GROWTH RESPONSE OF COBB 500 BROILER CHICKS FED LOW PHOSPHOROUS DIETS

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SUMMARY

Lowering dietary phosphorous (P) in poultry diets allows to reduce feed cost, environmental impact and to improve the welfare of broiler. 180 unsexed one day-old Cobb 500 were distributed equal in to 6 dietary treatments in 3 replicates of 10 chicks each. Current Ca and P recommendation of Cobb 500 broiler was considered as control (T_1) for starter and grower phase (100/100). The rest 5 dietary treatments (T_{2-6}) were formulated to meet (100/75-T_2), (100/50-T_3), (75/75-T_4), (75/50-T_5), (50/50-T_6) of Ca and P levels for starter and grower phase. Body weight, body weight gain, feed consumption, feed conversion ratio, carcass traits and economic efficiency were determined to evaluated and examine the effect of reduced levels Ca and P in broiler chicks diet. The results indicated that: Growth performance showed that, all chicks fed the reduced Ca and P diets (T_{2-6}) didn't show any growth depression. Besides it was interestingly obtained that all reduced Ca and P diets has better body weight gain and fed conversion ratio than control. Carcass traits (carcass% and Total edible parts%) were non-significantly different for all treatment group. Economical evaluation study indicated that chicks fed on lower levels of Ca and P below the requirements enhance economic efficiency. The results of the present study showed that the current Ca and P recommendation of Cobb 500 broilers could be lower than real requirement and needs to be updated. So it was concluded that 50% reduction can be possible in dietary Ca and P level of broiler diets, and this wouldn't cause any impairment in broiler growth and carcass traits. In conclusion**:** The result indicated that broiler chicks fed on lower levels of Ca and P below the requirements had a positive effect on the economic efficiency of broiler chicks, without any adverse effects characteristics.

Keywords: *Available phosphorus, broilers, calcium, performance, and economic efficiency.*

INTRODUCTION

Reducing the cost of poultry feeding is one of the important goals which is given to precision poultry production and maximize the economic efficiency of poultry farming. Nutrient management is that the highest concern for today's modern poultry innovativeness, because feed represents, is that the greatest costs associated with poultry production. Whereas formulating a broiler's diet, the importance is given for using the correct amount of balanced diets from protein and amino acids (AA) because it is one amongst the highest ingredients costs of poultry diets then energy ingredients and protein has the highest effect on growth performance.

Phosphorus being the third costly dietary component and deserves special consideration at feed formulation to meet precise requirements of poultry (Summers, 1997). Phosphorus is an essential mineral for poultry to attain maximal potential in growth performance. However, endogenous plant phytate binds to minerals, and this has negatively affect processes of digestion and absorption for other nutrients and cause decrease availability of nutrients. The utilization efficiency of dietary P is considered low (20–27%) while, manure phosphorus content is a significant amount (Ferket *et al*., 2002). Most P excretion is associated with swine and poultry because of the P concentration in the manure. Poultry and swine excrete about 36% of the total P output (Crenshaw and Johanson 1995). Results of studies by Ravindran *et al.* (1995); Woyengo and Nyachoti (2013) reported that the majority of plant phosphorus (P) as based feedstuffs is bound as phytate that is very poorly digested by non-ruminant animals.

Kahindi *et al.* (2017) studied broilers fed phosphorus by levels zero, 50% and 100% from the requirement in its diets, the results indicated that reducing the content of available P had negatively affected that resulted in depression in the growth of the broiler chickens. Furthermore, they showed that there was a reduction (P<0.05) in average daily gain (ADG) with reducing dietary phosphorus by 50% in bird's diets. Moreover, giving broilers sufficient amounts of dietary phosphorus to meet its requirements had higher average daily gain (ADG) than those fed diets with 50% of requirements.

A high Ca content depresses phytate hydrolysis and P availability to the bird due to chelate formation leading to lowered feed consumption. (Selle *et al*., 2009; Wilkinson *et al*., 2014). Birds fed P diets with sufficient amounts of P requirements average daily feed intake (ADFI) was higher (P<0.001) than those fed diets with P reduced by 50%. (Kahindi *et al.,* 2017). Birds fed P diets with sufficient amounts of P requirements and those fed diets with P reduced by 50%. The feed conversion ratio was not affected by diet (P>0.10). (Kahindi *et al.,* 2017)

However, Rousseau *et al.* (2016) found that feed conversion ratio (FCR) was almost higher for birds fed diets containing the highest level of Ca and the lowest NPP concentration (P<0.05). Emmenes *et al.* (2018) observed that there were no differences in carcass yield among broilers fed either different levels of P in dietary.

