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Influence of Energy, Protein and Fishmeal Levels on the Growth and Egg Production of Japanese Quails (*Coturnix coturnix Japonica*)

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Abstract: **Feeding experiment was conducted to determine the influence of dietary levels of metabolizable energy (ME) of 2900 and 3000 kcal/kg, crude protein (CP) of 20, 22 and 24 percent, and fishmeal (FM) of 0, 4 and 8 percent on the growth (Study 1), egg production (Study 2). The procedure experiments in a Completely Randomized Design were followed using 540 day-old Japanese quails. These were randomly assigned in each dietary preparation and three replications of 10 birds in each cage. The birds were fed with starter diet from 1 to 42 days old while layer diet was fed from 43 to 126 days old. Feed intake of the growing quails was enhanced by FM inclusion particularly in the diet with 2900 kcal ME/kg and 22 percent CP. Optimal feed conversion ratio (FCR) was noted in the 3000 kcal ME/kg, 24 percent CP and 4 percent FM, but only in 18 days old. Egg production rate was higher with 2900 than 3000 kcal ME/kg irrespectively of CP and FM levels. This was also translated in terms of lower feed conversion ratio. Optimal conversion of feed to egg and egg to weight was attained with 8 percent FM, irrespectively of ME and CP levels in the diet. The economic analysis in the Study 2 showed higher income over feed cost (IOFC) for diet with2900 than 3000 kcal ME/kg irrespective of CP and FM levels. Also, IOFC was higher in the 8 percent FM than 0 FM but comparable with 4 percent FM irrespective of ME and CP.**

Keywords: **Metabolizable energy (ME), crude protein (CP), fishmeal (FM), and Egg production.**

1. INTRODUCTION

Quail belongs to gallinaceous family like the chicken introduces in Asia, Africa, Europe, and USA as migratory birds. There are four varieties of domesticated quails namely, bobwhite quail *(Collinus virginianus)*, California quail (*Lophortyx california*), European quail (*Coturnix coturnix coturnix*), and Japanes quail (*Coturnix coturnix japonica*). All or nearly modern domestic quails were derived from the wild Japanese quail, now recognized as distinct species *Coturnix coturnix japonica*. Domestication began about 11th century in Japan, China and Korea although very little information is available concerning domestication and early history of Japanese quail (Ali, 1984).

The development of quail industry has not only been in terms of size, but also in productivity, sophistication, image, and versatility. Some factors, which have favored the growth and development of quail production during such a short span are the following: small initial investment; short generation interval of quail compared with other livestock species; plentiful; availability of good quality quail chicks; quick and assured financial return; availability of trained manpower; better understanding and knowledge of improved and scientific methods of feeding; management; and health control; government measures for easy availability of loans; acceptance of quail eggs and meat by all sectors of the society irrespective of caste, creed, and religion, and special role of quail in helping to overcome poverty and effort to reduce nutritional differences and to improve the quality of human diet not only in the Philippines but also other countries.

Despite the advantages of the quail industry in the Philippine society and economy, studies on the nutritional requirements of quails are few. As such, optimum performance and profitability are compromised due to the lack of information on the levels of nutrients that should be provided in the diet of the birds. This problem is further confounded by the introduction of new generation of quails that are more productive than their earlier counterparts it is in this context that this study was undertaken.

To help solve this gap on quail nutrition, this study was undertaken to determine the influence of dietary metabolizable energy (ME), crude protein (CP) and fishmeal (FM) levels on the performance of Japanese quails (Coturnix coturnix japonica). Specifically, it was aimed to determine the influence of ME, CP and FM levels on the growth performance of quails and determine the effect of ME, CP and FM levels on the egg production performance.

2. MATERIALS AND METHODS

Study 1. Influence of Energy, Protein, and Fishmeal Levels on the Growth Performance of Japanese Quails:

Experimental Animals and Design:

The 540 female day-old Japanese quails (*Coturnix coturnix japonica*) used in the study were procured from a farm in Santa Maria, Bulacan. This were randomly assigned into 18 dietary preparations in a 2 x 3 x 3 factorial experiments with three replications of 10 birds each cage following completely randomized design.

Experimental Diets:

Diets were formulated using maize (yellow), coconut oil and rice bran D1, and plant protein supplements (soybean meal). The dietary treatments consisted of two levels of ME (2900 and 3000 kcl ME/kg), three levels of CP (20, 22, and 24 percent) and three levels of FM (0, 4 and 8 percent)

Data Gathered:

All pertinent data and other relevant information were properly monitored and recorded. These were needed in the calculation of technical and financial results related to the different parameters of the study at sexual maturity of 42 days.

Cumulative Body Weight Gain:

Initial and weekly body weight gain of the birds was determined by groups. The cumulative body weight gain (g) of the birds was obtained by using the formula:

Cumulative body weight gain = Present weight (g) – Initial weight (g)

Average Cumulative Feed Consumption per Bird:

At the start of the study, the required amount of feed in a given period was weighed in plastic bags while the remaining feed at the end of the period was also weighed. The difference between the weight of the allotted feeds and left- over feeds was recorded as the feed consumed of the group for the period. Cumulative feed consumption was calculated using this formula:

$$\text{Average Cumulative Feed Consumption per Bird} = \frac{\text{Total feed consumed of the flock (g)}}{\text{No. of chicks housed}}$$

Average Cumulative Feed Conversion Ratio per Bird:

The feed conversion ratio (FCR) was calculated as the ratio of the total amount of feed consumed (g) and total body weight gain (g) for the same period. This was measured using the formula:

$$\text{Average Feed Conversion Ratio} = \frac{\text{Total feed consumed (g)}}{\text{Total body weight gain}}$$

Average Uniformity Percentage:

The uniformity percentage of the birds was determined at sexual maturity at 42 days. Birds from each treatment replicate were weighed individually to determine their uniformity percentage using the formula:

$$\text{Average Uniformity percentage} = \frac{\text{No. of birds with weight w/in} \pm 10\% \text{ of the mean body weight}}{\text{No of samples}}$$

All data collected were organized and analyzed using Statistical Analysis Software (SPS). Significant treatment differences were compared by Least Significant Difference.

