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THE EFFECT OF SOME LEAF MEAL KINDS AS A SUPPLEMENT IN THE BASAL DIET ON LUONG PHUONG BROILER PERFORMANCE

TU Q. HIEN; TRAN T. HOAN; MAI A. KHOA; TU. T. KIEN; TU. Q. TRUNG
Thai Nguyen University of Agriculture and Forestry, Thai Nguyen Province, Viet Nam

Abstract

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The aim of this study was to determine the performance of Luong Phuong broilers with basal diets supplemented with cassava, leucaena leaf meals and stylosanthes grass meal (CLM, LLM and SGM). The study used 630 birds, from 14 – 70 days of age, allocated into 7 treatment groups. The treatment groups were named as follows: The control (CG), 1A, 2A, 3A and 1B, 2B, 3B. Birds in the control group were fed with a basal diet without the inclusion of leaf meal. The metabolic energy and crude protein levels were complied with nutrient requirement standards for colored feather broilers. Diets were prepared for birds in 1A, 2A, 3A with the addition of CLM (1A), LLM (2A), and SGM (3A). ME and CP levels in these diets were adjusted to achieve the standard recommendation so that they were similar to that of the control (Addition or the 1st method). Diets prepared for birds in groups 1B, 2B, 3B with the replacement of leaf meal in the basal diet without taking into account ME and CP levels (Replacement or the 2nd method). The results showed that: i) Diets with the inclusion of leaf meals had significant effect on broiler's performance in comparison with that of the control diet, ii) inclusion of CLM had more positive effect than the inclusion of LLM, and inclusion of LLM had more effect than that of SGM, iii) Addition of leaf meals into the diet with adjustment of ME and CP levels had more significant effect on bird's performance than that of the replacement method without ME and CP level adjustment. However, CLM and LLM can be supplemented into diets in either addition or replacement, but SGM should be added into diet with adjustment of ME and CP levels.

Key words: leaf meal; carotenoids; Luong Phuong broiler; cassava; leucaena, stylosanthes
Abbreviations: Ab.: abdominal, ADFI: average day of feed intake, BD: Basal diet; BW: Body weight; CG: Control group; CF: Crude fiber; CLM: Cassava leaf meal; CP: Crude protein; CW: Carcass weight; DM: Dry matter; DWG: daily weight gain; EE: Ether extract (lipid); EN: economic number; FCR: Feed conversion ratio; FI: Feed intake; LLM: Leucaena leaf meal; LWG: Live weight gain; ME: Metabolic energy; P.av.: phosphorus available; PI: Production index; SGM: Stylosanthes grass meal

Introduction

Pigment in animal diets play an important role such as improved feed utilization efficiency and decreased mortality in fish (Watanabe and Aquis, 2003; Aquis el al., 2001; Ilyasov and Golovin, 2003), improved sow fertility and improved livability of piglets (Lignell and Inboor, 2000), and improved chicken's skin and egg yolk color (Sirri et al., 2007; Latscha, 1990; Williams, 1992, Hien et al., 2016). However, this pigment cannot be synthesized by the animal; it must be provided from feed (Marusich and Bauernfeind, 1981; Liufa et al., 1997). Pigment added into animal feed consists of synthetic and natural pigment. The addition of synthetic pigment into animal diets sometimes showed unexpected results, and the consumers were worried that it might have a negative effect on human health. Thus, natural pigment is a safe alternative source to be used as a feed additive in the animal feed industry in many countries.

Cassava, leucaena, stylosanthes forage crops have a large amount of leaves. The total leaf meal yield (tons/ha/year) from cassava was 7.76 tons (Hien and Trung, 2016) from *leucaena* was 6.69 tons (Hoan et al., 2017), from *stylosanthes* was 6.05 tons (Ngoc, 2012). The leaves of *cassava, leucaena* and *stylosanthes* are very rich in pigment content. The pigment content in cassava leaves was 470 – 650 mg/kg dry matter (DM) (Hoan, 2012), that of *leucaena* was approximately 484 – 692 mg kg DM (Hien et al., 2008), and that of *stylosanthes* was 220 – 250 mg/kg DM (Ngoc, 2012). Thus, this study was carried out in order to determine the effect of the above mentioned leaf meals and the way they are used as supplements in broiler diets on performance, meat quality, and production cost per 1 kg body weight gain. Based on the research findings, this study will identify the most efficient way the 3 leaf meals will be supplemented in broiler diets, prioritizing the use of the 3 leaf meals.

