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EFFECT OF VITAMIN K_3 ON CHICKEN PRODUCTION PERFORMANCE AND BONE QUALITY 2-DURING GROWING PERIOD

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ABSTRACT: The present study was performed to study the influence of dietary supplementation of Mandarah female birds during the growing period with higher levels of vitamin K_3 more than that recommended on growth performance, tibia bone parameters, X-Ray examination, histological observation and some blood parameters. Three hundred Mandarah chicken females were assigned in cages from 4 to 16 weeks of age. The birds were randomly divided into 5 groups with 3 replicates per each representing the dietary supplementations. The first group was served as control (T1) without any supplementation and fed basal diet containing 3 mg K_3 / kg diet . The rest 4 groups were fed diet supplemented with menadion as additional doses of vitamin K_3 source to be 5, 7,9and 11mg k_3 / kg diet for T2, T3, T4 and T5 groups, respectively. Results revealed that during the whole experimental period (4-16 wks) of age, all extra supplementations of vitamin k_3 resulted in a significant ($P \leq 0.05$) improvement in body weight gain and feed conversion ratio compared to those for control group (T1), besides T_5 group realized the best significant record of body weight gain and feed conversion ratio compared with the rest experimental groups. Moreover, the best improvement of tibia parameters including length , width , breaking strength, weight, ash%,Ca% and P% were recorded for birds of T4 and T5 groups. Birds of T_5 group (11mg k_3/kg diet) had the highest values of the serum osteocalcin (OC) and plasma Ca, P, ionized calcium (ICa) and alkaline phosphatase (AP). X- Ray pictures of tibia bone for all vitamin K3 supplemented groups represented high bone density and did not show any incidence of osteopenia. Histological observations of tibia bone for birds of T3, T4 and T5 groups illustrate marked increase of trabecular bone density, osteocytes and periosteum. In conclusion, supplementing the diet containing 3 mg K_3 / kg diet of Mandarah female birds during the growing period with vitamin k_3 to be 11 mg vitamin K_3 / kg diet could be recommended due to beneficial influence of these extra doses on improving growth performance, bone mass ,quality and strength .

Keywords: Vitamin K_3 – cage - growing – osteocalcin - X-Ray - bone parameters

INTRODUCTION

Vitamin k is a series of compounds with structure of polyisoprenoid-substituted naphthoquinone, it includes vitamin k_1 and k_2 which originate from plants or bacteria, respectively and a group of synthetic menadione derivatives such as menadione (k_3) (Jin and Sell, 2001).Bone is a dynamic tissue influenced by physiological, nutritional and physical factors such as mechanical stress and physical activities and under controlled conditions of feeding, bone strength of growing birds can be adequately maintained to last their productive life (Rath et al.,2000). During the pre and starter laying period, female birds need more Ca to form medullar bone that is essentially woven bone with high rate of remodeling providing Ca to meet demand of egg shell formation throughout laying periods (Fleming et al., 1998 and Rath et al., 2000). While, Fernandes et al.(2009) reported that, excessive Ca can impair the bioavailability of minerals such as P, Mg ,Mn and Zn and diet can become less palatable and dilute other components when high calcium carbonate levels are used. Thus currently vitamin k is now receiving more attention in relation to its role in bone metabolism especially human and originally recognized as a factor required for normal blood coagulation (Bügel, 2003), and there is some evidence that vitamin k affects the Ca balance (Fernandes et al.,2009). Furthermore, vitamin k is required for the post-translation modification of osteocalcin which is the most abundant none-collagenous protein and has a high affinity for Ca associated with bone growth (Fleming et al, 1998 and Jagtap and Ganu, 2011).

There is evidence indicating that the production of vitamin k by microbiota seems not sufficient for body function (Caroline et al., 2015). Therefore, Leeson and Summers (2001) reported that, there is a need for vitamin k_3 supplementation to the diet for bone growth of broiler. Moreover, Zhang et al. (2003) concluded that there is a positive effect of vitamin k on bone quality and feed efficiency for broiler. Also, Jin et al (2001) found that supplementation the diet with vitamin k significantly increased turkey tibia ash. Furthermore, Caroline et al. (2015) detected that vitamin k supplementation affects plasma alkaline phosphatase beside increased tibia length and ash% for meat quail.

As previously indicated, there is little collaborative data on the effect of vitamin k on bone and related parameters for female birds during the growing period. Therefore, this study was performed to determine the influence of dietary k_3 supplementation on growth performance, bone quality and related plasma parameters of Mandarah females during the period from 4 to 16 wks of age.