Study II. Effect of Dietary Energy, Protein, and Fishmeal Levels on Egg Production Performance of Japanese Quails:

The study was undertaken to determine the influence of energy, protein and fishmeal levels on the egg production performance of Japanese quails (*Coturnix coturnix japonica*).

Experimental Animals, Design, and Treatments:

The same experimental birds units, treatment and statistical design used in Study 1 were used in Study 2. Eighteen layer diets were formulated for the study.

Feeding Management:

At the start of the 43rd day, the feeds were gradually changed to layer diets. The type of feed given was in the form of mash. *Ad libitum* feeding was practiced.

Left-over feeds were collected and weighed on a weekly basis to determine weekly feed intake.

Data Gathered:

All pertinent data for the measurement of technical and financial results were properly monitored and recorded. The data gathered were as follows:

Average Laying Percentage:

Eggs were collected, counted, and recorded daily from 43 to 168 days. The hen-day egg production rate was computed using the formula.

$$\text{Average Egg production rate} = \frac{\text{Total number of eggs collected, pcs.}}{\text{Number of hen-days}} \times 100$$

Average Feed Consumption:

The required amount of feed in a given period was weighed in plastic bags and the remaining feed at the end of each period was also weighed. The difference between the weighed allotted feed and left-over feeds were recorded as the feed consumption of the group for the period. Feed consumption of the bird per day was computed using the formula.

$$\text{Average Feed consumption} = \frac{\text{Total feed consumed per group (g)}}{\text{Number of hen-days}}$$

Average Feed Conversion Ratio:

The feed conversion ratio (FCR) was calculated as the ratio of the amount of feed consumed and total weight of eggs produced by birds over the same period. FCR was calculated using the formula:

$$\text{Feed Conversion Ratio} = \frac{\text{Total feed consumed (g)}}{\text{Total egg weight (g)}}$$

Average Egg Weight

The eggs were randomly sampled from the eggs collected twice a week, every Tuesday and Friday and weighed. The average egg weight was calculated using the formula:

$$\text{Average egg weight} = \frac{\text{Total egg weight (g)}}{\text{Number of samples (pieces)}}$$

Eggshell Thickness:

This was measured in millimeter by means of a micrometer Vernier caliper. Measurement was done following procedure of Whyte (1992) as follows:

1. Measured one time at the blunt end
2. Measured one time between the midpoint of the blunt and pointed end
3. Measured one time at the pointed end
4. Then the average of the three figures was calculated.

Income over Feed Cost:

Income over feed costs of birds fed with 18 diets from 43rd day up to 168 days of egg production was computed by deducting the cost of feed from the sales of egg produced. The cost and income analysis of the study was based on the prevailing prices of raw ingredient and farm-gate price of eggs. This was constant at 0.60 per egg. All collected eggs were assumed to be all sold based on cumulative measurement while the price of feed was based on the computed cost of feed consumed using the formula:

Income over feed cost = Sale value of eggs (PhP)- Cost of feeds (PhP)

3. RESULTS AND DISCUSSIONS

This section presents the analyses and interpretation of the data obtained from the two experiments. This evaluated the influence of metabolizable energy (ME), crude protein (CP) and fishmeal (FM) levels on the growth, egg production and egg quality of Japanese Quails.

Study 1. Dietary Energy, Protein and Fishmeal Levels On the Growth of Japanese Quails:

Average Cumulative Body Weight Gain:

The mean cumulative body weight gain of the birds in various periods (18d, 25d, 32d, 39d and 42d) revealed that mean body weight gain of the birds was not influenced by dietary ME in any of the measurement periods. Rather, body weight gain of the birds was influenced by crude protein (CP) at 25 days and fishmeal (FM) at 18, 25 and 32 days old. Interaction effects of these dietary factors were not significant in any of the measurement periods.

Moreover, the diet with 24 percent CP significant supported body weight gain with a value of 39.48 g. this was higher than the diet with 22 and 20 percent CP (36.17 g and 36.26 g respectively). Also, the inclusion of 4 percent FM in the diet significantly resulted in higher body weight gain of 18.29 g, 39.85 g and 64.38 g. these values were higher than the diet without fishmeal (15.24 g, 34.87 g and 60.66 g) at 18, 25 and 32 days old respectively. However, 8 percent FM inclusion in the diet did not increase body weight gain of the birds.

Table 1. Mean cumulative body weight gain of the Japanese quails as influenced by metabolizable energy (ME), crude protein (CP), and fishmeal (FM) levels

ME (kcal/kg)	CP (%)	FM (%)	PERIOD Initial Weight	18d	25d	32d	39d	42d
			0.1214	0.3717^{ns}	0.6586^{ns}	0.5304^{ns}	0.3280^{ns}	0.3857^{ns}
2900	20	0	20.86	15.54	35.72	58.73	78.63	88.41
		4	20.96	19.30	38.55	62.82	80.07	91.42
		8	22.26	17.63	37.46	62.44	84.28	96.25
	22	0	18.97	14.02	34.69	57.60	82.19	92.52
		4	23.43	17.18	40.30	62.83	84.16	93.47
		8	22.43	16.59	36.34	59.31	78.99	90.75
	24	0	22.46	15.32	35.20	60.57	78.65	87.24
		4	23.77	17.74	42.70	65.03	83.79	95.66
		8	22.17	16.14	36.64	62.20	79.34	89.36
3000	20	0	19.96	16.57	33.52	60.91	76.59	86.48
		4	21.85	15.77	38.27	66.63	81.80	90.20

