LAYING PERFORMANCE OF QUAIL (*Coturnix coturnix*) FED DIETS FORMULATED BASED ON CRUDE PROTEIN RESTRICTION

Brando A. Cuaresma[1], Harvey L. Ermube[1], Ronald A. Fabros[1], Ronald D. Lantano[1], Janine I. Berdos[1], Marliza D. Viloria[1] and Ronaldo C. Briones[1]

ABSTRACT

The 60-day feeding trial was conducted to determine the effects of varying dietary crude protein (CP) levels (22, 21, 20, 19, 18%) on the laying performance of quails. Proximate composition of diets, egg production, egg quality parameters, and income over feed cost were measured to evaluate the effects of dietary protein restriction. For the feeding trial, a total of 150 quails were randomly assigned in five treatments following Completely Randomized Design (CRD); each treatment had three replications with 10 quails per replicate. The experimental treatments were: basal diet (BD) containing 20% CP (recommended/standard level), BD containing 22% and 21% (higher levels), and BD containing 19% and 18% (lower levels). Proximate analysis on the diet used indicated the same level of energy at 2900 ME kcal/kg. Feed offered was fixed at 30g/bird/day. Results of the study showed that quail layers given diets containing 22% CP and 18% CP had higher final weight ($P<0.01$). No differences were observed on egg production using different levels of CP ranging from 18% up to 22%. Improved yolk pigmentation ($P<0.01$) was observed using quail feed containing 18% CP. Numerically, higher income over feed cost (Php 16.98/quail) was attained from quail layer fed with 19% CP, beyond the recommended rate of 20% CP.

Key words: crude protein, quail, income over feed cost and yolk pigmentation

INTRODUCTION

One of the most important and growing industries in our country today is quail raising. It is a business that can be considered a profitable one because it can start with a small capital and small space requirement. Many quail farming creates a profitable business by selling eggs and meat which are good sources of protein (Decal, 2019).

The status of the quail industry in the Philippines is still in the growth stage, because not the entire country is having a quail business. This is the chance to develop and enhance the techniques in quail farming. The common breeds in the country are Japanese quail, Japanese Seattle and Japanese Taiwan (PinoyBisnesIdeas, 2018). With this, to be able to meet the demand for food and nutrition, one can be engaged in quail farming. This may lessen the dependency of the country on the importation of such poultry productions.

[1]Tarlac Agricultural University, Camiling, Tarlac, 2306 (janine.berdos@gmail.com).

Quail eggs are very nutritious than other poultry eggs because these contain comparatively more protein. It also contains carbohydrates, easily digestible fats and minerals (Wang, 2011). However, the quail egg production is hindered by the cost of some feed ingredients such as corn and soybean which significantly increased in pricing over the years. Thus, it is important to formulate diets to efficiently meet the needs of quail by formulating the correct amount of crude protein (CP) for optimum performance. Normally, the producing performance as recommended is increasing with the dietary CP (24% for growing and 22% for laying stage) with appropriate formulation (PHILSAN, 2010). Hence, the study was conducted to assess the proximate composition and its effect on egg production, egg weight and egg quality, and economic benefit when used as part of the ration of quail layers.

MATERIALS AND METHODS

A total of 150 six-week-old quail with an average weight of 145 g were used in the study. They were randomly assigned in five treatments following Completely Randomized Design (CRD). Each treatment had three replications with 10 quails per replicate. The experimental treatments were: 1) Basal diet (BD) containing 20% CP (standard level), 2) BD containing 22% CP, 3) BD containing 21% CP, 4) BD containing 19% CP, and 5) BD containing 18% CP.

The basal diet (Table 1) was least-cost formulated using User Friendly Feed Formulation (Pesti and Miller, 1993) following the recommended nutrients for quail (PHILSAN, 2010). The diet was in mash form and manually mixed.

A 150 g feed samples were placed in separate zip-lock plastic bags marked and sealed and were sent personally to the Department of Agriculture - Regional Feed Analysis Laboratory for proximate analysis.