MATERIALS AND METHODS

Experimental Design:

The present study was performed at EL-Sabahia Poultry Research Station, Animal Production Research Institute, Agriculture Research Center. Three hundred females of Mandarah birds were housed in galvanized cages from 4 up to 16 weeks of age. The reason of avoiding the doing of this experiment during the first four weeks of age that McDowell (1989) mentioned that vitamins can be synthesized by bacteria in intestinal tract in sufficient for very young chicks, also Rath et al.(2000) found that bone strength normally increase from day 1 to a peak between 3 to 5 wks of age. The birds were randomly divided into five groups representing the dietary supplementations with 3 replicates per each. The first group was served as control (T1) without any supplementation and fed basal diet contains 3 mg menadion (k_3) / kg diet . The four rest groups were supplemented with additional doses of vitamin K_3 to be 5, 7,9 and 11 mg K_3 / kg diet for T2, T3, T4 and T5 groups respectively. The ingredient profile and nutrient composition of the basal diet are shown in Table 1 according to the feed composition for animal and poultry feed stuff in Egypt (2001). Feed and water were provided *ad- libitium*.

Measurements:-

Body weight (g) and feed consumption (g) were recorded every week for each replicate per treatment then calculated during 4 weeks and for the whole experimental periods for all groups. Body weight gain (g) and feed conversion (g feed/ g gain) ratio were calculated. No mortality was recorded during the experimental period.

At 16th week of age, three birds from each replicate were randomly taken for slaughter. Tibia bones of both sides were removed, cleaned from all soft tissues and weighed. Tibia length and width were detected using micrometer according to the method of Samejima (1990). Right tibia was used for breaking strength evaluation (Newton) in the laboratory of Mechanical Properties and Test Materials, Faculty of Engineering, Ain-Shams University according the method of Park et al.(2003). The tibia was dried at 105 C$^{\circ}$ until constant weight and the quantities of crude ashes were detected according to Yi et al.(1996), then dissolved and filtered to determine Calcium(Ca) and Phosphorus(P) percentages by atomic absorption. Left tibia was taken for X- Ray examination and subjected to histological observation in the Laboratory of Poultry Physiology, Faculty of Veterinary Medicine, Kafr EL-Sheikh University.

Blood samples were taken from the same previous slaughtered birds. A portion of the fresh blood was used immediately for determining clotting time (seconds) beside measuring both of serum osteocalcin protein (OC) (ng/ml) according to method of Jiang et al. (2013) and serum parathyroid hormone PTH (Pg/ml). In addition, other portion of blood was collected in heparinized tube for measuring plasma alkaline phosphatase (AP, I.u/L), calcium (Ca, mg/dl), ionized calcium (ICa, mg/dl) and phosphorus (P, mg/dl) by available commercial bio-diagnostic kits, Egypt.

Statistical Analysis:

Data obtained were statistically analyzed using General Linear Model procedure (GLM) of SAS (2004). The significant differences among treatment means were tested according to Duncan (1955).

The following model was used

$Y_{ij} = \mu + L_i + e_{ij}$ where,

Y_{ij} = observed traits

μ = the overall mean

L_i= effect of vitamin K_3 level (1,2,3,4,5)

e_{ij} = experimental random error.

RESULTS AND DISCUSSIONS

Growth Performance:

Effects of dietary supplementation with vitamin K_3 for Mandarah females from 4 - 16 weeks of age on body weight, body weight gain and feed conversion ratio are shown in Table 2.No significant changes were observed among treatments for body weight at 4^{th} week of age. Birds of T_3,T_4 and T_5 groups represented the highest ($P \leq 0.05$) body weight compared to those for T_2 and T_1 groups at 8 and 12 wks of age. Whereas, at 16 wks of age, all groups of extra vitamin k_3 supplementation realized the highest ($P \leq 0.05$) body weight values compared to control group (T_1), and birds of T_5 group recorded the highest ($P \leq 0.05$) increase of body weight compared with the rest experimental groups. Birds of T_3(7mg k_3/ kg diet) , T_4 (9mg k_3/ kg diet) and T_5(11mg k_3/ kg diet) groups realized the best values of body weight gain and feed conversion ($P \leq 0.05$)compared with those for T_1 and T_2 groups during the first experimental period (4-8 wks of age). While, throughout the period of 9-12 and 13-16 wks of age birds of T_5 group recorded highest numerical increase of body weight gain and feed conversion improvement compared with all experimental groups and did not represent any significant change with the rest of treated groups.

Generally, during the whole experimental periods (4-16 wks) of age, all extra supplementations of vitamin k_3 for T_2, T_3, T_4 and T_5 groups represented significant ($P \leq 0.05$) increase of body weight gain and significant ($P \leq 0.05$) improvement of feed conversion ratio compared with those for T_1 group, besides T_5 group realized the best significant record of body weight gain and feed conversion ratio compared with all rest experimental groups. In this respect, Thijssen and Drittij- Reijnders (1994) detected that increased body weight gain and the improvement of feed conversion by vitamin K_3 supplementation to the diet could be related to role of vitamin K on digestive enzymes. Partial agreement with previous results was reported by Zhang et al. (2003) who mentioned that, diet supplemented with 8 mg/kg diet, vitamin K improved broiler growth performance during 6-7 wks of age. Whereas, our results did not support the results of Jin et al. (2001) who found that dietary K_1 with levels of 0.5, 1 or 2 mg/kg did not affect body weight gain or feed efficiency of poults through the first fourteen days of age. Likewise, Caroline et al. (2015) represented the same conclusion with growing quail during 1-14 days of age with vitamin K level of 0.7, 1, 1.3, 1.6, 1.9, 2.2, or2.5 mg/kg diet.

