

TIBIA CHARACTERISTICS AND STRENGTH IN JAPANESE QUAIL FED LOW PHOSPHORUS DIETS SUPPLEMENTED WITH MICROBIAL PHYTASE

By

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ABSTRACT: *An experiment was performed to assess the influence of reducing the dietary available phosphorus (Av.P) level and adding microbial phytase (M.Ph) on some tibia characteristics and live body weight (LBW) of male and female Japanese quail chicks.*

A total of 420 unsexed one-week-old quail chicks were reared in brooder batteries up to 3 weeks of age, then transferred to grower batteries and raised up to 6 weeks of age. Chicks were randomly distributed into 5 experimental groups with two replicates of 42 chicks each. The control group was fed a basal diet that contained 1% Ca and 0.45% Av.P. The second and third groups were fed diets contained 0.66% Ca and 0.30% Av.P without and with M.Ph (900 FTU/kg), respectively. The fourth and fifth groups were fed diets included 0.33% Ca and 0.15% Av.P without and with M.Ph (900 FTU/kg), respectively. At 6 weeks of age, 8 birds (4 males and 4 females/ treatment) were randomly chosen and used to measure the tibia measurements. The main results could be summarized as follows:

Live body weight (LBW) was significantly increased in both sexes as a result of adding M.Ph to low Av.P diets. Tibia length (TL) of females was significantly ($P \leq 0.05$) increased in response to phytase addition, while its increase was insignificant in males. Adding M.Ph to 0.15% Av.P diet significantly increased TL in both sexes. Tibia relative weight (TRW) insignificantly decreased in males as a result of decreasing dietary Av.P level, while this decrease was significant in females. Regardless of Av.P level, addition of M.Ph resulted in a significant increase in tibia weight (TW) and TRW of males but not in females. TW and TRW of males were significantly increased in response to M.Ph addition either to 0.30 or 0.15% Av.P levels, while females were not influenced. Tibia ash (TA) did not significantly respond to the reduced Av.P level and M.Ph supplementation

and the interaction between them. Tibia breaking strength (TBS) of both sexes was significantly increased as a result of feeding 0.30% Av.P level comparing with those fed either 0.45 or 0.15 % Av.P-included diets. Regardless of Av.P, tibia breaking strength was significantly increased in females by adding M.Ph, while the increase in TBS was not significant in males. Phytase supplementation either to 0.30 or 0.15% Av.P levels significantly increased TBS in females, while this increase was significant in males only when M.ph was added to 0.30% Av.P level.

From the previous results it could be concluded that phytase supplementation increased the availability of phosphorus and subsequently increased body weight and bone mineralization that leads to increasing the bone rigidity in Japanese quail chicks fed low Av.P diets.

INTRODUCTION

The major ingredients of poultry diets are feedstuffs of plant origin, such as corn and soybean meal. The availability of phosphorus (P) in these feedstuffs is about 30 to 40% (NRC, 1994). This low availability is generally attributed to the existence of about 70% of P in cereals in the form of phytate (Punna and Roland, 1999). The diets of monogastric animals are often supplemented with sources of inorganic P to meet the P requirement of the animal, because of the low availability and utilization of phytate P.

Phytase, myo-inositol hexakisphosphate phosphohydrolase, is the necessary enzyme for breakdown of the phytate molecule and subsequent release of P for absorption (Gibson and Ullah, 1990). Microbial phytase (M.Ph) can chemically hydrolyze 97% of the P from phytate in soybean meal (Nelson *et al.*, 1968). A similar improvement in P availability was observed in a field trial conducted by Nelson *et al.* (1971) where the bone ash of chicks fed soybean meal diet supplemented with M.Ph was increased. The efficacy of M.Ph to improve dietary P bioavailability and P and Ca utilization in broilers and layers has been reported by several researchers (Kornegay *et al.*, 1996; Sohail and Roland, 1997).

The status of bones, especially leg bones may have a direct effect on either the quality of the poultry meat produced or the normal stand of breast meat producing birds like turkey and Japanese quail where phosphorus deficiency causes breakage or defects of these bones and subsequently results in a decrease in the amount or grade of produced meat. As far as we know, there is no literature concerning the effects of dietary supplemental phytase on P and Ca availability and utilization in Japanese quail as measured by bone characteristics. Therefore, the aim of this study was to evaluate the influence of dietary M.Ph on the utilization of P and Ca in

Japanese quail receiving low Av.P-diets. Live body weight (LBW), tibia length (TL), tibia weight (TW) and relative weight (TRW), tibia ash (TA) and tibia breaking strength (TBS) served as the response criteria.

