Effect of Choice Feeding on the Nutrient Intake and Performance of Broiler Ducks

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ABSTRACT : An experiment was conducted at the experimental duck farm of Cantho University in the Mekong Delta of Vietnam to evaluate the effects of offering pairwise feeds with different crude protein (CP) levels to Cherry Valley broiler ducks from 28-63 days of age on feed intake and performance. Five diets consisting of mixtures of soya bean meal, fish meal, maize meal and fine rice bran, were formulated to give isocaloric diets with 30, 24, 18, 16 and 12% CP. These were offered separately as pellets to growing ducklings in the following combinations: 30+18, 30+12, 24+16 and 18+12. A diet with 20% CP (CP20) was used as control. All the diets were offered ad libitum. Daily feed intakes (g dry matter, DM) were 161, 168, 150, 101 and 143 g for the 30+18, 30+12, 24+16, 18+12 and CP20 treatments, respectively. CP intakes were 29.6, 27.0, 24.8, 17.1 and 22.9% of total DM intake, and the ratio of methionine+cystine to lysine was 0.76, 0.75, 0.75, 0.76 and 0.75 for the 30+18, 30+12, 24+16, 18+12 and CP20 treatments, respectively. Live weights at 63 days of age were 2,937, 3,054, 2,898, 2,200, and 2,811 g ($p<0.001$), and daily live weight gains 57.8, 61.7, 57.0, 38.5 and 55.7 g ($p<0.001$) for the 30+18, 30+12, 24+16, 18+12 and CP20 treatments, respectively. The weights and yields of the carcass, breast and thigh muscles, and heart decreased in the order 30+18, 30+12, 24+16, CP20 and 18+12 ($p<0.001$). The present study suggests that growing broiler offered a combination of high and low protein feeds pairwise will eat excessive amounts of the high protein feed, thus resulting in protein intakes above requirements. *(Asian-Aust. J. Anim. Sci. 2001. Vol 14, No. 12 : 1728-1733)*

Key Words : Broiler Ducks, Amino Acids, Choice Feeding, Nutrient Intake, Weight Gain, Carcass Parameters

INTRODUCTION

In modern farming systems animals are typically presented with a single feed. This is not a situation in which most species of birds and mammals have evolved, and must be considered unnatural. The ancestors of our farm animals had the opportunity to select from a range of available feeds and obviously were able to select a mixture which allowed them to grow and produce. It is possible that by eating at random from a variety of feeds they obtained sufficient nutrients to survive and perform well. Many species of animal eat a variety of feeds and need to learn the properties of these feeds. Therefore, they sample a wide range of potential feeds and learn by experience those which are palatable and nutritious (Forbes, 1995). It might be supposed from experimental results that birds which start to eat a meal consisting of one feed will tend to find another feed more attractive as the meal progresses. Indeed, 60% of the meals taken by broilers given free access to high and low protein feeds are from both feeds, i.e. there is a strong tendency to change feeds during the meal, as found by Shariatmadari and Forbes (cited by Forbes, 1995). Even when the bird has learned that one feed is adequate it still samples other feeds to ensure that a change in the quality of an extreme feed does not go undetected, and this allows a novel feed to be sampled with relative safety (Forbes, 1995).

Growing ducks in the Mekong Delta of Vietnam are commonly allowed to scavenge in the rice fields and waterways (Men, 1996), and as their intake of nutrients is not known a supplementary feeding system that allows them to select the nutrients they require to complement what they have obtained by scavenging may be more efficient than providing a single, nutritionally balanced supplement. Protein and energy are two major nutrients for the duck growth (Shen, 2000). In addition, as CP requirements decrease with age, providing two separate feeds with different concentrations of CP will allow the ducks to select from the feeds so that overall CP intake matches their continually changing requirement.

In order to evaluate the effects of feeding different feed combinations to broiler ducks a trial was conducted on growing ducks (28-63 days of age) given feeds pairwise *ad libitum* with crude protein levels ranging from 12-30%, with the objectives of estimating voluntary feed and nutrient intakes when offered two feeds with different CP concentrations, and further to determine the effects of the different diet combinations on the performance and carcass characteristics of the ducks.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at the experimental duck farm of Cantho University in the Mekong Delta of

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Vietnam, between December 1998 and February 1999.