The present study was, therefore, conducted to assess the effect of decreasing the phosphorus level in broiler diets on growth performance, carcass characteristics and economic efficiency.

MATERIALS AND METHODS

The present experiment was carried out at the Poultry Nutrition Farm, Poultry Production Department, Faculty of Agriculture, Ain Shams University, Egypt. It was designed to evaluate how far the dietary phosphorous level effect on growth performance, carcass traits and economic efficiency in Cobb 500 broiler chicks.

Table (1): Composition and calculated analysis of experimental diets.

Ingredients%	Starter			Grower		
	100%	75%	50%	100%	75%	50%
Yellow corn	56.68	57.14	58.52	63.95	64.31	65.10
Soybean meal (44 % CP)	31.15	33.35	34.00	25.18	27.70	29.15
Corn gluten meal(60%CP)	5.60	4.00	3.35	4.10	2.20	1.05
Vegetable Oil	2.00	2.00	1.65	2.50	2.50	2.35
Ca Carbonate	1.60	1.17	0.77	1.47	1.08	0.70
Mono Ca Ph	1.85	1.25	0.64	1.65	1.10	0.56
Salt (NaCl)	0.30	0.30	0.30	0.30	0.30	0.30
Premix*	0.30	0.30	0.30	0.30	0.30	0.30
HCl-Lysine	0.28	0.24	0.22	0.31	0.26	0.23
DL- Methionine	0.24	0.25	0.25	0.24	0.25	0.26
Total	100	100	100	100	100	100
Price L.E /Ton	5680	5550	5410	5420	5280	5150
Calculated analysis:-						
CP %	22	22.01	22.01	19.06	19.02	19.01
ME (Kcal/Kg)	2999	3004	3006	3103	3101	3102
Calcium %	1.01	0.75	0.51	0.91	0.68	0.45
Available phosphorous %	0.51	0.38	0.25	0.46	0.34	0.23
Lysine%	1.32	1.32	1.32	1.2	1.19	1.19
Methionine %	0.62	0.62	0.62	0.57	0.57	0.57
Meth. + Cys. %	0.985	0.984	0.980	0.896	0.891	0.892

* *The premix contains: Vitamins: A: 12000000 IU; Vit. D3 2000000 IU; E: 10000 mg;* K_3*: 2000 mg;* B_1*:1000 mg;* B_2*: 5000 mg;* B_6*:1500 mg;* B_{12}*: 10 mg; Biotin: 50 mg; Coline chloride: 250000 mg; Pantothenic acid: 10000 mg; Nicotinic acid: 30000 mg; Folic acid: 1000 mg; Minerals: Mn: 60000 mg; Zn: 50000 mg; Fe: 30000 mg; Cu: 10000 mg; I: 1000 mg; Se: 100 mg and Co: 100 mg.*

Birds and experiment design:

One hundred and eighty, one-day-old Cobb 500 broiler chicks were weighted, and randomly assigned to six experimental groups, (control and 5 treatments). Each group included three replicates, each of 10 chicks. Chicks were fed three diets (100/75 and 50% of calcium and Phosphor) requirements according to guidebook of Cobb 500 broiler in period 1-21 day (starter) and 22-42 day (grower).

Birds in the in the T_1 which served as the control, where fed diets contains (100/100) of calcium and phosphorus requirements at starter and grower periods, while those in T_{2-6} fed a diet contains (100/75, T_2), (100/50, T_3), (75/75, T_4), (75/50, T_5) or (50/50, T_6) of Ca and P requirements at starter and grower period, respectively. The composition and calculated analysis of experimental diets were presented in Table (1).

