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Effects of Dietary Supplemental Phosphate from Different Sources on Performance of Young Broiler Chicks and It's Biological Availability

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서로 다른 인 공급원들의 생물학적 이용율과 어린 육계의 능력에 미치는 영향

류 경 선

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ABSTRACT

An experiment was conducted with male broiler chicks to determine the effect of different dietary phosphorus sources and evaluate the biological availability of phosphorus sources. The biological availability of phosphorus from dicalcium phosphate (DCP) was used as a reference standard (100%) compared to defluorinate phosphate (DFP). DCP and DFP was supplemented to a corn-soy basal diet at levels of 0.05, 0.15, 0.25, 0.35%. Each of 24 pens of 10 male broiler chicks with three replications was used for three weeks. The results indicated that weight gain, feed intake, feed efficiency, nonphytic phosphorus (NPP) and tibia ash were significantly different among treatments. Dietary supplemental phosphorus of DFP improved weight gain, NPP intake and feed efficiency consistently, whereas supplements of DCP did not show consistent increase. Regression equations was used for the availability of DFP compared with DCP when percent bone ash was a function of total phosphorus in the diet. The percent (%) bone ash of DFP groups compared to that of DCP groups showed a value of 59.98% as a slope ratio. DFP indicated lower biological availability compared to DCP, but it's dietary supplementation tended to increase bone ash and maximize the growth of young broiler chicks.

(Key words : phosphorus, biological value, dicalcium phosphate, defluorinated phosphate, broiler chicks)

INTRODUCTION

There have been numerous researches on the phosphorus(P) as an essential nutrient for performance of broiler chicks(Mussehl, 1935; Choi and Harms, 1977; Edwards and Veltman, 1983; Long et al., 1984 a, b, c). Many of these studies were chosen to evaluate availability of phosphorus from inorganic sources for the chick

(Gillis et al., 1954; Yoshida and Hoshii, 1979; Jenson et al., 1980; Yohida and Hoshii, 1983). P is an important dietary nutrients due to its functions when balancing diets of chicks which have been selected for fast gain. The amount of P absorbed by the bird depends upon many factors, including biological availability of the P source, calcium (Ca) to P ratio (Edwards, 1983; Edwards and Veltman, 1983) and dietary vitamin D (Frits et al., 1969).

Biological availability of P refers to the portion of the dietary P which can be utilized by chicks (Gillis et al., 1954; Nelson and Peeler, 1961). Biological availability of P is affected by phytin. Phytin P has been shown to be unavailable to broiler chicks (Nelson et al., 1968).

In most studies, body weight gain and tibia ash were the measurement of choice to evaluate availability of P sources (Nelson and Walker, 1964; Yoshida and Hoshii, 1977). These have been found to be successfully in P bioavailability studies with chicks as a relative biological value of phosphorus from various sources. The availability of P in supplements for the turkey using DFP was about to 80% of DCP, indicating that a product of high availability could be produced. In general, monocalcium phosphate tends to have a higher relative biological value than does DCP, whereas DCP tends to have a greater relative biological value than that of DFP. (Edwards, H. M., 1968; Waibel et al., 1984; Nelson et al., 1990).

Although several studies have been conducted on P availability, precise measurements of the relative value of many commercially available phosphates remain to be undertaken. Therefore, the objective of this study was to evaluate the effect of dietary supplemental DCP and DFP on performance of young broiler chicks and to determine the relative biological values of DCP and DFP.

MATERIALS AND METHODS

Two hundred and forty day-old broiler males were used in this experiment. The birds were wing banded, vaccinated for infectious bronchitis, and randomly placed in 24 pens with 10 birds each in a Petersime battery brooder with wire floors. The birds were assigned to eight dietary treatments with three pens each. The feed and water were provided *ad libitum* from one day to three weeks of age.

The composition of basal diet is shown in Table 1. This diet contained 0.11% available phosphorus has the reference phosphorus source from DCP and DFP. Both DCP and DFP were fed at levels to furnish 0.05. 0.15, 0.25, and 0.35% phosphorus, respectively. The phosphorus sources were analyzed for calcium and phosphorus and the values are presented in Table 2. Ca carbonate (36% Ca) was used to establish the ratio of Ca to P at approximately 2:1 in all diets.

Body weight, feed intake, and feed efficiency were measured at the end of the 21 day feeding. After finished the experiment, birds were sacrificed by CO_2 gas and left tibia was removed and cleaned. Bone ash was measured by AOAC (1954).

