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Effect of Dietary Calcium and Phosphorus Levels on Productive Performance, Carcass and Tibia Characteristics of Sudani Ducklings

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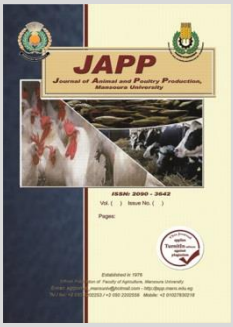

ABSTRACT

This study was planned to evaluate varying dietary calcium (Ca) and phosphorus (P) levels effects on the productive performance of Sudani ducklings during the growth period. A total of 240 unsexed ducklings, 7 days-old were split into four empirical groups, each of three replicates (20 ducklings each). The ducklings in the 1st up to the 4th group fed diet contained Ca plus P levels as follows 0.70% Ca+0.35% P (T_1), 0.85% Ca+0.40% P (T_2, as a control), 1.0% Ca+0.45% P (T_3) and 1.15% Ca+0.50% P (T_4), respectively during the starter and grower periods. Ducklings in T_4 group recorded a significant improvement of live body weight, body weight gain, and feed conversion ratio compared to the ducklings in T_1 group at 7-91 days-old period. Both eviscerated carcass and total edible parts (%) were ameliorated (P>0.05) by increasing levels of Ca and P. All hematological parameters not significantly affected except for hemoglobin, which decreased by increasing levels of Ca and P. Serum Ca, P, vitamin D and alkaline phosphatase content for ducklings were not differed by varying Ca and P levels. Duckling's tibia calcium content significantly augmented by mounting Ca and P levels; however, their content from P not affected. From the obtained results, it could be concluded that the necessity to use the diet containing 1:1.15 Ca with 0.45: 0.50 P (%) to achieve the best growth characteristics and the ratio of edible parts, as well as tibia Ca content for Sudani ducklings during the growing period.

Keywords: Ducklings, Calcium, Phosphorus, Growth performance, Carcass

INTRODUCTION

Sudani ducks are one of Egyptian duck breeds, they reared for diversified production circumstances and more appropriate to the Egyptian consumers taste. Ducks production is becoming had more attention lastly in Egypt for augmentation meat production especially from local breeds (Awad *et al.*, 2013). Thus, a good conception of the nutritional requirements of local ducks is necessarily needed to reach their potential productivity, especially their requirement from dietary calcium (Ca) and phosphorus (P), which play crucial role in economic profitability of meat ducks. New strains of ducks are genetically selected on the basis of high growth rates, which need nutrient-dense diets (Cherry and Morris, 2008), that increase risk factors such as leg issues (Waldenstedt, 2006).

Many bole issues induced due to quick muscle growth that unintentionally put stress on the unripe skeleton and cause a variety of skeletal malformations and turmoil's (Brickett *et al.*, 2007). The skeletal deformities escort to a mortality increase, financial losing, and poor animal health. A current line of conception to attenuate these bole issues is how to encourage mineralization of the skeleton. Increasing dietary nutrient density accelerated weight gain of ducklings (Fan *et al.*, 2008), but also resulted in higher incidence of gait abnormality (Brickett *et al.*, 2007). The intensive nutrition for rapid growth in meat-type birds has the main cause of inadequate bone quality (Williams *et al.*, 2004).

Calcium (Ca) and phosphorus (P) are the more fundamental minerals tangled in plentiful biological processes, like enzyme activation, intracellular notification, acid-base balance, nucleic acid synthesis and skeleton mineralization (Akter *et al.*, 2016; Li *et al.*, 2017). Furthermore, Ca and P are present skeleton, by 99 and 80%, respectively and stored in hydroxyapatite form (Proszkowiec and Angel, 2013). The deficiency of Ca or P and their untrue ratio usually block bone growth and cause to a more incidence of bole abnormality (Valable *et al.*, 2017), and if severe enough could cause rickets, particularly in broilers during the earlier period (Xie *et al.*, 2009). Moreover, Ca plays sensitive roles in the bone evolution and its durability for poultry (Rath *et al.*, 2000). Some reports explained, rising dietary Ca improved tibia minerals contents and breaking strength in broilers (Abdulla *et al.*, 2017). Thus, Ca-based supplements were used to improve the bone health (Walk *et al.*, 2012), and promote tibia mineralization in rapid growth ducklings. P also plays an important role in nucleic acid synthesis, energy metabolism, muscle function, enzyme activity, lipid metabolism and the mineralization of bone (Berndt and Kumar, 2009). Ducks are more sensitive to dietary P deficiency, because it lessened the intestinal digestion and absorption ability and weakened the intestinal immune and physical function, resulted in a lower productivity (Xie *et al.*, 2011; Chen *et al.*, 2018). Moreover, Dai *et al.* (2018) reported that dietary P levels effect on the variety and structural of cecal microbiota in meat-type ducks, specifically when the level of P increase, that positively influenced on the cecal microbiota and the growth of meat ducklings. Consequently, this work was planned to evaluate the varying dietary calcium and phosphorus levels effects on the productivity, carcass and tibia characteristics of Sudani ducklings during the growth period.

