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EFFECT OF FEEDING LAYERS DIFFERENT SOURCES AND LEVELS OF CALCIUM AT GRADED ANIMAL FAT LEVELS ON SOME PRODUCTIVE TRAITS

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SUMMARY

Number of 648 hens from a brown layer strain were distributed in a 3 X 3 X 3 factorial design during the 47th to 69th weeks of age. Hens of each treatment were housed in 6 wire cages with 4 birds/ replicate. Source of calcium in the ration was either limestone (Lim.), oystershell (Oyst.) or Lim.+Oyst. at a level 3.7, 4.0 or 4.3%. Animal fat (AF) was added at a level of 0.0, 2.0 or 4.0% to the different combinations. Results indicated that : 1- There were significant differences in hen-day egg production, egg weight,egg mass and feed conversion due to calcium level, source, animal fat level and their interactions.2- There were significant differences in calcium intake, Ca utilization, shell weight percentage and shell weight per unit surface area (SWUSA) due to interaction between Ca level X Ca source X AF level. There were highly significant differences in shell weight due to interaction between Ca level X Ca source, but there were no significant differences in shell thickness.3- Bone calcification values expressed as ash weight (AW), percentage ash weight in fat-free dry matter (AW/FFDM) and ash weight per volume (AW/VOL)of either whole single femur bone, its cortics or medulla. The best value of (AW/VOL) in whole bone obtained by feeding 4.0% Ca being 431.73 mg/ml followed by 4.3% Ca (430.02 mg/ml) then 3.7% Ca (392.21 mg/ml). There were no significant differences in AW and AW/FFDM of medullary and cortical femur bone due to Ca level, source, AF level and their interactions. However there were significant differnces in AW/VOL of whole and cortical bone due to interaction between Ca source X AF level, In medullary bone the significant difference was due to interaction between Ca level X Ca source. 4- There were no significant differences due to Ca level, source, AF level and there interactions on total calcium, inorganic-phosphorous, total lipids in blood plasma and total lipid contents in liver tissue.5- The best values of most traits were obtained using 4.0% Ca of 120g feed intake/ hen/ day (equivalent to 4.8g Ca/ hen/ day, Ca:AP ratio10: 1) from Lim.+ Oyst. and supplemented with 4% animal fat saving 10% yellow corn.

Keywords: Laying hens, limestone, oystershell, animal fat, calcium utilization.

INTRODUCTION

The latest NRC report (1994) recommesnded Ca and NPP requirements for Brown-egg layers to be ranged from 3 to 4.5 g and 275 mg/hen/day, respectively.

Studies conducted on Ca sources for laying hens have indicated inconsistent results. Many authors reported that oystershell and limestone were equivalent sources of Ca for egg production and found no significant differences in egg shell quality. Others suggest that Ca from limestone is more available than that of oystershell, inspite of the reports that egg shell quality was improved with the feeding of oystershell. Energy content of feed is the most important factor in reducing feed costs of egg production because birds consume more low energy than high energy feed to produce the same number of eggs (Scott *et al.*,1982). Animal fats are economic source of energy but many factors affect chicken utilization of dietary fat including mineral content of the diet particularly calcium. Soap formation has been implicated in decreasing the availabilities of both calcium and fat from the diet of laying hen.Therefore the aims of this study was to investigate the effect of different sources and levels of calcium and animal fats in laying hens on some productive traits, egg shell quality,bone calcification and some consituents in plasma and liver.

MATERIALS AND METHODS

Number of 648 Lohmann Brown layers housed in 162 cages, 4 hens/cage were divided into 3 X 3 X 3 factorial treatments each consisted of 6 replicates. At the start of the experiment, they were 47wk of age and their weight ranged 1865±112.23 g. Birds were offered 125 g feed/hen daily and residuals were measured. The rations (Table 1) included three calculated levels of Ca (3.7,4.0,4.3% corresponded to determined values 3.71, 4.11 and 4.37 respectively),sources of Ca were limestone, oystershell or mixer of both considering their determined Ca content, and three levels of animal fat added as cooker waste from a slaughter company appended to the rations contents of ether extracts. All diets were fed as dry mash and were calculated to be Iso-caloric and Iso-nitrogenous based on the Layer management program for Lohmann Brown Hens. Feed conversion (feed consumed per unit of egg mass) was calculated every two weeks. Calcium utilization was calculated using the following equation according to Abdalla *et al* (1993) [(Ca in the shell / Ca intake)X100].Eggs were gathered daily within 2 hr of lay for 22 weeks, weighed,and egg mass was calculated every two weeks. Every 30 days, six eggs from each treatment were used for determination of egg quality. Shells were washed to remove adhering albumen,dried at 105^{0}c for 24 hr and shell thickness and weight (SW) were measured with membranes.Shell weight per unit surface area (SWUSA) was calculated according to Nordstrom and Ousterhout (1982): SWUSA (mg/ Cm^2) = SW / SA.Where (SA) = 3.9782 X Fresh egg weight ($gm^{0.7056}$).

