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# Effect of Protein level and Dietary Energy on Production, Intestinal Morphology and Carcass Yield of Meat Duck during Starter Phase of 14 days

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**Abstract:** Seven hundred and fifty six, one day old male ducks were used to study the effect of dietary protein and energy on production, intestinal morphology and carcass yield of meat ducks during starter phase (1-14 days of age). The experimental diets were divided into 9 groups and each consisting 6 replications with 14 ducks. A completely randomized 3×3 factorial study design with 2 main effects was used. The main effects were as follows: (1) dietary energy; 2,700, 2,950 and 3,200 kcal $kg^{-1}$ and (2) dietary protein levels; 18, 20 and 22%. (The standard recommendations for commercial duck starter diets are protein level 22% and energy level 2,920 kcal $kg^{-1}$). At the end of feeding trial, the results revealed that there was a statistically significant interaction ($p<0.01$) between the levels of energy and protein in the diets offered with respect to all of the performance traits during the 14 day test period. The combination 18% protein and 2,700 kcal $kg^{-1}$ resulted in the highest average daily gain, final weight and food intake and the most efficient food conversion ratio. There were no significant changes in villus height or crypt depth in the duodenum, jejunem or ileum in response to variation in dietary energy content. The only statistically significant change in these parameters in response to variation of dietary protein was in the case of the villus height of the jejunum which was highest at the lowest dietary protein level. Abdominal fat was significantly lower at the lowest energy level than for both of the higher levels. It is concluded that the combination of dietary energy concentration of 2,700 kcal $kg^{-1}$ and protein content of 18% resulted in maximal growth during the starter phase of duck rearing.

**Key words:** Energy, protein, feed, production, intestine, intestinal morphology, carcass yield, duck

## INTRODUCTION

Foods derived from animal products are an important source of nutrients in the human diet and will play an increasing role in human nutrition in the future (Givens, 2005). There has been a considerable increase in the production of animal product types for human consumption during recent decades. The growth of poultry meat production and in particular duck meat, has been very especially rapid in recent years to the extent that poultry now occupies second place in terms of volume in the world just following pork. Poultry has become one of the cheapest types of food derived from animal worldwide (Niu *et al*., 2009).

Dietary protein and energy affect the economic efficiency of poultry farm. The levels of protein and balance of amino acids in the diets are all important nutritional variables (Al-Saffar and Rose, 2002). There has been demonstrated that increasing dietary energy and protein levels in the diet of broilers result in an improvement in feed conversion rate by reducing feed intake (Dozier *et al*., 2007; Nukreaw *et al*., 2011). On the other hand, it has been recommended a reduction in dietary protein and supplementation essential amino acids, especially in low diet is becoming a strategy in feed formulation to reduce the nitrogen excretion and feed cost (Bunchasak and Silapasorn, 2005; Hsu *et al*., 1998). Therefore, the level of dietary energy and protein may have important effects on the performance and carcass traits also in the case of ducks. The objective of this study was conducted to investigate the effects of dietary energy and protein content on growth performance, intestinal morphology and carcass yield of ducks at the age of 1-14 days (starter diet).

## MATERIALS AND METHODS

The study was conducted at Animal Research Farm, Department of Animal Science, Faculty of Agriculture, Kasetsart University, Thailand in April to June, 2012. The

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experimental animals were kept, maintained and treated in adherence to accepted standards for the human treatment of animals.

**Birds and diet treatments:** In this study, seven hundred and fifty six, one day old male Cherry Valley ducks were used. Ducks were randomly assigned to 9 dietary treatments, replicated with 6 groups and each group contained 14 ducks. The experimental design was 3×3 factorial in a completely randomized design. The energy and protein in diets were used as the main experimental factor and each factor consisted of 3 levels as following: 2700, 2950 and 3200 kcal $kg^{-1}$ of diet and 18, 20 and 22% protein, respectively. The diets were prepared in mash form and the composition of diets is presented in Table 1 and 2. Food and water were provided *ad libitum* for 14 days during the experimental period. The ducks received 24 h of light for the first week and 18 h of light daily thereafter.

**Managements:** At 1 day of age, ducks were weighed individually and randomly assigned to pens with raised cement floors. The temperature under the brooder lamp, during the first week of age was 32°C and the ambient temperature in the building fluctuated between 28 and 31°C for thereafter. At the end of feeding trail, five birds from each replicate were slaughtered after a 12 h fast and access to water *ad libitum* to measure eviscerated carcass composition and intestinal morphology.