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MATERIALS AND METHODS

Birds and management:

This work was conducted at El–Serw Water Fowl Research Station, Animal Production Research Institute, Egypt. Two hundred and forty of unsexed Sudani ducklings, 7 days-old were taken, weighed and split into four empirical groups in completely randomized design to assess the effects of varying dietary Ca and P levels on the productive performance of Sudani ducklings during the growth period. Each empirical group was comprised of three replicates of 20 ducklings each. Ducklings were reared under analogous healthful, ecological and administrative conditions.

Experimental diets:

Four diets was prepared that contained different Ca and P levels during both starter and growing period. The empirical diets contained Ca plus P levels as follows 0.70% Ca + 0.35% P (T_1), 0.85% Ca + 0.40% P (T_2, as a control), 1.0% Ca+0.45% P (T_3) and 1.15% Ca + 0.50% P (T_4). The starter diet used from 7 up to 49 days, then followed by grower diet from 49 up to 91 days-old. The composition of empirical diets are presented in Table 1.

Growth performance parameters:

Live body weights (LBW) of ducklings were recorded at 7, 28, 49, 70 and 91 days-old, while feed consumption (FC) recorded during 7-28, 28-49, 49-70, 70-91 periods for each replicate then averaged per duckling through each interval and the entire period. While, body weight gain (BWG) and feed conversion ratio (FCR) were calculated at the same intervals periods.

Carcass traits:

At 91 days, six ducklings (n = 6) per each empirical group were taken and slaughtered. Carcass characteristics were calculated as a percentage of the LBW.

Table 1. Diet composition at starter and grower periods

Ingredients	Starter diets 7-49 days-old				Grower diets 49-91days-old			
(%)	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
Yellow corn	64.00	63.43	63.07	62.49	68.44	68.86	68.70	68.90
Soybean meal (44% CP)	33.05	33.16	33.01	33.12	16.00	16.29	16.56	16.80
Wheat bran	0.00	0.00	0.00	0.00	12.45	11.20	10.60	9.79
Di-calcium phosphate	1.18	1.44	1.73	2.01	1.26	1.55	1.83	2.11
Limestone	0.88	1.12	1.34	1.58	0.90	1.15	1.36	1.60
Vit. & Min. Premix[1]	0.34	0.30	0.30	0.30	0.45	0.45	0.45	0.30
NaCl	0.35	0.35	0.35	0.30	0.30	0.30	0.30	0.30
DL-Methionine (99%)	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
DL-Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Calculated analysis[2]								
Metabolisable energy (kcal/kg)	2888.00	2871.40	2856.00	2839.00	2832.00	2835.00	2827.00	2828.00
Crude protein (%)	20.16	20.16	20.06	20.06	15.00	15.00	15.00	15.00
Either extract (%)	2.70	2.68	2.66	2.64	4.15	4.02	3.95	3.87
Crude fiber (%)	3.72	3.72	3.70	3.70	4.00	3.89	3.84	3.77
Calcium (%)	0.70	0.85	1.00	1.15	0.70	0.85	1.00	1.15
Av. phosphorus (%)	0.35	0.40	0.45	0.50	0.35	0.40	0.45	0.50
Lysine	1.06	1.06	1.05	1.05	0.68	0.69	0.69	0.69
Methionine	0.32	0.32	0.32	0.32	0.25	0.25	0.25	0.25

