EFFECT OF PHYTATE IN DIET AND LEAD IN DRINKING WATER ON BLOOD MINERAL AND GROWTH OF DUCKS

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Abstract

The experiment concerning the effect of diet containing different level of phytate and lead (Pb) in drinking water on blood mineral and growth of local starting duck was conducted at the Laboratory of Physiology and Biochemistry, Faculty of Animal Husbandry and the Laboratory of Chemistry Material and Environment, Faculty of Mathematics and Natural Science, Padjadjaran University. In this experiment, study of the effect of diet containing different level of phytate and lead in drinking water on calcium, zinc and iron of blood; feed consumption, body weight gain, and feed conversion ratio of starting duck were conducted. The experimental design used a completely randomized design with a factorial pattern 3x3. Three dietary treatments containing different levels of phytate (0,15; 1,17 and 2,16%) and 3 levels of lead in drinking water (0, 45 and 90 ppm) with 3 replication were applied. The results showed that there was an interaction of phytate in diet and lead in drinking water on feed consumption. The main effect of lead treatment up to 90 ppm increased calcium, zinc and iron of blood. Concentration of lead up to 90 ppm in drinking water did not affect feed consumption, body weight gain and feed conversion ratio. The main effect of phytate up to 2,16% in diet increased feed consumption, body weight gain and feed conversion ratio.

Key words: Phytate, lead, blood mineral, duck

INTRODUCTION

Water has a very important role in the lives of animals, especially ducks. Besides functioning to meet daily needs, water is also a place of pollution from various industrial wastes. Therefore, good or bad quality of water affect the mineral content and growth of ducks. Pointed out many problems encountered in the field as extensively reared ducks that allows ducks exposed to lead contamination. The effects of this pollution result to consumers who consume the ducks.

Lead is second most harmful heavy metal after mercury (Saeni, 1989). The danger seems to livestock, among others, the disruption of metabolism that causes decreased body weight and high mortality. Lead can enter the body in addition through food or water intake, also through the air and penetrate directly through the skin. In an effort to minimize the lead, then the technology could be developed to prevent the absorption of lead in the duck is by way of phytate in the diet because phytate is able to bind lead. Phytate that functions other than as a antinutrition substance, phytate also functions as a chelating agent for metal valency two in particular lead. Another alternative that can be done is by changing the pattern from extensive to intensive care in areas suspected of heavy metal contaminated lead.

MATERIALS AND METHODS

Ducks used were 1 day old duck (DOD) with body weight, 40-50 grams of 216 ducks. The ducks were placed into the cage colonies randomly and were treated for 4 weeks. At the end of week four taken randomly a duck from each unit of the cage as a sample for analysis.

Phytate source used in the experimental diet was phytate contained in rice bran, corn and soybean meal. Based on the analysis and calculations, the phytate content of the diets

as follows: R0=0.15%, R1=1.17% and R2=2.16%.

The source of heavy metal pollutants were used as lead acetate with molecular formula (CH_3COO) +3 H_2O_2. Lead was given to duck through drinking water provided to duck *ad-libitum*. Treatment concentrations of lead given in drinking water was made in the following manner: Pb0=0 ppm; Pb1= 45 ppm and Pb2=90 ppm.

Diet was mash-shaped and made with 19% protein content and metabolizable energy 3000 kcal/kg (Table 1).

Table 1. Nutrient Content of Experimental Diet of Starting Ducks (1-4 weeks)

Materials	R0	R1	R2
Dry matter, (%)	90,25	90,30	91,29
Crude protein, (%)	19,02	19,06	19,00
Crude fat, (%)	8,63	9,29	12,34
Crude fibre, (%)	5,32	4,69	5,17
Ca, (%)	0,90	0,91	1,07
P, (%)	0,78	0,80	0,93
Phytate, (%)	0,15	1,17	2,16
Metabolizable energy (kkal/kg)	3016	3004	3000

Blood samples were destructed using a wet ashing. The filtrate of each sample was filtered with filter paper and then stored in a separate vial and subsequently be measured blood concentration of calcium, zinc and iron by using AAS. Feed intake, body weight gain and feed conversion were the parameter for the growth of duck for 4 weeks.