The conflicting results of body weight gain and conversion due to vitamin k_3 supplementation exceeding than that recommended could be due to different factors such as species, flock age and vitamin k concentrations.

Bone Parameters

Data of Table 3 display the effect of dietary vitamin k_3 level on some parameters of tibia bone at 16 wks of age. It can be observed from data of this table that supplementation all experimental levels of vitamin k_3 significantly ($p \leq 0.05$) increased the studied parameters of tibia bone including length, width, breaking strength, weight, ash %, Ca % and P% compared with those for control group.

Moreover, supplementing the diet with 9 or 11 mg k_3/kg diet (T_4 andT_5) recorded the best values of all tibia bone measurements and composition. Results herein are keeping with the previous reports including vitamin k levels supplementation at different bird's age and species. Jin et al. (2001) found that supplementation the diet with 2 mg vitamin k to turkey diet significantly increased tibia ash at 7 days of age. Moreover, Zhang et al. (2003) found that bone breaking strength, bone ash and bone mineral content were significantly increased by increasing supplementation of vitamin k to broiler diet. Also, Caroline et al. (2015) pointed out that tibia bone length of broiler had a linear increase according to the vitamin k supplementation levels. The increase of bone ash and breaking strength for birds supplemented with extra vitamin k_3 could be explained on light of tibia Ca and P percentages increase. This statement is supported by Rath et al. (2000) who showed that adequate Ca in the bone is necessary to decrease bone turnover. Also, Moreki (2005) mentioned that Ca plays a vital role in bone formation and development. Furthermore, Fernandes et al. (2009) found that low level of vitamin k induces the synthesis of non-carboxylated osteocalcin that presents poor affinity for hydroxyapatite leading to deficient bone mineralization. Moreover, Boskey and Coleman (2010) referred that the strength of bone is determined by the mineral amount content.

The improvement in bone quality and maturation of tibia bone during the pre-laying period in the current study could be due to the extra vitamin k_3 supplementation which contributes to raise carboxylated osteocalcin which can be bind to Ca from the bone matrix and induce better mechanism of Ca use.

Blood Parameters:

Data of Table 4 reveal that all vitamin k_3 supplementations numerically decreased clotting time for Mandarah birds at 16 wks of age compared to control (T_1). Furthermore, all extra doses of vitamin k_3 supplementations resulted in significant ($p \leq 0.05$) increase of serum OC and plasma Ca, ICa, p and AP compared with those for control one, besides birds of T_5 groups (11mg k_3/kg diet) had the highest values of the previous mentioned parameters. While, all vitamin k_3 supplementations significantly ($p \leq 0.05$) decreased serum PTH concentration compared to control.

However, there is little actual data published to support the concept of blood parameters due to extra vitamin k_3 supplementations. Fleming et al. (1998) and Zhang et al. (2003) found that vitamin k increased broilers OC concentration. Moreover, Caroline et al. (2015) detected that AP values increased with vitamin k supplementation to diet of growing quail at 14 day of age. While, the same authors found that, plasma Ca concentration was not affected by the vitamin k levels. Furthermore, Wesam et al.(2018) revealed that, dietary vitamin k_3 increased serum OC and plasma Ca, ICa, P and AP and decreased serum PTH hormone for aged hens.

The increasing values for serum OC and plasma Ca, ICa, P and AP could be the reason of increasing measurements and composition of tibia bone as detected in Table 3.This conclusion could be interpreted by different previously statements as Mckee et al.(1992) noted that OC plays an important role in bone formation and extracellular mineralization process. Also, Jagtap and Ganu (2011) reported that osteocalcin has a high affinity for Ca and elevated levels of serum OC and may be associated with increased activity of osteoblasts. Furthermore, Plantalech et al. (1991) and Bügel (2003) detected that, vitamin k is a coenzyme for glutamate carboxylase in which glutamic acid residues (GLA) transform the g- carboxyglutamic glutamatic acid into blood coagulation factors and bone proteins and Gla residues attract Ca^{2+} (ICa) and incorporate these ions into hydroxyapatite crystals. While, low levels of vitamin k results in an increase in under-carboxylated OC caused low bone mineral density and increased bone fracture. Moreover, AP is seen in activated osteoblasts and involved in the mineralization process and greater AP activity is a good sign of bone formation (Li et al., 2014).