[1]Each 3 kg of the Vit. & Min. contains; Vit A 10 million IU, Vit. D 2 million IU, Vit E 10 g, Vit. K 2 g, Thia 1 g, Ribo 5 g, Pyrid 1.5 g, Niac 30 g, Vit. B12 10 mg, Panto 10 g, Folic 1.5 g, Biot 50 mg, Chol chlo 250 g, Man 60 g, Zin 50 g, Iro 30 g, Co 10 g, Iod 1g, Sel 0.10 g, Cob 0.10 g. and carrier CaCO3 to 3000 g; [2]According to NRC (1994).

Tibia measurements:

During the slaughter trail, tibias flesh-free were taken, dried, weighted and measured, then prudently ground to and stored until the chemical analysis , the values were expressed as percentage on dry matter basis (AOAC, 1995).

Blood samples:

Two blood samples for each duckling from 6 ducklings (n = 6) per each empirical group were carefully collected at slaughter, the first blood sample was collected in heparinized tubes to evaluate some hematological parameters. Where, hemoglobin (Hb) was measured by using the commercial kits (Diamond Diagnostic, Egypt). Both total red blood cells (RBCs) and total white blood cells (WBCs) were counted (Dacie and Lewis, 2001). While, the second blood sample was collected in non-heparinized tubes and kept at the room temperature, then the tubes centrifuged at 3000 rpm for 15 min. to obtain the serum. Serum samples were allocated for determination of triglycerides according to MGowan *et al.* (1983), very low-density lipoprotein (vLDL) according to NCEP (1995). While, serum total calcium, ionic calcium, total phosphorus, vitamin D and activity of alkaline phosphatase (ALP) enzyme were measured by using AFT-500 Electrolytes Analyzer produced by Meizhou Cornley Hi-Tech Co., Ltd., Guangdong, China.

Statistical analysis:

All data were statistically analyzed using the General Linear Model (GLM) of SPSS (2008), however differences among treatment means were assessment by Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Productivity traits:

LBW and BWG of Sudani ducklings as affected by dietary treatments are illustrated in Table 2. It is worth to note that ducklings fed 0.70% Ca + 0.35% P (T_1) reflected the lowest LBW (P<0.05) at 28, 49 and 91 days-old compared to those fed 1.15% Ca + 0.50% P (T_4), while they not affected in both of the control group (T_2; 0.85% Ca + 0.40% P) and those fed 1.0% Ca + 0.45% P (T_3). Duckling's LBW was elevated (P<0.05) by 6.13% for ducklings in T_4 than those in T_1 at 91 d-old. Also, BWG of ducklings was (P<0.05) affected at 7-28 and 7-91 days-old due to dietary treatment. Ducklings fed 1.15% Ca + 0.50% P (T_4) achieved the highest significant BWG by 15.38% and 6.34% as compared to those fed 0.70% Ca + 0.35% P (T_1) at 7-28 days-old and the entire experimental period (7-91 days-old), respectively. However, the differences failed to be significant in ducklings BWG among all treatments during 28-49, 49-70, and 70-91 days-old consequent to the different Ca and P levels within the diet.

Table 2. Influence of various dietary calcium and phosphorus levels on live body weight and weight gain of Sudni ducklings

Age (day)	Treatment				Pooled ± SEM	Sig.
	T_1	T_2	T_3	T_4		
	Live body weight (g)					
Initial (7-days)	81.80	83.90	84.60	82.40	1.30	NS
28	695.10^{b}	717.20^{ab}	715.90^{ab}	790.00^{a}	15.60	*
49	1252.40^{b}	1330.90^{ab}	1270.60^{ab}	1390.00^{a}	23.30	*
70	1839.00	1854.10	1898.40	1957.20	21.10	NS
91	2237.80^{b}	2227.80^{ab}	2321.80^{ab}	2375.00^{a}	25.20	*
	Body weight gain (g/ bird/period)					
7-28	613.20^{b}	633.30^{ab}	631.30^{ab}	707.50^{a}	15.70	*
28-49	557.30	613.70	554.70	600.00	12.30	NS
49-70	586.60	523.20	627.80	567.30	17.50	NS
70-91	398.90	373.70	423.50	417.80	15.70	NS
7-91	2156.00^{b}	2143.90^{ab}	2237.20^{ab}	2292.60^{a}	25.70	*

a , b :means within the same row of each item bearing various super letters are significantly different ($P \leq 0.05$), SEM: stander error of mean ; NS: non-significant; *: significant effect at $P \leq 0.05$; T_1: (0.70% Ca : 0.35% P); T_2: (0.85% Ca : 0.4% P; as a control); T_3: (1.0% Ca : 0.45% P), and T_4 (1.15% Ca : 0.50% P).