Experimental design, ducks and diets

A total of 160 male and female Super M Cherry Valley ducklings were brooded and confined from 1-28 days of age and fed a pelleted starter diet *ad libitum* that contained 13.1 MJ ME/kg and 22% crude protein (CP). At 22 days of age the ducklings were randomly allocated to the pairwise diets with different protein levels, and then adapted to the new diets by feeding them combined with the starter diet for a further six days. From 28 to 63 days of age the ducks were fed a pelleted control diet with 20% CP (CP20) or the different pairwise pelleted diets offered separately and *ad libitum* with CP combinations as follows: 30+18; 30+12; 24+16 and 18+12. The ingredient composition of the diets is shown in table 1.

There were 32 birds per treatment, with four replicates of eight ducks housed and fed in groups. The ducks were not sexed at the start of the experiment and so each replicate group consisted of varying numbers of males and females. The crude protein and other nutrient contents in the control (CP20) diet were according to the recommendations of Cherry Valley Ltd. for growing Super M ducks. The diets were formulated (Ultramix, 1988) so as to be isocaloric (15.0 ME MJ/kg DM), and lysine and methionine were added to give ratios of methionine + cystine to lysine of 0.75 in all diets. The nutrient composition of the diets is shown in table 2.

Feeds and feeding

The fine rice bran, soya bean meal, fishmeal and synthetic methionine and lysine were from batches purchased at the same time from a local feed company. A premix containing trace minerals and vitamins was mixed with all diets. Also, common salt, bone meal and oyster meal was added to some diets. Diets were pelleted, with a pellet diameter of 3.0 mm.

The feeders used were round plastic basins, 40 cm in diameter and 15 cm deep. Different pairwise diets were placed in different coloured feeders for each treatment and offered *ad libitum* three times per day in the morning, afternoon and evening. The amounts given on each occasion depended on the intakes on the previous two occasions, to minimize spillage. The residues were gathered and weighed the following morning to calculate the actual intakes. Water was freely available for both drinking and bathing. Both drinkers and feeders were cleaned daily in the morning.

Management

The ducks were housed in the same building divided into pens, each containing eight ducks. The pens were made from bamboo, with thatched roofs and concrete floors covered with rice straw for bedding, with an average density of two ducks per m^2. The ducks also had access to outside concrete yards, with one m^2 per duck. The temperature in the house averaged 25°C in the morning, 30-32°C (maximum 37°C) at noon and 21-27°C at night. Relative humidities fluctuated from 58.3 (at noon) to 84.9% (in the early morning). The yards were scaffolded by palm leaves to provide shade in the middle of the day, and were cleaned regularly. Rice straw was dried and used as litter and replaced when the old litter become wet and dirty. Natural light was used in the daytime and electric bulbs at night, with an intensity of 5 w/m^2 at floor level during the whole experimental period.

Chemical analyses

Samples of feed ingredients i. e. maize meal, rice bran, soya bean meal and fish meal, and the pelleted diets were analysed for dry matter (DM), crude protein (N*6.25, CP), amino acids, crude fibre (CF), ether extract (EE), calcium and phosphorus by standard AOAC methods (AOAC, 1990) at the laboratories of Cantho University and the National Institute of Animal Husbandry in Hanoi.

Table 1. Ingredient composition of the feed mixtures (% as fed)

	Feed mixture					
	12	16	18	20	24	30
Yellow maize meal	72.37	60.00	56.00	52.50	43.28	23.00
Rice bran	16.00	21.80	21.15	19.60	16.20	15.40
Soya bean meal	7.00	9.50	12.50	14.50	24.00	43.90
Fishmeal	2.00	7.80	10.00	13.00	16.00	17.00
Lysine	0.08	0	0	0	0	0
Methionine	0	0.04	0.10	0.15	0.27	0.45
Oyster meal	0.50	0.41	0	0	0	0
Bone meal	1.50	0.20	0	0	0	0
Vitamin-mineral premix*	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.30	0	0	0	0	0

* Mixture of vitamins (A, D, E, K and B group) and micro minerals (Zn, Mn, I, Se and Mg).