Materials and Methods

Experimental design and diets

The leaf meals of *cassava* (*Manihot esculenta* Crantz*)* variety KM 94, here after named shortly as *cassava, Leucaena gleucoscephala,* here after named shortly as *leucaena* and *stylosanthes guianensis* CIAT 184 grass, here after named shortly as *stylosanthes* were used for this trial.

Chickens used in the experiment were the broiler Luong Phuong breed. This is the breed that can be reared in different systems, from free range to intensive. This breed is a slow growing type, but gives a better flavor and a tasty meat.

The experiment was conducted at the University of Agriculture and Forestry's Farm. The collected samples were analyzed at the Institute of Life Sciences, Thai Nguyen University, Vietnam.

Experimental birds were cared for and treated in compliance with Vietnamese Regulations for experimental animals.

The study employed 630 broiler chickens from 14 – 70 days of age, allocated into 7 treatment groups; each group consisted of 90 birds divided into 9 subgroups with 10 birds in each subgroup which was used as 9 times repetition. The experimental groups were named as follows: Control group (CG), 1A, 2A, 3A and 1B, 2B, 3B. The A groups were those in which leaf meals were added into basal diet with the adjustment of ME and CP levels in accordance to the bird's nutrient requirement (Addition or the 1st method). The B groups were those in which leaf meals were replaced in the basal diet without adjustment of ME and CP levels (Replacement or the 2nd method).

In the control group, birds were fed with a basal diet in which its ME and CP contents complied with colored feather broiler's nutrient recommendations, which is 12.56 Mj ME and 20% CP per kg of feed for birds from 14 – 42 days of age and 12.77 Mj ME and 19% CP for birds from 43 – 70 days of age.

Diets of A experimental groups (1A, 2A, 3A) were formulated by the 1st method of inclusion, in which 2% and 4% *cassava* leaf meal (1A), *leucaena* leaf meal (2A) and *stylosanthes* grass meal (3A) were made to meet the bird's nutrient requirements for both periods.

Diets of B experimental groups (1B, 2B, 3B) were formulated by the 2nd method, in which 2% and 4% basal diet were replaced by cassava leaf meal (1B), *leucaena* leaf meal (2B) and *stylosanthes* grass meal (3B), respectively, without adjustment of ME and CP content to comply with the standard recommendations.

Experimental diets were formulated with the following ingredients: yellow maize, fish meal, soybean meal, leaf meals and some other feed additives. The nutrient composition of the experimental diets for both periods, 14 – 42 days of age and 43 – 70 days of age, were presented in Table 1a and 1b.

Housing and care

All experimental animals were housed in open houses with a litter floor. The bird density was 10 birds/m^2 (period 14 – 42 days of age) and 5 birds/m^2 (period of 43 – 70 days of age). The care program for the birds including vaccination and light was carried out in accordance with the Vietnamese Standard for the colored feather broiler. Feed and water were offered adlibitum.

Parameters and monitoring procedures

The bird's performance parameters included: Live body weight (BW), daily weight gain (DWG), feed intake (FI), feed conversion ratio (FCR), metabolic energy (ME) and crude protein (CP) for each kg live weight gain (LWG) and these were recorded. Mean data obtained from each experimental group was calculated from the mean of 9 subgroups (n = 9).

Bird dissection: Bird dissection was performed by using the method reported by Bui Huu Doan et al. (2011). Six birds, 3 males and 3 females, from each experimental group were dissected (n = 6). The mean body weight (BW) of these birds was similar to the mean BW of the whole groups. The monitoring parameters included: dressing percentage, thighs, breast, liver and abdominal fat weight.

The production index (PI) and Economical number (EN) were calculated after Tran Thanh Van et al., 2015.