The research carried out experimentally and the experimental design used was a completely randomized design with factorial pattern 3x3. The first factor was the phytate in the diet with 0.15% (R0); 1.17% (R1) and 2.16% (R2). The second factor was lead in drinking water with levels of 0 ppm (Pb0): 45 ppm (Pb1) and 90 ppm (Pb2). Data were analyzed with ANOVA followed by Duncan's test. Replications of this experiment had 3 times with 8 individuals per sub-test that gained 216 ducks.

RESULTS AND DISCUSSIONS

Treatment Effect on Blood Minerals

There was no interaction between phytate content in diet and Pb in drinking water on calcium, zinc and iron of blood. Effect of Pb in drinking water showed significant difference ($P<0.05$) on calcium, zinc and iron of blood, while the phytate in diet showed no significant difference on them.

a. Lead Effect on Blood Minerals

Table 2 showed that the average blood calcium in treatment of Pb1 and Pb2 did not show significant difference, but the blood calcium in both treatments were significantly higher than Pb0. Likewise, blood zinc in treatment of Pb1 and Pb2 did not show significant differences, but blood zinc was significant higher than Pb0 treatment. Similarly, blood iron of Pb1 and Pb2 treatment did not show significant differences, but the blood iron in both treatments were significant higher than Pb0 treatment.

Table 2. Effects of Pb in Drinking Water on Blood Minerals of Starting Ducks (1-4 weeks)

Treatments	Blood Calcium (ppm)	Blood Zinc (ppm)	Blood Iron (ppm)
Pb0 (0 ppm)	68,17 ± 4,93[a]	7,34 ± 2,16[a]	82,83 ± 10,30[a]
Pb1 (45 ppm)	95,12 ± 9,59[b]	10,17 ± 1,46[b]	153,77 ± 21,70[b]
Pb2 (90 ppm)	92,96 ± 7,90[b]	9,16 ± 1,46[b]	165,10 ± 15,48[b]

Description : Different letters in the same column showed significant difference

Increased concentrations of Pb were given through drinking water turned out to spur the increase of calcium, zinc and iron of blood. Increased blood calcium intake along

with Pb, occured due to mobilization of calcium from the thigh bones into the blood due to the occurrence of a high Pb deposition in the femur which encourages the release of calcium from the thigh bone matrix due to the work of parathyroid hormone. According to Campbell (1988) and Chapman (1992) reported that parathyroid hormone to mobilize bone mineral from the thigh bone and its role in the synthesis of 1.25-dihidxyvitamin D. The action of these hormones resulted in the collection of citrate in the femur. Citrate solution of this caused of woven bone mineral mobilization thigh and move into the extracellular fluid, resulting to the thigh bone mineral dissolution and transport of calcium citrate to pass into the blood plasma. Citrate will experience the metabolism in plasma or excreted in urine, while calcium remained in the blood plasma.

The increase in blood zinc and iron of starting duck treated Pb through drinking water, it was because more and more incoming Pb, were likely to change the pH of small intestine which was the main place for absorption. According to Anggorodi (1995), pH of small intestine had a pH in the range 5-6. Increased intake of Pb was given, most likely the more acidic small intestine and leaded to increased absorption of iron so that iron in the blood increased. Another possibility for the existence of chronic Pb intoxication beyond the safety threshold, the most common was anemia. This condition indicated either the use of iron in the marrow or the femur so that the blood iron increased (Syamsudin and Suryatna, 2008).

b. Phytate Effect on Blood Mineral

Calcium, zinc and iron in the blood of starting duck groups of R0, R1 and R2 did not show significant differences (Table 3). These were due to most likely break down phytate late so that the influence of phytate did not show significant difference on calcium, zinc and iron of blood. This was supported by the fact that the influence of phytate on Pb had any larger molecules did not show significant effect. Other possibility that need a higher phytate to affect calcium, zinc and iron of blood, as seen from the phytate content in the diet up to 2.16% had no significant effect on the duck starter despite a molecular weight of Pb was larger than calcium, zinc and iron of blood.

