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Increasing Laying Performances and Egg Vitamin A Content Through Zinc Oxide and Phytase Enzyme Supplementation

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ABSTRAK

Tujuan penelitian ini adalah untuk meningkatkan performan ayam petelur dan kandungan vitamin A dalam telur ayam yang diproduksi dari ayam yang diberi ransum berkadar asam fitat tinggi yang berasal dari dedak padi. Penelitian ini menggunakan 162 ekor ayam petelur strain ISA-Brown umur 18 minggu dan dipelihara sampai umur 33 minggu. Penelitian ini menggunakan rancangan acak lengkap (RAL) pola faktorial dengan 3 ulangan, masing-masing ulangan terdiri atas 6 ekor ayam. Faktor pertama (A) adalah suplementasi Zn dalam bentuk ZnO (0, 252 dan 567 mg ZnO/kg ransum), faktor kedua (B) adalah suplementasi enzim fitase (0, 300 dan 400 unit fitase/kg ransum). Data performan ayam petelur dianalisis sidik ragam (analyses of variance/ ANOVA), sedangkan data vitamin A dalam telur dianalisis secara deskriptif. Hasil penelitian menunjukkan bahwa suplementasi ZnO maupun enzim fitase dalam ransum tidak mempengaruhi produksi telur hen day, konsumsi ransum, konversi ransum dan berat telur. Suplementasi ZnO maupun enzim fitase dalam ransum meningkatkan kandungan vitamin A dalam telur. Telur ayam yang diberi ransum dengan perlakuan suplementasi 252 mg ZnO/kg ransum mengandung vitamin A paling tinggi.

Kata kunci : asam fitat, fitase, zinc, vitamin A, ayam petelur

INTRODUCTION

Since the major ingredients in commercial poultry diets are seed (cereal grains) or seed by products (oil seed meal and grain by products), which has phytic acid, myo-inositol 1, 2, 3, 4, 5, 6 hexakis dihydrogen phosphate, zinc may be the trace element where its bioavailability is most influenced (Kornegay, 2001). Zinc deficiency resulted in lower the rate of growth, feed efficiency as well as egg production and depressed the activity of plasma alkaline phosphatase (Mc Dowell, 1992). The nutritional status of zinc influences vitamin A metabolism in animals and humans (Noh & Koo, 2003).

The present study was conducted to determine whether the supplementation of ZnO in the diets and the supplementation of phytase enzyme could improve the performances of laying hens and increased the vitamin A content in the egg.

MATERIALS AND METHODS

One hundred sixty two laying hens of ISA-brown from 18 weeks old up to 33 weeks old were divided into 8 treatment diets and one control diet. The treatment diets were:

- T0 = Diet without zinc nor phytase enzyme supplementation
- T1 = Diet T0 + 252 mg ZnO/kg diet
- T2 = Diet T0 + 567 mg ZnO/kg diet
- T3 = Diet T0 + 300 Unit phytase enzyme/kg diet
- T4 = Diet T0 + 400 Unit phytase enzyme/kg diet
- T5 = Diet T1 + 300 Unit phytase enzyme/kg diet
- T6 = Diet T1 + 400 Unit phytase enzyme/kg diet
- T7 = Diet T2 + 300 Unit phytase enzyme/kg diet
- T8 = Diet T2 + 400 Unit phytse enzyme/kg diet

All treatment diets were formulated as to contain isoprotein and isocaloric (Table 1). The amount of ZnO supplemented in the diets was based on the molar ratio of phytic acid: Zn in the diets (Bosscher *et al.*, 2001). The molar ratio of phytic acid : Zn in the experiment diets were : 76 (T0), 15 (T1), 7.5 (T2), 76 (T3), 76 (T4), 15 (T5), 15 (T6), 7.5 (T7), 7.5 (T8). The level of phytase enzyme added into the diets was according to recommendation of BASF (2002).

A completely randomized design with factorial of 3 x 3; 3 replicates consisted of 2 factors, i.e. factor A : 3 levels of ZnO suplementation (0, 252 mg and 567 mg ZnO/kg diet) and factor B was 3 levels of phytase enzyme supplementation (0, 300 and 400 Unit of phytase enzyme/kg diet).

