ORIGINAL ARTICLE

Effects of dietary protein and energy on growth performance and carcass characteristics of Betong chicken at early growth stage

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Abstract

Nguyen, T.V. and Bunchasak, C.
Effects of dietary protein and energy on growth performance and carcass characteristics of Betong chicken at early growth stage
Songklanakarin J. Sci. Technol., 2005, 27(6) : 1171-1178

Four hundred and sixteen one-day-old Betong chicks were used to determine the effect of dietary protein and energy levels on growth performance and carcass characteristics. The chicks were randomly allotted into 4x2 factorials in a completely randomized design. Four levels of dietary proteins (23, 21, 19, and 17% CP) and two levels of energy (3,200 and 3,000 ME kcal/ kg) were offered *ad libitum* to the chicks from 0-42 days of age. There was no significant interaction effect between dietary protein and energy levels in the diets. At 0-21 days of age, the Betong chicks fed with the lowest protein diet (17% CP) showed reduced live weight and weight gain, but not at 22-42 days of age. Dietary protein levels higher than 17% CP did not show any significant effect on growth performance, although increasing dietary protein levels positively improved growth performance and feed utilization. However, the Betong chicks fed with lower protein diet converted protein to body weight gain more efficientcy than those fed higher protein diets (P<0.01). Dietary energy contents of 3,000 and 3,200 ME kcal/kg did not alter the growth performance of the Betong chicks, while higher energy (3,200 ME kcal/kg) increased abdominal fat yield from 0.39% to 0.57% (P<0.05). In contrast,

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Received, 12 September 2004 Accepted, 25 February 2005

dietary protein levels linearly reduced abdominal fat in these animals. In conclusion, protein levels in the diets at 19% CP and energy contents between 3,000-3,200 ME kcal/kg were met or over requirements for growth performance and carcass quality.

Key words : Betong chickens, protein, energy, growth performance, carcass

บทคัดย่อ

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ผลของระดับโปรตีนและพลังงานในอาหารต่อสมรรถภาพการเจริญเติบโต และลักษณะซากของไก่เบตงระยะแรก

ว. สงขลานครินทร์ วทท. 2548 27(6) : 1171-1178

การศึกษาผลของระดับโปรตีนและพลังงานในอาหารต่อสมรรถภาพการเจริญเติบโตและคุณภาพซากของไก่เบตง โดยใช้ไก่อายุ 1 วันจำนวน 416 ตัว วางแผนการทดลองแบบ 4x2 factorials in CRD โดยมี 2 ปัจจัยคือ 1) โปรตีน 4 ระดับ (23, 21, 19 และ 17%) และ 2) พลังงานใช้ประโยชน์ (ME) 2 ระดับคือ 3,200 และ 3,000 กิโลแคลอรีต่อกิโลกรัม ให้อาหารแบบไม่จำกัด (*ad libitum*) ในช่วง 0-21 วัน พบว่าไก่ที่ได้รับอาหารโปรตีน 17% มีน้ำหนักตัวและน้ำหนักตัวที่เพิ่มต่ำกว่ากลุ่มที่ได้รับอาหารโปรตีนที่สูงกว่า (P<0.05) ส่วนในช่วง 22-42 วันนั้น การให้ระดับโปรตีนสูงกว่า 17% ไม่มีผลทำให้สมรรถภาพการเจริญเติบโตแตกต่างกันอย่างมีนัยสำคัญ แม้ว่าระดับโปรตีนที่เพิ่มขึ้นจะมีแนวโน้มช่วยปรับปรุงสมรรถภาพการเจริญเติบโตและประสิทธิภาพการใช้อาหาร อย่างไรก็ตาม ไก่ที่ได้รับอาหารโปรตีนต่ำมีประสิทธิภาพการเปลี่ยนโปรตีนเป็นน้ำหนักตัวดีกว่ากลุ่มที่ได้รับโปรตีนสูง (P<0.01) ส่วนระดับพลังงานใช้ประโยชน์ 3,000 และ 3,200 กิโลแคลอรี/กก. ไม่มีผลต่อสมรรถภาพการเจริญเติบโต ขณะที่ระดับพลังงานสูง ทำให้การสะสมไขมันช่องท้องเพิ่มขึ้นจาก 0.39% เป็น 0.57% ของน้ำหนักตัว (P<0.05) แต่ในทางกลับกัน ระดับโปรตีนที่เพิ่มขึ้นมีแนวโน้มทำให้ไขมันช่องท้องลดลง การศึกษาครั้งนี้ชี้ให้เห็นว่าการใช้อาหารโปรตีนระดับ 19% ที่มีพลังงานใช้ประโยชน์ระหว่าง 3,000-3,200 กิโลแคลอรี/กก. นั้น เพียงพอหรือมากเกินความต้องการเพื่อการเจริญเติบโตและปรับปรุงคุณภาพซากของไก่เบตง

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In addition to the increasing demand of poultry production, there is an interest in composition and quality of the poultry carcasses (Lesson and Summers, 2000; Carmen and Mountney, 1998; and Summers *et al.*, 1992). Subsequently, many attempts have been made to study nutrient requirements in order to improve both carcass composition and carcass quality.

