<u>Emam, R. M. S. (2013).</u> Effect of phytase supplementation on performance of broiler fed triticale diets varying in their phosphorus content. ***Egyptian J. Nutrition and Feeds, 16 (3): 517-532.***

EFFECT OF PHYTASE SUPPLEMENTATION ON PERFORMANCE OF BROILER FED TRITICALE DIETS VARYING IN THEIR PHOSPHORUS CONTENT

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SUMMARY: The experimental work of the present study was carried out at El-Azab Poultry Research Station, Fayoum, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Dokki, Egypt during the period from June to August 2011. Chickens was initially fed a control diet for four days. A total number of 144 five-day old unsexed broiler (Ross strain) were divided into six treatments (24 birds each), each treatment contained three replicates of eight birds each. Three levels of dietary available phosphorus (recommended (R), R-25% available phosphorus and R-50% available phosphorus) and two levels of dietary phytase (0.00 and 0.10%) were used in a 3×2 factorial arrangement giving six dietary treatments.

Results obtained could be summarized in the following:

Productive performance: Main effect of level of available phosphorus (AP) was significant LBW, LBWG, FI and CCR during the period from 5 to 42 days of age, however, insignificantly affected FC, CPC, GR and PI during the same period. Chicks fed recommended level -25% AP had higher LBW at 42 days and LBWG during the period from 5 to 42 days of age. Chicks fed recommended level of AP had the worst CCR value during the from 5 to 42, and those fed R-25% AP had the best CCR value during the same period. No significant differences were found in FI between chicks fed phytase supplement diets and those given phytase un-supplement diets during the period from 5 to 42 days. Inclusion of phytase in broiler diet at 0.1% caused a significant increase in PI during the period from 5 to 42 days of age. Interaction due to level of AP x phytase level (experimental treatments) insignificantly affected LBW, LBWG, FC, CPC, CCR, GR and PI during the period from 5 to 42 days.

Slaughter parameters% and blood constituents: No significant differences were detected due to level of AP, phytase level and interaction due to level of AP x phytase level on slaughter parameters% and blood constituents.

Correlation coefficients estimate: Phytase level had significant positive correlation with PI at the end of experimental period. Regardless of level of AP and phytase level LBW had positive correlation with LBWG, FI, PI and GR. Significant negative correlation was observed between each of CPC and CCR with PI and GR. Higher PI is correlated (significant positive) with higher GR at the end of experimental period. Significant positive correlation was observed between WBCs with RBCs, hemoglobin (HGB, g/dL) and hematocri (HCT%). Also, RBCs had significant positive correlation with HGB (g/dL) and HCT% and HGB (g/dL) with HCT%.

Economical efficiency (EEf): EEf values during the period from 5 to 42 days of age improved in chicks fed all experimental diets as compared with those fed the control diet.

It would be concluded that, a satisfactory broiler performance and economic efficiency could be achieved by decreasing AP from the recommended level by 50% and supplement these diets with phytase (genetically, maintain the same performance as that obtained from chicks fed diets containing recommended level of AP). Besides, using such diets reduces feed cost and P pollution.

Key words: Triticale, available phosphorus, phytase and broiler performance.

INTRODUCTION

Poultry production was one of the fastest growing industries in Egypt and its improvement is one of the main objectives of both private and public sectors. Feeding cost is considered the most expensive item in the whole production process. In Egypt, the traditional feed grains, corn and soybeans are not produced in quantities that make them available to poultry, so it depends on the use of imported corn and soybeans. The key for successful process in poultry projects is through maximizing the profit, on the other hand, minimizing the feed cost could be achieved through the use of untraditional feed grains, particularly from local producers (by reducing transportation costs of commodities) or improving utilization of common feeds by using some additives.

Triticale (*X Triticosecale Wittmack*), the first successful human-made cereal grain, was deliberately produced in 1875 by crossing wheat (***Triti****cum* sp.) with rye(*Se****cale*** sp.), **FAO (2013**). Triticale is a relatively new feed grains (in Egypt) that is not used to any great degree in poultry feed (**Hermes and Johnson, 2004** and **Emam, 2010)**. Triticale can grow well in some areas where wheat does not, disease resistance of wheat with the vigor, hardiness, and high lysine content of rye and some varieties can make more efficient use of water and soil nutrients. Triticale can provide ecological benefits by diversifying crop production, reducing pests, protecting and improving soil by increasing organic matter. Triticale was found to be more efficient than wheat in utilizing and absorbing nitrogen from the soil, it also produced a 30% higher yield on acidic soils, and was superior to wheat on copper-deficient soil **(Myer and Barnett, 2000** and **Emam, 2010)**. Triticale contains some known and perhaps unknown anti-nutritional factors (ANFs). The main ANFs in triticale are arabinoxylans, β-glucans, pentosans and cellulose. All of these have been found in small amounts in triticale, but at levels much lower than in rye, seem to have no effect on the growth performance of broiler consuming diets containing triticale grains **(Emam, 2010). Dekic *et al.* (2012 a),** reported that triticale grains are a good source of protein (the protein content of triticale of 14.0%, which is about 1.64 times the protein of corn) and amino acids especially lysine (the lysine content of triticale of 0.39%, which is about 1.5 times the lysine of corn)**.** The energy content 3163 Kcal/kg**,** which is about 0.94 times the energy of corn, while, the energy content of modern triticale grains cultivars averages about 95 to 100% of that of maize or wheat for poultry **(Boros, 2002** and **Van Barneveld, 2002).** Also, triticale grains are good source of minerals, especially the available phosphorus (0.1%, which is about 1.25 times the available phosphorus (AP) of corn), calcium (0.05%, which is about 2.50 times the calcium of corn) and copper (8 mg/kg, which is about 2.67 times the copper of corn), **NRC (1994).** Because of triticale's higher lysine and minerals, especially the phosphorus content, producers who mix their diets using a soybean meal-premix can save 100 Libra (lb) soybean meal (44%) and 5 lb dicalcium phosphate per ton of diet over comparable corn-based diets, which gives further advantage to producers who mix their own diets from "scratch"**(Myer and Barnett, 2000** and **Emam, 2010)**. On the other hand, triticale is worth approximately 4 to 8% more than the purchase price of corn on an equal-weight basis because triticale not only replaces all of the corn in a typical poultry diet, but also part of the soybean meal or other protein supplement, as this approach facilitates their incorporation into least-cost formulations **(Varughese *et al.*, 1996** and **Emam, 2010).** Triticale's vitamin content is about the same as that of wheat (**Michela and Lorenz, 1976)**. Numerous studies suggest that triticale successfully replace part of corn, wheat or barley in animal feed without negative consequences to the impact of domestic animals (**Dekic *et al.,* 2011**; **2012a and b). Hermes and Johanson (2004)** and **Dekic *et al.* (2012b)**, reported that triticale in the diet of heavy line hybrids and who participated in various proportions in the mixture for broilers showed no adverse effects on performance traits of chickens. Because of favorable enzyme composition, triticale grains favorably effect the intestinal tract of monogastric animals **(Dekic *et al.,* 2012b).**