Table 2. Analysed nutrient composition (% in DM) of the diets offered

	Feed mixture					
	12	16	18	20	24	30
Dry matter	87.0	87.4	87.5	87.7	88.2	89.1
Crude protein	13.8	18.4	20.7	23.0	27.7	34.5
Amino acid						
Lysine	0.60	0.97	1.15	1.35	1.70	2.20
Methionine	0.35	0.42	0.55	0.67	0.90	1.18
Methionine+cystine	0.45	0.73	0.88	1.02	1.28	1.66
Tryptophan	0.15	0.20	0.23	0.26	0.32	0.42
Threonine	0.52	0.71	0.80	0.90	1.09	1.38
Crude fibre	4.54	5.06	5.04	4.87	4.74	5.25
Ether extract	6.84	8.14	8.69	9.00	10.32	13.40
Calcium	0.84	0.76	0.80	0.88	1.02	1.11
Phosphorus	0.70	0.73	0.65	0.83	0.95	1.03
Available P	0.40	0.45	0.49	0.58	0.67	0.70
ME, MJ/kg*	15.1	15.0	15.1	15.1	15.1	15.0

* Calculated values.

Statistical analysis and measurements

All ducks were weighed invidually at the beginning of the experiment, weekly, and at the end of the experiment. Daily intakes of the two diets were calculated according to the total feed consumption of the group in each pen. At the end of the experiment eight representative ducks per treatment were slaughtered for carcass evaluation, and carcass traits and weights of internal organs were recorded.

The data were analysed by analysis of variance using the General Linear Model (ANOVA) procedure of Minitab version 12 program statistical sofware (Minitab, 1998).

RESULTS

Feed and nutrient intake

Data for feed intakes presented in table 3 show that total feed intake of the ducks in the 18+12 treatment was significantly lower than for the other treatments, with the highest intakes noted for the 30+12 and 30+18 diet combinations. For the treatments 30+18, 30+12 and 24+16 intakes of the high CP pellets were 0.64, 0.64. 0.69, respectively of total feed intake, while intakes of the 18% CP and 12% CP feeds were similar.

Total intakes of crude protein, metabolizable energy and other nutrients are shown in table 4. Crude protein intakes of the ducks on the 30+18 and 30+12 treatments were highest ($p<0.001$), and were lowest on the 18+12 treatment. Because total daily feed intake of the ducks on this treatment was lower than for the other treatments, intakes of nutrients such as amino acids and also minerals were correspondingly lower compared to the other treatments ($p<0.001$). The ratio of methionine plus cystine to lysine was 0.75 and threonine to lysine varied between 0.64 and 0.72.

Daily liveweight gains and feed conversion

Data in table 5 show that after 5 weeks on experiment, live weights and daily live weight gains were lowest on the 18+12 treatment compared to the other treatments ($p<0.05$). There were no significant differences for feed conversion ratios among treatments ($p>0.05$).

Carcass evaluation

Data in table 6 show that carcass weights of the ducks slaughtered for carcass evaluation were significantly higher for the ducks fed combinations of high and low protein diets than the low protein diets (18+12). Carcass yields and breast and thigh muscle weights of ducks fed the high

Table 3. Daily dry matter intakes of growing ducks offered pairwise mixtures with different levels of crude protein

Treatment	High CP (g)	Low CP (g)	High CP/total intake	Total intake (g)	Total DM intake
CP20	158.8	0.0	-	158.8[a]	142.9[a]
30+18	115.0	63.7	0.64	178.7[bc]	160.9[bc]
30+12	119.5	67.3	0.64	186.9[b]	168.2[b]
24+16	114.1	52.1	0.69	166.2[ac]	149.6[ac]
18+12	54.8	57.8	0.49	112.6[d]	101.3[d]
SE	5.26	-	-	3.41	3.07

[a,b,c,d] Means without common superscripts within columns are significantly different ($p<0.05$).

Table 4. Daily nutrient intakes of the different diet combinations (DM basis)