In Thailand, there are many varieties of Thai native chicks. Among them, Betong chicken is popular in the Southern region due to very high meat quality, low carcass fat and high lean meat compared to other Thai native chicks (Nirat and Ratana, 1996). Recently, the Betong is increasing in demand from Thai people, especially in Bangkok. However, information of nutrient requirements of the Betong are limited, particularly protein and energy, since energy supplies the fuel to maintain the body temperature and the processes of organs while dietary protein is the most expensive composition in poultry diet (Rose, 1997). Therefore, in order to improve the Betong chick; there is a strong need to investigate the requirements of protein and energy levels for this variety.

Our previous study (unpublished data) had shown that the growth pattern of the Betong chicken could be divided into three periods: starter (0-42 days), grower (42-84 days) and finisher periods (unidentified). Moreover, the starter period seemed to be divided into substages (0-21 and 22-42 days of age). In general, it is accepted that young chicks are more sensitive to nutrients deficiency than the older chicks. Thus, the objective of this study was to investigate the protein and energy requirements of the Betong chicks in the starter period (0-42 days of age).

Materials and Methods

Animals and managements

Four hundred and sixteen one-day-old Betong chicks (33.46±0.06 g/chick) were individually weighed and randomly divided into eight treatment groups. According to the treatment groups, the chicks were arranged as 4x2 factorials in completely randomized design (four protein levels and two energy levels). Each treatment group consisted of 4 replicates of 13 chicks per experimental unit. The chicks were randomly allocated in wire cages (87x122x45 cm) and light was provided 24 hours daily at 0-21 days of age and then they were kept at natural lighting until 42 days of age. Temperature and management were maintained according to conventional rearing practice.

Experimental diets

Eight experimental diets were formulated to provide similar nutrients content according the broilerís nutrients requirement suggested by NRC (1994), except protein and energy levels (Table 1). These diets consisted of four dietary protein levels (23, 21, 19, and 17% CP) and two energy levels (3,200 and 3,000 ME kcal/kg). The experimental diets in mashed form were based on corn, soybean

Table 1. Feed ingredients and compositions of experimental diets

Ingredients	Treatment diets							
	1	2	3	4	5	6	7	8
	(%)							
Corn	58.07	51.94	63.91	57.20	65.45	60.42	65.70	66.23
Rice bran	—	—	—	—	3.60	5.50	8.44	5.76
Palm oil	1.00	5.61	0.19	5.00	—	3.70	—	2.83
Soybean meal (44% CP)	30.73	32.82	26.35	29.20	22.80	20.70	18.40	16.00
Fishmeal (55% CP)	8.80	8.00	7.80	6.50	6.00	8.00	4.85	7.21
Oystershell meal	0.64	0.70	0.75	0.81	0.95	0.81	1.11	0.90
Dicalcium phosphate, P 0.18	—	0.14	0.20	0.50	0.50	0.10	0.70	0.28
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Premix*	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Total	100.04	100.01	100.00	100.01	100.10	100.03	100.00	100.01
Compositions (calculated)								
CP	23.00	23.00	21.00	21.00	19.00	19.00	17.00	17.00
CP (analyzed)	23.17	23.55	20.85	21.36	19.37	19.35	17.55	18.15
ME	3,000	3,200	3,000	3,200	3,000	3,200	3,000	3,200
GE (analyzed)	3,615	3,856	3,629	3,872	3,622	3,864	3,597	3,853
Calcium	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Available P.	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45

*** Content per kg premix: Vitamin A 4,800,000 IU; Vitamin D3 960,000 IU; Vitamin E 3.20g; Vitamin K3 0.80g; Vitamin B1 0.4g; Vitamin B2 0.6g; Vitamin B6 1.2g; Vitamin B12 0.0047g; Pantothenic acid 3.8g; Niacin 6g; Folic acid 0.2g; Biotin 0.036g; Selenium 0.04g; Iron 24g; Manganese 24g; Zinc 16g; Copper 2.4g; and Iodine 0.14g.**

meal and fishmeal, while rice bran and palm oil were used to adjust the levels of protein and energy contents. Feed and water were provided *ad libitum* throughout the experiment.

