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EFFECT OF ORGANIC AND INORGANIC SOURCES OF CALCIUM AND PHOSPHORUS ON LAYING HENS PERFORMANCE

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ABSTRACT

Three hundred White Bovans laying hens aged 24 weeks were used , to evaluate the effects of dietary organic and inorganic sources of calcium (Ca) and phosphorus (P) on laying performance and egg quality. Hens were randomly divided into four experimental treatments . .Thus four isocaloric (ME ; 2850 kcal / kg) and isonitrogenous (18 % CP) experimental diets were formulated , having equal Ca (4%) and available P (0.45%) contents . . Hens in (Tr1) received 2.6% bone meal (BM) and 8.5% limestone (LS); those in (Tr 2) received 2.6% BM and 8.5% eggshell meal (ESM); those in (Tr 3) received 1.8% dicalcium phosphate (DCP) and 9.5% LS ; and those in (Tr 4) received 1.8% DCP and 9.5% ESM. The experiment was terminated at forty weeks of age.

The obtained results revealed that, layers feed a diet contaning a combination of BM as a source of P and LS as a source of ca (Tr1) , attained a better performance for of egg production, and feed conversion compeared the other treatments . Means of egg weight, feed intake and Haugh unit were not significantly affected by the dietary treatments. However , those layers feed a diet contaning a compination of DCP as a source of P and ESM as a source of Ca (Tr 4) , achiaved the lowest performance for egg production , and produced eggs of thinner shells compared with nthe other treatmentes .

The highest values of nutrients digestibdity and reteution rates of Ca and P were obtained with diets of (Tr1) and (Tr 3) , fallowed by intermedicete values for (Tr 2) , while that of (Tr 4) gave the lowest ones .

Generally , the consistent trends of egg production and shell thickness showed beneficial effects of BM ; as an organic source of P , and LS ; as an inorganic source of Ca ; when being added to laying hen diets , in comparison with DCP and ESM .

Keywords: Calcium, phosphorus, limestone, bone meal, dicalcium phosphate, laying hen , egg production

INTRODUCTION

Calcium (Ca) is the most abundant mineral element in bird body. The major function of calcium is to work in conjunction with magnesium and phosphorus for building and maintaining strong bones . Calcium is an essential constituent of living cells and tissue ftuids as well as egg shell . It is also essential for the activity of a number of enzyme systems including those necessry for the translission of nerveimpulses and for contractile properties of muscle . In addition , it is involved in hormonal secretion, and blood clotting . Besides, it facilitates the passage of nutrients in and out of the cell walls (Kuchinski and Harms, 1997) Many foods provide calcium and there is little chance of an overdose by food supply. But, it is important to regulate the amount of calcium supplied in laying hen diet in the form of a supplement (Scheideler and Robeson, 1997). There are several types of calcium supplements on the market, but not all of them are of equalbioavailability. For example , bone meal contains a high calcium concentration and is the most affordable type of calcium, however, it may be assimilated handly and may also contain lead residues. Limestone is commonly used as amain source of calcium in poultry diets.Also, eggshell and hatchery by-products are used as dietary sources of calcium.

Phosphorus (P) is the second most abundant mineral in birds' bodies.In addition to being of major importance as a constituent of bone , phosphorus is also an essential component of organic compounds involved in almost all expects of metabolisn . It is important for RNA and DNA synthesis, nerve health, heart and muscle contraction, kidney function, and for the growth, maintenance and repair of cells, as well as for the production of energy. Dietary Ca : P ratio should be approximately 2:1 for attaining an efficient utilization of these two elements by the growing birds (Shafey *et al.*, 1990).

