Effect of Particle Size of Egg Shell Mash with Treated Phosphoric Acid in Feed on Performance, and Status of Blood Plasma

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ABSTRACT

This research aimsis to study the effect of particle size of egg shell mash was treated with different levels of phosphoric acid on egg shell waste as a source of minerals in laying hens on performance, eggs production, and levels of Ca & P blood plasm of laying hens. Eggshell waste was collected from bakery, and separated into three treatments (K0/control) eggs shell washed with hot water of 80°C; (K1) eggs shell washed with hot water of 80°C + 3% phosphoric acid, (K2) eggs shell washed with hot water of 80°C + 6% phosphoric acid. Egg shell was grounded into two particle mamely sizes 1 mm and 3 mm. Completely randomized design factorial (3x2) is used in biological tests used 72 chickens laying pullet phase. Chickens were randomly divided into 3 groups of phosphoric acid treatment and two measures of particle size. Each treatment was repeated three times using four laying chickens. The data was collected are feed consumption, body weight, egg production, and Ca and P levels in the blood plasm. Data were analyzed with analysis of variance according to completely randomized factorial design (3x2) in the form (3) treatment of phosphoric acid x (2) treatments particle size followed by Duncan's different test to determine the effect of treatment. Results showed that greater levels of phosphoric acid used to wash the egg shell mash has effect significantly ($P<0.01$) on chicken body weight, blood plasm levels of calcium, phosphorus content of blood plasm. And not affected on feed consumption, calcium intake, and egg production. Difference particle sizes of egg shell mash is not affected on feed consumption, calcium intake, body weight, phosphorus content of blood plasm, and egg production, but significantly different ($P<0.01$) on blood plasm calcium levels. There was no interaction between phosphoric acid treatment with particle size of egg shell mash on performance, and levels of Ca & P blood plasm of laying hens.

Keywords: Egg shell powder, Phosphoric acid, Performance laying hens, Levels of Ca and P blood plasm

INTRODUCTION

Many untapped farm waste and cause environmental pollution and hard to degraded by microbes in the ground. Eggshell is a household industrial waste, bakery company and hatchery that can pollute the environment, whereas eggshells are contained in large numbers has never been utilized in Indonesia. Egg production in Indonesia by 2016 from livestock statistics data of the Directorate General of Animal Husbandry and Veterinary was estimated at 1.5 million tons. If the proportion of egg shells 10%, then it will produce 150,000 tons of eggshell waste (Anonym, 2016). That's number does not include the amount of eggshell produced by the hatchery. The average requirement of calcium in chicken feed is 4%, so that the eggshell waste is able to provide 6,000 tons of mineral resources. Eggshell was not used and it is a waste that is difficult to degraded by microbes in the ground and takes more than 15 years to be degraded, so

the utilization of the eggshell is necessary so that the eggshell waste does not pollute the environment.

One alternative to meet the diet for improved quality of egg shell and egg production is the use of calcium sources. Calcium is one of the essential elements that required for the production and maintenance of laying hens. Most of the calcium in the body is found in the bones (Wahyu, 1988; Elaroussi *et al*., 1994). Laying hens need sufficient amount of calcium at the time of eggshell formation, thereby reducing the uptake of calcium in the medullary bone (Tri-Yuwanta, 1992).

Eggshell is a waste product of breeding and laying hens are very potent when used as a mineral source, especially calcium, because it contains 95.1% minerals and 3.3% protein. Among the most common minerals are 98.43% calcium carbonate ($CaCO_3$), 0.84% magnesium carbonate ($MgCO_3$) and 0.75% calcium phosphate ($CaPO_4$) (Parson, 1982). According to Guinotte and Nys (1991a), laying hens fed with calcium sources derived from eggshells resulted in higher yields (76.2 ± 14.5%) than sea shells (72.4 ± 115.3%) or Limestone mash (71.1 ± 16.7%). Treatment of eggshell by using phosphoric acid can increase the breakdown of mineral bonds, thus increasing the digestibility of these minerals. Scott *et al*. (1982), stated that phosphoric acid (H_3PO_4) can increase the digestibility of eggshell, in acidic atmosphere, salt of calcium carbonate will be easily dissociated into Ca ions so easily absorbed in the duodenum. In addition, phosphoric acid can also function to increase the surface area of particles, stimulate the breakdown of mineral bonds and increase the solubility of minerals contained in mineral resources, to kill the bacteria that is present on the eggshell, and phosphoric acid can be used as a source of phosphorus in the feed (Guinotte and Nys, 1991b; Guinotte *et al*., 1991).

