The Prediction of Skeletal Weight From Femur Compartmental Analysis in Fayoumi Layers

A.A. Darwish, M.K. Shebaita, M.A. Khalifa and G.A. Arram.
College of Agriculture at El-Fayoum, Cairo University.

A TOTAL of 54 Fayoumi layers at age of 16 month and average body weight of about 1300 gm were used in this study. The birds were sacrificed by axial dislocation and the skeleton was removed and weighed. Dry weight,fat,ash, calcium and phosphorus contents of the femur were determined. Also , the compatments of protein, cell mass, extracellular water and intracellular water of the femur were calculated. Significant ($P < 0.01$)relationship ($r = 0.352$ to $r = 0.991$) were found between body weight, skeletal weight, femur weight and its compartments. Prediction equations were developed to be applied in layers as follow:

I- Skeletal weight,gm
= 190.831 + 50.980 body weight,kg
2- = 59.237 + 49.816 dry femur weight,gm
3- Femur protein,gm
= 0.222 + 0.432 fat-free dry femur weight,gm
4- Femur calcium,gm
= 0.083 + 0.252 fat-free dry femur weight,gm
5- = 0.308 + 0.376 femur ash weight,gm
6- Femur phosphorus,gm
= 0.014 + 0.123 fat-free dry femur weight,gm
7- = 0.139 + 0.176 femur ash weight,gm

The metabolism of skeletal minerals in chickens has been studied by determining either as percentage, spicific mineral content or the distribution of administered isotopes in individual bones(Cox and Balloun, 1971).

Fat-free dry bone was used as an index of calcium and phosphorus status in growing birds (Waldroup et al., 1963;Jensen and Edwards,1980). In adults, only the proportion of mineralized and unmineralized osteoid determines the amount of each in conditions such as osteomalacia (Ham and Leeson, 1961).

In the mature hens the external dimensions of the femur or the external bone volume would be expected to remain constant, while the quantity of minerals within the medullary and cortical segments may vary in response to dietary calcium and phosphorus adequacy (Garlish et al., 1982). In calcium deficiency state, both the minerals and the organic matrix decreased (Ham and Leeson, 1961; Pechet et al., 1967) , while in case of phosphorus deficiency, only reduction in minerals content in the femur of the laying hens was observed (Garlich et al., 1982).

In most studies, the tibia has been used as a bone sample for analysis (Baird and Mac Millan, 1942; Migicovsky and Emslie 1950; Itoth and Hatano, 1964). The humerous and sternum have been used by Martin and Patrick (1962), although some investigations for a biological vitamine D assay have been developed using toe bones (Baird and Mac Millan, 1942; Evans and Carver 1944; Campbell et al., 1945) or beak (Wei et al., 1954). With the exception of the reports by Taylor and Moore (1954, 1956), Taylor et al., (1960) and Taylor and Morris (1964), very few studies have been conducted on the metabolism of the total skeleton of the laying hen, and little have been reported concerning the differences in the metabolism of individual bones.

Itoth and Hatano (1964) studied calcium contents and radio-calcium uptake ratio in eight bone samples from the skeletons of chicks and reported that the values for the femur were more similar to the total skeleton than were those from any other bone sample. Morris et al.,(1966) and Cox and Balloun (1971) presented a regression equation and reported very good agreement between the predicted skeletal weight based on the regression of skeletal weight on femus bone weight and the observed skeletal weight. Moreover, they proposed simple mathematical equations for predicting skeletal weight, skeletal ash weight, and skeletal ash/body weight from the femur weight , femur ash weight, and femur ash weight/body weight, respectively.

In experiments concerned with the calcium and phosphorus metabolism of laying hens it is desirable to know the weight of skeleton of birds killed at different stages of lay.Due to the individual variation in skeletal weight it may be necessary to kill a substantial number of hens to establish a reliable mean and this raises the difficulty that the recovery, cleaning and fat extraction of a complete skeleton is a tedious and time consuming process. This note describes an equation which can be used to predict total skeletal weight from a knowledge of body weight or femur bone weight. from this equation we can determine the deboning percentage of carcass and the degree of skeletal depletion.

