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EFFECT OF USING UNIFIED MIX OF CALCIUM AND PHOSPHORUS IN BROILER DIETS

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ABSTRACT: Five weeks feeding trial using 150 one-day old unsexed Hubbard broiler chicks was carried out to study the effect of feeding different levels of a unified mixture of calcium and phosphorus (*PhoCal Mix*) on productive performance, tibia measurements and economic efficiency of broilers. Five dietary treatments were applied within the present study, each group comprised of 30 chicks in 6 replicates of 5 chicks each. The control group (T1) was fed diets including ordinary Ca & available phosphorus (AP) sources and no *PhoCal Mix* was added, while other groups were fed *PhoCal Mix* as the only Ca & AP source. In that, (T2) fed *PhoCal Mix* 3.50%, (T3) fed *PhoCal Mix* 2.63%, (T4) fed *PhoCal Mix* 1.75% and (T5) fed *PhoCal Mix* 3.50% and 1.75% during starter and grower stages, respectively. Results showed that live body weight (LBW) and feed conversion ratio (FCR) during starter period was not significantly affected by using different levels of *PhoCal Mix*, while daily weight gain (DWG) and daily feed consumption (DFC) were significantly affected. Whereas, during grower period, LBW, DWG or FCR were not significantly affected by using different levels of *PhoCal Mix*. All carcass traits were not significantly affected by different dietary treatments. Plasma Ca and P levels and alkaline phosphatase (ALP) activity were not significantly affected by using different levels of *PhoCal Mix*. Percentages of wet or dry tibia weight or tibia ash were not significantly affected by dietary treatments. While, tibia Ca and P percentages, were significantly affected. In the same manner, tibia length, tibia width, tibia Seedor index or robusticity index were not significantly affected by dietary treatments. Whereas, tibia breaking strength was significantly reduced only with birds fed (T5) diets and chicks fed control diets gave the highest figures representing tibia chemical composition (Ca & P %) and tibia breaking strength when compared to those fed *PhoCal Mix* diets (T2: T5). Results of economic evaluation showed that *PhoCal Mix* could be included at different levels (T2: T5) in broiler diets to support and enhance economic efficiency without adverse effect on productive performance or carcass characteristics. In conclusion, it could be recommended that using of *PhoCal Mix* as a unified source of Ca and AP in different levels could keep better utilization of both Ca & AP to maintain performance, carcass and tibia as well as minimize feed cost.

Key Words: Calcium, Phosphorus, Broilers and Performance

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INTRODUCTION

The phosphorus (P) found in plant-origin feed ingredients is not entirely accessible for birds because of its complexity in phytate bound with inositol and divalent cations (Scott *et al.*, 1982). Consequently, there is an opposite linkage between availability of minerals including P and dietary phytate (Kornegay *et al.*, 1996). Using plant-origin feed ingredients in formulating chicken diets, result in excretion of excess P and other minerals that are bound with phytate in significant quantities and cause ecological contamination. Low P diets offer advantage of lower costs and less excretion of P into environment (Nahm and Carlson, 1998). Dietary level of Ca and P at their suggested concentrations is known to reduce utilization of phytate phosphorus (PP) (Schoner *et al.*, 1993; Qian *et al.*, 1994). Recently, ecological and economic implication of excessive P in poultry feeds, and in excreta have become of serious concern (Henuk and Dingle, 2003). Adaptation of animals to a specific deficient nutrient has been long renowned. In this regard, animals respond to nutrient restriction by increasing absorption and utilization, which in turn, decreases excretion of restricted nutrient (Yan *et al.*, 2005; Abdelaziz, 2011; Thabet *et al.*, 2014). There is a clear evidence stating increased PP availability from plant feed ingredients at their deficient concentrations of P (Onyango *et al.*, 2006) with reducing costs of supplemented inorganic P and minimizing P excretion (Rama Rao *et al.*, 2006; Rama Rao *et al.*, 2007). On the other hand, Yan *et al.* (2001) found that broilers grown on a diet adequate in P (0.45%) and Ca (1.0%) up to 3^{rd} week only required 0.186% AP from 3^{rd} to 6^{th} week of age for maximum BWG. Diets deficient by either -10%, -20% or -30% in P of control diet, had depressed growth rate and feed efficiency (Fernandes *et al.*, 1999; Li *et al.*, 2000). Furthermore, Ibrahim *et al.*, (1999) reported that average LBW was reduced with low dietary P levels. On contrary, Summers (1997) declared that dietary P levels can be reduced by up to 20% for most classes of poultry without any adverse effect on bird's performance. However, this is effective only in conjunction with attention to dietary Ca levels which can influence P absorption and retention. Low levels of Ca and NPP can be fed up to the finisher phase without retarding performance (Skinner *et al.*, 1992a and 1992b; Skinner and Waldroup, 1992; Chen and Moran, 1995; Dhandu and Angel, 2003). The current study aimed to examine the effect of using different levels of a unified mix of Ca and P (*PhoCal Mix*) in broiler diets, on productive performance, carcass traits, blood parameters, tibia measurements and economic efficiency.