Bone parameters were measured according to Cheng and Coon (1990b). Right femur bone from each slaughtered hen, (5 birds at the start and 3 birds at the end aged 69 Wk from each treatment) was defleshed without boiling. Bone volume measured in 1% glycerol solution,the whole femur bone (WB) was then split longitudinally, the medullary bone (MB) was scraped away and the cortical bone (CB) volume was taken.The (MB) volume was calculated by difference. Dry bone weight (DW) was obtained after drying the (MB) and (CB) in a 100^{O}C oven for 10 hr. Fat-free dry weight (FFDW) was later obtained after 36 hr. of ether extraction and ash weight (AW) was obtained after ashing at 600^{O}C for 36 hr. Ash % in fat-free dry matter and bone ash concentration [ash weight per volume (mg/ml)] were calculated.

Chemical analysis

Blood samples were taken at time of slaughtering and collected into dry clean heparinized tubes.Plasma was separated by centrifugation of blood for 15 minutes at 3000 r.p.m. and kept frozen at -20°c for colorimetric determination of total Ca (Elveback, 1970), inorganic-P (Goldenberg,1966) and total lipids (Schmit, 1964). From the same birds that blood samples were taken, liver was removed and packed into polyethylene bag and kept frozen around -20°c for total lipids analysis(Knight *et al.*,1972).

Table 1 -a. Composition of the experimental rations.

Ingradient	Treatment No. (a,b,c)[1]								
	1	2	3	4	5	6	7	8	9
Yellow corn (a,b,c)	68.1	62.6	57.3	68.1	62.6	57.3	68.1	62.6	57.3
Soy bean meal(a,b,c)	9	10.2	11.3	9	10.2	11.3	9	10.2	11.3
L. concentrate[2] (a,b,c)	10	10	10	10	10	10	10	10	10
Added animal fat (a,b,c)	0	2	4	0	2	4	0	2	4
Limestone[a] (35% Ca.)	7.86	7.85	7.84	0	0	0	3.93	3.925	3.920
Oystershell[a] (32% Ca.)	0	0	0	8.6	8.59	8.59	4.30	4.295	4.295
Limestone[b]	8.71	8.709	8.709	0	0	0	4.355	4.354	4.354
Oystershell[b]	0	0	0	9.53	9.525	9.525	4.765	4.763	4.763
Limestone[c]	9.57	9.56	9.56	0	0	0	4.785	4.780	4.780
Oystershell[c]	0	0	0	10.47	10.46	10.45	5.235	5.230	5.225
[Sand=100-other][3b]	4.190	6.491	8.691	3.370	5.675	7.875	3.780	6.080	8.280

Table 1-b. Proximate analysis of the experimental rations

Item	a	b	c
Avereage calculated analysis			
ME, Kcal / Kg	2702.057 ± 1.2	2702.06 ± 1.2	2702.062 ± 1.2
Protein %	15.10 ± 0.006	15.1 ± 0.005	15.1 ± 0.005
C/P ratio	178.92 ± 0.035	178.90 ± 0.04	178.91 ± 0.04
Ca %	3.70 ± 0.003	4.00 ± 0.003	4.30 ± 0.001
Determined analysis			
Moisure	6.55 ± 0.27	6.48 ± 0.31	6.32 ± 0.27
Crude protien	15.38 ± 0.18	15.42 ± 0.27	15.42 ± 0.32
Ether extract	5.14 ± 1.69	5.19 ± 1.71	5.45 ± 1.61
Crude fiber	2.34 ± 0.20	2.41 ± 0.34	2.52 ± 0.30
Crud ash	20.39 ± 1.81	20.17 ± 1.94	20.73 ± 2.39
NFE	56.75 ± 3.59	56.81 ± 3.55	55.89 ± 3.94
Total	100	100	100
Calcium	3.710 ± 0.07	4.110 ± 0.19	4.372 ±0.22
NPP	0.435 ± 0.04	0.405 ± 0.03	0.413 ± 0.03
Ca / NPP ratio	8.605 ± 0.83	10.210 ± 0.98	10.647 ± 0.86

1- a,b,c calculated Ca %; a= 3.7, b= 4.0, c= 4.3%., 2- Layer concentrate contains 51% Crude protein, Crude fiber 2.23% , Crude fat 5.24%, Calcium 9.12%, Phosphorus 3.35% Methionin 1.63%, Methionin+Cystein 2.21%, Lysine, 2.83%, Calorie 2200 Kcal / Kg ME and several vitamins and minerals, 3-Figures in the Table are in case of 4.0% Ca rations, other are reported in Rabea, 1995.

