EFFECTS OF DIETARY THREONINE AND PROTEIN ON GROWTH PERFORMANCE AND CARCASS TRAITS OF WHITE PEKIN DUCK

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ABSTRACT
A 2×12 factorial experiment using 2 proteins (16.99%, 20.1%) and 12 total dietary threonine levels (0.46%, 0.52%, 0.58%, 0.64%, 0.70% and 0.76% of total Thr in low-protein diet and 0.54%, 0.60%, 0.66%, 0.72%, 0.78%, and 0.84% of total Thr in High-protein) was conducted to study the effects of dietary threonine and protein on growth performance and carcass traits of white pekin ducks from 1 to 21 days of age. Six hundred and twenty-four 1-day-old white Pekin male ducklings were randomly allocated to 36 pens with 8 birds per pen according to similar pen weight. There were 12 dietary treatments, consisting of six replicate pens. Weight gain, feed intake, and feed/gain of ducks from each pen were measured every week. At 21 days of age, two ducks were selected randomly from each pen, and slaughtered to evaluate the carcass quality. The results showed that in both the high and low-protein diets the threonine supplementation increased the feed intake, weight gain, and feed conversion ratio. Peak weight gain responses appeared in ducks fed the 0.67% and 0.79% threonine in both low and high-protein diets. Thr supplementation significantly affected feed/gain in the 2-3-week period (P≤0.05) and daily feed intake in the 3 weeks (P). Significant responses from Thr supplementation in both the low and high protein diet were observed for the leg meat, breast meat, and gizzard percentages. The optimal requirement of white Pekin ducks from 1 to 21 days of age was 0.00% for breast meat percentages. The results of our experiment are reported herein. Threonine supplementation has an impact on growth and carcass traits. An increase in dietary threonine had a significant impact on feed intake, weight gain, and feed-to-gain ratio during the 1-3-week period in both low and high-protein diets. Threonine supplementation did not have a significant impact on abdominal fat, liver, heart, spleen, and tibia percentages in both low and high-protein diets. However, there was a notable effect on gizzard percentages
Keywords: *Threonine, White Pekin ducks, Growth performance, Carcass traits*

INTRODUCTION
The nutrient Threonine must be considered in dietary formulation for poultry because its excess is costly and its deficiency will decrease the efficiency of sulfur amino acid (SAA) and lysine use. Thr is typically the third limiting amino acid behind SAA and lysine in poultry diets composed of maize or sorghum, soybean meal, and meat meal (Zhang et al., 2014).

The improvement of growth performance and carcass traits caused by threonine supplementation in diets were reviewed in broilers and turkeys and National Research Council provided the threonine recommendations for chickens and turkeys, but the information for Threonine is missing for ducks in the National Research Council (1994) recommendation. As in other avian species, threonine was also needed by ducks and the body weight, weight gain, and feed intake of white pekin ducklings were all improved by increasing dietary threonine (Kidd, 2000).

Threonine is important not only for protein deposition but also for mucin production and digestive processes. Currently, Thr requirements studies are mostly focused on chickens and turkeys. However, limited information has been published describing the Thr requirements of white Pekin ducks (Council, 1994).

Although the threonine requirement of white Pekin ducks from hatch to 21 days of age has been reported recently by (Penz Jr, Colnago, & Jensen, 1997), this study does not describe the relationship of threonine and crude protein on growth performance and carcass traits of white Pekin duck. Therefore, the objective of our study was to study the effects of dietary threonine and protein on the growth performance and carcass traits of white Pekin ducks. (Baylan, Canogullari, Ayasan, & Sahin, 2006)