Birds and management:

The birds of each replicate (10 birds) were housed in a battery cage of triple-tiered galvanized cages and raised under adequate environmental and managerial conditions during the whole experimental period (42 days). The birds were kept under 32 °C during the first week and the temperature then was reduced gradually (2 °C / week) until 24 °C by fourth week of age, after which it was fisced till the experiment end. Feed and water were supplied ad-libitum and a constant (22L:2D) light period was provided during the experimental period. All chicks were kept under the same managerial, hygienic and environmental conditions. During the experimental period, body weight and feed consumption were weekly recorded and body weight gain and feed conversion ratio were calculated.

Carcass characteristics:

At the end of experiment (42 days), out of 6 birds / treatments were fasted for 12 hours prior to slaughtering and individually weight as a pre- slaughter weight. The internal organs (liver, heart, and empty gizzards) and carcass were weighted and expressed as percentages of live body weight.

Economic evaluation:

The economic evaluation of the end product was based on the difference between total return and total cost.

Total return = price of kg (LBW) * final (LBW).

Net return = total return – (total feed cost + price of one-day old chick + incidental expenses).

Economic efficiency = {(price of kg LBW - feed cost/kg LBW) / feed cost/kg LBW} *100

Relative economic efficiency = Economic efficiency of each experimental group /economic efficiency of the control X 100.

Statistical analysis:

Data that were statistically analyzed using the general linear models (GLM) of SAS, (2005). Using one-way analysis of variance. Significant differences among means were achieved using the Duncan`s Multiple Range test Duncan (1955). The level of statistical significance was set at ($P< 0.05$). The following statistical model was applied:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where: Y_{ij} = observation of the parameter measured; μ = overall mean; T_i = the effect of treatment; e_{ij} = random error effect.

RESULTS AND DISCUTION

Productive performance:

Live body weight (LBW) and daily weight gain (DWG):

The live body weight and daily weight gain of broiler chicks affected by dietary treatments are illustrated in Table (2). The obtained data showed that there were insignificant differences in live body weight and daily body weight gain during the studied period (0-6 wks). Birds fed control diets (100/100, T_1) reflect the lowest LBW and DWG compared with other treatment (T_{2-6}). However, LBW decreased by 7% (1941 Vs 1816 g) compared with that fed (100/50, T_3) diets and DWG showed similar trend (47.42 Vs 44.26 g). Besides, the differences between the two treatments were insignificant. Moreover, feeding low levels of Ca and P in starter and grower diets containing (75/50,T_5) gave the best LBW (1909 g) compare the diets containing other levels, (75/75, T_4) and (50/50, T_6) being (1896 and 1880 g) respectively, however, the differences failed to be significant. These results confirmed by those obtained by Rousseau *et al.* (2016) who reported that during 10 to 35 days of birds 'age, decreasing level of NPP in diets affected on daily gain. However, Kahindi *et al.* (2017) found that birds fed diets containing sufficient amounts of inorganic phosphorus to meet P requirements had higher ($P<0.001$) daily gain than those fed diets with inorganic phosphorus reduced by 50%. Also, results by Shang *et al.* (2015) showed no significant effects of reduced levels of Ca and available P on birds' growth was observed for all treatments during 5 to 14 d of age.

Daily feed consumption (DFC) and feed conversion ratio (FCR:)

The results in table (2) showed the relationship between diets with different levels of Ca and P and DFC and FCR. The obtained data showed that, broiler chicks fed low Ca and P diets during grower phase (T_{2-3}) fed chicks to consume more feed compared with those fed control diet (T_1), however, the differences failed to be significant. The corresponding figures were (79.93 Vs 82.19) and 84.27 g/chick / day). In the same order, feed consumption per chick (g/d) increased by feeding low Ca and P diets in starter and grower phase (T_{5-6}) compared with those fed T_3 diet. The corresponding figure were 78.95 Vs 79.95 and 83.11 (g/chick/d), without any significant difference. These results are in agreement with results of Shang *et al.* (2015) and Rousseau *et al.* (2016), they indicated that reduce levels of available P didn't significantly affected on birds' growth and feed consumption at an early age.

Table (2): Effects of successive levels of calcium and phosphorus on live body weight and daily live body weight gain of broiler chicks.