Statistical analysis

The data were subjected to analysis of variance using the general linear model (SAS Institute,Inc.,1988). Two models were used to describe any observation.

Model 1

$Y_{ijkl} = \mu+L_i+S_j+F_k+(LS)_{ij}+(LF)_{ik}+(SF)_{jk}+(LSF)_{ijk}+e_{ijkl}$

where Y_{ijkl} = the yth observation on lth individual, μ = over all mean, L_i = main effect due to i th Ca level, S_j = main effect due to Ca source, F_k = main effect due to kth fat levels, $(LS)_{ij}$,$(LF)_{ik}$,$(SF)_{jk}$ = first order interactions, $(LSF)_{ijk}$= the second order interaction involving the three factors.e_{ijkl}= sampling error assumed to be independently distributed with mean 0 and variance σ^2e. Because of the problems of interpreting the second-order interactions.

Model 2

$Y_{ijk} = \mu+S_i+F_j\ (SF)_{ij}+e_{ijk}$. was used to test the main effects of Ca sources and fat level and their interactions at each of Ca level. Significant mean differences ($P \leq 0.05$) were determined using least square means according to the statistical analysis system and reported in Rabea (1995).

RESULTS AND DISCUSSIONS

Egg Production(H.D.%)

Main treatment effects are presented in (Table 2). Analysis of variance indicated that there was a significant interaction due to Ca levels X Ca sources X fat levels on egg production. However, (Model 2)showed that at 3.7 % Ca, Ca source X fat level interaction affected egg production significantly. At 4% and 4.3% Ca levels there were no significant differencesdue to Ca source, fat level or the interaction between them. 4.0 % Ca level gave the highest egg production of 67.32 % followed by 3.7 % Ca being 65.96 % then 4.3 % Ca level (63.66%). Abdallah *et al*,(1993) found that egg production was significantly lower for hens fed both low-Ca (2.2%) and Ca deficient diet (1.7%) than hens fed the control diet (3.9% Ca). Lohmann brown layer management program (1992) expects 69 wk old hens fed 3.7% Ca to reach 71.6% H.D egg production. Keshavarz,(1986a) found that 42 Wk old hens fed 3.5, 4.5, 5.5 and 6.5% Ca levels had no significant differences in egg production. Clunies *et al*;(1992) reported that dietary Ca level (2.5, 3.5 or 4.5% each providing 0.45% available phosphorus) had no different effect on egg production. Oyster shell gave the highest egg production (66.81%) followed by Lim:Oyst (65.66%) and finally by limestone (64.46%). Askar (1977), concluded that Limestone was superior for egg production followed by oyster shell and finally bone meal. No significant effect was detected due to appended fat or Ca on egg production (Atteh *et al*., 1989).

Egg weight

Table (2) shows that; 4 % Ca level resulted in egg weight mean (58.48) followed by 3.7 % Ca (58.46) and finally by 4.3 % Ca (58.22 g). Ousrerhout,(1980) found that egg weight was highly significant related to dietary calcium level, 1% additional Ca depressed egg weight approximately 0.4 gm. Limestone gave the highest mean (58.78 g) followed by Limestone.+Oyster shell.(58.54 g) and finally oyster shell (57.85 g). 2% additional animal fat resulted in egg weight (58.95 gm.) followed by 4% animal fat mean (58.30 gm.) and finally by nil animal fat (57.91 gm). Atteh and

Leeson (1985) found no significant effect of the fat (0, 5 or 10%) or calcium level (3.0, 3.6 or 4.2%) on egg weight.The statistical analysis indicated that the interaction was significant between Ca levels and sources but there were no significant effect of animal fat levels on egg weight (Model 1). At 4.0 % Ca there was significant difference due to Ca sources but at 3.7and 4.3% Ca no significant differences due to calcium sources or animal fat.