Phosphorus (P) is not only a component of bone but also is an essential mineral element that plays a vital role in various physiological processes **(Soares, 1995).** On the other hand, P plays a critical role in the formation of hydroxyapatite, nucleic acids, bioactive signaling proteins and phosphorylated enzymes **(Berndt *et al.,* 2005)**. Its is also the most expensive mineral added to diets due to decreased rock phosphate stores **(Moore *et al.,* 1999).** As a result, it is necessary to supplement most mono gastric diets with P to meet the requirements of that animals especially in the early stages of development **(Viljoen, 2001)**. Further, poultry production increased from just over 118.8 million birds at the end of 2000 to over 145.6 million birds by the end of 2011 in Egypt **(FAO, 2013);** this increase in production resulted in an increase in poultry litter available for land application. Major ingredients used in poultry feeds are of plant origin. About two third of the P in these feedstuff is present as phytate P, which is poorly utilized by poultry (due to low phytase activity found in the digestive tract) leading to a net excretion of 50% or more into poultry litter **(Selle and Ravindran, 2007).** These anti-nutritive properties require further investigation, but phytate probably compromises the utilization of protein/amino acids, energy, calcium and trace minerals (**Shelton *et al.,* 2004)** and reduces the activity of pepsin, trypsin, and α-amylase **(Sebastian *et al.,* 1998).** Phytates are associated with other cations such as Ca, Mn and Zn **(Maenz, 2000)**; Ca, Mg and Cu **(Sebastian *et al.,* 1998)**; Ca, Mg, Zn, Fe, K and Cu as well as amino acids **(Ravindran *et al.,* 1998).** Thus any attempt to maximize the utilization of dietary P could reduce the feed cost and thus achieve the underlying objective of reducing the environmental pollution**.** Many researches indicated that the best way is adding exogenous phytase to phosphorus availability in plant feed. Possibly, **Warden and Schaible (1962)** were the first to show that exogenous phytase enhances phytate-P utilization and bone mineralization in broiler chicks. Phytase is a part of enzymes called phosphatases, which are responsible for catalyzing the hydrolysis of phytate to inorganic monophosphate, free esters of myo-inositol, and free myo-inositol, making P available for absorption in both plants and animals **(Haefner *et al.*, 2005).**

An important part of the carbohydrates that reach the intestine of birds are non starch polysaccharides (NSP). Non starch polysaccharides are not digested due to the presence of ß-glycosidic bonds between the NSP building monosaccharides what makes them resistant from degradation by intrinsic digestive enzymes**.** Exogenous enzymes capable of degrading NSP in broiler diets based on 'viscous' grains, including wheat and barley **(Bedford and Schulze, 1998)**. Microbial phytase can chemically hydrolyze 97% of the P from phytate in soybean meal (**Nelson *et al.,* 1968).** On the other hand, the beneficial effect of exogenous phytase enzyme on the productive performance of the bird is mainly related to the release of minerals and trace elements from complexes with dietary phytic acid, and increase in digestibility and availability of macro- and micro-elements **(Cowieson *et al.,* 2004)**. **Waldroup *et al.* (2000)** demonstrated that phytase supplementation to low available phosphorus containing-diet maintained livability and improved growth and feed conversion (FC) of broiler. Also, **Ragab *et al.* (2013)** reported that broilers fed a P-deficient C-SBM diet with phytase supplementation had improved live body weight gain (LBWG), FC and performance index (PI) compared with those fed un-supplemented diet, but differences were not significant.

Therefore, the purpose of the present study was to determine the influence of reducing dietary phosphate with or without phytase supplementation on growth performance, mortality rate, carcass parameters, blood serum parameters and economical efficiency of broiler chicks.

MATERIALS AND METHODS

This study was carried out at the Poultry Research Station, El-Azab, Fayoum, Egypt during the period from June to August 2011. Chemical analyses were performed in the laboratories of the Poultry Research Station, Poultry Production Department, Faculty of Agriculture, Fayoum University. This experiment was conducted to study the effect of using three levels of AP (recommended (R), R-0.25 and R-0.50%) and each with two levels (0.00 and 0.10%) of microbial phytase in 3 x 2 factorial arrangement (giving six dietary treatments) on growth, feed utilization and economical efficiency of broiler chicks. Accordingly**,** a total numbers of 144 one-day old unsexed Ross broiler chickens were initially fed a control diet for four days.

The experimental treatments were as follows:

1. Chicks were fed the control diet (C). **2**.C+0.1% phytase. **3**.C–25% AP.
4. C–25% AP+ 0.1% phytase. **5**.C–50% AP. **6**.C–50% AP +0.1% phytase.

At five days of age, birds were divided into six treatments (24 birds each), each treatment contained three replicates of eight birds each. Chicks were raised in electrically heated batteries with raised wire mesh floors and had a free access of feed and fresh water from nipple drinkers (2 nipples/cage) throughout the experiment. The composition and calculated analysis of the experimental diets (without phytase supplementation) are presented in Table (1). The experimental diets were supplemented with minerals and vitamins mixture, DL-methionine and L-Lysine HCl to cover the recommended requirements according to the strain catalog recommendations and were formulated to be iso-nitrogenous.

Table 1: Composition and analyses of the experimental diets.

Items	Starter (5-11 days)			Grower (12-23 days)			Finisher (24-42 days)		
	Control (Con.)	Con. -25% AP	Con. -50% AP	Control (Con.)	Con. -25% AP	Con. -50% AP	Control (Con.)	Con. -25% AP	Con. -50% AP
Triticale, ground	57.00	58.00	58.00	61.00	62.00	62.00	63.08	64.00	64.00
Soybean meal	24.87	25.01	24.85	18.20	17.88	17.69	19.24	19.27	19.31
Corn glutein meal	8.44	8.23	8.21	9.86	9.89	9.89	5.89	5.76	5.62
Wheat bran	0.67	0.34	0.88	0.80	0.65	1.17	0.72	0.43	0.83
Calcium carbonate	1.55	1.79	2.04	1.39	1.62	1.83	1.35	1.56	1.77
Sodium chloride	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Vit. and Min. premix [1]	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Monocalcium phosphate	1.73	1.13	0.55	1.56	1.00	0.49	1.42	0.90	0.40
Vegetable oil [2]	4.41	4.17	4.14	6.00	5.76	5.73	7.37	7.15	7.14
DL–Methionine	0.27	0.27	0.27	0.17	0.17	0.17	0.11	0.11	0.11
L-Lysine HCl	0.46	0.46	0.46	0.42	0.43	0.43	0.22	0.22	0.22
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Calculated analysis[3]:									
Crude protein	23.50	23.50	23.50	22.00	22.00	22.00	20.00	20.00	20.00
Ether extract	5.68	5.44	5.42	7.23	6.99	6.97	8.54	8.31	8.31
Linoleic acid	2.99	2.87	2.85	3.89	3.76	3.75	4.69	4.57	4.56
Crude fiber	3.75	3.76	3.82	3.66	3.67	3.72	3.73	3.74	3.79
Calcium (Ca)	1.00	1.00	1.00	0.90	0.90	0.90	0.85	0.85	0.85
Available phosphorus (AP)	0.50	0.38	0.25	0.45	0.34	0.23	0.42	0.31	0.21
Ca/AP ratio	2.00	2.66	3.93	1.99	2.68	3.92	2.01	2.70	4.05
Methionine	0.69	0.69	0.69	0.59	0.59	0.59	0.48	0.48	0.48
Methionine+Cystine	1.09	1.09	1.09	0.97	0.97	0.97	0.83	0.83	0.83
Lysine	1.44	1.44	1.44	1.25	1.25	1.25	1.05	1.05	1.05
ME, Kcal./Kg	3010.6	3010.0	3010.0	3175.0	3175.2	3175.0	3225.2	3225.0	3225.0
Cost (£.E./ton) [4]	2464.4	2415.0	2380.6	2478.1	2435.0	2404.6	2367.0	2324.3	2293.5
Relative cost [5]	100.00	98.00	96.60	100.00	98.26	97.04	100.00	98.20	96.89