Data record

Body weight and feed consumption were recorded weekly. At 42 days of age, one male and one female from each replicate that had body weight close to the replication mean were chosen to evaluate carcass quality. Before the evaluation, these chicks were banded and moved for an overnight without feed (approximately 12 h) while water was provided *ad libitum*. The carcass weight, abdominal fat pad, liver, gizzard, heart, breast meat, thigh, wing and legs were immediately excised, weighed, and recorded.

Statistical analysis

The data were analyzed by two-way analysis of variance using the general linear model (GLM) procedure described by Cody and Smith (1997). Data in percentage were tested for being normally distributed before analysis of variance. Significant treatment means were further analyzed by using Duncanís New Multiple Range Test. Correlation of input (% CP of diet) against body weight gain (g/b) of the experimental chicks was subjected to find the best-fit equation.

Results and Discussion

There was no significant (P>0.05) interaction effect between protein and energy levels on any parameters observed. Therefore, only main effect of protein levels and energy contents were considered to determine the requirements of dietary protein and the energy for growth performance and carcass characteristics of the Betong chicken.

Effects of dietary protein and energy on growth performance

The effects of protein and energy levels on growth performance and feed efficiency of the Betong chicks are shown in Table 2. During 0-21 days of age, the chicks fed with 17% CP had

Table 2. Effects of dietary protein and energy levels on growth performance and feed utilization of the Betong chick.

	0-21 days of age							22-42 days of age						
	Live weight	Weight gain	Feed intake	FCR	ME intake	CP intake	PCR[1]	Live weight	Weight gain	Feed intake	FCR	ME intake	CP intake	PCR[1]
CP (%)	---------- (g/ b) ----------			(feed:gain)	(kcal)	(g/ b)	(protein: gain)	---------- (g/ b) ----------			(feed:gain)	(kcal)	(g/ b) gain)	(protein:
23	154.87^{a}	121.50^{a}	306.96	2.53^{a}	951.23	70.60^{a}	0.58^{a}	434.70	279.83	834.55	3.04	2,587	191.95^{a}	0.69^{a}
21	152.35^{a}	119.02^{a}	302.36	2.55^{a}	937.62	63.49^{b}	0.54^{b}	433.93	281.58	797.83	2.84	2,471	167.54^{b}	0.59^{b}
19	149.40^{a}	115.79^{a}	299.84	2.59^{a}	931.35	56.97^{c}	0.49^{c}	420.19	270.79	816.24	3.03	2,529	155.09^{bc}	0.58^{b}
17	139.14^{b}	105.60^{b}	300.18	2.85^{b}	929.57	51.03^{d}	0.48^{c}	412.42	273.27	827.53	3.04	2,565	140.68^{c}	0.52^{c}
P-value	0.0033	0.0030	0.8291	0.0064	0.8418	0.0001	0.0001	0.4260	0.8783	0.7273	0.5074	0.7505	0.0001	0.0001
ME (kcal/kg)														
3,200	150.66	117.19	304.22	2.61	973.52^{a}	60.82	0.52	429.57	278.90	814.47	2.93	2,606	162.94	0.58
3,000	147.22	113.76	300.45	2.66	901.37^{b}	60.22	0.53	421.06	273.83	823.60	3.03	2,470	164.69	0.61
P-value	0.3350	0.2356	0.5389	0.4376	0.0007	0.6297	0.4919	0.4500	0.6459	0.7273	0.3868	0.1022	0.7518	0.3325
CP*ME														
P-value	0.2178	0.2074	0.6026	0.5471	0.6123	0.6437	0.4878	0.9708	0.8977	0.9075	0.7864	0.8942	0.9027	0.7927

[a-b-c-d] Means followed by different superscripts within a column of each parameter are significantly different.
[1] PCR = protein conversion ratio.

smaller weight gain and poorer feed per gain (FCR) than those that received higher protein levels (P< 0.05), while among those receiving dietary protein of 19, 21, and 23% CP did not show significant difference in growth performance. In addition, during 22-42 days of age, dietary protein and energy at any levels did not affect feed intake and growth performance of the chicks. However, at both periods, these nutrients levels tended to improve growth performance of the chicks (Figure 1 and 2).

Protein intake of the Betong was significantly increased as protein levels increased (P< 0.01). At both periods, the chicks fed lower dietary protein converted protein to body weight gain more efficientcy than chicks fed higher protein levels (P<0.01), (Table 2). Table 3 shows response of the Betong from 0-42 days of age to the experimental diets. At this overall period, dietary proteins affected protein intake and caused the improvement of reduced protein utilization (P<0.05). Two energy levels did affect to energy intake of the Betong (P<0.01). However, the other parameters were not affected by either dietary protein or energy contents.

