



## Basic nutrient requirements of the domestic quails under tropical conditions: A review

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### ABSTRACT

Due to multiple benefits and prolific nature of the domestic quails, a review on basic nutrient requirements is highly relevant. Requirement under tropical conditions for water, protein, essential and non-essential amino acids were reviewed. Other basic requirements that included energy, vitamins, major and micro minerals were also captured.

**Keywords:** Nutrients; Japanese Quails; tropical conditions

### 1. INTRODUCTION

Quail belong to the family *Phasianidae*, order *Galliformes*. Species most frequently used in research and testing include the Japanese quail (*Coturnix japonica*), the European quail (*Coturnix coturnix*), the bobwhite (*Colinus virginianus*), the California (*Lophortyx californica*), and the Chinese painted (*Excalfactoria chinensis*) (Ani *et al.*, 2009).

The domesticated subspecies, *Coturnix coturnix japonica*, is called Japanese quail. It is also known by other names such as Common quail, Eastern quail, Asiatic quail, Stubble quail, Pharaoh's quail, Red-throat quail, Japanese gray quail, Japanese migratory quail, King quail, and Japanese King quail (NRC, 1991). Japanese quail are raised mainly for meat and egg production and also are valued research animals (NRC, 1994). Japanese quails have less

feeding requirement (about 20-25 g per day) compared to chicken (120-130 g per day) (Ani *et al.*, 2009). Quail attain a market weight of 140-180 g between 5-8 weeks of age and reaches peak egg production at the age of 5-8 weeks (Garwood and Diehl, 1987). Quails lay 200-300 eggs in their first year of production. The review focused on basic nutrient requirements of the animals for growth and laying purposes.

## **2. THE NUTRIENT REQUIREMENTS**

### **2. 1. Requirements for Water**

Although all are essential, adequate water may be considered the single most important nutrient (NRC 1991). The amount of water required is dependent on environmental temperature and relative humidity, the composition of the diet, rate of growth, egg production, and efficiency of kidney resorption of water in individual birds (NRC, 1994). Fresh clean water should be provided continuously to all birds, especially under tropical environments. Quails require at least twice, as much in weight of water as they require in weight of dry feed (Farrell *et al.*, 1982). They require more water when there are excess salts in feed or when the ambient temperature is high especially during the hot weather. Newly hatched quail is about 75-80% water (Shrivastav, 2000). This falls as the bird ages, but the need for water remains. The water requirement of quail chick changes with age, and with quantity and quality of feed dry matter. Water intake is typically 3:1 - 4:2 g/g body weight at 12-29 days of age which stabilizes at around 2g/g body weight thereafter. The water feed ratio for the above period are 2:0 - 2:3 respectively (Farrell *et al.*, 1982).

### **2. 2. Protein Requirements**

Protein provides the amino acids for tissue growth and egg production. Hence, the requirement for protein is mainly requirement for amino acids. The dietary protein and amino acids requirement of quail is influenced by age, egg production and metabolizable energy content and the ingredients used to formulate the diets. The type of protein to be fed to quails must be provided from a high quality source. Protein quality is generally based on amino acid composition of the feedstuff and the availability of these amino acids from the feedstuff following digestion in the gut. Amino acids are considered as the building blocks of proteins (Babangida and Ubosi, 2006). Out of 19 total amino acids required by quail, 13 are considered as essential, because they cannot be produced in the quail's body and must be supplied in the diet. Six are considered as nonessential, because they are synthesized by the body and need not be supplied in the diet. The 13 essential amino acids are: arginine, cystine, glycine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, tyrosine and valine (Murakami *et al.*, 1993).

