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Nano phosphorus on egg production and quality in Japanese quail

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Abstract

Supplementation of nano form of mineral increases bio-availability and efficiency of utilization. In this regard, an experiment was performed to study the effects of calcium phosphate nano particle (NCP) supplementation with or without combination with DCP (Dicalcium Phosphate) on the performance of Japanese quail birds. NCP was synthesized in the laboratory and the particle size was determined by using scanning electron microscope. NCP size was found in the range of 51- 200 nm. For performance study, 192 Japanese Quail birds divided into 8 groups viz, T1-Control DCP 100%, T2- 25%NCP+ 75% DCP, T3- 25% NCP, T4-50% NCP, T5- 50% DCP + 50% NCP, T6- 75% NCP, T7- 75% NCP + 25% D.C.P., T8- 100% NCP. Performance of egg production was carried out for 100days after onset of laying. Total hen housed egg production percent ranges from 38.142±2.285 (T4) to 2.428±0.286 (T8). Shape index of the eggs ranges from 89.992±2.871 (T7) to 76.023±0.043 (T3). The average weight (g) of the eggs ranges from 11.982±0.185 (T4) to 6.022±0.123 (T8). Shell thickness of the eggs (mm) ranges from 0.172±0.007 (T4) to 0.12±0 (T8). The Haugh unit of the eggs ranges from 85.512±0.540 (T4) to 79.095±0.655 (T5).There are significant differences in the above mentioned egg quality parameters among different dietary treatment groups. Considering the above results of the present study, it may be concluded that dietary NCP at 50% level supplementation with 50% DCP have better bioavailability with higher production indices in Japanese quail birds. Significantly higher differences (p>o.o5) were achieved in case of egg production parameters and egg quality traits. In other wards supplementation of NCP at 100% level had adverse effects on growth, and seriously altering egg quality and other parameters.

Keywords: Japanese quail; Nano phosphorus; Egg production; Egg quality

1. Introduction

Among several other technologies to enhance the bio availability of phosphorus, nano technology has opened new horizons by increasing simultaneously the surface area and the absorption of that element. Nanotechnology can be defined as manipulation of particle with dimensions less than a micron by re-designing and synthesis to that of individual atom. In this technology the particle size of the element will be decreased but the surface area of the particle will increase. From past few years several methods have been introduced for synthesis and preparation of nano particles, but it is important to determine the size, shape, surface area, phase constitution, and micro-structural features. The size and shape of the powder particles can be determined accurately by using Transmission electron microscopy (TEM) to measure relatively coarse powders.

Nano particles can be efficiently utilized to fulfil the requirement of major and micro elements to promote growth rate, enhance the feed efficiency and overall performance and outcome from the birds by enhanced bioavailability. Feeding of calcium and phosphorus in nano particle form instead of using conventional di-calcium phosphate has increased the feed efficiency in the broiler birds (Vijayakumar and Balakrishnan, 2014) in comparison to traditional di-calcium phosphate, nano calcium phosphate supplementation has improved the tibia bone parameters. Trials have been conducted on effects of nano calcium phosphate supplementation in poultry birds. Still very limited and most of them

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are non-conclusive. As per Japanese quail is concerned, no such reports have been seen. Hence keeping a view on the above facts the present trial has been undertaken.

2. Material and methods

The experiment was conducted in The Dairy & Poultry Farm complex of the Department of Animal Science, Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Shantinketan spreading over a period of 06 months from September 2018 to February 2019. Day old Japanese quail chicks of CARI Uttam variety, supplied by Tollygunje State Poultry Farm, Govt. of West Bengal were taken for the study. Egg production studies were carried out for 100 days after onset of laying. An aqueous solution of calcium nitrate (18 mM) was prepared and mixed with an aqueous solution of diammonium hydrogen phosphate (10.8 mM). The pH of both the solutions was adjusted to 9 using 0.1M sodium hydroxide prior to mixing. The mixture of solutions were centrifuged at 10000 rpm and the particles were allowed to settle at the bottom which was then spread out as a thin film in trays and dried in hot air oven at 90°C. After drying white soft powder (calcium phosphate nanoparticles) was obtained using an indigenously fabricated unit. The size of the prepared calcium phosphate nanoparticles was carried out by using Transmission electron microscopy (TEM) the particle size was found to be in the from 51 to 200 nanometer. Calcium was determined by Talapatra et al. 1940 and available phosphorus was determined by IS: 1374-1968. The calcium and phosphorus content of Calcium phosphate nanoparticles were analysed as 30.80% and 14.90%, respectively.