Guinotte and Nys (1993), say that grain a greater source of calcium will stimulate an increase in the activity of digestive enzymes in the stomach by 20% so that the absorption of Ca being larger, It was revealed by Tri Yuwanta (2004) that in laying hens, HCl production of proventricular secretion will make the atmosphere of the gizzard into acidic (pH 1 to 2) to pulverize 7 to 8 g $CaCO_3$. Absorption of Ca at night from the feed in sufficient amounts is needed by the chicken considering the eggshell formation occurs at night (Guinnote and Nys, 1991b; Tri-Yuwanta, 1992).

This research aims to determine the effect of eggshell mash treatment soaked with phosphoric acid, the effect of various particle sizes their interaction on the appearance, eggs production and the level of Ca and P blood plasma of laying hens. The results of the research are expected to be informed to increase the use value of farm wastes, especially eggshell as a source of calcium that has never been utilized in Indonesia and information on the benefits of eggshell waste as an alternative source of calcium in the laying hens rations.

MATERIAL AND METHOD

A total of 72 pullets of laying hens (Lohmann Brown strains with 24 weeks old and uniform weight) are used in the research. The material used are: eggshell obtained from bakery, hot water (± 80^o C) and phosphoric acid with a concentration of 0%, 3% and 6% as mixed materials of egg shell. The results of proximate analysis of eggshell mash treat are shown in Table 1, and the results of macro mineral and micro mineral analyzes are shown in Table 2.

Table 1. The results of proximate analysis of eggshell mash treat

Treatment	Water content (%)	Crude protein (%)	Crude fat (%)	Crude fibre (%)	Ash (%)
Washed water 80°C + soaked 0% phosphat acid (K0)	1.66	5.70	0.64	0.43	91.22
Washed water 80°C + soaked 3% phosphat acid (K1)	1.42	5.44	1.12	1.12	90.30
Washed water 80°C + soaked 6% phosphat acid (K2)	1.49	6.82	0.66	0.66	89.70

Information : The result of proximate analysis at the Laboratory of Biochemistry at the Faculty of Animal Husbandry, Universitas Gadjah Mada, Yogyakarta

Table 2. The results of macro mineral and micro mineral analyzes (%)

Treatment	Calsium	Magnesium	Phosphor	Carbonat	Mangaan
Washed water 80°C + soaked 0% phosphat acid (K0)	37.20	0.38	0.35	56.00	6.12
Washed water 80°C + soaked 3% phosphat acid (K1)	36.61	0.36	0.35	54.68	7.91
Washed water 80°C + soaked 6% phosphat acid (K2)	37.12	0.37	0.34	54.58	7.02

Information : The result of proximate analysis at the Laboratory of Biochemistry at the Faculty of Animal Husbandry, Universitas Gadjah Mada, Yogyakarta.

The battery cages used with size 20 cm x 40 cm x 40 cm for keeping laying hens and accompanied with feeding place, drinking water, thermometers, shovels, trays, buckets, and tools to clean the cage.

Grouping of Laying Hens. Grouping of laying hen is presented in Table 3.