		8	20.95	14.20	34.02	59.93	76.71	89.49
	22	0	23.96	13.31	30.87	57.28	75.27	87.78
		4	23.10	17.53	36.37	63.92	77.33	86.00
		8	23.84	19.23	38.46	62.60	77.73	91.61
	24	0	22.19	16.67	39.21	68.90	84.66	94.22
		4	24.35	22.23	42.94	65.03	83.23	90.76
		8	22.93	18.73	40.18	62.23	81.35	90.38
Significant of main effects								
ME			0.1221	0.5033 ^{ns}	0.7254 ^{ns}	0.2263 ^{ns}	0.2273 ^{ns}	0.1997 ^{ns}
2900			21.92	16.86	36.89	61.73	79.49	90.54
3000			22.65	16.19	37.71	62.89	81.07	90.76
CP			0.0036	0.2525 ^{ns}	0.0455*	0.1633 ^{ns}	0.2870 ^{ns}	0.8586 ^{ns}
	20		21.14	16.76	37.17^{ab}	61.06	81.44	92.35
	22		22.62	16.95	36.73^{b}	62.54	79.47	89.51
	24		23.10	17.94	38.00^{a}	63.32	79.93	90.09
FM			0.3533	0.0111*	0.0060**	0.0978 ^{ns}	0.3353 ^{ns}	0.5384 ^{ns}
		0	21.52	15.57^{b}	34.86^{b}	60.66	79.33	89.41
		4	22.91	18.29^{a}	39.86^{a}	64.82	81.72	91.25
		8	22.43	17.08^{ab}	37.17^{ab}	61.45	79.79	91.30
ME x CP			ns	0.057^{ns}	0.212^{ns}	0.879^{ns}	0.096^{ns}	0.384^{ns}
ME x FM			ns	0.996^{ns}	0.769^{ns}	0.675^{ns}	0.928^{ns}	0.472^{ns}
CP x FM			ns	0.361^{ns}	0.788^{ns}	0.615^{ns}	0.887^{ns}	0.587^{ns}
ME x CP x FM			ns	0.372^{ns}	0.659^{ns}	0.530^{ns}	0.328^{ns}	0.386^{ns}

Mean having different superscript a-b within the column of CP and FM is significantly different from each other at ($p < 0.05$)
ns = not significant
* = Significant ($p < 0.05$)
** = highly significant ($p < 0.01$)

These findings indicated that 24 percent CP and 4 percent FM irrespective of ME, supported optimal growth in the early period. Dietary proteins of 24 percent appeared to provide the amino acids for tissue synthesis. The earlier work of Vohra (1971) also showed that best growth response was during the first 21 days with 24 percent CP while 20 percent CP was satisfactory after this period. For quails grown in the Philippines, Lazaro (2001) recommended 23 percent CP with 2800 kcal ME/kg.

The response to 4% FM, irrespective of ME and CP level reflected the favorable contribution of FM to the quality of protein from the diet. This was also highlighted by *Lee et al* (1981).

Evidently the present results revealed that during the growing period (past 32 days), the birds had comparable growth responses to any of the dietary factors. Similarly, findings of *Murakami et al* (1993a) showed lack of body weight differences of quails until 42 days of feeding diets with 2800-3000 kcal ME/kg and 20-26 percent CP. This present result suggests that growing quails can be fed with low nutrient density (20 percent CP and 2900 kcal ME/kg) and without FM.

Average Cumulative Feed Consumption:

The mean cumulative feed consumption of the birds in various periods (18d, 25d, 32d, 39d and 42d) as influenced by dietary factors and presented in Table 2 revealed that the mean feed consumption was not influenced by ME and CP in any of the measurement periods.

Table 2. Mean cumulative feed consumption (g) of Japanese quails as influenced by dietary metabolizable energy (ME), crude protein (CP), and fishmeal (FM) levels

ME (kcal/kg)	CP (%)	FM (%)	PERIOD				
			18d	25d	32d	39d	42d
			0.0488*	0.0376*	0.0187*	0.2500^{ns}	0.2002^{ns}
2900	20	0	92.63^{ab}	193.87^{a}	297.86^{a}	390.34	442.12
		4	89.27^{abc}	184.75^{abcd}	290.48^{abcd}	387.41	452.95
		8	86.85^{abc}	187.74^{abc}	276.65^{cdf}	378.36	433.68
	22	0	76.81^{c}	168.91^{b}	261.06^{f}	324.38	377.73