There is a comon concept that this mineral element is oversupplied in poultry diets and scarcely its deficiency occurs. In general, a deficiency of this element may cause weight loss problems, joint stiffness, mascular weakness, metabolic disorders as well as impaired rates of reproduction.. Dicalcium phosphate is one of the mineral sources of P that are commonly used in poultry diets. The P sources used in poultry diets should be in acid-treated form to remove heavy metals that can be toxic to the birds. (Sturkie, 1986). The objectives of this study were to evaluate the effects of dietarey supplementation of organic and inorganic sources of Ca and P on laying hens performance and egg quality.

MATERIALS AND METHODS

The present work was carried out at the Poultry Production Station of El-Shark El-Awsat Company , Ghmaza , Giza , Egypt , during the period from August 2002 to the end of January 2003 . Three hundred White Bovans laying hen aged 24 weeks were used. Hens were randomly divided into four experimental treatment groups. Each treatment were subdivided into three replications of twenty-five hens eash ., Birds were reared in Battery cages under the standard management regime of light. The experimental treatments were differing according to the dietary source of calcium and phosphorous as shown in Table 1. Hens in treatment 1 (Tr1) received 2.6% bone meal (BM) and 8.5% limestone (LS); those in treatment 2 (Tr2) received 2.6% (BM)and 8.5% eggshell meal (ESM); those in treatment 3 (Tr3) received 1.8% dicalcium phosphate (DCP) and 9.5% LS and those in treatment 4 (Tr4) received 1.8% DCP and 9.5% ESM Composition and calculated analyses of the expermental diets are presented in Table 2 . All the experimental diets were formulated according to the recommended nutrient requirements of laying hens , as suggested by the strain recommended catalogue. All birds received tap water and feed *ad Libitum* during the experimental period, which lasted 24 weeks . The production period was divided to five period (28 day each).

Within each replicate, egg production percentage and egg weight were recorded daily. Feed intake values were recorded weekly and then the values of feed conversion were calculated. Eggs from three consecutive days of each28-day interval ; were taken to determine the interior quality of eggs ; as measured by the Haugh unit index (HU) . This was calculated by using the HU formula (Eisen *et al.*, 1962). Data were recorded also for shell-less eggs ,while shell thickness was measured by using a dial pipe gauge.

Five birds from each treatment were used for a digestiblity trials to evaluate nutrient digestibility of the tested diets and the retention rates of calcium and phosphorus. The birds were housed individually and fed the tested diets. After a 3-day adjusting period, the collection period continued for 6 days during which feed intake was measured and excreta were quantitatively collected daily . then excreta were oven dried , weighed and finely ground. Representative samples of diets and excreta were analyzed for dry matter (DM , ether extrect (EE) ; crude protein (CP) , crude fiber (CF) , and ash according to A.O.A.C. (1995) . For calculating the digestibility of CP, the fecal protein was determined according to Ekman *et al.* (1949). To obtain % urinary organic matter, the figure of urinary nitrogen was multiplied by the factor 2.62 (Abou Raya and Galae , 1971) . Atomic absorption was used to determine Calcium content of feed and excreta , while total Phosphorus was determined calorimetrically according to the method described by David (1966).

Data were statistically analyzed by factorial desien (2 x 2) . procedure of the SAS Institute (SAS, 1998). Presented data on the perecentages of egg production and-shell less eggs , and those of digestibility coefficients were transformed into the corresponding arcasin values , then statistically processed . All statements of significance are based on the 0.05 level of probability. Significant differences among means of meas rements were separated by using Duncan's multiple range test (Duncan, 1955).

All treatments were economically evaluated by calculating the feed cost to produce one kg eggs

Table (1) : Expremental design :

Dietary Treatments	Source of Calcium		Source of Phosphorus	
	Organic (ESM) %	Inorganic (LS) %	Organic (BM) %	Inorganic (DCP) %
Tr 1		8.5	2.6	
Tr 2	8.5		2.6	
Tr 3		9.5		1.8
Tr 4	9.5			1.8

ESM Contained 35.35 Ca 0.12 P
LS Contained 36.57 Ca 0.00 P
BM Contained 28.29 Ca 11.34 P
DCP Contained 22.31 Ca 15.46 P

Table (2): Compositions and calculated analysis of the experimental diets.

