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Requirement of Calcium and available Phosphorus for Laying Japanese quail birds (Coturnix coturnix japonica) in Nigeria

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Abstract

An experiment was conducted to evaluate the performance and egg production of Japanese quail (Coturnix coturnix japonica) fed diets with varying calcium (Ca) and available phosphorus (aP) levels. A total of 270 female quails (7weeks old) were raised on deep litter for fourteen weeks (98 days). The birds were assigned to nine dietary treatment groups of 30 birds each with three replicates of 10 birds per pen. They were fed nine dietary treatments with three levels of Ca (2.5, 3.0, and 3.5%) and three aP levels (0.35, 0.45 and 0.55%). The diets were formulated to be iso-nitrogenous (22%CP) and iso-caloric (2630kcal/kgME). Results revealed highest final weight, hen housed production for diets containing 2.5% Ca+0.35%aP. Feed conversion ratio and feed cost per crate of egg were also lowest for 2.5%Ca+0.35%aP. Diet containing 2.5%Ca+0.45%aP yielded the lowest average daily feed intake. Birds fed 3.5%Ca+0.35% aP yielded the highest average egg weight but highest mortality. The result of single effect of calcium revealed lowest mortality for 2.5%Ca. For single effect of Phosphorus, 0.35% resulted in the highest final weight but had the lowest average daily feed intake. The result of the layer phase showed that quails from (7-20) weeks can be raised optimally on 2.5%Ca+0.35%aP.

Key words: Available Phosphorus, Calcium, Egg production, Japanese quails, Performance

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Introduction

Research works have shown that environment has definite effect on efficiency of feed utilization, growth rate and egg production (Screenivasaiah and Joshi, 1988). Olomu (1976) and Njike (1978) reported that nutrient requirements established in temperate environments may not be entirely satisfactory in the tropics. According to the NRC (National Research Council) (1994), the nutritional requirement for Ca is 2.5% for laying Japanese quails fed diets containing 2,900kcal/kg while available P is 0.35%. According to INRA (1999), Ca requirement in quails is 3.0 and 3.4% to the stage of egg production when feeding diets containing, 2,800 and 3,000kcal/kg respectively. Experiments conducted by Shrivastav et al. (1989), Raju et al. (1992), Pedroso et al. (1999) and Masukawa et al. (2001), indicated requirements of 2.8, 3.5, 2.5 and 2.0% Ca, respectively in diets for laying Japanese quail production in the laying phase. In addition, Nelson *et al*. (1964) reported that for young quails the ratio of Ca and P should be 1:1 or 2:1. They need a minimum of 0.8% of the diet as Ca and 0.45% as available P. Laying quails on the other hand need 2.5 - 3% of Ca which is the main constituent of egg shell. These data demonstrates that the requirement of Ca and P for quail seems not to be well defined since they vary even in the temperate region and these birds are tolerant to variations in the levels of Ca and P in the diet. This study was therefore designed to investigate the response of laying Japanese quails to varying levels of calcium (Ca) and available phosphorus (aP) on feed utilization and optimum laying performance.

Materials and Methods

Experimental site

The study was conducted at the Department of Animal Science, Teaching and Research farm, Ahmadu Bello University (ABU), Zaria.

Experimental diet

Nine experimental diets were formulated to be iso-nitrogenous (22% CP) and iso-caloric (2630 kcal/kg DM) with three (3) levels of calcium (2.5, 3.0 and 3.5%) and three (3) available phosphorus (0.35, 0.45, and 0.55%) as shown in Table 1.

Experimental birds and management

Two hundred and seventy (270), seven weeks old female Japanese quail birds with an average initial weight of 162g were used for this study. The birds were randomly assigned to nine (9) dietary treatments of three replicates with 10 birds each in a completely randomized design. All the birds were subjected to similar management practice (lighting, feeding and watering) throughout the experimental period, except for the diets offered. Light regime was 24 hours. The birds had free access to feed and water throughout the trial period. The following parameters were studied; Feed intake, feed conversion ratio, hen housed production, hen day production, average egg weight, feed cost/crate of egg and mortality.