Quail were weighed individually at the start of the experiment (day 0) and the end of the experiment (day 60). Total feed offered was also weighed and restricted feeding was followed consuming 30 g/quail/day. Feed conversion ratio (FCR) was calculated by dividing average daily feed intake by the average egg weight. Average egg weight was calculated by dividing total egg weight by the total number of eggs produced.

Egg composition and egg quality were estimated based on hen-day egg production, yolk color score and weight, and albumen weight. Thirty percent of eggs collected per replication was used for evaluating the egg composition and egg quality. This was done every week throughout the study.

Economic benefit was calculated using income over feed cost (IOFC) as the criterion. Income over feed cost was calculated as the difference of the total sale value of eggs and the cost of feeds consumed per hen-housed.

Data were analyzed using ANOVA (Analysis of Variance) of STAR (Statistical Tool for Agricultural Research), version 2.0.1 (IRRI,2014). The least-significant differences (LSD) test was used to determine significant differences between treatment means at P=0.05.

RESULTS AND DISCUSSION

The analyzed proximate values (Table 2) generally characterized the chemical composition of the basal diet and were in most cases in agreement with those in the literature. Results indicate that the crude protein was of main interest in the study where it was

Table 1. Ingredient and nutrient composition (as fed basis) of quail layer diet.

Item	Price/ kg (Php)	Basal Diet				
		20% CP (Recommended)	22% CP	21% CP	19% CP	18% CP
Ingredients, %						
Yellow Corn	22.00	40.50	37.13	38.52	41.78	56.87
Soybean meal, USHP	33.00	23.00	23.00	23.00	23.00	23.00
Rice bran, D1	18.00	8.12	8.23	8.64	8.12	9.20
Wheat, soft	22.00	15.00	15.00	15.00	15.00	--
Pork meal, 60%	60.00	5.00	5.00	5.00	3.15	2.14
Palm oil, refined	65.00	2.13	2.25	2.14	2.33	1.94
Limestone, coarse	9.00	2.00	2.00	2.00	2.00	2.00
Limestone, fine	9.00	3.12	3.13	3.12	3.24	3.29
Salt	15.00	0.30	0.30	0.30	0.30	0.30
Monodicalcium phosphate	40.00	0.44	0.45	0.44	0.69	0.84
Vitamin premix[1]	1,300.00	0.03	0.03	0.03	0.03	0.03
Mineral premix[2]	100.00	0.15	0.15	0.15	0.15	0.15
Choline chloride	80.00	0.10	0.10	0.10	0.10	0.10
DL-Methionine	200.00	0.09	0.09	0.09	0.11	0.13
L-lysine	100.00	0.03	0.48	1.47	--	--
L-Threonine	98.00	--	2.66	--	--	--
Total	--	100.00	100.00	100.00	100.00	100.00
Calculated composition, %						
CP	--	20.00	22.00	21.00	19.00	18.00
Crude fiber	--	2.62	2.49	3.04	2.59	2.65
Crude fat	--	6.00	6.00	6.00	6.00	6.00
ME (kcal/kg)	--	2900	2900	2900	2900	2900
Met	--	0.45	0.45	0.48	0.45	0.45
Met+Cys	--	0.78	0.78	0.85	0.78	0.76
Lys	--	1.05	1.50	1.20	1.05	1.00
Thr	--	0.73	3.38	0.80	0.72	0.69
Trp	--	0.23	0.23	0.25	0.23	0.21
Ca	--	2.50	2.50	2.50	2.50	2.50
P, available	--	0.35	0.35	0.35	0.35	0.35
Costing diet, Php	--	27.15	29.58	28.26	26.59	26.05

[1]The vitamin premix provided the following quantities of vitamins per kg of complete diet: vit. A, 65,000,000 IU; vit. D3, 5,000,000 IU; vit. E, 100,000 mg; vit K3, 10,000 mg; vit. B1, 10,000 mg; vit. B2, 27,000 mg; vit. B6, 15,000 mg; vit. B12, 200 mg; niacin, 200,000 mg; folic acid, 5,000 mg; pantothenic acid, 60,000 mg; and biotin, 1,000 mg; [2]The mineral premix provided the following quantities of minerals per kg of complete diet: iron, 80,000 mg, copper, 10,000 mg, zinc, 80,000 mg, manganese, 70,000 mg, cobalt, 200 mg, selenium, 200 mg, and iodine, 800 mg.

expected to influence egg synthesis by quail.