[1] Each 3.0 Kg of the Vit. and Min. premix manufactured by Agri-Vet Company, Egypt and contains : Vit. A, 12000000 IU; Vit. D_3 2000000 IU; Vit. E, 10 g; Vit. K_3, 2.0 g; Vit. B1, 1.0 g; Vit. B2, 5 g; Vit. B6, 1.5 g; Vit. B12,10 mg; choline chloride, 250 g; biotin, 50 mg; folic acid, 1 g; nicotinic acid , 30 g; Ca pantothenate, 10 g; Zn, 50 g; Cu,10 g; Fe, 30 g; Co, 100 mg; Se, 100 mg; I, 1 g; Mn, 60 g and anti-oxidant, 10 g, and complete to 3.0 Kg by calcium carbonate. [2] Mixture from 75% soybean oil and 25% sunflower oil. [3] According to **NRC, 1994** (except triticale and soybean meal were analysis before start the experiment). [4] According to the local market price at the experimental time. [5] Assuming the price of the control group equal 100.

Phytase used in this study were purchased from Sigma Chemical Co. (Natuphos 500 BASF Corp., Mt. Live, Nj) source also had 10.000 unit active phytase per gram.

Batteries were placed into a room provided with a continuous light (23 h/d up to 42 days of age) and fans for ventilation. The experimental birds were reared under similar environmental conditions (open system), and were fed starter diet from five to 11 day, grower diet from 12 to 23 day, and finisher diet from 24 day to the end of the experiment at 42 day of age (triticale-soy bean meal basal diet).

The tested raw material was analyzed for moisture, crude protein (CP), ether extract (EE), crude fiber (CF), ash, nitrogen free extract (NFE)% and metabolizable energy (ME) Kcal/Kg, by the methods outlined by Association of Official Analytical Chemists, **A.O.A.C. (1990)**. The determined chemical analysis of triticale grains (the triticale grains used in the present study were obtained from the Agricultural Research Center, Ministry of Agriculture, Dokki, Egypt, then grown locally in Fayoum Governorate (yield, 2010) showed that triticale grains contained, 10.19, 12.51, 0.99, 4.06, 1.85, 70.40% and 2999.95 for moisture, CP, EE, CF, ash, NFE% and ME Kcal/Kg, respectively (the ME value was calculated according to **Janssen, 1989** by applying the equation:

Triticale MEn(Kcal/kg)=(34.49×CP)+(62.16×EE)+(35.61×NFE). And soy bean meal contained, 10.10, 42.01, 1.89, 4.47, 2.53, 39.00% and 2230.0 for moisture, CP, EE, CF, ash, NFE% and ME Kcal/Kg (the ME value was calculated according to **NRC, 1994**), respectively.

The vaccination program adopted by recommended requirements according to standard commercial guidelines. Birds were individually weighed to the nearest gram at 5,11,23 and 42 days of age intervals during the experimental period. At the same time, feed consumption was recorded and LBWG and FC (g feed/g gain) were calculated. Crude protein conversion (CPC), caloric conversion ratio (CCR) and growth rate (GR) were also calculated as follows: $GR_{5\text{-}42}=(LBW_{42}–LBW_5)/0.5(LBW_{42} + LBW_5)$. Performance index (PI) was calculated according to the equation described by North (1981) as follows: PI = (LBW, Kg/FC) x100. Accumulative mortality rate was obtained by adding the number of dead birds during the experiment divided by the total number of chicks at the beginning of the experimental period (mortality% was within normal limits and not related to treatments studied).

At the end of the finishing period (42 days of age), slaughter tests were performed using three chicks around the average LBW of each treatment. The birds were on feed withdrawal overnight (approximately 12h), then individually weighed to the nearest gram, and slaughtered by severing the jugular vein (Islamic method). After four minutes bleeding time, each bird was dipped in a water bath for two minutes, and feathers were removed. After the removal of head, carcasses were manually eviscerated to determine some carcass traits, dressing% (eviscerated carcass without head, neck and thighs) and total giblets% (gizzard empty, liver, heart and spleen). The eviscerated weight included the front part with wing and rear part.

The abdominal fat was removed by hand from the parts around the viscera and gizzard, and was weighed to the nearest gram. The bone of front and rear were separated and weighed to calculate meat percentage. The meat from each part was weighed and blended using a kitchen blender. Also, individual blood samples were taken from three birds. The biochemical characteristics of blood were determined colorimetrically, using commercial kits.

The economic efficiency was calculated as the price of body weight gain–total costs of raising a broiler as relative to total raising costs which was estimated based upon local current prices at the experimental time. Statistical analysis of results was performed using the General Linear Models (GLM) procedure of the SPSS software (version 16, SPSS Inc., Chicago, IL), according to the follow general model:

$$\mathbf{Y_{ijk} = \mu + L_i + P_j + LP_{ij} + e_{ijk}}$$

Where:

Y_{ijk}: observed value   **μ:** overall mean

L_i: level of AP effect (**i**: recommended (R), R-0.25 and R-0.50%)

P_j: phytase level effect (**j**: 0.0 and 0.1%)

LP_{ij}: interaction of level of AP effect by phytase level effect

e_{ijk}: random error

Treatment means indicating significant differences (P≤0.01 and P≤0.05) were tested using Duncan's multiple range test **(Duncan, 1955)**.

RESULTS AND DISCUSSION

Productive performance: Impact of phytase supplementation to triticale diets varying in their phosphorus content on live body weight (LBW), LBWG and FI are shown in Table 2. Data presented in Table (2) indicate the main effects of level of AP was significant (P≤0.01 and P≤0.05) for LBW at 23 and 42 days, LBWG during the periods from 12 to 23 and 5 to 42 days of age and FI during all periods studies (Table 2). Chicks fed recommended level (R) -25% AP had higher LBW at 23 and 42 days and LBWG during the periods from 12 to 23 and 5 to 42 days of age, while, chicks fed recommended level of AP had lower values LBW at 23 days and LBWG during the period from 12 to 23 days of age. Chicks fed recommended level -50% AP had lower values LBW at 42 days and LBWG during the period from 5 to 42 days of age (differences between R and R-50% AP were not significant).