Table 1. Composition of Experimental diet (7-20 weeks)

INGREDIENTS	0.35%aP			0.45%aP			0.55%aP		
	2.5% Ca (T1)	3.0%Ca (T2)	3.5%Ca (T3)	2.5%Ca (T4)	3.0%Ca (T5)	3.5%Ca (T6)	2.5%Ca (T7)	3.0%Ca (T8)	3.5%Ca (T9)
Maize	38.90	42.90	47.37	38.60	42.58	47.37	38.60	43.31	48.05
Maize offal	15.80	9.40	2.18	15.75	9.50	2.00	15.50	8.20	1.00
Groundnut cake	27.35	28.20	29.40	27.50	28.22	29.4	27.20	28.54	29.47
Soya bean cake	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Limestone	6.00	7.15	8.30	5.40	6.65	7.75	4.90	6.00	7.18
Bonemeal	0.85	1.25	1.65	1.65	1.95	2.38	2.40	2.85	3.20
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Vit Premix*	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
CALCULATED ANALYSIS									
%Crude Protein	22.04	22.01	22.06	22.07	22.00	22.04	22.04	22.05	22.02
M E(KCal/Kg)	2648	2640	2635	2640	2632	2630	2634	2631	2630
%Crude Fibre	4.06	4.15	4.27	4.02	4.14	4.27	4.05	4.17	4.28
% Ether Extract	4.99	4.45	3.87	4.98	4.46	3.85	4.96	4.36	3.76
%Ca	2.51	3.01	3.51	2.50	3.01	3.50	2.51	3.01	3.50
Available P%	0.35	0.35	0.35	0.45	0.45	0.45	0.55	0.55	0.55
Ca:P	7.20	8.50	9.90	5.50	6.80	7.80	4.60	5.40	6.40
% Lysine	1.15	1.13	1.11	1.15	1.13	1.11	1.15	1.13	1.11
%Methionine	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Cost/Kg	81.65	82.49	83.63	81.68	86.03	83.78	82.00	83.08	87.08

*Biomix premix provide per Kg of diet: Vit. A, 8,500i.u; Vit. D_3, 1500i.u; Vit E,10mg;Vit.K_3,1mg;Vit B_1,1.5mg; Vit B_2,4.5mg; Niacin,150mg; Pantothenic acid 4.5mg; Vit.B_{12}, 0.015mg; Folic acid, 0.6mg; Biotin H_2,0.5mg;Cholin Chloride, 175mg; Vit. B_6,3mg; Manganese,40mg;Iron,20mg; Zinc,30mg; Copper,3mg; iodine,1mg; Cobalt, 0.2mg; Selenium,0.2mg

Chemical analysis

The proximate compositions of the test ingredients and diets were determined by the method of AOAC (1995). The moisture content of the diet was determined by oven drying to a constant weight at 65°C for 24 hours.

Statistical analysis

The experimental layout was a 3 x 3 factorial arrangement. The data obtained were subjected to analysis of variance using SAS (1999). Significant ($P < 0.05$) means were separated using Duncan Multiple Range Test (Duncan, 1955). The components of variance, mean values and standard errors were estimated using experimental model:

$$Y_{ijk} = \mu + A_i + B_j + (AB)_{ij} + E_{ijk}$$

Y = observation k in i^{th} level of factor A and j^{th} level of factor B

μ = overall mean

A_i = effect of i^{th} level of factor A (Calcium level)

B_j = effect of j^{th} level of factor B (available Phosphorus level)

$(AB)_{ij}$ = effect of the interaction of i^{th} level of factor A with j^{th} level of factor B

E_{ijk} = random error

Results and Discussion

The results of the interaction effect of varying levels of calcium and available phosphorus on the performance of quail birds during the laying phase are presented in Table 2. Calcium and available phosphorus interaction had significant ($P<0.05$) effect on all the parameters studied. Quail birds in treatment 1 (2.5% Ca + 0.35% aP) and treatment 6 (3.5% Ca + 0.45% aP) had the highest final weights. At 0.35%aP the best and highest weight was at 2.5% Ca. Increasing the Ca beyond this level showed a significant decrease at 3.0% Ca + 0.35% aP. At 0.45% aP there is need to increase the level of Ca to 3.5% to obtain an increase in weight. Available phosphorus of 0.55% was not recommended as this level did not improve the weight gain rather there was a gradual decrease. Calcium and available phosphorus interaction had significant ($P < 0.05$) effect on average daily feed intake; low feed intake was obtained for 3.0% Ca + 0.35% aP, 3.5% Ca + 0.35% aP, and 3.5% Ca + 0.55% aP. This revealed that 3.5% Ca reduced feed intake when in combination with 0.35% aP and 0.55% aP. This result is in agreement with the findings of Amoah *et al.* (2012) who reported significant ($P < 0.05$) interaction of available phosphorus and calcium on feed intake. The significant interaction between calcium and available phosphorus indicated that the reduction in feed intake with diet containing 3.5% Ca tended to accentuate when level of available phosphorus increased from 0.35% to 0.55%. Excess calcium has a neutralizing effect in the intestines and causes of pH level rise of intestine (Bristol, 2007). This causes deficiency by formation of insoluble calcium phosphate in the digestive tract (Keshavarz, 2000) and impairs metabolic functions (Kheiri and Rahmani, 2006) that caused the birds to refrain from eating.