Material and Methods

A total of 54 Egyptain Fayoumi laying hens at 16 months of age were used in this study. The birds were sacrificed by axial dislocation, and the skeleton was excised and weighted. To prevent dehydration, skeletons were sealed in individual plastic bags and refrigerated. The dry weight of the right femur was determined after breaking the bone in the middle and dried at II0°C for 16 hours. Fat was extracted by using petrolium ether for 24 hours in a Soxhlet apparatus. The fat-free dry femur was ashed at 500-550°C for 8 hours. The difference in wight between the fat-free dry femur and the femur ash is mainly femur protein. The ash solution was made according to A.0.A.C. (1980). Calcium was determined by using atomic absorption spectrophotometer, while phosphorus was determind according to the method of Fiske and Subbarow (1925).

The compartments of the femur were calculated according to Shebaita etal(1975) and Shebaita etal(1977) The following equations were used:-

Femur cell mass,gm = femur water weight (gm) X 0.833

Femur intracellular water, gm =
femur cell mass (gm) - organic matter (gm)

Femur extracellular tissue, gm =
femur fat-free weight (gm) - famur cell mass (gm)

Femur extracellular water, gm =
femur extracellular tissue (gm) - femur ash (gm)

The statistical analysis of the data were made according to Snedecor and Cochran (1968) and Steel and Torrie (1980).CASIO PB-100 computer used for calculation.

Results and Discussion

Table 1 shows the body weight, skeletal weight and the chemical composition of the femur in the Egyptian Fayoumi laying hens. The variation in body weight was greater than the variation in skeletal weight, as indicated by the magnitude of the respective standard errors. This may be due to the variation in the percentage of body fat between birds. However, the water content of the skeleton is lower than the other organs in the body which is not increase than 40% as indicated by the water content of the femur bone (Table , 1).The water content is about 8.2 volume percent of compact bone and is higher in bones of young animals (Mc-Lean and Urist, 1961). Most of the femur water isextracellular compartment (about 90%), while the intracellular water is very low (about 10%) as shown in Table 1. On the other hand, the fat content of the femur is very low (about 4%). Bone consists of both organic and inorganic substances with approximately the same percentage. Protein represents about 29%and 50% of fat-free and fat-free dry femur bone (Table, 1). Most of the organic protein consists of collagen(90-96 per cent), insoluble scleroprotein and mucoprotein (Mclean and Urist, 1961). The above-mentioned percentages were also observed for the femur ash content (Table, 1) on the same basis . These data are in agreement with Junqueire et al. (1971) and disagreement with McLean and Urist (1961). It seems that the difference in the basis of calculation is the reason for the said contradiction . Moreover, the proportion of mineralized and unmineralized osteoid determines the amount of ash in condition such as osteomalacia (Ham and Leeson, 1961). On the other hand, the femur cell mass represents about 1/3 of the fresh femur bone (Table, 1). This indicates that Haversian, external and internal circumferential and intermediate lamella represent the major part of the bone, while the bone cells represent the minor part of the bone. Osteocytes are found within the bone matrix in lacunas from which canaliculi radiate; osteoblasts are responsible for the synthesis of the organic components of bone matrix and osteoclasts are appear on bone surfaces wherever bone resor-

Table 1. Body weight, skeletel weight, and femur bone composition in Egyptian Fayoumi laying hens at 16 months of age.

Items	Mean	± S.E.
Body weight,gm	1299.00	± 29.000
Skeletal weight,gm	257.05	± 4.163
as% body weight	20.18	± 0.472
Fresh femur weight,gm	6.44	± 0.113
as% body weight	0.50	± 0.010
as% skeletal weight	2.51	± 0.030
Fat-free femur weight,gm	6.17	± 0.113
as% body weight	0.48	± 0.010
as% skeletal weight	2.40	± 0.024
as% fresh femur weight	95.79	± 0.242
Dry femur weight,gm	3.97	± 0.547
as% body weight	0.31	± 0.008
as% skeletal weight	1.54	± 0.030
as% fresh femur weight	61.10	± 1.027
as% fat-free femur weight	64.18	± 1.049
Fat-free dry femur weight,gm	3.70	± 0.104
as% body weight	0.29	± 0.009
as% skeletal weight	1.44	± 0.030
as% fresh femur weight	57.25	± 1.051
as% fat-free femur weight	59.74	± 1.063
as% dry femur weight	92.99	± 0.437
Femur water weight,gm	2.47	± 0.045
as% fresh femur weight	38.53	± 1.003
as% fat-free femur weight	40.25	± 1.067
Femur fat weight,gm	0.27	± 0.015
as% fresh femur weight	4.21	± 0.242
Femur protein weight,gm	1.82	± 0.052
as% fresh femur weight	28.20	± 0.574
as% fat-free femur weight	29.36	± 0.575
as% dry femur weight	45.98	± 0.676
as% fat-free dry femur weight	50.45	± 0.700

