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# Effects of Dietary Protein Levels on the Growth Performance and Carcass Characteristics of Nakorn Thai Black-boned Chickens

**Norakamol Laorodphan[1*], Punnares Rattanapradit[1], Khongdet Phasinam[1], Rangsun Charoensuk[2], Tossaporn Incharoen[2], Prasit Yimket[3], Chirawath Phatsara[4]**

[1]Faculty of Food and Agricultural Technology, Pibulsongkram Rajabhat University, Phitsanulok, Thailand.
[2]Faculty of Agriculture Natural Resources and Environment, Naresuan University, Phitsanulok, Thailand.
[3]Tak Livestock Research and Breeding Center, Tak, Thailand.
[4]Department of Animal and Aquatic Science, Faculty of Agriculture, Chiang Mai University, Chiang Mai, Thailand.
*Corresponding author's e-mail: norakamol.l@psru.ac.th

***Abstract:* - Introduction:** Customers are increasingly demanding to consume black bone chicken. They believe that black bone chicken is good for health because it is rich in amino acids of Carnosine. But the production of black bone chicken is still not as developed as it should be. There is still a lack of information on the nutritional requirements that will help the production of black bone chicken more efficiently.

**Purpose:** To evaluate growth performance and carcass characteristics of Nakorn Thai black bone chicken fed by different levels of protein.

**Materials and Method:** Ninety-six 14 days old Nakorn Thai black-bone chickens of an average initial body weight 32.87+0.77 g were used. Chickens were divided into 4 groups as the follow regressive protein levels; group 1 fed 20, 19, 18 and 17%CP (T1), group 2 fed 19, 18, 17 and 16%CP (T2), group 3 fed 18, 17, 16 and 15%CP (T3) and group 4 fed 17, 16, 15 and 14%CP (T4) during 0-2, 2-6, 6-10 and 10-16 weeks of age, respectively.

**Results:** ADG and FCR had no significance among treatments during 0-2, 2-6 and 10-16 weeks of age ($p>0.05$), while body weight of T1 tended to be higher than T4 during 6-10 weeks of age ($p=0.07$). Moreover, weight gain and ADG of T1 were clearly higher than T4 ($p<0.05$). Furthermore, the carcass percentage of T1 had a tendency to be higher than T4 ($p=0.11$). Breast percentage of T1 and T2 were significantly higher than T4 ($p<0.05$) and thigh percentage of T1 was significantly higher than T3 and T4 ($p<0.05$).

**Conclusion:** dietary crude protein contents of 20, 19, 18 and 17% during 0-2, 2-6, 6-10 and 10-16 weeks of age had higher growth performance and carcass characteristics compared with other crude protein levels.

***Keywords:*** *Protein levels, Black-boned chicken, Growth performance, Carcass characteristics*

## I. INTRODUCTION

Nakorn Thai black-bone regional chickens were prioritized to Thai native chicken under Department of Livestock Development on 4th January 2013. Black-boned chickens are widely reared in the highlands. They are easy to raise, fast-growing, and fast-propagated compared with other local chickens. The black-boned chickens have unique identity because of its black flesh. The consumers consider it a healthy food [1] which based on the longtime belief of the benefits of Black-boned chickens has double the amount of carnosine than White Plymouth Rock chicken [2]. Carnosine has a rich dietary source of antioxidant [3]. Carnosine has some anti-glycosylation [4]. Carnosine includes physiological buffer [5]. Carnosine

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strengthens the body immune, heals wound, and resists to infection [6]. Due to these benefits of its black flesh, black-boned chickens are more widespread consumed as a result of health conscious trends on today's food consumption [7] Nakorn Thai District, Phitsanulok Province is a highland where there are various ethnic groups, especially Hmong. They raise black-boned chickens for offering ceremonies and consoling rituals. The black-boned chickens which were used to perform the rituals have golden or red feather wings [8]. Phitsanulok Livestock Research and Breeding Center has started to collect and categorize the black-boned chickens which have these characteristics of Males: red-yellow feather, red-brow head, brown-yellow neck, brown-black single comb crest, black feet, black edge of the eyelids, yellow ear cover, black mouth. Females: pale-yellow with some black feather, yellow head, brown-yellow neck, small black straight crest, black feet, black edge of the eyelids, yellow ear cover, black mouth, black tongue to specify the uniqueness for black-bone regional chickens in Phitsanulok.

Even though, there were some research about the growth performance of the chickens fed with the different level of protein [9]–[11], there was no information about feeding chickens at different ages in black-boned chickens. The researcher needed to study about poultry nutrition especially the level of protein as an appropriate guide to raising Nakorn Thai black-boned chickens. Therefore, the research purpose was to study the growth performance and characteristics of Nakorn Thai black-bone chicken feeding difference protein levels.

