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Effects of Different Ingredient Ratios in Diets on Growth and Carcass Quality of Local H'mong Broiler at 5-14 Age Week

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***Abstract*— A raising trial on one hundred twenty of local H'mong broilers at 5-14 age-week was carried out in order to evaluate effects of different ingredient ratios of diets on growth rate and carcass quality. The experiment was conducted including two periods (5-9 and 10-14 age week) and designed in a randomly completed design with five treatments and four each replicate of six broilers. Five diets of both two periods were formulated with the same metabolisable energy, crude protein, and lysine, in which the control diet only contained maize and soybean meal, and the others were supplied to replace a part of maize and soybean meal by rice bran (RB), broken rice (BR), and fish meal (FM). The birds were weighed each week; water and feed were given *ad libitum*; feed consumption was recorded each day throughout 2 periods; and birds were slaughed at 14 age-week.**

The results showed that birds receiving the diet containing (4.7% FM, 28.91% BR, and 4.22%RB for first phase; 3.14% FM, 32.3% BR, and 4.24%RB for second phase) consumed the most feed and gained fastest ($P<0.01$), but feed/gain ratio was not different ($P>0.05$) in both two periods. The chemical composition of H'mong chicken meat; carcass, breast, and thigh yield were not significantly different ($P>0.05$), in contrast, there were significantly different ($P<0.05$) in pH_{15} and the water loss after storing and cooking.

***Keywords*— H'mong broiler, metabolisable energy, lysine, ingredient ratio, carcass quality.**

I. Introduction

Local H'mong chickens have black skin, bone, and meat [4] and their meat contains high lysine and methionine making it good taste when eating [6].

As well as other variety chickens, the growth and development of H'mong birds depend on several factors, but metabolizable energy (ME) and protein of ingredient play a very important role. Soybean meal (SBM) and maize are used extensively as traditional ME and protein sources in dietary formulations for broilers. However, because of the increasing price of two both, many developing countries as well as Vietnam are faced not only with the problem inadequate feed resources providing for poultry, but also with the import of the high price feedstuffs. [8] showed that feed cost constitutes up to 80% of the variable costs in the production poultry.

Therefore, when the traditional feed cost increases, which results in the feed cost of poultry production climbing up 80%. In an effort to limit the lack of feed source associated with the imported feed price and increased requirement, the replacement of local ingredients has been concentrated. Fish meal (FM) is of good protein quality and rice bran (RB) and broken rice (BR) are available source energy for poultry. Moreover, available data on the energy value and amino acid (AA) digestibility of these feedstuffs for poultry have often been obtained in studies, but still no much with H'mong chickens in Mekong delta. Evaluation of alternative ingredients as substitutes for conventional feed on growth performance and carcass quality of local H'mong broibers is, therefore, required.

II. Materials And Methods

A. Location

The experiment was carried out in the household's farm in Travinh province, Vietnam and lasted for 10 weeks from April to June 2012.

B. Experimental design

One-hundred-twenty-4-age-week H'mong broilers were allocated into five treatments with 4 replicates (cages) of six birds (mean body weight of each replicate: 213 ± 1.3g) of each (3 males and 3 females). The experiment was designed in a randomly completed design with two periods: a growing phase 5-9 age-week and a finishing phase10-14 age-week. All birds were raised in bamboo floor cages, continuous lighting, natural ventilation, and 27 - 30◦C of ambient temperature. The diets were offered *ad libitum* and water was freely available throughout the ten-week-trial.

C. Feed analyses and calculations

The feedstuffs were analyzed for dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE), ash, Ca, and P by standard Weende methods (AOAC, 1990) in College of Agriculture and Applied Biology - Can Tho University.

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ME of soybean oil (SBO) was calculated by formulation of [9] $ME = 8.227 - 10.318^{[-1,168(\text{ratio unsaturated fatty acid : saturated fatty acid})]}$. The AA content was analyzed in Laboratory department of Animal nutrition - Institute of Agricultural Science for Southern Viet Nam. ME content of the ingredients was calculated from chemical analysis data using the equation of [10].

Maize: ME (kcal/kg of feed) = 19.0 +37.5CP + 78.5EE + 11.2CF + 37.7 NFE

SBM: ME (kcal/kg of feed) = -2.7 + 35.1CP + 96.7EE - 4.2CF + 28.6NFE

Broken rice: ME (kcal/kg of feed) = -6.5 + 37.9CP + 86.1EE - 9.48CF + 38.3NFE

Bran rice: ME (kcal/kg of feed) = -77 + 49.6CP + 71.8EE - 20.4CF + 28.1NFE

Fish meal: ME (kcal/kg of feed) = -348 + 44.7CP + 72.3EE + 4.17CF + 37NFE

Five diets, including a maize-soybean meal control and four experimental diets containing maize, SBM, BR, RB, SBO, and FM were formulated using equivalent ME and AA.