Results of the present study generally agree with several investigators that increased dietary protein content resulted in improved growth performance (Jackson *et al*., 1982; Smith and Pesti, 1998; Temin *et al*., 2000) and the young chicks are more sensitive to dietary levels than the older chicks (Figures 1 and 2). In the present study, growth performance of the Betong chick was significantly reduced when 17% CP was provided at a very early stage of growth (0-21 days). This was also similar to the study of broiler chicks by Jackson *et al*. (1982) who found that a low protein diet below 18% CP reduced growth rate.

Energy contents in experimental diets did not significantly affect body weight and weight gain of the chicks. However, body weight and weight gain were slightly improved with higher level of energy. This result is in agreement with the observations of Leeson *et al*. (1996b) who found no significant effect of energy content in diet on body weight and weight gain of broiler chicks.

Surprisingly, the results of this study showed that dietary protein and energy had less effect on the growth performance. This phenomenon may be

Table 3. Effects of dietary protein and energy levels on feed utilization of the Betong chicken from 0-42 days of age.

	Live weight	Weight gain	Feed intake	FCR (feed:gain)	ME intake	CP intake	PCR[1]
CP (%)	------------------ (g/ b)	------------------		(g/ g)	(kcal/b)	(g/ b)	(g/ g)
23	434.70	401.33	1,141	2.85	3,539	262.55[a]	0.656[a]
21	433.93	400.61	1,100	2.75	3,496	231.04[b]	0.578[b]
19	420.19	386.58	1,116	2.89	3,459	212.05[c]	0.550[b]
17	412.42	378.87	1,127	2.98	3,409	191.71[d]	0.507[c]
P-value	0.4260	0.4154	0.6617	0.1588	0.6494	0.0001	0.0001
ME (kcal/kg)							
3,200	429.57	396.10	1,118	2.83	3,579a	223.76	0.565
3,000	421.06	387.60	1,124	2.91	3,372b	224.91	0.581
P-value	0.4500	0.4500	0.8247	0.2819	0.0099	0.8202	0.2472
CP * ME							
P-value	0.9708	0.9867	0.9097	0.7034	0.8968	0.9159	0.7027

[a-b-c-d] **Means followed by different superscripts within a column of each parameter are significantly different.**
[1] **PCR = protein conversion ratio.**

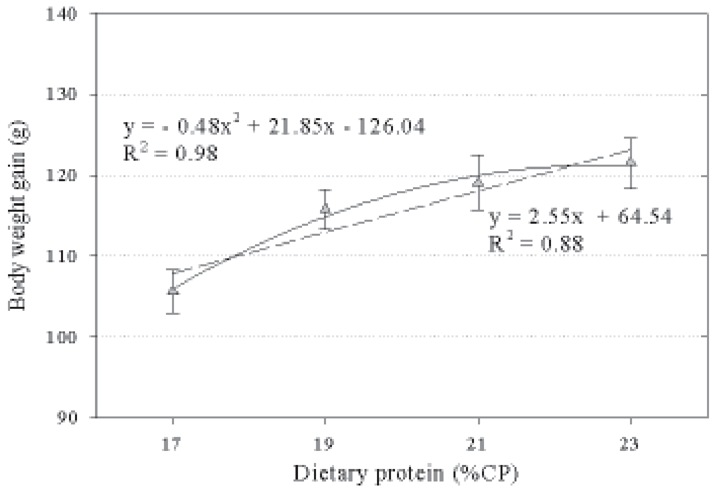

Figure 1. Means of Betong body weight gain affected by four levels of protein diet (% CP) from 0-21 days old. Vertical bars indicated ±SEM. The fitted models represent linear response (dashed line) and quadratic response (solid line).

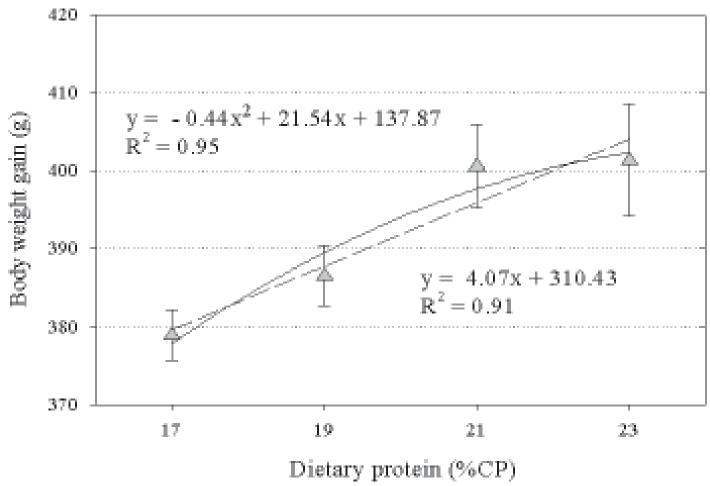

Figure 2. Means of Betong body weight gain affected by four levels of protein diet (% CP) from 22-42 days old. Vertical bars indicated ±SEM. The fitted models represent linear response (dashed line) and quadratic response (solid line).