MATERIALS AND METHODS

This study was conducted in the Poultry Physiology Laboratory, Department of Poultry Production, Faculty of Agriculture, Ain Shams University.

A total of 420 one-week-old unsexed quail chicks were reared and raised in five-deck brooder and grower batteries up to 3 and 6 weeks of age, respectively. Birds were randomly distributed into five groups with two replicates of 42 chicks each. The control group was fed a basal diet that contained 1% Ca and 0.45% Av.P (Diet 1). The second and third groups were fed diets contained 0.66% Ca and 0.30% Av.P (Diet 2) without and with M.Ph (900 FTU/kg), respectively. The fourth and fifth groups were fed diets included 0.33% Ca and 0.15% Av.P (Diet 3) without and with M.Ph (900 FTU/kg), respectively. The composition and calculated analysis of the experimental diets are shown in Table (1). Birds were reared and raised under similar environmental, managerial and hygienic conditions. Feed and water were provided for *ad libitum* consumption. At 6 weeks of age birds were individually weighed and 8 birds from each treatment (4 males and 4 females) having average body weight around the treatment were randomly selected and massacrred.

Tibia of both legs of Japanese quail were then removed, cleaned from flesh and all soft tissues, and oven-dried. Dry tibia weight and length were then recorded and tibia relative weight as a percentage of live body weight was calculated. Tibia breaking strength (TBS) was measured in the Laboratory of Mechanical Properties and Test of Materials, Faculty of Engineering, Ain Shams University using a universal testing machine (Tinuls Olsen Toting Machine Co).

One of the tibia samples of each bird was dried at 105°C until constant weight, ashed at 550 °C for 8 hrs, then tibia ash (TA) percentage was calculated.

Statistical Analysis

Data were subjected to the two way analysis of variance using the general linear model (GLM) procedures of SAS software (SAS Institute, 2001) to determine the effects of dietary Av.P level and M.Ph addition. Differences between means were compared using Duncan's Multiple Range Test, (Duncan, 1955).

RESULTS AND DISCUSSION

1- Live body weight (LBW)

Live body weight of male and female Japanese quails as influenced by different levels of available phosphorus (Av.P) and microbial phytase (M.Ph) at six weeks of age are shown in Tables 2 and 3, respectively.

Concerning dietary Av.P level, feeding the 0.30% Av.P level to male Japanese quail resulted in a significant ($P \leq 0.05$) increase in LBW as compared to those fed 0.45 and 0.15% Av.P diets, while there was no significant difference in LBW of the females fed the same experimental diets. Regardless of Av.P level, addition of 900 FTU M.Ph /kg to the experimental diets resulted in a significant increase in LBW either for males or females Japanese quail. A significant interaction between dietary Av.P levels and M.Ph addition was obtained in both male and female Japanese quails and this could be attributed to M.Ph effect was more pronounced with 0.30% and 0.15% Av.P level in male and female, respectively. Where, males and females receiving low-Av.P diets (0.15 and 0.30%) supplemented with M.Ph had significantly higher LBW than those fed 0.15 and 0.30% Av.P diets without M.Ph addition and control group.

The effect of phosphorus (P) deficiency on LBW of males Japanese quail was reported in broiler chicks (Sohail and Roland, 1999). Increasing the dietary Av.P level to 0.30% in the present study, improved LBW of males. This result is consistent with the findings of Sohail and Roland (1999) who reported that increasing non-phytate phosphorus (nPP) to 0.325% improved body weight of broiler during the period from 3 to 6 weeks of age. The improvement in LBW due to adding M.Ph to low Av.P diets either for male or female Japanese quails are in agreement with those obtained by Broz *et al.*(1994) who reported that addition of M.Ph to low phosphorus broiler diets significantly improved the body weight. They added that, the improvement observed in body weight was attributed to increase bioavailability of phosphorus by phytase. Also, Sohail and Roland (1999) found that supplementing low nPP-diets with inorganic P or M.Ph, improved performance of broilers. In this respect, Nelson and Walker (1964) reported that body weight is considered to be one of the criteria for evaluating the availability of dietary phosphorus. On the other hand, these results are disagreement with the results of Lesson *et al.* (2000) who reported that there were no significant differences in LBW values due to adding M.Ph to low Av.P-broiler diet. However, the improvement in body weight observed in quails fed on low Av.P diet with M.Ph may be due to increased release and utilization of phosphorus from the phytate-mineral

complex (Qian *et al.*, 1996), increased starch digestibility (Knuckles and Betschart, 1987), increased utilization of protein and amino acids (Ravindran *et al.*, 2000) or increased overall utilization of nutrients (Miles and Nelson, 1974).

