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Effect of Dietary Supplementation of Herbal Calcium on Production, Egg Quality, Egg Biochemical Parameters and Cost of Economics of White Leghorn Layers

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ABSTRACT

The objective of the present study was to evaluate the herbal calcium supplements in Commercial layers under cage and deep litter systems of rearing. For this purpose, 240 White Leghorn layers (*Bovans*) were distributed randomly in to 4 different treatments with 4 replicates having 15 birds in each replicate. The production performance and egg quality were evaluated from 54 to 61 week of age. The Basal Diet consist of corn and soybean meal was prepared as a control and fed to birds under cage (T1) and deep litter (T3) system. The remaining two experimental diets were supplemented with herbal calcium supplement (Ayucal D) @ 9 g/60 birds/day by mixing uniformly in feed for 10 days in every month and fed to birds under cage (T2) and deep litter system (T4). The results revealed that the Ayucal D supplementation improved ($P<0.01$) the egg production and egg mass in birds reared under deep litter and it was comparable with that of birds reared under cage system with or without supplementation of Ayucal D. The Ayucal D supplementation to layers reared under both the systems significantly ($P<0.01$) lowered the feed intake and feed efficiency. Ayucal D supplementation and systems of rearing did not influence the egg biochemical constituents and egg quality parameters. From the present study, it can be concluded that supplementation of Ayucal D to layer birds reared under cage and deep litter systems improved the production performance without affecting egg quality and biochemical parameters. Besides, Ayucal D supplementation increased net profit over control groups.

KEY WORDS: Ayucal-D, Cage, Deep litter, Layers, Performance

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INTRODUCTION

Calcium is one of the key nutrients required for egg production and optimal eggshell quality of laying hens. To our knowledge, a considerable amount of research has been conducted on the effect of feeding various calcium and phosphorus levels during early, mid or total laying stage, but only limited information is available on herbal calcium supplements to diets of commercial layers reared under both cage and deep litter system. Ayucal premix is calcium and phosphorus supplement enriched with synergistic herbs (Ayurvet Limited, India). This poly herbal formulation is meant for improving the utilization of calcium and phosphorus. Previous studies on Ayucal liquid and Ayucal premix indicated improved egg specific gravity, egg shell thickness and egg weight, breaking strength and they were correlated with the activity of herbal constituents of the products owing calcium and phosphorus mineralization properties, responsible for enhancing the bio-availability of calcium and phosphorus in gizzard (Sharma et al., 2009). The significant improvement in tibial mineralization was attributed to synergistic herbs present in the Ayucal liquid which have the enhancing ability of mineral absorption (Ashan et al., 1989 and Jadhav et al., 2010). The synergistic herbs of Ayucal Liq. namely *Cissus quadrangularis, Lepidium sativum, Terminalia arjuna, Uraria picta* and many were scientifically proven for increased Ca and P mineralization and regulate their mobilization from skeletal system to optimize the serum Ca and P levels (Ashan et al., 1989, Deka et al., 1994; Prasad et al., 1965). Further, the use of phytogenic feed additives or herbal plants has recently received much attention as alternatives to traditional feed

supplements. However, studies on herbal calcium and phosphorus supplementations in layer birds reared under different systems of rearing appear negligible. Thus current investigation was made to study the effect of dietary herbal calcium and phosphorus supplementation to commercial layers reared under cage and deep litter system on production performance, egg quality and cost economics.

MATERIALS AND METHODS

This study was undertaken with an aim to evaluate the herbal calcium supplements in commercial layers under cage and deep litter system. During this experiment 240 commercial layers (Bovans) were randomly distributed to 4 experimental groups with 4 replicates per group and each replicate having 15 birds. The birds of first two groups (T1 & T2) were kept under cage system, while birds of other two groups (T3 & T4) were kept under deep litter system. In both systems of rearing the birds were kept under standard hygienic conditions throughout the experiment. Replicate groups were offered the feed and water were provided *ad libitum* daily.

A corn soya diet was prepared as a basal diet (Table 1) and fed to birds under cage (T1) and deep litter (T3) system. The remaining two experimental diets were supplemented with herbal calcium supplement (Ayucal D) @ 9 g/60 birds/day, as a top up supplement by mixing uniformly in the feed for 10 days in every month and fed to birds under cage (T2) and deep litter system (T4).