		4	94.27^{ab}	195.03^{a}	294.13^{ab}	386.68	450.53
		8	86.80^{abc}	176.29^{bcd}	272.41^{ef}	373.70	433.11
	24	0	90.56^{abc}	192.25^{ab}	282.97^{abcde}	316.35	373.96
		4	89.16^{abc}	188.99^{abc}	293.65^{abc}	386.52	450.68
		8	85.52^{abc}	183.92^{abcd}	286.29^{abcde}	380.83	432.99
3000	20	0	82.69^{bc}	173.48^{cd}	275.15^{def}	374.43	426.78
		4	89.30^{abc}	182.81^{abcd}	284.36^{abcde}	376.90	434.22
		8	86.33^{abc}	175.58^{bcd}	276.76^{cdef}	376.53	438.18
	22	0	99.24^{a}	187.76^{abc}	292.80^{abc}	382.93	443.94
		4	87.87^{abc}	180.46^{abcd}	282.11^{abcd}	377.99	431.13
		8	91.82^{ab}	184.11^{abcd}	286.24^{abcd}	387.26	448.49
	24	0	89.62^{abc}	179.34^{abcd}	277.34^{bcdef}	370.65	432.35
		4	93.08^{ab}	181.28^{abcd}	284.81^{abcde}	382.20	438.41
		8	95.67^{ab}	188.64^{abc}	284.23^{abcde}	376.89	432.71
ME			0.2519^{ns}	0.1395^{ns}	0.6507^{ns}	0.1708^{ns}	0.2062^{ns}
2900			87.99	185.75	283.95	269.40	427.53
3000			90.62	181.50	282.65	378.42	436.25
CP			0.6119^{ns}	0.5535^{ns}	0.6167^{ns}	0.3192^{ns}	0.4052^{ns}
	20		87.85	183.04	283.54	380.66	437.99
	22		89.47	182.09	281.46	372.16	430.82
	24		90.60	185.74	284.88	368.91	426.85
FM			0.7593^{ns}	0.6281^{ns}	0.0592^{ns}	0.0134^{*}	0.0071^{**}
		0	88.59	182.60	281.20	359.85^{b}	416.15^{b}
		4	90.49	185.55	288.26	382.95^{a}	442.99^{a}
		8	88.83	182.71	280.430	378.93^{ab}	436.53^{ab}
ME x CP			0.159^{ns}	0.090^{ns}	0.0124^{*}	0.136^{ns}	0.159^{ns}
ME x FM			0.555^{ns}	0.495^{ns}	0.163^{ns}	0.0418^{*}	0.0106^{*}
CP x FM			0.995^{ns}	0.728^{ns}	0.444^{ns}	0.196^{ns}	0.462^{ns}
ME x CP x FM			0.0488^{*}	0.0376^{*}	0.0187^{*}	0.250^{ns}	0.200^{ns}

Mean having different superscript a-f within the column of FM and ME are significantly different from each other at ($p < 0.05$)

ns = not significant

* = Significant ($p < 0.05$)

** = Highly significant ($p < 0.01$)

However, FM significantly influenced mean feed consumption at 39 and at 42 days old. Also, significant interactions were observed in ME x CP on mean feed consumption at 32d and ME x FM at 39 days old as well as at 42 days old. Also, ME x CP x FM interactions were observed at 18, 25 and 32 days old.

Comparisons among means showed that FM at 4 percent in the diet significantly resulted in the highest mean feed consumption of the birds (382.95g) at 39 days old. The least feed consumed (359.85g) was observed in the diet without FM. Meanwhile, 8 percent FM had comparable feed intake (378.93 g) with 4 percent FM.

The significant interactions effect of ME x FM were revealed by the marked decrease in feed consumption of the birds when diet did not contain FM but with 2900 kcal ME/kg (343.69g). However, 4 percent FM with the same ME level had a consumption value of 397.94 g, respectively at 39 and 42 days old. The significant ME x CP x FM interactions effects indicated low feed consumption of the birds fed with diet of 2900 kcal ME/kg, 22 percent CP and 0 percent FM (76.81g). This consumption value was significantly different from most of the dietary combinations.

The significant interactions of ME x FM at 39 and 42 days old showed that birds fed with diet of 2900 kcal ME/kg and 0 percent FM had the least feed intake among the dietary combinations. However, feed intake did not vary significantly at 39 and 42 days old.

Moreover, significant interaction effects were observed on ME, CP and FM. This indicated that the combined effects of the diet with 2900 kcal ME/kg, 22 percent CP and 0 percent FM can markedly influence feed intake of the birds at 18, 25 and 32 days old.

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The findings indicated that feed intake of the birds was enhanced by FM inclusion in the diet. This effect was most profound in diet with 2900 kcal ME/kg and 22 percent CP and 4 percent FM inclusion level although a favorable effect of FM on feed intake is known (Ravindran and Blair, 1993) while it is unclear why most profound effect is at 22 percent CP. Feed intake associated to fishmeal is normally attributed to higher amount and quality of amino acids and unknown factors for this feedstuff (Martin, 1995). This is attributed to the lack of positive effect of FM as seen in the diet with only 20 percent CP which can be figured out to have lower level amino acids.

Average Feed Conversion Ratio:

The mean feed conversion ratio (FCR) of the birds as influenced by dietary factors is presented in Table 3 revealed that the mean feed conversion ratio was significantly influenced by ME at 39 and 42 days old. In contrast, CP did not show any significant effect on FCR in any of the measurement periods.

Meanwhile, significant influence of FM levels was observed only at 18 and 25 days old. Only ME x CP x FM interactions was also found significant only at 18 days old.

Moreover, the birds fed with diet of 2900 kcal ME/kg significantly supported better FCR of 4.57 and 4.68 at 39 and 42 days old, respectively with 3000 kcal ME/kg with a value of 4.78 and 4.88 at 39 and 42 days old, respectively. With the inclusion of 4 percent FM in the diet, FCR values significantly increased (5.07 and 4.69, respectively) at 18 days old and increased further (5.91 and 5.30, respectively) at 25 days old. These values showed FCR was improved with 4 and 8 percent FM inclusion in the diet.

The significant interaction effect was observed on ME, CP and FM. This revealed that the combined effects of 3000 kcl ME/kg, 24 percent CP and 4 percent FM significantly manifested better feed conversion of the birds at 18 days old.