Egg mass

Table (2) indicates that 4% Ca resulted in the highest egg mass (39.48 g) followed by 3.7% Ca (38.91 g) and finally by 4.3% Ca (37.08 g). Lim+Oyst gave the highest value (39.01 gm) followed by Oyster shell (38.79 gm) and finally by Limestone (37.67 gm). 2% animal fat gave the highest egg mass (39.28 g) followed by nil animal fat (38.15 g) and finally by 4% animal fat (38.04 g).

Table 2. Effect of feeding different levels and sources of calcium and animal fat levels on some productive traits and egg shell quality.

Traits	Calcium level, %			Calcium source			Animal fat level,%		
	3.7	4.0	4.3	Lime-stone	Oyster shell	Lim. +Oyst	0.0	2.0	4.0
Egg production (H.D %)	65.96 ± 1.54	67.32 ± 1.2	63.66 ± 1.6	64.46 ± 1.6	66.81 ± 1.6	65.66 ± 1.38	65.89 ± 1.8	65.76 ± 1.08	65.29 ± 1.7
Egg weight (g)	58.46 ± 0.4	58.48 ± 0.6	58.22 ± 0.43	58.78 ± 0.5	57.85 ± 0.3	58.54 ± 0.6	57.91 ± 0.72	58.96 ± 0.4	58.30 ± 0.30
Egg mass (g/hen/day)	38.91 ± 1.02	39.48 ± 0.67	37.08 ± 0.87	37.67 ± 0.89	38.79 ± 0.83	39.01 ± 1.02	38.15 ± 1.09	39.28 ± 0.6	38.04 ± 0.9
Feed intake (g /hen/day)	116:8 ± 1.6	119.9 ± 1.8	118.4 ± 1.2	114.9 ± 1.8	120.5 ± 0.7	119.7 ± 1.4	116.2 ± 2.0	119.9 ± 1.07	119.1 ± 1.4
Feed conversion	3.00 ± 0.11	3.04 ± 0.14	3.19 ± 0.09	3.05 ± 0.10	3.11 ± 0.1	3.07 ± 0.1	3.05 ± 0.1	3.05 ± 0.07	3.13 ± 0.1
Shell weight (%)	9.39 ± 0.32	9.01 ± 0.14	9.05 ± 0.0	9.03 ± 0.1	9.63 ± 0.2	8.79 ± 0.1	9.19 ± 0.18	9.04 ± 0.28	9.22 ± 0.16
SWUSA (mg/cm^2)	78.16 ± 2.5	74.96 ± 1.0	75.30 ± 0.4	75.22 ± 0.86	79.91 ± 2.1	73.30 ± 0.77	76.23 ± 1.4	75.49 ± 2.20	76.71 ± 1.2
Shell thickness (μm)	392.3 ± 2.32	388.9 ± 3.09	393.6 ± 2.23	395.3 ± 2.53	391.0 ± 2.45	388.5 ± 2.46	391.1 ± 2.3	388.2 ± 2.5	395.5 ± 2.3
Calcium intake (g)	4.32 ± 0.06	4.80 ± 0.0	5.09 ± 0.05	4.60 ± 0.14	4.82 ± 0.1	4.79 ± 0.1	4.66 ± 0.1	4.79 ± 0.11	4.76 ± 0.11
Shell weight (g)	5.40 ± 0.1	5.02 ± 0.22	5.27 ± 0.04	5.28 ± 0.06	5.27 ± 0.27	5.14 ± 0.06	5.30 ± 0.11	5.31 ± 0.14	5.08 ± 0.2
Ca in shell (g)	1.37 ± 0.1	1.29 ± 0.11	1.28 ± 0.09	1.30 ± 0.06	1.35 ± 0.17	1.29 ± 0.08	1.34 ± 0.15	1.33 ± 0.1	1.27 ± 0.19
Ca utilization (%)	31.60 ± 1.3	27.03 ± 1.33	25.10 ± 0.3	28.47 ± 1.8	28.29 ± 3.0	26.97 ± 0.4	28.90 ± 1.3	28.01 ± 1.3	26.81 ± 1.5

Analysis of variance showed that there were no significant differences due to calcium sources and animal fat levels at 4.0% or 4.3% calcium levels (Model 2). However, at 3.7 % Ca level, the effect of the interaction between Ca sources X fat levels was highly significant ($P< 0.01$) . Brahma and Ramakvishnan (1989), indicated that both egg number and egg mass were significantly superior in birds fed 4.0 % dietary calcium.