The NRC (1994) recommended protein levels of 24 and 20% for quails in the rearing and production periods, respectively. A lot of researches were conducted varying the recommended levels at different environments. Quail flocks were successfully raised on turkey starter diets containing 25-28% crude protein (Wilson *et al.*, 1959; Woodard *et al.*, 1973). Lee *et al.* (1977a and b) have shown that a dietary crude protein level of 24% is needed in starter diet for quail and the protein content may be reduced to 20% by 3rd week of age. Four crude protein levels (20, 22, 24 and 26%) were evaluated for Japanese quails and it was found that after lysine, methionine and cysteine requirements were met, 20% crude protein

level resulted in best performance from 1 to 42 days of age (Nwokedi *et al.*, 2010). Hyankova *et al.*, (1997) reported that Japanese quails fed 26 and 21.6% crude protein had good performance from 1 to 21 and from 22 to 35 days of age, respectively. Thus, requirements decrease with age. During the laying period, Murakami *et al.* (1993) recommended 18% crude protein, which is lower than the 20% recommended by NRC (1994) and 22.42% recommended by Pinto *et al.* (1998). They however reported improved egg weight and feed conversion per egg mass were observed when protein level of diet was increased above 18%, whereas feed intake, laying rate, feed conversion per dozen egg, shell percentage and shell thickness were not significantly affected. Pinto, (1998) study the effects of two energy levels (2,850 and 2,950 kcal/ME/kg) and five protein levels (16, 18, 20, 22.42 and 24%) in the diet of quails during the production phase and recommended 22.42% protein.

Cheng and shim, (1989) reported better egg production with 0.62% Methionine+Cystine compared to 0.52; 0.57; 0.67 and 0.72% Methionine+Cystine. During production, quails after 5 weeks of age require 0.375% of methionine and 0.30% available Cystine in a diet with 20% CP (Cheng and Shim, 1989). Intake levels of 79.5mg available methionine were required for maximum egg production. Bello (1997) evaluated methionine levels in diets for quails in the early laying period. Quails with 19.2% CP, 0.48% methionine and 0.69% Methionine + Cystine, with other diets containing 16% CP, 0.28-0.43 methionine and 0.55 to 0.69% Methionine + Cystine, it was observed that performance was better when Methionine + Cystine levels in the diet were increased. Although egg characteristics were not affected, shell thickness was poorer with higher methionine levels (Bello, 1997).

Shim and Lee (1993) evaluated the effects of increased lysine levels from 0.9 to 1.3% on the fertility and hatchability and reported higher production and improvements in egg size, fertility and hatchability with 1.0% lysine. Japanese quails aged 60 days were fed diets supplemented with synthetic amino acids with 16% CP and 0.16% sulphur amino acids, 1.0% Lysine, 0.43% Methionine and 0.18% cystine and resulted in higher egg production, higher egg weight and higher feed efficiency. Oliveira (1998) reported similar estimated requirements for maximal egg production and egg weight (1.07% and 1.08% lysine, respectively).

**Table 1.** Recommended levels of crude protein (%) for domestic quail.

Starter/grower	Finisher	Adult/breeder	Author
24	20	-	Wilson <i>et al.</i> 1959
20	-	18	Murakami <i>et al.</i> 1993
21.6	-	-	Hyankova <i>et al.</i> 1997
-	-	22.4	Pinto <i>et al.</i> 1998
-	24	20	NRC, 1994
24	-	18	Musa, <i>et al.</i> 2008
24	20	-	Lee <i>et al.</i> 1977a and b

Feedstuffs differ qualitatively and quantitatively in their amino acid composition. Quail diets consist mainly of plant materials, the most commonly used plant products are maize, soybean meal, groundnut cake, sorghum, millet and rice or wheat bran. Methionine and lysine are generally low in plant products (Babangida and Ubosi, 2006). Animal protein products such as fish meal, meat meal, blood and bone meal etc., are good sources of most of the essential amino acids, but they are usually more expensive than plant protein ingredients (Murakami *et al.*, 1993). Synthetic methionine and lysine are usually added to the diets to balance the amino acid composition (Shim and Lee, 1984a). The major commercial source of plant protein concentrates for the livestock feed industry in Nigeria are groundnut cake, soybean cake or meal and cotton seed cake. Soybean meal is a by-product of soybean oil industry and it is the most balanced vegetable protein source available in the country (Amaza and Ubosi, 2007). It is very rich in lysine and other essential amino acids except methionine. However, it is expensive and at times if not properly processed may impair performance of the ingesting animals due to the presence of trypsin inhibitors (Nagalakshmi *et al.*, 2007).