MATERIALS AND METHODS

<u>Experimental diets and birds:</u> One hundred fifty unsexed one day old Hubbard broiler chicks were randomly distributed into 5 treatments. Each treatment comprised of 30 chicks which were divided into 6 replicates of 5 chicks each. Chicks were reared up to 5 weeks of age in wire-floored batteries. Chemical composition of (*PhoCal Mix*) as a unified mixture of calcium and phosphorus was as follows: Ca: 26.37%, P: 13.19%, Na: 0.06%, Cl: 0.01%, Mg: 0.42%, K: 0.11% and S: 1.20%. Level of 3.50% *PhoCal Mix* in the diet represents normal (100%) requirements of broilers for both Ca & AP. While level of 2.63% *PhoCal Mix*, represents 75% of normal Ca & AP requirements. And 1.75% *PhoCal Mix* represents 50% of normal Ca & AP requirements. Diets listed in Table (1) were formulated ensuring adequate supply of nutrients suggested by guide-book of Hubbard broilers to be isocaloric and isonitrogenous according to NRC (1994) and were offered in mash form. All chicks were reared under similar management and hygienic conditions. Feed and water were

provided ad libitum. All chicks were vaccinated by drinking-water-based vaccination against Newcastle and Gumboro diseases by vaccines purchased form veterinary serum and vaccine research institute.

Growth performance: Live body weight (LBW) of each replicate was recorded, and the average body weight gain (BWG) was calculated per replicate by subtracting the initial LBW of birds in a certain stage from final LBW in the same stage. Average of daily feed consumption (DFC) was calculated from difference between weekly amount of feed provided for each replicate within treatments and residual quantity for same replicate. Feed conversion ratio (FCR) (g feed/ g gain) was calculated in different stages as the amount of feed consumed, in grams, in a certain stage which is required to produce out one gram of weight gain in the same stage.

Carcass traits and blood plasma parameters: At 5 weeks of age, six birds from each treatment having LBW around the average of treatment were selected and sacrificed by severing the carotid artery and the jugular vein. Blood samples were collected simultaneously with slaughtering. Blood samples were immediately centrifuged at 3000 r.p.m. for 10 minutes to separate plasma. Plasma calcium, phosphorus (Tietz, 1995) and alkaline phosphatase (Young, 2000) were assayed by colorimetric method using commercial kits. After slaughtering, bleeding and scalding, viscera were removed manually without disrupting of abdominal fat. Dressed carcasses and giblets were weighed independently. The dressing percentage (DP) was calculated by determining carcass weight (including the carcass fat) as a percent of LBW.

Tibia composition and measurements: Tibia bones of both sides were removed, cleaned of all soft tissues and weighed. Tibia length and width were determined using a digital micrometer according to the method described by Samejima (1990). The Seedor index (SI) was determined according to Seedor *et al.* (1991). It represents an indication of tibia density: the higher the value, the denser the tibia. Robusticity index (RI) which was calculated according to Reisenfeld (1972), also gives an indication of tibia mineral density as an absolute figure. In contrast with SI, RI indicated that the lower the value, the denser the tibia. Tibia breaking strength (TBS) was determined on tibiae at wet-basis following method of Crenshaw *et al.* (1981) by applying simple three-point bending concept. Tibiae samples were oven-dried at 105º C until constant weight, ashed (Yi *et al.*, 1996) at 600º C for 3 hour, dissolved by using concentrated HCl and 2 N HCl, and then filtered. Calcium and phosphorus content were then assayed in the filtrate by a colorimetric method according to AOAC (1995).