**Statistical analysis:** The data obtained were statistically analyzed using the General linear model of SAS (1998). In this study, a 3×3 factorial in a completely randomized design was used, considering the energy level and protein level as the main effects, as follows:

$$y_{ijk} = \mu+T_i+R_j+TR_{ij}+\varepsilon_{ijk}$$

where, $Y_{ijk}$ is an observation; μ is overall mean; T is effect of energy levels, R is effect of protein level, TR is effect of interaction between energy and protein levels and $\varepsilon_{ijk}$ is random error. Statements of statistical significance were based on $p<0.05$. Significant differences among treatments were tested by Duncan's multiple range test (Duncan, 1955).

Table 1: Feed ingredients and chemical composition of the experimental diets

| Item | Values | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Energy (kcal $kg^{-1}$) | 2700 | - | - | 2950 | - | - | 3200 | - | - |
| Protein (%) | 18 | 20 | 22 | 18 | 20 | 22 | 18 | 20 | 22 |
| **Ingredients** | | | | | | | | | |
| Broken rice | 10.00 | 10.00 | 10.00 | 10.00 | 13.00 | 13.00 | 10.00 | 13.00 | 10.00 |
| Corn | 36.59 | 34.71 | 30.94 | 41.70 | 36.64 | 34.36 | 38.55 | 35.24 | 32.19 |
| Palm oil | 3.63 | 1.50 | 1.60 | 5.51 | 4.37 | 5.07 | 9.52 | 9.05 | 10.35 |
| Rice bran | 3.00 | 9.79 | 10.49 | 2.00 | 5.14 | 1.00 | 3.00 | 2.00 | 0.90 |
| Wheat bran | 7.97 | 8.54 | 5.00 | 2.00 | 3.00 | 2.00 | 4.14 | 1.00 | 0.50 |
| Soybean 44% | 28.10 | 30.19 | 37.13 | 29.56 | 32.60 | 39.73 | 29.10 | 34.47 | 41.24 |
| L-Lysine | 0.53 | 0.43 | 0.22 | 0.52 | 0.39 | 0.18 | 0.52 | 0.36 | 0.16 |
| DL-Methionine | 0.36 | 0.32 | 0.26 | 0.36 | 0.31 | 0.25 | 0.36 | 0.31 | 0.25 |
| L-Threonine | 0.24 | 0.18 | 0.08 | 0.22 | 0.16 | 0.06 | 0.23 | 0.15 | 0.05 |
| MDCP 21% | 2.04 | 1.94 | 1.89 | 2.04 | 1.97 | 1.97 | 2.04 | 2.01 | 1.98 |
| $CaCO_3$ | 1.61 | 1.49 | 1.47 | 1.62 | 1.48 | 1.44 | 1.62 | 1.47 | 1.43 |
| Salt | 0.17 | 0.15 | 0.16 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.18 |
| Premix[1] | 0.76 | 0.76 | 0.76 | 0.76 | 0.76 | 0.76 | 0.76 | 0.76 | 0.76 |
| Corn Cob | 5.00 | - | - | 3.54 | - | - | - | - | - |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| **Nutrients** | | | | | | | | | |
| Fat | 6.07 | 5.00 | 5.00 | 7.00 | 6.99 | 6.95 | 11.75 | 10.99 | 12.00 |
| Fiber | 4.08 | 4.51 | 4.02 | 4.14 | 4.07 | 4.07 | 3.82 | 3.72 | 3.93 |
| Ca | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Available P | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| Salt | 0.21 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.21 | 0.20 | 0.20 |
| Lysine | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 |
| Methionine+Cysteine | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Methionine | 0.63 | 0.61 | 0.58 | 0.63 | 0.61 | 0.57 | 0.63 | 0.61 | 0.58 |
| Threonine | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Tryptophan | 0.23 | 0.25 | 0.28 | 0.23 | 0.25 | 0.29 | 0.23 | 0.26 | 0.29 |
| Chlorine (mg $kg^{-1}$) | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 |