Table 1. Ingredients and Nutrient composition of basal diet

S.No	Ingredients	Quantity (kg)
1	Maize	622.0
2	Soyabean meal 45%	235.0
3	Deoiled Rice bran	16.0
4	Dicalcium Phosphate	14.0
5	Shell grit	104.0
6	Salt	3.200
7	DL Methionine	1.500
8	Trace Minerals	1.000
9	Vitamin Premix	0.500
10	Choline chloride 75%	0.500
11	Toxin Binder	1.000
12	Sodium Bicarbonate	1.500
TOTAL		1000
Nutrient composition		
S.No	Nutrient	
1	M.E (Kcal/kg)	2628
2	Crude Protein (%)	16.5
3	Lysine (%)	0.81
4	Methionine (%)	0.40
5	Calcium (%)	4.04
6	Available phosphorus (%)	0.38

* Trace mineral provided per kg diet: Manganese -120mg, Zinc -80mg, Iron -25mg, Copper -10mg, Iodine -1mg and Selenium -0.1mg.

** Vitamin premix provided per kg diet: Vitamin A 200000 IU, Vitamin B_2 -25 mg, Vitamin D_3 - 3000IU, Vitamin K -2mg, Riboflavin- 25mg, Vitamin B_1- 1mg, Vitamin B_6- 2mg, Vitamin B_{12} - 40mg and Niacin - 15mg.

Data on egg production was recorded two laying periods and percent hen day egg production was calculated for each treatment. Feed consumption of each replicate was recorded during each period and feed conversion ratio was calculated for each period and also on cumulative basis for entire study period. Feed conversion ratio was calculated (Feed intake/ egg mass) considering mortality.

Egg Quality Parameters

Internal egg quality parameters were evaluated for all the treatment groups at the end of the each laying period from the eggs laid by birds consecutively for three days. Egg quality traits viz., haugh unit score was measured by using Ames Haugh unit meter, albumen and yolk index were calculated using the formula of Romanoff and Romanoff (1963), yolk color score was determined using DSM yolk color fan, shell strength was measured using Kalpak universal testing machine with 20 kg load strength (KIC-1-100-C, SI. No. 120301), shell weight was recorded after drying in hot air oven, shell thickness was measured using Mitutoyo dial gauge meter (Model no. 7301, Japan), to an accuracy of 0.01 mm and the egg density was measured by using digital density balance with 0.0001 g/cm^3 accuracy.

Egg biochemical parameters

Egg weighted and the contents were dried in a bowl at 65^{o}C for 5-6 days and powdered. About 0.1 g of dried egg powder was weighted and transferred to a 1.5ml tube. Nine times by weight of anhydrous ethanol were added to the tube and mixed vigourously by inverting the tube several times. Mixing was repeated for 3 times with hourly gap. Next, all samples were centrifuged for 10 min at 2,500 rpm. Supernatant was collected to a fresh 1.5ml tube and analyzed egg total protein, cholesterol and direct LDL Cholesterol in Turbo Chem 100 Manager Blood analyzer by using commercial test kits (CPC diagnostics, Chennai,India).

Cost of Economics

The cost of feeding of layers was calculated for all treatment groups by multiplying feed intake with feed cost. The cost of production was calculated as cost per production of dozen (12) eggs and arrived by multiplying feed intake with feed cost divided by twelve. The net profit / dozen eggs (Rs.) and the net profit over control (Rs.) by considering the market price of egg

Statistical analysis

The data was subjected to one way analysis of variance using SPSS software package (version 12, SPSS, Chicago, IL, USA). Means from each replicate was considered as unit for statistical analysis. Analysis of variance was used to compare the effect of dietary variation on different dependant variables (Snedecor and Cochran, 1989). The differences between the means were tested by significance using Duncan's multiple range test (Duncan, 1955).