2- Tibia measurements

Tibia measurements of male and female Japanese quails as affected by different levels of Av.P and M.Ph at six weeks of age are presented in Tables 2 and 3, respectively.

2.1- Tibia length (TL)

Respecting dietary Av.P level, males and females fed the 0.15 and 0.30 % Av.P levels had significantly ($P \leq 0.05$) longer TL than those fed the 0.45%-Av.P level. As regards phytase supplementation, females fed diet supplemented with 900 FTU M.Ph /kg had a significant ($P \leq 0.05$) longer TL than that of those received diet without added M.Ph. Such effect was not obtained for males. There was a significant ($P \leq 0.05$) interaction between Av.P level and M.Ph addition in both males and females Japanese quail, where adding M.Ph to the diet containing 0.15% Av.P level significantly ($P \leq 0.05$) increased TL in both sexes when compared with 0.15% Av.P diet without M.Ph and control group (0.45% Av.P). This means that phytase addition may enhance tibia growth where M.Ph increases the availability and utilization of P,Ca and protein. This explanation was confirmed by several researches (Sebastian *et al.*, 1997, and Akyurek *et al.*, 2005). They reported that phytase enzyme has the ability to release inorganic P, Ca and protein from phytate molecule. On the other hand, Nese Kocabagli (2001) demonstrated that the TL of broiler fed graded phytase supplements (300, 500 and 700 FTU/kg) did not significantly differ from those of broilers fed the control diet.

2.2-Tibia weight (TW) and relative weight (TRW)

Regarding dietary Av.P level, a significant increase in TW and TRW was noticed in females fed the 0.45% Av.P diet comparing with those fed the 0.30 and 0.15% Av.P diets, but males were not significantly influenced. Decreasing the dietary Av.P to 0.30 and 0.15% resulted in a reduction in TW for females by 10.4 and 14.8%, respectively as compared with that of those fed 0.45% Av.P level. Such results are consistent with the results of Viveros *et al.* (2002) who reported that the decrease in npp content of a broiler diet caused a decrease in tibia weight by 14.7% at 6 weeks of age. Our results also are similar to the previous observations reported by (Lesson *et al.*, 2000) on chickens. However, Keshavarz (2000) reported that tibia

weight of laying hens was not influenced by dietary npp level. Irrespective of Av.P level, males fed phytase-supplemented diet had a significant increase in TW and TRW as compared to those fed phytase-unsupplemented diet. On the other hand, there was no significant difference in TW and TRW between females fed M.Ph-supplemented diet and those fed M.Ph-unsupplemented diet. On the same way, a significant interaction was detected between the effects of Av.P and M.Ph levels on TW and TRW in males but not in females, where adding M.Ph either to 0.15% or 0.30% Av.P diets significantly increased TW and TRW in males over than corresponding M.Ph-unsupplemented diets. The previous results mean that males were more efficient for the P utilization with adding phytase than females.

2.3- Tibia ash (TA)

Neither dietary Av.P level nor phytase supplementation could alter the percentage of TA in both male and female quails. Furthermore, no synergistic effect between Av.P level and phytase-added level as revealed from the nonsignificant interaction between both of them (Tables 2 and 3). A little increase in TA percentage (about 1.35%) as a result of phytase addition to 0.30 and 0.15% Av.p diets was observed in males only when compared to that of those fed 0.30 or 0.15% Av.P without M.Ph addition.

The slight increase in TA percentage in response to phytase supplementation agrees with the results of Nese Kocabagli (2001) who reported that the percentage of TA was slightly improved due to dietary phytase supplementation. The percentage of TA for female quails did not significantly affect by dietary phytase supplement in the present study. This result is in consistent with the results of Keshavarz (2000) in pullets and Rama-Rao *et al.* (1999) in chickens.