The amount of crude protein could be lowered beyond the standards with those found in the literature (Table 3). On the other hand, the ash, crude fiber and crude fat values were lower, except for the diet containing 19% CP in which crude fiber was higher from the Philippine recom-mendations for poultry (PHILSAN, 2010).

It is recognized that the high variation can be attributed to samples used for analysis, which reflects the unpredictability and inconsistency of nutritional quality among the feed ingredients (Nasaka *et al*., 2018).

There were no significant (P>0.05) differences among groups regarding the production parameters, except for final weight in which a lower value (P<0.01) was observed for quail in the control group and quail offered 21% CP and 19% CP compared with their counterpart (Table 4).

It was observed that the significantly lower final weight of the quail fed the diet with 19% CP was associated with other factors like physiological since the quail were layers, thus, they were not required to be overfed. The low body weight of the quails fed diets with 19% CP is attributed also to the very low fat and high fiber content of the diet compared with the other treatments. However, these quail fed diets with 19% CP had the highest egg production, with satisfactory FCR . Meanwhile, the weight of its counterparts was found to be in the range as report-ed that female quail weighs 120-160 g (Randall, 2007).

It was also considered that feed restriction (30/g/day) for quail did not deteriorate egg production (Mahrose *et al*., 2020). Additionally, Murakami *et al*. (1993) recommended 18% of crude protein, which is lower than the level of 22.42% recommended by Pinto *et al*. (1998) (as cited by Soares *et al*. 2003) for quails during laying period. As such, reported crude protein levels in the study had no effect on its production performance.

Table 2. Proximate content of quail layer diet on dry matter (DM) basis.

Amount	Item				
	20% CP (Recommended)	**22% CP**	**21% CP**	**19% CP**	**18% CP**
Proximate, %					
Moisture	9.40	10.70	10.50	10.80	10.50
Crude protein	19.40	19.30	17.00	20.60	17.00
Ash	12.10	11.80	12.30	13.30	12.30
Crude fiber	3.70	5.90	5.40	9.80	5.40
Crude fat	2.90	2.30	2.60	0.70	2.60
Nitrogen free extract	61.30	58.00	58.70	57.20	61.70
Metabolizable energy, kcal/kg	2900	2900	2900	2900	2900

Table 3. Published proximate or chemical composition of quail layer diet.

Proximate, %	A[1]	B[2]	C[3]
Dry matter	92.30	92.50	-
Moisture	-	-	-
Crude protein	19.00	16.80	17.60
Crude fiber	6.00	6.30	6.22
Ether extract	6.40	6.50	6.94
Ash	20.20	19.50	-
Nitrogen-free extract	-	-	-

[1,2] - DM basis, [3] - as fed
A, B - Nasaka *et al*., 2018; C- Ayuni *et al*., 2019

Table 4. Performance and body weights of laying quail fed with different levels of dietary crude protein

Item	Treatment					SEM	*P*-Value
	20% CP (Recommended)	22% CP	21% CP	19% CP	18% CP		
Production Performance							
Hen-day egg production, %	82.00	78.39	81.50	86.44	79.67	4.88	0.56
Feed intake, g/day	30.00	30.00	30.00	30.00	30.00	0.00	0.58
Feed conversion ratio	2.88	2.90	2.89	2.97	2.98	0.09	0.70
Body Weights							
Initial weight, g	147.19	146.60	145.65	146.21	147.21	2.57	0.97
Final weight, g	130.57^{bc}	138.28^{a}	126.68^{c}	115.22^{d}	136.25^{ab}	3.24	0.00

[a-d] Means within a row with different superscript are significantly different (P<0.05).