Table 3. Chicken grouping on eggshell treatment with phosphoric acid immersion treatment and different particle size

Particle size	Washing		
	Washed water 80°C + soaked 0% phosphat acid (K0)	Washed water 80°C + soaked 3% phosphat acid (K1)	Washed water 80°C + soaked 6% phosphat acid (K2)
1 mm	3 repeated @ 4 birds (T1)	3 repeated @ 4 birds (T2)	3 repeated @ 4 birds (T3)
3 mm	3 repeated @ 4 birds (T4)	3 repeated @ 4 birds (T5)	3 repeated @ 4 birds (T6)

Information :
T1 : Ration + eggshell soaked 0% phosphat acid with particle size 1 mm
T2 : Ration + eggshell soaked 3% phosphat acid with particle size 1 mm
T3 : Ration + eggshell soaked 6% phosphat acid with particle size 1 mm
T4 : Ration + eggshell soaked 0% phosphat acid with particle size 3 mm
T5 : Ration + eggshell soaked 3% phosphat acid with particle size 3 mm
T6 : Ration + eggshell soaked 6% phosphat acid with particle size 3 mm

Feeding and drinking. Feed and drinking water are given ad libitum on all treatments.

Data Collection. The data collected on invitro assay was the mineral content of shell powder. Data on biological tests collected were feed consumption, body weight, egg production, and levels of Ca and P in the blood plasm.

Data Analysis. The research was analyzed by analysis of variance according to factorial completely randomized design (3x2) in the form of (3) phosphoric acid treatment x (2) treatment of particle size followed by Duncan different test to determine the effect between treatments (Astuti, 1980).

RESULTS AND DISCUSSION

All Analysis of treatment of feed consumption, calcium consumption, body weight, egg production, level of calcium in blood plasm, level of phosphorus in blood plasm are represented in table 4.

Table 4. Analysis of treatment of feed consumption, calcium consumption, body weight, egg production, level of calcium in blood plasm, level of phosphorus in blood plasm.

Parameters	Particle Size	Phosphat Acid			Average
		0%	3%	6%	
Feed Consumption (g/bird/day)	1 mm	129	109	78	105^{ns}
	3 mm	104	103	130	113^{ns}
	Avg.	116^{ns}	106^{ns}	104^{ns}	109
Calcium Consumption (g/bird/day)	1 mm	4,291	3,633	2,717	$3,547^{ns}$
	3 mm	3,469	3,462	4,522	$3,818^{Ns}$
	Avg.	$3,880^{ns}$	$3,547^{ns}$	$3,620^{ns}$	3,682
Body Weight (gram)	1 mm	1808	2033	1933	1925^{ns}
	3 mm	1800	1867	1967	1878^{ns}
	Avg.	1804^{a}	1950^{b}	1950^{b}	1901
Egg Production (%)	1 mm	80,95	82,14	92,26	$85,12^{ns}$
	3 mm	92,56	92,56	92,36	$92,49^{ns}$
	Avg.	$86,76^{ns}$	$87,35^{ns}$	$92,31^{ns}$	88,81
Level of Calcium in Blood Plasm (mg/100 ml)	1 mm	23,13	23,21	26,58	$24,31^{ns}$
	3 mm	23,64	24,11	28,08	$25,27^{ns}$
	Avg.	$23,39^{a}$	$23,66^{a}$	$27,33^{b}$	24,79
Level of Phosphor in Blood Plasm (mg/100 ml	1 mm	6,02	6,68	7,81	$6,84^{ns}$
	3 mm	4,66	6,93	7,77	$6,45^{ns}$
	Avg.	$5,34^{a}$	$6,81^{b}$	$7,79^{b}$	6,64

Information : ^{ns} non significant; $^{a, b, c}$ Different superscripts on the mean row show a marked difference ($P < 0.05$).

Feed Consumption. The results of the analysis showed that there was no significant difference in feed intake from 3 phosphoric acid leaching treatments and also to 2 treatment of particle size. The feed used is the feed with the same energy and protein content (iso-energy and iso-protein), so feed consumption tends to be the same in every given ration treatment. This opinion is in accordance with Makled and Charles (1987), who states that the consumption of laying chicken is not influenced by sources of calcium. This opinion is reinforced by Guinotte and Nys (1991a) which suggest that modification of calcium sources in feed (lime mash, eggshell mash, oyster shells, and sea shells) has no effect on feed consumption.