Table 1. Composition of laying hen diets (18 – 33 weeks of age)

Ingredient	Treatment diets								
	T0	T1	T2	T3	T4	T5	T6	T7	T8
Yellow corn	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Rice bran	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Soybean meal	13.20	13.20	13.20	13.20	13.20	13.20	13.20	13.20	13.20
Fish meal	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Palm oil	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10
$CaCO_3$	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30
Premix	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Salt	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
ZnO (mg/kg)[1]	-	252.00	567.00	-	-	252.00	252.00	567.00	567.00
Phytase (U/kg)[2]	-	-	-	300.00	400.00	300.00	400.00	300.00	400.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Nutrients :									
Energy (kcal ME/kg)	2859.00	2859.00	2859.00	2859.00	2859.00	2859.00	2859.00	2859.00	2859.00
Protein	17.10	17.10	17.10	17.10	17.10	17.10	17.10	17.10	17.10
Crude fiber	8.24	8.24	8.24	8.24	8.24	8.24	8.24	8.24	8.24
Ca	3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28
Nonphytate phosphorus	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
Lysine	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Methionine	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
Zn (mg/kg)	49,8	253.00	506.00	49,8	49,8	253.00	253.00	506.00	506.00

[1] ZnO (contains 80% Zn), PT. INDOLYSAGHT, Jakarta.
[2] Phytase enzyme Natuphos 5000 G (contains 5000 U/g) (EC 3.1.3.8), PT BASF, Jakarta.

The variabels observed were : egg production, feed consumption, feed conversion, egg weight and vitamin A content in the egg. The vitamin A was analysed at the Laboratory of Balai Besar Industri Agro (BBIA) Bogor by using Shimadzu LC-6A Liquid Chromathography and retinol acetate was used as the standard.

RESULTS AND DISCUSSIONS

Performances of Laying Hens

The effect of zinc and phytase enzyme supplementation on hen day egg production, feed consumption, feed conversion and egg weight from age 18 till 33 weeks old is presented in Table 2. The average of hen day egg production ranging between 62.5% – 74.2%. Piliang *et al.* (1982a) reported that 79% ricebran in the diet that contained crude fiber 9.3% gave 67.9% hen day egg production. In other research conducted by Piliang *et al.* (1982b) using rice bran 75% in the diet contained crude fiber 7.9%, gave 70.2% hen day egg production.

The statistical analysis indicated no significant differences among treatment diets on egg production, feed consumption, feed conversion and egg weight, however the supplementation of phytase enzyme alone (400 Unit phytase/kg diet) increased the hen day egg production as compared to those of the control diet (72.3% and 70.9%, respectively). Lim *et al.* (2003) reported that supplementation of 300 U phytase/ kg diet did not affect the hen day egg production of ISA-brown hens of 21 weeks old up to 30 weeks old (72.66% vs 75.25%). It was found that supplementation of 252 mg ZnO/kg diet + 300 unit phytase/kg diet increased the egg production as compared to that of the control group (74.2% and 70.9% respectively). The supplementation of zinc alone as well as zinc-phytase combination produced heavier egg weight as compared to that of the control group.

The control diet did not result any significant deficiency sign to the laying hens performances, it could be due to the usage of fish meal (6%) in the diet. FAO and WHO (2002) reported that animal protein improve zinc absorption from a phytate-containing diet. The availability of zinc from the diet can be improved by inclusion of animal protein sources.

The supplementation of the phytase enzyme could improved the egg production and the egg weight, it could be due to the availability of protein and amino acids as well zinc those were released

Table 2. Average hen day egg production, feed consumption, feed conversion and egg weight of laying hens ages 18-33 weeks old