Table 1 Continue

Items	Mean	±	S.E.
Femur ash weight,gm	1.88	±	0.064
as% fresh femur weight	28.60	±	1.035
as% fat-free femur weight	30.44	±	0.759
as% dry femur weight	47.08	±	0.693
as% fat-free dry weight	49.40	±	1.000
Femur cell mass weight,gm	2.06	±	0.057
as% fresh femur weight	31.60	±	1.576
as% fat-free femur weight	33.43	±	4.040
Femur intracellular water weight,gm	0.26	±	0.081
as% femur water weight	10.18	±	3.336
Femur extracellular tissue weight,gm	4.12	±	0.102
as% fresh femur weight	63.81	±	0.887
as% fat-free femur weight	66.79	±	0.883
Femur extracellular water weight,gm	2.21	±	0.067
as% femur water weight	89.47	±	3.404
Femur intra/femur extracellular water weight,gm	0.13	±	0.069
Femur calcium weight,gm	1.02	±	0.027
as% fresh femur weight	15.75	±	0.296
as% fat-free femur weight	16.44	±	0.301
as% fat-free dry femur weight	27.56	±	0.204
as% femur ash weight	54.94	±	0.806
Femur phosphorus weight,gm	0.47	±	0.014
as% fresh femur weight	7.28	±	0.152
as% fat-free femur weight	7.60	±	0.155
as% fat-free dry femur weight	12.72	±	0.131
as% femur ash weight	25.38	±	0.441
Femur calcium / femur phosphorus weight	2.18	±	0.023

ption occurs (Junqueira et al.,1971).The data on the femur cell mass confirmed the general concept of bone in body composition study (Moore, 1968).

Calcium and phosphors represent about 80% of the femur ash (Table, 1) Also, calcium/ phosphorus ratio is about 2 under normal condition. Calcium and phosphorus are especial abundant in bone ash. X-ray diffraction studies have shown that calcium and phosphorus from hydroxyapatite crystals with the composition $Ca_{10}(PO_4)_6(OH)_2$ (Junqueire et al., 1971),Calcium and phosphorus as fraction of fat-free dry femur bone are 27.56% and 12.72% respectively (Table, 1). These values are inagreement with Mclean and Urist (1961). When laying hens consume inadequate, phosphorus, the bones may serve as a reserve from which phosphorus may be drawn to maintain production (Garlich et al., 1975) In hens laying on a low-calcium diet the amount of medullary bone is maintained while the cortical bone becomes progressively thinner as laying continues, the medullary bone is poorly calcified in an advanced state of calcium deficiency (Taylor and Morre, 1954). The variation in mineral content of femur bone explained a larger proportion of the variation in the total skeletal content than did that of other bones indicates that femur mineral was a more reliable estimator of total skeletal mineralization (Itoh and Halano, 1964; Hurwitz, 1965; Hurwitz and Bar, 1966 and Cox and Balloun, 1971).

The relationships between body weight, skeletal weight and femur bone weight are show in Table, 2. The coeffecient of correlation (r= 0.60) between body weight and skeletal weight is highly significant ($P < 0.01$). Therefore, the skeletal weight could be calculated from the live body weight by the following equation:-

Skeletal weight,gm = 190.831 + 50.980 body weight (kg).Therefore, it can be calculate the skeletal weight in grams of the birds to determine the depletion and/ or the repletion bone of the laying hens according to the rate of egg production and / or the adequate calcium and phosphorus in the diet without kill the birds. On the other hand, the skeletal weight of carcasses can be calculate from the weight of single femur bone by the

Table 2. Relationship between body weight, fresh femur weight, fat-free femur, dry femur, fat-free dry femur and femur ash weights and the femur composition in Egyptian Fayoumi laying hens at 16 months of age.