192 Japanese quail birds were divided into 8 groups viz. T1- Control (DCP 100%), T2 (25% NCP+75% DCP), T3 (25% NCP), T4 (50% NCP), T5 (50% DCP+50% NCP), T6 (75% NCP), T7 (75% NCP+25% DCP) and T8 (100% NCP) respectively. There were 8 experimental groups including control (T1). Each group have 3 replicates.

Basal diets were prepared to meet the nutrient requirement of starter, grower and layer phases of Japnese Quail birds as per Singh and Panda (1988) and NRC (1971). The basal diets were analysed for proximate composition as per AOAC (1995). Calcium was determined by Talapatra et al, 1940 and available phosphorus was determined by IS: 1374-1968)

Collection of eggs has been started after 7 days from 1st day of onset of laying . The collection process has been continued for up to 100th day. As Japanese Quails are mostly evening layers, eggs were being collected twice in a day and then cleaned by rubbing sand paper and dipped in antiseptic and disinfectant solution. Then they were placed on sanitized disposable paper made dry filler flats as per different treatment groups and replication groups. Those filler flats were being stored in sanitized egg storage room of the farm under 16° Centigrade and 70% relative humidity in a controlled way.

The parameters calculated are hen housed egg production per bird, total hen housed egg production per bird, average weekly hen housed percent, and hen day percent and total hen housed egg production percentage.

The external qualities of an egg include size, shape, shell colour and texture. The standard weight of a Japanese quail egg is 10 g. The shape indicate that the egg should not be too round or too elongated and is measured in term of shape index, egg weight, yolk index, shell thickness, Haugh unit respectively. The data were subjected to statistical analysis by the software SPSS (1997).

3. Results

3.1. Egg Production

Egg production performance of Japanese quail has been presented in Table-1. It indicated that the average weekly hen housed egg production per bird in group T4 has significantly ($P>0.05$) achieved highest yield than any other treatment group, however group T8 has the lowest yield. The total hen housed egg production per bird, average weekly hen housed egg production percent and total hen housed egg production percent also followed the same trend in group T4 in which 50% NCP was present has significantly ($P>0.05$) higher egg production than any other treatment group, however group T8 has the lowest egg production.

3.2. Egg Quality

The egg quality of Japanese quail with different levels of NCP has been presented in Table-2. Results showed that the average Shape Index of Japanese Quail eggs among different dietary treatment groups T7 has significantly ($P>0.05$) achieved highest percentage values than any other treatment group, however group T5 resulted the lowest percentage. The average egg weight of Japanese quail among different dietary treatment groups showed that group T4 having significantly (P>0.05) higher egg weight than any other treatment group, however group T8 has the lowest weight value. The average Shell Thickness of Japanese Quail eggs from different groups of birds indicated that group T5 has significantly (P>0.05) higher shell thickness than other treatment groups, howeverT8 group of birds having the lowest shell thickness of eggs. The average Yolk Index of Japanese Quail eggs in percentage among different dietary treatment groups resulted that Yolk index of eggs from group T7 eggs having comparatively higher value than any other treatment groups, however group T2 has the lowest percentage. No significant (P<0.05) difference has been observed among different treatment groups. The average Haugh Unit of Japanese quail eggs also showed that group T4 having significantly (P>0.05) higher values than any other treatment group, however group T5 having the lowest Haugh Unit values of eggs.

Table 1 Hen housed egg production

Sl. No.	Parameters	T1	T2	T3	T4	T5	T6	T7	T8
1.	Average Weekly Hen Housed Egg Production/bird	f 0.494 ±0.035	e 1.009 ±0.081	b 1.351 ±0.035	a 2.724 ±0.163	c 1.259 ±0.045	d 1.106 ±0.025	c 1.208 ±0.035	g 0.173 ±0.020
2.	Total Hen Housed Egg Production/bird	g 6.928 ±0.500	ef 14.142 ±1.142	b 18.928 ±0.5	a 38.142 ±2.285	c 17.642 ±0.642	ef 15.499 ±0.357	cd 16.928 ±0.5	h 2.428 ±0.286
3.	Average Weekly Hen Housed Egg Production%	f 7.069 ±0.510	e 14.431 ±1.166	b 19.314 ±0.510	a 38.92 ±2.332	c 18.002 ±0.655	e 15.815 ±0.364	d 17.273 ±0.510	g 2.477 ±0.291
4.	Total Hen Housed Egg Production %	f 6.928 ±0.500	e 14.142 ±1.142	b 18.928 ±0.5	a 38.142 ±2.285	c 17.642 ±0.642	e 15.499 ±0.357	d 16.928 ±0.5	g 2.428 ±0.286