Treatment diets	ZnO (mg/kg diet)	Phytase enzyme (Unit/kg diet)	Hen day egg production (%)	Feed consumption (g/hen/day)	Feed conversion (g feed/g egg)	Egg weight (grams/egg)
T0	0	0	70.9±1.4	90.20±8.77	2.86±0.38	48.15±0.61
T1	252	0	69.5±4.6	87.23±3.69	2.76±0.08	48.92±0.60
T2	567	0	68.2±2.8	87.76±4.30	2.92±0.37	49.43±1.16
T3	0	300	67.4±7.1	92.78±7.83	3.06±0.20	49.36±0.62
T4	0	400	72.3±8.8	90.68±9.33	2.79±0.24	49.28±1.41
T5	252	300	74.2±2.5	88.97±6.11	2.66±0.26	48.39±0.71
T6	252	400	62.5±3.1	84.90±9.88	3.03±0.08	49.40±1.49
T7	567	300	63.6±13.8	87.71±8.80	3.21±0.79	50.24±1.68
T8	567	400	68.2±5.8	85.20±2.46	2.69±0.29	49.75±1.04

by the phytase enzyme from the complexes of phytate-protein/amino acids – zinc. Kornegay (2001) reported that phytate can bind with protein/ amino acids. These complexes may occur in foodstuffs in the native state, and may be formed in the upper gastrointestinal tract. These potential phytate-protein complexes may reduce the utilization of protein and amino acids. These adverse effects of phytic acid were effectively overcome by supplemental phytase. Leeson & Summers (2001) reported that protein and amino acids, and especially methionine, have a large influence on egg size. Underwood & Suttle (2001) reported that carboxypeptidases A and B are zinc metallo-enzymes those are required to hydrolise the amino acids from peptides, and hence these amino acids, including methionine will be available for the laying hens. Rutherfurd *et al.* (2004) reported that supplementation of 500 unit phytase/kg diet significantly increased the apparent amino acids digestibility, including the methionine, in the broiler chickens.

Vitamin A Content in The Eggs

The vitamin A content in the eggs is presented in Table 3. Zinc supplementation in the form of zinc oxide 252 mg/kg diet or 567 mg/kg diet increased the vitamin A content in the eggs of 29.81% and 15.35% respectively as compared to the control group. Baker *et al.* (1979) reported that zinc is required for release of vitamin A from liver, zinc deficient rats have low serum vitamin A. Underwood & Suttle (2001) reported that low plasma vitamin A values in the presence of adequate dietary vitamin A occur in zinc-deficient pigs. Noh & Koo (2003) reported that zinc status is an important factor determining the intestinal absorption of β–carotene and hence the nutritional status of vitamin A. Mc Dowell (1992) reported that zinc maintains normal concentration of vitamin A in plasma and is necessary for the normal functioning of the general epithelium of the ovary.

Phytase enzyme supplementation 400 Unit/ kg diet was more effective to increase the vitamin A content in the eggs as compared to supplementation of 300 Unit phytase/kg diet with the increasing values of 24.41% and 5.92% respectively as compared to the control group, indicating that phytase enzyme has succeeded in releasing zinc and therefore increased the vitamin A in the eggs. Sebastian *et al.* (1996) reported that phytic acid was hydrolyzed by phytase microbes which then release some minerals such as Ca, P, Mg, Cu, Zn and Fe.

Table 3. Vitamin A content in the eggs

Treatment diets	ZnO (mg/kg diet)	Phytase enzyme (Unit /kg diet)	Vitamin A (IU/100 g)[1]	% Increasing of vitamin A[2]
T0	0	0	1347.37	-
T1	252	0	1749.00	29.81
T2	567	0	1554.16	15.35
T3	0	300	1427.15	5.92
T4	0	400	1676.27	24.41
T5	252	300	1354.00	0.49
T6	252	400	1410.22	4.66
T7	567	300	1412.73	4.85
T8	567	400	1602.07	18.90

[1] Fresh egg without shell

[2] As.

The combination of ZnO and phytase enzyme supplementation in the diets increased the egg vitamin A content. Among these treatments, the combination of 567 mg ZnO/ kg diet + 400 unit phytase/kg diet gave the highest vitamin A content of the eggs. This result showed that zinc is required in vitamin A metabolism. Groff & Gropper (2000) reported that zinc deficiency decreased hepatic mobilization of retinol from its storage as retinyl esters. The activity of the enzyme retinyl ester hydrolase, which releases the vitamin from its storage form, may be inhibited by the lack of zinc. Leeson & Summers (2001) reported that physiologically active vitamin A is mobilized from the liver as retinol which is bound to a specific transport protein termed the retinol binding protein (RBP). The delivery of vitamin A to tissues is controlled by processes which control the production and secretion of RBP in the liver.