2.4- Tibia breaking strength (TBS)

The dietary Av.P level significantly ($P \leq 0.05$) affected the TBS either for males or females (Tables 2 and 3). It is of interest to notice that TBS of males fed 0.30% dietary Av.P level exceeded that recorded for males fed 0.15% and those fed the recommend level (0.45%) by 18.5 and 17.2%, respectively. The same trend was recorded for females (22.5 and 21.7%, resp.).

Addition of microbial phytase significantly ($P \leq 0.05$) increased the TBS of females where, female quails fed M.Ph-supplemented diet had significant stronger tibia than those fed M.Ph-unsupplemented diet, while a non-significant increase in TBS was noticed with males. A significant

($P \leq 0.001$) interaction between the dietary Av.P level and Phytase addition was detected either for males or females. Such interaction suggests a significant improvement for TBS when M.Ph was added to the diet contained 0.30 or 0.15% Av.P levels in females, but this increase was significant in males only when M.Ph was added to 0.30% Av.P level. However, the highest value for TBS was recorded for 0.30% Av.P level with added M.Ph in both sexes comparing with control and the other experimental treatments.

The present results revealed that the TBS of quails increased as Av.P level increased (from 0.15 to 0.30%) or phytase supplemented with low-Av.P diets. These results are in agreement with those of Vetesi *et al.* (1998), Sohail and Roland (1999) and Hammad (2005) who reported that addition of M.Ph to low Av.P diets significantly increased tibia breaking strength in broiler chicks. The improvement in TBS in response to phytase supplementation could be attributed to an increase in phosphorus deposition into bones. In this respect, Nese Kocabagli, (2001) reported that TA percentage or mineral retention which revealed an elevation in bone mineral content and bone density and consequence increase the rigidity of bone as a whole.

In general, the discrepancy in our results of all tested parameters between males and females Japanese quail may have resulted from: -

- 1- Large variations in the growth rate and bone mineralization.
- 2- Sex-related response depending on the different physiological status of both sexes and of Japanese quail as a migrated bird.

In conclusion, addition of M.Ph enzyme to low Av.P diets significantly increased live body weight and bone rigidity in Japanese quail chicks.

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

Ingredients	Diet 1 0.45% Av.P	Diet 2 0.30% Av.P	Diet 3 0.15% Av.P
Yellow corn	56.00	56.00	56.00
Soybean meal (44%)	27.90	27.90	27.90
Corn gluten meal (60%)	12.00	12.00	12.00
Di-calcium phosphate	1.70	0.88	0.07
Calcium carbonate	1.35	0.97	0.53
Wheat bran	----	1.20	2.45
Salt	0.25	0.25	0.25
Hy-mix broiler pre*	0.30	0.30	0.30
DL-methionine	0.20	0.20	0.20
Lysine	0.30	0.30	0.30
Calculated analysis			
ME (kcal/kg)	2948.3	2963.9	2980.2
CP (%)	24.39	24.58	24.77
Calcium (%)	0.97	0.66	0.31
Total.P (%)	0.71	0.57	0.44
Av.P (%)	0.45	0.30	0.15

* HY-mix broiler PRE contains (vit.) and minerals mixture 0.3g/kg.

Each 1.5kg contains the following: 12 I.U vit. A, 122 I.U Vit. D3, 10 mg vit. E, 2 mg vit. K, 1 mg vit. B1, 4 mg vit. B2, 10 mg vit. B12, 1.5 mg vit. B6, 20 mg Niacin B5, 1 mg Folic acid, 10 mg Pantothenic acid B4, 0.5 mg Biotin (vit. H), 50 mg Choline chloride, 10 mg Copper, 1 mg iodine, 55 mg Manganese, 50 mg Zinc, 1 mg Selenium, 30 mg Iron.

Table (2): Effects of available phosphorus (Av.P) and microbial phytase (M.Ph) levels on live body weight (LBW) and some tibia measurements of males Japanese quail at 6 weeks of age.