RESULTS & DISCUSSION

Hen day egg production and egg mass was influenced significantly ($P<0.01$) by dietary variation during 54-57 & 58-61 weeks laying periods and overall experiment (54-61 weeks) (Table 2 & 3). Egg production and egg mass significantly reduced in birds reared under deep litter system. The Ayucal D supplementation improved ($P<0.01$) the egg production and egg mass in birds reared under deep litter and it was comparable with that of birds reared under cage system with or without supplementation of Ayucal D. Feed intake and Feed conversion ratio of layers was affected significantly ($P<0.01$) among treatment groups during 58-61 weeks and overall experiment (54-61 weeks), while such effect was not observed during 54-57 weeks (Table 2 and 3). The system of rearing has no influence on feed intake and feed efficiency of layers and it was comparable among birds fed basal diet under both the systems. However, the Ayucal D supplementation to layers reared under both the systems significantly ($P<0.01$) lowered the feed intake. The lowest ($P<0.01$) feed conversion ratio was observed in birds reared under cage system fed with basal diet supplemented with Ayucal D while, feed conversion ratios were comparable in birds under deep litter system with or without Ayucal D feeding and birds under cage

system fed without Ayucal D. In line with our findings, Jadhav et al., (2010) reported improved production and FCR in Ayucal D supplemented broilers compared to control. Use of different metabolites of vitamin D in diets of layers improved the egg production and FCR (Nascimento et al., 2014). Similarly supplementation of herbal compounds in diets of Japanese quails (Agnivesh et al., 2023) and weaned piglets (Lavanya et al., 2023) improved the performance. The improved performance of birds in the present study might be due to improved bioavailability of dietary nutrients with herbal constituents present in the Ayucal D. The reduced performance noted in un supplemented birds of deep litter system might be due to higher physical activity and reduced feed intake in birds.

Table 2. Effect of dietary supplementation of herbal calcium on the Hen, day Egg Production and Feed Intake in White Leghorn layers during 54-61 weeks of age

Diet	Hen day Egg Production (%)			Feed Intake (g/bird/d)		
	Period 1 (54-57 wks)	Period 2 (58-61 wks)	Overall (54-61 wks)	Period 1 (54-57 wks)	Period 2 (58-61 wks)	Overall (54-61 wks)
Cage + Basal diet	84.8^{a}	82.7^{a}	83.7^{a}	112.11	108.98^{a}	110.55^{a}
Cage + Ayucal D	86.8^{a}	84.1^{a}	85.5^{a}	108.86	102.81^{b}	105.83^{b}
Deep litter + Basal	81.6^{b}	78.9^{b}	80.3^{b}	113.71	109.00^{a}	111.34^{a}
Deep Litter +	86.01^{a}	84.9^{a}	85.5^{a}	110.41	103.29^{b}	106.86^{b}
SEM	0.415	0.319	0.384	0.847	0.8701	0.6807
P value	0.001	0.002	0.001	0.205	0.004	0.008

^{ab}Means with different superscripts in a column differ significantly; P<0.05

The mortality was within the limitation between 54-61 weeks of age. During the first (54-57 wks) period there was no mortality of birds, whereas in the second period (58-61 wks) there was only one bird mortality recorded in the birds fed basal diet reared under deep litter system.

Table 3. Effect of dietary supplementation of herbal calcium on the Egg mass and Feed Conversion ratio in White Leghorn layers during 54-61 weeks of age

Diet	Egg mass (EM, g egg/hen/d)			Feed Conversion ratio (g intake/g egg)		
	Period 1 (54-57 wks)	Period 2 (58-61 wks)	Overall (54-61 wks)	Period 1 (54-57 wks)	Period 2 (58-61 wks)	Overall (54-61 wks)
Cage + Basal diet	45.5^{a}	43.8^{ab}	44.7^{a}	2.49	2.49^{a}	2.49^{a}
Cage + Ayucal D	45.8^{a}	44.6^{a}	45.2^{a}	2.41	2.33^{b}	2.37^{b}
Deep litter + Basal	43.5^{b}	41.9^{b}	42.7^{b}	2.57	2.52^{a}	2.54^{a}
Deep Litter +	46.1^{a}	45.7^{a}	45.9^{a}	2.41	2.49^{a}	2.45^{ab}
SEM	0.319	0.379	0.2802	0.033	0.025	0.019
P value	0.015	0.003	0.001	0.288	0.026	0.008