Moreover, the results of increasing Ca, ICa, P and AP by dietary supplementation of vitamin k_3 could be the reason of increasing bone formation and in turn body weight gain. Monika and Roselina (2013) mentioned that Ca and P are essential elements and play an important role in bone development and mineralization and increased growth rate. The results of PTH decrease besides OC and Ca increase in blood and bone due to elevation of vitamin k_3 supplementations are documented with close explanation of Monica and Roselina (2013) who noted that low Ca in the blood secrete extra PTH which stimulated the conversion of vitamin D_3 to 1,25 ($OH)_2$ D_3 that in turn increases intestinal Ca absorption and finally losses of more Ca from bone. Furthermore, Kristina (1995) added that extra PTH may be restrictive the OC synthesis in osteoblasts.

X- Ray Examination of Tibia Bone:

X- Ray pictures of the tibia bone for growing female birds at 16 wks of age are presented in Figure 1. Tibia bone of control group showed incidence of osteopenia and clear decline of bone density while all pictures of tibia bone for all vitamin K_3 groups had high bone density and did not show any incidence of osteopenia. The increase of bone density and controlling of osteoporosis for tibia bone of vitamin K_3 groups could be related to the increase for each of bone Ca% and bone strength (Table 3) and blood OC (Table 4). Using X ray for evaluating bone density was previously detected by Rath et al. (2000) who showed that bone density is a reflection of bone mineral content and could be used as indices of bone strength.

Histological Observation of Tibia Bone:

Figure 2 illustrates cross sections of tibia bone for Mandarah female birds at 16 wks of age subjected to extra doses of vitamin K_3. Sections of tibia bone for control group (T_1) showed decrease of ossification and bone density with reduction of trabecular (cancellous) bone formation (osteocytes) and thickness besides, an increase of osteopenia incidence. While, pictures of tibia bone for birds of T_3, T_4 and T_5 groups represented marked increase for each of trabecular bone density, osteocytes and periosteum. Whereas, pictures of T_2 group show moderate increase of the previously mentioned characters appeared for T_3, T_4 and T_5 groups. All sections of tibia for all female birds groups supplemented with extra vitamin K_3 did not show any incidence of osteoporosis. There is a paucity of information describing associated changes in the histology of bird's tibia bone subjected to higher dietary supplementation of vitamin K_3. Fleming et al. (1998 and 2003) found that dietary supplementation with extra vitamin K_3 to female diet can enhance cancellous bone formation during the growing period. Also, Iwamoto et al. (2011) suggested that, a beneficial effect of vitamin K_2 on bone mass of rats. Moreover, Zhang et al. (2016) showed that vitamin K_2 has been shown to play an important and beneficial role in bone metabolism for rats. Also, Wesam et al. (2018) found that, vitamin K_3 play a vital role in controlling osteoporosis disease for aged layers. The combining results of thickness decrease in trabecular and trabecular space increase for female tibia bone of growing birds for control group suggesting that there is insufficient bone formation or bone loss in the birds of this group and these histological signs may shed some lights on the corresponded results of osteocalcin concentration reduction as presented in Table 4. These results approach with those previously reported by Tomazewska et al. (2016).

IN CONCLUSION

To gain a more accurate results and further insight , we have separated the chicken sexes in two experiments to monitor the change in calcium metabolism due to supplying the diet with vitamin k_3 and data of chicken males will be published in the coming research. The results of this study proved that supplementing the diet contains 3 mg k_3 / kg diet to be 11 mg k_3 / kg diet more than recommended during the early stage of Mandarah female life could be a potential approach for improving bone mass, strength, and quality and finally the productive performance. Thus, this outcome could be beneficial for reducing the opportunity of osteoporosis appearance for layers .We hope that this strategy could open alternative ways for overcoming the skeletal problems and improve the productive performance.

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

Diet / Ingredients	Starter (4-8 wks)	Grower (9-16 wks)
Yellow corn	630.00	615.00
Wheat bran	0.00	200.00
Corn gluten meal. 60	35.00	46.00
Soybean meal	292.00	95.00
Vit. and Min. Premix[1]	3.00	3.00
Sodium chloride (NaCl)	3.00	3.00
Dicalcium phosphate	19.5	19.1
Limestone	15.7	16.00
Lysine	0.5	2.1
DL – Methionine	1.3	0.8
Total	1000	1000
Calculated analysis		
Crude protein (%)	20.01	15.07
ME(Kcal/Kg diet)	2906	2715
C/P ratio	145	180
Ether extract (%)	2.82	3.42
Crude fiber (%)	3.08	3.89
Calcium (%)	1.08	1.04
Phosphorus available (%)	0.51	0.51
Methionine (%)	0.46	0.36
Methionine + Cysteine (%)	0.80	0.64
Lysine (%)	1.00	0.75
Chemical analysis		
Crude protein (%)	20.00	15.00
Ether extract (%)	2.80	3.40
Crude fiber (%)	3.14	3.90

Vit+Min mixture provides per Kilogram of diet: Vit. A, 1200 IU; Vit. E, 10 IU; menadione, 3 mg; Vit. D_3, 2200 ICU; riboflavin, 10mg; Ca pantothenate, 10mg; nicotinic acid, 20 mg; Choline chloride, 500mg, Vit. B_{12}, 0.01mg; Vit.B_6, 1.5mg; Vit.B_1, 2.2mg; Folic acid, 1mg; Biotin, 0.05mg. Trace mineral (milligrams per kilogram of diet) Mn.55; Zn. 50; Fe. 30; Cu. 10; Se.0.10;Antioxidant.3mg.