caused by the varying levels of protein and energy did not affect in feed intake at this period. This is similar to the study of broiler chicks by Summers *et al*. (1992) who found no significant effect on feed intake of broilers when fed three levels of protein ranging from 16.5 to 23.5% protein. The effect of energy levels agree with NRC (1994), which reported that it is not always accurate to conclude that poultry adjust feed intake to achieve a minimum energy intake from diets containing different energy levels. On the other hand, it may be assumed that the energy contents between 3,000-3,200 ME kcal/kg were met or exceeded the requirement of the Betong chicks, so that subsequent varying energy levels did not affect to the growth performance.

Table 4. Effects of dietary protein and energy contents on carcass yields of the Betong chickens.

	Carcass weight[1]	Breast meat	Thigh	Wing Leg	Abdominal fat	Liver Heart Gizzard
CP (%)	(g)	----------------------- (% of carcass weight)				-----------------------
23	374.90	9.32	23.19	15.26	0.35	6.58
21	364.17	9.52	22.87	14.87	0.41	6.62
19	364.85	9.30	22.91	15.56	0.52	6.72
17	363.58	9.34	23.27	15.29	0.65	6.83
P-value	0.8788	0.8308	0.8446	0.2005	0.0743	0.7284
ME (kcal/kg)						
3,000	366.84	9.37	22.85	15.18	0.39a	6.66
3,200	366.91	9.36	23.27	15.31	0.57b	6.71
P-value	0.9948	0.9590	0.2817	0.5635	0.0331	0.7493
ME * CP						
P-value	0.4544	0.2483	0.3067	0.1600	0.6236	0.1058

[a-b] Means followed by different superscripts within a column are significantly different.
[1] Carcass weight = Weight of carcass after bleeding and removing feathers.

Effects of dietary protein and energy on carcass yield

Relative carcass yields of Betong chicks were calculated based on carcass weight. The analyses of variance for protein, energy and its interaction effect on carcass yields of the Betong chicks at 42 days old are presented in Table 4. There was no statistical interaction effect between protein and energy levels on carcass yields of the Betong chicks (expressed as percentage of carcass weight). Varying protein levels did not affect carcass yields of the Betong chicks. However, abdominal fat tended to decrease as dietary protein increased (P>0.05), while higher energy levels increased abdominal fat pads from 0.39% to 0.57% when energy was increased from 3,000 to 3,200 ME kcal/kg, (P<0.05). The other carcass components yields were not affected by varying levels of protein and energy in the diet.

Varying dietary protein levels did not affect carcass yield of the Betong chicks. However, abdominal fat tended to decrease as dietary protein levels increased. This result is in agreement with Leeson *et al*. (1996a) and Smith and Pesti (1998), who found that levels of protein in diet did not affect carcass yield and protein deposition. Similarly, Renden *et al*. (1992) found no significant effect of protein levels on carcass quality of broiler chicks. Leeson and Summers (2000) also found similar results that, except when very low protein diets are used, dietary protein levels have no effect on the quality of protein deposited in the carcass. In addition, Smith and Pesti (1998) showed that abdominal fat pad was negatively related to dietary protein levels. The significant effect of energy levels on abdominal fat is similar to the previous study of Seatton *et al*. (1978), who found an increasing carcass fat with elevation of energy levels.

Conclusion

There was no significant interaction effect between protein and energy levels on growth performance and carcass yields of the Betong chicks. During 0-21 days of age, dietary protein of 17% CP reduced growth performance and feed efficiency of the experimental birds; however, during 22-42 days old, the chicks response was similar among treatments except for protein intake and PCR. It is suggested that, at very early stage of rearing (0-21 days old), dietary protein should not be lower than 19% CP. However, during 22-42 days old, dietary protein can be reduced to save feed cost.

Dietary energy content of 3,000-3,200 ME kcal/kg did not show a statistical effect on the performance of the Betong chicks, but carcass fat yield was significantly increased as dietary energy increased. Consequently, energy content of 3,000 ME kcal/kg is sufficient for the Betong chicks in the early growth period.

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