Item	Treatment					SE
	CP20	30+18	30+12	24+16	18+12	
Crude protein, g	32.7^{a}	47.6^{b}	45.5^{b}	37.0^{c}	17.4^{d}	0.79
CP / kg intake, g	205.9^{a}	266.1^{b}	243.1^{c}	222.8^{d}	154.1^{e}	2.75
Ether extract, g	12.9^{a}	18.9^{b}	18.6^{b}	14.4^{c}	7.8^{e}	0.33
CP, % of DM intake	22.9^{a}	29.6^{b}	27.0^{c}	24.8^{d}	17.1^{e}	0.31
Lysine, g	1.92^{a}	2.94^{b}	2.74^{b}	2.20^{c}	0.89^{d}	0.06
Met+cys/lysine	0.75	0.76	0.75	0.75	0.76	0.004
Threonine/lysine	0.67^{a}	0.64^{b}	0.65^{b}	0.66^{c}	0.72^{d}	0.003
Tryp./lysine	0.19^{a}	0.19^{b}	0.20^{c}	0.19^{b}	0.22^{d}	0.001
Calcium, g	1.25^{a}	1.57^{b}	1.70^{c}	1.39^{d}	0.76^{e}	0.03
Total phosphorus, g	1.19^{a}	1.53^{b}	1.54^{b}	1.33^{c}	0.76^{d}	0.03
Avai. phosphorus, g	0.83^{a}	1.00^{b}	0.99^{b}	0.90^{a}	0.45^{c}	0.02
ME, MJ	2.16^{ac}	2.42^{bc}	2.53^{b}	2.25^{ac}	1.53^{d}	0.05

^{a,b,c,d,e} Means without common superscripts within rows are significantly different ($p<0.05$).

Table 5. Effect of dietary treatment on daily weight gains and feed conversion

Item	Treatment					SE
	CP20	30+18	30+12	24+16	18+12	
Live weight, g						
Initial	863	914	893	901	853	22.12
Final	2,811^{a}	2,937^{ab}	3,054^{b}	2,898^{ab}	2,200^{c}	42.18
Daily gain, g	55.7^{a}	57.8^{a}	61.7^{a}	57.0^{a}	38.5^{b}	1.63
Mean daily DM intake, g	142.9^{a}	160.9^{bc}	168.2^{b}	149.6^{ac}	101.3^{d}	3.07
FCR, g DM/g gain	2.57	2.78	2.73	2.62	2.66	0.09
g protein/ g gain	0.59^{a}	0.82^{b}	0.74^{c}	0.65^{a}	0.46^{d}	0.02

^{a,b,c,d} Means without common superscripts within rows are significantly different ($p<0.05$).

Table 6. Effect of dietary treatment on carcass parameters

Item	Treatment					SE
	CP20	30+18	30+12	24+16	18+12	
Live weight (LW), g	2,843.8^{a}	2,991.3^{a}	3,031.3^{a}	2,900.0^{a}	2,123.8^{b}	67.11
Carcass, g	1,861.3^{a}	2,006.2^{a}	2,038.8^{a}	1,995.0^{a}	1,277.5^{b}	51.27
Carcass, % of LW	65.6^{ab}	67.0^{a}	67.3^{a}	68.7^{a}	60.4^{b}	1.40
As % of carcass weight						
Breast muscle	14.2^{ab}	15.2^{a}	14.6^{a}	14.6^{a}	11.3^{b}	0.75
Thigh muscle	12.5^{a}	12.0^{a}	10.5^{a}	11.7^{a}	14.0^{b}	0.43
Heart weight	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{ab}	1.2^{b}	0.05
Liver weight	4.1^{a}	3.3^{a}	3.5^{a}	3.3^{a}	5.6^{b}	0.27
Gizzard weight	4.5^{ab}	4.4^{ab}	3.8^{a}	4.1^{a}	5.2^{b}	0.28
SI length, cm	231.3	230.1	236.1	219.1	236.4	6.41
LI length, cm	15.8	14.9	15.4	15.3	13.5	0.74
Cecum length, cm	34.9	36.8	35.4	32.2	31.4	1.64

SI: small intestine; LI: large intestine.

^{a,b} Means without common superscripts within rows are significantly different ($p<0.05$).

protein diets (30+18, 30+12 and 24+16) were significantly higher than those of ducks fed the low protein diet combination (18+12) ($p<0.05$). There were no significant differences for ceca, small intestine and large intestine lengths among treatments.