Table (2): Effect of extra dietary vitamin K_3 on growth performance of Mandarah female birds (Means ± SE)

Items	weeks	vitamin K_3 (mg/Kg diet)				
		T1 (control,3mg)	**T2 (5 mg)**	**T3 (7mg)**	**T4 (9mg)**	**T5 (11mg)**
Body weight (g)	4wks	170.93±1.18	172.33±1.79	171.46±3.0	175.60±2.0	171.73±2.30
	8 wks	500.20±11.54^{b}	506.26±15.93^{b}	545.93±18.92^{a}	547.93±12.18^{a}	554.80±15.37^{a}
	12 wks	842.20±31.10^{b}	867.20±20.03^{b}	918.01±16.17^{a}	921.86±20.07^{a}	947.20±17.26^{a}
	16 wks	1150.33±14.82^{d}	1184.53±19.21^{c}	1240.04±14.19^{b}	1248.60±11.72^{b}	1288.00±12.24^{a}
Body weight gain (g)	4-8 wks	329.26±9.55^{b}	333.93±5.81^{b}	374.46±17.78^{a}	372.33±5.31^{a}	383.06±2.66^{a}
	9-12 wks	342.00±8.54^{b}	360.93±12.38^{ab}	372.06±18.86^{ab}	373.93±18.08^{ab}	392.40±6.98^{a}
	13-16 wks	308.13±7.54^{b}	317.33±0.95^{ab}	322.40±9.79^{ab}	326.73±15.24^{ab}	340.80±6.20^{a}
	4-16 wks	979.40±12.58^{d}	1012.20±5.92^{c}	1068.93±4.51^{b}	1073.00±3.41^{b}	1116.27±3.55^{a}
Feed conversion ratio (g /g)	4-8 wks	4.15±0.11^{a}	4.06±0.06^{a}	3.61±0.16^{b}	3.57±0.02^{b}	3.46±0.05^{b}
	9-12 wks	4.63±0.08^{a}	4.34±0.17^{ab}	4.29±0.18^{ab}	4.19±0.24^{ab}	4.03±0.03^{b}
	13-16 wks	6.00±0.15^{a}	5.79±0.03^{a}	5.74±0.60^{a}	5.57±0.29^{ab}	5.18±0.10^{b}
	4-16 wks	4.88±0.03^{a}	4.68±0.03^{b}	4.43±0.01^{c}	4.33±0.02^{d}	4.18±0.04^{e}

a,b,c and d means having different letters in the same row are significantly different (P≤0.05).

Table (3): Effect of extra dietary vitamin K $_3$ on tibia bone parameters of Mandarah female birds at16 wks of age (Means ±SE)

Items	Vitamin K$_3$ (mg/Kg diet)				
	T1 (control ,3mg)	**T2 (5mg)**	**T3 (7mg)**	**T4 (9mg)**	**T5 (11mg)**
Tibia length (mm)	100.00 ± 0.36^{d}	103.25 ± 0.003^{c}	104.07 ± 0.03^{b}	106.9±0.03^{a}	106.83±0.07^{a}
Tibia width (cm)	0.47 ± 0.003^{d}	0.55 ± 0.003^{c}	0.57 ± 0.003^{b}	0.64 ±0.003^{a}	0.64 ±0.003^{a}
Breaking strength(N)	171.04 ± 0.03^{e}	184.70 ± 0.03^{d}	219.4±0.03^{c}	241.2±0.03^{b}	263.2±0.03^{a}
Tibia weight (g)	8.05 ± 0.03^{e}	10.80±0.083^{d}	11.03±0.03^{c}	12.13±0.05^{b}	12.8±0.03^{a}
Ash (%)	36.00 ± 0.36^{c}	43.53±0.84^{b}	46.08±0.03^{a}	56.10±0.02^{a}	47.00±0.36^{a}
Calcium (Ca%)	11.02 ±0.36^{c}	17.2 ±0.46^{b}	19.01±0.36^{a}	24.80±0.02^{a}	19.4±0.36^{a}
Phosphorus (P%)	6.02 ±0.003^{e}	8.02±0.003^{d}	8.34±0.004^{b}	10.30±0.002^{b}	8.92±0.001^{a}

a,b,c,d and e means having different letters in the same row are significantly different ($P \leq 0.05$).