Economic efficiency: The economic traits were calculated according to North (1981) in relation to prices of local market at the time of the study. Performance index (PI) was also determined according to North (1981), while production efficiency factor (PEF) was calculated according to Emmert (2000).

Statistical analysis: Data were processed by one way ANOVA analysis of variance using general linear model (GLM) procedure of SAS software (SAS, 2004) user's guide according to the model; $Y_{ij} = \mu + T_i + e_{ij}$ Where; μ= overall mean, T_i= dietary treatment, e_{ij}= experimental error. Individual effects of experimental groups were compared using Duncan (1955) multiple range tests at a level equal to 0.05 or 0.01.

RESULTS AND DISCUSSION

Growth performance: Results presented in Table (2) showed no significant differences among LBW values for all groups during starter stage. Similarly, values of final LBW showed no significant differences among all groups. Values of DWG indicated that birds of (T2) gained significantly less weight during starter compared to other groups, while during grower stage or overall test period, differences within DWG for all groups remained insignificant. DFC values showed that birds fed on (T2) consumed less feed during starter stage or during overall test period, differences within DFC for all groups remained significant. Values of FCR indicate that birds of (T3) recorded better FCR during starter, grower or overall test period compared to other groups except for control, while differences within FCR for all groups remained insignificant. When comparing birds of different groups, it is clear that no adverse effects were observed on LBW, DWG, DFC or FCR when Ca and P levels were reduced in moderately between starter and grower stages. The corresponding values for LBW ranged between 1718 and 1615 (g), DFC ranged between 47.88 and 44.95 (g), while FCR raged between 1.67 and 1.59. Results of productive performance are in agreement with those of Abdelaziz (2011) who stated that using low levels of Ca and P gave results nearly matching those of control group. Current results are also in conformity with those of Thabet *et al.* (2014); Thabet (2010); Dhandu and Angel (2003) and Angel *et al.* (2000). The fact that birds of (T5) presented productive performance similar to those of (T1) and (T2) is clarified by data presented in Table (3) which indicate that birds fed (T1) or (T5) consumed more Ca and AP during starter period compared to other experimental groups. While during grower period, birds fed (T2) consumed significantly more Ca and AP compared to all other groups (Table 3). According to Yan *et al.* (2005), these results would be explained by two reasons. First, chicks fed diet with low Ca and P demonstrated ability to adapt to that deficiency. Second, although (T5) grower diet was formulated to have less Ca and P than (T5) starter diet and bird's requirement of Ca and P decreases with age, most of rapid growth of tibias occurs during starter period (Yan *et al.*, 2005).

Carcass traits: Data representing carcass characteristics at 5 weeks of age are shown in Table (4). In regard to dressed carcass weight percentage (DP), no significant differences were observed within all groups. Values of DP for different treatments ranged between 67.64% and 71.61% while RTC% (carcass weight + giblets weight) ranged between 72.52 and 76.37 for (T1) and (T5), respectively. As shown in Table (4), data of relative weights percentages of liver, gizzard, heart, spleen and total giblets presented insignificant differences among all groups. Data of carcass characteristics, dressing percentage are in harmony with those observed by Thabet *et al.* (2014); Santos and Soto-Salanova, (2005) and Nawaz *et al.*, (2008). Results of carcass traits being in general not significantly affected by dietary treatment, which may justify birds' adaptation to AP and/or Ca dietary limitation (Abdelaziz, 2011).