Table 3. Mean feed conversion ratio of the Japanese quails as influenced by dietary metabolizable energy (ME), crude protein (CP), and fishmeal (FM) levels

ME (kcal/kg)	CP (%)	FM (%)	PERIOD				
			18d	25d	32d	39d	42d
			0.0302*	0.1240ns	0.1590ns	0.2510ns	0.3070ns
2900	20	0	6.00abc	5.42	5.07	4.96	4.94
		4	4.67cd	4.80	4.62	4.84	4.96
		8	5.12bcd	5.04	4.44	4.50	4.51
	22	0	5.48bcd	4.88	4.57	4.01	4.12
		4	5.52bcd	4.90	4.50	4.60	4.81
		8	5.24bcd	4.94	4.63	4.74	4.78
	24	0	5.97abc	5.53	4.68	4.03	4.28
		4	5.25bcd	4.45	4.55	4.63	4.85
		8	5.80bcd	5.03	4.61	4.80	4.85
3000	20	0	5.02bcd	5.21	4.55	4.89	4.94
		4	5.67bcd	4.79	4.24	4.61	4.81
		8	6.28ab	5.19	4.65	4.91	4.91
	22	0	7.51a	6.16	5.14	5.10	5.08
		4	5.01bcd	4.97	4.43	4.89	5.02
		8	4.95bcd	4.85	4.64	4.10	4.92
	24	0	5.50bcd	4.59	4.03	4.42	4.61
		4	4.27d	4.24	4.40	4.60	4.83
		8	5.30bcd	4.77	4.58	4.63	4.79
ME			0.5362ns	0.8617ns	0.2620ns	0.0374*	0.0414*
2900			5.34	4.99	4.63	4.57b	4.68b
3000			5.50	4.97	4.52	4.78a	4.88a
CP			0.3930ns	0.1176ns	0.3528ns	0.0820ns	0.4759ns
	20		5.46	5.07	4.59	4.79	4.84
	22		5.62	5.12	4.65	4.72	4.79
	24		5.18	4.78	4.47	4.52	4.70
FM			0.0316*	0.0064**	0.2179ns	0.2757ns	0.1764ns
		0	5.91a	5.30a	4.67	4.57	4.66
		4	5.07b	4.69b	4.46	4.69	4.88

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	8	5.28^{ab}	4.97^{ab}	4.59	4.76	4.79
ME x CP		0.437^{ns}	0.058^{ns}	0.145^{ns}	0.076^{ns}	0.228^{ns}
ME x FM		0.622^{ns}	0.943^{ns}	0.467^{ns}	0.174^{ns}	0.215^{ns}
CP x FM		0.388^{ns}	0.682^{ns}	0.311^{ns}	0.152^{ns}	0.257^{ns}
ME x CP x		0.0302^{*}	0.124^{ns}	0.159^{ns}	0.251^{ns}	0.307^{ns}

Mean having different superscript a-d within the column of ME, FM and ME x CP x FM are significantly different from each other at ($p < 0.05$)

ns = not significant

* = Significant ($p < 0.05$)

** = Highly Significant ($p < 0.01$)

It was evident that the starting chicks (18d) attained optimal FCR at dietary levels of 3000 kcal ME/kg, 24 percent CP and 4 percent FM. This was shown by the relatively high weight gain of the birds. With the diet, the birds were provided with optimal amount of energy and amino acids. These findings conformed with Murakami et al. (1993a) who revealed higher FCR at higher energy levels in the diet of Japanese quail.

The higher FCR of birds given the diet with 3000 kcal ME/kg than 2900 kcal ME/kg at 39 and 42 days was largely due to the higher feed intake of the birds. Normally, feed intake decreases with high dietary ME intake (NRC, 1984). However, this was not the case in the present study. It was unclear what dietary factor was responsible for the higher feed intake of birds with higher ME in the diet than those with low ME diet.

Uniformity Percentage at 42 Days of Age:

The percent uniformity of body weight of Japanese quails at 42 days of age as influenced by dietary factors is presented in Table 4 revealed that this was not influenced by any of the dietary factors nor their interactions. The data clearly showed that none of the dietary factors affected the body weight of the birds. This observation could be due to the similar management practices employed. The over-all flock uniformity (76.00) was slightly lower than 80 percent which is regarded as satisfactory.

Table 4. Mean uniformity of body weight of Japanese quails as influenced by dietary metabolizable energy (ME), crude protein (CP), and fishmeal (FM) levels

ME (kcal/kg)	CP (%)	FM (%)	%
			0.7633^{ns}
2900	20	0	71.66
		4	81.00
		8	72.33
	22	0	78.00
		4	72.33
		8	74.33
	24	0	80.66
		4	79.66
		8	76.00
3000	20	0	75.33
		4	73.66
		8	66.66
	22	0	71.66
		4	72.66
		8	78.33
	24	0	80.00
		4	82.33
		8	84.66
ME			0.98^{ns}
2900			76.22
3000			76.15
CP			0.12^{ns}
	20		80.56
	22		74.56
	24		73.44
FM			0.91^{ns}
		0	76.94
		4	76.22

	8	75.39
ME x CP		0.65 ns
ME x FM		0.85 ns
CP x FM		0.77 ns
ME x CP x FM		0.7633 ns

ns = not significant
* = Significant ($p < 0.05$)
** = highly significant ($p < 0.01$)

Study 2. Dietary Energy, Protein, and Fishmeal levels on the Egg Production of Japanese Quails:

Average Egg Production Rate:

The mean hen-day production of Japanese quail layers as influenced by dietary factors (Table 5) was highly influenced by dietary ME. However, this was not true with CP and FM levels although the effect of the latter approached statistical significance. There was no significant interaction effects noted among the dietary factors.

Table 5. Mean hen-day egg production of the Japanese quail layers as influenced by dietary Metabolizable Energy (ME), crude protein (CP), and fishmeal (FM) levels

ME (kcal/kg)	CP (%)	FM (%)	HEN-DAY EGG PRODUCTION
			0.801 ns
2900	20	0	71.34
		4	73.53
		8	69.92
	22	0	70.68
		4	75.60
		8	75.43
	24	0	74.41
		4	73.14
		8	69.90
3000	20	0	54.58
		4	67.15
		8	70.36
	22	0	58.10
		4	65.51
		8	69.68
	24	0	65.10
		4	62.35
		8	71.19
ME			0.0003**
2900			72.66 a
3000			64.89 b
CP			0.7812 ns
	20		67.82
	22		69.17
	24		69.35
FM			0.0790 ns
		0	65.70
		4	69.55
		8	71.08
ME x CP			0.79 ns
ME x FM			0.06 ns
CP x FM			0.50 ns
ME x CP x FM			0.81 ns