[1]Provided/kg of diet: Vitamin A 12,000 IU, vitamin E 10 mg, vitamin D 2,200 IU, Niacin 35.0 mg, D-pantothenic acid 12 mg, Riboflavin 3.63 mg, Pyridoxine 3.5 mg, Thiamine, 2.4 mg, Menadione 1.3 mg, Folic acid, 1.4 mg, Biotin, 0.15 mg, vitamin B 0.03 mg, Mn 60 mg, Zn 40 mg, Fe 1280 mg, Cu, 8 mg, I 0.3 mg, Se 0.2 mg, [2]Chlorine 0.200 g, Antioxidants 0.013 g, Mycrotoxin binder 0.05 g

Table 2: Effect of dietary energy and protein levels on production of meat type duck (cherry valley) at 14 days of age

| | | CP | | | | p-value | | | |
|---|---|---|---|---|---|---|---|---|---|
| Items (%) | ME | 18 | 20 | 22 | Average | ME | CP | ME*CP | SEM |
| Initial body weight (g) | 2700 | 53.33 | 53.09 | 52.97 | 53.13 | 0.95 | 0.52 | 0.63 | 0.05 |
| | 2950 | 52.97 | 52.97 | 53.09 | 53.01 | | | | |
| | 3200 | 53.09 | 53.21 | 53.21 | 53.17 | | | | |
| | Average | 53.13 | 53.09 | 53.09 | | | | | |
| Final body weight (g) | 2700 | 644.08 | 544.76 | 582.68 | 590.51$^{x}$ | <0.01 | <0.01 | <0.01 | 0.3 |
| | 2950 | 583.18 | 543.95 | 583.89 | 570.34$^{y}$ | | | | |
| | 3200 | 557.90 | 532.03 | 527.91 | 539.28$^{z}$ | | | | |
| | Average | 595.05$^{X}$ | 540.25$^{Y}$ | 564.83$^{Y}$ | | | | | |
| Average daily gain (ADG, g) | 2700 | 45.73 | 38.64 | 41.35 | 41.91$^{x}$ | <0.01 | <0.01 | <0.01 | 0.37 |
| | 2950 | 41.39 | 38.58 | 41.44 | 40.47$^{y}$ | | | | |
| | 3200 | 39.58 | 37.73 | 37.44 | 38.25$^{z}$ | | | | |
| | Average | 42.23$^{X}$ | 38.32$^{Z}$ | 40.08$^{Y}$ | | | | | |
| Feed Intake (g/bird/day) | 2700 | 58.9 | 57.80 | 56.81 | 57.80$^{x}$ | 0.02 | <0.01 | 0.01 | 0.56 |
| | 2950 | 58.03 | 53.12 | 58.07 | 58.07$^{x}$ | | | | |
| | 3200 | 54.67 | 50.54 | 49.99 | 51.73$^{y}$ | | | | |
| | Average | 56.53$^{A}$ | 53.82$^{B}$ | 55.62$^{AB}$ | | | | | |
| Feed Conversion Ratio (FCR) | 2700 | 1.24 | 1.49 | 1.41 | 1.38$^{y}$ | 0.02 | <0.01 | <0.01 | 0.01 |
| | 2950 | 1.39 | 1.37 | 1.39 | 1.38$^{y}$ | | | | |
| | 3200 | 1.37 | 1.33 | 1.33 | 1.34$^{x}$ | | | | |
| | Average | 1.33$^{C}$ | 1.40$^{A}$ | 1.38$^{AB}$ | | | | | |

ME: Metabolizable energy, CP: Crude protein, ME*CP: The interaction between metabolizable energy and crude protein, SEM: Standard error of the mean, $^{X,Y,Z}$Mean in the same row with different superscripts are different (p<0.01), $^{x,y,z}$Mean in the same column with different superscripts are different (p<0.01), $^{A,B,C}$Mean in the same row with different superscripts are different (p<0.05)

## RESULTS AND DISCUSSION

**Production performance:** There was a significant effect of protein level with respect to final body weight, Average Daily Gain (ADG) and Feed Intake (FI) (p<0.01). Final bodyweight and ADG were significantly higher in the case of ducks which received 18% CP compared to both of the higher protein levels (p<0.01). Feed intake was highest and Feed Conversion Ratio (FCR) lowest at the 18% CP level but the differences were significant only in comparison to the 20% CP level (p<0.05). The results indicated a highly significant effect of energy level on both final bodyweight and ADG (p<0.01); the mean values for both of these performance traits were higher for the 2,700 kcal level in comparison to both of the higher energy levels (p<0.01). Feed intake was similar at the 2,700 and 2950 kcal kg$^{-1}$ energy levels and both were significantly higher than for the 3200 kcal kg$^{-1}$ level (p<0.01). Although the analysis of variance indicated a significant effect of energy level on FCR (p<0.01) none of the comparisons among the levels were statistically significant. There was a highly significant interaction between dietary protein and energy with respect to final body weight, ADG, FI and FCR (p<0.01). The source of the interaction can be seen by inspection of the sub-class means where it can be seen that the combination 18% protein and 2,700 kcal kg$^{-1}$ resulted in the highest average daily gain, final weight and food intake and the most efficient food conversion ratio (Table 2).