Blood plasma parameters: Plasma Ca and P concentrations and alkaline phosphatase (ALP) activity are presented in Table (5). Plasma Ca and P concentrations and ALP activity values obtained at 5 weeks of age indicated no significant differences between all five groups. Data of plasma Ca, P and ALP activity were in accord with those obtained by Thabet *et al.* (2014); Abdelaziz (2011); Papesova *et al.* (2008) and Bolu *et al.* (2006). Birds fed *PhoCal Mix* diets containing low levels of Ca & AP, provoke lower plasma levels of both Ca and P. When blood Ca decreases, parathyroid hormone (PTH) motivates Ca and P transfer from body tibia skeleton to blood stream and impresses kidneys to produce endogenous form of vitamin D_3 which promotes small intestine and increases Ca and P absorption (Kheiri and Rahmani, 2006).

Tibia composition and measurements: Data of tibia composition at the end of 5 weeks are presented in Table (6). It is noticed that values of tibia wet weight percentage; tibia dry weight percentage and tibia ash percentage appeared appreciably equivalent within all experimental groups. Also, data showed that birds fed (T1) diet have recorded significantly higher tibia Ca percentage when compared to other groups. While, data of tibia P percentage showed that birds fed (T1) diet have significantly similar to those fed (T4) diet and are typically higher when compared to birds of other dietary treatments. Data obtained were generally in harmony with Thabet *et al.* (2014) and Abdelaziz (2011). In Accordance with Yan *et al.* (2005), birds of (T1) had higher tibia minerals content. These authors indicated that when expressing tibia ash in relation to consumed Ca or AP (Table 3), birds fed (T4) had higher ash weight as Ca or AP consumed when compared to birds of other groups. This could be attributed to considerable adaptation to Ca and P limitation in (T4) birds. These observations was in agreement with those of Coto *et al.* (2008a and b), Fritts and Waldroup (2003). Data of tibia measurements at the end of 5 weeks are presented in Table (7). Data of tibia length (cm), tibia width (cm), tibia Seedor index (SI) or tibia robusticity index (RI) showed insignificant differences within all groups. On the other hand, values of tibia breaking strength (Kg/cm^2) indicated that only birds fed (T5) diet had weaker tibiae bones when compared to other groups. Data of tibia measurements were generally in harmony with Thabet (2010) in regard to tibia length & width, and with Abdelaziz (2011) in regard to tibia SI and with Thabet *et al.* (2014) in regard to tibia RI values.

Economic efficiency: Profitability of applying current experimental treatments in poultry feeding depends to a great extent on both feed expenses and economic competence as presented in Table (8). As of data representing feed cost (L.E.), it is generally observed that birds fed (T2), (T3), (T4) or (T5) diet have been less costly compared to those fed (T1) control diet. Data concerning total return (L.E.) indicated that birds fed (T3) diet have recorded more return compared to those fed (T2), (T4) and (T5) diets which in turn, are more profitable compared to those fed (T1) diet. Regarding net return (L.E.) values, it was noticed that birds fed (T3) diet were better compared to those fed (T2), (T4) and (T5) diet, which in turn, are better compared to those fed (T1) diet. Economic efficiency (EE) and relative economic efficiency (REE) values indicated that birds of all dietary treatments were better than those fed (T1) diet with superiority to those fed (T3) diet. In the same way, values of performance index (PI) or production efficiency factor (PEF) showed that birds fed (T3) diet had superiority of both PI and PEF when compared to other groups especially those fed (T1) diet. Data of economic efficiency were generally in harmony with those of Abdelaziz (2011) and with those of Thabet *et al.* (2014). It would be anticipated that using lower levels of *PhoCal Mix* representing lower levels than recommended of Ca & AP in broiler diets would give better economic solution (Abdelaziz, 2011).

CONCLUSION

Finally, after reviewing all these results, it might be advisory to state that *PhoCal Mix* would be suitable to be the only source for both Ca and AP in broiler diets in order to reduce feed cost without any adverse effect on performance, carcass, blood and tibia features. Additionally, dietary mineral utilization of broiler chicks would be maintained by feeding close to requirements dietary Ca and AP levels presented by *PhoCal Mix*.

Table (1): Feed ingredients and chemical composition of experimental diets.