These results suggested that ducks fed 1.15% Ca + 0.50% P (T_4) presented a normal performance. The recommendation of NRC (1994) explained that dietary non-phytate phosphorus level did not decrease at 0.40%. These results are similar with Xie *et al.* (2009) who stated that diet contained 0.806 % Ca plus 0.403 % non-phytate phosphorus could attained the highest daily BWG and the best FCR for White Pekin ducks through the first 6 wks-old. Xu *et al.* (2019) also showed that ducklings fed 0.22% P had minimal (P<0.05) growth while when dietary non-phytate phosphorus levels were increased led to increased (P <0.05) LBW at 14 and 21 days and BWG. Inversely, Papesova *et al.* (2008); Nawaz *et al.* (2008) and Rao *et al.* (2008) mentioned non-significant improvement in BWG in birds fed low level of Ca and P. Generally, Macari *et al.* (2002) affirmed that the optimum balance between Ca and P requirements, and their metabolic relation, provide preferable performance and development.

Data in Table 3 shows no significant differences in FC between treatments during all empirical periods except for 70-91 d-old, while FCR recorded significant differences among treatments during 49-70 and 7-91 days-old. Ducklings fed 0.85% Ca + 0.40% P (T_2; as a control) recorded (P<0.05) the highest FC value than those fed 0.70% Ca + 0.35% P (T_1) at 70-91 days-old. Also, FC per ducklings (g) was (P>0.05) increased in both T_2 and T_3 compared to those fed other dietary treatments (8794.70g T_1, and 8614.80g T_4) at the entire studied period. FCR was improved for ducklings fed T_3 diet than those fed T_2 (the control diet) at 49-70 days-old, while the best FCR was detected for ducklings in T_4 group than those in T_1 and T_2 groups during the entire period, which could be due to the highest BWG (Table 2) and lowest FC (Table 3).

Table 3. Influence of various dietary calcium and phosphorus levels on feed consumption and feed conversion ratio for Sudani ducklings at empirical periods

Age (day)	Treatment				Pooled ± SEM	Sig.
	T_1	T_2	T_3	T_4		
	Feed consumption (g/bird/period)					
7-28	1655.40	1593.20	1697.50	1625.60	23.20	NS
28-49	1997.20	2013.20	1902.50	2004.70	22.60	NS
49-70	2462.10	2438.00	2407.90	2283.90	40.00	NS
70-91	2680.00^{b}	2954.40^{a}	2813.90^{ab}	2700.60^{ab}	46.90	*
7-91	8794.70	8998.80	8821.80	8614.80	74.30	NS
	Feed conversion ratio (g feed / g BWG)					
7-28	2.72	2.53	2.69	2.30	0.08	NS
28-49	3.59	3.28	3.45	3.45	0.06	NS
49-70	4.22^{ab}	4.68^{a}	3.84^{b}	4.05^{ab}	0.13	*
70-91	6.77	7.91	6.67	6.64	0.24	NS
7-91	4.08^{a}	4.20^{a}	3.95^{ab}	3.76^{b}	0.06	*

a , b :means within the same row of each item bearing various super letters are significantly different ($P \leq 0.05$), SEM: stander error of mean ; NS: non-significant; *: significant effect at $P \leq 0.05$; T_1: (0.70% Ca : 0.35% P); T_2: (0.85% Ca : 0.4% P; as a control); T_3: (1.0% Ca : 0.45% P), and T_4 (1.15% Ca : 0.50% P).