Mean having different superscript a-b within the column of ME is significantly different from each other at ($p < 0.05$)
ns = not significant
* = Significant ($p < 0.05$)
** = Highly Significant ($p < 0.01$)

Egg production was significantly higher in birds fed with diet 2900 kcal ME/kg (72.66 %) than birds fed with diet containing 3000 kacl ME/kg (64.89 %) irrespective of CP and FM levels. This finding confirmed the recommendation by the Philippine Society of Animal Nutrition (PHILSAN, 2003) which was 2900 kcal ME/kg for laying quails under local condition. Apparently, laying quails do not need high energy diet because of the high ambient temperature and humidity prevailing in the country. This environmental condition possibly reduces the bird's energy requirement for maintenance. Also, Philippine Council for Agriculture Resources and Research Development (PCARRD, 1991) recommended that dietary requirements for egg type quail under local condition should be 2900 kacl ME/kg and 20 percent CP at 6 weeks old or more for best egg production.

Average Daily Feed Consumption (g):

The mean feed consumption of the Japanese quail layers as influenced by dietary factors as presented in Table 6 revealed that mean feed consumption of Japanese quail layers was not influenced by any of the dietary factors nor their interactions. This daily feed consumption of the birds conformed to the standards (20-25 g) for laying Japanese quails as indicated by Captain (2003).

The observed effects of FM and CP on feed intake during the growing period were not in any way evident during the laying period. The same feed intake showed that intake of CP and ME varied. The ME intake was a concern since diet with 3000 kcal ME/kg gave lower egg production than the 2900 kcal ME/kg. It could not be established whether the higher energy intake contributed to the decrease in egg production as shown by the birds with feeding diet containing 3000 kcal ME/kg.

Table 6. Mean daily feed consumption of the Japanese quail layers as influenced by dietary Metabolizable energy (ME), crude protein (CP), and fishmeal (FM) levels

ME (kcal/kg)	CP (%)	FM (%)	FEED CONSUMPTION
			0.37^{ns}
2900	20	0	23.27
		4	23.55
		8	22.67
	22	0	23.35
		4	24.67
		8	22.28
	24	0	23.90
		4	23.42
		8	21.20
3000	20	0	22.35
		4	24.16
		8	22.07
	22	0	21.92
		4	21.74
		8	22.66
	24	0	23.27
		4	21.53
		8	23.03
ME			0.1694^{ns}
2900			23.15
3000			22.53
CP			0.8516^{ns}
	20		23.01
	22		22.77
	24		22.73
FM			0.2557^{ns}
		0	23.01
		4	23.18
		8	22.32
ME x CP			0.53^{ns}
ME x FM			0.18^{ns}
CP x FM			0.54^{ns}
ME x CP x FM			0.37^{ns}

Mean having different superscript a-b within the column are significantly different from each other at ($p < 0.05$)
ns = not significant
* = Significant ($p < 0.05$)
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Average Feed Conversion Ratio:

The mean FCR of Japanese quail layers as influenced by the dietary factors as presented in Table 7 revealed that the mean FCR was influenced by ME and FM. Significant ME x FM interaction effects were also evident.

Specifically, lower FCR was observed in the birds fed with diet containing 2900 kcal ME/kg than those birds fed with 3000 kcal ME/kg. The significant ME x FM interaction effects indicated improved FCR when FM was added to the diet with 2900 kcal ME/kg. The response was observed in both 4 and 8 percent FM levels.

The poor effect of 3000 kcal ME/kg on FCR could be attributed to the widening ME and CP ratio. Thus, the response to FM inclusion on diet with ME could have been due to the optimal ratio of ME: CP which means higher amount and quality of amino acids for the birds to use.

Overall, the result indicated that a dietary ME level of 2900 kcal ME/kg is optimal for FCR irrespective of CP and with or without FM. These results confirmed the recommendation of the Philippine Council for Agricultural Resources and Research Development (1991) that 20 percent crude protein (CP) and 2900 kcal ME/kg given to birds over 6 weeks are sufficient for better feed conversion ratio.

Table 7. Mean feed conversion ratio of the Japanese quail layers as influenced by dietary Metabolizable energy (ME), crude protein (CP), and fishmeal (FM) levels

ME (kcal/kg)	CP (%)	FM (%)	FEED CONVERSION RATIO
			0.59^{ns}
2900	20	0	3.12
		4	2.97
		8	2.97
	22	0	3.24
		4	3.16
		8	2.80
	24	0	3.07
		4	3.02
		8	2.84
3000	20	0	4.53
		4	3.34
		8	2.93
	22	0	3.93
		4	3.88
		8	3.03
	24	0	3.76
		4	3.35
		8	2.97
ME			0.0003^{**}
2900			3.02^{b}
3000			3.52^{a}
CP			0.5058^{ns}
	20		3.31
	22		3.34
	24		3.17
FM			0.0004^{**}
		0	3.61^{a}
		4	3.29^{ab}
		8	2.92^{b}
ME x CP			0.81ns
ME x FM			0.04*
CP x FM			0.53^{ns}
ME x CP x FM			0.59^{ns}

Average having different superscript a-b within the column ME, FM and ME x FM are significantly different from each other at ($p < 0.05$)

ns = not significant

* = Significant ($p < 0.05$)

** = Highly Significant ($p < 0.01$)

Average Egg Weight (g):

The mean egg weight of Japanese quail layers as influenced by dietary factors presented in Table 8 revealed that mean egg weight of the Japanese quail layers was influenced by FM but not by ME and CP. Interaction effect of any of the dietary factors was not observed.