Items	"r'*	Predicted Equation
Body weight (kM) versus		
1.skeletal weight	+ 0.6014	Y = 190.8310 + 50.9800X
2.fresh femur weight	+ 0.5566	Y = 3.5701 + 2.2093X
3.fat-free femur weight	+ 0.5285	Y = 3.4628 + 2.0862X
4.dry femur weight	+ 0.5369	Y = 2.1490 + 1.4026X
5.fat-free dry femur weight	+ 0.3523	Y = 2.0446 + 1.2759X
Fresh femur weight versus		
1.skeletal weight	+ 0.8273	Y = 60.8787 + 30.4620X
2.fat-free femur weight	+ 0.9914	Y = - 0.1837 + 0.9869X
3.dry femur weight	+ 0.8931	Y = 0.1856 + 0.5878X
4.fat-free dry femur weight	+ 0.7795	Y = 0.8775 + 0.7112X
Fat-free femur weight versus		
1.skeletal weight	+ 0.8272	Y = 68.2430 + 30.5913X
2.dry femur weight	+ 0.8014	Y = - 0.5330 + 0.7297X
3.fat-free dry femur weight	+ 0.8002	Y = - 0.8239 + 0.7334X
Dry femur weight versus		
1.skeletal weight	+ 0.8904	Y = 59.2367 + 49.8155X
2.fat-free dry femur weight	+ 0.9895	Y = 0.2522 + 0.9960X
Fat-free dry femur weight versus		
1.femur protein weight	+ 0.8567	Y = 0.2223 + 0.4315X
2.femur ash weight	+ 0.9008	Y = - 0.1825 + 0.5582X
3.femur calcium weight	+ 0.9579	Y = 0.0829 + 0.2523X
4.femur phosphorus weight	+ 0.9285	Y = 0.0138 + 0.1232X
Femur ash weight versus		
1.femur calcium weight	+ 0.8850	Y = 0.3081 + 0.3762X
2.femur phosphorus weight	+ 0.8234	Y = 0.1389 + 0.1759X

* All correlation coefficients were significant at $P < 0.01$

following equations:-
Skeletal weight,gm = 60.879 + 30.462X
or = 68.243 + 30.591X_1
or = 59.257 + 49.816X_2

where X = fresh femur weight.gm.
X_1= fat-free femur weight,gm.
X_2 =dry femur weight,gm.

These equations my be usefull for determining the deboning percentage of the carcass and also, for determine any changes in the mineralization of the bones. Cox and Balloun (1971) used the following equation:-
Fat-free dry skeletal weight,gm=
0.887 + 16.06 x fat-free dry femur weight,gm.
However, this equation depend on fat-free dry femur weight to calculated. the fat-free dry skeletal weight. Thus, the skeletal weight calculated from this equation was not usefull for calculating the deboning percentage of the carcass, but only usefull in explaining the variation in total skeletal mineral content. Also , Morris et al. (1966) used the weight of the fat-free dry tibiae for calculating the fat-free dry skeletal weight by using the following equation:- Skeletal weight,gm = 2.997 + 6.601 x tibiae weight,gm.

In our study (Table,2) applaying the weight of the fat-free dry femur bone to calculate the composition of the femur bone by using the following equations:-

Femur protein,gm	= 0.2223	+ 0.4315X
Femur calcium,gm	=0.0829	+ 0.2523X
Femur phosphorus,gm	= 0.0138	+ 0.1232X

where (X) is the weight of fat-free dry femur bone. Using the abovementioned equations, it can be calculate the changes in the composition of the bones according to any factors which may affect on the mobilization of the minerals.

According to the concept of the bone model compartments (Moore et al., 1968), different relations are taken into account chemical femur as shown in Tables 3 and 4. The most important observations in Table 3 are that femur water as fraction of fresh femur weight, femur protein as fraction of fat-free dry femur weight, and femur ash as fraction of fat-free and dry femur weight did not affected by femur weight, fat-free femur weight,femur

Table 3. Relationships between the femur composition and the parameter of femur composition in Egyptian Fayoumi laying hens at 16 months of age.