Table 2: Effect of phytase supplementation to triticale diets varying in their phosphorus content on live body weight (LBW, g), live body weight gain (LBWG, g) and feed intake (FI, g).

Items		LBW, g (age/days)				LBWG, g (age period/days)				FI, g (age period/days)			
		5	11	23	42	5-11	12-23	24-42	5-42	5-11	12-23	24-42	5-42
Level of AP[1] (L):													
Recommended (R)		114.84	198.57	665.3^{B}	1606.7^{ab}	83.73	464.6^{B}	903.78	1491.8^{ab}	123.44^{B}	923.66^{C}	1877.4^{AB}	2928.1^{b}
R-25% AP		115.63	197.25	754.9^{A}	1740.1^{a}	87.38	555.9^{A}	948.59	1619.2^{a}	128.61^{A}	985.21^{B}	1945.4^{A}	3057.7^{a}
R-50% AP		114.73	196.54	709.6^{AB}	1540.8^{b}	83.66	514.1^{AB}	793.75	1422.2^{b}	128.64^{A}	1023.7^{A}	1777.3^{B}	2929.6^{b}
±SEM[2]		2.60	6.39	19.62	57.10	3.98	17.42	49.78	53.60	0.84	7.26	36.66	36.41
Phytase addition (Ph)%:													
0.00 (Un-supplemented)		114.85	196.43	669.9^{B}	1589.5	81.58	473.1^{B}	877.83	1470.2	125.81^{b}	932.30^{B}	1939.4^{A}	2999.5
0.10		115.28	198.48	750.0^{A}	1668.9	88.27	550.0^{A}	886.25	1551.9	127.98^{a}	1022.8^{A}	1793.9^{B}	2944.1
±SEM		2.12	5.21	16.34	47.48	3.25	14.31	39.02	44.57	0.68	5.93	30.48	30.28
L × Ph% (treatments):													
R	0.00	114.17	197.53	642.9	1555.3	83.95^{ab}	442.8	871.06	1445.3	121.01^{B}	923.21^{C}	2011.5^{A}	3069.7^{A}
	0.10	114.79	198.21	682.1	1655.3	83.42^{ab}	483.9	932.56	1541.8	126.64^{A}	919.71^{C}	1746.3^{B}	2791.1^{B}
R-25% AP	0.00	115.49	190.93	677.8	1750.3	75.44^{b}	489.9	1029.4	1627.2	128.57^{A}	930.79^{C}	2061.8^{A}	3118.1^{A}
	0.10	115.76	203.57	832.1	1730.0	99.32^{a}	621.9	867.80	1611.3	128.64^{A}	1039.6^{B}	1829.0^{B}	2997.3^{A}
R-50% AP	0.00	114.18	199.43	683.4	1460.2	85.25^{ab}	483.9	729.10	1341.7	128.64^{A}	938.50^{C}	1748.0^{B}	2815.1^{B}
	0.10	115.27	193.64	735.8	1621.3	82.06^{ab}	544.2	858.40	1502.8	128.64^{A}	1108.9^{A}	1806.5^{B}	3044.0^{A}
±SEM		3.67	9.03	27.23	76.14	5.63	24.17	66.37	75.81	1.18	10.27	51.85	51.50

a, …b, and A,.. C, values in the same column within the same item followed by different superscripts are significantly different (at $P \leq 0.05$ for a to b; $P \leq 0.01$ for A to C). [1]Available phosphorus [2] Pooled SEM

However, level of AP had insignificant effect on LBW at 5 and 11 days of age and LBWG during the periods from 5 to 11 and 24 to 42 days. Chicks fed recommended level of AP had lower FI during the periods from 5 to 11, 12 to 23 and 5 to 42 days and those fed R-50% AP had lower FI during the period from 24 to 42 days, however, chicks fed R-50% AP had higher FI values during the periods from 5 to 11 and 12 to 23 days of age and those fed R-25% AP had higher FI during the other periods studied (Table 2).

Inclusion of phytase in broiler diet at 0.1% caused a significant ($P \leq 0.01$) increase in LBW at 23 days and LBWG during the period from 12 to 23 days of age. Numerically, as shown in Table 2, phytase supplementation increase LBW and LBWG during all experimental periods studied compared with those fed phytase un-supplement diet (0.0%), however, these did not reach a level of statistical significance (the improvement in LBW and LBWG may be due to the effect of phytase on the utilization of minerals affecting growth).

Data presented in Table (2) indicate the main effects of phytase supplementation on FI of broilers. The results cleared that chicks fed phytase supplement diets recorded significantly ($P \leq 0.05$ and $P \leq 0.01$) higher FI values during the periods from 5 to 11 and 12 to 23 days than those fed phytase un-supplement diets (0.0%). Although, no significant differences were found in FI between chicks fed phytase supplement (0.1%) diets and those given phytase un-supplement diets during the period from 5 to 42 days. Interaction due to level of AP x phytase level (experimental treatments) insignificantly ($P > 0.05$) affected LBW and LBWG during all periods studied except, the period from 5 to 11 days which was significantly ($P \leq 0.05$) affected (Table 2).

Interaction due to level of AP x phytase level had significant for FI during all periods studied (Table 2). Chicks fed R-25% AP un-supplement diets with phytase had higher FI during the periods from 24 to 42 and 5 to 42 days (differences between R-25% AP un-supplement diets with phytase and recommended level of AP un-supplement diets with phytase were not significant), while, chicks fed recommended level of AP with phytase supplement diets had lower FI values during the same periods.

It can be concluded that AP can be reduced from the recommended level by -50% and supplement these diet with phytase without affecting LBW, LBWG and FI.

Data presented in Table (3) indicate the main effects of level of AP insignificantly affected FC and CPC during all periods studied, while, level of AP was significant ($P \leq 0.01$ and $P \leq 0.05$) for CCR during the periods from 12 to 23 and 5 to 42 days of age. Chicks fed recommended level of AP had the worst CCR value during the previous periods, and those fed R-25% AP had the best CCR value during the same periods. Neither phytase level nor interaction between level of AP with phytase level had any significant effect on FC, CPC and CCR during all periods studied. Numerically, results indicated that dietary supplementation with phytase improved FC, CPC and CCR during all periods studied (this may be partially attributed to significantly lower FI of phytase supplemented groups and the improved CCR could be attributed to calories released from hydrolyses of phytate molecule upon phytase addition), however, these did not reach a level of statistical significance (Table 3). These results are in harmony with those obtained by **Sebastian *et al.* (1998)** who reviewed the effect of phytate molecule on protein and energy utilization and its inhibitory effects on proteolytic and energetic enzymes such as pepsin, trypsin and α-amylase and concluded that phytase improved protein and energy utilization of chicken diets. On the other hand, **Cowieson *et al.* (2004)** reported that phytate significantly increased the excretion of total endogenous amino acids in broilers (112 mg/bird/48 h *versus* 87 mg/bird/48 h), which was ameliorated by phytase. Also, probably revealing an increase in the ME availability due to NSP-splitting enzyme. Cell-wall splitting enzymes were reported to improve ME value of cereals containing-diet i.e. rye, wheat, barley, triticale for broilers and ducklings **(Attia *et al.,* 2001)**.