Items	Dietary treatments							
	T1 (100-100)	T2 (100-75)	T3 (100-50)	T4 (75-75)	T5 (75-50)	T6 (50-50)	MSE	Prob.
Live body weight g.								
Initial weight	45.60	44.80	44.90	44.07	44.83	42.90	0.43	NS
3. Wks.	654.90	690.20	630.07	672.70	666.90	659.4	8.12	NS
6 Wks.	1816.12	1905.15	1941.65	1896.02	1909.41	1880.00	27.79	NS
Daily live body weight gain g/day								
0-3. Wks.	29.01	30.73	27.87	29.93	29.62	29.36	0.38	NS
3-6 Wks.	55.30	57.85	62.46	58.25	59.17	58.12	1.25	NS
0-6 Wks.	44.26	46.51	47.42	46.30	46.61	45.93	0.69	NS

[a,b]Means in the same row with the same letters are not significantly different.

*MSE: Mean standard error NS: Non-significant **: ($P\leq 0.01$).*

Feed conversion ratio (FCR) showed the same trend since chicks fed control diets (T_1) were less efficient in converting their food into body weight gain with those fed (T_{2-3}) diets. The correspond figures were 1.90 Vs 1.87 and 1.86 without any significant differences. In the same order, the figures of FCR indicated insignificant differences between chicks fed diet with low Ca and P in starter and grower phase (T_{4-6}) compared with those fed control diet (T_1). The best FCR was detected for the birds fed 75/50, T_5 diet (1.79). on the other hand, the worst FCR were found in chicks fed control (100/100, T_1) or 50/50 T_6 diets, (being the same figure 1.90, respectively), however, the differences failed to be significant. These results are in agreement with result of Kahindi *et al.* (2017) Summers (1997), they showed that the FCR wasn't affected by reducing Phosphor in broiler diets up to 50%.

Carcass characteristics:

Table (4) showed the effect of different dietary treatments on carcass characteristics for the chicks slaughtered at the end of 6wks of age. Experimental treatments with different levels of Ca and P (T_{2-6}) had no significant effect on most studied parameters compared with control (T_1). The corresponding value for dressing percentage ranged between 72.24 and 73.35% while ready to cook% (hot carcass weight + giblets weight) percentage ranged between 78.35 and 78.99%. In the same order the figure of giblets % (liver + gizzard + heart) indicated insignificant difference between treatments and the corresponding figure ranged between 5.49 and 6.04%.

On the other hand, the figures of gizzard% indicated significant difference between chicks fed (100/100, T_1) control diet compare with those fed (100/50, T_3) diet and the corresponding figures ranged between 1.61 and 2.04% and in most carcass differences between treatments were significant.

Table (3): Effects of successive levels of calcium and phosphorus on daily feed consumption and feed conversion ratio of broiler chicks.

Items	Dietary Treatments						Prob.
	T1 (100-100)	T2 (100-75)	T3 (100-50)	T4 (75-75)	T5 (75-50)	T6 (50-50)	
Daily feed consumption g/day							
0-3. Wks.	41.35	41.27	37.27	40.52	40.08	41.14	NS
3-6 Wks.	118.52	123.10	131.27	117.38	118.84	125.09	NS
0-6 Wks.	79.93	82.19	84.27	78.95	79.46	83.11	NS
Feed conversion ratio							
0-3. Wks.	1.43	1.34	1.34	1.36	1.36	1.40	NS
3-6 Wks.	2.15	2.17	2.10	2.03	2.07	2.16	NS
0-6 Wks.	1.90	1.87	1.86	1.80	1.79	1.90	NS

[a,b]Means in the same row with the same letters are not significantly different.

Table (4): Effects of successive levels of calcium and phosphorus on carcass traits of broiler chicks.

Items	Dietary Treatments						Prob.
	T1 (100-100)	T2 (100-75)	T3 (100-50)	T4 (75-75)	T5 (75-50)	T6 (50-50)	
Dressing %	73.03	72.55	72.24	72.75	73.35	72.86	NS
Liver %	3.37	3.46	3.10	3.12	3.03	3.02	NS
Gizzard %	1.61	1.85	2.04	1.75	1.89	1.79	NS
Heart %	0.61	0.61	0.62	0.66	0.58	0.55	NS
Giblets %	5.72	6.04	5,89	5.65	5.65	5.49	NS

[a,b]Means in the same row with the same letters are not significantly different.