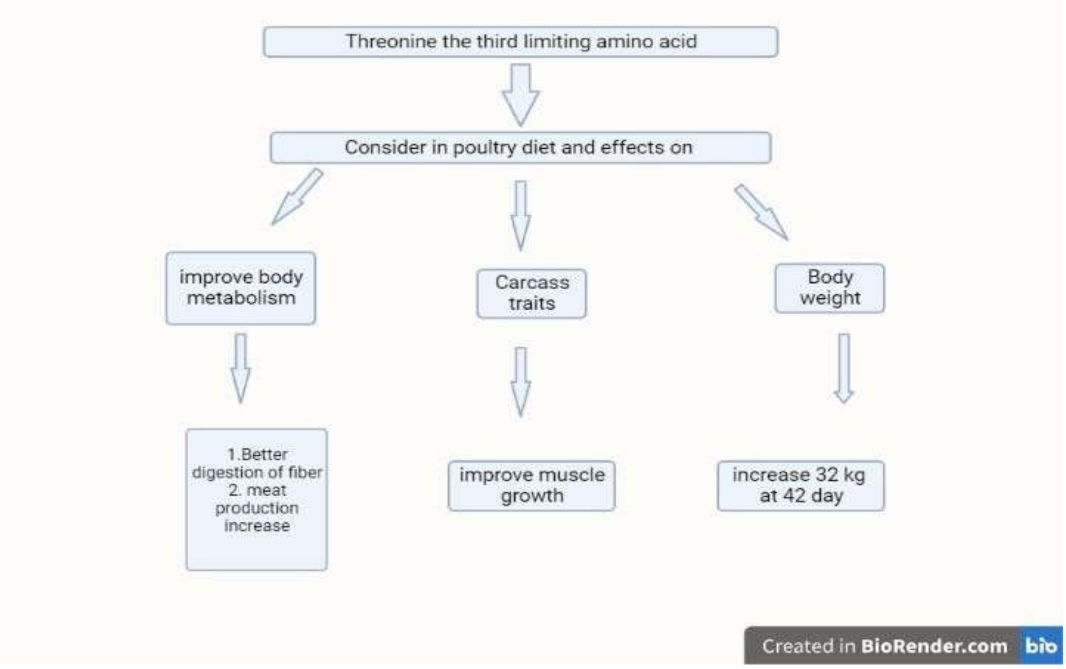

Figure 1: Effect of dietary threonine

MATERIAL AND METHODS

Six hundred and twenty-four 1-day-old white Pekin ducklings obtained from the Pekin duck breeding center of the Chinese Academy of Agricultural Sciences were randomly distributed to 72 pens of 8 birds, each according to similar pen weight. There were 12 dietary treatments each containing 6 replicate pens. Two Low and High protein diets containing 0.49% and 0.43 % Thr were formulated to provide adequate levels of all nutrients for white Pekin ducks. The basal Diet was supplemented with 6 levels of Thr (0, 0.06, 0.12, 0.18, 0.24, and 0.30%) to provide 0.46, 0.52, 0.58, 0.64, 0.70, and 0.76% of total Thr in low-protein diet and 0.54, 0.60, 0.66, 0.72, 0.78, and 0.84% of total Thr in High-protein diet. Feed and water were provided ad libitum; the experiment was conducted from 1 to 21 days of age.

Weight gain, feed intake, and feed/gain of ducks were measured at the beginning, middle, and end of the experiment. At 21 days of age, after being deprived of feed overnight, 2 ducks with the average body weight of the pen were selected randomly from each pen and killed by cervical dislocation, eviscerated manually, body weight was recorded, breast meat (including the pectorals major and pectorals minor muscles) leg meat (including thigh and drumstick), abdominal fat, liver, heart, pancreas, gizzard, spleen, and tibia were measured.

Birds were eviscerated manually, body weight was recorded, breast meat (including the pectorals major and pectorals minor muscles), leg meat (including thigh and drumstick), abdominal fat, liver, heart, pancreas, gizzard, spleen, and tibia were measured.

AMINO ACID ANALYSIS

To determine the amino acid contents of diets a water ion-exchange HPLC system was used. Samples were hydrolyzed by 6M HCL at 110° C for 24 h[10] and the oxidation process was carried out according to the AOAC method (AOAC,2000).and the amino acid in the diets was analyzed by ion-exchange chromatography (LC 3000; Biotronik, Eppendorf – Netheler – HinzGmbh, Hamburg, Germany)

STATISTICAL ANALYSIS

Data was analyzed by using the GLM procedure of SAS software. Dietary Threonine requirement was estimated by using the quadratic broken–line regression model by the NLIN procedure of SAS.

