LEAD (Pb) IN BLOOD, MEAT, BONE AND EXCRETA OF GROWING DUCK GIVEN PHYTATE IN DIET AND LEAD (Pb) IN DRINKING WATER

Kamil A. Kamil[1*], Kartasudjana Ruchyat[1], Iskandar Sofjan[2]

[1] Faculty of Animal Husbandry, Padjadjaran University, Bandung, Indonesia
[2] Research Institute, Bogor, Indonesia

Abstract

The experiment concerning lead (Pb) in blood, meat, bone and excreta of growing duck given phytate in diet and lead (Pb) in drinking water 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, University of Padjadjaran. In this experiment, study of lead (Pb) in blood, meat, bone and excreta of growing duck given phytate in diet and lead (Pb) in drinking water were conducted. These ducks were treated phytate and lead (Pb) since they were old day duck (DOD) and they were caged for 16 weeks. The experimental design was a completely randomized design with a factorial pattern 3x3. Three dietary treatments containing different levels of phytate (0.12; 1.16 and 2.18%) 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 and lead on lead of blood, meat, and excreta, but no for bone. The main effect of lead treatment up to 90 ppm significantly increased lead of bone, while the main effect of phytate up to 2,18% in diet did not affect lead of bone in growing ducks.

Key words: Lead, blood, meat, bone, phytate

INTRODUCTION

Duck life is strongly influenced by water availability in their environment due to the addition of water to the needs of daily living ducks; the water quality will also affect the survival of ducks. In connection with the pollution, especially heavy metals such as lead (Pb) is feared to adversely affect the natural ducks are reared in the open fields. Indirectly when the ducks consume feed containing Pb in the long term with significant amounts, it will cause the accumulation of Pb in the body of ducks. This condition would be bad if the human consumption of meat that comes from ducks.

Pb is consumed by the ducks will be absorbed by the body through the intestine and transported to various cells, tissues and even organs via blood. Large Pb concentrations will affect the concentration of Pb which is deposited in meat and bone. Meat contains protein and fat will be able to bind Pb easily distributed via the blood. Bone is an organ that can easily lead to deposit in it. Excreta which are waste products of metabolism will be an indicator to determine Pb absorbed and wasted.

Basically phytate found in whole grains and rice has the highest phytate content. The presence of phytate in the ration is actually a *limiting factor* in metabolism, but in the other condition phytate is also acts as a *chelating agent* which is able to bind heavy metals such as Pb having valence two. Therefore, the presence of phytate derived from the grain in the ration is expected to bind Pb into the body of growing ducks.

Ducks have an important role in contributing to the improvement of nutrition through meeting the needs of meat and eggs for the community. In general the ducks reared extensively, but in recent years with a number of environmental pollution, especially heavy metals lead (Pb), then the rear of these ducks need to be re-evaluated to avoid contamination of lead through ration or drinking water.

*Corresponding author: kurniakamil@yahoo.co.uk
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For solving this problem the authors tried to gather various information field research the extent of contamination by simulating the effects of Pb on Pb in blood, meat, bones and excreta of ducks given phytate in diet. For more information conducted laboratory studies to simulate field conditions. The source of physiological parameters was used as a quantitative basis in drawing a conclusion.

MATERIAL AND METHODS

Ducks used were female ducks which is a continuation of the first study, aged 29 days as many as 135 head with an average body weight of 212.5 to 306.5 grams. Ducks were placed in the same cage as the starter and were treated for 12 weeks. At the end of sixteen weeks to be taken at random a duck from each cage unit as a sample for analysis. The source of phytate used in diet of the experiment was phytate contained in rice bran, corn and soybean meal. Diet of experiment was made with the form of pellets and 15% protein content and metabolic energy 2800 kcal/kg. (Table 1). The heavy metals were used as a source of pollutant was Pb acetate with the molecular formula (CH_3COO) $2Pb+3H_2O$.