A linear regression analysis was used to evaluate the percent bone ash as compared to P intake per bird to determine the biological availability. Determination of the availability of the P from DFP was made by using the methods described by Huyghbaert et al., (1981). Comparisons of mean value among treatments were also made by the method of Gillis et al.(1949). All regressions were made using the GLM procedure of the SAS (1985).

Table 1. Composition of basal diet

Ingredients	%
Corn	59.05
Soybean meal	35.00
Poultry fat	5.00
DL-methionine	0.20
Sodium chloride	0.40
Vitamin premix[1]	0.25
Mineral premix[2]	0.10
Total	100.00
Calculated analyses	
ME(kcal/kg)	3.20
Crude protein(%)	23.00
Methionine + cysteine(%)	0.93
Ca(%)	0.22
Available P(%)	0.11

[1] Supplied per kilogram of diet: vit. A, 5,500IU; vit. D3, 1,100IU; vit. E, 11IU; vit. B12 0.0066mg; riboflavin, 4.4mg; niacin, 44mg; pantothenic acid, 11mg(Ca-pantothenate, 11.96mg); choline, 190.96mg(choline chloride 220mg); menadione, 1.1mg (menadione sodium bisulfite complex, 3.33mg); folic acid, 0.55mg; pyridoxine, 2.2mg(pyridoxine hydrochloride, 2.67mg); biotin, 0.11mg; thiamin, 2.2mg(thiamine mononitrate, 2.40mg); ethoxyquin, 125mg.

[2] Supplied per kilogram of diet: Mn, 120mg; Zn, 100mg; Fe, 60mg; Cu, 10mg; I, 0.46mg; Ca, min: 150mg max: 180mg.

Table 2. Determined value for Ca and P

Source	Ca(%)	P(%)
Dicalcium P	22.30	18.50
Defluorinated P	32.50	18.00

RESULTS AND DISCUSSION

Chick performance is summarized in Table 3. Body weight, feed intake, and gain per feed did not equal responses towards the two sources of P supplementation. As dietary P increased, chicks fed supplemental DFP showed significantly increased ($P<0.05$) mean body weight, bone ash and NPP intake consistently. Supplemental DFP improved feed efficiency as compared to the control, whereas chicks fed DCP did not show significance among treatments. The slope of body weight treated with DFP was greater than that of DCP groups. The P of DFP appeared to be better utilized than that of DCP in this aspect (Figure 1). However, relative biological value of P from DCP showed higher than that of DFP.

Bone ash (%) was used to determine the influence of P in the diet and was analyzed by linear regression. When the basal diet was fed

Table 3. Effect of dietary P sources and content on weight gain, feed intake, feed/gain, nonphytic phosphorous(NPP), and bone ash of young broiler chicks

Diet	Inorganic P level(%)	BW gain(g)	Feed intake(g)	Feed/gain	NPP intake(g)	Bone ash(%)
DCP	0.05	520.9 ± 7.7^{c}	786.1 ± 9.1^{c}	1.510 ± 0.037^{ab}	1.258 ± 0.044^{E}	30.78 ± 1.026^{E}
	0.15	583.9 ± 15.2^{ab}	870.7 ± 27.7^{ab}	1.491 ± 0.014^{ab}	2.264 ± 0.029^{D}	35.58 ± 0.791^{C}
	0.25	541.1 ± 22.0^{bc}	851.9 ± 16.6^{ab}	1.579 ± 0.059^{a}	3.067 ± 0.105^{C}	39.11 ± 1.182^{B}
	0.35	569.5 ± 22.2^{abc}	856.1 ± 7.6^{ab}	1.507 ± 0.044^{ab}	3.853 ± 0.093^{B}	40.27 ± 1.033^{A}
DFP	0.05	549.0 ± 14.2^{bc}	819.0 ± 4.9^{bc}	1.494 ± 0.031^{ab}	1.130 ± 0.023^{E}	33.40 ± 1.113^{D}
	0.15	549.6 ± 15.2^{bc}	805.6 ± 25.2^{bc}	1.465 ± 0.006^{b}	2.094 ± 0.009^{D}	35.35 ± 0.786^{C}
	0.25	584.8 ± 26.4^{ab}	865.3 ± 31.1^{ab}	1.481 ± 0.014^{ab}	3.115 ± 0.030^{C}	37.89 ± 0.842^{B}
	0.35	618.8 ± 10.7^{a}	891.1 ± 15.9^{a}	1.441 ± 0.026^{b}	4.099 ± 0.074^{A}	39.54 ± 0.972^{A}

[a, b, c] Means($\pm$SE) within a column with no common superscripts are significantly different($P<0.05$).
[A, B, C, D, E] Means($\pm$SE) within a column with no common superscripts are significantly different($P<0.01$).