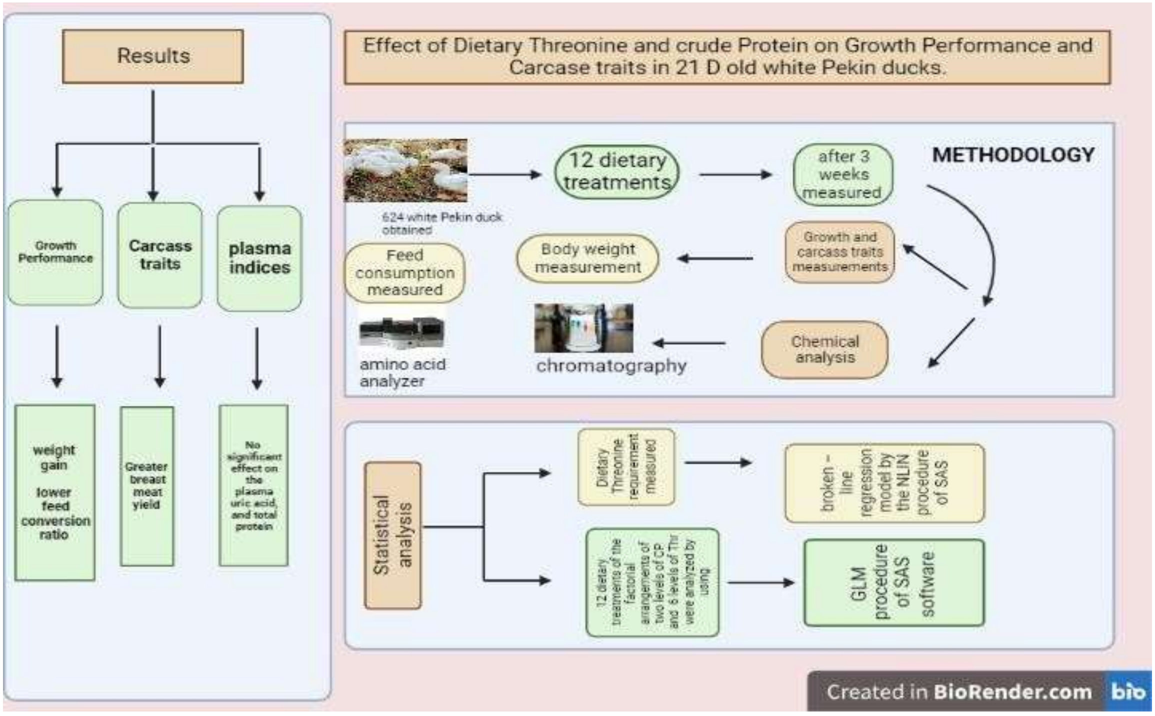

Figure 2: an overview of methodology and results

RESULTS AND DISCUSSION GROWTH PERFORMANCE

The effect of dietary Threonine and Protein on the growth performance of white Pekin ducks is shown in Table 2. In both the Low and High-Protein, diet an increase in dietary threonine significantly affected the feed intake, weight gain, and feed/gain in a 1-3 week period. In this study, Broken-line regression was used to estimate the Threonine requirement. According to regression, the Threonine requirement was 0.54% of the diet for feed intake and weight gain in the low-protein diet. While in the High-protein diet, the threonine requirement was 0.62% of the diet for feed intake and 0.61% of the diet for weight gain.

Threonine is an important part of many proteins and is required to help maintain the proper protein balance in the body. Threonine combines with the amino acids aspartic acid and methionine to help the liver with lipotropic function and supports cardiovascular, central nervous, and immune system function (Jiang et al., 2018).

Dietary threonine imbalance is known to reduce the growth of the small intestine, liver, and skeletal muscle in young animals, but the underlying mechanism is largely unknown. Threonine is known to require vitamin B-6, magnesium, and niacin for its optimal utilization and metabolism in the body (Xie et al., 2014).

CARCASS TRAITS

The effect of dietary Threonine and Protein on the carcass traits of white Pekin ducks is shown in Table. An increase in the dietary threonine in both the low and high-protein diets significantly affected the breast meat, leg meat, and gizzard percentages. Ducks fed the 0.73% Threonine in the low-protein diet reached the highest BMP and LMP. While the highest BMP in the ducks fed the 0.67% and the highest LMP was recorded in the ducks fed the 0.49% Threonine in the High- protein diet. apart from the Gizzard percentages, the abdominal fat, liver, heart, spleen, and tibia percentages have not been affected significantly in both the low or high-protein diets.