^{ab}Means with different superscripts in a column differ significantly; P<0.05

Supplementation of Ayucal D to birds reared under cage and deep litter system did not influence egg quality parameters viz., egg weight, shape index, haugh unit shell weight, shell thickness (mm), Shell breaking strength, albumin percentage, yolk percentage and organoleptic parameters (Table 4). The percentage of shell less eggs and shell broken eggs in overall experiment ranges between 0.036 to 0.065%. These were comparable among all treatment groups. Yolk index and yolk color score were significantly improved ($P<0.01$) in birds fed on Ayucal D diets under both the systems of rearing. Egg biochemical parameters viz., egg protein, egg cholesterol and egg direct LDL concentrations were not affected with Ayucal D supplementation to birds reared under both the systems and were comparable among all treatment groups during 54-57, 58-61 weeks and overall period (54-61 weeks) of experimentation (Table 5). Egg quality parameters viz. egg weight, specific gravity, shape index, haugh unit, albumen quality and egg biochemical parameters were neither influenced by system of rearing nor by Ayucal D supplementation. Thus it indicates the herbal constituents in Ayucal D do not influence the egg quality and egg biochemical parameters. Previous studies also demonstrated no influence on egg quality parameters with of herbal garlic (Olobatoke and Mulugeta, 2011) and ashwagandha root (Sandeep et al., 2020) powder supplementation. In contrary, Sharma et al. (2009) observed improved egg specific gravity, egg shell thickness and egg weight, breaking strength with supplementation of Ayucal liquid and Ayucal premix. In the present study, the improved yolk index and yolk color score in Ayucal D supplemented birds reared under both the systems might be due to presence of herbal compounds present in the Ayucal D supplement.

Table 4. Effect of dietary supplementation of herbal calcium on the Egg quality Parameters in White Leghorn layers during 54-61 weeks of age

Diet	Egg Wt (g)	Shape Index	Haugh Unit	Shell Weight (g)	Shell Thickness (mm)	Breaking Strength (N)	Albumen %	Albumen Index	Yolk %	Yolk Index	Yolk color Score	Specific gravity (g/cm^3)	Organoleptic Score
Cage + Basal diet	54.8	0.75	76.28	4.79	0.35	21.09	61.1	0.07	26.5	0.30^b	5.45^b	1.0728	2.00
Cage + Ayucal D	55.03	0.75	78.05	4.75	0.35	20.8	64.8	0.07	26.3	0.31^a	5.75^a	1.0755	2.17
Deep litter + Basal diet	54.8	0.75	77.17	4.79	0.35	20.07	61.5	0.07	26.6	0.29^b	5.56^b	1.0741	2.20
Deep Litter + Ayucal D	54.8	0.75	77.21	4.82	0.35	20.6	61.4	0.07	26.5	0.30^a	5.68^a	1.0759	2.00
SEM	0.088	0.003	0.343	0.029	0.002	0.236	0.958	0.001	0.074	0.001	0.033	0.001	0.087
P value	0.807	0.645	0.345	0.686	0.851	0.470	0.505	0.703	0.405	0.001	0.002	0.451	0.601

Table 5. Effect of dietary supplementation of herbal calcium on the egg biochemical parameters in White Leghorn layers at 61st weeks of age.

Diet	Egg Protein	Egg Cholesterol	Egg direct LDL
Cage + Basal diet	2.90	223.17	247.48
Cage + Ayucal D	2.90	227.45	234.15
Deep litter + Basal diet	2.43	237.63	276.18
Deep Litter + Ayucal D	2.91	242.65	290.93
SEM	0.098	3.854	18.046
P value	0.238	0.263	0.698

Feed cost/dozen eggs (Rs.) in birds fed basal diet supplemented with or without Ayucal D reared under cage and deep litter system is 30.94/-, 32.98/-, 31.24 and 34.65/-, respectively (Table 6) . The net profit over control with Ayucal D supplementation in birds reared under cage and deep litter system is Rs. 2.05 and Rs. 1.75, respectively. Increased net profit in Ayucal D supplemented groups over control groups could be due to improved egg production and FCR in Ayucal D supplemented birds in both the systems.