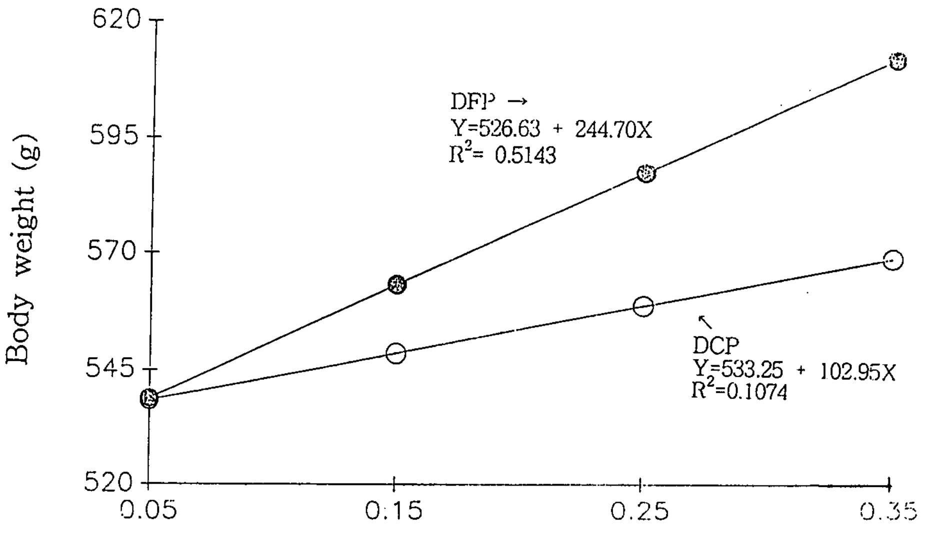

Figure 1. Effect of dietary supplemental phoshporus on body weight of young broiler chicks.

with 0.05% supplemental P from DCP and DFP, bone ash (%) were only 30.78 and 33.40%, respectively. It was increased by the more supplemental phosphorus in both diets. The data for the percent bone ash as a function of supplements of phosphorus resulted in slopes of the lines to be 31.28 and 18.76 for DCP and DFP, respectively (Figure 2). The relative biological availability value (RBV) of DFP was 59.98% when DCP was used as a reference standard.

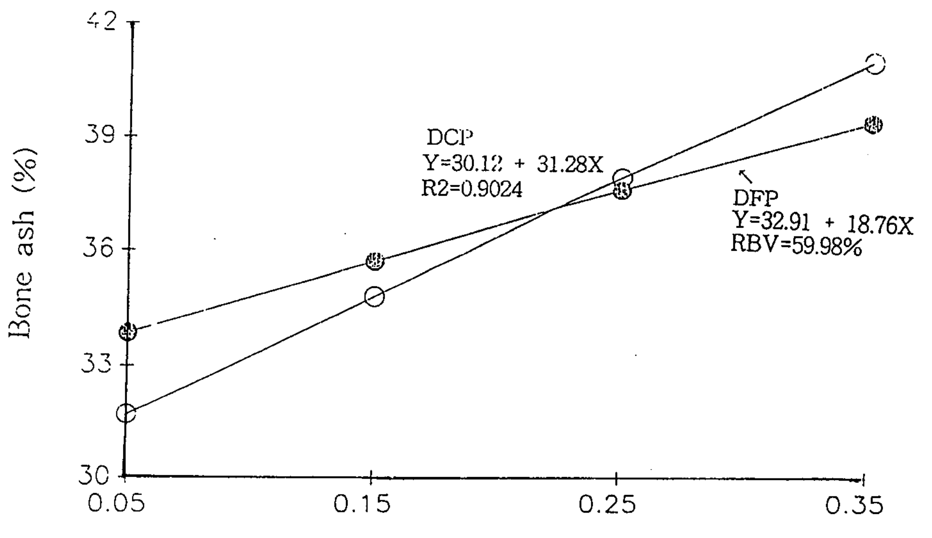

Figure 2. Effect of dietary supplemental phoshporus from DCP and DFP on the relative biological availability of bone ash in young broiler chicks.