Calcium Consumption. The results of the analysis showed that there was no significant difference in calcium consumption from the treatment. According to Farmer and Roland (1983) that chicken consumes calcium according to his needs. This opinion is reinforced by Tri-Yuwanta (1992), which states that laying hens have the ability to regulate and consume calcium as needed.

Body Weight. The results of variance analysis showed that chicken body weight to feed treatment, there was a significant difference with eggshell mash with 0%, 3% and 6% phosphoric acid leaching treatment. And the treatment of 1mm by 3 mm particle size was not significantly different. The result of feed treatment by adding eggshell mash, which was washed with phosphoric acid (3 and 6%) was significantly different with chicken weight, which was given eggshell mash without wash treatment with phosphoric acid (0%) due to laying hens ration in this experiment (Phosphoric acid 3 and 6%) using the initial treatment in the form of addition of phosphoric acid, so that other feed nutrients will be easily digested and dissolved in the body of the chicken. In accordance with the opinions expressed by Guinotte and Nys (1991a), Guinotte and Nys (1991b) which states that phosphoric acid can increase the surface area of particles, stimulate the breakdown of mineral bonds and increase the solubility of minerals. It was further expressed that phosphoric acid treatment can increase the surface area of coarse seashell from 0.284 to 0.697 m^2/g and increases the solubility of 12%.

Levels of Calcium in Blood Plasm. Although the addition of 3% phosphoric acid can increase levels of calcium in blood plasm even in relatively small amounts when the phosphoric acid level is 0%, but has no significant difference when compared to washing with 6% phosphoric acid, it is suspected that 3% phosphoric acid level is not enough to stretch the calcium minerals in the eggshell until it is easy to dissolve in the body. Whereas the granting of phosphoric acid with a level of 6% is sufficient to stretch the bonds of calcium in eggshell mash and easily dissolve in the body. This is in accordance with the opinion expressed by Guinotte and Nys (1991a), which reported that the use of seashell added with phosphoric acid can increase calcium levels in blood plasma. Phosphoric acid can break up mineral bonds so as to increase the surface area and solubility rate in the body. Particle size (1mm and 3 mm) in treatment has an effect on calcium levels in blood plasma because the larger particle size have the length of calcium retention in the gastrointestinal tract. This is accordance with Leeson and Summers (1991); Guinotte and Guy (1997), who stating that the source of the Ca with larger particles will be stored longer in the digestive tract. This causes more Ca that can absorb and is important for the availability of Ca directly from the feed during the calcification of eggshell.

Levels of Phosphor in Blood Plasm. The results of the analysis showed that phosphorus levels in blood plasma with eggshell mash washed with phosphoric acid (3 and 6%) showed a significant difference compared with washless with phosphoric acid (0%). This is in accordance

with the opinion of Ganong (1992) which states that calcium ions will be absorbed by the intestine into the blood circulation, while chloride ions will also be absorbed and used as blood buffers or as gastric HCl formers. The phosphoric acid produced in reaction II will be ionized into H^+ and PO_4^{3-} ions. Ion H^+ will be used as a blood buffer, while phosphorus derived from PO_4^{3-} will be absorbed in the body.

CONCLUSIONS

The greater levels of phosphoric acid used to wash the egg shell mash has effect significantly ($P<0.01$) on chicken body weight, blood plasm levels of calcium, phosphorus content of blood plasm. And not affected on feed consumption, calcium intake, and egg production. Difference particle sizes of egg shell mash is not affected on feed consumption, calcium intake, body weight, phosphorus content of blood plasm, and egg production, but significantly different ($P<0.01$) on blood plasm calcium levels. There was no interaction between phosphoric acid treatment with particle size of egg shell mash on performance, and levels of Ca and P blood plasm of laying hens.

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