Table 1a
Nutrient composition of diets (period of 14 -42nd day)

Items	CG	1A	1B	1C	2A	2B	2C
ME, Mj/kg	12.57	12.57	12.57	12.57	12.48	12.50	12.45
CP, %	20.02	20.00	20.00	20.01	20.03	20.12	19.94
EE, %	3.70	4.10	4.00	4.20	3.80	3.70	3.70
CF, %	2.99	3.17	3.05	3.50	3.19	3.08	3.50
Lysine, %	1.16	1.17	1.15	1.16	1.17	1.16	1.15
Methionine %	0.43	0.43	0.43	0.43	0.43	0.43	0.43
Calcium, %	1.01	1.02	1.02	1.03	1.00	1.01	1.01
P.av., %	0.46	0.47	0.46	0.46	0.46	0.46	0.46
Carotenoids, mg/kg Feed	9.16	18.84	19.59	13.40	18.89	19.59	13.53

Table 1b
Nutrient composition of diets (period of 43 -70th day)

Items	CG	1A	1B	1C	2A	2B	2C
ME, Mj/kg	12.78	12.77	12.78	12.78	12.60	12.64	12.55
CP, %	19.02	19.02	19.00	19.00	19.08	19.25	18.89
EE, %	4.70	5.60	5.30	5.70	4.80	4.70	4.60
CF, %	3.10	3.51	3.23	4.12	3.54	3.28	4.12
Lysine, %	1.08	1.10	1.07	1.08	1.10	1.08	1.06
Methionine %	0.41	0.42	.041	0.41	0.41	0.41	0.40
Calcium, %	0.96	0.96	0.97	0.97	0.93	0.94	0.95
P.av., %	0.45	0.46	0.45	0.45	0.45	0.45	0.45
Carotenoids, mg/kg Feed	8.96	28.30	28.81	17.45	28.45	28.85	17.73

The feed nutrient composition and meat chemical composition were analyzed after A.O.A.C 1990. Carotenoids content in feed and bird liver was analyzed by High Pressure Liquid Chromatography (HPLC). Data was obtained from the mean of 5 times analysis for each parameter (n = 5).

The water lost from chicken meat (drip loses) after storage and processing was monitored after Tran Thanh Van et al, 2015 (n = 5).

The skin color darkness was measured by using Roche color fan (Roche, 1988).

Data analysis

Collected data was analyzed with excel 2007 and ANOVA statistical analysis was performed by using IRRISTAT 5.0 and SPSS 16.0.

Results and Discussions

The livability and growth rate of experimental birds

The livability and growth rate of experimental birds were presented in Table 2.

Table 2
Survival rate, body weight, live weight gain of experimental chickens

Indexes	Unit	CG	1A CLM	2A LLM	3A SLM	1B CLM	2B LLM	3B SLM	SEM	P
Survival rate	%	96.7	96.7	97.8	97.8	97.8	98.9	96.7		
BW at 1th day	g	42	42	42	42	42	42	42		
BW at 14th day	g	194	194	194	194	194	194	194	-	-
BW at 42nd day	g	1132[a]	1200[d]	1186[bd]	1173[bc]	1168[bc]	1152[ac]	1144[a]	7,352	0.0001
BW at 70th day	g	1978[a]	2125[b]	2095[cb]	2071[cd]	2080[c]	2043[d]	2003[a]	12,75	0.0001
DWG14-42nd day	g	33.5[a]	35.9[b]	35.4[bc]	35.0[c]	34.8[cd]	34.2[d]	33.9[ad]	0.237	0.0001
DWG43-70th day	g	30.2[a]	33.0[b]	32.5[c]	32.1[cd]	32.6[bc]	31.8[d]	30.7[a]	0.197	0.0001
DWG14-70nd day	g	31.8[a]	34.5[b]	33.9[bc]	33.5[cd]	33.7[c]	33.0[d]	32.3[a]	0.215	0.0001

Note: BW: body weight; DWG: Daily weight gain

The results presented in Table 2 showed that the livability rate of all 7 experimental groups was acceptable (more than 96%). It was indicated that all 3 kinds of tested leaf meals and the method they were supplemented into broiler's diets did not affect the livability rate of broilers.

The mean BW of birds at 42 and 70 days of age in experimental groups was higher than that in birds from the control. Mean BW of experimental birds at 70 days of age (except birds in 3B group) was significantly different compared to the control ($p<0.001$). Thus, the inclusion of leaf meals had positive effect on growth of the tested broilers.