These results may be due to ducklings reared for meat production that need higher demand of available phosphorus because their faster growth and heavier bodies weights (Rostagno *et al.*, 2005 & 2011). The worst FCR for T_1 or T_2 (as a control group) may be due to more feed consumed and low BW gain. Also, when ducklings fed a diet that P deficiency, effect on their gut microbial communities efficiency, that convert more need to obtain P phytate (Dai *et al.*, 2018), requiring that more energy is spent on the life maintenance and decrease available energy to growth (Zeng *et al.*, 2015). These results are harmony with Xu *et al.* (2019) who announced, ducklings fed 0.22% P had lower feed intake and nutrients utilization, while increasing dietary levels of non-phytate phosphorus led to increase (P<0.05) feed intake and improve FCR.

Carcass traits:

Carcass traits data are present in Table 4. There is no differences in all carcass traits except for heart and spleen weight (%) among nutritional plans. Ducklings fed 0.70% Ca + 0.35% P (T_1) had lower eviscerated and total edible parts weight (%) as compared with other treatments. However, ducklings fed 0.85% Ca + 0.40% P (T_2; as a control group), 1.0% Ca + 0.45% P (T_3) and 1.15% Ca + 0.50% P (T_4) were presented better carcass parameters. These results are confirmed with Costa *et al.* (2019) who affirm Muscovy ducklings fed diet contained higher available P (0.50-0.60%) produced the better carcass traits than those fed the low level of P.

Table 4. Influence of various dietary calcium and phosphorus levels on carcass measurements at 91 d-old of Sudani ducklings

Measurements	Treatment				Poole ± SEM	Sig.
	T_1	T_2	T_3	T_4		
Slaughter weight (g)	2853.00	2866.70	2916.70	2900.00	31.70	NS
Eviscerated (%)	69.69	70.35	70.63	70.90	0.20	NS
Total giblets (%)	4.17	4.58	4.21	4.07	0.10	NS
Total edible parts (%)	73.86	74.94	74.84	74.96	0.20	NS
Liver (%)	1.37	1.67	1.56	1.37	0.05	NS
Gizzard (%)	1.94	2.02	1.82	1.90	0.06	NS
Heart (%)	0.86^{ab}	0.90^{a}	0.83^{ab}	0.79^{b}	0.02	*
Spleen (%)	0.08^{a}	0.07^{ab}	0.07^{a}	0.05^{b}	0.005	*
Pancreas (%)	0.18	0.21	0.16	0.16	0.011	NS

a , b :means within the same row of each item bearing various super letters are significantly different ($P \leq 0.05$), SEM: stander error of mean ; NS: non-significant; *: significant effect at $P \leq 0.05$; T_1: (0.70% Ca : 0.35% P); T_2: (0.85% Ca : 0.4% P; as a control); T_3: (1.0% Ca : 0.45% P), and T_4 (1.15% Ca : 0.50% P).

Blood metabolites:

All blood constituents of Sudani ducklings at 91 days-old not ($P > 0.05$) affected, except for Hb content (Table 5). Values of Hb were significantly lowered by increasing Ca and P levels within the diet. On the other hand, both serum ionic and total calcium constituents were not ($P>0.05$) affected among all groups owing to various dietary Ca and P levels (Table 5). Moreover, serum total phosphorus content recorded a similar value without significant effect among dietary treatments. The present findings are in agreement with Yang *et al.* (2020) who recently illustrated, diet Ca level didn't affect ($P>0.05$) on Ca and P in serum of broilers at 28 days-old.

Serum ALP was recorded a higher value for ducklings fed 1.15% Ca + 0.50% P (T4) than other groups. Alkaline phosphatase enzyme (ALP) is centralized in the plasma membrane of osteoblasts before extracellular relief, correlates with bone reabsorption (Golub and Boesze-Battaglia, 2007). In the current study, serum ALP activity was elevated by increase Ca and P levels within the diet, which explaining that ducklings might evolve bone reabsorption to obtain P for important metabolism activities. The higher ALP activity was connected with the escalated bone reabsorption might be to serum P was elevated in the T4 compared with T2 or T1 groups. The present result is in the line with Yang *et al.* (2020) who recently stated that diet Ca level didn't affect (P>0.05) on serum ALP of broilers at 28-d-old. In contrary, Xu *et al.* (2019) showed that ducks fed 0.22% non-phytate phosphorus had more (P<0.05) serum Ca and ALP content, while increasing dietary non-phytate phosphorus level led to linearly increasing (P<0.05) of serum P content.