Birds were weighed to evaluate the weight gain and feed was weighed to calculate their feed consumption every week. Weight, feed intake, and feed conversion ratio (g feed/g weight gain) were measured for each phase.

D. Evaluating carcass and meat quality

H'mong broilers were slaughtered at 14 age-week with eight birds (four males and four females) for each treatment to evaluate carcass performance, pH_{15}, store loss, cooking loss, and chemical composition of meat.

Table 1
Ingredient composition of experimental diets

Ingredients	**Treatments**				
	Ctrl	**lF-lBR**	**hF-lBR**	**lF-hBR**	**hF-hBR**
Growing phase					
Maize (kg)	66.51	55.03	56.22	37.50	40.69
Broken rice (kg)	-	10.96	11.38	28.91	24.80
Rice bran (kg)	-	4.20	4.05	4.22	6.45
Soybean meal (kg)	29.20	22.44	19.96	22.09	19.76
Fish meal (kg)	-	4.60	6.41	4.70	6.22
Soybean oil (kg)	1.32	0.47	-	0.13	-
L-Lys-HCl (kg)	0.22	0.20	0.19	0.18	0.17
L-Met (kg)	0.20	0.17	0.16	0.18	0.17
L-Thr (kg)	0.07	-	-	-	-
DCP (kg)	1.65	1.10	0.90	1.36	1.01
Shell (kg)	0.10	0.10	-	-	-
Premix (kg)	0.25	0.25	0.25	0.25	0.25
Salt (kg)	0.48	0.48	0.48	0.48	0.48
Total (kg)	100	100	100	100	100
Finishing phase					
Maize (kg)	74.12	60.68	61.40	40.74	41.62
Broken rice (kg)	-	11.25	11.50	32.30	32.10
Rice bran (kg)	-	5.00	5.00	4.24	4.61
Soybean meal (kg)	20.90	15.77	14.10	15.82	13.92
Fish meal (kg)	-	3.30	4.50	3.14	4.49
Soybean oil (kg)	2.00	1.50	1.20	1.07	0.80
L-Lys-HCl (kg)	0.23	0.21	0.20	0.20	0.19
L-Met (kg)	0.17	0.16	0.15	0.16	0.15
L-Thr (kg)	0.06	-	-	-	-
DCP (kg)	1.79	1.40	1.20	1.60	1.39
Premix (kg)	0.25	0.25	0.25	0.25	0.25
Salt (kg)	0.48	0.48	0.48	0.48	0.48
Total (kg)	100	100	100	100	100

Ctrl: no fishmeal, broken rice, and bran rice; lF-lBR: low fishmeal and low broken rice; hF-lBR: high fishmeal and low broken rice; lF-hBR: low fishmeal and high broken rice; hF-hBR: high fishmeal and high broken rice; DCP: dicalcium phosphate.

Chemical composition analysis of H'mong meat

Eight breast samples in each treatment were measured DM, CP, fat, and ash by the Weende method [1].

pH_{15} measurement of H'mong meat

Eight broilers from each treatment were used to measure pH decline at 15 minutes using a pH meter by inserting the pH probe into solution containing 10g chopped-fine of breast meat and cooled boil-water by method of [20].

Store loss of H'mong meat

Breast samples (n = 8) were weighed, then contained in nylon. These samples were patted dry by blotting-paper and reweighed after frozen at 2^oC for 24 hours by method of [7].

Cooking loss H'mong meat

Breast samples (n = 8) were cooked in boiling water in 10 minutes after weighed. Then, cooked breast were cooled to air temperature and reweighed by method of [7].

E. Statistical analysis

Analysis of variance was calculated with the General Linear Model procedure (GLM) in [13].

III. RESULTS AND DISCUSSIONS

A. Nutritional composition of feedstuffs and diets

The chemical composition of feedstuffs from the laboratory analyses and calculations are presented in Table 2. Maize and BR contain high ME as compared to ME of RB, SBM and FH, indicating that the major nutritional content in maize and BR is carbohydrate as energy source. Also, EE content of RB is high, but CF content is high too, that resulted in ME of RB is low.