The mean egg weight was significantly higher from hens fed with 8 percent FM (10.81g) than those birds fed without FM (10.49g). However, 4 percent FM in the diet had a comparable egg weight (10.71g). This effect of FM was noted irrespective of ME and CP levels.

Table 8. Mean egg weight (g) of the Japanese quail layers as influenced by dietary metabolizable energy (ME), crude protein (CP), and fishmeal (FM) levels

ME (kcal/kg)	CP (%)	FM (%)	EGG WEIGHT
			0.31 ns
2900	20	0	10.65
		4	10.81
		8	10.79
	22	0	10.50
		4	10.53
		8	11.02
	24	0	10.36
		4	10.95
		8	10.66
3000	20	0	10.34
		4	10.88
		8	10.68
	22	0	10.67
		4	10.55
		8	10.78
	24	0	10.42
		4	10.54
		8	10.92
ME			0.5542 ns
2900			10.70
3000			10.64
CP			0.9031ns
	20		10.69
	22		10.68
	24		10.64
FM			0.0273*
		0	10.49[b]
		4	10.71[ab]
		8	10.81[a]
ME x CP			0.90ns
ME x FM			0.92 ns
CP x FM			0.41 ns
ME x CP x FM			0.31 ns

Mean having different superscript a-b within the column of FM are significantly different from each other at ($p < 0.05$)
ns = not significant
* = Significant ($p < 0.05$)
** = Highly Significant ($p < 0.01$)

The higher egg weight in the 8 percent FM dietary level, irrespective of ME and CP level could be attributed to the excellent quality of amino acids and unidentified factors from FM (NRC, 1994). It was evident that with higher FM inclusion level, higher amount of egg protein materials were synthesized by the birds. This present study maintains that the quality of protein achieved with the inclusion of FM is a greater overriding factor that can influence egg size than total CP.

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Average Eggshell Thickness:

The mean eggshell thickness of Japanese quail eggs was influenced by dietary factors as presented in Table 9. Analysis of variance revealed that the mean egg shell thickness of Japanese quail eggs was significantly variable showing the significant interaction effects of the dietary factors.

The quail eggs from birds fed with diet of 3000 kcal ME/kg had significantly thicker shell (0.1800 mm) than those birds fed with diet of 2900 kcal ME/kg (0.1770 mm). The 22-24 percent CP and 4-8 percent FM in the diet revealed improved mean eggshell thickness (0.1800 mm and 0.1800 and 0.1788 mm, respectively) compared to the 20 percent CP and without FM (0.1755 mm and 0.1766 mm, respectively).

The significant interaction effects were observed on ME, CP and FM. This indicated that the combined effects of 2900 kcal ME/kg, 20 percent CP and 0 percent FM gave the thinnest egg shell (0.1600 mm). Meanwhile, the 2900 kcal ME/kg, 20 percent CP and 4 percent FM combination had thicker egg shell (0.1733 mm) than without FM. This thickness was not statistically different across combinations.

Table 9. Eggshell thickness of the Japanese quail eggs as influenced by dietary metabolizable energy (ME), crude protein (CP), and fishmeal (FM) levels

ME (kcal/kg)	CP (%)	FM (%)	EGGSHELL THICKNESS
			0.0001**
2900	20	0	0.1600[c]
		4	0.1733[b]
		8	0.1800[a]
	22	0	0.1800[a]
		4	0.1800[a]
		8	0.1800[a]
	24	0	0.1799[a]
		4	0.1800[a]
		8	0.1800[a]
3000	20	0	0.1800[a]
		4	0.1800[a]
		8	0.1800[a]
	22	0	0.1800[a]
		4	0.1800[a]
		8	0.1800[a]
	24	0	0.1800[a]
		4	0.1800[a]
		8	0.1800[a]
ME			0.0001**
2900			0.1770[b]
3000			0.1800[a]
CP			0.0001**
	20		0.1755[b]
	22		0.1800[a]
	24		0.1800[a]
FM			0.0001**
		0	0.1766[b]
		4	0.1788[a]
		8	0.1800[a]
ME x CP			0.0001**
ME x FM			0.0001**
CP x FM			0.0001**
ME x CP x FM			0.0001**

Mean having different superscript a-c within the column of ME, CP, FM and ME x CP x FM are significantly different from each other at ($p < 0.05$)

ns = not significant

* = Significant ($p < 0.05$)

** = highly significant ($p < 0.01$)

The thin eggshell of the birds fed with diet of 2900 kcal ME/kg, 20 percent CP and without FM could be due to the low quantity and quality of nutrients needed for shell material synthesis. Calcium and phosphorus are main minerals in shell synthesis. These minerals should be provided in all diets in accordance with the recommended levels of the Philippine Society of Animal Nutritionist (PHISAN, 2003). The favorable effect of FM inclusion to the same diet (2900 kcal ME/kg and 20 percent CP suggests that FM contains an important factor which can enhanced shell synthesis.

Income over Feed Cost:

The cumulative income over feed cost of Japanese quail layers as influenced by dietary factors and presented in Table 10 revealed that the sale value eggs, feed cost, and IOFC were significantly affected by ME and FM and that only feed cost was influenced by CP. Interaction effects of the dietary factors were not found significant.