Table 5. Influence of various dietary calcium and phosphorus levels on hematological and serum metabolites constituents of Sudani ducklings at 90 d-old

Parameters	Treatments				Pooled ± SEM	Sig.
	T_1	T_2	T_3	T_4		
Hematological parameters						
Hemoglobin (g/dL)	18.34^{a}	16.06^{b}	15.95^{b}	14.99^{b}	0.47	*
Red blood cells ($\times 10^6$/dL)	3.59	3.56	3.50	3.31	0.05	NS
White blood cells ($\times 10^3$/dL)	21.35	21.87	22.07	20.69	0.29	NS
Serum constituents						
Triglycerides (mg/dL)	33.00	33.00	33.67	34.67	1.03	NS
vLDL (mg/dL)	6.60	6.63	6.73	6.93	0.21	NS
Total calcium (mg/dL)	8.80	8.33	8.10	8.63	0.10	NS
Ionic calcium (mg/dL)	4.13	4.07	3.93	4.10	0.04	NS
Phosphorus (mg/dL)	5.63	5.97	5.57	5.68	0.13	NS
ALP (IU/dL)	35.73	31.03	30.93	38.20	2.14	NS
Vit. D (IU/dL)	8.10	8.00	8.00	10.80	0.49	NS

a , b :means within the same row of each item bearing various super letters are significantly different ($P \leq 0.05$), vLDL: very low-density lipoprotein; ALP: alkaline phosphatase; SEM: stander error of mean; NS: non-significant; *: significant effect at $P \leq 0.05$; T_1: (0.70% Ca : 0.35% P); T_2: (0.85% Ca : 0.4% P; as a control); T_3: (1.0% Ca:0.45% P), and T_4 (1.15% Ca : 0.50% P).

Serum vit. D content not ($P>0.05$) change for all ducklings fed various dietary Ca and P levels, although serum vit D recorded a higher ($P>0.05$) level for ducklings fed 1.15% Ca + 0.50% P (T4) than those in other experimental groups (Table 5). This results is similar with Yang *et al.* (2020) who found that dietary Ca level didn't affect (P>0.05) on serum vit. D content of broilers at 28-d-old.

Tibia Bone Characteristics:

Data for tibia bone measurements are summarized in Table 6. There were no significant differences ($P>0.05$) in all tibia bone measurements among all treated groups of Sudani ducklings except for tibia Ca content at 91 days-old. Ducklings fed 0.70% Ca + 0.35% P (T1) had lower Ca contents in tibia bone than those fed 1.0% Ca + 0.45% P (T3) or those fed 1.15% Ca + 0.50% P (T4) diet. On the other hand, there is no changes in tibia P content among all treated groups of ducklings. The higher demand of available P is needed in the initial phase for ducklings, which is due to the swifter growth of bone tissue than other tissues, with Ca and P sedimentation very necessary at this stage (Sousa *et al.*, 2015). These findings in same line with Rao *et al.* (2008) who reported that the relative weight of tibia and tibia ash content were attenuated significantly with Ca and P reduction within the diet. Scarcity of P within the diet could be achieved non-deleterious effects on bone mineralization if Ca is lowered concomitantly, as a result of Ca : P ratio is still in the range between 2:1 and 1:1, which is mostly appropriately for poultry industry (Driver *et al.*, 2005; Rao *et al.*, 2006).

Serum and bone constituents from Ca and P could reflect broilers bodies content from these minerals, where Li *et al.* (2012) and Yang *et al.* (2020) discussed that, broilers tibia Ca was attenuated when feeding low Ca diet, while tibia P not influenced by non-phytate phosphorus, which was partially harmonious with Akter *et al.* (2016); Yang *et al.* (2020) who stated that non-phytate phosphorus within the diet didn't affect in tibia phosphorus content.