CONCLUSIONS

The supplementation of ZnO and phytase enzyme in the laying hen diets did not affect the hen day egg production, feed consumption, feed conversion as well as the egg weight. Zinc supplementation in the form of oxide of 252 mg/kg diet increased the eggs vitamin A content up to the highest value as compared to the control group.

Phytase enzyme supplementation of 400 Unit/ kg diet was more effective to increase the vitamin A content in the egg as compare to the supplementation of 300 Unit phytase/kg diet. The combination of 567 mg ZnO/ kg diet + 400 unit phytase/kg diet gave the highest eggs vitamin A content.

REFERENCES

Baker, H.J., J.R. Lindsey & S.H. Weisbroth. 1979. The Laboratory Rat. Volume I : Biology and Diseases. Academic Press, Inc. London.

BASF. 2002. Technical Information. 2[rd] Ed. BASF Corporation, New Jersey.

Bosscher, D., Z. Lu, G. Janssens, M.V. Caillie-Bertrand, H. Robberecht, H. DeRycke, R. DeWilde & H. Deelstra. 2001. In vitro availability of zinc from infant foods with increasing phytic acid contents. British J. Nutr. 86 : 1246 – 1251.

FAO & WHO. 2002. Human vitamin and mineral requirement. Food and Agricultural Organization of the United Nation and World Health Organization, Rome.

Groff, J.L. & S.S. Gropper. 2000. Advanced Nutrition and Human Metabolism. 3[rd] Ed. Australia Canada Denmark Japan Mexico New Zealand Wadsworth Thomson Learning, United States, United Kingdom.

Kornegay, E.T. 2001. Digestion of phosphorus and other nutrients : the role of phytase and factors influencing their activity. In : M.R. Bedford MR & G.G Partridge (Eds). Enzyme in Farm Animal Nutrition. CAB International, Marlborough.

Leeson, S. & J.D. Summers. 2001. Nutrition of the Chicken. 4[th]Ed. University Books, Guelph, Ontario.

Lim, H.S., H. Namkung & I.K. Paik. 2003. Effects of phytase supplementation on the performance, egg quality, and phosphorus excretion of laying hens fed differet levels of dietary calcium and nonphytate phosphorus. J. Poult Sci. 82: 92 – 99.

McDowell, L.R. 1992. Minerals in Animal and Human Nutrition. Academic Press,Inc. London.

Noh, S.K., & S.I Koo. 2003. Low zinc intake decreases the lymphatic output of retinol in rats infused intraduodenally withβ - carotene. J. Nutr.Biochem. 14 : 147-153.

Piliang, W.G., H.R. Bird, M.L. Sunde, & D.J. Pringle. 1982a. Rice bran as the major energy source for laying hens. Poult. Sci. 61 : 357 – 363.

Piliang, W.G., S. Djokowoerjo, & M. Wasmen. 1982b. Pengaruh penambahan berbagai tingkat kadar Zn dalam ransum yang mengandung dedak padi terhadap penampilan serta metabolisme Zn pada ayam-ayam petelur. Laporan Penelitian. Direktorat Pembinaan Penelitian dan Pengabdian Pada Masyarakat. Direktorat Jenderal Pendidikan Tinggi Departemen Pendidikan dan Kebudayaan, Jakarta.

Rutherfurd, S.M., T.K. Chung, P.C.H. Morel & P.J. Moughan. 2004. Effect of microbial phytase on ileal digestibility of phytate phosphorus, total phosphorus, and amino acids in a low-phosphorus diet for broilers. Brit. Poult. Sci. 43 (4): 598-606 (9).

Sebastian, S., S.P. Touchburn, E.R. Chavez, & P.C. Lague. 1996. Efficacy of supplemental microbial phytase at different dietary calcium levels on growth performance and mineral utilization of broiler chickens. Poult. Sci. 75: 1516-1523.

Underwood, E.J., & N.F. Suttle. 2001. The Mineral Nutrition of Livestock. 3rd Ed. CABI Publishing. Wallingford, UK