In both the low and high-protein diets, the Threonine supplementation did not affect significantly the abdominal fat, liver, heart, spleen, and tibia percentages except for gizzard percentages. The experimental low and high-protein basal diet consisted of a mixture of corn, wheat, and peanut meal according to the NRC recommendation (NRC) (Council, 1994)

In this study, we observed that by increasing the threonine supplementation in the high protein diet the feed intake, weight gain, BMP, and LMP have been affected significantly. However, the mortality rate in the ducks fed with the high protein diet was higher than the ducks fed with the low protein diet (Yamashita & Ashida, 1971).

In the ducks fed the low-protein diet, another phenomenon of bowed legs was observed. some of these ducks had smaller body sizes as compared to the ducks fed with a high protein diet. This suggests that excess or deficiency of Threonine caused an imbalance in the amino acid profile of the diet, which affected the body's metabolism. Hence while formulating the diets an adequate level of Threonine and protein should be supplied. A study already done in geese showed that the supplemental Threonine did not significantly affect carcass traits but improved the ECP. A similar phenomenon was observed in chickens and turkeys by other researchers. Threonine, besides its role as an essential amino acid in protein synthesis, is a metabolic precursor of glycine ((Rangel-Lugo, Su, & Austic, 1994).

According to a study by Barkley and Wallis, the dietary crude protein concentration in diets could cause the variation in threonine requirements for poultry. In broilers, when expressed as a percent of the diet, the threonine requirement increased as dietary protein content increased. However, when expressed as a percent of dietary protein, the threonine requirements were not markedly affected by dietary protein content (Dozier III, Moran Jr, & Kidd, 2000).

Therefore, when the threonine requirement estimated in the present study is extrapolated to practical duck production, one must be cautious that the threonine requirement is a percent of dietary protein if dietary protein increases or decreases (Abudabos & Aljumaah, 2012).

Composition of the Basal diet and the reference diet

Ingredient	high protein（%）	low protein（%）
Corn	22.00	25.25
wheat	48.00	53
peanut meal	24.50	16
soybean oil	1.00	0.97
dicalcium phosphate	1.30	1.3
limestone	1.00	1
salt	0.30	0.3
Premixture	1[1]	1[1]
Met	0.20	0.35
Lys	0.7	0.8
Try	-	0.03
Calculated		

composition		
Metabolizable energy	2.89	2.92
Crude protein	20.1	16.99
Calcium	0.8	0.79
Available phosphorus	0.38	0.37
Lys	1.09	1.07
Met	0.45	0.58
Thr	0.49	0.43

			1-2 weeks			1-3 weeks		
Calculated protein	Calculated threonine levels %	Added threonine levels %	average feed intake g/bird/day	weight gain g/bird/day	conversion rate g/g	average feed intake g/bird/day	weight gain g/bird/day	conversion rate g/g
	0.49	0	33.90	26.53e	1.28c	67.20d	43.47d	1.55d
	0.55	0.06	47.52	36.29c	1.31bc	93.63b	57.86b	1.62bc
High	0.61	0.12	53.71	40.37a	1.33abc	99.78ab	60.53ab	1.65bc
protein	0.67	0.18	54.64	41.10a	1.33abc	102.18a	62.67a	1.63bc
	0.73	0.24	54.57	39.98ab	1.37ab	101.04ab	60.32ab	1.68b
	0.79	0.30	54.56	40.65a	1.34ab	99.23ab	61.20ab	1.62bc
	0.43	0	21.08	15.29f	1.38a	39.90e	22.44e	1.78a
	0.49	0.06	39.70	29.52d	1.34ab	79.95c	50.33c	1.59cd
Lower	0.55	0.12	48.96	36.03c	1.36ab	96.65ab	58.24b	1.66b
protein	0.61	0.18	48.66	36.29c	1.34ab	94.46b	58.37b	1.62bc
	0.67	0.24	49.90	37.69bc	1.32abc	95.89ab	59.21ab	1.62bc
	0.73	0.30	49.33	36.99c	1.33abc	96.09ab	58.63ab	1.64bc
Pooled SE			1.47	0.90	0.02	2.34	1.27	0.02
protein	H	16.99	49.82a	37.49	1.32	93.85	57.67	1.62b
	L	20.1	42.94b	31.97	1.35	83.82	51.20	1.65a
Pooled SE			0.60	0.37	0.009	0.96	0.52	0.009
		0	27.49c	20.91	1.32	53.55	32.96	1.66
		0.06	43.61b	32.91	1.33	86.79	54.09	1.60
Added	threonine	0.12	51.33a	38.21	1.34	98.22	59.38	1.65