## II. MATERIALSAND METHODS

The experiment was conducted in Phitsanulok Livestock Research and Breeding Center. Ninety-six 14 days old Nakorn Thai black-boned chickens (48 males and 48 females) were randomly allotted to receive one of four dietary treatments each with 3 replicates of 8 chickens. The first group (T1) was fed by the level of protein at the percentage of 20, 19, 18 and 17. The second group (T2) was fed by the level of protein at the percentage of 19, 18, 17 and 16. The third group (T3) was fed by the level of protein at the percentage of 18, 17, 16 and 15. The fourth group (T4) was fed by the level of protein at the percentage of 17, 16, 15 and 14. All groups were fed in week 0-2, 2-6, 6-10, and 10-16 respectively. Every group was fed at the level of 2,900 Kcal/kg. Chicken was offered *ad libitum* feed and water. The initial weight, feed intake, weight gain during a feeding time of 16 weeks was recorded to measure the growth potential rate. Then all the chickens were slaughtered. After chilling for 24 h, all carcass was dressed by Thai (boneless) cutting style [12] to evaluate the carcass characteristics. The pH value was measured at 45 min and 24 h postmortem in the breast muscle at a 2-cm depth. The chicken skins and meat (breasts) color were evaluated at 48 h postmortem with Chroma Meter (model CR-300, Minolta Camera Co. Ltd., Osaka, Japan) to record lightness (L*), redness (a*) and yellowness (b*). The samples weighing about 50 g was obtained from the breast meat was used to assess drip loss. Drip loss was measured by keeping samples suspended in covered plastic bag on sieved plastic racks for 24 h at 2–4°C and calculated as percentage of weight loss during storage. Chilled carcass percentage was calculated as chilled carcass weight / slaughter weight x 100, chicken segmented was calculated from chilled carcass weight.

### Statistical Analysis Used

Data on growth performance and characteristics of chicken carcass were analyzed with one-way analysis of variance (ANOVA) using the SPSS Version 19.0. Differences among means were determined by Duncan's New Multiple Range Test.

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## III. RESULTS

The experiment revealed that the initial weight at week 2, 6, and 16 showed no significance in the level of protein. However, black-boned chickens in T1 tended to have more weight than T4 ($p=0.07$) at week 10. Weight gain and ADG at week 6–10 in T1 and T2 were higher than T4 ($p<0.05$). But the results showed no significance in FCR in each experimental group ($p>0.05$) (Table 1). The results showed no significance in FCR.

**Table 1 Growth performance of Nakhon Thai (NT) black bone chicken fed different protein levels**

| | T1 | T2 | T3 | T4 | SEM | p-value |
|---|---|---|---|---|---|---|
| Body weight | | | | | | |
| Initial weight | 33.00 | 33.08 | 32.63 | 32.75 | 0.22 | 0.91 |
| 2 weeks | 67.21 | 61.92 | 63.54 | 58.34 | 1.83 | 0.43 |
| 6 weeks | 273.38 | 226.09 | 195.25 | 173.00 | 17.05 | 0.18 |
| 10 weeks | 707.50$^{a}$ | 627.54$^{ab}$ | 570.75$^{ab}$ | 442.75$^{b}$ | 38.91 | 0.07 |
| 16 weeks | 1519.82 | 1366.25 | 1358.81 | 1273.56 | 41.33 | 0.20 |
| Weight gain | | | | | | |
| 0-2 weeks | 34.21 | 28.84 | 30.92 | 25.59 | 1.74 | 0.40 |
| 2-6 weeks | 206.17 | 164.17 | 131.71 | 114.67 | 15.64 | 0.17 |
| 6-10 weeks | 434.13$^{a}$ | 401.46$^{a}$ | 375.50$^{ab}$ | 269.75$^{b}$ | 23.30 | 0.04 |
| 10-16 weeks | 812.32 | 738.71 | 788.06 | 830.81 | 29.73 | 0.77 |
| ADG | | | | | | |
| 0-2 weeks | 2.85 | 2.40 | 2.58 | 2.13 | 0.15 | 0.40 |
| 2-6 weeks | 7.36 | 5.86 | 4.70 | 4.10 | 0.56 | 0.17 |
| 6-10 weeks | 15.50$^{a}$ | 14.34$^{a}$ | 13.41$^{ab}$ | 9.63$^{b}$ | 0.83 | 0.04 |
| 10-16 weeks | 19.34 | 17.59 | 18.76 | 19.78 | 0.71 | 0.77 |
| FCR | | | | | | |
| 0-2 weeks | 5.74 | 7.23 | 6.53 | 8.42 | 0.58 | 0.46 |
| 2-6 weeks | 3.28 | 3.72 | 5.23 | 6.52 | 0.60 | 0.22 |
| 6-10 weeks | 3.46 | 3.53 | 3.89 | 6.01 | 0.45 | 0.12 |
| 10-16 weeks | 2.85 | 2.40 | 2.58 | 2.13 | 0.12 | 0.40 |