Ingredients	Dietary Treatments - Starter (1-14 days)				
	1	2	3	4	5
Yellow corn	52.97	56.58	57.32	58.06	56.58
Soybean meal 44 %	30.80	26.00	27.25	28.50	26.00
Corn gluten 60 %	9.00	11.00	10.00	9.00	11.00
Soybean oil	2.57	1.50	1.40	1.30	1.50
Ca carbonate (Ca Co_3)	1.59	---	---	---	---
MCP	1.82	---	---	---	---
PhoCal Mix	---	3.50	2.63	1.75	3.50
Lysine - HCl	0.34	0.45	0.42	0.40	0.45
Methionine (MHA)	0.21	0.27	0.28	0.29	0.27
Salt (NaCl)	0.40	0.40	0.40	0.40	0.40
Premix (3 Kg/ Ton)	0.30	0.30	0.30	0.30	0.30
Total	100	100	100	100	100
Chemical composition (Calculated)					
Crude protein %	23.03	23.07	23.06	23.06	23.07
ME Kcal/ Kg diet	3010	3032	3038	3043	3032
Ca %	1.00	0.96	0.75	0.53	0.96
AP %	0.50	0.55	0.45	0.34	0.55
Lysine %	1.39	1.41	1.40	1.41	1.41
Methionine %	0.60	0.65	0.66	0.66	0.65
Methionine + Cystein %	0.99	1.05	1.05	1.05	1.05
Price/ Ton (L.E.)	3745	3707	3666	3626	3707
	Dietary Treatments - Grower (15-35 days)				
Yellow corn	55.23	61.14	61.87	62.62	62.62
Soybean meal 44 %	30.00	22.00	23.25	24.50	24.50
Corn gluten 60 %	6.00	10.00	9.00	8.00	8.00
Soybean oil	4.50	2.00	1.90	1.80	1.80
Ca carbonate (Ca Co_3)	1.43	---	---	---	---
MCP	1.62	---	---	---	---
PhoCal Mix	---	3.50	2.63	1.75	1.75
Lysine - HCl	0.24	0.40	0.38	0.35	0.35
Methionine (MHA)	0.28	0.26	0.27	0.28	0.28
Salt (NaCl)	0.40	0.40	0.40	0.40	0.40
Premix (3 Kg/ Ton)	0.30	0.30	0.30	0.30	0.30
Total	100	100	100	100	100
Chemical composition (Calculated)					
Crude protein %	21.05	21.08	21.07	21.06	21.06
ME Kcal/ Kg diet	3117	3108	3113	3119	3119
Ca %	0.90	0.98	0.76	0.53	0.53
AP %	0.45	0.56	0.45	0.34	0.34
Lysine %	1.25	1.25	1.25	1.25	1.25
Methionine %	0.62	0.62	0.62	0.62	0.62
Methionine + Cystein %	0.98	0.98	0.98	0.98	0.98
Price/ Ton (L.E.)	3639	3560	3521	3480	3480

MCP: mono-calcium phosphate, MHA: methionine hydroxy-analogue, AP: Available Phosphorus. Each 3 Kg of 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.

Table (2): Effect of dietary treatments on productive performance.