Table 6. Effect of dietary supplementation of herbal calcium on the feed cost per egg mass in White Leghorn layers during 54-61 weeks of age

S no	Criteria	Cage + Basal	Cage + Ayucal D	Deep litter +	Deep Litter +
1	Cost of feed per kg (Rs.)	20.8	20.8	20.8	20.8
2	Feed consumption/dozen eggs (kg)	1.58	1.48	1.66	1.500
3	Feed cost/dozen eggs (Rs.)	32.9	30.9	34.6	31.2
4	Selling price / dozen eggs (Rs.)	53.9	53.9	53.89	53.9
5	Net profit / dozen eggs (Rs.)	20.9	22.9	19.2	22.6
6	Net profit over control (Rs.)	0	2.05	-1.66	1.75

Selling price of egg Rs: 4.49

CONCLUSION

It can be concluded that supplementation of Ayucal D to layer birds reared under cage and deep litter systems improved the production performance without affecting egg quality and biochemical parameters. Besides, Ayucal D supplementation increased net profit over control groups.

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REFERENCES

Agnivesh, Ch., Rambabu, D., Srinivas Gurram. and Narasimha, J. 2023. Dietary inclusion of *Tinospora cordifolia* (Giloy) stem powder on performance, serum parameters and carcass traits of Japanese Quails. Indian Journal of Animal Nutrition. 40(3): 331-336.

Ashan, S.K., Tariq, M., Ageel, M., Al-yaha, M.A. and Shah, A.H. 1989. Studies on some herbal drugs used in fracture healing. International Journal of Crude Drug Research. 27: 235-239.

Deka, D.K., Lahon, I.C., Saikia, J. and Mukti, A. 1994. Effect of clssus quadrangular/s in accelerating healing process of experimentally fractured radius-ulna of dog: a preliminary study. Indian Journal of Pharmacology. 26: 44-45.

Duncan, D.B. 1955. Multiple range and multiple F tests. Biometrics. 11(1): 1-42.

Jadhav, N.V., Awati, B., Pardeep Kumar., Kartikesh, S.M., Ravikanth, K., Shivi Maini and Divesh Sood. 2010. Role of Ayucal Liquid in improving overall performance and tibial mineralisation in broilers. Veterinary World. 3(9): 424-426.

Lavanya, M., Suresh Babu, D., Suresh, J., Punya Kumari, B., Bhaskar Reddy, G.V., Bhaskar Ganguly. and Kamalnath Reddy, M. 2023. Efficacy of polyherbal feed supplements on growth performance and nutrient digestibility in grower pigs. Indian Journal of Animal Nutrition. 40(3): 369-374

Nascimento, G.R., Murakami, A.E.I., Guerra, A.F.Q.M.I., Ospinas-Rojas, I.C.I., Ferreira, M. F.Z.I. and Fanhani, J.C.I. 2014. Effect of different vitamin D sources and calcium levels in the diet of layers in the second laying cycle. Brazilian Journal of Poultry Science. 16(2): 37-42.

Olobatoke, R.Y. and Mulugeta, S.D. 2011. Effect of dietary garlic powder on layer performance, fecal bacterial load, and egg quality. Poultry Science. 90: 665-670.

Romanoff, A.L. and Romanoff, A.J. 1963. The Avian egg. John Wiley and Sons Co., New York.

Prasad, G., Sankaran, P.S. and Deshpande, P.J. 1965. Studies on fracture healing by using radioactive P-32 and Ca-45 under the influence of *Uraria picta*. Indian Journal of Medical Research. 53: 645-650.

Sandeep, K., Raj Singh, B., Ramsawroop and Sajjan, S. 2020. Effect of dietary supplementation of Ashwagandha root powder on production performance, egg quality and blood biochemical constituents of laying hens. Indian Journal of Animal Nutrition. 37(4): 352-357

Sharma, R.K., Ravikanth, K., Maini, S., Rekhe, D.S. and Rastogi, S.K. 2009. Influence of calcium and phosphorus supplements with synergistic herbs on egg shell quality in late layers. Veterinary World. 6(2): 231-233

Snedecor, G.W. and Cochran, W.G. 1980. Statistical Methods. Oxford and IBH. Publishing Company, New Delhi.