Table 3. Effects of Phytate in Diet on Blood Minerals of Starting Ducks (1-4 weeks)

Treatments	Blood Calcium (ppm)	Blood Zinc (ppm)	Blood Iron (ppm)
R0 (0,15 %)	85,96 ± 5,27[a]	8,92 ± 2,48[a]	137,60 ± 14,67[a]
R1 (1,17 %)	83,36 ± 10,38[a]	9,19 ± 1,77[a]	133,34 ± 19,64[a]
R2 (2,16 %)	86,94 ± 6,77[a]	8,57 ± 0,83[a]	130,75 ± 13,17[a]

Description : The same letters in the same column indicated no significant difference

Treatment Effect on Growth

Treatment Effect on Feed Intake

There was interaction between phytate in diet and Pb in drinking water on feed intake.

Average feed intake with combination treatment of Pb0R0, Pb0R1 and Pb0R2 did not show significant differences (Table 4). Feed intake with a combination treatment of Pb1R1 depressed, causing a difference was lower ($P<0.05$) compared with the groups of Pb1R0 and Pb1R2, while feed intake on the treatment of Pb1R2 and Pb1R0 were not significantly different. Similarly, the treatment of Pb2R1 had feed intake significantly lower ($P<0.05$) compared with the groups of Pb2R0 and Pb2R2, but feed intake of Pb2R0 and Pb2R2 was similar.

Table 4. Interaction of Phytate in Diet and Pb in Drinking Water on Feed Intake of Starting Ducks (1-4 weeks)

Treatments	Feed Intake (g/tail/4 weeks)		
	R0 (0,15 % phytate)	R1 (1,17 % phytate)	R2 (2,16 % phytate)
Pb0 (0 ppm)	808,09 ± 47,21 $^{a}_{A}$	822,62 ± 3,03 $^{a}_{A}$	800,23 ± 82,51 $^{a}_{A}$
Pb1 (45 ppm)	826,77 ± 40,11 $^{a}_{A}$	773,07 ± 42,82 $^{b}_{A}$	856,86 ± 10,66 $^{a}_{A}$
Pb2 (90 ppm)	807,41 ± 34,37 $^{a}_{A}$	687,56 ± 20,42 $^{b}_{A}$	831,89 ± 23,97 $^{a}_{A}$

Description : Supercript different small letters within the same line showed significant difference
Subcript same big letters in the same column indicated no significant difference

There was no difference in feed intake with treatment of Pb0R0, Pb1R0 and Pb2R0. The difference on average feed intake per head in Pb2R1 treatment was lower (P<0.05) compared with both treatment groups either Pb1R1 or Pb0R1.

The absence of differences in average feed intake in the treatment group of Pb0R0, Pb0R1 and Pb0R2 caused ducks were given water that had no content of Pb in drinking water. The duck starter provided Pb1, average feed intake was lower than groups of Pb1R1 Pb1R0 or Pb1R2. This phenomenon occured most likely ratio of phytate contained in the R1 had not been able to do the binding of Pb given. Even this phenomenon can be seen in Pb2R1 of duck starter group was lower (P <0.05) compared with Pb2R0 and Pb2R2. Besides the factor of Pb, diet palatability and individuals certainly played a role. The situation improved feed intake of Pb1R2 or Pb2R2 was predicted that phytate in diet R2 working properly or proportionately so that phytate could bind Pb. The absence of differences in feed intake in the treatment group of Pb0R0, Pb1R0 and Pb2R0 possibly the duck starter was tolerant on the dose and duration of Pb in drinking water.

Treatment Effect on Body Weight Gain

No interaction between phytate content in diet and Pb in drinking water on body weight gain. Effect of phytate in the diet showed significant effect (P <0.05) on body weight gain, whereas Pb in drinking water showed no significant effect on body weight gain.

a. Phytate Effects on Body Weight Gain

Table 5 showed that the treatment of R0 and R2 did not show significant differences, but the weight gain in both treatments were significantly higher (P <0.05) compared to the R1 treatment. This was due to average feed intake in R0 and R2 treatment group was significantly higher than the average feed intake in the group R1. This was a similar result with studies on the duck that had been done by Achmanu (1992) who reported that body weight increased in parallel with the increased feed intake. This means the higher the average feed intake the greater the nutrients that enter the body so that the nutrient and energy needs were met and the body's normal activity which in turn increased the body weight gain.