At 42 and 70 days of age, the mean BW of birds in A and B experimental groups followed the similar trend: For the A groups (1A was higher than 2A and 2A was higher than 3A), for the B groups (1B was higher than 2B and 2B was higher than 3B). These results indicated that there was a different effect of different leaf meals on broiler's growth, the effect of *cassava* leaf meal was higher than that of *leucaena* leaf meal, and *leucaena* leaf meal was higher than that of *stylosanthes* grass meal. Within the A treatment groups, there was only the significant different in BW of 1A compared to 3A ($p<0.001$). Whereas 2A was not different compared to 3A; within B treatment groups, the mean BW of 1B, 2B, and 3B was significantly different ($p<0.001$).

Mean BW of birds in the A treatment groups was always higher ($p<0.001$) than that of B treatment groups in both periods (1A>1B; 2A>2B; 3A>3B). This proved that the inclusion of leaf meals into diet following the 1st method (Addition) was better than the 2nd method (Replacement). However, mean BW of birds in 1B and 2B was not different compared to 3A. Thus, leaf meals with moderate ME content and higher CP content (such as *cassava* and *leucaena* leaf meals) can be used as the replacement, but with leaf meals with lower ME and CP and higher fiber contents (such as *stylosanthes* grass meal), a negative result would be seen.

The daily weight gain (DWG) per bird per day during periods of 14 – 42 and 43 – 70 days of age and the overall DWG followed the similar trend that was: *i)* ADG in birds fed with diets that contained leaf meals (except 3B group) was higher when compared to the Control ($p<0.001$). *ii)* The DWG of birds fed with diets that contained *cassava* leaf meal was higher than that of birds fed diet that contained *leucaena* leaf meal and the diet that contained *stylosanthes* grass meal. The overall DWG (14 – 70 days of age) of the A treatment groups: 1A > 3A, that of the B treatment groups: 1B > 2B > 3B with significant different ($p<0.001$). *iii)* The DWG of birds fed with diets formulated followed the 1st method was higher than that of birds fed diets formulated following the 2nd method, as it showed: The overall body weight gain (14 – 70 days of age) of birds in 1A > 1B, 2A > 2B and 3A > 3B with level of significant $p<0.001$.

Feed intake and feed utilization efficiency

The feed intake per bird per day and the feed conversion ratio (FCR), protein and ME conversion were presented in Table 3.

Birds fed with diets containing leaf meals tended to consume more feed than those in the control. This might be because the inclusion of leaf meals improved the palatability of feed. Birds in B treatment groups (1B, 2B, 3B) tended to consume more feed than those in A treatment groups (1A, 2A, 3A). This might be due to the ME content of diets with inclusion of leaf meal without the adjustment for ME content was lower than that of diets with the inclusion of leaf meals with ME adjustment. This caused birds to consume more feed to compensate for the ME shortage in the diet. However, the statistical analysis showed that the average daily feed intake of birds did not significantly differ among all groups ($p>0.05$).

The feed conversion ratio (FCR) of this trial showed as follows: During period 14 – 42 days of age, FCR of birds

Table 3
Feed intake, feed, protein and metabolic energy conversion of Experimental chickens

Indexes	Unit	CG	1A CLM	2A LLM	3A SGM	1B CLM	2B LLM	3B SGM	SEM	P
ADFI 14-42ndday	g	69.0^{a}	70.9^{a}	70.5^{a}	70.8^{a}	71.6^{a}	71.3^{a}	71.8^{a}	0.756	0.182
ADFI 43-70ndday	g	113.2^{a}	115.6^{a}	114.0^{a}	113.7^{a}	116.4^{a}	116.2^{a}	117.1^{a}	1.526	0.456
ADFI 14-70thday	g	91.1^{a}	93.3^{a}	92.3^{a}	92.3^{a}	94.0^{a}	93.8^{a}	94.4^{a}	1.134	0.383
FCR 14-42ndday	kg	2.06^{a}	1.97^{b}	1.99^{b}	2.02^{d}	2.06^{a}	2.08^{c}	2.12^{e}	0.008	0.0001
FCR 43-70thday	kg	3.75^{a}	3.50^{b}	3.51^{b}	3.54^{b}	3.57^{bc}	3.65^{c}	3.81^{d}	0.027	0.0001
FCR 14-70thday	kg	2.86^{a}	2.70^{b}	2.72^{b}	2.75^{bc}	2.79^{c}	2.84^{a}	2.92^{d}	0.017	0.0001
CP/LWG14-70thd.	g/kg	558^{d}	519^{a}	527^{a}	533^{ab}	542^{bc}	555^{cd}	564^{d}	11.224	0.0000
ME/LWG 14-70thd.	Mj/kg	36.33^{a}	34.31^{b}	34.50^{b}	34.50^{b}	35.07^{c}	35.70^{d}	36.57^{a}	0.130	0.0000

