APRW -37

Calcium and Phosphorus Retention by Laying Hens Fed Diets Supplemented with Ascorbic Acid and Cholecalciferol

B.S. Adedeji, O.A. Ogunwole, F.O. Jemiseye, A.O. Mosuro, S.O. Olufeko and T.V. Abokede
Agricultural Biochemistry and Nutrition Unit, Department of Animal Science, University of Ibadan, Nigeria
Corresponding author: B.S. Adedeji; E-mail: bs.adedeji@gmail.com; Tel: +2348162954581

Abstract

This study was designed to assess the influence of supplemental ascorbic acid and cholecalciferol on calcium (Ca) and phosphorus (P) retention in laying hens. Bovan Brown pullets (n=384) aged 12 weeks were randomly assigned to 12 dietary treatment in a 3x4 factorial arrangement of a completely randomised design. Diets were supplemented with three levels of vitamin C at 0, 300 and 600 mg/kg and four levels of cholecalciferol at 0, 1000, 2000 and 3000 IU/kg with feed and water provided *ad libitum* for 58 weeks. At week 70, four birds per treatment were selected and arranged in metabolic cages for faecal collection. Faecal calcium and phosphorus were determined according to standard procedures while calcium and phosphorus retention were calculated. There were highly significant ($p<0.01$) variations in Ca and P retention (73.10 and 70.13) in birds on 300 mg/kg ascorbic acid compared with birds on 0 mg/kg (66.92 and 55.82) and 600 mg/kg ascorbic acid (70.55 and 66.43). Also, calcium retention in birds on supplemental cholecalciferol at 3000 IU (81.66) was significantly higher ($p<0.01$) than 61.23, 76.40 and 61.47 in birds fed supplemental cholecalciferol at 0, 1000 and 2000 IU/kg, respectively. Though, calcium retention in birds on 0 and 2000 IU/kg cholecalciferol were similar ($p>0.01$), phosphorus retention in birds on 3000 IU/kg cholecalciferol supplementation (77.57) was higher ($p<0.01$) than in birds on 1000 IU/kg (69.56), 2000 IU/kg (58.71) and 0 IU/kg cholecalciferol (50.65). Interaction of ascorbic acid and cholecalciferol however, was significant ($p<0.01$) on calcium and phosphorus retention. Sole supplemental ascorbic acid or cholecalciferol and their interaction improved calcium and phosphorus retention in laying hens.

Keywords: Supplemental vitamins, faecal collection, laying hens, calcium, phosphorus

Introduction

Calcium and phosphorus are important minerals that are essential in livestock production. These minerals are essential nutrients needed for skeletal growth and functions. The nutritional role of calcium (Ca) is closely linked to that of phosphorus (P) and to the effect of vitamin D (Mandey *et al*., 2015). More than 70% of animal body ashes consist of Ca and P with about 99% and 80%, respectively present in the bones (Mcdowell, 1992). The nutritional status of an animal affects Ca and phosphorus utilisation and absorption (Mandey *et al*., 2015). Roland *et al.* (1996) reported decreased egg production, feed consumption and bone density and strength due to Ca deficiency while excess calcium has also been reported to significantly reduced egg production and feed consumption (Harms and Waldroup, 1971) with negative effect on P absorption in different species (Liu *et al*., 2000).

Factors that may affect Ca and P digestion, absorption and metabolism include the diet's phytic acid contents, Ca to P ratio, sodium and vitamin D_3 level (Edwards *et al*., 1992; Managi and Coon, 2008). Hurwitz and Bar (1972) reported that the effects of vitamin D_3 on Pi absorption may be independent of that on Ca absorption while Edwards *et al.* (1992) observed that adequate vitamin D_3, with or without phytase supplementation was shown to enhance P utilization in broilers.

The role of ascorbic acid in absorption and utilisation of nutrients has been reported. Ascorbic acid has been implicated in the metabolism of cholecalciferol (Faria *et al*., 2001; DeLuca, 2008), amino acid (El-Shobaki, 1977) and other nutrients. Ascorbic acid has a role in metal ion metabolism due to its reducing and chelating properties thus, enhancing absorption of minerals from the diet and their mobilisation and distribution throughout the body (Olivares *et al*., 1997). Despite the avalanche of information on the roles of ascorbic acid and cholecalciferol in calcium and phosphorus metabolism, little is known about their interplay on absorption and retention in laying hens.