Table 1 Nutrients of Experimental Diet of Growing Ducks (5-16 weeks)

Materials	R0	R1	R2
Dry matter, (%)	90,74	90,42	90,57
Raw protein, (%)	15,00	15,08	15,00
Raw fat, (%)	8,69	8,65	9,93
Raw fibre, (%)	7,49	6,31	5,70
Ca, (%)	0,75	0,78	0,84
P, (%)	0,67	0,72	0,77
Phytate, (%)	0,12	1,16	2,18
Metabolic energy (kcal/kg)	2816	2800	2802

Samples dried in an oven at 70°C for 24 hours. Samples of known dry ingredients using was *wet ashing system*. Filtrate from each sample was filtered with filter paper and then stored in a separate vial and then performed measurements of the consent diet of Pb in blood, meat, bones and excreta by using AAS.

Research carried out experimentally and experimental design used a Completely Randomized Design with 3x3 factorial patterns. The first factor was the phytate in diet with 0.12% (R0); 1.16% (R1) and 2.18% (R2). The second factor was the lead in drinking water with levels of 0 ppm (Pb0): 45 ppm (Pb1) and 90 ppm (Pb2). Data were analyzed with variance followed by Duncan test. The experiment had 3 times replication with 5 individuals per sub-test and the overall gained 135 growing ducks.

RESULTS AND DISCUSSIONS

Effect of Treatment on Pb in Blood

There was interaction ($P<0.05$) between phytate content in the ration and Pb in drinking water on Pb in blood.

Table 2 shows that the combination treatment Pb0R0, Pb0R1 and Pb0R2 were not significant differences on Pb in blood. The same treatment of Pb1R0, Pb2R2 and Pb1R1 was no significance. Pb in blood of Pb2R1 treatment was lower ($P<0.05$) compared with Pb2R0 and Pb2R2, but Pb of Pb2R0 and Pb2R2 showed was not significant differences. Combination of Pb1R0 and Pb2R0 was not significance, but Pb in blood of both combinations is significantly higher ($P<0.05$) compared with Pb0R0. Pb in combination of Pb1R1 significantly higher ($P<0.05$) than Pb0R1 and Pb2R1, while Pb of Pb2R1 were lower ($P<0.05$) than Pb0R1. Pb in Pb0R0, Pb1R2 and Pb2R2 were not difference.

There was no difference from the phytate in the ration on Pb is strongly suspected of the presence of phytate did not influence the strong bond of Pb given through drinking water. This is also supported by the opinion Rustiawan, et al. (1993) who reported that the intestinal capacity to absorb Pb is relatively small at 8-12%.

Table 2 The Results of Duncan's Multiple Range Test of the Interaction the Effect of phytat in Diet and Pb in Drinking Water on Pb of Blood of Growing Ducks (5-16 Weeks)

Treatments	Pb of Blood (ppm)		
	R0 (0,12 % Phytate)	R1 (1,16 % Phytate)	R2 (2,18 % Phytate)
Pb0 (0 ppm)	$2,4956^{a}{}_{A}$	$4,1276^{a}{}_{B}$	$2,5778^{a}{}_{A}$
Pb1 (45 ppm)	$5,4358^{a}{}_{B}$	$6,7287^{a}{}_{C}$	$4,4146^{a}{}_{A}$
Pb2 (90 ppm)	$6,5533^{a}{}_{B}$	$1,2251^{b}{}_{A}$	$4,8683^{a}{}_{A}$

Notes :
- Small capital of different superscript in the same line indicates significant differences
- Big capital of different subscript in the same column indicates significant differences

As comparison, Pb of R0 treatment either starter or grower increased with the administration of Pb in drinking water. The same pattern also occurred with the treatment of R2, but not in R1 [7]. Increased Pb could be interpreted as a response to a given Pb intake through drinking water.

The existence of Pb were relatively stable both in starter (Research I) which was treated Pb in drinking water for a month or grower which is a continuation of duck starter which were treated Pb in drinking water during 4 months continuously but Pb in blood in the two phases were relatively equal. This was because the concentration of Pb in blood had a certain *threshold* that was relatively stable. No difference between Pb1 and Pb2, most likely due to the body has its own mechanism to regulate the capacity of Pb in blood by the greater intake of Pb, the greater the Pb was removed. Another possibility on the administration of Pb with Pb2 treatment (90 ppm) was much more concentrated so that the acid treatment compared with Pb1 (45 ppm) so instinctively duck through the brain controls would limit the intake of drinking water. Therefore, the duck which took drinking water to the treatment of Pb2 tended to be less than the duck in the treatment of Pb1.