$^{a,b,c}$ Mean within the same row with different superscripts differ significantly ($p<0.05$) by treatments effect.
T1 = NT black bone chicken fed 20, 19, 18, 17 %CP; T2 = NT black bone chicken fed 19, 18, 17, 16 %CP; T3 = NT black bone chicken fed 18, 17, 16, 15 %CP; T4 = NT black bone chicken fed 17, 16, 15, 14 %CP during 0-2, 2-6, 6-10 and 10-16 weeks of age

Moreover, it found that the carcass percentage had no significance in level of protein ($p>0.05$) and the carcass percentage of male and female showed similar ($p>0.05$). The percentage of breast, tenderloin, drumstick and wings revealed no significance among experimental groups, but the percentage of the chicken thigh in T1 was higher than T3 and T4 ($p<0.05$). The quality of the meat mostly had no significance ($p>0.05$) as showed in Table 2 and Table 3. The brightness of the black-boned chickens breast fed by the different level of protein showed no statistical significance ($p>0.05$) at general brightness level of 34.06-38.11 in every group.

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## IV. DISCUSSION

The black-boned chickens fed by high level of protein gained weight at week 10 and showed growth rate at week 6-10 which is higher than the chicken fed by low level of protein due to fast growth rate during 6-10 weeks. This result was identical to the previous study [13]–[15] which showed that the highest growth curve at week 8-12 so the chickens were well responded to high protein feeding as high crude protein has more adequate amino acids required for growth than the low crude protein [16], [17]. The results showed no significance in FCR as a result of each group of chickens ate at the same amount of food. Furthermore, every experimental group obtained the total energy equally so it didn't affect in feeding amount [18] because chickens will eat until they obtain proper energy then stop. The carcass percentage fed by different level of protein showed no significance [19] while the black-boned chickens thigh fed by high protein was higher than the ones fed by low protein due to the level of amino acids [17]. The meat color of black-boned chickens in every group had darker color than usual (L* less than 46) [20]. The brightness of black-boned chicken meat was lower in some research [19], [21]. The darker color meat in black-boned chickens was affected by Melanocortin 1-receptor (MC1R) controlled the pigmentation Eumelanin (black/brown) in chicken muscle [22].

It can be concluded from this study that black-boned chickens at week 0–6, Nakorn Thai black-boned chickens should be fed by the level of protein at 17–20% which showed no significance. However, the level of protein should be no less than 17% at week 6–10 to maintain the appropriate growth rate. If needed the large carcasses, it's better to raise male black-boned chickens.

**Table 2 Carcass characteristics of Nakhon Thai (NT) black bone chicken fed different protein levels.**

| Parameters | T1 | T2 | T3 | T4 | Sex | | SEM | | | Significance | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Male | Female | Treatment | Sex | Treatment ×Sex | Treatment | Sex | Treatment ×Sex* |
| Slaughter weight, kg | 1,359.82 | 1,422.32 | 1,381.61 | 1,322.32 | 1,536.79$^{x}$ | 1,206.25$^{y}$ | 41.78 | 29.53 | 59.06 | 0.40 | <0.01 | 0.60 |
| Chilled carcass percentage, % | 66.88$^{a}$ | 65.59$^{ab}$ | 65.14$^{b}$ | 65.72$^{ab}$ | 65.87 | 65.80 | 0.51 | 0.36 | 0.73 | 0.11 | 0.89 | <0.01 |
| *Retail cuts* | | | | | | | | | | | | |
| Breast, % | 16.27$^{a}$ | 16.00$^{a}$ | 15.74$^{ab}$ | 15.00$^{b}$ | 15.12$^{y}$ | 16.38$^{x}$ | 0.33 | 0.23 | 0.47 | 0.05 | <0.01 | 0.49 |
| Fillet, % | 5.27 | 5.22 | 5.05 | 4.94 | 4.96$^{y}$ | 5.28$^{x}$ | 0.12 | 0.08 | 0.17 | 0.20 | 0.01 | 0.19 |
| Thigh, % | 18.37$^{a}$ | 17.34$^{ab}$ | 16.41$^{bc}$ | 15.94$^{b}$ | 17.19 | 16.84 | 0.39 | 0.28 | 0.55 | <0.01 | 0.38 | 0.01 |
| Drumstick, % | 17.46 | 17.42 | 17.18 | 16.84 | 18.19$^{x}$ | 16.26$^{y}$ | 0.25 | 0.18 | 0.35 | 0.27 | <0.01 | 0.08 |
| Wing, % | 14.50 | 14.34 | 14.52 | 15.02 | 14.84 | 14.35 | 0.29 | 0.20 | 0.41 | 0.38 | 0.09 | 0.46 |
| Skeletal, % | 26.77$^{c}$ | 27.37$^{bc}$ | 28.77$^{ab}$ | 29.77$^{a}$ | 28.08 | 28.26 | 0.60 | 0.42 | 0.84 | <0.01 | 0.77 | 0.25 |