Economical evaluation:

Data for economical evaluation are summarized in table (5) the results of economic efficiency and relative economic efficiency estimated for experimental treatments were based on the recent of local market for feed ingredients and selling period. The average cost/ton of final experimental diets (starter and grower) are shown in table (1). It was clear that using low levels of Ca and P in broiler diets relatively decreased cost/ton final diets compared with control. This difference could be explained on the basis of the high price of mono Ca and P for Kg and the levels using.

As shown in Table (5) it is interesting to state that under the condition of the present studies the chicks fed control diets (100/100, T_1) gave the lowest economical and efficiency values being 61.18 and 100% respectively. This may be due to total return. Whereas, chicks fed (75/50,T_5) diets had the highest corresponding values being 74.60 and 21.29 respectively.

On the other hand, in general, using low Ca and p diets (T_{2-6}) increase economic efficiency and relative economic efficiency of broiler chicks compare with those fed the control diet and correspond increasing valued in relative economic efficiency were 11.52, 16.21, 17.90, 21.93 and 11.23% respectively.

Table (5): Effects of successive levels of calcium and phosphorus on economic efficiency of broiler chicks.

Items	Dietary Treatments					
	T1 (100-100)	T2 (100-75)	T3 (100-50)	T4 (75-75)	T5 (75-50)	T6 (50-50)
Feed Cost / Bird (LE)	18.42	18.57	18.65	17.74	17.53	18.20
Total Cost[1] / Bird (LE)	30.42	30.57	30.65	29.74	29.53	30.20
Total Return[2] Bird (LE)	49.04	51.44	52.43	51.19	51.55	50.76
Net Return / Bird (LE)	18.61	20.86	21.79	21.45	22.03	20.56
Economic Efficiency[3]	61.18	68.23	71.10	72.13	74.60	68.05
Relative Economic Efficiency[4]	100	111.52	116.21	117.90	121.93	111.23

[1] *Total cost = (feed cost + price of one-day live chicks + incidental costs); L.E.: Egyptian Pound*
[2] *According to the local price of Kg sold live birds was 27.00 L.E.*
[3] *Economic efficiency = net return/total feed cost*100. Whereas net revenue= total return - total feed cost.*
[4] *Assuming that the relative economic efficiency of control group equals 100.*

CONCLUSION

The results indicated that broiler chicks fed on lower levels of Ca and P below the requirement had a positive effect on the economic efficiency of broiler chicks, without any adverse effect on productive performance or carcass characteristics.

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استجابة نمو كتاكيت التسمين كب 500 المغذاه على علائق منخفضة فى الفوسفور

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أجريت تجربة بإستخدام 180 كتكوت كب 500 غير مجنس عمر يوم وزعت الكتاكيت على (6 معاملات غذائية × 23 T × 10 كتاكيت) وكانت المعاملات كالآتى T_1 كنترول عليقة تحتوى على احتياجات الكالسيوم والفوسفور فى عليقتى البادئ والنامى تبعاً لاحتياجات السلالة (100/ 100) وباقى المعاملات احتوت على (T_2, 75/100)، (T_3, 50/100)، (T_4, 75/75)، (T_5, 50/75)، (T_6, 50/50) من احتياجات السلالة من الكالسيوم والفوسفور فى عليقتى البادئ (صفر – 3 أسبوع) والنامى (4 – 6 أسبوع)

أوضحت النتائج أن:

- الاداء الانتاجى (الوزن الحى – الوزن المكتسب – استهلاك العلف – معامل التحويل الغذائى) لم يتأثر بإنخفاض الكالسيوم والفوسفور فى علائق كتاكيت التسمين.
- مواصفات الذبيحة (% للذبيحة، % للأجزاء الكلية المأكولة) لم تتأثر بالمعاملات المختلفة.
- العائد الاقتصادى تخفيض محتوى العلائق من الكالسيوم والفوسفور حسن العائد الاقتصادى .

الخلاصة: اوضحت تلك الدراسة أن احتياجات كتاكيت التسمين كب 500 من الكالسيوم والفوسفور أقل من توجيهات الشركة المنتجة للسلالة حيث يمكن تخفيض المستوى الى 50% من احتياجات السلالة بدون تأثير على الأداء الانتاجى و صفات الذبيحة مع تحسين العائد الاقتصادى.