Note: ADFI: Average day of feed intake, LWG: Live weight gain, CP: Crude protein in A treatment groups (1A, 2A, 3A) was significantly lower than that compared to the Control (p<0.001). Whereas, that of B treatment groups (1B, 2B, 3B) was similar or higher than that of the Control. This can be explained that: the ME content of diets in B treatment groups was lower and fiber content was higher compared to that of the Control and during early age, chickens won't be able to consume more feed to compensate to this shortage and their fiber digestion capacity was still low.

During period 43 – 70 days of age, birds were fed with diets that contained leaf meals (except birds in 3B group), and had better FCR compared to those in the Control (p<0.001). This can be explained as follows: during this period, birds had grown up with more a mature digestive tract, thus, they had better digestion of fiber, and they were capable of consuming more feed to compensate for the shortage of nutrient content in the ingested feed. In addition, pigment content in leaf meals might contribute to the feed utilization efficiency, which resulted in better performance in birds fed with diets contained leaf meals.

Overall, FCR of A treatment groups (1A, 2A, 3A) and 1B group was significantly different compared to the Control (p<0.001), but it was not for those in other groups compared to the Control (p>0.05).

FCR in groups fed with diets containing *cassava* leaf meal tended to be better compared to those fed with diets containing *leucaena* leaf meal and this was also better compared to those fed with diets containing *stylosanthes* grass meal in both A and B treatment groups. However, overall, from 14 to 70 days of age, performance of birds in A treatment groups was not different (p>0.05). For those in B treatment groups, only 1B was significantly different compared to 3B (p<0.001).

Protein and ME conversion ratio for each kg LWG was also found to be a similar trend which has been shown in FCR.

Meat production of birds

In order to assess the effect of different leaf meals on meat production of tested broilers, 6 birds (3 males, and 3 females) in each group were dissected. The dissected birds had an average BW similar to that of all birds in the experiment. This was done to compare the ratio between dressing percentage among treatment groups and the proportion of meat produced compared to carcass. The results were presented in Table 4.

Results in Table 4 revealed that, the dressing percentage, liver/carcass, abdominal fat/carcass of birds in 7 treatment groups was not significantly different. This indicated that the addition or replacement of leaf meals did not affect these above mention parameters in broiler meat production.

The percentage of breast meat and thigh meat compared to carcass weight were different among the treatment groups. These parameters were significantly higher in the experimental groups compared to the Control (p<0.001). This can be explained because birds fed with diets containing leaf meals were heavier and had more developed breast and thigh muscle compared to those fed with a diet without inclusion of leaf meals (the Control).

These parameters of birds in A treatment groups were not significantly different, whereas within B treatment groups, the 1B, 2B groups, were significantly higher than as compared to 3B (p<0.001). The reason for this finding might be that birds in 3B group were fed with diets containing lower ME and CP contents compared to those in 1B and 2B, which led to poorer growth and development of breast and thigh muscles.

Birds were fed diets where there was both the addition or replacement of leaf meals. The birds where there was the replacement of the basal diet by leaf meals (except 3B group) tended to have thigh + breast percentage/carcass weight higher than when the birds were fed with addition of leaf meals into diet. This might be because CP content in this diet was higher, whereas ME content was lower which made the ME/CP ratio lower compared to diets prepared for A treatment groups. These factors might have a positive effect on the development of muscle (thigh, breast muscles) of birds.