### **2. 3. Energy requirement**

Rather than a nutrient, energy is a property of energy-yielding nutrients when they are oxidized during metabolism (NRC, 1994). Energy is an essential component of poultry diet that must be supplied in adequate amount to meet up the bird's requirements for maintenance, optimum growth, egg production and reproduction (Farrell *et al.*, 1982). Energy requirement of quails depends on age of the birds, reproductive status and ambient temperature (Shim, and Vohra, 1984). An energy requirement of 2,600 to 3,000 ME kcal/kg diet for growing quail has been reported for temperate regions (Farrell *et al.*, 1982), whereas, findings under our tropical condition indicated that Metabolizable energy for growing quails is 2,800 ME kcal/kg while that of laying quails is 2,550 ME kcal/kg (Shim, and Vohra, 1984). Increasing the dietary energy levels from 2,600 to 2,800 ME kcal/kg did not influence weight gain but significantly affected the efficiency of feed consumption and utilization (Bawa, 2010). The main sources of energy are cereal grains which are the main ingredients for most diets. Fat such as animal tallow, lard or vegetable oils are added to the diet if high energy is required (Shrivastav, 2000).

### **2. 4. Vitamins requirements**

Vitamins are categorized as fat soluble, (A, D, E, and K) and water soluble (the B-complex vitamins). Many vitamins are quite stable, but some deteriorate rapidly on exposure to heat, sunlight, or air (Murakami *et al.*, 1993). Housed quails are entirely dependent on the vitamins that are incorporated in feed ingredients and those that are supplemented in diets (Shrivastav and Panda, 1982)

#### **2. 4. 1 Vitamin A**

The principal feature of vitamin A is its function in ensuring adequate growth and in assisting the birds in disease resistance. Vitamin A is essential for normal vision, egg production, and reproduction (Parrish and Al-Hasanbi, 1983). Laying quails receiving insufficient vitamin A produce fewer and unhatchable eggs (Parrish and Al-Hasanbi, 1983). For egg production and fertility of females, a level of 2,500 I.U. vitamin A/kg diet is required (Parrish and Al-Hasanbi, 1983).

#### **2. 4. 2. Vitamin D**

This vitamin has several forms, but ergocalciferol and cholecalciferol are the most important. Vitamin D<sub>3</sub> is utilized by birds, man, and four-footed animals, while vitamin D<sub>2</sub> is of value to man and four-footed animals. Thus D<sub>3</sub> becomes essential for quail. Vitamin D aids the absorption of calcium and phosphorus from the intestinal tract and the deposition of calcium on eggshell (Vohra *et al.*, 1979).

Vohra *et al.*, (1979) observed that dietary deprivation of supplementary vitamin D<sub>3</sub> did not affect body weight of male and female quail despite a reduction in feed intake. However, the production of eggs was reduced from 74% to 20%. In another study mature male quail remained in good physical condition on practical diets devoid of vitamin D<sub>3</sub> for one year but mortality of about 90% was observed in females and 16% in males even when both were on negative calcium balance of about the same order (Chang and McGinnis, 1967).

#### **2. 4. 3. Vitamin E**

A deficiency of vitamin E causes a disease of the nervous system in chicks known as 'crazy chick disease' (encephalomalacia). It is also essential to breeding stock for the good hatchability of eggs. Encephalomalacia occurs when the diet contains unsaturated fats that are susceptible to rancidity (Price, 1968). The essentiality of vitamin E for quail was demonstrated by Cunningham and Soares (1979); Kling and Soares (1980). Deficiency of vitamin E in semi-purified diets containing isolated soybean protein and starch did not affect the body weight, feed consumption, or egg production. But cause sterility in males, however the problem which was overcome by restoring 40 I.U. vitamin E/kg to the diet for about 2 weeks. The fertility and hatchability of quail eggs were severely depressed after the birds were fed a conventional diet containing glucose and soybean meal without vitamin E for 20 weeks. In addition, no encephalomalacia or muscular dystrophy was observed when quail were fed vitamin E deficient diets for 35 weeks.