Table (4) : Effect of extra dietary vitamin K $_3$ on some blood parameters of Mandarah female birds at 16 wks of age (Means ±SE)

Items	Vitamin K$_3$ (mg/Kg diet)				
	T1(control,3mg)	**T2 (5mg)**	**T3 (7mg)**	**T4 (9mg)**	**T5(11mg)**
Clotting time (second)	12.13±0.03	12.05±0.04	12.01±0.04	12.03±0.08	12.08±0.07
Osteocalcin protein (OC) ng/ml	80.47 ± 0. 05^{e}	92.70 ± 0.05^{d}	105.76 ± 0.08^{c}	116.90 ± 0.05^{b}	120.10 ± 0.05^{a}
Calcium (Ca) mg/dl	10.12 ± 0. 05^{e}	12.61 ± 0.05^{d}	12.92 ± 0.05^{c}	14.60 ± 0.05^{b}	15.10 ± 0.05^{a}
Ionized calcium(ICa) mg/dl	4.40 ± 0.05^{c}	5.38 ± 0. 08^{b}	6.26 ± 0.08^{ab}	6.01 ± 0. 05^{ab}	6.43 ± 0.02^{a}
Phosphorus (P) mg/dl	4.10 ±0.05^{e}	4.89 ±0.04^{d}	5.30 ±0.05^{c}	5.50 ± 0.05^{b}	6.10 ±0.05^{a}
Alkalin phosphatase (AP) I.U./L	23.90 ± 0.05^{e}	27.60 ± 0.05^{d}	27.90 ± 0.05^{c}	31.22 ± 0. 05^{b}	32.70 ± 0.05^{a}
Parathyroid hormone (PTH) pg/ml	19.20 ± 0.05^{a}	18.89 ± 0.03^{b}	18.80 ± 0.04^{d}	18.85± 0.05^{b}	18.32 ± 0.05^{c}

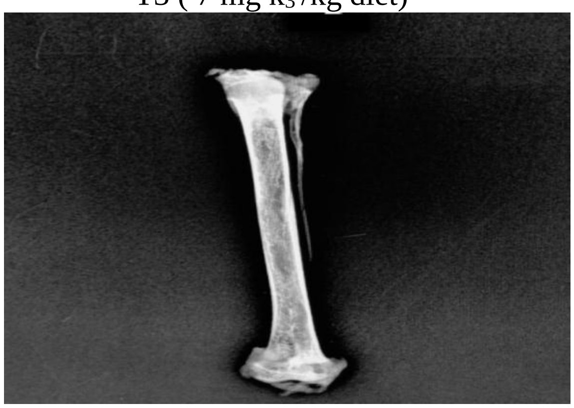
a,b,c,d, and e means having different letters in the same row are significantly different ($P \leq 0.05$).

Figure(1): X-ray of tibia bone for female birds at 16 wks of age as affected by extra vitamin K_3 supplementation

Control (T1 3 mg k_3 / kg diet)

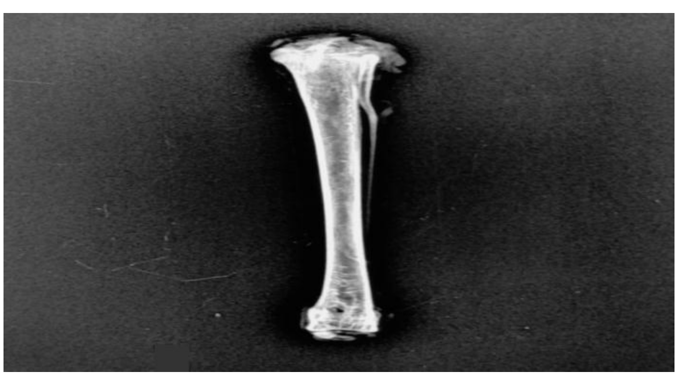
T2 (5 mg k_3 /kg diet)

T3 (7 mg k_3 /kg diet)



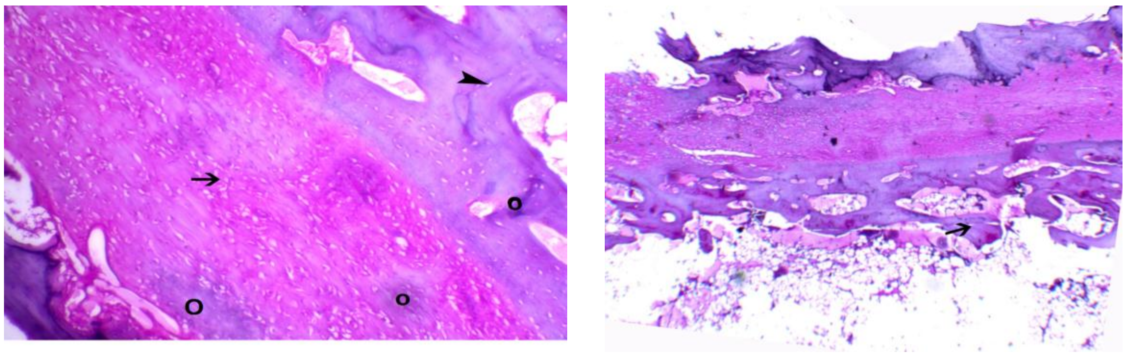
T4 (9 mg k_3 /kg diet)

T5 (11 mg k_3 /kg diet)