Feed intake

Table (2) shows that 4% Ca level resulted in the highest feed intake (119.94 g) followed by 4.3% Ca (118.46 g) and finally by 3.7% Ca (116.82 g). Oyster shell gave the highest feed intake followed by Lim+Oyst and finally by Limestone being 120.58, 119.73 and 114.90 gm, respectively. 2% animal fat resulted in the highest figure followed by 4% animal fat and finally by nil animal fat being 119.89, 119.05 and 116.28 gm, respectively. Significant Ca level X Ca source X Fat level interaction was detected . However, at 4.0% Ca there was a significant interaction between Ca sources and fat levels (Model 2), there were no significant differences due to Ca sources, fat levels or their interaction at 3.7% and 4.3% Ca level. Atteh and Lesson (1985) who found that there was no significant effect of 0, 5, or 10% fat or 3, 3.6, or 4.2% Ca on feed intake.

Feed conversion

As shown in Table (2) , it ranged 3.00 : 3.19. Analysis of variance showed that there were no significant effects due to calcium levels, sources and animal fat levels (Model 1). Ousterhout,(1980) found that feed efficiency was not significantly affected by dietary calcium level (2.75, 3.75 and 4.75%).

Shell weight percentage

As shown in table (2) it ranged 8.79:9.63%.Analysis of variance showed that there were significant differences due to interaction between Ca levels X Ca sources X fat levels (model 1) . Brahma and Ramakvishnan (1989) found that percent shell was significantly better in eggs laid by hens fed 3.5% and 4.0% dietary calcium.

Shell weight per unit surface area (SWUSA)

As shown in table (2) it ranged 73.30:79.91mg/cm^2. Analysis of variance showed significant interaction due to calcium levels X calcium sources X animal fat levels (Model 1). However, SWUSA was highly significantly affected by calcium sources but no significant differences due to animal fat level at 3.7% Ca level. At 4.0% Ca level, SWUSA was affected significantly by interaction between Ca sources and fat levels (Model 2). March and Amin,(1981) found that shell weight per unit surface area was greater for the egg laid by the birds fed oyster shell. Also Cheng and Coon,1990a) reported that the SWUSA was significantly affected by particle size and calcium intake levels ranged from 2.0 to 4.5 gm/day. Sunder *et al.* (1990) found that SWUSA was better with diet had 3.25% Ca and 0.9% phosphorous.

Shell thickness

As shown in table (2) , 4.3% Ca gave the highest value (393.59μm) followed by 3.7 and 4.0% Ca (392.33, 388.87 μm).Limestone gave the highest values followed by oyster shell and Lim+Oyst. being 395.27, 391.00 and 388.52 respectively.4% animal fat gave the highest value (395.52) than both 0% (391.05) and 2.0% fat (388.22). Analysis of variance showed no significant differences due to treatments .

Calcium intake

As shown in table (2) 4.3% Ca level acquired the highest intake(5.09g) followed by 4% Ca (4.80g) and finally 3.7% Ca (4.32g). Oyster shell gave the highest value followed by Lim.Oyst and finally Limestone being 4.82g, 4.79g and 4.60g, respectively. 2% fat resulted the highest Ca-intake value (4.79g) followed by 4% fat (4.76g) and finally nil animal fat (4.66g). Analysis of variance showed that there were significant differences due to interaction between calcium levels X calcium sources X animal fat level (Model 1). Leeson *et al.* (1993) found that the brown-egg layer required no more than 3.4 gm Ca/day. Clunies *et al.* (1992) found that hens fed lower Ca diets were not able to increase their efficiency of calcium retention from the diet to compensate for differences in calcium intake.

Calcium utilization

There were highly significant differences due to interaction between Ca level X Ca source (model 1). Analysis of variance showed that there were highly significant differences due to Ca level,but there were no significant differences due to animal fat levels or Ca source or interaction between them at 3.7% calcium level. There were no significant differences ($P< 0.05$) due to interaction between Ca sources X fat level at 4.0% and 4.3% calcium level (model 2). 3.7% Ca level resulted in the highest Ca utilization being 31.60 % followed by 4.0% Ca (27.03 %) and finally by 4.3% Ca (25.10 %) on overall average. Limestone gave the highest Ca utilization followed by Oyst. and finally by Lim.+Oyst (1:1) being 28.47, 28.28 and 26.97 respectively. Nil animal fat resulted in the highest figure followed by 2% and finally by 4% additional fat being 28.90, 28.01 and 26.81 %, respectively. Abdallah *et al* (1993),reported that calcium utilization of 56 - 64 wk old layers offered low Ca (2.2 %) diet was greater than the control (3.9 % Ca) being 71.2 and 49.0 % respectively. Their figures were higher than obtained in the present study perhaps due to breed, better egg production and using dicalcium phosphate beside limestone as sources of Ca.