Table 5. Effects of Phytate in Diet on Body Weight Gain of Starting Ducks (1-4 weeks)

Treatments	Body Weight Gain (g)/tail	Significance 0,05
R0 (0,15 % fitat)	240,32 ± 21,35	a
R1 (1,17 % fitat)	189,21 ± 28,29	b
R2 (2,16 % fitat)	245,62 ± 12,86	a

Description : the same letter in the same column indicated no significant difference

b. Lead Effect on Body Gain

Body weight gain in treatment groups of Pb0, Pb1 and Pb2 did not show significant differences (Table 6). This was due to that duck starter had the ability threshold that was wide enough. This was evidenced in this

study were given Pb through drinking water up to 90 ppm was no significant difference on body weight gain. Therefore, body weight gain was not solely influenced by feed intake. This phenomenon was similar with the opinion Soeharsono (1976) which revealed that the growth was a resultant of genetic and environmental factors including ambient temperature, diet and managment.

Table 6. Effects of Pb in Drinking Water on Body Weight Gain of Starting Ducks (1-4 weeks)

Treatments	Body Weight Gain (g)/tail	Significance 0,05
Pb0 (0 ppm)	227,71 ± 25,94	a
Pb1 (45 ppm)	228,59 ± 17,15	a
Pb2 (90 ppm)	218,86 ± 19,41	a

Description : the same letters in the same column indicated no significant difference

Treatment Effect on Feed Conversion Ratio

No interaction between phytate content in diet and Pb in drinking water on feed conversion ratio. Effect of phytate in diet showed a significant effect ($P<0.05$) on feed conversion, while Pb in diet showed no significant effect on feed conversion of starting ducks.

a. Phytate Effects on Feed Conversion Ratio

Feed conversion ratio significantly greater than in the treatment of R0 and R2, while feed conversion ratio in treatment of R0 and R2 did not show significant differences (Table 7). This difference was due to the amount of diet consumed by ducks in the treatment of R1 got body weight gain was lower than the weight gain on treatment of R0 and R1 in the same quantity of diets. The implications of this difference resulted in lower weight gain achieved by the treatment of duck starter at R1 compared with average weight gain in treatment of R0 and R2. Therefore, feed conversion ratio in treatment of duck starter of R0 and R2 had the feed conversion was far more efficient than the feed conversion ratio in the treatment of R1.

Table 7. Effects of Phytate in Diet on Feed Convertion Ratio of Starting Ducks (1-4 weeks)

Treatments	Feed Conversion Ratio	Significance 0,05
R0 (0,15 % fitat)	3,40 ± 0,17	a
R1 (1,17 % fitat)	4,09 ± 0,57	b
R2 (2,16 % fitat)	3,38 ± 0,11	ac

Description : the same letters in the same column indicated no significant difference

b. Lead Effects on Feed Conversion Ratio

Table 8 showed that the feed conversion ratio in the treatment of Pb0, Pb1 and Pb2 did not show significant differences. This was due to average feed intake in each treatment Pb in drinking water was not significant difference, resulting in body weight gain was also not significant difference.

Table 8. Effects of Pb in Drinking Water on Feed Conversion Ratio of Starting Ducks (1-4 weeks)

Treatments	Feed Conversion Ratio	Significance 0,05
Pb0 (0 ppm)	3,60 ± 0,33	a
Pb1 (45 ppm)	3,64 ± 0,15	a
Pb2 (90 ppm)	3,64 ± 0,37	a

Description : the same letters in the same column indicated no significant difference

CONCLUSIONS

It can be concluded that there was an interaction between phytate in diet and lead in drinking water on feed intake. The main effect of Pb up to 90 ppm increased calcium, zinc and iron of blood. Concentrations of Pb up to 90 ppm in drinking water did not affect feed intake, body weight gain and feed conversion ratio. The main influence of phytate up to 2.16% in the diet increased feed intake, body weight gain and feed conversion ratio.