In this study, FI was significantly influenced by dietary energy in agreement with Wang and Liu (2002). Dietary intake is influenced by requirement for their body needs (Nahashon *et al*., 2005; Wang *et al*., 2010). A decrease of dietary protein results in an increase in the efficiency of protein utilization conversely an excess of dietary protein results in an increase in nitrogen excretion and loss of energy for metabolism of N-excretion in urea cycle (Poosuwan *et al*., 2010; Nukreaw *et al*., 2011). In the present study feeding 2,700 kcal kg$^{-1}$ resulted in a significant increased FI in comparison to feeding 3,200 kcal kg$^{-1}$. An explanation for this may be that the animals responded to the high dietary energy by decreasing FI for keep calorie intake. Therefore, in this study, among dietary treatments, 18% CP and 2,700 kcal were the appropriate levels for improved feed efficiency and presented the best final body weight and FCR. In agree with Velu and Baker (1974), Shen (1988), Chen and Jiang (1992) and He (1994) reported that 18.70 to 19.03%. CP is suitable for the production of duck.

**Carcass quality:** The effects of dietary energy and protein on carcass quality are presented in Table 3. Variation in dietary energy and protein had a significant influenced on wing percentage (p<0.01). There was a significant effect of protein level on the percentage of thigh meat (p<0.05). Feeding 3,200 kcal kg$^{-1}$ significantly reduced wing percentage compared to both 2,700 and 2,950 kcal kg$^{-1}$ (p<0.01) and feeding 22% CP increased the wing percentage compared to 18 and 20% CP (p<0.01). These effects may be due to the stage of physiological development of the ducks whereby at a time when the wingspan is growing rapidly, the increased feed intake in the 2,700 and 2,950 kcal kg$^{-1}$ groups resulted in selective accumulative effects of the wing muscles.

Table 3: Effect of dietary energy and protein levels on carcass quality of meat type duck (cherry valley) at 14 days of age

| | | CP | | | | p-value | | | |
|---|---|---|---|---|---|---|---|---|---|
| Items (%) | ME | 18 | 20 | 22 | Average | ME | CP | ME*CP | SEM |
| Inner breast | 2700 | 4.06 | 3.74 | 4.09 | 3.96 | 0.27 | 0.95 | 0.26 | 0.04 |
| | 2950 | 3.85 | 3.96 | 3.98 | 3.93 | | | | |
| | 3200 | 3.76 | 4.00 | 3.44 | 3.73 | | | | |
| | Average | 3.89 | 3.90 | 3.84 | | | | | |
| Outer breast | 2700 | 0.36 | 0.39 | 0.38 | 0.38 | 0.39 | 0.34 | 0.71 | 0.1 |
| | 2950 | 0.34 | 0.28 | 0.34 | 0.32 | | | | |
| | 3200 | 0.37 | 0.33 | 0.48 | 0.39 | | | | |
| | Average | 0.36 | 0.33 | 0.40 | | | | | |
| Wing | 2700 | 3.00 | 2.99 | 3.46 | $3.15^{X}$ | <0.01 | <0.01 | 0.02 | 0.03 |
| | 2950 | 3.12 | 2.89 | 3.27 | $3.09^{X}$ | | | | |
| | 3200 | 2.71 | 2.79 | 2.88 | $2.79^{Y}$ | | | | |
| | Average | $2.94^{Y}$ | $2.89^{Y}$ | $3.20^{X}$ | | | | | |
| Thigh | 2700 | 13.95 | 13.11 | 13.68 | 13.40 | 0.49 | 0.03 | 0.96 | 0.07 |
| | 2950 | 13.86 | 13.25 | 13.60 | 13.57 | | | | |
| | 3200 | 113.56 | 13.39 | 13.40 | 13.45 | | | | |
| | Average | $13.79^{A}$ | $13.25^{B}$ | $13.56^{A}$ | | | | | |
| Drumstick | 2700 | 13.44 | 13.34 | 13.43 | 13.40 | 0.53 | 0.49 | 0.09 | 0.15 |
| | 2950 | 13.67 | 13.49 | 13.38 | 13.51 | | | | |
| | 3200 | 13.46 | 13.23 | 13.17 | 13.29 | | | | |
| | Average | 13.52 | 13.53 | 13.33 | | | | | |
| Abdominal fat | 2700 | 0.27 | 0.43 | 0.37 | $0.36^{z}$ | <0.01 | 0.01 | 0.22 | 0.01 |
| | 2950 | 0.38 | 0.48 | 0.46 | $0.44^{y}$ | | | | |
| | 3200 | 0.47 | 0.46 | 0.49 | $0.47^{y}$ | | | | |
| | Average | $0.37^{B}$ | $0.44^{A}$ | $0.46^{A}$ | | | | | |