Bone calcification values

As shown in table (3), 4.3% Ca resulted in ash weight (AW) and percentage ash weight in fat-free dry matter (AW/FFDW) (2.85 gm, 57.61%) followed by 4.0% Ca (2.82 gm, 57.16%) and finally 3.7% Ca (2.76 g, 54.25%) but 4.0% Ca level gave ash weight per volume (AW/Vol) equal to (431.73 mg/ml) followed by .3% calcium (430.02 mg/ml) and finally 3.7% Ca (392.21 mg/ml). However, limestone gave the values of AW, AW/FFDW and AW/VOL (2.87 gm, 65.53% and 421.60 mg/ml), respectively compared with Oyster shell (2.78 gm, 56.12% and 417.23 mg/ml) and Lim+ Oyst (2.78 gm, 56.37% and 415.14 mg/ml). 2.0% animal fat gave the highest AW and AW/FFDW (3.03 gm, 56.68%) than other levels of fat {2.62, 55.70 (0% fat), 2.78, 56.64 (4.0% fat)} but 4.0% animal fat level resulted in AW/Vol (427.31) followed by 2% animal fat (425.18 and finally 0% additional animal fat (401.47)). There were no significant differences in AW and AW/FFDM of cortical femur bone due to Ca levels, sources, animal fat levels and their interactions. But there were significant interaction between Ca sources X fat levels and highly significant differences due to Ca levels on AW/Vol of cortical bone, other interactions were not significant. Regarding AW/FFDM, 4.3% Ca gave the highest value being 58.85% followed by 4.0% Ca (58.46%) and finally 3.7% Ca (55.26%). However 4.0% Ca level resulted the highest AW/VOL (525.08 mg/ml) followed by 4.3% Ca (517.75 mg/ml) and finally 3.7% Ca level (455.64 mg/ml). Regarding AW, 2.0% animal fat gave the highest value (2.79 g) followed by 4.0% fat (2.49 g) and finally nil animal fat (2.39 g).

Table 3. Effect of feeding different levels and sources of calcium and animal fat levels on right femur- bone calcification values .

Treatment	Whole bone			Cortical bone			Medullary bone		
	AW (g)	AW/FFDW (%)	AW/VOL (mg/ml)	AW (g)	AW/FFDW (%)	AW/VOL (mg/ml)	AW (g)	AW/FFDW (%)	AW/VOL (mg/ml)
Calcium level									
3.7 %	2.76 ±0.17	54.25 ± 1.65	392.21 ± 14.84	2.63 ± 0.17	55.26 ± 1.69	455.64 ± 16.71	0.14 ± 0.01	42.44 ± 2.17	110.87 ± 10.46
4.0 %	2.82 ±0.11	57.16 ± 0.71	431.73 ± 12.88	2.53 ± 0.10	58.46 ± 0.38	525.08 ± 12.55	0.29 ± 0.03	48.03 ± 1.15	182.21 ± 19.07
4.3 %	2.85 ±0.12	57.61 ± 1.42	430.02 ± 17.61	2.51 ± 0.12	58.85 ± 1.63	517.75 ± 22.22	0.34 ± 0.03	49.78 ± 1.24	211.64 ± 27.15
Calcium source									
Limestone	2.87 ±0.13	56.53 ± 0.95	421.60 ± 16.61	2.68 ± 0.13	57.94 ± 0.79	508.41 ± 16.67	0.20 ± 0.02	43.77 ± 1.91	132.25 ± 12.88
Oystershell	2.78 ± 0.15	56.12 ± 1.38	417.23 ± 15.84	2.52 ± 0.16	56.88 ± 1.62	502.58 ± 22.40	0.26 ± 0.03	49.36 ± 1.57	159.35 ± 13.56
Lim .+ Oyst.	2.78 ± 0.11	56.37 ± 1.55	415.14 ± 14.39	2.46 ±0.09	57.74 ±1.63	487.47 ±15.93	0.32 ± 0.03	47.13 ±1.41	213.12 ±30.61
Animal fat level									
0.0 %	2.62 ± 0.11	55.70 ± 1.40	401.47 ± 14.38	2.39 ± 0.11	56.33 ± 1.62	473.71 ± 18.71	0.23 ± 0.03	47.08 ± 1.81	156.07 ± 25.62
2.0 %	3.03 ± 0.16	56.68 ± 1.55	425.18 ± 18.61	2.79 ± 0.17	57.91 ± 1.62	498.81 ± 19.14	0.24 ± 0.03	48.01 ± 1.49	167.79 ± 19.07
4.0 %	2.78 ± 0.10	56.64 ± 0.91	427.31 ± 12.87	2.49 ± 0.10	58.32 ± 0.78	525.95 ± 16.54	0.29 ± 0.03	45.16 ± 1.75	180.86 ± 19.63