Interaction of the two dietary levels showed significant ($P < 0.05$) influence on the feed conversion ratio with treatments 1, 2, 3 and 8 having the best feed conversion ratios. Amoah et al. (2012) showed significant calcium and available phosphorus interaction effect on birds.

Table 2. Interaction effect of Calcium and available Phosphorus interaction on productive performance of Japanese quail birds at 7-20 weeks of age

Parameters	0.35%aP			0.45%aP			0.55%aP			SEM
	2.5%Ca	3.0%Ca	3.5%Ca	2.5%Ca	3.0%Ca	3.5%Ca	2.5%Ca	3.0%Ca	3.5%Ca	
Initial weight (g/bird)	162	162	162	162.15	162.23	162.02	162.00	162.17	162.13	0.211
Final weight (g/bird)	204.70^{a}	192.59^{bcde}	196.30^{abc}	193.33^{bcd}	181.25^{f}	197.33^{ab}	190.00^{bcde}	180.00^{f}	177.69^{f}	3.996
ADFI (g/bird)	34.20^{d}	33.17^{e}	32.34^{f}	30.74^{g}	36.20^{ab}	36.21^{a}	36.07^{ab}	35.11^{c}	32.41^{ef}	0.431
Total feed intake (g/bird)	3327.67^{bcd}	3169.97^{def}	2876.27^{g}	3012.93^{f}	3522.43^{a}	3366.33^{abc}	3476.43^{ab}	3256.47^{cde}	3038.93^{f}	82.801
FCR (feed(g)/egg(g))	4.07^{a}	4.11^{a}	4.07^{a}	4.26^{abc}	4.49^{cd}	4.50^{d}	4.50^{d}	4.22^{ab}	4.38^{bcd}	0.123
HHP (%)	83.71^{a}	79.63^{abc}	70.78^{h}	76.74^{cdef}	83.47^{ab}	76.63^{cdefg}	78.91^{abcd}	78.71^{abcde}	72.31^{fgh}	2.728
HDP (%)	82.44^{ab}	79.91^{abcde}	75.36^{e}	75.48^{e}	82.23^{abc}	80.82^{abcd}	79.74^{abcde}	82.87^{a}	75.32^{e}	2.303
Average Egg weight(g)	10.00^{b}	9.88^{bcd}	10.21^{a}	9.64^{e}	9.64^{e}	10.00^{b}	10.00^{b}	9.98^{bc}	9.83^{bcd}	0.093
Feed cost/crate of egg (₦)	99.84^{a}	100.77^{a}	104.24^{a}	101.15^{a}	111.52^{ed}	113.13^{e}	110.56^{cde}	104.97^{abcd}	108.66^{bc}	3.450
Mortality (%)	3.33^{c}	6.66^{bc}	13.33^{a}	0.00^{e}	3.33^{c}	10.00^{bc}	0.00^{e}	3.33^{c}	3.33^{c}	2.490

$^{a, b, c}$ Means with different superscripts on the same row differ significantly ($p<0.05$)   SEM – Standard error of means

ADFI – average daily feed intake   FCR - Feed conversion ratio

HDP – Hen day production   HHP – Hen housed production

They observed that birds fed 3.0% Ca with 0.25% phosphorus diet elicited tendency for better feed conversion ratio than when 0.35% available phosphorus was provided. In their study, feed conversion ratio for diet containing 3.0% calcium and 0.25% available phosphorus showed no significant differences compared with the groups fed on diet with 3.5% calcium, irrespective of available phosphorus levels. Improved feed conversion ratio with increased dietary calcium was associated with the capacity of the birds to maintain optimal egg production despite the decrease in their feed intake. A dietary level of 3.5% Ca, irrespective of phosphorus level was optimal. For this study a dietary level of 0.35% aP was optimal for feed conversion ratio irrespective of the calcium level. Yakourt (2003) and Kadam (2006) in their studies observed that calcium level maintained at 3.0% with 0.35% aP effected optimal feed conversion.