Table 6. Influence of various dietary calcium and phosphorus levels on tibia measurements of Sudani ducklings at 91 d-old

Measurements	Treatment				Pooled ± SEM	Sig.
	T_1	T_2	T_3	T_4		
Weight (g)	13.00	13.33	13.33	13.33	0.07	NS
Length (cm)	11.65	11.92	11.90	11.93	0.09	NS
Radius (cm)	0.35	0.35	0.33	0.34	0.01	NS
Size (cm^3)	3.95	3.94	3.54	3.59	0.08	NS
Density (g/cm^3)	3.30	3.38	3.78	3.71	0.10	NS
Tibia minerals content						
Calcium (mg/dL)	12.63[b]	12.91[ab]	13.18[a]	13.01[a]	0.09	*
Phosphorus (mg/dL)	4.32	4.32	4.30	4.34	0.05	NS

a , b :means within the same row of each item bearing various super letters are significantly different ($P \leq 0.05$), SEM: stander error of mean ; NS: non-significant; *: significant effect at $P \leq 0.05$; T_1: (0.70% Ca : 0.35% P); T_2: (0.85% Ca : 0.4% P; as a control); T_3: (1.0% Ca : 0.45% P), and T_4 (1.15% Ca : 0.50% P).

CONCLUSION

Based on the present data, we concluded that necessity to use the diet containing 1:1.15 calcium with 0.45: 0.50 phosphorus (%) to achieve the best growth characteristics and the ratio of edible parts as well as tibia Ca content for Sudani ducklings during growing period.

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تأثير مستويات الكالسيوم والفوسفور في العليقة على الأداء الإنتاجي وصفات الذبيحة وعظمة الساق لكتاكيت البط السودانى

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أجري هذا البحث لتقييم تأثير استخدام مستويات مختلفة من الكالسيوم والفوسفورفى عليقة كتاكيت البط السودانى علي أدائها الإنتاجي، صفات الذبيحة وعظمة التبيا خلال فترة النمو. حيث استخدم عدد 240 كتكوت بط سودانى عمر7 أيام تم وزنها وتقسيمها فى تصميم تجريبى تام العشوائية إلي أربعة مجموعات تجريبية كل فى ثلاث مكررات (20 كتكوت/مكررة). وقد غذيت كتاكيت المجموعة الأولى على عليقة تحتوي علي 0.70% كالسيوم و0.35% فوسفور، المجموعة الثانية على 0.85% كالسيوم و0.40% فوسفور (المجموعة الضابطة)، والمجموعة الثالثة على 1.00% كالسيوم و 0.45 % فوسفور، والمجموعة الرابعة على 1.15 % كالسيوم و 0.50 % فوسفور فى كل من العليقة البادئة (7-49 يوم) والنامية (49 -91 يوم) للتجربة. أوضحت النتائج وجود تحسن معنوى فى وزن الجسم الحي عند 91 يوم من العمر وكذلك الزيادة المكتسبة فى وزن الجسم ومعدل التحويل الغذائى للكتاكيت بالمجموعة الرابعة بالمقارنة بكتاكيت المجموعة الأولى خلال الفترة الكلية للدراسة (7-91 يوم من العمر). أيضا تلاحظ تحسن كل من نسبتى الذبيحة المفرغة ومجموع الأجزاء القابلة للأكل بزيادة مستوى كل من الكالسيوم والفوسفور فى العليقة. كما لوحظ عدم تأثر الصفات الهيماتولوجية للدم معنويا فيما عدا محتواه من الهيموجلوبين والذى انخفض بزيادة مستوى كل من الكالسيوم والفوسفور فى العليقة. أيضا لم يتأثر محتوى سيرم الدم من الكالسيوم والفوسفور وفيتامين د وانزيم الألكالين فوسفاتيز بمستويات الكالسيوم والفوسفور فى العليقة. كما لوحظ وجود زيادة معنويه فى محتوى عظمة الساق من الكالسيوم بزيادة مستوى الكالسيوم فى عليقة الكتاكيت، بينما لم يتأثر محتواها من الفوسفور. لذلك تشير النتائج المتحصل عليها إلى ضرورة استخدام علائق تحتوى على الكالسيوم بنسبة من 1.0 : 1.15 % والفوسفور بنسبة من 0.45 : 0.50 % للحصول على أفضل أداء إنتاجى وصفات الذبيحة ومجموع الأجزاء المأكولة وتحسين محتوى عظمة الساق من الكالسيوم لكتاكيت البط السودانى خلال فترة النمو (7-91 يوم).