., 2007). Moreover, the differences may partly various chicken breeds which exhibit varying degrees of feed intake.

Table 5. Daily weight gain of chickens (g/bird/day)

Week	Treatments				SEM	P
	T0	T1	T2	T3		
Average of 5-8 weeks	17.54^{b}	17.71^{b}	21.39^{a}	21.91^{a}	0.680	0.01
Average of 9-12 weeks	22.70^{b}	24.98^{a}	22.40^{b}	22.89^{b}	0.330	0.01
Average of 5-12 weeks	20.12^{b}	21.34^{ab}	21.90^{ab}	22.40^{a}	0.400	0.02

Note*: T0, control treatment; T1, 0,1% supplement; T2, 0,3% supplement; T3, 0.5% supplement; SEM, standard error of mean; P, statistical significance.*
Mean values with different letters in the same row are statistically different (P<0.05).

Table 5 demonstrates a statistically significant difference (P<0.05) in the body weight gain (BWG) of chickens over the two stages (5-8 and 9-12 weeks) between the treatments. More precisely, the T3 group exhibited a greater body weight gain (BWG) compared to the other groups. The findings of BWG are lower to those of the study conducted by (Rahman & Yang, 2018). Earlier research has also demonstrated that pineapple leaves aid in the process of digestion and expedite the healing of wounds (Maurer, 2001). Enhances pancreatic function, hence enhancing the capacity to metabolize dietary protein. The findings indicated that plant-based enzymes have a notable impact on trypsin activity in the pancreas, potentially by improving the availability of amino acids derived from dietary proteins (Hashimoto & Hara, 2003) or by directly stimulating mucosal receptors. This is supported by the fact that the enzyme bromelain can remain active in the stomach during digestion (Hale, 2004). Hence, consuming diets abundant in plant enzymes can impact the breakdown of proteins into shorter peptides, thereby enhancing the digestibility of food and influencing the composition of microorganisms in the intestines. Furthermore, the use of bromelain enhances the chicken's capacity to metabolize nutrients. Results in enhanced feed efficiency, hence decreasing FCR and enhancing BW.

Table 6. Feed conversion ratio of birds during 5-12 weeks of age

Week	Treatments				SEM	P
	T0	T1	T2	T3		
Average of 5-8 weeks	2.170[a]	2.190[a]	1.880[b]	1.840[b]	0.060	0.01
Average of 9-12 weeks	3.530[a]	3.220[b]	3.380[ab]	3.810[ab]	0.050	0.01
Average of 5-12 weeks	2.850[a]	2.700[ab]	2.630[b]	2.610[b]	0.030	0.01

Note: *T0, control treatment; T1, 0,1% supplement; T2, 0,3% supplement; T3, 0.5% supplement; SEM, standard error of mean; P, statistical significance.*

Mean values with different letters in the same row are statistically different (P<0.05).

Table 6 demonstrates a statistically significant difference (P<0.05) in the feed conversion ratio (FCR) of the chickens, with the lowest FCR observed at T3 group. The findings of this study are comparable to the previous publication, at 5 weeks of age, which is 1.85 (Yenice et al., 2023). The inclusion of pineapple leaf powder in the diet has enhanced their FCR. Several studies have shown that pineapple leaf or its constituents has significant nutritional value and serve as a protein source. The feed contains a plentiful amount of vitamins A, B, C, as well as some minerals such as calcium, phosphorus, and iron (Hossain & Rahman, 2011). Furthermore, it exhibits a targeted antibacterial action by generating an environment conducive to the growth of beneficial bacteria, including Lactobacillus, while inhibiting the growth of harmful bacteria such as E. coli and Listeria monocytogenes (Russo et al., 2014). Additionally, it possesses anti-inflammatory properties. The antibacterial and antiparasitic characteristics of this substance make it effective against protozoa and anthelmintic organisms (Ali et al., 2015; Domingues et al., 2013; Stepek et al., 2006). Assists in decreasing the attachment of harmful microorganisms and maintaining a stable population of bacteria in the intestines, resulting in enhanced digestion and absorption of nutrients, leading to improved consumption and utilization of chicken feed.