Values bearing different superscripts in a row differ significantly (P<0.05)

Table 2 Egg quality parameters

Parameters	T1	T2	T3	T4	T5	T6	T7	T8
Shape Index (%)	e 79.88 ±0.473	cd 81.766 ±0.020	f 76.023 ±0.043	cd 80.42 ±0.135	g 75.974 ±1.355	f 76.478 ±0.052	a 89.992 ±2.871	b 86.96 ±0.220
Egg Weight (g)	b 11.608 ±0.022	c 10.936 ±0.025	d 10.6 ±0.168	a 11.982 ±0.185	cd 10.827 ±0.132	d 10.262 ±0.029	ab 11.321 ±0.123	e 6.022 ±0.123
Shell Thickness (mm)	b 0.17 ±0.002	d 0.14 ±0.002	d 0.147 ±0.003	b 0.172 ±0.007	a 0.185 ±0.009	c 0.15 ±0.002	e 0.134 ±0.004	f 0.12 ±0
Yolk Index (%)	e 36.518 ±6.156	f 33.305 ±4.813	b 38.77 ±0.923	d 37.34 ±0.290	ab 39.939 ±0.391	c 38.82 ±1.536	a 40.267 ±0.664	ab 39.967 ±0.650
Haugh Unit	g 79.51 ±0.020	eb 2.543 ±0.023	cd 83.26 ±0.823	a 85.512 ±0.540	g 79.095 ±0.655	f 80.861 ±0.580	b 84.863 ±0.103	c 83.479 ±0.602

Values bearing different superscripts in a row differ significantly (P<0.05)

4. Discussion

The egg production parameters of Japanese quail birds like hen housed egg production per bird, Total Hen housed egg production per bird, Average weekly hen housed egg production percentage, Total hen housed egg production percent of dietary NCP supplemented groups has achieved significant ($P<0.05$) difference than the control group where superior results were seen in T4 group (50%NCP+ 50% DCP) than other dietary groups. As per as egg quality parameters are concerned, parameters like shape index, egg weight, shell thickness, yolk index, albumin weight of the Japanese quail birds of dietary NCP supplemented groups has achieved significant ($P< 0.05$) difference than DCP supplemented groups. In most of the cases group T5 (50% NCP only) supplemented groups have shown better performance than other group of DCP and NCP combination groups or only NCP groups. Supplementation of nano selenium content in commercial laying chicken has also resulted in increased laying performance, increased egg mass and increased particular blood mineral level in the birds (Radwan *et al,* 2015). The experimental trial on commercial laying chicken in nano Zinc Oxide has also shown similar increased results in case of egg production and egg quality parameters (Tsai *et al,* 2016). As per as nano technology is concerned results in this feeding trial also have similar effect with nano Zinc Oxide supplementation in Japanese Quail Birds, which also have shown increased performance in both egg production parameters as well as egg quality parameters in Japanese Quail birds than non-nano Zinc Oxide supplemented birds (Amiri *et al,* 2015). However supplementation of nano calcium carbonate in commercial laying chickens has shown negative effect on production performance and decreased shape index of eggs from the supplemented birds (Ganjigohari *et al*, 2018). The egg production and egg quality both type of parameters have increased significantly may be due to better bio availability of calcium and phosphorus as these two are key minerals involved in formation of egg and its constituents. Due to reduced particle size and increased surface area of the NCP material than DCP, it has better absorption through intestinal villai and for that reason it has better bioavailability in the body of the birds which resulted in to better performance (Konkol *et al*, 2018). The lower performances in T2, T3 and control group may be due to lower availability of the minerals than their optimal requirements. However lower performance of the birds has also been seen in dietary increased NCP supplemented groups like T6, T7 and T8, respectively. It may be interpreted that higher supplementation of NCP surely can increase the bio availability of calcium and phosphorus in the body of the Japanese Quail birds but at the same time it also can disrupt or hinders the required availability of other essential minerals and nutrients, as excess of particular one mineral can easily increase the requirement of other nutrients which are practically very limited in the present feeds. As a result cumulative effect of all the nutrients is lower than optimal requirements and the performance of egg production has also been decreased. Thus, proper supplementation is vital for the birds.

5. Conclusion

Supplementation of nano phosphorus at different levels with or without Dicalcium phosphate in Japanese quail on egg production and quality of eggs indicated that superior performance was observed at the levels of 50%NCP with 59% DCP in the diet.

Compliance with ethical standards

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Disclosure of conflict of interest

Authors have no conflict of interest in this study.

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