Items	Dietary Treatments					
	1	2	3	4	5	Sig.
Live body weight (g)						
1 day old	41.8±0.1	41.7±0.2	42.2±0.1	41.2±0.1	42.9±0.6	NS
2 weeks	234.00 ±5.29	217.50 ±14.16	251.50 ±9.94	240.00 ±10.23	238.25 ±13.36	NS
5 weeks	1615.00 ±25.90	1652.75 ±54.82	1718.00 ±38.66	1646.00 ±49.95	1631.75 ±17.04	NS
Daily weight gain (g)						
0–2 weeks	16.36[a] ±0.15	12.56[c] ±0.37	14.95[b] ±0.47	14.20[b] ±0.46	13.95[b] ±0.59	**
3–5 weeks	65.76 ±1.25	68.34 ±3.06	69.83 ±2.29	66.95 ±2.45	66.35 ±0.74	NS
0–5 weeks	46.00 ±0.80	46.02 ±1.91	47.88 ±1.22	45.85 ±1.64	45.39 ±0.48	NS
Daily feed consumption (g)						
0–2 weeks	21.25[a] ±0.83	18.96[b] ±0.47	21.80[a] ±0.25	21.03[a] ±0.36	21.57[a] ±0.37	**
3–5 weeks	111.43 ±0.30	111.88 ±0.19	112.30 ±0.09	112.52 ±0.19	112.19 ±0.19	NS
0–5 weeks	75.35 ±0.46	74.71 ±0.30	76.10 ±0.10	75.93 ±0.17	75.94 ±0.20	NS
Feed conversion ratio (g feed/ g gain)						
0–2 weeks	1.29[b] ±0.03	1.51[a] ±0.08	1.46[a] ±0.03	1.48[a] ±0.02	1.55[a] ±0.03	*
3–5 weeks	1.69 ±0.02	1.64 ±0.07	1.61 ±0.05	1.69 ±0.05	1.69 ±0.01	NS
0–5 weeks	1.64±0.02	1.63±0.07	1.59±0.04	1.66±0.05	1.67±0.01	NS

a, b, c Means within the same row with different superscripts are significantly different. Sig. = Significance, ** ($P \leq 0.01$), * ($P \leq 0.05$). NS = Non Significant.

Table (3): Effect of dietary treatments on calcium and phosphorus intake.

Items		Dietary Treatments					
		1	**2**	**3**	**4**	**5**	**Sig.**
Starter	Ca intake (g)	2.97^{a} ±0.11	2.55^{b}±0.06	2.29^{c}±0.02	1.56^{d}±0.02	3.02^{a}±0.05	**
	AP intake (g)	1.49^{a} ±0.05	1.46^{a}±0.03	1.34^{b}±0.01	0.97^{c}±0.01	1.51^{a}±0.02	**
Grower	Ca intake (g)	21.06^{b}±0.05	23.02^{a}±0.03	17.68^{c}±0.01	12.52^{d}±0.02	12.48^{d}±0.02	**
	AP intake (g)	10.52^{c}±0.02	13.15^{a}±0.02	10.61^{b}±0.01	7.79^{d}±0.01	7.77^{d}±0.01	**
Overall	Ca intake (g)	24.03^{b}±0.15	25.57^{a}±0.10	19.97^{c}±0.03	14.08^{e}±0.03	15.50^{d}±0.05	**
	AP intake (g)	12.01^{b}±0.07	14.61^{a}±0.05	11.95^{b}±0.01	8.77^{d}±0.02	9.28^{c}±0.03	**

a, b, c, d, e Means within the same row with different superscripts are significantly different.
Sig. = Significance, ** (P<0.01).

Table (4): Effect of dietary treatments on carcass characteristics.

Items	Dietary Treatments					
	1	**2**	**3**	**4**	**5**	**Sig.**
Dressed carcass %	67.64±0.83	71.09 ±1.30	70.55 ±7.85	71.41±0.51	71.61±0.21	NS
Liver %	2.62 ±0.04	2.30 ±0.09	2.71 ±0.37	2.24 ±0.08	2.63±0.27	NS
Gizzard %	1.77 ±0.21	1.91 ±0.13	1.98 ±0.41	1.75 ±0.06	1.63±0.07	NS
Heart %	0.48 ±0.05	0.58 ±0.05	0.47 ±0.07	0.52±0.01	0.49±0.06	NS
Spleen %	0.13 ±0.01	0.10 ±0.01	0.14 ±0.02	0.12±0.02	0.13±0.02	NS
Giblets * %	4.87 ±0.25	4.79 ±0.24	5.16 ±0.83	4.52±0.14	4.76±0.26	NS
RTC # %	72.52 ±0.98	75.89 ±1.07	75.71 ±8.69	75.93±0.63	76.37±0.10	NS
Abdominal fat %	1.54 ±0.22	1.58 ±0.22	1.37 ±0.13	1.41±0.24	1.91±0.55	NS

Sig. = Significance, NS = Non Significant.
* Giblets = Liver + Gizzard + Heart, # Ready to Cook = (Carcass weight + Giblets weight)

Table (5): Effect of dietary treatments on blood plasma parameters.