Impact of phytase supplementation to triticale diets varying in their phosphorus content on GR and PI are shown in Table 4. Main effects of level of AP was significant ($P \leq 0.01$ and $P \leq 0.05$) for GR and PI during the period from 12 to 23 days of age (Table 4). Chicks fed recommended level -25% AP had higher GR and PI during the previous period (differences between R-25% AP and R-50% AP were not significant).

Table 3: Effect of phytase supplementation to triticale diets varying in their phosphorus content on feed conversion (FC), crude protein conversion (CPC) and caloric conversion ratio (CCR).

Items		FC (age period/days)				CPC (age period/days)				CCR (age period/days)			
		5-11	12-23	24-42	5-42	5-11	12-23	24-42	5-42	5-11	12-23	24-42	5-42
Level of AP[1] (L):													
Recommended (R)		1.60	2.07	2.18	1.99	0.375	0.454	0.436	0.406	4.80	6.56[A]	7.04	5.91[a]
R-25% AP		1.60	1.84	2.16	1.92	0.375	0.404	0.433	0.392	4.33	5.29[B]	6.34	5.16[b]
R-50% AP		1.65	2.04	2.41	2.13	0.389	0.449	0.482	0.417	4.48	5.87[B]	7.05	5.52[ab]
±SEM[2]		0.10	0.08	0.15	0.08	0.02	0.02	0.03	0.01	0.21	0.22	0.43	0.19
Phytase addition (Ph)%:													
0.00 (Un-supplemented)		1.67	2.04	2.36	2.09	0.392	0.448	0.472	0.414	4.68	6.07	7.14	5.66
0.10		1.56	1.93	2.15	1.94	0.367	0.424	0.429	0.397	4.40	5.74	6.47	5.40
±SEM		0.08	0.06	0.12	0.06	0.02	0.01	0.02	0.01	0.23	0.18	0.35	0.15
L × Ph% (treatments):													
R	0.00	1.56	2.19	2.39	2.13	0.366	0.479	0.475	0.418	4.69	6.81	7.77	6.10
	0.10	1.64	1.97	1.97	1.84	0.386	0.434	0.393	0.399	4.94	6.26	6.34	5.75
R-25% AP	0.00	1.84	1.95	2.07	1.94	0.433	0.429	0.414	0.406	4.99	5.60	6.06	5.31
	0.10	1.35	1.73	2.26	1.91	0.318	0.380	0.452	0.378	3.66	4.97	6.61	5.01
R-50% AP	0.00	1.62	2.00	2.61	2.17	0.380	0.440	0.522	0.421	4.38	5.75	7.63	5.60
	0.10	1.69	2.08	2.21	2.08	0.398	0.458	0.442	0.414	4.59	5.98	6.46	5.45
±SEM		0.14	0.11	0.20	0.11	0.03	0.02	0.04	0.02	0.39	0.31	0.60	0.25

a, …b, and A,.. B, values in the same column within the same item followed by different superscripts are significantly different (at P≤0.05 for a to b; P≤0.01 for A to B). [1]Available phosphorus [2] Pooled SEM while, chicks fed recommended level of AP had lower values GR and PI during the same period. However, no significant differences were detected in GR and PI during the other periods studied (Table 4). Inclusion of phytase in broiler diet at 0.1% caused a significant increase in GR (P≤0.01) during the period from 12 to 23 days of age and PI (P≤0.05) during the periods from 12 to 23 and 5 to 42 days of age. Numerically, as shown in Table 4, phytase supplementation to broiler diets improved PI during all periods studied compared with those fed phytase un-supplement diet, but differences were not significant (Table 4).

Table 4: Effect of phytase supplementation to triticale diets varying in their phosphorus content on growth rate (GR) and performance index (PI).

Items		GR (age period/days)				PI (age period/days)			
		5-11	12-23	24-42	5-42	5-11	12-23	24-42	5-42
Level of AP[1] (L):									
Recommended (R)		0.529	1.07^{B}	0.779	0.808	13.73	34.29^{b}	79.67	44.10
R-25% AP		0.523	1.16^{A}	0.745	0.811	14.47	43.55^{a}	86.48	49.73
R-50% AP		0.529	1.14^{A}	0.684	0.787	13.36	36.74^{ab}	70.85	42.72
±SEM[2]		0.02	0.02	0.03	0.01	0.94	2.35	5.86	2.45
Phytase addition (Ph)%:									
0.00 (Un-supplemented)		0.518	1.09^{B}	0.754	0.795	13.16	34.87^{b}	73.62	42.44^{b}
0.10		0.535	1.15^{A}	0.718	0.809	14.55	41.52^{a}	84.38	48.60^{a}
±SEM		0.02	0.02	0.02	0.01	0.77	1.93	4.88	2.01
L × Ph% (treatments):									
R	0.00	0.530	1.04	0.779^{ab}	0.801	14.17^{ab}	31.90	69.05	39.92
	0.10	0.528	1.09	0.778^{ab}	0.815	13.28^{ab}	36.68	90.28	48.29
R-25% AP	0.00	0.487	1.13	0.829^{a}	0.811	11.66^{b}	36.41	88.63	47.41
	0.10	0.558	1.19	0.660^{b}	0.812	17.27^{a}	50.70	84.33	52.06
R-50% AP	0.00	0.538	1.09	0.653^{b}	0.771	13.63^{ab}	36.29	63.17	39.98
	0.10	0.520	1.18	0.715^{ab}	0.802	13.09^{ab}	37.18	78.53	45.45
±SEM		0.03	0.03	0.04	0.02	1.33	3.27	8.29	3.37

a, …b, and A,.. B, values in the same column within the same item followed by different superscripts are significantly different (at P≤0.05 for a to b; P≤0.01 for A to B). [1]Available phosphorus [2] Pooled SEM

Interaction due to level of AP x phytase level had insignificantly (P>0.05) affected GR and PI during all periods studied except, GR during the period from 24 to 42 days and PI during the period from 5 to 11 days which were significantly (P≤0.05) affected (Table 4). Numerically, as shown in Table 4, all dietary treatments improved PI during the overall period studied compared with those fed control diet (but differences were not significant) and faster growth was associated with more efficient utilization of feed in phytase fed groups.

It can be concluded that AP can be reduced from the recommended level by -50% and supplement these diet with phytase without affecting performance. Similar results were reported by **Sohail and Roland (1999)** who studied the effects of three levels of phytase (0, 300, and 600 phtase units (FTU)/kg) in broilers fed two levels of AP (0.225 and 0.325%).