#### **2. 4. 4. Vitamin K**

Vitamin K is an essential element in the synthesis of prothrombin, a chemical substance necessary for blood clotting. A deficiency of vitamin k can lead to the rupture of blood vessels and cause excessive bleeding. Vitamin k is present naturally in all green foods, especially in Lucerne meal. The needs are small; 2 i.u./kg will suffice under normal conditions. A synthetic water-soluble form of vitamin K<sub>3</sub> is generally added in diets (Price, 1968).

#### **2. 4. 5. Vitamin B complex**

The B vitamins are well distributed in cereals grains. Deficiencies are normally unlikely to occur. The main functions of the B vitamins are to assist the quail in achieving its optimum growth (NRC, 1994).

#### **2. 4. 6. Thiamin (Vitamin B<sub>1</sub>)**

Vitamin B<sub>1</sub> is needed for the metabolism of carbohydrates. Charles *et al.* (1972) reported classical symptoms of polyneuritis in newly hatched quail chicks from a flock fed turkey breeder diet calculated to contain 3.2 mg thiamin/kg. These quail responded positively to thiamin therapy. Breeding Japanese quail may have a higher requirement for thiamin (Shim

and Boey, 1988) than breeding fowls which is reported to have a requirement of 0.8 mg thiamin/kg diet (NRC, 1994).

#### **2. 4. 7. Riboflavin (Vitamin B<sub>2</sub>).**

Ramchandran and Arscott (1974) suggested a minimum requirement of 8 mg riboflavin/kg diet in absence of vitamin B<sub>12</sub> and vitamin C, but it decreased to 4 mg per kg in presence of these vitamins. The characteristic symptoms of riboflavin deficiency were slow growth, high mortality, impaired gait and posture ('curled toe paralysis) in quails.

Shim (1985) studied the maternal riboflavin deficiency on reproductive and embryonic development in Japanese quail and found high mortality in the riboflavin deficient group. The 4 and 8 mg/kg of riboflavin were sufficient to maintain normal egg production. Data obtained for weekly hatches showed that the addition of small quantities of riboflavin supplemented to the basal ration increased the incidence of curled-toe paralysis whereas larger amounts did not.

#### **2. 4. 8. Nicotinic acid**

Ramchandran and Arscott (1974) fed a nicotinic acid-free diet to four week old quail and found a subsequent depression in growth, but no other classical deficiency symptoms. The age of the birds determines the severity of symptoms of nicotinic acid deficiency. Ramchandran and Arscott (1974) suggested a marked depression in growth, closure of eyes, reduced activity and a marked atrophy of the pectoral muscle. A 40 mg Nicotinic acid/kg diets is recommended for normal growing quails (Ramchandran and Arscott 1974).

#### **2. 4. 9. Pantothenic acid**

It has been reported that supplementary level of 7.5 mg calcium pantothenate/kg is needed in purified diets for prevention of mortality and for normal growth of quail chicks. However 10-30 mg is needed for normal feathering (Cutler and Vohra, 1977). Spivey-Fox *et al.* (1966) reported 40 mg Pantothenic acid/kg diet for quail of up to 5 weeks of age. Breeding quail required 15 mg supplementary calcium pantothenate acid/kg diet for optimal fertility and hatchability. Eggs from pantothenic acid deficient hens were characterized by embryonic mortality late in incubation haemorrhagic embryos, oedema and embryos with crooked legs (Cutler and Vohra, 1977).

#### **2. 4. 10. Choline**

Growing quail require higher levels of dietary choline to support maximum growth, prevent perosis (Ketola and Young, 1973). Maintain maximum egg weight, egg production and hatchability (Latshaw and Jensen, 1972). The suggested requirement of quail for egg laying is about 3,100 mg/kg diet (Latshaw and Jensen, 1971).