ME: Metabolizable energy, CP: Crude protein, ME*CP: The interaction between metabolizable energy and crude protein, SEM: Standard error of the mean, $^{X,Y,Z}$Mean in the same row with different superscripts are different (p<0.01), $^{x,y,z}$Mean in the same column with different superscripts are different (p<0.01), $^{A,B,C}$Mean in the same row with different superscripts are different (p<0.05)

The percentage thigh meat was significantly lower at the 20% CP level compared to both the 18 and 22% levels (p<0.05). There was no effect of energy level on this carcass trait. Abdominal fat content was significantly influenced by variation in both protein and energy levels ($p\leq 0.01$). These fat percentages were similar for the 20 and 22% CP levels and both were significantly higher compared to the 18% CP level (p<0.05). In the case of dietary energy the abdominal fat percentages were similar for the 2,950 and 3,200 kcal $kg^{-1}$ levels both of which were significantly higher compared to the 2,700 kcal $kg^{-1}$ (p<0.01). There was no evidence for any interaction between dietary protein and energy with regard to any of the carcass traits, with the exception wing.

In practice, the indices of growth and feed efficiency are considered as conventional indicators on the requirements of energy and protein in diet. They may not, however, always reflect the requirements for the best carcass quality. Consequently, indicators of the carcass quality, especially the abdominal fat, need to be taken into account in the study of dietary energy and protein requirements (Niu *et al*., 2009). In the present study increasing dietary energy and protein levels were associated with increased abdominal fat percentage. Animals eat to provide the nutrient and energy for growth and maintenance and the rest is stored as adipose tissue which is primarily as abdominal fat in ducks. Therefore, it can be said that in general if energy levels are increased, there will be a resulting increase in carcass fat in duck meat and that high protein diets also result in the accumulation of fat in the carcass as has been reported by Siregar *et al*. (1982a,b).

**Intestinal morphology:** The effect of dietary energy and protein on intestinal morphology is presented in Table 4. There were no significant changes in villus height or crypt depth in the duodenum, jejunem or ileum in response to variation in dietary energy content. The villus height of the duodenum was slightly affected by variation in protein level and approached statistical significance (p = 0.07); it was highest in the 18% CP level. The only statistically significant change in these parameters in response to variation of dietary protein was in the case of the villus height of the jejunum (p<0.05). This was highest at the 18% CP level but the differences were statistically significant only in the case of the comparison between the 18 and 20% CP levels. (p<0.05). There was also a tendency There was no evidence for an interaction between energy and protein in diet with respect to any aspect of intestinal morphology (p>0.05).

The ducks which received 18% CP had increased villus height in the duodenum and jejunum compared to the higher CP levels; this is probably due to the 18% CP diet being better balanced with synthetic amino acids than the diets with higher CP levels. Reducing dietary protein increased the protein utilization and therefore the excess