Items	"r"	Predicted Equation
Femur water as%fresh femur weight versus		
1.Femur fat percentage	- 0.0966	insignificant
2.Femur fat	- 0.0610	insignificant
3.Fresh femur weight	- 0.2032	insignificant
4.Fat-free femur weight	- 0.2122	insignificant
5.Fat-free dry femur weight	- 0.7471**	Y = 6.6619 - 0.0768X
Femur fat as% fresh femur weight versus		
1.Femur fat percentage	+ 1.0000**	Y = 0.0000 + 1.0000X
2.Femur fat	+ 0.9334**	Y = 0.0265 + 0.0573X
3.Fresh femur weight	- 0.2315	insignificant
4.Fat-free femur weight	- 0.3555**	Y = 6.8697 - 0.1657X
5.Fat-free dry femur weight	- 0.3653**	Y = 4.3594 - 0.1560X
as% dry femur weight versus		
1.Femur fat percentage	+ 0.9439**	Y = 0.5687 + 0.5212X
2.Femur fat	+ 0.8790**	Y = 0.0597 + 0.0297X
3.Fresh femur weight	- 0.2519	insignificant
4.Fat-free femur weight	- 0.2494	insignificant
5.Fat-free dry femur weight	- 0.4623**	4.4718 - 0.1083X
Femur protein as% fresh femur weight versus		
1.Femur fat percentage	- 0.3336*	Y = 8.1667 - 0.1403X
2.Femur fat	- 0.3177*	Y = 0.4990 - 0.0082X
3.Fresh femur weight	+ 0.1341	insignificant
4.Fat-free femur weight	+ 0.1765	insignificant
5.Fat-free dry femur weight	+ 0.5525**	Y = 0.9047 + 0.0992X

* $P < 0.005$

** $P < 0.01$

Table 3, Continue

Items	"r"	Predicted Equation
Femur protein		
as% fat-free dry femur weight		
versus		
1.Femur fat percentage	– 0.0662	insignificant
2,Femur fat	– 0.0777	insignificant
3.Fresh femur weight	– 0.1517	insignificant
4.Fat-free femur weight	– 0.1263	insignificant
5.Fat-free dry femur weight	– 0.2743*	Y = 5.7002 - 0.0404X
as% dry femur weight		
versus		
1.Femur fat percentage	- 0.3149*	Y = 9.4622 - 0.1147X
2.Femur fat	- 0.3872**	Y = 0.6581 - 0.0085X
3.Fresh femur weight	- 0.0553	insignificant
4.Fat-free femur weight	- 0.0131	insignificant
5.Fat-free dry femur weight	- 0.1480	insignificant
Femur ash		
as% fresh femur weight		
versus		
1.Femur fat percentage	- 0.2004	insignificant
2.Femur fat	- 0.1459	insignificant
3.Fresh femur weight	+ 0.2362	insignificant
4.Fat-free femur weight	+ 0.6910**	Y = 0.8909 + 0.0967X
5.Fat-free dry femur weight	+ 0.2565*	Y = 5.0335 + 0.0391X
as% fat-free dry femur weight		
versus		
1.Femur fat percentage	+ 0.0732	insignificant
2.Femur fat	+ 0.0599	insignificant
3.Fresh femur weight	- 0.0315	insignificant
4.Fat-free femur weight	- 0.0420	insignificant
5.Fat-free dry femur weight	+ 0.0625	insignificant
as% dry femur weight		
versus		
1.Femur fat percentage	- 0.2490	insignificant
2.Femur fat	- 0.1922	insignificant
3.Fresh femur weight	+ 0.1900	insignificant
4.Fat-free femur weight	+ 0.2162	insignificant
5.Fat-free dry femur weight	+ 0.4067**	Y = 0.8293 + 0.0610X

* $P < 0.05$

Table 4. Relationship between the two compartment model of the ratios of femur composition in Egyptian Fayoumi laying hens at 16 months of age.