They reported a decrease in LBW and FI in broilers fed the 0.225%P diet and the inclusion of phytase regardless of level negated the effects on growth and bone variables. Further, **Singh and Khatta (2003)** who reported that addition of microbial phytase to low P broiler diets significantly improved the LBWG, FI and FC and that improvement was dependent on the level of phytase added. Similarly, **Cowieson *et al.* (2006) and Ravindran *et al.* (2006)** reported that supplementation of microbial phytase to P-inadequate diets enhances performance**.** Moreover, **Ragab *et al.* (2013)** studied the effects of three levels of AP (0.0,–25% AP and –50% AP) with two levels of phytase supplementation (0.0 and 0.1%) in broilers diets. They reported improve in LBW, LBWG, FC and PI compared with those fed un-supplemented diet, but differences were not significant. In this respect, **Musapuor *et al.* (2006)** reported that dietary phytase caused a significant improvement in FI and FC. The present results disagree with the findings of **Mulyantini *et al.* (2004)** who showed that phytase supplementation to broiler diets did not show any changes in performance. Also, **Denbow *et al.* (1995)** reported that FC was unaffected by phytase addition. However, **Broz *et al.* (1994)** found that inclusion of phytase (125, 250 or 500 FTU/kg) in broiler diets increased growth rate and FI, but had no effect on FC. Likewise, **Angel *et al.* (2005)** reported that broilers fed very low level of dietary P had depressed LBWG and even with an excess activity of supplemental phytase, LBWG was not equivalent to controls with NRC-recommended P levels **(NRC, 1994)** in their diets. Also, **Peter and Baker (2001) and Augspurger and Baker (2004)** finding that phytase was found to have no effect on protein utilization by using purified diets.

Slaughter parameters%: As shown in Table 5, no significant differences due to level of AP on slaughter parameters%, except, carcass weight after evisceration ($P \leq 0.05$) and dressing which were significantly ($P \leq 0.01$) affected.

Table 5: Effect of phytase supplementation to triticale diets varying in their phosphorus content on some slaughter parameters%.

Items		Live body weight (g)	Slaughter parameters%									
			Total giblets	Abdominal fat	Breast bone	Rear bone	Breast meat	Rear meat	Carcass weight after evisceration	Dressing	Bursa	Thymus
Level of AP[1] (L):												
Recommended (R)		1613.8	4.85	1.69	13.57	16.47	86.43	83.53	64.46^{a}	69.31^{A}	0.07	0.35
R-25% AP		1879.5	4.65	1.57	13.62	14.73	86.38	85.27	63.59^{a}	68.24^{A}	0.13	0.46
R-50% AP		1719.5	4.67	1.86	14.10	15.43	85.90	84.57	61.40^{b}	66.07^{B}	0.13	0.42
±SEM[2]		65.40	0.17	0.28	0.58	0.72	0.58	0.71	0.56	0.50	0.03	0.05
Phytase addition (Ph)%:												
0.00 (Un-supplemented)		1643.2^{b}	4.77	1.47	14.01	15.71	85.99	84.30	62.87	67.64	0.09	0.43
0.10		1841.0^{a}	4.67	1.95	13.52	15.38	86.48	84.62	63.43	68.10	0.12	0.40
±SEM		53.40	0.14	0.23	0.47	0.58	0.47	0.58	0.46	0.41	0.02	0.04
L × Ph% (treatments):												
R	0.00	1518.0	4.89	1.95	14.02	16.08	85.38	83.52	64.14	69.22	0.07	0.36
	0.10	1716.5	4.82	1.41	13.02	16.75	86.98	83.25	64.38	69.20	0.07	0.34
R-25% AP	0.00	1823.5	4.46	1.45	13.83	14.52	86.17	85.48	64.08	68.54	0.10	0.51
	0.10	1935.5	4.83	1.69	13.41	14.94	86.59	85.06	63.11	67.94	0.16	0.41
R-50% AP	0.00	1568.0	4.98	0.99	14.09	16.41	85.91	83.59	59.99	64.97	0.12	0.40
	0.10	1871.0	4.36	2.73	14.12	14.45	85.88	85.55	62.80	67.16	0.14	0.45
±SEM		92.49	0.24	0.39	0.82	1.01	0.82	1.01	0.79	0.71	0.04	0.07

a, …b, and A,.. B, values in the same column within the same item followed by different superscripts are significantly different (at $P\leq0.05$ for a to b; $P\leq0.01$ for A to B). [1]Available phosphorus [2] Pooled SEM

It can be concluded that, chicks fed recommended level of AP had higher values carcass weight after evisceration and dressing% (differences between R and R-25% AP were not significant). Chicks fed recommended level -50% AP had lower values. Neither phytase level nor interaction between level of AP with phytase level had any significant effect on slaughter parameters% (Table 5). Similarly, **Ebrahimnezhad *et al.* (2008)** and **Ragab *et al.* (2013)** reported that supplementation of diet with phytase had no effect on liver, spleen and abdominal fat relative weight. However, **Pillai *et al.* (2006)** reported that broilers fed P deficient diets supplemented with phytase had increased breast and leg yield when compared to broilers fed the P adequate diet. Differences in dressing and front parts paralleled the variations in chicks body weight as larger birds produce carcasses of higher dressing percentage compared to lean birds **(Attia *et al.,* 2001). Kornegay *et al.* (1998)** found that microbial phytase restored breast meat yield to the level of the positive control group.

Blood constituents: As shown in Table 6, no significant ($P>0.05$) differences were detected in blood constituents due to level of AP, phytase level and interaction due to level of AP x phytase level. Numerical improvements in white blood cells count (WBCs), red blood cells count (RBCs) hemoglobin (HGB, g/dL), hematocrit (HCT%), mean corpuscular hemoglobin **(**MCH) and mean corpuscular volume concentration (MCHC%) were frequently observed when phytase was added and all experimental treatments improved WBCs ($P>0.05$) during the period from 5 to 42 days of age as compared with control diet however, these did not reach a level of statistical significance. In this regard, **Ragab *et al.* (2013)** reported that broiler chicks fed diet un-supplemented with phytase had higher values of hemoglobin and RBCs, (lower values of MCV and MCH), while, those fed diet supplemented with 0.1% phytase had lower values of hemoglobin and RBCs (higher values of MCV and MCH).

Correlation coefficients estimate: As shown in Table 7, phytase level had significant positive correlation with PI ($P\leq0.01$) at the end of experimental period. Regardless of level of AP and phytase level، LBW had positive correlation with LBWG, FI, PI and GR ($P\leq0.01$). Whereas, LBW negatively correlated with each of FC, CPC and CCR ($P\leq0.01$). Also, LBWG had positive correlation with FI, PI and GR ($P\leq0.01$), however, correlation coefficient of negative nature was observed among

LBWG and FC, CPC and CCR ($P \leq 0.01$). Results showed that correlation coefficient of positive nature was observed among FI with GR, whereas, relationship between FC with CPC and CCR was positive ($P<0.01$). Significant negative correlation was observed between each of CPC and CCR with PI and GR ($P \leq 0.01$). Higher PI is correlated (significant positive) with higher GR ($P \leq 0.01$) during the over all period, as illustration in Table 7.

Table 6: Effect of phytase supplementation to triticale diets varying in their phosphorus content on some blood parameters.