Significant (P < 0.05) effect of interaction of calcium and available phosphorus was observed for hen housed production. Treatment 1 had the highest value, made up of 2.5% Ca + 0.35% aP, with treatments 2, 5, 7 and 8 made up of 3.0% Ca+0.35% aP, 3.0%Ca+0.45%aP, 2.5% Ca + 0.55% aP and 3.0%Ca+0.55% aP respectively being similar to it statistically. This revealed that 0.35% aP in combination with 2.5 and 3.0% Ca, (3.0% Ca+0.45% aP) and 0.55% aP in combination with 2.5% and 3.0%Ca yielded higher hen housed production compared to other dietary treatments. This is in agreement with Amoah et al. (2012) who reported significant (P<0.01) interaction between the two dietary levels. There was significant (P<0.05) effect of interaction of calcium and available phosphorus on average egg weight with treatment 3 having the highest egg weight. In a related study, Kadam (2006) observed improvement in egg weight with increase in calcium level from 2.5 to 3.25% Ca with 0.35% available phosphorus. For most of the parameters discussed above treatments 1 and 2 had better performances compared to other treatments in terms of economic traits such as weight gain, feed conversion ratio, hen day production, hen housed production, feed cost per crate and mortality rate.

The result of the effect of varying levels of calcium on the performance of quail birds during the laying phase is presented in Table 3. Dietary Calcium levels did not show significant influence on final body weight gain. It is in contrast to finding of Raju et al. (1992), who found an increase in body weight of birds with elevated levels of dietary Ca from 2.0% to 3.5%. Also, Moreki et al. (2011), reported that body weight of hen significantly increased (P<0.05) as dietary Ca concentration increased from 1.5 to 3.5%. This difference may be due to the fact that the experiment was carried out in a temperate region. Calcium levels had no significant influence on average daily feed intake. This result corroborates the findings of Barreto et al. (2007) who reported that levels of calcium did not influence (P>0.05) feed intake of birds. Kornegay et al. (1985), Clunies and Leeson (1995) and Ahmad et al. (2003), also reported no effect of dietary Ca level on feed consumption of hens fed on diets containing Ca levels ranging from 2.5 to 5.0%. It also agrees with the findings of Pedroso et al. (1999) and Masukawa et al. (1996), who tested, respectively, levels from 2.5 to 3.5% and 2.0 to 3.5% Ca in Japanese quail and also found that feed intake was not influenced by diet calcium levels, but is in contrast to the findings of Amoah et al. (2012) who reported significant decrease in feed intake with increasing calcium level.

Table 3. Effect of varying Calcium levels on Productive Performance of Japanese quail birds at 7-20 weeks of age

Parameters	2.5%Ca	3.0%Ca	3.5%Ca	SEM
Initial weight g/bird	162.44	162.17	162.28	0.366
Final weight g/bird	196.01	184.61	190.44	6.922
Average daily feed intake (g)	33.67	34.82	33.65	0.747
Total feed intake (g)	3272.30	3316.30	3093.80	143.415
FCR (feed(g)/ egg(g))	4.28	4.27	4.32	0.213
Hen-housed production (%)	79.79	80.62	73.24	4.725
Hen-day production (%)	79.05	81.67	77.17	3.990
Average Egg weight(g)	9.88	9.83	10.02	0.161
Feed cost/crate of egg (₦)	103.85	105.75	108.68	5.974
Mortality	1.11^{a}	4.44^{ab}	8.89^{b}	3.304

$^{a, b, c}$Means with different superscripts on the same row differ significantly (p<0.05)
SEM – Standard error of means
FCR-Feed conversion ratio

Feed conversion ratio was not significantly influenced by dietary calcium levels. This corroborates the findings of Garcia et al. (2000), who found no effect on feed conversion by egg weight, a result similar to that found by Masukawa et al. (1996), who worked with diets containing 2.0 to 3.5% of calcium. This is in contrast to report by Amoah et al. (2012) who noted a significant effect of Ca on feed conversion ratio (2.5%Ca compared to diets containing 3.0 and 3.5% Ca). Barreto et al. (2007) revealed that best conversions were observed in diets with 3.2 and 3.6% Ca, noting that the diet with 3.6% was only 0.73% better than that with 3.2%. Calcium did not show significant influence on hen day production. This agrees with the findings of Amoah et al. (2012). Garcia et al. (2000), working with Japanese quail in peak production levels fed diets containing 2.5 to 4.0% Ca, noted that the level of 3.06% Ca, similar to that found in this experiment, promoted egg production.