Interactions between phytate in the ration and Pb were given in drinking water on Pb only occurred in the combination treatment of grower in Pb2R1, where Pb in Pb2R1 had the lowest Pb. The same was indicated by Pb did not differ in each Pb treatment on the treated R2. The existence of this phenomenon, most likely phytate in the ration only work on an appropriate proportion between phytate and Pb which were bound [10].

Increased Pb in R0 and R2 treated with increasing levels of Pb were given through drinking water, it was closely related to the role of blood plasma protein that can bind to foreign bonds in addition to normal physiologic constituents. Like albumin has the capacity to bind to multiple bonds. Transferrin, alpha-globulin, is essential for transport of iron in the body. The main metal-binding proteins in blood plasma are another ceruloplasmin, which transports copper function in serum [8, 12].

Effect of Treatment on Pb in Meat of Femur

There was an interaction ($P<0.05$) between phytate content in the ration and Pb in drinking water on Pb of meat.

Table 3 shows that Pb of Pb0R0, Pb0R1 and Pb0R2 were not significant difference. Pb in meat of Pb1R1 and Pb1R2 was not difference but Pb in both were lower ($P<0.05$) than in Pb1R0.

Table 3 The Results of Duncan's Multiple Range Test of the Interaction the Effect of Phytat in Diet and Pb in Drinking Water on Pb of Meat of Growing Ducks (5-16 Weeks)

Treatments	Pb of Meat (ppm)		
	R0 (0,12 % Phytate)	R1 (1,16 % Phytate)	R2 (2,18 % Phytate)
Pb0 (0 ppm)	$5,45\pm^{a}{}_{A}$	$7,37^{a}{}_{AB}$	$6,01^{a}{}_{AB}$
Pb1 (45 ppm)	$16,65^{a}{}_{A}$	$4,93^{bc}{}_{B}$	$3,76^{c}{}_{B}$
Pb2 (90 ppm)	$10,08^{a}{}_{A}$	$19,37^{a}{}_{C}$	$16,27^{a}{}_{C}$

Notes: - Small capital of different superscript in the same line indicates significant differences
- Big capital of different subscript in the same column indicates significant differences

Pb of Pb2R0, Pb2R1 and Pb2R2 was not difference. Pb of Pb0R0, Pb1R0 and Pb2R0 was not difference, while the difference of Pb0R1 and Pb1R1 was not difference, but the combination of both lower ($P<0.05$) than in Pb2R1. Similarly, Pb in Pb0R2 and Pb1R2 was not significance but Pb of both were lower ($P <0.05$) than Pb of Pb2R2.

Increased Pb along with the increasing levels of Pb were given in drinking water, this indicated that meat was responsive to the deposition of Pb in both starter and grower. This phenomenon occurred most likely because of the pressure Pb was more powerful than the phytate in the ration to bind Pb.

The lack of effect of phytate in ration most likely not enough to bind Pb in sufficient quantity so many escaped and Pb deposited in meat. This was confirmed by data on Pb of blood increased with increasing blood intake through drinking water.

Logical consequence of increased Pb in blood resulted in a rapid deposition of Pb in meat. This situation was possible because meat as a source of protein and fat. Due to some of the organic bond lipolytic entered is high, a characteristic allowed the rapid penetration and uptake by the tissues, so it was not surprising that a high lipolytic toxicant distributed and concentrated in body fat. Toxicant appeared to accumulate in the fat by simple physical dissolution in neutral fat. Neutral fat percentage depends on the size of the body [8, 12]. Its difference that meat in grower phytic works has appeared evident from the low Pb in meat of Pb1R1 Pb1R2.

Effect of Treatment on Pb of Bone

There was no interaction between phytate content in the ration and Pb in drinking water on Pb in bone.

Table 4 shows that Pb of Pb2 significantly higher ($P<0.05$) than Pb of Pb1 and Pb0. Furthermore, Pb in Pb1 is significantly higher ($P<0.05$) than Pb of Pb0.