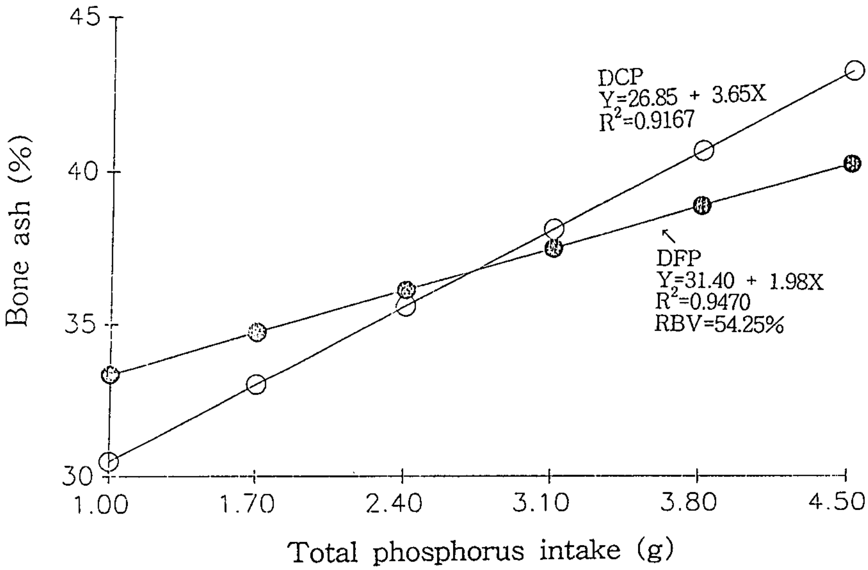

Figure 3. Effects of total NPP intake of young broiler chicks' bone ash on the RBV of DFP compared to DCP.

The value appeared to be low, which is not agreement with those of Wilcox et al. (1954) and Nelson et al.(1990) who reported substantially higher values for the utilization of DFP compared to DCP. Using the same method as above, the RBV of DFP determined when bone ash was a function of NPP intake was 54.25% as compared to DCP (Figure 3).

The availability of P to the bird from different sources may vary depending upon a variety of factors such as vitamin D (Waldroup et al., 1984) and orthophosphates (Gillis et al., 1954). It can be also influenced by breed and strain or calcium content of the diet (Edwards, 1982, Sanders et al., 1992). In this study, two biological availability values for DFP were determined. Results of this study indicated that variation in the procedure used to assay phosphate sources or to interpret the results of such assays may significantly influence the RBV of P source. The use of different levels of both DFP and DCP supplementation appears desirable in order to respond maximum growth of the chick and allow full utilization of phosphorus. However, DFP supplementation may affect more influence for chick growth. The response curve of the bone ash(%) and total NPP intake in the DCP diet versus supplemental phosphorus was dependent on the response curves being linear.

적 요

본 시험은 사료내 서로 다른 형태의 인 급여가 어린 육계의 생산성적에 미치는 영향과 제 2인산칼슘을 기준으로 탈불인광석의 상대적인 생물학적인 가치를 비교하기 위하여 3주 동안 시행하였다. 기초사료는 옥수수 대두박 위주로 이루어졌으며, 제 2 인산칼슘과 탈불인광석을 사료내 인함량이 각각 0.05, 0.15, 0.25, 0.35% 수준으로 첨가 급여하였다. 시험 처리구는 8개로서 3반복이었고, 반복당 10마리씩 240마리를 이용하

였다.

증체량, 사료섭취량, 사료효율, 비피틴태 인, 경골회분이 측정되었으며, 처리구간에 차이가 있었다. 탈불인광석은 사료내 첨가수준에 따라서 일관적으로 증체량, 사료효율을 개선하고, 비피틴태인 섭취량을 증가시켰으며, 제 2인산칼슘의 첨가구도 이와 비슷한 경향을 보였으나, 일관성은 없었다. 경골의 회분함량을 나타낸 회귀 방정식에서 제 2인산칼슘과 탈불인산칼슘은 각각 31.28, 18.76의 기울기를 나타내므로서, 제 2인산칼슘에 대한 탈불인광석의 상대적인 생물학적인 가치는 59.98%로 평가되었다. 탈불인광석은 제 2인산칼슘에 비하여 상대적인 생물학적인 가치가 낮았을지라도 육계 전기 사료에 첨가함으로서 제 2인산칼슘에 비하여 어린 육계에서 골회분을 증가시키고, 성장을 극대화하는 경향을 보였다.

(색인 : 생물가, 제 2인산칼슘, 탈불인광석, 육계)

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