Average egg weight was not significantly influenced by calcium. This result agrees with the findings of Amoah et al. (2012) who reported that mean egg weight was not significantly influenced by calcium levels. Pedroso et al. (1999), who used levels from 2.5 to 3.5% Ca in diets for Japanese quail found no significant effect on egg weight. Oliveira (2001) also found no significant effect on egg weight. However it was is in contrast to the report of Barreto et al. (2007) which revealed Ca levels influenced significantly ($P < 0.05$) the size of eggs and that there was a linear increase of 0.1775 g in egg weight for each 1% increase in dietary Ca supplementation. Diets containing 2.5% Ca yielded the lowest mortality. In this study with respect to mortality, 2.5%Ca diet was the best.

The results of the effect of varying levels of available phosphorus on the performance of quail birds during the laying phase is presented in Table 4.

There were significant differences in total and average daily feed intake per bird as a result of feeding varying levels of aP at 0.35 - 0.55%. It was observed that 0.35 and 0.45% aP resulted in the higher final weight gain, while 0.55% aP resulted in the lowest. Highest average daily feed intake was observed for 0.45 and 0.55% aP, while 0.35% aP resulted in the lowest. From the above observation, it can be inferred that the maximum level of phosphorus for increment in weight at this phase should not be more than 0.45%, revealing that quail birds need a lower aP to increase their weight and vice versa.

Table 4. Effect of varying available Phosphorus levels on Productive Performance of Japanese quail birds at 7-20 weeks of age

Parameters	0.35%aP	0.45%aP	0.55%aP	SEM
Initial weight g/bird	162.33	162.22	162.33	0.366
Final weight g/bird	197.86[a]	190.64[a]	182.56[b]	6.922
Average daily feed intake (g/bird)	33.23[b]	34.38[a]	34.53[a]	0.647
Total feed intake (g)	3124.60	3300.60	3257.30	143.415
FCR (feed(g)/ egg(g))	4.08	4.42	4.37	0.213
Hen-housed production (%)	78.06	78.95	76.64	4.725
Hen-day production (%)	79.24	79.51	79.14	3.990
Average Egg weight(g)	10.03	9.76	9.93	0.161
Feed cost/crate of egg (₦)	101.62	108.60	108.06	5.974
Mortality	7.78	4.44	2.22	4.304

[a, b] Means with different superscripts on the same row differ significantly ($p<0.05$)
SEM – Standard error of means
FCR - Feed conversion ratio

This is in contrast to the finding of Amoah et al. (2012) who reported no significant effect on feed intake with available phosphorus.

The above observation which indicates that lowest feed consumption gave the highest final weight further buttress the point that 0.35% aP is the optimum level. There is gradual increase in daily feed intake as the weight decreased gradually. Average egg weight was not significantly influenced by available phosphorus. This result agrees with the findings of Amoah et al. (2012) who reported mean egg weight was not significantly influenced by available phosphorus. Since, 0.35% aP resulted in the lowest feed intake and highest weight gain for this study, it is therefore recommended as the optimum level of inclusion.

Conclusion

The result of this experiment showed that quails from (7-20) weeks can be raised optimally by feeding on 2.5%Ca+0.35%aPh rations.

References

Ahmad, H. A., S. S. Yadalam, and Sr. D.A. Roland. 2003. Calcium requirements of Bovanes hens. *International Journal of Poultry Science,* 2:417-420.

Amoah, J. K., E. A. Martin, J. A. Barroga, E. P. Garillo, and I. Domingo. 2012. Calcium and phosphorus requirements of Japanese quail layers. *Journal of Applied Biosciences,* 54: 3892-3900.

AOAC, 1995. *Association of Official Analytical Chemist, Official Method of Analysis 16th Ed Washington D.C. U.S.A.*

Barreto S. L. T., C. A. Pereira, R. T. Umigi, T. C. Rocha, M. A. Santana, S. C. Smith, and T. A. F. Rodolpho. 2007. Determination of nutritional Calcium requirement of Japanese Quails in the initial Production Phase. R. Bras. *Zootec, 36, 1* .

Bristol, R. H., 2007. Calcium Research. *ILC resources –Mineral*

Clunies, M., and S. Leeson. 1995. Effect of dietary calcium level on plasma proteins and calcium flux occurring during a 24 hour ovulatory cycle. *Canadian Journal of Animal Science,*75:439-444.