3.2 Effect of pineapple leaf powder on carcass characteristics at 12 weeks of age

Table 7: Carcass characterisics

Criteria	Treatments				SEM	P
	T0	T1	T2	T3		
Live weight, g	1452[c]	1534[b]	1586[a]	1609[a]	9.470	0.01
Carcass weight, g	1001[c]	1068[b]	1116[a]	1141[a]	10.20	0.01
Carcass percentage, %	68.96	69.63	70.35	70.87	0.560	0.17
Breast meat weight, g	181.6[c]	193.5[bc]	205.8[ab]	211.7[a]	3.600	0.01
Breast meat percentage, %	18.14	18.12	18.44	18.51	0.350	0.80
Thigh meat weight, g	204.1[b]	216.0[ab]	214.6[ab]	229.0[a]	4.710	0.03
Thigh meat percentage, %	28.39	20.22	19.23	20.07	0.420	0.30
Liver weight, g	30.07	30.98	29.03	31.18	1.750	0.81
Heart weight, g	8.630	6.900	8.230	7.750	0.870	0.56
Gizzard weight, g	41.74	47.55	48.00	41.38	8.150	0.89
Bursa of fabricius, g	3.950	3.200	3.850	3.030	0.380	0.31
Thymus weight, g	5.800	5.150	6.330	5.930	0.610	0.61
Spleen weight, g	4.930	4.470	4.120	4.330	0.350	0.46
Small intestine length, cm	127.5	140.5	130.5	131.5	8.900	0.76
Large intestine length, cm	11.25	13.50	12.17	11.67	0.760	0.25
Ceacum length length, cm	16.25	16.67	15.83	15.50	0.590	0.56

Note*: T0, control treatment; T1, 0,1% supplement; T2, 0,3% supplement; T3, 0.5% supplement; SEM, standard error of mean; P, statistical significance.*

Mean values with different letters in the same row are statistically different (P<0.05).

Table 7 indicates the differences in the treatments including the addition of pineapple leaf powder are statistically significant (P<0.05) in T3 group, which are the live weight (1609 g/head) and carcass weight (1141 g/head). T3 group has the greatest weight increase in both breast meat (211.7 g/head) and thigh meat (229.0 g/head) weight. In contrast, the measure of carcass, breast meat, thigh meat percentage, liver, heart, gizzard, thymus, spleen, Bursa of fabricius weight, small intestine, large intestine, and cecum length did not show any significant differences (P>0.05). The differences may be attributed to the selective antibacterial properties of bromelain, which restricts the growth of dangerous bacteria while promoting a conducive environment for beneficial bacteria. This, in turn, enhances digestion and facilitates the absorption of nutrients, resulting in improved carcass weight for the chicken.

The breast and thigh are considered the most valued sections of poultry carcasses (Vo et al., 2019). The weight of the breast and thigh are crucial economic characteristics that are strongly linked and play a decisive role in determining the overall meat production of poultry. Therefore, the inclusion of pineapple leaf powder in the diet has a beneficial effect on certain parameters of the chickens from 5 to 14 weeks, resulting in this observed distinction.

4.3 Effect of pineapple leaf powder on pH and cooking loss

Table 8: pH and cooking loss of the chickens

Criteria	Treatments				SEM	P
	T0	T1	T2	T3		
pH (breast meat)	6.250	6.000	6.440	6.300	0.110	0.13
Cooking loss (breast meat)						
Before cooking, g	5.160	5.030	5.060	5.060	0.060	0.55
After cooking, g	3.560	3.700	3.650	3.680	0.090	0.77
Cooking loss, %	30.98	26.48	27.93	27.82	1.800	0.37
Cooking loss (thigh meat)						
Before cooking, g	5.030	5.060	5.100	5.100	0.060	0.88
After cooking, g	3.630	3.610	3.760	3.700	0.140	0.87
Cooking loss, %	27.85	28.53	26.10	27.48	2.820	0.93

Note: *T0, control treatment; T1, 0,1% supplement; T2, 0,3% supplement; T3, 0.5% supplement; SEM, standard error of mean; P, statistical significance.*

The table 8 indicates that there is no statistically significant difference (P>0.05) in breast pH, breast meat, thigh meat cooking loss. The acidic nature of pineapple lowers the pH of meat, resulting in a drop in pH due to the increased quantity of bromelain. The water retention capacity of meat is a crucial attribute that influences its quality, juiciness, flavor, and color. Bromelain exerts its enzymatic activity by hydrolyzing protein structures by the action of protease enzymes. This leads to the breakdown of myofibril and collagen proteins, resulting in an increase in the volume of muscle fibers. Additionally, it causes muscular enlargement, fragmentation, and reduction of water retention. Consequently, the capacity of meat to hold water diminishes (Gokoglu et al., 2017). Nevertheless, the present investigation did not see any differences with the inclusion of pineapple leaf powder on pH and cooking loss. It may be because the cooking loss of meat is affected by the enzymatic activity of bromelain, which is dependent on both time and concentration.

CONCLUSION

Supplementing 0.5% pineapple leaf powder enhances chicken growth performance throughout the 5–12-week of age by increasing their weight and daily weight gain, while simultaneously reducing their feed intake and optimize the feed conversion ratio in poultry. Nevertheless, the findings did not indicate any difference in slaughter parameters, such as carcass, internal organs, pH, and cooking loss of chicken meat.

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