Table 4 The Results of Duncan's Multiple Range Test of the Effect of Pb in Drinking Water on Pb of Bone of Growing Ducks (5-16 Weeks)

Treatments	Pb of Bone (ppm)	Significance 0.05
Pb0 (0 ppm)	12.02 ± 3.01	a
Pb1 (45 ppm)	53.67 ± 48.34	b
Pb2 (90 ppm)	125.89 ± 9.57	c

Note: The same letters in the same column indicates no significant differences

Increased Pb were parallel with increasing Pb were given in drinking water, this indicated that the bone was very responsive to the deposition of Pb. This phenomenon was due to that bone was the largest repository for some toxins such as lead that reached 90% [8]. The interesting thing that Pb in bone of starter (study I) and grower had a quantity of Pb was relatively stable, even where the different duration of a month whiles the duck grower 4 months which was given the same doses. Besides starter more responsive than the grower, it was likely that bone was full by Pb due to an input of Pb caused Pb carried by excreta.

Effect of phytate in the ration showed was not differences on Pb in bone. This phenomenon was most likely caused by phytate in the form of bonds, causing a slow breaking that eventually lead to bound a little [10]. Alternatively, it took a higher phytate in the ration to bind Pb in the digestive tract and as a comparison in this study was up to 2.18% phytate in the ration did not show a significant effect. Phytic opportunity to bind Pb occurred in the digestive tract caused by phytate was not absorbed by the body [8, 12]. Therefore, the binding of Pb by phytic was minimum. This was supported by the fact that the effect of phytate in the ration of Pb was not difference. This was due to bone received a supply of Pb from blood.

Effect of Treatment on Pb of Excreta

Duncan's multiple range test results of the interaction effect of phytate in the ration and Pb in drinking water on Pb of excreta can be seen in Table 5.

Table 5 The Results of Duncan's Multiple Range Test of the Interaction the Effect of Phytat in Diet and Pb in Drinking Water on Pb of Excreta of Growing Ducks (5-16 Weeks)

Treatments	Pb of Excreta (ppm)		
	R0 (0,12 % Phytate)	R1 (1,16 % Phytate)	R2 (2,18 % Phytate)
Pb0 (0 ppm)	$0,99^{a}{}_{A}$	$3,11^{a}{}_{A}$	$5.22^{a}{}_{A}$
Pb1 (45 ppm)	$33,84^{a}{}_{B}$	$35.74^{a}{}_{B}$	$24,71^{a}{}_{B}$
Pb2 (90 ppm)	$46,45^{a}{}_{B}$	$63,35^{b}{}_{C}$	$80,23^{b}{}_{C}$

Notes :
- Small capital of different superscript in the same line indicates significant differences
- Big capital of different subscript in the same column indicates significant differences

Table 5 describes that Pb of Pb0R0, Pb0R1 and Pb0R2 was not difference. Similarly Pb of Pb1R0, Pb1R1 and Pb1R2 was not difference. Pb of Pb2R1 and Pb2R2 was not difference but Pb of both treatments significantly higher ($P<0.05$) than Pb of Pb2R0.

Pb of Pb2R0 and Pb1R0 was not difference, but in both treatments was significantly higher ($P<0.05$) compared with Pb0R0. Pb of Pb2R1 significantly higher ($P<0.05$) compared with Pb1R1 and Pb0R1. The same pattern occurred in Pb2R2 significantly higher ($P<0.05$) compared with Pb1R2 and Pb0R0, whereas Pb of Pb1R2 significantly higher ($P<0.05$) than Pb0R2.

The interaction between phytate treatment in the ration and Pb in drinking water on Pb of excreta given the fact that phytate could bind Pb was evident from the existing data was increased phytate content in the ration, Pb of excreta raised sharply. This reinforces the prediction that phytate worked to bind Pb occurred in adult ducks. Another possibility that additional Pb in excreta originated from urine as a logical consequence of the provision of Pb in drinking water were absorbed through the intestinal tract and had exhausted through the urine [8]. Mixing urine contain Pb with excreta, because ducks had a channel that was cloacae. This fact was supported that Pb in the kidneys increased in parallel with increasing levels of Pb were given in drinking water [7].

CONCLUSIONS

From the results and discussions, it can be concluded that there was an interaction of phytate and lead on lead of blood, meat, and excreta, but no for bone. The main effect of lead treatment up to 90 ppm has significantly increased the lead in bone, while the main effect of phytate up to 2.18% in diet did not affect lead of bone in growing ducks.

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