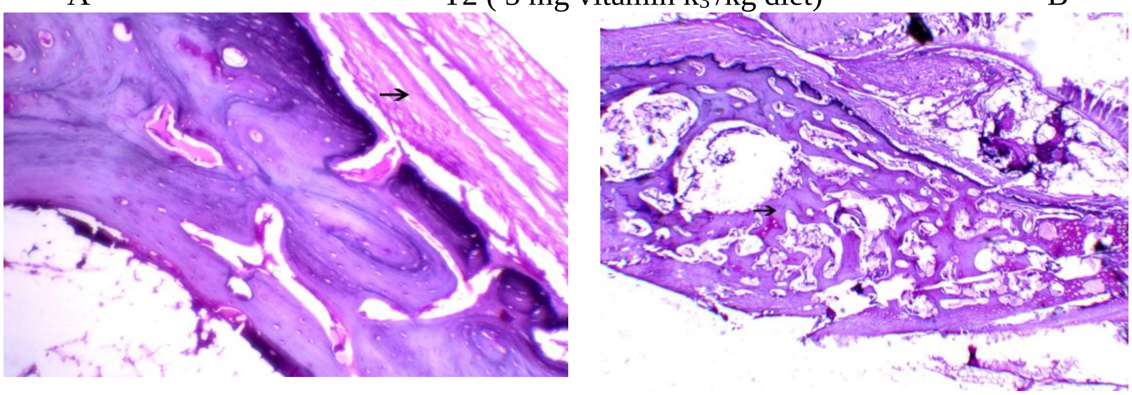


Figure(2): Photomicrographs cross-sections of tibia bone for female birds at 16 wks of age as affected by extra vitamin K_3 supplementation

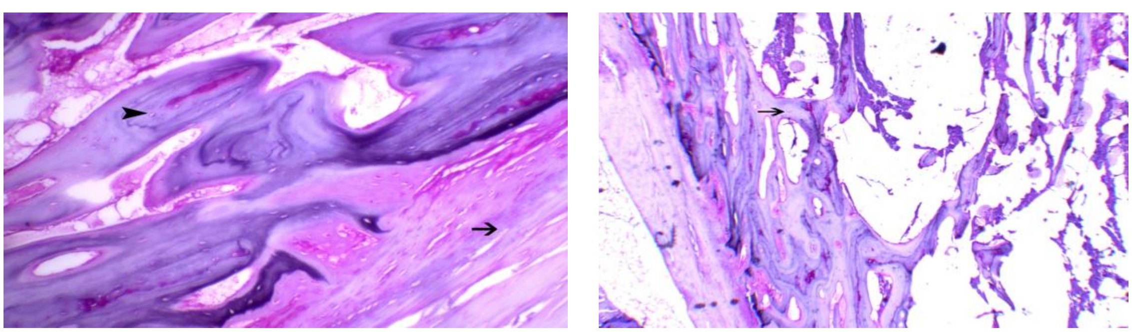
A (magnification, 200) Control (T1) B (magnification, 100)