REFERENCES

[1] Achmanu: Pengaruh Faktor Intrinsik terhadap Nilai Energi Metabolisme Bahan Makanan dan Aplikasinya dalam Ransum Itik, Disertasi, Universitas Padjadjaran, Bandung, 1992.
[2] Cosgrove, DJ.: Inositol Phosphate: Their Chemistry, Biochemistry and Physiology. Elsevier Scientific Publishing Company Amsterdam, 1980.
[3] Darmono: Lingkungan Hidup dan Pencemaran. Universitas Indonesia Press, Jakarta, 2001.
[4] Depkes RI: Bahan-bahan Berbahaya dan Dampaknya terhadap Kesehatan Manusia, Departemen Kesehatan, Jakarta, 2001.
[5] Dirjen POM dan Depkes R.I: Logam Berat dalam Makanan, 1998.
[6] Irving, GCJ.: Phytase in Cosgrove, D.J. (Ed), Inositol Phosphatase: Their Chemistry, Biochemistry and Physiology, in Elsevier Scientific Publishing Company Amsterdam, 1980.
[7] Kamil, KA.: Pengaruh Pemberian Ransum dengan Kandungan Fitat Berbeda dan Timbal (Pb) Dalam Air Minum Terhadap Pb dalam Tubuh Itik Lokal Tipe Petelur, Disertasi, Program Pascasarjana Universitas Padjadjaran, 2009.
[8] Kamil, KA.: Pengaruh Fitat dalam Ransum dan Timbal dalam Air Minum terhadap Pb Hati dan Ginjal Itik Starter, Prosiding Seminar Nasional 2, Peternakan Berkelanjutan, 2010: 385-390.
[9] Klaassen, CD.: Distribution, Excretion and Absorption of Toxicants, In Klaassen CD., Amdur MO., Doulss J. (Eds): Casarett and Doull's Toxicology, The Basic Science of Poisons, Third Edition, Macmillan Publishing Company, New York, 1986: 33-63.
[10] Klaassen, CD., Amdur, M.O and Doull, J.: Casarett & Doull's Toxicology The Basic Science of Poisons. Fifth Edition. Mc Graw Hill Health Profession Division, America, 1986.
[11] Lu, F.C.: Toksikologi Dasar, Edisi 2, UI Press, Jakarta, 1995.
[12] Murtidjo, BA.: Mengelola Itik, Penerbit Kanisius, 1988.
[13] Noor, Z.: Senyawa Anti Gizi, Pusat Antar Universitas-Pangan dan Gizi, Universitas Gadjah Mada, Yogyakarta, 1992.
[14] Oatway,L., Vasanthan T., and Helm JH.: Phytic Acid, in: Food Reviews International. Vol. 17 (4), 2001: 419-431.
[15] Pounds, JG.: The Toxic Effect of Metals, in: Williams PL and Burson JL. (Eds.), Industrial Toxicology, Van Nostrand Reinhold New York. 1985.
[16] PPSDAL: Laporan Hasil Pemantauan Kualitas Air Waduk Saguling, Pusat Penelitian Sumber Daya Alam dan Lingkungan, Lembaga Penelitian Universitas Padjadjaran Bandung, 2004.
[17] Saefulhadjar, D., Hernaman I dan Kamil KA.: Penyerapan Kadmium pada Ayam Kampung yang Diberi Dedak Padi dalam Ransum. Media Peternakan, Agustus 2008. ISSN 0126-0471.
[18] Saeni, MS.: Kimia Lingkungan Bahan Pengajaran, Dept. P&K, Ditjen Dikti, PAU Ilmu Hayat, IPB, Bogor, 1989.
[19] Sjamsudin, U dan Suyatna, F.D.: Keracunan Pb. Farmakologi Universitas Kedokteran Indonesia. Jakarta. Diakses dari: http//www.kampung-online.com/cermin Dunia Kedokteran no. 13.1878.=Keracunan Pb...01/06/09, 2008.
[20] Soeharsono: Respons Broiler terhadap Berbagai Kondisi Lingkungan. Disertasi, Fakultas Peternakan, Universitas Padjadjaran, 1976.
[21] Wahju J.: Ilmu Nutrisi Unggas, Gadjah Mada University Press, Yogyakarta, 1997.