Chemical composition of broiler meat

The dry matter (DM), crude protein (CP), and lipid (ether extract - EE) contents of breast, thigh meat, and the percent-

Table 4
Meat production of Experimental chickens

Indexes	Unit	CG	1A CLM	2A LLM	3A SLM	1B CLM	2B LLM	3B SLM	SEM	P
CW	g	1508	1620	1601	1575	1589	1565	1518		
CW/BW	%	76.2	76.4	76.6	76.0	76.6	76.7	75.8	0.35	0.464
Breast & thigh/CW	%	38.51[a]	39.42[bc]	39.44[bc]	39.40[cd]	39.59[cd]	39.78[d]	38.91[e]	0.12	0.0001
Liver/CW	%	2.50	2.38	2.36	2.44	2.45	2.44	2.48	0.06	0.722
Ab. Fat /CW	%	1.61	1.64	1.72	1.39	1.36	1.41	1.34	0.10	0.089

Note: CW: Carcass weight, Ab.: abdominal age of carotenoid content in the liver were analyzed. The skin yellow color darkness was measured by using Roche color fan and these results were presented in Table 5.

Results presented in Table 5 showed that the DM, CP and EE contents in breast and thigh meat were not significantly different among the treatments (p>0.05). The percentage of carotenoid content in the liver was different among the treatments. These differences were found to be significantly higher than compared to the Control (p<0.001). This was because the carotenoid content in the diets containing leaf meal was higher compared to the basal diet (Control) from 8.5 – 19.9mg/kg feed.

The retention of carotenoids in the liver of birds fed with diets containing *cassava* leaf meal and diets containing *leucaena* leaf meal was higher than those fed with diets containing *stylosanthes* grass meal. This was because the carotenoid content of diets containing *cassava* leaf meal and diets containing *leucaena* leaf meal was higher compared to diets containing *stylosanthes* grass meal by 10 – 11 mg/kg feed.

The percentage of carotenoids retention in the liver in birds fed with leaf meal addition in the diets tended to be higher than those fed with diets where the basal diet was replaced by leaf meals. This was because vegetable oil was added to adjust ME content level, and lipids in this addition had stimulated the absorption of carotenoids.

The absorbed carotenoids were partly retained in chicken skin and the yellow color darkness of skin was dependent on the carotenoid content in the ingested feed. Thus, birds fed with diets containing leaf meals resulted in darker yellow skin color compared to those in the Control and birds fed with diets containing CLM and LLM had darker yellow skin color than those fed with diets containing SGM. Either the addition of leaf meals or replacement of basal diet by leaf meal resulted in skin color darkness appearance.

Drip loss of meat after storage and processing

Data of meat water loss (drip loss) after being stored at 0^0C in 24 hrs and meat water loss after steaming for 30 minutes were presented in Table 6.

Data in Table 6 showed that, the drip loss after storage of breast meat among treatments ranged from 2.39 – 2.63% and that of the thigh meat ranged from 1.99 – 2.12%. There was no significant difference among treatments (p>0.05). The drip loss after storage was not remarkably notable and is because low temperature during storage (freezing) had prevented the drip loss of meat.

The drip loss of meat after processing ranged from 19.13 – 20.48% for breast meat and 17.88 – 18.97% for

Table 5
Chemical composition of experimental chicken's meat

Indice	Unit	CG	1A CLM	2A LLM	3A SLM	1B CLM	2B LLM	3B SLM	SEM	P
Breast muscle										
Dry mater	%	25.59	25.64	25.60	25.81	25.67	25.66	25.84	0.237	0.983
Protein	%	23.19	23.30	23.27	23.40	23.41	23.33	23.52	0.220	0.958
EE	%	1.01	0.98	1.00	1.01	0.96	0.96	0.98	0.034	0.946
b) Thigh muscle										
Dry mater	%	23.71	23.64	23.69	23.68	23,70	23,77	23.74	0.229	1.000
Protein	%	20.13	20.04	20.13	20.18	20.15	20.25	20.42	0.135	0.577
EE	%	2.20	2,20	2.18	2.13	2.18	2.16	1.96	0.079	0.325
c) Liver Carotenoids	mg/kg	1.02^{a}	1.93^{bc}	1.95^{c}	1.75^{d}	1.76^{bd}	1.78^{bcd}	1.68^{d}	0.059	0.001
d) Skin fan score	point	2.8^{a}	4.8^{c}	4.9^{c}	3.8^{b}	4.6^{c}	4.6^{c}	3.5^{b}	0.463	0.001