Regarding AW/VOL, 4.0% animal fat resulted the highest value (525.95 mg/ml) followed by 2.0% animal fat (498.81 mg/ml) and finally nil animal fat (473.71 mg/ml). Regarding AW/FFDM, 4% animal fat gave the highest value (58.32%) followed by 2.0% animal fat (57.91%) and finally nil animal fat (56.33%). Limestone resulted the highest value of AW (2.68 gm), AW/FFDW (57.94%) and AW/VOL (508.41 mg/ml) followed by Oyster shell for both AW (2.52 gm) and AW/VOL (502.58 mg/ml) but not for AW/FFDW (56.88 %). However, Lim+Oyst gave the best value than oyster shell for AW/FFDW (57.74%). Finally Lim+Oyst for both AW (2.46 gm) and AW/VOL (487.47 mg/ml) but not for AW/FFDW. Where Oystershell gave the lowest value of AW/FFDW.There were no significant differences in AW and AW/FFDM of medullary femur bone due to first or second order interactions. However, there were highly significant differences due to main effect of Ca level. Both 4.3 % and 4.0 % Ca level gave the highest estimates than 3.7% Calevel (0.34 g, 49.78%), (0.29 g, 48.03%) and (0.14 g, 42.44%), respectively. There were highly significant differences due to Ca sources on AW. Lim:Oyst gave the highest value (0.32 gm) followed by Oyster shell (0.26 gm) and finally Limestone (0.20 gm). There were significant differences due to calcium sources on AW/FFDW, Oyster shell gave the highest value (49.36%) followed by Lim:Oyst (47.13%) and finally Limestone (43.77%). Regarding AW/VOL, there were significant interaction between Ca levels X Ca source, other interactions were not significant. 4.3% Ca from Lim+Oyst gave the highest average (311.35 mg/ml), whereas 3.7% Ca from Lim+Oyst gave the lowest average (101.55 mg/ml). There were no significant differences due to fat levels on AW, AW/FFDW and AW/VOL of medullary bone. Farmer *et al.* (1986) reported that skeletal calcium utilization was directly related to time and level of calcium intake, the greater the dependency on skeletal calcium, the loss the quantity of Ca deposited on the egg shell. Cheng and Coon (1990b) found that medullary bone had a different composition (less ash) than cortical bone and was the most sensitive to levels of Ca intake. These response criteria showed aged linear relationship and very significant slopes within the range of Ca intake employed thus concluded that the AW/VOL measure should be a better indicator of bone mineral reserve because it could differentiate between bone resorption and bone loss. Atteh *et al.* (1989) found that increased the dietary level of fat (from 5% to 10%) generally reduced bone ash content. Bone calcium contents varied depending on the dietary sources of fat and Ca levels.

Total calcium, Inorganic-P and Total lipids in blood plasma and the liver. Results are listed in Table 4 and .all differences in these traits were insignificant (Model 1).

Table 4. Effect of treatments on total Ca, inorganic-P and total lipids in plasma and liver tissues.

Traits	Calcium level,%			Calcium source			Animal fat level, %		
	3.7	4.0	4.3	Lime-stone	Oyster shell	Lim.+ Oyst.	0.0	2.0	4.0
Blood plasma									
Total calcium (g/l)	186.44 ±11.27	168.83 ± 8.93	172.04 ± 0.47	179.77 ± 1.69	177.68 ± 9.22	169.06 ±11.26	178.14 ± 8.99	179.26 ± 1.29	169.91 ± 0.62
Inorganic-P (g/l)	94.84 ± 9.56	78.45 ± 8.52	101.72 ±1.79	100.86 ±10.34	94.37 ±12.69	79.78 ± 6.09	87.59 ±10.75	78.16 ± 6.97	109.25 ±11.41
Total lipids (g/l)	10.75 ± 1.36	11.16 ± 1.74	11.36 ± 1.67	9.90 ± 1.15	12.54 ± 1.41	10.83 ± 1.86	11.08 ± 1.54	11.39 ± 1.35	10.80 ± 4.11
Liver lipids (%)	35.03 ± 2.48	30.49 ± 1.90	33.71 ± 2.77	34.35 ± 2.85	29.71 ± 2.05	35.17 ± 2.20	32.07 ± 2.40	30.27 ± 1.96	36.88 ± 2.71

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تأثير تغذية مصادر ومستويات مختلفة من الكالسيوم عند مستويات متدرجة من الدهن الحيواني على بعض الصفات الإنتاجية للدجاج البياض.