Ingredient %	Tr1 2.6%BM+ 8.5%LS	Tr2 2.6%BM+ 8.5%ESM	Tr3 1.8%DCP +9.5%LS	Tr4 1.8%DCP+ 9.5% ESL
Ground yellow corn	58.25	58.25	58.17	58.17
Soybean meal (44%)	24.50	24.50	24.00	24.00
Corn Gluten meal (60%)	3.00	3.00	3.38	3.38
Vegetable Oil*	2.35	2.35	2.35	2.35
Bone meal ; BM	2.60	2.60	—	—
Dicalcium phosphate ;DCP	—	—	1.80	1.80
Limestone ; LS	8.50	—	9.50	—
Egg Shell meal ; ESM	—	8.50	—	9.50
Premix**	0.30	0.30	0.30	0.30
NaCl	0.35	0.35	0.35	0.35
DL-Methionine	0.15	0.15	0.15	0.15
Total	100	100	100	100
*****Calculated analysis**				
CP%	18	18	18	18
ME ; Kcal / Kg	2850	2850	2850	2850
Calcium ; Ca%	4.00	4.00	4.00	4.00
Available. Phosphorus;AP%	0.45	0.45	0.45	0.45
Methionine %	0.47	0.47	0.47	0.47
Lysine %	0.88	0.88	0.88	0.88
Determined analysis				
	09.43			
Moisture %	17.31	09.89	09.97	10.47
Ash %	17.64	16.85	17.45	16.98
CP %	04.95	17.42	17.84	17.80
EE %	03.74	04.87	05.36	05.47
CF %	04.27	03.77	03.68	03.58
Ca %	00.58	04.39	04.10	04.23
P %		00.55	00.57	00.56
Price (L.E / Ton)	1078	1075	1083	1078

***Oil used is third grade**

**** Each 3 kg of vitamins and minerals mixture contains:**

12000,000 IU vitamin A acetate; 2000,000 IU vitamin D3; 10.000 mg vitamin E acetate; 2000 mg vitamin K3; 100 mg vitamin B1; 4000 mg vitamin B2; 1500 mg vitamin B6; 10 mg vitamin B12; 10.000 mg Pantothenic acid; 20.000 mg Nicotenic acid; 1000 mg Folic acid; 50 mg Biotin; 500,000 mg Choline; 10.000 mg Copper; 1000 mg Iodine; 3000 mg Iron; 55,000 mg Manganese; 55,000 mg Zinc, and 100 mg Selenium..

***** Calculated analysis according to NRC (1994)**

RESULTS

1- Productive performance:

Obtained results (Table 3) showed that the average values of egg production (%) and feed conversion ratio (FCR) were improved significantly ($P<0.05$) by using of either LS as a source of inorganic Ca or BM as a source of organic P , while , there were no significant differences for average values of egg weight and dialy feed intake due to experimental treatments . Interaction results (Table 4) indicated that throughout the experimental period, hens received BM (Tr1 and Tr2.) recorded significantly the higher egg production rates than those received DCP (Tr3 and Tr4). These results may indicate a beneficial èffect of BM ; as a source of P in laying hen diets , on egg production . However, hens received BM as an organic source of P performed well compared with those received DCP as an inorganic source of P . Similar trends were clearly surpassed those given ESM as an organic source of Ca in egg production (Tr1 versus Tr2, and Tr3 versus Tr4) . Generally, BM as a source of P and LS as a source of Ca resulted in an improvement of egg production rate

Table 3: **Means ± SE of egg production, egg weight, feed intake and feed conversion as affected by the dietary treatments.**