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Table 2
Chemical composition of feedstuffs

Ingredients	DM (%)	Chemical composition of feedstuffs, % of feed							
		CP	ME*	EE	CF	Lys	Met+cys	Ca	P
Maize	86.90	7.59	3,236	3.31	4.84	0.21	0.28	0.63	0.29
Broken rice	87.41	7.98	3,345	1.82	1.23	0.28	0.26	0.50	0.13
Rice bran	88.00	12.64	2,667	14.72	8.34	0.63	0.23	0.37	1.58
SBM	87.50	42.74	2,512	2.35	7.35	2.23	1.14	0.63	0.67
Fish meal	90.77	53.91	2,891	8.48	0.73	3.17	2.08	5.30	2.76
SBO	-	-	8,227	-	-	-	-	-	-
DCP	-	-	-	-	-	-	-	24.11	19.29
Shell	-	-	-	-	-	-	-	29.22	-

**: kcal/kg*

The nutritional values of the experimental diets from calculations are showed in Table 3. ME, CP, AA, and ash value of five trial diets are equivalent in both two periods. The concentration of essential AAs is the same ideal ratio of [2]. Although almost scavenge poultry need low ME and AA requirement, nutritional requirement of H'mong chickens of this trial are calculated as same as broiler requirement of [14] due to purpose obtaining high performance.

Table 3
Nutritional value of the diets

Ingredients	Treatments				
	Ctrl	lF-lBR	hF-lBR	lF-hBR	hF-hBR
Growing phase					
ME (kcal/kg feed)	2,994	2,994	2,994	2,994	2,994
CP (%)	18.02	18.02	18.02	18.02	18.02
EE (%)	4.21	4.03	3.68	3.44	3.74
CF (%)	5.37	4.80	4.67	4.15	4.27
Lys (%)	1.00	1.00	1.00	1.00	1.00
Met+cys (%)	0.72	0.72	0.72	0.72	0.72
Ca (%)	1.03	1.09	1.10	1.10	1.10
P (%)	0.71	0.73	0.73	0.75	0.75
Finishing phase					
ME (kcal/kg feed)	3,088	3,088	3,088	3,088	3,088
CP (%)	15.02	15.02	15.02	15.02	15.02
EE (%)	4.94	5.10	4.89	4.27	4.15
CF (%)	5.12	4.65	4.57	3.88	3.82
Lys (%)	0.85	0.85	0.85	0.85	0.85
Met+cys (%)	0.61	0.61	0.61	0.61	0.61
Ca (%)	1.03	1.06	1.07	1.08	1.09
P (%)	0.70	0.74	0.73	0.73	0.72

B. Weight gain, feed intake, and feed conversion ratio

Table 4 presents effects of different levels of BR, RB, and FM on the total weight gain (TWG), the total feed intake (TFI) and the feed conversion ratio (FCR) of two both periods. TWG and TFI of broiler H'mong chickens in growing and finishing phases are significantly different (P<0.05). These results are the highest in hF-hBR, which indicates that TFI and TWG are positive correlation.

When increasing BR in growing phase diet from 10.96% to 28.91% and maintain FM ratio at 4.6% and 4.7% in the diet, TFI of broiler grows up significantly. Similarly, in finishing period when increasing BR in diet at 32.3% and FM 3.14%, broiler's TFI raises.

However, although TWG and TFI of H'mong chickens are different, the difference of feed conversion ratio (FCR) of chickens of two phases is non-significant (P>0.05). Because the trial diets are formulated from many different ingredients, but nutritional values of diets satisfy nutrition requirement of chicken for weight gain such as CP, ME, AA, and ash.

Final bodyweight of broiler chicken of this study is as same as bodyweight of chicken at 12 age-week in research of [19]. However, FCR of this is higher than result of [19] due to birds taking natural feed sources from a combination system, both confined and scavenge.

Table 4
Weight gain, feed intake and feed conversion ratio of H'mong broilers

Items	Treatments						
	Ctrl	lF-lBR	hF-lBR	lF-hBR	hF-hBR	SEM	P
Growing phase							
Initial	213	213	214	213	213	0.73	0.99
Final	697^b	700^b	701^b	725^a	695^b	3.05	0.001
TWG (g)	484^b	487^b	487^b	512^a	482^b	2.67	0.001
TFI (g)	$1,483^b$	$1,489^b$	$1,491^b$	$1,579^a$	$1,466^b$	9.48	0.001
FCR	3.06	3.06	3.06	3.09	3.04	0.01	0.20
Finishing phase							
Initial	697	696	697	696	697	2.57	0.99
Final	$1,237^{ab}$	$1,238^{ab}$	$1,233^b$	$1,253^a$	$1,229^b$	5.13	0.046
TWG (g)	540^{ab}	542^{ab}	536^b	557^a	532^b	3.99	0.001
TFI (g)	$2,202^{ab}$	$2,202^{ab}$	$2,183^b$	$2,260^a$	$2,164^b$	13.26	0.001
FCR	4.08	4.06	4.08	4.06	4.07	0.01	0.18

TWG: total weight gain; TFI: total feed intake; FCR: feed conversion ratio; ^{a,b} Means within each row with the same superscript letter are not significantly different (P > 0.05).