A T2 (5 mg vitamin k_3 /kg diet) B

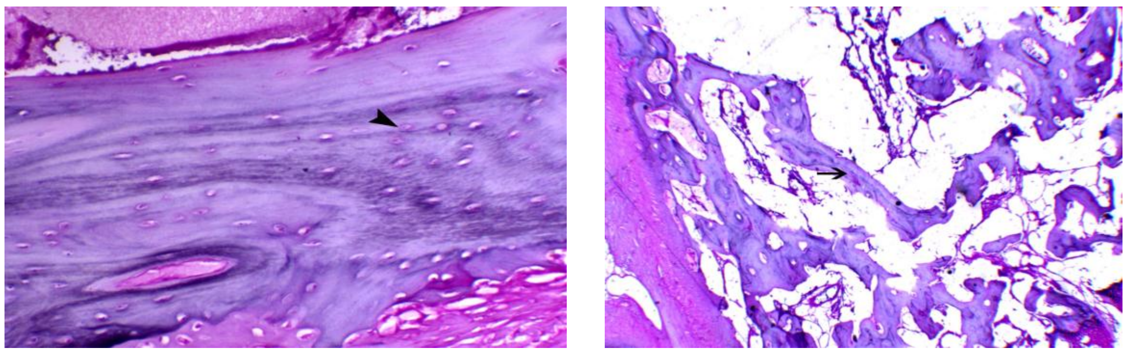


A T3 (7 g vitamin k_3 /kg diet) B

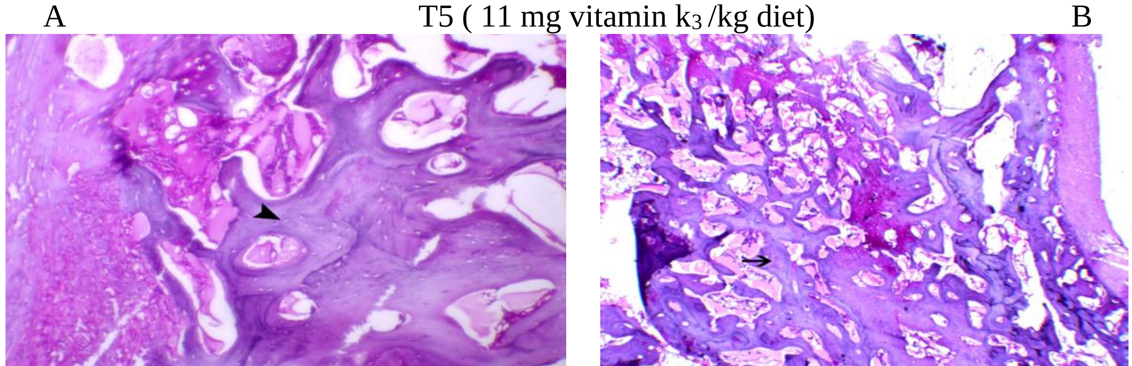


To be continued

A T4 (9 mg vitamin k_3 /kg diet) B



A T5 (11 mg vitamin k_3 /kg diet) B



O:osteoporosis, Trabecular → and : Ostiocytes

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الملخص العربى

تأثير فيتامين ك3 على الاداء الأنتاجى للدجاج و جودة العظام

2- خلال فترة النمو

وسام اديب فارس ، منى رفعت محمد أحمد ، مروه رمضان الدقن
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تم إجراء هذه التجربة لدراسة تأثير إضافة مستويات عالية من فيتامين ك3 أكثر من الموصى بها لعليقة إناث المندرة خلال فترة النمو على صفات النمو و نسبة التحويل الغذائى و مقاييس عظمة الساق إضافة لدراسة صور الأشعة السينية و كذا القطاعات الهستولوجية للساق بجانب بعض القياسات الفسيولوجية . إستخدم فى هذه الدراسة عدد 300 كتكوت أنثى من سلالة المندرة و تم تربيتها فى أقفاص من عمر 4 حتى 16 أسبوع . تم تقسيم الطيور عشوائياً إلى 5 مجاميع على حسب مستوى إضافة فيتامين ك3 للعليقة كل فى ثلاث مكررات . المجموعة الاولى (T1) و هى المقارنة و فيها تغذت الطيور على العليقة الأساسية بدون أى إضافة لفيتامين ك3 و هى محتوية أساسا على 3 ملجم ميناديون (ك3) / كجم عليقة . أما بالنسبة إلى المجموعات الاربع الاخرى فقد تم إضافة الميناديون إليها كمصدر لفيتامين ك3 ليصبح مستوى ك3 كما يلى 5 ، 7 ، 9 ، 11 ملجم / كجم عليقة لكل من المجاميع الثانية (T2) و الثالثة (T3) و الرابعة (T4) و الخامسة (T5) على التوالى . و قد أظهرت النتائج إلى وجود تحسن معنوى فى وزن الجسم المتحصل عليه (جم) و الكفاءة التحويلية و ذلك لكل المجاميع المضاف إليها فيتامين ك3 مقارنة بمجموعة الكنترول و ذلك خلال فترة التجربة من 4 – 16 أسبوع من العمر . و قد سجلت المجموعة الخامسة (T5) أحسن النتائج لوزن الجسم المتحصل عليه و الكفاءة التحويلية مقارنة بجميع باقى المجاميع التجربية المستخدمة . و قد أظهرت طيور كل من المجموعة الرابعة و الخامسة تحسناً معنوياً مقارنة بكل المجاميع المستخدمة فى التجربة للصفات الأتية لعظمة الساق عند عمر 16 أسبوع متضمنة طول و عرض و قوة كسر و وزن و نسبة كل من الرماد و الكالسيوم و الفوسفور كما زاد معنوياً كل من تركيز بروتين الاوستيوكالسين فى سيرم الدم و أيضاً تركيز الكالسيوم و الكالسيوم المتأين و الفوسفور و الالكالين فوسفاتيز فى بلازما الدم و ذلك لإناث المجموعة الخامسة مقارنة بباقى المجاميع عند عمر 16 أسبوع . و أظهرت صور الأشعة السينية زيادة فى كثافة العظام لكل المجاميع المضاف إليها فيتامين ك3 كما أظهرت خلو هذه المجاميع من هشاشة العظام . و أيضاً أوضحت صور القطاعات الهستولوجية لعظمة الساق لكل من المجاميع T3 ، T4 ، T5 زيادة فى كثافة منطقة الترابيق و الخلايا العظمية و الغشاء العظمى . و بذلك قد أوصت الدراسة أنه بإستخدام مستوي 11 ملجم ك3 / كجم عليقة فى التغذية لإناث طيور المندرة خلال فترة النمو و هى مستويات أعلى من الموصى بها و ذلك لفائدتها فى تحسين كل من النمو و التحويل الغذائى فى تلك الفترة إضافة الى تحسن فى جودة و كثافة عظام الساق .