Therefore, retention of calcium and phosphorus in laying hens fed supplemental ascorbic acid and cholecalciferol was assessed in this study.

Materials and Methods

Experimental location

The experiment was carried out at the poultry unit of the Teaching and Research Farm, University of Ibadan, Nigeria. Bovan Brown pullets (n=384) aged 12 weeks were randomly assigned to 12 diets. A basal isocaloric (2702.90 Kcal/kg) and isonitrogenous (17.39%) diet was formulated and supplemented with three levels of vitamin C at 0, 300 and 600 mg/kg and four levels of cholecalciferol at 0, 1000, 2000 and 3000 IU/kg in a 3x4 factorial arrangement. The birds were provided with feed and water *ad libitum* for 58 weeks.

At week 70, four birds per treatment were selected and arranged in metabolic cages and were fed respective diets before the commencement of faecal collection. Excreta were collected on a daily basis from trays placed beneath the metabolic cages for a period of four days. Daily collection was weighed, bulked and stored in the refrigerator and was subsequently oven dried at 80^oC until constant weight was attained. Proximate analysis was done according to AOAC (2000). Ca and P retention were calculated as shown:

$$\frac{\text{Nutrient in excreta} - \text{Nutrient in feed}}{\text{Nutrient in feed}} \times 100$$

Data were subjected to ANOVA at $\alpha_{0.05}$ using SAS (2003) and means where significant were separated using Tukey's HSD option of the same software.

Results and Discussion

There were highly significant ($p<0.01$) variations in Ca and P retention (73.10 and 70.13) in birds on 300 mg ascorbic acid as they were higher than 66.92 and 55.82 as well as 70.55 and 66.43 in birds on 0 and 600 mg ascorbic acid supplementation, respectively. It was observed that calcium and phosphorus were better retained at 300 mg/kg of ascorbic acid supplementation. The improvement in retention due to ascorbic acid may be as a result of the chelating ability of ascorbic acid for metallic ions (Olivares *et al*., 1997) thus making absorption and utilisation of nutrients efficient. Also, calcium retention in birds on supplemental cholecalciferol at 3000 IU (81.66) was significantly higher than 61.23, 76.40 and 61.47 in birds fed supplement of cholecalciferol at 0, 1000 and 2000 IU, respectively, although calcium retention in birds on 0 and 2000 IU cholecalciferol were similar ($p>0.01$). Phosphorus retention in birds on 3000 IU cholecalciferol supplementation (77.57) was however, higher than in those on 1000 IU (69.56), 2000 IU (58.71) and 0 IU cholecalciferol (50.65).

Interaction of ascorbic acid and cholecalciferol however, was significant ($p<0.05$) on calcium and phosphorus retention. Also improvement in Ca and P retention observed could be due to the role of cholecalciferol in the mobilisation of calcium and phosphorus after absorption for use by the body (Soaves *et al*., 1995; Xu *et al*., 2002) as earlier authors have reported the importance of cholecalciferol in calcium (Hattenhauer *et al*., 1999) and phosphorus metabolism (Edwards *et al*., 1992). The significant interaction observed in calcium and phosphorus retention due to supplemental ascorbic acid and cholecalciferol may be attributed to the interplay of these vitamins in calcium and phosphorus metabolism. This was similar to earlier reports on the role of ascorbic acid and cholecalciferol on calcium and phosphorus utilisation in chickens (Lohakare, 2005).

Conclusion

Sole supplemental ascorbic acid or cholecalciferol and their interaction improved calcium and phosphorus retention in laying hens.

Table 1: Effect of supplemental ascorbic acid and cholecalciferol on nutrient retention in laying hens

	Calcium (%)	Phosphorus (%)
Ascorbic acid (mg/Kg)		
0	66.92^c	55.82^c
300	73.10^a	70.13^a
600	70.55^b	66.43^b
SEM	0.68	0.19
Cholecalciferol (IU/Kg)		
0	61.23^c	50.65^d

1000	76.40^{b}	69.56^{b}
2000	61.47^{c}	58.71^{c}
3000	81.66^{a}	77.57^{a}
SEM	0.78	0.22
P-Value		
Ascorb.	<0.001	<0.001
Chole.	<0.001	<0.001
Ascorb.*Chole.	<0.001	<0.001

^{abc}Means with similar superscripts along the same column are not significantly different (P>0.05) Ca: Calcium; P: Phosphorus; SEM: Standard Error of Mean. Ascorb.: Ascorbic acid; Chole: Cholecalciferol

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