Table 6
Drip loses of breast and thigh meats after storage and processed

Indice	Unit	CG	1A CLM	2A LLM	3A SLM	1B CLM	2B LLM	3B SLM	SEM	P
After storage										
Breast muscle	%	2.49	2.45	2.41	2.63	2.41	2.39	2.58	0.071	0.143
Thigh muscle	%	2.12	2.11	2.05	2.05	2.06	1.99	2.11	0.053	0.621
after processing										
Breast muscle	%	20.17^{ac}	20.23^{ac}	20.29^{ac}	20.48^{c}	19.76^{ab}	19.32^{b}	19.13^{b}	0.244	0.002
Thigh muscle	%	18.97^{a}	$18{,}63^{abd}$	18.52^{ad}	18.34^{cd}	17.88^{c}	18.01^{c}	18.17^{cd}	0.178	0.002

thigh meat. The drip loss of meat in birds from 1A, 2A, 3A groups and in birds from 1B, 2B, 3B was not significantly different (p>0.05), however, birds fed with diets with addition of leaf meals had meat drip loss significantly (p<0.01) higher than those fed with leaf meal replacement diets (1A > 1B, 2A > 2B and 3A > 3B). This finding had relationship with the ME/CP ratio in the diet. The ME/CP ratio of diets prepared for birds in B treatment groups was lower than that for the birds in the A groups, which resulted in the CP content of meat in birds from B groups being higher than that in birds from A treatment groups, whereas this content of EE in B treatment groups tended to be lower than those in A treatment groups. The drip loss from protein was lower than that from fat, thus the drip loss of meat from birds in A treatment groups was higher than compared to those in B treatment groups.

The production and economic indexes

Data of the production index (PI), economic number (EN) and the cost of production per each kg LWG were presented in Table 7.

Data in Table 7 showed that, the PI and EN of birds fed with diets containing leaf meals (except 3B group) were significantly higher than compared to the Control (p<0.05).

The PI between the A treatment groups was not significantly different (p>0.05), whereas between the B treatment groups, the 1B and 2B group index was significantly higher than compared to 3B (p<0.05). The way leaf meals were included in the diet also had a significant effect on this parameter, in which when leaf meals were added into diet, this index was higher than when basal diet was replaced partly by leaf meals (p<0.05).

The economic number (EN) among the treatment groups (except 3B group) was higher than compared to the Control with the level of significant different (p<0.05). There was no significant difference found among the A treatment groups, whereas, this index between B treatment groups found significant different between 1B, 2B compared to 3B (p<0.05). The way leaf meals were included into basal diets did not significantly affect this index between 1A compared to 2A and 1B compared to 2B, but that of 3A was higher significantly compared to 3B (p<0.05).

The production cost for every kg of LWG in birds fed with diets containing leaf meals (except for the 3B) was significantly reduced from 2.4 – 5.9% compared to those in the Control (p<0.05). Between the A treatment groups there was no significant difference for this parameter, and between the B treatment groups, there was a significant difference between 1B and 2B compared to 3B (p<0.05). Either addition or replacement of leaf meals into diets had no significant effect on cost of production between 1A and 1B groups, but there was significant difference between 2A compared to 2B and between 3A compared to 3B.

Table 7
Production and Economic indexes

Indexes	CG	1A CLM	2A LLM	3A SLM	1B CLM	2B LLM	3B SLM	SEM	P
PI (63-70thday)	107.7^{a}	124.8^{c}	122.7^{c}	119.3^{bc}	120.0^{bc}	116.9^{b}	109.0^{a}	1.420	0.024
EN (63-70thday)	3.6^{a}	4.5^{b}	4.4^{b}	4.2^{b}	4.5^{b}	4.2^{b}	3.8^{a}	0.054	0.022
Feed Cost/kg LWG (%)	100^{d}	94.1^{a}	94.4^{a}	96.8^{bc}	95.8^{ab}	97.6^{bc}	100.6^{d}	0.522	0.043

Conclusions

Birds fed with diets containing leaf meals demonstrated better performance, improved meat quality and lowered cost of production.

The effect of different kind of leaf meals used in this study on bird's performance was ranked from the highest effect to the lowest as follows: CLM, LLM, SGM.

The method leaf meals were included into diet with the addition of leaf meals resulted in better bird's performance than when leaf meals were replaced in the diets. However, for the leaf meals which have moderate ME content, and higher CP content (such as CLM, LLM) can be either added or replaced into diets without any different effect on bird's performance. Leaf meals having lower ME content and moderate CP content (such as SGM), are not recommended as replacement in the diet.