Items	Dietary Treatments					
	1	2	3	4	5	Sig.
Calcium (mg/dl)	9.94±0.77	7.61±0.34	9.34±0.66	8.9±0.91	8.17±0.52	NS
Phosphorus (mg/dl)	3.72±0.57	4.22±0.30	4.45±0.12	4.43±0.09	3.40±0.51	NS
Alkaline phosphatase (U/l)	221.66 ±29.01	171.00 ±45.61	152.66 ±22.65	181.00 ±24.01	171.01 ±14.84	NS

Sig. = Significance, NS = Non Significant.

Table (6): Effect of dietary treatments on tibia composition.

Items	Dietary Treatments					
	1	2	3	4	5	Sig.
Wet tibia %	0.87±0.10	0.97±0.10	0.75±0.07	0.89±0.08	0.82±0.03	NS
Dry tibia %	0.47±0.05	0.51±0.03	0.41±0.05	0.48±0.03	0.43±0.02	NS
Tibia ash %	40.54±2.29	39.22±0.96	36.39±0.79	40.38±0.48	38.34±1.47	NS
Tibia Ca %	17.62^{a}±0.65	16.18^{b}±0.12	15.87^{b}±0.22	14.50^{c}±0.21	14.08^{c}±0.33	**
Tibia P %	8.78^{a}±0.04	7.78^{bc}±0.14	7.43^{c}±0.13	8.31^{ab}±0.36	7.98^{bc}±0.19	**

a, b, c Means within the same row with different superscripts are significantly different.
Sig. = Significance, ** (P≤0.01), NS = Non Significant.

Table (7): Effect of dietary treatments on tibia measurements.

Items	Dietary Treatments					
	1	2	3	4	5	Sig.
Tibia length (cm)	9.25±0.11	9.22±0.17	8.94±0.12	9.19±0.15	9.31±0.08	NS
Tibia width (cm)	1.02±0.03	1.05±0.08	1.01±0.06	1.10±0.02	1.03±0.06	NS
Tibia seedor index[1] (SI)	1.00±0.11	1.03±0.08	0.89±0.12	1.00±0.08	0.95±0.05	NS
Tibia robusticity index[2] (RI)	3.62±0.14	3.55±0.18	3.70±0.16	3.59±0.16	3.63±0.07	NS
Tibia breaking strength[3] (Kg/cm^2)	22.40^{a}±0.40	20.84^{a}±2.47	21.88^{a}±0.63	21.21^{a}±0.52	15.35^{b}±0.83	*

a, b Means within the same row with different superscripts are significantly different.
Sig. = Significance, * (P≤0.05), NS = Non Significant.
1: Seedor *et al.* (1991), 2: Reisenfeld (1972), 3: Crenshaw *et al.* (1981)

Table (8): Effect of dietary treatments on economic traits.

Items	Dietary Treatments					
	1	2	3	4	5	Sig.
Average feed consumption (Kg)	2.63^{ab}±0.02	2.61^{b}±0.01	2.66±0.01	2.65^{a}±0.01	2.66^{a}±0.01	*
Total costs (LE)	16.13±0.08	15.85±0.02	15.92±0.01	15.79±0.02	15.82±0.02	-
Feed cost (LE)	9.63±0.08	9.35±0.02	9.42±0.01	9.29±0.02	9.32±0.02	-
Live body weight (Kg)	1.61±0.02	1.65±0.05	1.72±0.03	1.64±0.05	1.63±0.01	NS
Total return# (LE)	20.99±0.33	21.48±0.71	22.33±0.50	21.40±0.64	21.21±0.22	-
Net return (LE)	4.86±0.26	5.63±0.72	6.41±0.51	5.60±0.63	5.39±0.23	-
Economic efficiency	30.15±1.56	35.58±4.61	40.27±3.28	35.49±3.95	34.10±1.47	NS
Relative economic efficiency*	100.00 ±0.00	118.03 ±15.29	133.5 ±10.91	117.73 ±13.13	113.11 ±4.89	NS
Performance index[1]	98.61±2.55	102.27±7.54	108.30±5.31	99.67±6.48	97.57±2.09	NS
Production efficiency factor[2]	281.76 ±7.29	292.21 ±21.55	309.42 ±15.18	284.79 ±18.52	278.77 ±5.97	NS

a, b Means within the same row with different superscripts are significantly different.
Sig. = Significance, * (P≤0.05), NS = Non Significant.
# According to the local price of Kg LBW which was 13.00 L.E.
* Assuming that the relative economic efficiency of control group equals 100.
1: North (1981), 2: Emmert (2000)