Items	"r"	predicted Equation
Femur water/femur fat versus		
1.Femur water/femur protein	+ 0.0447	insignificant
2.Femur water/femur ash	+ 0.0888	insignificant
3.Femur fat/femur protein	- 0.5842**	Y = 0.2121 - 0.0045X
4.Femur fat/femur ash	- 0.5525**	Y = 0.2050 - 0.0042X
5.Femur protein/femur ash	+ 0.0674	insignificant
Femur water/femur protein versus		
1.Femur water/femur ash	+ 0.8350**	Y = - 0.0731 + 1.0517X
2.Femur fat/femur protein	+ 0.5337**	Y = 0.0221 + 0.0944X
3.Femur fat/femur ash	+ 0.5399**	Y = 0.0198 + 0.0939X
4.Femur protein/femur ash	+ 0.0225	insignificant
Femur water/ femur ash versus		
1.Femur fat/ femur protein	+ 0.3152*	Y = 0.0937 + 0.0441X
2.Femur fat/ femur ash	+ 0.5840**	Y = 0.0386 + 0.0809X
3.Femur protein/ femur ash	+ 0.5410**	Y = 0.7416 + 0.1791X
Femur fat/ femur protein versus		
1.Femur fat/ femur ash	+ 0.8678**	Y = 0.0194 + 0.8583X
2.Femur protein/ femur ash	- 0.1991	insignificant
Femur fat/ femur ash versus		
1.Femur protein/ femur ash	+ 0.2486	insignificant

* $P < 0.05$

** $P < 0.01$

fat and fat percentage. Therefore, measuring femur water, femur protein and/ or femur ash seem to be suitable parameters for skeletal composition. In this respect, Waldroup et al. (1963) and Jensen and Edwards (1980) reported that as a percent of the fat-free bone is a good indicator of calcium and phosphorus status. Also, femur bone weight is an even less reliable criterion for evaluating the mineral status that is femur ash weight (Cox and Balloun, 1971). Moreover, femur protein as fraction of fresh femur weight and as fraction of dry femur weight decrease with increasing femur fat and/or fat percentage (Table 3). On the other hand, the significant negative relationships between the ratios of water/fat and protein / ash with the fat percentage and/ or femur fat were observed (Table, 4). Significant positive relationships between the ratios of water/protein, water/ ash, fat/ protein and fat/ash with the fat percentage and/ or femur fat(Table5)

However, the significant negative relationships between the ratios of water/fat with the ratios of fat/protein and fat/ash (Table, 4). While, the significant positive relationships between water /protein, water/ash and fat/protein with the ratios of water/ash, fat /protein and fat/ash (Table, 4).

Generally, the following equations are recommonded to be apply to laying hens.

1.Skeletal weight,gm = 190.831 + 50.98 body weight,kg.
2. or = 113.571 + 0.11 body weight,gm.
3. or = 159.237 +49.82 dry femur weight , gm.
4.Femur calcium,gm = 0.083 + 0.2523X
5. or = 0.308 + $0.3762X_1$
6.Femur phosphorus,gm= 0.014 + $0.1232X^1$
7. or = 0.139 + $0.1759X_1$

where X is fat-free dry femur weight,gm.
X_1 is femur ash weight,gm.

Table 5. Relationships between the ratios of femur composition and femur composition in Egyptian Fayoumi laying hens at 16 month of age.

Items		"r"	Predicted Equation
Femur water/ femur fat versus			
1.Femur fat percentage	-	0.7028**	Y = 5.6760 - 0.1204X
2.Femur fat	-	0.7115**	Y = 0.3588 - 0.0075X
3.Fresh femur weight	+	0.0488	insignificant
4.Fat-free femur weight	+	0.1427	insignificant
5.Fat-free dry femur weight	+	0.0328	insignificant
Femur water/ femur protein versus			
1.Femur fat percentage	+	0.2650**	Y = 2.7370 + 1.0334X
2.Femur fat	+	0.2433	insignificant
3.Fresh femur weight	-	0.1822	insignificant
4.Fat-free femur weight	-	0.2151	insignificant
5.Fat-free dry femur weight	-	0.1732	insignificant
Femur water/ femur ash versus			
1.Femur fat percentage	+	0.1756	insignificant
2.Femur fat	+	0.1258	insignificant
3.Fresh femur weight	-	0.2382	insignificant
4.Fat-free femur weight	-	0.2558*	Y = 6.6993 - 0.3703X
5.Fat-free dry femur weight	-	0.7489**	Y = 5.1172 - 0.9936X
Femur fat/ femur protein versus			
1.Femur fat percentage	+	0.9286**	Y = 0.9871 + 20.6041X
2.Femur fat	+	0.8836**	Y = 0.0794 + 1.2037X
3.Fresh femur weight	-	0.1952	insignificant
4.Fat-free femur weight	-	0.3157**	Y = 6.6807 - 3.2432X
5.Fat-fre dry femur weight	-	0.4589**	Y = 4.3830 - 4.3493X
Femur fat/ femur ash versus			
1.Femur fat percentage	+	0.8795**	Y = 1.1783 + 19.7305X
2.Femur fat	+	0.8116**	Y = 0.1026 + 1.0865X
3.Fresh femur weight	-	0.2354	insignificant
4.Fat-free femur weight	-	0.3705**	Y = 6.7674 - 3.8736X
5.Fat-free dry femur weight	-	0.5863**	Y = 4.5658 - 5.6175X