For the production of leaf meals as a supplement ingredient in poultry feed industry, the priority of production for CLM and LLM was highly recommended. When considering leaf meals to be included into the diet, the addition of all 3 leaf meals (CLM, LLM, and GLM) was recommended, however, CLM and LLM can be also be used as replacer in poultry diets.

References

Aquis, R., T. Watanabe, S. Satoh, V. Kiron, H. Imaizumi, T. Yamazaki and K. Kawano, 2001. Supplementation of paprika as a carotenoid source in soft-dry pellets for broodstock yellowtail. *Aquaculture Research*, **32** (1): 263-272.

Doan, B.H., N. T. Mai, N.T.Son, N. H. Dat, 2011. The Indexes are Used in Poultry Research. *Agricultural Publishing House, Ha Noi*, pp. 119.

Hien, T. Q. and T. Q. Trung, 2016. Study on green matter and leaf meal production performance of cassava KM94 cultivated in Thai Nguyen province. *Journal of Animal Husbandry Sciences and Technology*. Viet Nam, 214: 52-56.

Hien, T. Q., N. D. Hoan, T. T. Hoan and T. Q. Trung, 2016. Relation between carotenoids content in egg yolk and hatching egg quality according to the time laying hens fed diet containing leaf meal. *Bulgarian Journal of Agricultural Science,* **22** (suppl. 1): 92-98.

Hien, T. Q., N. D. Hung, N. T. Lien and N. T. Inh, 2008. Study on Using *Leucaena gleucocephala* in Breeding, *Thai Nguyen University Publishing House*, 198 pp.

Hoan, T. T., 2012. Research on planting cassava for leaf harvest and using cassava leaf meal for Luong Phuong broiler chicken and parent laying hens, PhD thesis, *Thai Nguyen University*, Viet Nam.

Hoan, T. T., T. Q. Hien and T. Q. Trung, 2017. Study on green matter and leaf meal production performance of *Leucaena gleucocephala* cultivated in Thai Nguyen province. In: Proceedings of National Congress on Animal and Veterinary Sciences, Can Tho, Viet Nam, March, 11–12, 2017, pp. 290-296.

Ilyasov, Y. and P. Golovin, 2003. The effect of Natu Rose on growth, Survival and physiological Tate of two – year – old marketable sturgeons, Online file, *Cyanotech Corporation*.

Latscha, T., 1990. Carotenoids in Animal Nutrition, *F. Hoffmann La Roche,* Basel, Switzerland.

Lignell, A. and J. Inboor, 2000. Agent for Increasing the Production of/in Breeding and Production Mammals, USA. Patent 6054491.

Liufa, W., L. Xufang and Z.Cheng , 1997. Carotenoids from Alocasia leaf meal as xanthophylls sources for broiler pigmentation, *Trop. Sci.*, 37: 116-122.

Marusich,W. L. and J. C. Bauernfeind, 1981. Oxycarotenoids in poultry pigmentation. In: J. C Bauernfeind (ed.), Carotenoids as Colorants and Vitamin A Precursors. *Academic Press*, New York, pp. 319-462.

Ngoc, H. T. B, 2012. Research cultivation, processing, storage and use *Stylosanthes guianensis* CIAT 184 grass for Luong Phuong broiler and parent laying hens, PhD thesis, *Thai Nguyen University*, Viet Nam.

Roche, 1988. Vitamin and Fine Chemicals, Egg Yolk Pigmentation with Carophyll. 3rd ed., *Hoffmann-La Roche Ltd.*, Basel, Switzerland, pp. 1218.

Sirri, F., N. Iaffaldano, G. Minelli, A. Meluzzi, M. P. Rosat and A. Franchini, 2007. Comparative pigmentation efficiency of high dietary levels of apoetilester and marigold extract on quality traits of whole liquid egg of two strains of laying hens. *J. Appl. Poultry Res*, 16: 429-437.

Van, T. T., N. D Hoan and N. T. T. My, 2015. Text Book Poultry Husbandry, *Agricultural Publishing House*, 360 pp.

Watanabe, T. and R. Aquis, 2003. Broodstock nutrition research on marine finfish in Japan. *Aquaculture*, **227** (1-4): 75-88.

Williams, W. D., 1992. Origin and impact of color on consumer preference for food. *Poultry Science*, 71: 744-746.

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