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أستخدم في هذه الدراسة ٦٤٨ دجاجة بياضة من سلالة تجارية بنية اللون من عمر ٤٧ - ٦٩ اسبوع. صممت التجربة على أساس التجارب العاملية ٣x ٣ x ٣ . تحتوي كل معاملة على ٦ مكررات و المكررة الواحدة تحتوي على ٤ طيور. تحتوي العلائق على ثلاث مصادر رئيسية من الكالسيوم و هي الحجر الجيري، مسحوق الصدف أو خليط منهما بنسبة ١:١ عند مستوى ٣,٧ ، ٤,٠ أو ٤,٣٪ كالسيوم. و قد أضيف الدهن الحيواني لهذه العلائق بنسبة صفر ، ٢,٠ و ٤,٠٪ مع جميع إحتمالات التداخلات المختلفة بينهم . وقد دلت النتائج على ما يلي :

١- توجد إختلافات معنوية في نسبة إنتاج البيض (منسوبا إلى رصيد الإناث يوميا) و وزن البيض و كتلة البيض و معدل تحويل الغذاء ترجع إلى التداخل بين مستويات الكالسيوم X مصادر الكالسيوم X مستويات الدهن الحيواني

٢. توجد إختلافات معنوية في كمية الكالسيوم المأكول و نسبة الإستفادة من الكالسيوم و نسبة وزن القشرة إلى وزن البيضة و وزن القشرة منسوبا إلى سطح البيضة ترجع إلى التداخل بين مستويات الكالسيوم Xمصادر الكالسيوم X مستويات الدهن الحيواني. توجد إختلافات معنوية جدا في وزن قشرة البيضة ترجع إلى التداخل بين مستويات الكالسيوم X مصادر الكالسيوم، و لا يوجد إختلافات معنوية في سمك قشرة البيضة.

٣- عبر عن درجة تكلس العظم بوزن الرماد و وزن الرماد منسوبا إلى المادة الجافة الخالية من الدهن و وزن الرماد منسوبا إلى حجم عظمة الفخذ الكاملة و قشرتها و نخاعها. وجد أن ٤٪ كالسيوم حقق أعلى قيمة لوزن الرماد منسوبا إلى حجم العظمة الكاملة (٤٣١,٧٣ ملجم/مل) يليه ٤,٣٪ كالسيوم (٤٣٠,٠٢ ملجم/مل) ثم ٣,٧٪ كالسيوم (٣٩٢,٢١ ملجم/مل). لا توجد إختلافات معنوية في وزن الرماد و وزن الرماد منسوبا إلى وزن المادة الجافة الخالية من الدهن لكل من قشرة و نخاع عظمة الفخذ ترجع إلى التداخلات المختلفة بين مستويات و مصادر الكالسيوم و مستويات الدهن الحيواني. و يوجد إختلافات معنوية في وزن الرماد منسوبا إلى حجم العظمة الكاملة و قشرتها ترجع إلى التداخل بين مصادر الكالسيوم X مستويات الدهن المختلفة بينما وجد إختلافات معنوية في نخاع العظام ترجع إلى التداخل بين مستويات الكالسيوم X مصادر الكالسيوم.

٤- لم تظهر إختلافات معنوية في محتوى بلازما الدم من الكالسيوم الكلي و نسبة الفوسفور الغير عضوي و الدهون الكلية و كذلك محتوى أنسجة الكبد من الدهون الكلية ترجع إلى مستويات و مصادر الكالسيوم و مستويات الدهن الحيواني و كذلك التداخلات المختلفة بينهم.

٥- تحقق أفضل قيم لمعظم الصفات المدروسة باستخدام ٤٪ كالسيوم عند كمية غذاء مأكول ١٢٠جم/طائر/يوم (تساوي ٤,٨ جم كالسيوم / طائر/يوم عند نسبة كالسيوم:فوسفور متاح ١٠:١) الذي مصدره خليط من الحجر الجيري و مسحوق الصدف (١:١) و إضافة ٤٪ من الدهن الحيواني و التي توفر حوالي ١٠٪ من الأذرة الصفراء.