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الملخص العربى

تأثير إستخدام خليط مُوحَّد من الكالسيوم و الفوسفور فى علائق بدارى التسمين

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دراسة غذائية إستمرت فترة خمس أسابيع بإستخدام ١٥٠ كتكوت تسمين غير مجنس عمر يوم من سلالة Hubbard صممت لدراسة تأثير إستخدام خليط موحد من عنصرى الكالسيوم والفوسفور (*PhoCal Mix*) على الآداء الانتاجي ومقاييس العظام والتقييم الإقتصادى لبداري التسمين. تضمنت الدراسة خمس معاملات غذائية تم توزيعهم على خمس مجموعات من الطيور حيث إحتوت كل مجموعة على ٣٠ كتكوت فى ستة تكرارات بكل منها خمسة كتاكيت. غذيت مجموعة المقارنة (T1) على عليقة بها مصادر كالسيوم وفوسفور معتادة و بدون إضافة *PhoCal Mix*، بينما غذيت باقى المجموعات على *PhoCal Mix* كمصدر وحيد للكالسيوم والفوسفور. على النحو التالى: (T2) غذيت *PhoCal Mix* بنسبة ٣,٥%، (T3) غذيت *PhoCal Mix* بنسبة ٢,٦٣%، (T4) غذيت *PhoCal Mix* بنسبة ١,٧٥% و (T5) غذيت *PhoCal Mix* بنسبة ٣,٥% و ١,٧٥% خلال مرحلتى البادىء والنامى، على التوالي. أوضحت النتائج أن وزن الجسم الحى و معامل التحويل الغذائي فى مرحلة البادىء لم يتأثر معنويا بالتغذية على علائق تحتوى *PhoCal Mix* بمستويات مختلفة، بينما تأثر كل من الوزن المكتسب اليومى و الاستهلاك الغذائي اليومى معنويا. أما فى مرحلة النامى، فإن وزن الجسم الحى، الوزن المكتسب اليومى أو معامل التحويل الغذائي لم يتأثر معنويا بالتغذية على علائق تحتوى *PhoCal Mix* بمستويات مختلفة. لم تتأثر كل مقاييس الذبيحة معنويا بالمعاملات الغذائية المختلفة. مستويات الكالسيوم والفوسفور ونشاط إنزيم ألكالاين فوسفاتيز في بلازما الدم لم تتأثر معنويا بإستخدام مستويات مختلفة من *PhoCal Mix*. لم تتأثر قيم الوزن النسبى لعظمة الساق الرطبة والجافة ونسبة الرماد بها معنويا بالمعاملات الغذائية المختلفة. بينما تأثرت نسبة الكالسيوم والفوسفور بعظم الساق معنويا. بنفس الإتجاه، لم تتأثر قيم طول وسمك عظمة الساق ودليل سيدور لها معنويا بالمعاملات الغذائية. بينما كانت قيمة قوة كسر عظم الساق منخفضة معنويا فقط مع الطيور المغذاة على عليقة (T3). كانت المقاييس الإقتصادية للطيور المغذاة على عليقة (T3) أفضل نسبيا من مثيلاتها من المعاملات الأخرى. يستنتج من هذه الدراسة أنه يمكن التوصية بأن إستخدام *PhoCal Mix* كمصدر لعنصرى الكالسيوم والفوسفور بمستويات مختلفة يمكن أن يكفل إستفادة أفضل لعنصرى الكالسيوم والفوسفور لحفظ الآداء الانتاجي، مقاييس الذبيحة وجودة العظام بالاضافة الى تقليل تكلفة الغذاء.