Table 5. Continue

Items	"r"	Predicted Equation
Femur protein/ femur ash versus		
1.Femur fat percentage	- 0.0547	insignificant
2.Femur fat	- 0.0249	insignificant
3.Fresh femur weight	- 0.1039	insignificant
4.Fat-free femur weight	- 0.0934	insignificant
5.Fat-free dry femur weight	- 0.2576*	Y = 4.7282 - 1.0287X

* $P < 0.05$
** $P < 0.01$

References

Association of Official Agricultural Chemists (1980) Official method of Analysis, 13th Ed. Washington, D.C.

Baird, F.D., and M.J. MacMillan (1942) Use of toes rather than tibiae in A.O.A.C. chick method of vitamin D determination. Assoc. Official Agr. Chem. J. 25, 518.

Campbell, J.A., B.B. Migicovsky and A.R.G. Emslie (1945). Studies of the chick assay for vitamin D. II. A comparison of four criteria of calcification. Poultry Sci. 24, 72.

Cox, A.C. and S.L. Balloun (1971) Prediction of total skeleton mineralization from individual bone data. Poultry Sci., 50, 186.

Evans, R.J., and J.S. Carver (1944) The toe ash as a measure of calcification in chicks . Poultry Sci., 23,351.

Fiske, C.H. and Y Subbarow (1925) The colorimetric determination of phosphorus. J. Biol. Chem. 66, 375.

Garlich, J.,D., C. Morris and J. Brake (1982) External bone volume, ash and fat-free dry weight of femurs of laying hens fed diets deficient or adequate in phosphorus. Poultry Sci., 61, 1003.

Garlich, J.D., R.L. James and J.B. Ward (1975) Effects of short term phosphorus deprivation on laying hens. Poultry Sci. 54, 1193.

Ham, A.W. and T.S. Leeson (1961) Pages 310 , 322 - 325 in Histology. 4th ed. J.B. Lippincott Co., Philadelphia,PA

Hurwitz, S. (1965) Calcium metabolism of pullets at the onset of production, as influenced by dietary calcium level. Poultry Sci. 45, 1452.

Hurwitz, S. and A. Bar (1966) Calcium depletion and repletion in laying hens. 1. Effect on calcium in various bone segments, in egg shells and in blood plasma, and on calcium balance. Poultry Sci., 45, 345.

Itoh, H. and T. Hatano (1964) Comparison of calcium metabolism in various bones of growing chicks in varying states of vitamin D supplementation. Poultry Sci. 43, 70.

Jensen, L.S. and H.M. Edward (1980) Availability of phosphorus from ammonium polyphosphate for growing chickens. Poultry Sci. 59, 1280.

Martin, W.G. and H. Patrick (1962) Radio-nuclide mineral studies 4. Studies on the metabolism of Ca^{45} by the chick. Poultry Sci. 41, 213.

Migicovsky, B.B. and A.R.G. Emslie (1950) Deposition of radioactive calcium in rachitic and non-rachitic chick tibia from oral and intra-muscular doses of Ca^{45}. Arch. Biochem. 28, 324.