Main effects		Trait					
		LBW (g)	TL (cm)	TW (g)	TRW (%)	TA (%)	TBS (kg/cm ³)
Av.P (%)	0.45	171.65 ^b	5.68 ^b	1.57	0.916	51.81	3.350 ^b
	0.30	180.63 ^a	6.34 ^a	1.64	0.906	52.81	3.925 ^a
	0.15	175.69 ^b	6.12 ^a	1.54	0.879	52.87	3.313 ^b
Pooled SEM.		1.750	0.113	0.045	0.0255	0.425	0.1079
M.Ph (FTU)	0	176.02 ^b	6.09	1.46 ^b	0.821 ^b	52.84	3.450
	900	180.31 ^a	6.37	1.72 ^a	0.964 ^a	52.84	3.788
Pooled SEM		1.063	0.095	0.050	0.0280	0.4537	0.1120
Av.P (%)	M.Ph (FTU)						
0.45	0	171.65 ^c	5.68 ^b	1.57 ^b	0.916 ^a	51.81	3.350 ^b
0.30	0	178.98 ^b	6.43 ^a	1.57 ^b	0.860 ^b	52.14	3.675 ^b
0.30	900	182.28 ^a	6.25 ^a	1.71 ^a	0.953 ^a	53.49	4.175 ^a
0.15	0	173.05 ^c	5.75 ^b	1.36 ^c	0.785 ^c	52.19	3.225 ^b
0.15	900	178.33 ^b	6.48 ^a	1.73 ^a	0.975 ^a	53.54	3.400 ^b
S.O.V		Probability [#]					
Av.P		*	*	NS	NS	NS	*
M.Ph		*	NS	*	**	NS	NS
Av.PX M.Ph		*	*	**	*	NS	***

a,b,... means with different superscripts for phosphorus level, phytase level or phosphorus x phytase are significantly different.

NS= non-significant, * = $P \leq 0.05$, ** = $P \leq 0.01$, *** = $P \leq 0.001$.

LBW= Live body weight, TL = Tibia length, TW= Tibia weight
TRW= Tibia relative weight, TA = Tibia ash, TBS= Tibia breaking strength

Table (3): Effects of available phosphorus (Av.P) and microbial phytase (M.Ph) levels on live body weight (LBW) and some tibia measurements of females Japanese quail at 6 weeks of age.

Main effects		Trait					
		LBW (g)	TL (cm)	TW (g)	TRW (%)	TA (%)	TBS (kg/cm ³)
Av.P (%)	0.45	213.00	5.83 ^b	1.83 ^a	0.860 ^a	56.07	3.963 ^b
	0.30	212.44	6.37 ^a	1.64 ^b	0.779 ^b	53.07	4.825 ^a
	0.15	213.99	6.12 ^a	1.56 ^b	0.733 ^b	54.30	3.938 ^b
Pooled SEM.		4.016	0.099	0.044	0.0244	0.729	0.1597
M.Ph (FTU)	0	208.97 ^b	6.08 ^b	1.62	0.776	54.41	4.100 ^b
	900	217.47 ^a	6.41 ^a	1.58	0.736	52.97	4.663 ^a
Pooled SEM		4.444	0.082	0.040	0.0245	0.675	0.1654
Av.P (%)	M.Ph (FTU)						
0.45	0	213.00 ^b	5.83 ^b	1.83	0.860	56.07	3.963 ^c
0.30	0	209.18 ^c	6.30 ^a	1.67	0.798	54.22	4.375 ^b
0.30	900	215.70 ^b	6.43 ^a	1.61	0.758	51.93	5.275 ^a
0.15	0	208.75 ^c	5.85 ^b	1.57	0.753	54.59	3.825 ^c
0.15	900	219.23 ^a	6.38 ^a	1.55	0.713	54.02	4.050 ^b
S.O.V		Probability [#]					
Av.P		NS	*	*	*	NS	*
M.Ph		**	*	NS	NS	NS	*
Av.P X M.Ph		**	*	NS	NS	NS	***

a,b,... means with different superscripts for phosphorus level, phytase level or phosphorus x phytase are significantly different.

NS= non-significant, * = P ≤ 0.05, ** = P ≤ 0.01, *** = P ≤ 0.001

LBW= Live body weight, TL = Tibia length, TW= Tibia weight

TRW= Tibia relative weight, TA = Tibia ash, TBS= Tibia breaking strength

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الملخص العربي

خصائص و قوة عظمة الساق في السمان الياباني المغذى على علائق منخفضة الفوسفور مضاف إليها إنزيم الفيتيز الميكروبي .