level	0.18	51.65a	38.70	1.34	98.32	60.52	1.70
	0.24	52.24a	38.84	1.34	98.47	59.76	1.65
	0.30	51.95a	38.82	1.34	97.66	59.91	1.63
Pooled SE		1.04	0.64	0.014	1.66	0.90	0.015
Protein		<0.0001	<0.0001	0.0749	<0.0001	<0.0001	0.0318
Added threonine level		<0.0001	<0.0001	0.9334	<0.0001	<0.0001	0.0703
Protein *Added threonine level		0.0583	0.0001	0.0307	<0.0001	<0.0001	<0.0001

			1-2 weeks			1-3 weeks		
Calculated average protein levels g/bird/day	Calculated average threonine levels %	Added threonine levels %	average feed intake g/bird/day	weight gain g/bird/day	conversion rate g/g	average feed intake g/bird/day	average weight gain g/bird/day	conversion rate g/g
	0.49	0	33.90	26.53e	1.28c	67.20d	43.47d	1.55d
	0.55	0.06	47.52	36.29c	1.31bc	93.63b	57.86b	1.62bc
High	0.61	0.12	53.71	40.37a	1.33abc	99.78ab	60.53ab	1.65bc
protein	0.67	0.18	54.64	41.10a	1.33abc	102.18a	62.67a	1.63bc
	0.73	0.24	54.57	39.98ab	1.37ab	101.04ab	60.32ab	1.68b
	0.79	0.30	54.56	40.65a	1.34ab	99.23ab	61.20ab	1.62bc
	0.43	0	21.08	15.29f	1.38a	39.90e	22.44e	1.78a
	0.49	0.06	39.70	29.52d	1.34ab	79.95c	50.33c	1.59cd
Lower	0.55	0.12	48.96	36.03c	1.36ab	96.65ab	58.24b	1.66b
protein	0.61	0.18	48.66	36.29c	1.34ab	94.46b	58.37b	1.62bc
	0.67	0.24	49.90	37.69bc	1.32abc	95.89ab	59.21ab	1.62bc
	0.73	0.30	49.33	36.99c	1.33abc	96.09ab	58.63ab	1.64bc
Pooled SE			1.47	0.90	0.02	2.34	1.27	0.02
protein	H	16.99	49.82a	37.49	1.32	93.85	57.67	1.62b
	L	20.1	42.94b	31.97	1.35	83.82	51.20	1.65a
Pooled SE			0.60	0.37	0.009	0.96	0.52	0.009
		0	27.49c	20.91	1.32	53.55	32.96	1.66
		0.06	43.61b	32.91	1.33	86.79	54.09	1.60
Added	threonine	0.12	51.33a	38.21	1.34	98.22	59.38	1.65
level		0.18	51.65a	38.70	1.34	98.32	60.52	1.70
		0.24	52.24a	38.84	1.34	98.47	59.76	1.65
		0.30	51.95a	38.82	1.34	97.66	59.91	1.63

Pooled SE	1.04	0.64	0.014	1.66	0.90	0.015
Protein	<0.0001	<0.0001	0.0749	<0.0001	<0.0001	0.0318
Added threonine level	<0.0001	<0.0001	0.9334	<0.0001	<0.0001	0.0703
Protein *Added threonine level	0.0583	0.0001	0.0307	<0.0001	<0.0001	<0.0001

Conclusion

Threonine supplementations have an impact on growth and carcass traits. An increase in dietary threonine had a significant impact on feed intake, weight gain, and feed-to-gain ratio during the 1- 3-week period in both low and high-protein diets. Threonine supplementation did not have a significant impact on abdominal fat, liver, heart, spleen, and tibia percentages in both low and high-protein diets. However, there was a notable effect on gizzard percentages.

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