Duncan, D. B. 1955. Multiple Range and Multiple Range F-Test Biometric, 11,1- 42.

Garcia, J., A. E. Murakami, and E. N. Martins. 2000. Exigências nutricionais de cálcio e fósforo para codornas japonesas (*Coturnix coturnix japonica*) em postura. Acta Scientiarum, 22(3):733-739.

INRA, 1999. Instituto Nacional De La Recherche Agronomique - Alimentação dos animais monogástricos : suínos, coelhos e aves. 2.ed. São Paulo: Roca. 245p.

Kadam, M. M., A. B. Madal, A. B. Elangovan, and S. Kaur. 2006. Response of laying Japanese quail to dietary calcium levels at two levels of energy. *Journal of Poultry Science,* 43: 351-356.

Keshavarz*, K.,* 2000. Re-evaluation of non-phytate phosphorus requirement of growing pullets with and without phytase. *Poultry Science,* 70:1143-1153.

Kheiri, F., and H. R. Rahmani. 2006. The Effect of Reducing Calcium and Phosphorus on Broiler Performance. *International Journal of Poultry Science,* 5 (1):22-25.

Kornegay, E. T., B. G. Diggs, O. M. Hale, D. L. Handlin, J. P. Hitchcock, and R. A. Barczewski, 1985. Reproductive performance of sows fed elevated calcium and phosphorus levels during growth and development. *Journal of Animal Science,* 61:1460-1466.

Masukawa, Y., V. M. B. Moraes, and J. Ariki. 1996. Efeito dos níveis de cálcio sobre o desempenho produtivo e qualidade dos ovos de codornas japonesas (*Coturnix coturnix japonica*) In: Conferencia apinco de ciencia e tecnologia avicolas, Curitiba. *Anais Curitiba: Fundação Apinco de Ciência e Tecnologia Avícolas,* pp.35.

Masukawa, Y.,V. M. B. Moraes, and J.Ariki. 2001. Níveis de cálcio da dieta sobre o desempenho ea qualidade da casca de ovos de codornas japonesas. Ars Veterinária, 17(2):144-148.

Moreki, J.C., H.J. Van Der Merwe, and J.P. Hayes. 2011. Influence of dietary calcium levels on bone development in broiler breeder hens. *Online Journal of Animal Feed Resources*, 1(2):77–85.

Nelson, F.E., J.K. Lauber, and L.Mirosh. 1964. Calcium and phosphorus requirements for the breeding coturnix quail. *Poultry Science,* 43:1346.

Njike, M.C., 1978. Nutrient Requirement of chicks under Nigerian Environment. *A paper presented before the meeting organised for practicing professional Veterinarians at N.V.R.I. Vom , Nigeria.*

NRC, 1994. *Nutrient Requirement of Domestic Animals.* In: Nutrient requirements of poultry, 9th Ed. National Academy of Sciences, Washington, D.C.,USA. Pp 155.

Oliveira, J.R., 2001. Níveis de cálcio e fósforo em dietas para poedeiras leves e semipesadas no 2º ciclo de produção . Lavras: Universidade Federal de Lavras, 2001. 61p. Dissertação (Mestrado em Zootecnia) - Universidade Federal de Lavras.

Olomu, J. M., 1976. Determination of optimal Protein and energy levels for broiler chicks in the tropics. *Nigerian Journal of Animal Production*, 3:177-183.

Pedroso, A., V.M.B. Morores, and J.Ariki.1999. Efeito de níveis dietéticos de cálcio e fósforo disponível sobre o desempenho e qualidade dos ovos de codornas japonesas. Ars Veterinária , 15(2):135-139.

Raju, M., P.V. Rao, and V.R. Reddy. 1992. Effect of dietary calcium and inorganic phosphorus on the performance of laying Coturnix quail. *Indian Journal of Animal Science*, 62:1072-1076.

SAS, 1999. SAS/STAT Users guide (released 6.08) SAS Institute Inc. *Cary, North Caroline, USA.*

Screenivasaiah, P.V., and H.B. Joshi.1988. Influence of Hatching Season on Growth rate and feed consumption of Japanese Quails. *Indian Journal of Animal Science,* 58(3):394.

Shrivastav, A.K., B.Panda, and N.Darshan. 1989. Calcium and phosphorus requirements of laying Japanese quails. *Indian Journal Science,* 24(1):27-34.

Yakourt, H.M., 2003. Calcium and phosphorus requirement of Japanese quail hens during the early production period. *Egyptian Poultry Science Journal*, 33(3):617-628.