ايمان سيد عثمان – عبد المجيد مخيمر عبد المقصود* – أمينة عبده سالم – أحمد حاتم العطار*

معهد بحوث الانتاج الحيواني – مركز البحوث الزراعية *كلية الزراعة جامعة عين شمس

أجريت هذه التجربة لتقييم تأثير كل من خفض مستوى الفوسفور المتاح المأكول و إضافة إنزيم الفيتيز الميكروبي على بعض صفات عظمة الساق و وزن الجسم لكل من ذكور و إناث السمان الياباني.

تم توزيع عدد 420 كتكوت سمان ياباني غير مجنس عمر أسبوع عشوائيا على 5 مجاميع تجريبية ذات مكررين بواقع 42 كتكوت لكل مكرر . تم التحضين ثم النمو في بطاريات الحضانة و النمو لمدة 3 ، 6 أسابيع على الترتيب. غذيت مجموعة المقارنة على عليقة قاعدية احتوت على 1% كالسيوم ، 0.45% فوسفور متاح. غذيت المجموعة الثانية و الثالثة على علائق احتوت على 0.66% كالسيوم و 0.30% فوسفور متاح بدون او بإضافة إنزيم الفيتيز (900 وحدة/كجم علف) على الترتيب. غذيت المجموعة الرابعة و الخامسة على علائق احتوت على 0.33% كالسيوم و 0.15% فوسفور متاح بدون أو بإضافة إنزيم الفيتيز (900 وحدة /كجم علف) على الترتيب تم اختيار 8 طيور (4 ذكور ، 4 إناث / معاملة) عند عمر 6 أسابيع لتقدير مقاييس عظمة الساق كما تم اخذ الوزن الحى للجسم لجميع الطيور. و تلخص النتائج الأساسية لهذه الدراسة فيما يلي :

- ١ - زاد وزن الجسم الحى معنويا في كلا الجنسين كنتيجة لإضافة الفيتيز للعلائق منخفضة الفوسفور.
- ٢ - زاد طول عظمة الساق للإناث معنويا استجابة لإضافة الفيتيز بينما هذه الزيادة لم تكن معنوية مع الذكور.
- ٣ - اضافة الفيتيز للعلائق المحتوية على 0.15% فوسفور متاح ادى إلي زيادة طول عظمة الساق معنويا في كلا الجنسين.
- ٤ - انخفض الوزن النسبي لعظمة الساق انخفاض غير معنوى في الذكور كنتيجة لخفض مستوى فوسفور العليقة بينما كان هذا الانخفاض معنوى في الإناث.
- ٥ - بصرف النظر عن مستوى الفوسفور فإن اضافة إنزيم الفيتيز قد ادى لزيادة الوزنين المطلق و النسبي لعظمة الساق معنويا في الذكور بينما لم تتأثر الإناث.
- ٦ - زاد الوزنين المطلق و النسبي لعظمة الساق في الذكور معنويا استجابة لاضافه الفيتيز سواء لمستوى 0.30 أو 0.15 % فوسفور متاح بينما لم تتأثر الإناث.
- ٧ - نسبة الرماد في عظمة الساق لم تتأثر معنويا بخفض مستوى الفوسفور المتاح و إضافة الفيتيز و التداخل بينهما.
- ٨ - زادت قوة كسر عظمة الساق لكل من الإناث و الذكور معنويا بالتغذية على مستوى 0.30% فوسفور متاح مقارنة بالتغذية على مستوى 0.45 أو 0.15% فوسفور متاح.

٩ - بصرف النظر عن مستوى الفوسفور متاح زادت قوة كسر عظمة الساق معنويا في الاناث باضافة الفيتيز بينما لم تكن هذه الزيادة معنوية بالنسبة للذكور.

١٠ - اادت اضافة الفيتيز سواء لمستوى 0.30 أو 0.15% فوسفور متاح إلي حدوث زيادة معنوية في قوة كسر عظمة الساق للاناث بينما كانت هذه الزيادة معنوية في الذكور عند اضافة الفيتيز لمستوى 0.30% فوسفور متاح فقط.

من النتائج السابقة نستخلص أن اضافة الفيتيز قد أدت إلي زيادة أتاحة الفوسفور و بالتالى زياده ترسيبه في العظام مما زاد من صلابتها كما ادي اضافة الفيتيز إلي زيادة وزن الجسم للسمان اليابانى المغذى على علائق منخفضة الفوسفور.