C. Carcass performance and meat quality

Table 5 indicates that no differences (P>0.05) exist among five treatments with regard to carcass yield and breast and thigh yield. This result points out that different levels of ingredients in diets do not affect carcass performance of H'mong birds.

However, there are significantly differences (P<0.05) about pH_{15} and store and cooking loss of breast meat from broilers fed diets that differ in different ratios of maize, BR, RB, SBM, and FM. pH_{15} of breast meat is the lowest in diets containing (6.41% and 6.22% FM in growing phase and 4.5% and 4.49% FM in finishing phase) with pH_{15} obtaining 5.81 and 5.84, respectively. After harvesting, postmortem glycolysis is activated and accumulation of lactic acid in the muscle is increased, which results in a decline in pH.

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This pH value is one of the important parameters for quality profiling of meat [5]. Because pH is an indicator of meat quality, high levels of FM in diets can affect the chicken meat quality. However, only breast meat with either a very rapid pH decline (pH < 6.0 within 15 to 30 min postmortem) or a ultimate pH of less than 5.7 is considered poor-quality meat because of its low water-holding capacity and paleness [3]. Results of this study are similar to those of previous research in which the breast meat pH was reported to be between 5.8 and 6.0 at 24 h postmortem [3]; [16], and pH_{15} of breast meat of H'mong chicken at 14 age-week to be 6.06 [17].

Table 5
Carcass performance and H'mong meat quality

Items	Treatments						
	Ctrl	**lF-lBR**	**hF-lBR**	**lF-hBR**	**hF-hBR**	**SEM**	**P**
BW (g)	1,193	1,210	1,200	1,209	1,216	46.38	0.99
CW (g)	793	793	783	791	801	34.25	0.99
CY (%)	66.38	65.47	65.13	65.48	65.86	0.42	0.29
BrW (g)	114	112	110	110	112	3.93	0.93
BY/carcass (%)	14.44	14.10	14.08	13.93	14.08	0.16	0.26
TW (g)	168	163	162	164	164	7.89	0.98
TY/carcass (%)	21.19	20.41	20.63	20.77	20.42	0.21	0.08
pH_{15}	5.99^{b}	6.09^{a}	5.81^{c}	6.05^{ab}	5.84^{c}	0.02	0.001
SL 24 h (%)	2.32^{ab}	2.06^{b}	2.28^{ab}	2.25^{ab}	2.57^{a}	0.09	0.01
CL (%)	21.55^{ab}	21.02^{b}	21.13^{b}	21.40^{ab}	22.27^{a}	0.24	0.01

BW: body weight; CW: carcass weight; CY: carcass yield; BrW: breast weight; BY: breast yield; TW: thigh weight; TY: thigh yield; SL: storing loss; CL: cooking loss; ^{a,b} Means within each row with the same superscript letter are not significantly different (P > 0.05).

Ingredient sources are not usually responsible for quality changes in either carcasses or meat, but circumstances of use may lead to secondary changes [12]. Moreover, storage and cooking loss are indicators of water-holding capacity, which are important attributes of meat because of its relationship with other attributes that can critically affect meat quality [11]. Therefore, water in broiler breast meat from broilers is lost after storing and cooking, which may be affected apart by the fishmeal level of diet. Storing loss of this study is suitable with the result of [17], but slightly higher than the storing loss result of crossbred chicken meat (Ho and Luong Phuong) at 12 hours [18]. In contrast, ratio of cooking loss after cooking is lower than the result 24.54% reported by [17].

D. Chemical composition of breast meat

Chemical composition of H'mong breast is indicated in Table 6. The data of DM, CP, fat, and ash of breast meat of diets differs non-significantly (P>0.05). Obviously, different dietary feed sources in diets do not alter chemical compositions of breast meat. This result is in agreement with previous studies [15].

The CP content of this breast meat is higher than CP content of thigh meat analyzed at 14 weeks of age [17], but as same as the result of [6].

Table 6
Chemical composition of breast meat at 14 age-week

Items	Treatments						
	Ctrl	**lF-lBR**	**hF-lBR**	**lF-hBR**	**hF-hBR**	**SEM**	**P**
DM (%)	24,63	24,46	25,07	24,28	24,56	0,31	0,49
CP (%)	23,40	23,05	22,85	23,14	22,83	0,30	0,65
Fat (%)	1,15	1,17	1,22	1,17	1,20	0,05	0,82
Ash (%)	1,11	1,07	0,98	1,05	1,08	0,08	0,80

IV. CONCLUSION

Altering ingredient ratios in diets affects bodyweight gain of H'mong broiler, but feed efficiency of chicken do not change. However, formulating diets containing high fishmeal levels can slightly reduce H'mong chicken meat quality in pH and storing and cooking loss items.

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