Items		White blood cells count ($10^3/mm^3$)	Red blood cells count ($10^6/mm^3$)	Hemoglobin (g/dL)	Hematocrit (HCT)%	Mean corpuscular volume (MCV) μ^2	Mean corpuscular hemoglobin (MCH) $\mu\mu g$	Mean corpuscular hemoglobin concentration (MCHC)%
Level of AP[1] (L):								
Recommended (R)		**14.55**	**2.43**	**10.90**	**35.70**	**146.75**	**44.83**	**30.55**
R-25% AP		**15.20**	**2.43**	**11.13**	**37.03**	**153.00**	**45.90**	**30.05**
R-50% AP		**13.95**	**2.28**	**10.33**	**34.05**	**149.25**	**45.15**	**30.23**
±SEM[2]		**1.18**	**0.14**	**0.67**	**1.97**	**1.43**	**0.63**	**0.45**
Phytase addition (Ph)%:								
0.00 (Un-supplemented)		**13.63**	**2.28**	**10.28**	**34.17**	**149.83**	**45.07**	**30.07**
0.10		**15.50**	**2.48**	**11.28**	**37.02**	**149.50**	**45.52**	**30.48**
±SEM		**0.96**	**0.11**	**0.55**	**1.63**	**1.17**	**0.51**	**0.37**
L × Ph% (treatments):								
R	**0.00**	**12.48**	**2.35**	**10.72**	**35.09**	**145.00**	**45.75**	**30.75**
	0.10	**16.60**	**2.49**	**11.05**	**36.35**	**146.50**	**44.50**	**30.40**
R-25% AP	**0.00**	**14.45**	**2.28**	**10.55**	**35.20**	**155.00**	**46.50**	**30.00**
	0.10	**15.95**	**2.58**	**11.70**	**38.85**	**151.00**	**45.30**	**30.10**
R-50% AP	**0.00**	**13.95**	**2.19**	**9.55**	**32.25**	**147.50**	**43.55**	**29.50**
	0.10	**13.95**	**2.37**	**11.10**	**35.85**	**151.00**	**46.75**	**30.95**
±SEM		**1.67**	**0.19**	**0.95**	**2.82**	**2.02**	**0.88**	**0.64**

[1]Available phosphorus [2] Pooled SEM

Table 7: Correlation coefficients between live body weight (LBW), live body weight gain (LBWG), feed intake (FI), feed conversion (FC), crude protein conversion (CPC), caloric conversion ratio (CCR), performance index (PI), growth rate (GR), level of available phosphorus (LAP) and phytase% of broiler fed phytase supplementation to triticale diets varying in their phosphorus content.

Items	**LBW**	**LBWG**	**FI**	**FC**	**CPC**	**CCR**	**PI**	**GR**
LAP	**-0.128**	**-0.134**	**0.006**	**0.191**	**0.092**	**-0.176**	**-0.075**	**-0.196**
Phytase%	**0.181**	**0.186**	**-0.091**	**-0.217**	**-0.161**	**-0.164**	**0.294***	**0.175**
LBW		**0.999****	**0.464****	**-0.902****	**-0.792****	**-0.807****	**0.945****	**0.832****
LBWG			**0.461****	**-0.906****	**-0.787****	**-0.802****	**0.941****	**0.854****
FI				**-0.104**	**-0.191**	**-0.224**	**0.231**	**0.384****
FC					**0.829****	**0.817****	**-0.903****	**-0.819****
CPC						**0.945****	**-0.830****	**-0.705****
CCR							**-0.837****	**-0.684****

PI		0.722**

** Correlation is significant at the 0.01 level. * Correlation is significant at the 0.05 level

As shown in Table 8, WBCs had significant positive correlation with RBCs, HGB (g/dL) and HCT% ($P \leq 0.05$). Also, RBCs had significant positive correlation with HGB and HCT% ($P \leq 0.01$), HGB (g/dL) with HCT% ($P \leq 0.01$). Significant positive correlation was observed between MCH and MCHC% ($P \leq 0.01$).

Table 8: Correlation coefficients between white blood cells count (WBC), red blood cells count (RBC), hemoglobin (HGB), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), level of available phosphorus (LAP) and phytase % of broiler fed phytase supplementation to triticale diets varying in their phosphorus content**.**

Items	WBC	RBC	HGB	HCT	MCV	MCH	MCHC
LAP	-0.114	-0.272	-0.204	-0.196	0.282	0.094	-0.167
Phytase%	0.434	0.427	0.434	0.415	-0.046	0.159	0.262
WBC		0.653*	0.596*	0.660*	0.066	0.061	0.059
RBC			0.964**	0.971**	-0.114	0.207	0.385
HGB				0.972**	0.045	0.459	0.535
HCT					0.123	0.338	0.324
MCV						0.571	-0.226
MCH							0.668*

** Correlation is significant at the 0.01 level. * Correlation is significant at the 0.05 level.

Economical efficiency (EEf): Results in Table 9 showed that, EEf values during the period from 5 to 42 days of age improved in chicks fed all experimental diets as compared with those fed the control diet. Chicks fed diet containing recommended level of AP supplemented with 0.1% phytase had the best economical and relative efficiency values being 1.949 and 125.14%, respectively followed by chicks fed diet containing -25% AP supplemented with 0.1% phytase (1.921 and 123.36%, respectively) then chicks fed diet containing -25% AP unsupplemented with phytase (1.871 and 120.12%, respectively) as compared with those fed the control diet (the lowest corresponding values, being 1.557 and 100.00%, respectively). The relative efficiency varied between 100.00% to 125.14%, which is of minor importance relative to other factors of production. These results are in harmony with those obtained by **Bosch *et al.* (1998)** who utilized a Virginia farm as a model for investigating the economic benefits of incorporating phytase in poultry diets. They reported $1,435 in economic gains associated with the inclusion of phytase to turkey diets, due to increased sale of lower P litter that could be applied to farmland and to the reduction in dietary P supplementation. However, the optimal level of phytase is unknown because P equivalency of phytase can be affected by many factors such as dietary concentrations of phytate P, Ca and non phytate phosphorus, phytase inclusion levels, the source of exterior phytase and the level of endogenous phytase in the ingredients **(Selle and Ravindran, 2007).**

It would be concluded that, a satisfactory broiler performance and economic efficiency could be achieved by decreasing AP from the recommended level by 50% and supplement these diets with phytase (genetically, maintain the same performance as that obtained from chicks fed diets containing recommended level of AP). Besides, using such diets reduces feed cost and P pollution.

Table 9: Effect of phytase supplementation to triticale diets varying in their phosphorus content on economical efficiency (EEf).