There were significant differences in the quality of eggs between quail fed with different levels of dietary crude protein. Statistical analyses show that the kind of ration significantly (P<0.01) influenced yolk pigmentation (Table 5). The finding indicated that egg weight depended greatly on daily protein in-take (Murakami *et al*., 1993) yet a recent study shows a good result based on the ideal egg weight of quail with 9.3 g or more (Yamane *et al*., 1979). Likewise, yolk weight was consistent with the findings of Garcia *et al*. (2005) where protein levels had no effect on its yolk percentage. In contrast, Khosro *et al*. (2011) found that 20% CP level improved yolk weight (P <0.05). The results of Agboola *et al*. (2016) and Muhammad *et al*. (2016) on albumen weight supports

the result of the study wherein increasing the dietary CP from 18 to 24% did not affect yolk or albumen weight.

Furthermore, based on the DSM Roche yolk color, all values were within the range of indicating its pale-yellow color of egg yolk. The differences found in the study may be due to a dietary factor such as carotenoids. Meanwhile, Hasin *et al*. (2006) proved that the color of the egg yolk was only significant for consum-ers' fulfillment and, for the most part, consumers throughout the world are inclined toward yolk colors ranging from yellow to orange.

The quail fed with different levels of dietary crude protein did not differ in eggs produced. However, numerically, quails fed diets with 19% CP had the highest sale value of eggs. Overall, the highest IOFC can be derived from eggs produced by quails fed diets with 19% CP with a value of Php 16.98 per quail compared with its counterparts (Table 6).

Table 5. Quality and composition of egg produced from laying quail fed with different levels of dietary crude protein.

Egg Quality and Composition	Treatment					SEM	*P*-Value
	20% CP (Recommended)	22% CP	21% CP	19% CP	18% CP		
Albumen weight, g	5.54	5.71	5.75	5.42	5.38	0.20	0.31
Yolk weight, g	3.27	3.22	3.19	3.11	3.07	0.98	0.32
Yolk pigmentation, DSM units	4.74[b]	4.92[b]	4.86[b]	4.92[b]	5.61[a]	0.17	0.00
Egg weight, g	10.65	10.64	10.55	10.33	10.16	0.29	0.41

[a-b] Means within a row with different superscript are significantly different ($P<0.05$).

Table 6. Income over feed cost of laying quail fed with different levels of dietary crude protein.

Item	Treatment				
	20% CP (Recommended)	22% CP	21% CP	19% CP	18% CP
Eggs produced[1], pcs	49.20	47.03	48.90	51.87	47.80
Sale value of eggs[2], Php	61.50	58.78	61.13	64.84	59.75
Feed consumed[3], kg	1.80	1.80	1.80	1.80	1.80
Feeds consumed, Php	48.87	53.24	50.87	47.86	46.89
IOFC, Php	12.63	5.54	10.26	16.98	12.86

[1]Average egg production per bird for 60 days.

[2]Suggested retail price per egg is based on market price as of 2020. Price per fresh egg is Php 1.25.

[3]Average feed consumed per bird for 60 days and diet cost per kg is Php 27.15, Php 29.58, Php 28.26, Php 26.59, and Php 26.05, respectively.

The result indicated that lowering CP content could lower feed cost, thus increasing income while feed cost increased with diets containing higher CP levels. There is an economic advantage of lowering CP to a diet which in turn be profita-ble when it will be adopted into a larger farm scale (Sterling *et al*., 2005; Burley *et al*., 2013). However, it was only based on the production for the 60-day trial from the point of lay.

Based on the results, quail layer diets with varying CP levels from 18% to 22% did not affect egg production of quails. Moreover, CP levels could be lowered for quail diets without negatively affecting the production and laying performance of quail. Moreover, feeding low level of CP at 19% could increase IOFC.

ACKNOWLEDGEMENT

We acknowledge the College of Agriculture and Forestry of Tarlac Agricultural University for partly supporting the work in terms of the facility used. Likewise, we would like to acknowledge the Department of Agriculture-Region III Feed Analysis Laboratory for the free service provided to us.

REFERENCES

Agboola AF, Omidiwura BRO, Ologbosere DY and Iyayi EA. 2016. Determination of crude protein and metabolisable energy of Japanese quail *(Coturnix coturnix japonica)* during laying period. *J World Poult Res* 6(3):131-138.