Morris, T.R., J.K. Brookhouse and T.G. Taylor (1966) The prediction of skeletal weight from the weights of sample bones. Brit. Poultry Sci. 7, 153

Pechet, M.M., E. Bobadilla, E.L. Carroll and R. Hesse (1967) Regulation of bone resorption and formation. Am. J. Med. 43, 696.

Shebaita, M.K., M.A.I. Salem and G.A.R. Kamar (1975) Meat production following gamma- rays. Arch. Geflugelk, 39, 212.

Shebaita, M.K., M.A.I. Salem, A.L. Badreldin and G.A. Arram(1977) Study on body compartments. I. Logarithmic relationships. Arch. Geflugelk. 41, 49.

Sendecor, G.W. and W.C. Cochran,(1968) Statistical Methods. 5th Ed. The Iowa State Press Ames, Iowa, U.S.A.

Steel, R.G.D. and J.H. Torrie (1980) Principles and Procedures of Statistics. 2nd Ed. 4th printing. McGraw-Hill International Book Company. London, U.K.

Taylor, T.G. and J.H. Moore (1954) Skeletal depletion in hens laying on a low-calcium diet. Brit. J. Nutr. 8,112.

Taylor, T.G. and J.H. Moore (1956) The effect of calcium depletion on the chemical composition of bone minerals in laying hens. Brit. J. Nutr. 10, 250.

Taylor, T.G., J.H. Moore and F. Hertelendy (1960) Variations in the mineral composition of individual of the skeleton of the domestic fowl. Brit. J. Nutr. 14,49.

Taylor, T.G. and T.R. Morris (1964) The effects of early and late maturing on the skeletons of pullets. World's Poultry Sci. J. 20, 294.

Waldroup, P.W., C.B. Ammerman and R.H. Harms (1963) The relationship of phosphorus, calcium and vitamin D_3 in the diet of broiler-type chicks. Poultry Sci. 42,982.

Wei, L.,R.E. Pyke and D.B. Parrish (1954) Ash content of chick beak for vitamin D assays. J. Agric. Fd. Chem. 2,268.

التنبوء بوزن الهيكل العظمى من تحليل مكونات عظمة الفخذ فى دجاجات الفيومى البياضه

عبد الفتاح درويش وممدوح كامل شبيطه ومحمد عبد الصمد خليفه وجلال أمين عرام

أستعملت ٥٤ دجاجة فيومى بياضه عمر ١٦ أسبوع ومتوسط وزن ١٣٠٠ جرام تقريبا ذبحت الطيور واستخرج الهيكل العظمى ووزن. أجرى تقدير الوزن الجاف لعظمة الفخذ ومحتواها من الدهن والرماد والكالسيوم والفوسفور كما حسب بها كمية البروتين وكتله الخلية ووزن الماء داخل الخلية وخارجها .

وجدت علاقة معنوية جدا (على مستوى ١٠ر) بين كل من وزن الجسم ووزن الهيكل العظمى ووزن عظمة الفخذ ووزن مكونات عظمة الفخذ وتراوح معامل الارتباط بين ٣٥٢ر٠ و ٩٩١ر٠

أستنبطت معادلات تنبوء لاستعمالها بالنسبة للفيومى البياض كما يلى

١ـ وزن الهيكل العظمى بالجرام = ١٩٠ر٨٣١ + ٥٠ر٩٨٠ × وزن الجسم بالكيلو جرام

= ٥٩ر٢٣٧ + ٤٩ر٨١٦ × الوزن الجاف الخالى من الدهن لعظمة الفخذ .

٢ـ بروتين عظمة الفخذ بالجرام = ٢٣٢ر + ٤٣٢ر × الوزن الجاف الخالى من الدهن لعظمة الفخذ

٣ـ كالسيوم عظمة الفخذ بالجرام = ٠٨٣ر + ٢٥٢ر × الوزن الجاف الخالى من الدهن لعظمة الفخذ

= ٣٠٨ر + ٣٧٦ر × وزن رماد عظمة الفخذ بالجرام

٤ـ فوسفور عظمة الفخذ بالجرام = ٠١٤ر + ١٢٣ر × الوزن الجاف الخالى من الدهن لعظمة الفخذ

= ١٣٩ر + ١٧٦ر × وزن رماد عظمة الفخذ بالجرام