Level of available phosphorus (AP)	Recommended (R)		R-25% AP		R-50% AP	
Phytase addition %	**0.00**	**0.10**	**0.00**	**0.10**	**0.00**	**0.10**
a_1	0.1210	0.1266	0.1286	0.1286	0.1286	0.1286
b_1	246.44	249.04	241.50	244.10	238.06	240.66
$a_1 \times b_1 = c_1$	29.821	31.538	31.050	31.401	30.624	30.959
a_2	0.9232	0.9197	0.9308	1.0396	0.9385	1.1089
b_2	247.81	250.41	243.50	246.10	240.46	243.06
$a_2 \times b_2 = c_2$	228.78	230.30	226.65	255.85	225.68	269.53
a_3	2.0115	1.7463	2.0618	1.8290	1.7480	1.8065
b_3	236.70	239.30	232.43	235.03	229.35	231.95
$a_3 \times b_3 = c_3$	476.13	417.89	479.23	429.87	400.90	419.01
$(c_1+c_2+c_3)=c_{total}$	734.72	679.73	736.92	717.12	657.20	719.50
d	1.4453	1.5418	1.6272	1.6113	1.3417	1.5028
e	1300.0	1300.0	1300.0	1300.0	1300.0	1300.0
d x e=f	1878.9	2004.3	2115.4	2094.7	1744.2	1953.6
f- c_{total} =g	1144.2	1324.6	1378.4	1377.6	1087.0	1234.1
Economical efficiency (g/ c_{total})	1.5573	1.9487	1.8705	1.9210	1.6540	1.7153
Relative efficiency (r)	**100.00**	**125.14**	**120.12**	**123.36**	**106.21**	**110.15**

a_1, a_2 and a_3 ....average feed intake (Kg/bird) during the periods of starter, grower and finisher, respectively.
b_1, b_2 and b_3 ...... price / Kg feed (P.T.) during the periods of starter, grower and finisher, respectively (based on average local market price of diets during the experimental time).
c_1, c_2 and c_3 .... feed cost (P.T.) during the periods of starter, grower and finisher, respectively.
Total feed cost (P.T.) = c_{total} = $(c_1+c_2+c_3)$
Average LBWG (Kg/ bird) d
Price / Kg live weight (P.T.) e................(according to the local market price at the experimental time).
Total revenue (P.T.) = d x e = f
Net revenue (P.T.) = f - c_{total} =g
Economical efficiency = (g / c_{total}) ....(net revenue per unit feed cost).
Relative efficiency r..........(assuming that economical efficiency of the control group (1) equals 100).

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الملخــص العــربي

تأثير إضافة الفيتيز علي أداء بداري التسمين المغذاة علي علائق الترتيكال المختلفة في محتواها من الفوسفور

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تم إجراء التجربة في محطة بحوث الدواجن بالعزب بالفيوم – معهد بحوث الإنتاج الحيواني – مركز البحوث الزراعية – وزارة الزراعة بالدقي – مصر. وذلك خلال الفترة من شهر يونيو إلى أغسطس لسنة ٢٠١١. غذيت الكتاكيت عمر يوم ولمدة ٤ أيام علي عليقة المقارنة وتم توزيع ١٤٤ كتكوت غير مجنس (سلالة روس) بصورة عشوائية إلى ست معاملات (٢٤ طائر/معاملة) كل معاملة مقسمة إلي ثلاثة مكررات (٨ طائر/مكرر). أستخدم ثلاث مستويات من الفوسفور المتاح ((المستوي الموصي به (م))، م-٠.٢٥ فوسفور متاح، م-٠.٥٠ فوسفور متاح) ومستويين من الفيتيز (صفر و ٠.١%) في تجربة عامليه ٣ x ٢ للحصول علي ٦ معاملات غذائية.

وتم تلخيص النتائج المتحصل عليها كما يلي :

١-**الأداء الإنتاجي:** هناك تأثير معنوي لمستوي الفوسفور المتاح علي وزن الجسم الحي ، الزيادة في وزن الجسم ،كمية الغذاء المأكول، كفاءة تحويل الطاقة خلال الفترة من ٥-٤٢ يوم، بينما لم يكن هناك أي تأثير معنوي علي معامل تحويل الغذاء وكفاءة تحويل البروتين ومعدل النمو ومعامل الأداء الإنتاجي. ارتفع معنويا وزن الجسم الحي (عند عمر ٤٢ يوم) والزيادة في وزن الجسم (خلال الفترة من ٥-٤٢ يوم) للكتاكيت المغذاة علي -٢٥% من الفوسفور المتاح عن الموصي به. كان للكتاكيت المغذاة علي علائق تحوي المستوي الموصي به من الفوسفور المتاح أسوء كفاءة لتحويل الطاقة بينما كان للكتاكيت المغذاة علي -٢٥% من الفوسفور المتاح عن الموصي به أحسن كفاءة لتحويل الطاقة خلال الفترة من ٥-٤٢ يوم. لم يكن هناك أي اختلافات معنوية بين كمية الغذاء المأكول للكتاكيت المغذاة علي علائق مضاف أو غير المضاف إليها فيتيز خلال الفترة من ٥-٤٢ يوم. أدي إضافة ٠.١% فيتيز لعلائق بداري التسمين إلي زيادة معنوية في معامل الأداء الإنتاجي خلال الفترة من ٥-٤٢ يوم. لم يكن هناك أي تأثير معنوي للتداخل بين كل من مستوي الفوسفور والفيتيز (المعاملات التجريبية) علي وزن الجسم الحي والزيادة في وزن الجسم ومعامل تحويل الغذاء وكفاءة تحويل البروتين والطاقة ومعدل النمو ومعامل الأداء الإنتاجي خلال الفترة من ٥-٤٢ يوم.

٢-**صفات الذبيحة ومكونات الدم:** لم يكن هناك أي تأثير معنوي لأي من مستوي الفوسفور والفيتيز أو للتداخل بين كل من مستوي الفوسفور علي كلا من صفات الذبيحة ومكونات الدم.

3-**تقدير معامل الارتباط**: ارتبط مستوي الفوسفور ارتباط معنوي موجب مع معامل الأداء الإنتاجي في نهاية الفترة التجريبية- بغض النظر عن مستوي كل من الفوسفور المتاح والفيتيز ارتبط وزن الجسم الحي ارتباط معنوي موجب مع معدل الزيادة وزن الجسم الحي وكمية الغذاء المأكول ومعامل الأداء الإنتاجي ومعدل النمو. بينما كان الارتباط سالب ومعنوياً بين كلا من كفاءة تحويل البروتين والطاقة مع معدل النمو ومعامل الأداء الإنتاجي. ارتبط اعلي معامل للأداء الإنتاجي ارتباط معنوي موجب مع معدل النمو خلال فترة التجربة. ارتبط عدد كرات الدم البيضاء ارتباط معنوي موجب مع عدد كرات الدم الحمراء، الهيموجلوبين، الهيماتوكريت. ارتبط عدد كرات الدم الحمراء ارتباط معنوي موجب مع الهيموجلوبين، الهيماتوكريت%.

٥-**الكفاءة الاقتصادية:** تحسنت الكفاءة الاقتصادية والنسبية للكتاكيت المغذاة علي كل العلائق التجريبية مقارنة بتلك التي غذيت على عليقة المقارنة.

يمكن استنتاج انه يمكن لتحقيق أفضل أداء لبداري التسمين وأحسن كفاءة اقتصادية ونسبية خفض نسبة الفوسفور المتاح حتي ٥٠% عن المستوي الموصي به مع إضافة الفيتيز (عموماً نفس الأداء لتلك الكتاكيت المغذاة على العلائق المحتوية علي المستوي المثالي من الفوسفور المتاح). بالإضافة إلى أن استخدام هذه العلائق يقلل من تكلفة الغذاء والتلوث بالفوسفور.