Ayuni Y, Syamsuhaidi and Wiryawan KG. 2019. The effects of graded levels of fermented duckweed in quail diets on egg production and yolk cholesterol. *IOP Conf Ser: Earth Environ Sci* 387:012112.

Burley HK, Patterson PH and Elliot MA. 2013. Effect of a reduced crude protein, amino acid-balanced diet on hen performance, production costs, and ammonia emissions in a commercial laying hen flock. *J Appl Poult Res* 22:217–228.

Decal R. 2019. Magsasaka TV. *Quail Farming (Episode 26)*. YouTube. Retrived on 12 August 2019 from https://www.youtube.com/watch?v=qIXDW9Sa1P8&t=27s.

Garcia, EA, Mendes AA, Pizzolante CC, Saldanha ESPB, Moreira J, Mori C and Pavan AC. 2005. Protein, methionine + cystine and lysine levels for Japanese quails during the production phase. *Braz J Poult Sci* 7(1):11-18.

Hasin, BM, Ferdaus AJM, Islam MA, Uddin MJ and Islam MS. 2006. Marigold and orange skin as egg yolk color promoting agent. *Int J Poult Sci* 5(10):979-987.

Khosro G, Mehrelad I, Reza J, Afshar MA, Seyed AS, and Abbas JV. 2011. The effect of energy to protein ratio on production performance and characteristics of Japanese quail eggs. *Ann Biol Res* 2(2):122- 128.

Mahrose K, Abol-Ela S, Amin R and Abou-Kassem D. 2020. Restricted feeding could enhance feed conversion ratio and egg quality of laying Japanese quail kept under different stocking densities. *Anim Biotechnol* 1-9.

Muhammad N, Altine S, Abubakar A, Chafe UM, Saulawa LA, Garba MG and Yusuf A. 2016. Effect of varying protein levels and preservation methods on egg production performance and internal egg qualities of Japanese quails in a semi-arid environment. *Eur J Appl Sci* 3:8-19.

Murakami AE, Moraes AMB, De Ariki J, Junqueeira DM, Kronka OM and S. Don. 1993. Levels of protein and energy in diets of laying Japanese quails (*Coturnix coturnix japanica*). *R Bras de Zootec* 22(4):541-551.

Nasaka J, Nizeyi JB, Okello S and Katongole CB. 2018. Nutritional quality of quail feeds used in urban and peri-urban areas of Uganda: Chemical and energy composition. *Poult Sci J* 6(1):63-70.

Pesti GM and Miller BR. 1993. *Animal feed economic and computer application*. New York: Nostrand reinhold (Van).

PHILSAN. 2010. *PHILSAN Feed Reference Standards*. 4th ed. Philippines: Philippine Society of Animal Nutritionists. Philippines.

PinoyBisnesIdeas. 2018. *Quail Raising Guide - How to Raise Quails.* Blog. Retrieved on 24 December 2018 from https://businessdiary.com.ph/441/quail-raising-guide/.

Randall M. 2007. *Raising Japanese quail*. Newsletter. Retrieved on 25 March 2021 from https://www.thepoultrysite.com/articles/raising-japanese-quail-1#:~:text=Adult%20japanese%20quail%20eat%20between,free%20from%20animals%20and%20vermin.

Soares R, Fonseca JB, Santos AS and Mercandante MB. 2003. Protein requirement of Japanese quail (*Coturnix coturnix japonica*) during rearing and laying periods. *Braz J Poult Sci* 5(2):153-156.

Sterling KG, Vedenov DV, Pesti GM and Bakalli RI. 2005. Economically optimal dietary crude protein and lysine levels for starting broiler chicks. *Poult Sci J* 84:29-36.

Yamane T, Ono K and Tanaka T. 1979. Protein requirements of laying Japanese quail. *Br Poult Sci* 20:379-383.

Wang YX, Li YQ, Pang YZ, Li JX, Xie XH and Guo TJ. 2011. The effect of crude protein level in diets on laying performance, nutrient digestibility of yellow quails. *Int J Poult Sci* 2011 10(1):110-112.