DISCUSSION

The experiment was carried out in the hot dry season, and the high daytime temperatures (mean maximum 37°C) and humidities (maximum 84.9%) could have depressed the intakes of the exotic commercial ducks used in the experiment. Leclercq et al. (1987) stated that an increase in ambient temperature is accompanied by a reduction in feed intake, and Smith (1993) also reported that both growth rate and feed intake of growing birds decreases at environmental temperatures over 25°C, resulting in lower growth rates of broilers. Also, a recent study (Al-Batshan and Hussein, 1999) showed that high ambient temperature significantly reduced daily energy and protein intake and heat stress reduces broiler performance during the growing period. However, the ducks offered the high protein diets were able to consume sufficient essential amino acids and ME for normal growth. In contrast, intakes of the dietary treatment which was composed of the low and very low protein pellets (18+12) was 30-40% lower than intakes on the other treatments, and these birds were unable to increase their intakes sufficiently to meet requirements. Surprisingly there was no difference in intakes between the 18 and 12% CP diets in the treatment 18+12, although it would have been expected that the birds should have eaten much more of the 18% CP feed, and avoided the 12% CP mixture, which was substantially below their requirement. According to Forbes (1995), the lower critical content of protein in a feed for any class of livestock can be defined as that level below which voluntary intake is depressed. The present data suggest that a diet with 18% CP is below the critical content of protein for exotic broiler ducks under tropical conditions.

The ducks on treatments 30+18, 30+12 and 24+16 consumed from 223 to 266 g CP per kg feed. Thus, when offered these high and low protein feed combinations the ducks consumed more of the high protein than low protein pellets. For example, for the ducks in the 30+18 and 30+12 treatments consumption of the high CP feed was 64% of total intake, which resulted in intakes of protein that were in excess of requirements. These experimental results were in agreement with the findings by Forbes and Catterall (1993) that when broiler chicks were offered high and low protein feed combinations the intake of the low protein feed decreased with the increase in intake of the high protein feed, and the resulting total protein intake therefore increased markedly with increasing intake of the high protein feed, giving higher carcass weights, which was also found in our experiment. This is in contrast to the report of Kyriazakis et al. (1990), who found that when pigs had a choice between a feed close to their CP requirement and one with surplus CP, they consumed only a small amount of the latter feed. In our experiment it appears that the high protein feeds were more attractive to the ducks, possibly because of their strong taste and/or smell, as these characteristics are often associated with high protein feeds (Forbes, 1995). The ducks in treatment 24+16 also had very high intakes of the high protein feed (69% of the total intake), but still chose to eat significant amounts of the low protein feed. This is in agreement with Forbes (1995), who suggested that many species of animal eat a variety of feeds in order to determine the properties of these feeds, and learn by experience those which are palatable and nutritious. The experimental results thus confirm that birds which start to eat a meal consisting of one feed will tend to find another feed more attractive as the meal progresses.

Klasing (1998) recommended a diet containing 220 g CP kg^{-1} (with an ME content of 12.5 MJ/kg) for growing ducklings. Total protein and lysine intakes of the ducks on the 30+18, 30+12 and 24+16 treatments were in excess of requirements, while the ratios of methionine + cystine (0.75 - 0.76), threonine (0.64 - 0.67) and tryptophan (0.19) to lysine on all treatments were very close to recommendations for normal growth rates of ducks (Rose, 1997). Mean daily gains were thus not significantly influenced by treatment, except that the birds on the low protein (18+12) treatment had daily gains that were 30-40% lower than for the other treatment groups, probably as a result of the low intakes of DM and lysine. Although the ducks in the 18+12 treatment had the lowest protein intake they converted dietary protein to body tissues more efficiently. This is in agreement with Mastica and Cumming (1981), who found that choice-fed broiler chickens that ate less protein converted protein more efficiently. Birds on the 30+12, 30+18 and 24+16 had intakes of amino acids in excess of requirements and the surplus would have been excreted, resulting in a lower efficiency of protein utilization.

The carcass yields, breast and thigh muscles and heart weights of the ducks fed high protein diets were higher than those of the ducks offered the low protein diets, which had very low intakes of essential amino acids, especially lysine and methionine. This would have limited lean meat deposition, which requires relatively high levels of lysine (Rose, 1997). Addition of lysine to a lysine-deficient diet significantly increased protein synthesis in the pectoralis major muscle of growing chickens, as found by Tesseraud et al. (cited by Grizard et al., 1999).

IMPLICATIONS

When offered a combination of high protein (30 or 24% CP) and low protein (12, 16 or 18% CP) pellets separately the growing broiler ducks prefered the high protein feed over the low protein feed, resulting in excessive protein intakes. This indicates that providing feeds with different protein contents with the aim of allowing scavenging growing ducks to balance their total protein intakes to meet requirements will not be economically viable.

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