Table 10. Mean income over feed cost (Php) of eggs as influenced by dietary energy (ME kcal/kg), protein (CP), fishmeal (FM) levels

ME (kcal/kg)	CP (%)	FM (%)	VALUE OF EGGS	COST OF FEED (Php)	INCOME (Php)
			0.07^{ns}	0.08^{ns}	0.06^{ns}
2900	20	0	501.60	97.84	403.75
		4	566.20	87.40	478.94
		8	477.40	88.22	389.17
	22	0	471.60	96.31	375.28
		4	469.80	96.78	373.02
		8	556.00	88.14	467.85
	24	0	513.00	104.60	408.39
		4	472.80	99.08	373.72
		8	552.40	109.55	442.85
3000	20	0	378.20	100.33	277.87
		4	466.20	104.59	361.60
		8	515.20	97.92	417.28
	22	0	388.20	96.94	291.26
		4	498.40	105.93	392.47
		8	507.20	102.91	404.28
	24	0	503.00	119.76	383.23
		4	447.80	102.98	344.81
		8	454.20	95.27	358.92
ME			0.0071^{**}	0.0188^{*}	0.0010^{**}
2900			508.98^{a}	96.44^{b}	412.56^{a}
3000			462.04^{b}	102.96^{a}	359.08^{b}
CP			0.9054^{ns}	0.0184^{*}	0.9742^{ns}
	20		484.13	96.05^{b}	388.11
	22		481.87	97.84^{b}	384.03
	24		490.53	105.21^{a}	385.32
FM			0.0513*	0.2345^{ns}	0.0134*
		0	459.27^{b}	102.63	356.64^{b}
		4	486.87^{ab}	99.46	387.43^{ab}
		8	510.40^{a}	97.00	413.40^{a}
ME x CP			0.79^{ns}	0.42^{ns}	0.68^{ns}
ME x FM			0.55^{ns}	0.59^{ns}	0.50^{ns}
CP x FM			0.07^{ns}	0.42^{ns}	0.06^{ns}
ME x CP x FM			0.07^{ns}	0.08^{ns}	0.06^{ns}

Mean having different superscript a-b within the column of ME, CP and FM is significantly different from each other at ($p < 0.05$)
ns = not significant
* = Significant ($p < 0.05$)
** = highly significant ($p < 0.01$)

The sale value of eggs from the hens fed diet of 2900 kcal ME/kg was significantly higher than those fed 3000 kcal ME/kg. The hens fed with diet of 8 percent FM had significantly higher sale value of eggs than those without FM although these were comparable with those birds fed with 4 percent FM.

For the cost of feed, hens in the 3000 kcal ME/kg diet had significantly higher cost of feed consumed than those in the 2900 kcal ME/kg diet. Meanwhile, the cost of feed was significantly higher in the birds fed with diet of 24 percent CP than those in 20 percent CP diet, but comparable to the 22 percent CP diet.

IOFC was significantly higher in the birds fed with 2900 kcal ME/kg diet than 3000 kcal ME/kg diet. This finding reflected the marked effects on the higher sale value of eggs and lower cost of feed consumed from this group. IOFC was significantly higher in the birds fed with 8 percent FM than without FM but comparable to the 4 percent FM.

Over all, dietary level of 2900 kcal ME/kg and 8 percent FM, irrespective of CP, resulted in optimal IOFC. The business of quail egg production demands not only production efficiency but profitability as well. It is in these dietary level combinations that higher profitability is achieved.

4. CONCLUSION

Based on the result, the following conclusions were drawn:

1. Increasing the dietary CP to 24 percent and 4 percent FM was optimal for the growth of quails irrespective of ME level;

2. Feed intake of young quails was optimal with the inclusion of 2900 kcal ME/kg and 22 percent CP and enhanced by FM levels;

3. The birds fed with diet of 3000 kcal ME/kg, 24 percent CP and 4 percent FM had optimum FCR at 18 days;

4. Egg production rate was higher at 2900 kcal ME/kg than 3000 kcal ME/kg irrespective of CP and FM levels;

5. Feed conversion ratio of feed into eggs and egg weight was attained with 8 percent FM irrespective of ME and CP levels in the diet;

6. Higher income over feed cost was attained in the diet with 2900 kcal ME/kg irrespective of CP and FM levels;

5. RECOMMENDATIONS

Young quail diet may be supplemented with 24 percent CP and 4 percent FM for optimum growth.

1. A combination of 2900 kcal ME/kg, 22 percent CP and 0 percent FM is recommended in the diet for young quails for optimal feed intake.

2. A combination of 3000 kcal ME/kg, 24 percent CP and 4 percent FM is recommended in the diet for young quails for optimal FCR.

3. A combination of 2900 kcal/kg, 20 percent CP and 4 percent FM is recommended in the diet of laying quails for optimal eggshell thickness.

REFERENCES

[1] Ali, M. A. 1984. Evolution of Domesticated animals. Longman Inc. New York City.

[2] Whyte, J. E. M. 1992. Poultry administration, Barneveld College the Netherlands.

[3] Vohra, R., T. Rudybush. 1971. The effects of various levels of dietary protein on the growth and egg production of (Coturnix coturnix japonica). Poultry Science 50 (4) 1081.

[4] Lazaro, L. L. 2001. Applied Poultry Nutrition and Management. Philippine Society of Animal Nutritionist. First Outreach Program.

[5] Lee, T. K., F. F. Shim, and E. L. Tan. 1981. Protein requirements in breeding Japanese quail in the tropics 9 (2): 101-110.

[6] Murakami, A. E., V. M. B. Moraes, J. Ariki, O. M. Junguiera, S. Kronka. 1993. Proteins and energy levels in laying diets of Japanese quails (Coturnix coturnix japonica). Revista-da-Sociedade, Brasileira de Zootenica, Brazil.

[7] Ravindran, V., R. Blair. 1993. World Poultry Science Journal 49 (3) 219.

[8] Martin, E.A. 1995. Improving the utilization of rice bran in droughts for broiler chickens and growing ducks. Unpublished PhD Dissertation, University of New England, Australia.

[9] National Research Council. 1984. Nutient Requirements of Domestic Animals. 8th ed. National Academy Press Washington D.C.

[10] Philsan. 2003. Philsan Feed Reference Standards. 3rd Philippines Society of Animal Nutritionist. Philippines.

[11] PCARRD. 1991. The Philippines recommend for livestock feed formulation. Pp. 26.

[12] Capitan, S.S. 2003. The Science and Practice of Quail Production.