Table 4: Effect of dietary energy and protein levels on intestinal morphology of meat type duck (cherry valley) at 14 days of age

| | | CP | | | | p-value | | | |
|---|---|---|---|---|---|---|---|---|---|
| Items | ME | 18 | 20 | 22 | Average | ME | CP | ME*CP | SEM |
| **Villus height (µm)** | | | | | | | | | |
| Duodenum | 2,700 | 244.63 | 221.14 | 244.61 | 236.79 | 0.51 | 0.07 | 0.35 | 1.94 |
| | 2,950 | 232.87 | 220.54 | 248.20 | 233.87 | | | | |
| | 3,200 | 236.56 | 219.51 | 218.87 | 227.98 | | | | |
| | Average | 238.02 | 227.06 | 233.89 | | | | | |
| Jejunum | 2,700 | 240.98 | 222.93 | 233.60 | 232.5 | 0.62 | 0.03 | 0.54 | 1.94 |
| | 2,950 | 236.72 | 216.29 | 228.91 | 227.31 | | | | |
| | 3,200 | 229.72 | 212.48 | 212.67 | 218.29 | | | | |
| | Average | $235.81^{A}$ | $217.23^{B}$ | $225.06^{AB}$ | | | | | |
| Ileum | 2,700 | 178.59 | 167.78 | 176.84 | 174.21 | 0.15 | 0.49 | 0.97 | 2.13 |
| | 2,950 | 171.00 | 165.40 | 174.34 | 170.25 | | | | |
| | 3,200 | 160.67 | 161.22 | 162.77 | 161.55 | | | | |
| | Average | 170.09 | 164.80 | 171.32 | | | | | |
| **Crypt depth (µm)** | | | | | | | | | |
| Duodenum | 2,700 | 135.31 | 133.20 | 133.60 | 134.04 | 0.96 | 0.65 | 0.87 | 3.04 |
| | 2,950 | 129.68 | 130.60 | 134.73 | 131.67 | | | | |
| | 3,200 | 135.95 | 120.96 | 138.95 | 131.95 | | | | |
| | Average | 133.65 | 128.25 | 135.76 | | | | | |
| Jejunum | 2,700 | 123.66 | 117.71 | 114.32 | 118.56 | 0.59 | 0.73 | 0.74 | 2.13 |
| | 2,950 | 112.90 | 121.52 | 110.40 | 114.94 | | | | |
| | 3,200 | 110.90 | 112.85 | 113.78 | 112.51 | | | | |
| | Average | 115.82 | 117.36 | 112.83 | | | | | |
| Ileum | 2,700 | 100.07 | 101.99 | 108.26 | 103.44 | 0.71 | 0.29 | 0.82 | 1.36 |
| | 2,950 | 108.80 | 102.31 | 107.93 | 106.35 | | | | |
| | 3,200 | 104.12 | 103.57 | 107.91 | 105.20 | | | | |
| | Average | 104.33 | 102.62 | 108.03 | | | | | |

ME: Metabolizable energy, CP: Crude protein, ME*CP: The interaction between metabolizable energy and crude protein, SEM: Standard error of the mean, Mean in the same row with different superscripts are different ($p<0.05$)

N in the intestine is lowered. On the other hand, dietary 20 and 22% CP may have increased the unabsorbed N in the intestine and this was transformed into the toxic substances such as ammonia which results in a decrease in the intestinal villus development (Poeikhampha and Bunchasak, 2010; Lampromsuk *et al*., 2012).

In this study, feeding 18% CP probably decreased the potentially toxic substances. Lowering ammonia concentration in digesta by feeding low-protein diet was also reported in studies in broilers and layers (Poosuwan *et al*., 2010; Nukreaw *et al*., 2011). Hence, stimulation of beneficial intestinal mucosa development by decreasing the dietary protein may reduce the proteolysis of protein, or the N compounds in digesta. The intestinal mucosal development is associated with absorption of nutrients rather than the influence of catalyst (vitamin and minerals). Therefore, the synthetic amino acids have a direct impact on the growth of intestinal mucosal cells as precursors in the synthesis of proteins in the body and due to intestinal villus is rapidly developed form hatched to 2 days age (Geyra *et al*., 2001). Therefore, the intestinal mucosa is completely developed in starter phase. Consequently, this study implies that the optimum dietary energy requirement of ducks from 1-14 days age is 2700 kcal kg$^{-1}$ and the protein requirement is 18% which results in increased production and improved intestinal morphology without any negative effect on carcass yield of ducks during starter phase.

## CONCLUSION

During the 14 day, the dietary energy and protein influenced to all the performance of ducks. Feeding 18% protein and 2,700 kcal kg$^{-1}$ is well-organized to body weight, feed intake and feed conversion ratio. The dietary energy and protein manipulation involve abdominal fat accumulation and reducing dietary protein seems to increase villus height of the jejunum.

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