#### **2. 4. 11. Folic acid and Biotin**

Folic acid deficiency in growing quail caused poor feathering, high mortality, leg weakness and cervical paralysis (Wong *et al.*, 1977). These symptoms were similar to those observed in turkey (Wong *et al.*, 1977). Quail chicks also suffered from a mild anemia, and a curled toe syndrome. The folic acid requirement of growing quail is between 0.3 to 0.36

mg/kg casein-gelatin based diet (Wong *et al.*, 1977). Dobalova *et al.*, (1983) reported the need of supplementary biotin for gain in body weight of quail and for increase in egg production.

#### **2. 4. 12. Vitamin B<sub>12</sub> (Cobalamin)**

Vitamin B<sub>12</sub> is required for the development of normal red blood cells. For better hatchability, sufficient pantothenic acid and vitamin B<sub>12</sub> are also essential. Substantial quantities of vitamin B complex are found in all ingredients in feed (Wong *et al.*, 1977).

### **2. 5. Minerals**

Besides protein, carbohydrates, fats, and vitamins, many other elements form a part of the quail's nutritional requirements. Minerals can be divided into macro minerals and micro minerals (Shrivastav, 2000). Macro minerals are required in large amounts, and are often structured parts or acid-base elements. These are: calcium, phosphorus, potassium, magnesium, sulphur, sodium and chloride.

#### **2. 5. 1. Calcium and phosphorus**

The main function of these two minerals is in the make-up of the bones of the body. Calcium is essential for the deposition of egg shell. Calcium and phosphorus are required in sufficient quantity and in correct proportions (Shrivastav, 2000) The young quail needs a minimum of 0.8% of the diet as calcium and 0.45% as available phosphorus, whilst the laying quail needs about 2.5% to 3% of calcium since this is the main constituent of the egg shell (Shrivastav, 2000).

It was observed that there is no difference in body weight or bone ash of quail of 6 weeks of age diets containing 0.58% to 1.18% phosphorus and 0.44% to 2.3% calcium (Ong and Shim 1972). Lee and Shim (1971) found out that 0.5% calcium was adequate for the growing quail and 4.9% calcium retarded growth. Ong and Shim (1972) observed that growing and laying quails were in positive calcium balance as long as the diets contain 0.8%, 1.5%, 2.6% or 3.5% calcium. However a level of 3.5% dietary calcium was observed to reduce hatchability (Ong and Shim 1972). According to Shim and Vohra (1984), the requirement for growing Japanese quails is 0.8% ca and 0.3%. The use of 4.41g/kg of potassium is recommended in the diet for laying Japanese quails (Ong and Shim 1972).

Minerals are observed to be present in feed ingredients such as Fish meal, meat, bone meal and milk products, but are good supplemental sources of calcium and phosphorus are. Oystershell, limestone, tricalcium phosphate or calcium carbonate (Ong and Shim, 1972).

#### **2. 5. 2. Magnesium**

Magnesium is an essential constituent of tissues and body fluids. It serves as activators of important enzymes involved in intermediary metabolism (Shim and Vohra 1984). It has been shown that when magnesium is absent in diets, quails grow slowly, exhibit convulsions and may eventually die (Shim and Vohra 1984). Also deficiency of magnesium ratio will lead to rapid drop in egg production. A level of 300 mg/kg diet was recommended in the studies conducted by shim and vohra (1984). Magnesium requirement for survival and growth was met by supplementing 150 mg magnesium per kg diet, or 50 mg magnesium per liter drinking water. Sugahara *et al.*, (1982) found no detrimental effects from feeding 1,000 mg magnesium per kg purified diet.

### **2. 5. 3. Manganese**

The main function of manganese is to prevent perosis, a condition where Achilles's tendon slips off its groove behind the hock joint, pulling sideways and backwards (Murakami *et al.*, 1993). Manganese is also required for normal growth, egg shell deposition, egg production and good hatchability. It is supplemented in the diet in the form of manganese sulphate (Murakami *et al.*, 1993).