* Interaction between treatment and sex
$^{a,b,c}$ Mean within the same row with different superscripts differ significantly ($p<0.05$) by treatments effect.
$^{x,y}$ Mean within the same row with different superscripts differ significantly ($p<0.05$) by sex effect.
NS = Non Significance ($p>0.05$)
T1 = NT black bone chicken fed 20, 19, 18, 17 %CP; T2 = NT black bone chicken fed 19, 18, 17, 16 %CP; T3 = NT black bone chicken fed 18, 17, 16, 15 %CP; T4 = NT black bone chicken fed 17, 16, 15, 14 %CP during 0-2, 2-6, 6-10 and 10-16 weeks of age

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**Table 3 pH, drip loss and the Hunter Lab value of skin and breast color of Nakhon Thai (NT) black bone chicken fed different protein levels**

| Parameters | T1 | T2 | T3 | T4 | Sex | | SEM | | | Significance | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Male | Female | Treatment | Sex | Treatment×Sex | Treatment | Sex | Treatment×Sex* |
| *pH* | | | | | | | | | | | | |
| $pH_{45}$ | 6.81$^{b}$ | 6.81$^{b}$ | 6.95$^{a}$ | 7.03$^{a}$ | 6.83$^{y}$ | 6.96$^{x}$ | 0.03 | 0.02 | 0.05 | <0.01 | <0.01 | 0.10 |
| $pH_{24}$ | 6.86 | 6.86 | 6.91 | 6.87 | 6.91$^{x}$ | 6.83$^{y}$ | 0.02 | 0.01 | 0.03 | 0.25 | <0.01 | 0.10 |
| Drip loss, % | 9.29 | 13.42 | 9.28 | 9.83 | 10.69 | 10.23 | 2.37 | 1.68 | 3.35 | 0.55 | 0.85 | 0.76 |
| *Hunter L a b value* | | | | | | | | | | | | |
| *Skin color* | | | | | | | | | | | | |
| *L** | 36.90 | 34.06 | 38.26 | 34.36 | 37.95 | 33.84 | 2.63 | 1.86 | 3.72 | 0.62 | 0.13 | 0.51 |
| *a** | 0.38 | 0.24 | 0.46 | 0.32 | 0.44 | 0.26 | 0.13 | 0.09 | 0.19 | 0.69 | 0.17 | <0.01 |
| *b** | -0.50$^{ab}$ | -1.15$^{b}$ | 1.71$^{a}$ | -0.09$^{ab}$ | -0.19 | -0.18 | 0.74 | 0.53 | 1.05 | 0.05 | 0.62 | 0.47 |
| *Breast color* | | | | | | | | | | | | |
| *L** | 31.78$_{b}$ | 33.96$^{a}_{b}$ | 35.88$_{a}$ | 34.25$^{a}_{b}$ | 35.34$_{x}$ | 32.60$^{y}$ | 1.07 | 0.76 | 1.51 | 0.07 | 0.01 | 0.51 |
| *a** | 0.22 | 0.13 | 0.37 | 0.17 | 0.06$^{y}$ | 0.39$^{x}$ | 0.14 | 0.10 | 0.20 | 0.67 | 0.02 | 0.59 |
| *b** | -1.41 | -1.89 | 0.92 | -1.91 | -1.57 | -1.50 | 0.36 | 0.25 | 0.50 | 0.17 | 0.84 | 0.95 |

* Interaction between treatment and sex
[a,b,c] Mean within the same row with different superscripts differ significantly ($p<0.05$) by treatments effect.
[x,y] Mean within the same row with different superscripts differ significantly ($p<0.05$) by sex effect.
NS = Non Significance ($p>0.05$)
T1 = NT black bone chicken fed 20, 19, 18, 17 %CP; T2 = NT black bone chicken fed 19, 18, 17, 16 %CP; T3 = NT black bone chicken fed 18, 17, 16, 15 %CP; T4 = NT black bone chicken fed 17, 16, 15, 14 %CP during 0-2, 2-6, 6-10 and 10-16 weeks of age

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