### **2. 5. 4. Iron, Copper and Cobalt**

These trace elements are essential for the formation of haemoglobin. Nutritional anemia occur when deficiency of any of these minerals occur (Murakami *et al.*, 1993). The iron requirement of growing Japanese quail is 90-120 mg/kg, copper 5 mg/kg (Harland *et al.*, 1975).

### **2. 5. 5. Selenium**

Selenium is an essential element for growing quail even in the presence of vitamin E. Diets consisting of amino acids and 100 mg D-alpha-tocopheryl acetate/kg needed to be supplemented with 0.1 mg selenium as selenite for proper survival of quail (Thompson and Scott, 1967). Low selenium and vitamin E levels were observed to impair reproduction hatching and maturity in quails (Thompson and Scott, 1967).

However Dietary supplementation of either 1 mg selenium or 30 I.U. vitamin E/kg diet was observed to prevent impaired reproduction. Selenium supplementation of 0.2 mg/kg diet will also prevent pancreatic atrophy (Thompson and Scott, 1967).

### **2. 5. 6. Zinc**

Domestic quails are sensitive to dietary deficiency of zinc. Zinc deficiency in quail chicks is characterized by slow growth, abnormal feathering, labored respiration, in coordinated gait, low tibia ash, low liver zinc and tibias (Spivey-Fox *et al.*, 1966). The zinc requirement for normal growth, feathering, tibia length and conformation is 25 mg/kg diet (Spivey-Fox *et al.*, 1966). Harland *et al.* (1975) studied the protective effect of high zinc intake for rapidly growing quail to a subsequently fed low zinc diet. The birds fed an initial level of 75 mg zinc/kg grew significantly better than those fed initially 25 mg zinc/kg. Reduction in zinc absorption in adult quail by high levels of calcium was reported by Harland *et al.* (1975)

### **2. 5. 7. Salt (Sodium and chloride)**

Sodium and chloride are needed for protein digestion and acid-base equilibrium in the body. The growing Japanese quail fed a purified type of diet containing 0.042-0.051% sodium has been observed to have a poor growth, high mortality, adrenal enlargement, elevated haematocrit, and depressed plasma sodium suggestive and electrolyte haemostasis. A dietary sodium level of 0.1% overcame these difficulties (Lumijarvi and Vohra, 1976).

Natural feedstuffs usually require supplemental feeding of salt (NaCl) to satisfy the quail's requirement for sodium and chloride This is usually added to the feed at amounts of not less than 0.25 to 0.35%. However too much salt will produce a laxative effect that will results in wet droppings and wet litter (Lumijarvi and Vohra, 1976).

**Table 2.** Nutrient requirements of domestic quails under tropical conditions

	Quail broiler		Quail layer		
	0-2	3-5	0-2	3-5	> 6 weeks
<b>Nutrient</b>	<b>Weeks</b>	<b>Weeks</b>	<b>Weeks</b>	<b>Weeks</b>	<b>&gt; 6 weeks</b>
Metabolizable Energy (Kcal/kg)	2800	2900	2750	2700	2650
Protein (%)	27	24	24	20	19
<b>Minerals</b>					
Calcium (%)	0.8	0.6	0.8	0.6	3.0
Phosphorus (%)	0.3	0.3	0.3	0.3	0.45
<b>Vitamins</b>					
Vitamins A (IU)	8000	8000	8000	8000	8000
Vitamin D3(ICU)	1200	1200	1200	1200	1200
Riboflavin, (mg)	6	6	6	6	6
<b>Amino acids</b>					
Lysine (%)	1.30	1.20	1.20	1.10	0.80
Methionine (%)	0.48	0.45	0.45	0.40	0.33
Methionine + Cystine %	0.75	0.70	0.70	0.65	0.60

Source: Prabakaran (2003)

### 3. CONCLUSION

The nutrient requirements of the Japanese Quails are variable depending on the age of the birds, growth, egg laying and purpose of production.

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