Items	peariod	Ca			Ph		
		Organic Tr2&Tr4	Inorganic Tr1 &Tr3	Sig.	Organic Tr2&Tr4	Inorganic Tr1 &Tr3	Sig.
Egg production%	1	91.20±1.14	92.90±0.15	**	93.25±0.24	90.83±0.98	**
	2	92.67±1.71	92.80±1.96	NS	96.82±0.21	88.65±0.19	**
	3	87.85±2.70	89.73±0.95	**	92.85±0.50	84.73±1.31	**
	4	84.48±4.05	90.03±2.90	**	95.00±0.67	79.52±1.83	**
	5	82.62±4.57	90.05±2.42	**	94.15±0.60	78.52±2.74	**
	Overall	87.76±2.83	91.10±1.63	**	94.41±0.18	84.45±1.35	**
Egg weight ; g	1	55.17±0.60	55.17±0.87	NS	55.67±0.71	54.67±0.71	NS
	2	56.67±0.61	57.00±0.58	NS	56.83±0.60	56.83±0.60	NS
	3	58.33±0.61	58.33±0.56	NS	58.50±0.43	58.17±0.70	NS
	4	59.00±0.37	60.00±0.37	NS	59.50±0.43	59.50±0.43	NS
	5	62.33±0.76	62.17±0.60	NS	61.33±0.49	63.17±0.60	NS
	Overall	58.30±0.53	58.53±0.50	NS	58.37±0.50	58.47±0.54	NS
Daily feed intake ; g	1	110.7±0.71	112.0±0.93	NS	111.5±0.89	111.1±70.87	NS
	2	112.7±0.76	112.1±70.79	NS	112.0±0.82	112.8±30.70	NS
	3	112.7±0.55	114.0±0.77	NS	112.8±0.79	113.8±0.60	NS
	4	114.7±0.71	115.0±0.73	NS	114.3±30.71	115.3±0.67	NS
	5	116.8±0.48	115.7±0.90	NS	116.2±0.60	116.3±0.99	NS
	Overall	113.±10.32	113.8±0.34	NS	113.7±0.37	113.9±0.25	NS
Feed conversion (g feed/g eggs) :	1	2.20±0.02	2.19±0.04	NS	2.15±0.02	2.24±0.02	**
	2	2.15±0.04	2.13±0.05	NS	2.05±0.03	2.23±0.03	**
	3	2.21±0.07	2.15±0.05	NS	2.05±0.03	2.30±0.04	**
	4	2.33±0.12	2.14±0.07	**	2.03±0.02	2.44±0.07	**
	5	2.30±0.11	2.07±0.06	**	2.01±0.03	2.35±0.09	**
	Overall	2.24±0.07	2.13±0.05	**	2.06±0.02	2.31±0.04	**

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

Results of egg weight and feed intake (Table 4) indicated that there were no significant differences in both parameters among treatments. The enhanced egg production of Tr 1 and Tr 2 compared with Tr 3 and Tr 4 ; without differences in feed intake , may be attributable to the improvement of the Ca and P by the laying hens of these two treatments .

The values of feed conversion (Table 4) showed also that the hens received BM (Tr 1 and Tr 2) as source of P converted the feed significantly better than those received DCP (Tr 3 and Tr 4) .

Tabel 4 : Means ± SE of interaction due to dietary treatments .

Items	Peariod	Experimental Treatments				
		Tr1 2.6%BM+8.5 %LS	Tr2 2.6%BM+8.5% ESM	Tr3 1.8%DCP+9.5 %LS	Tr4 1.8%DCP+9.5 %ESM	Sig.
Egg production %	1	92.80±0.17 ^{b}	93.70±0.25 ^{a}	93.00±0.26 ^{ab}	88.67±0.23 ^{c}	**
	2	97.17±0.24 ^{a}	96.47±0.20 ^{b}	88.43v0.18 ^{c}	88.87±0.33^{c}	**
	3	91.83±0.26 ^{b}	93.87±0.38 ^{a}	87.63±0.26 ^{c}	81.83±0.20 ^{d}	**
	4	96.47±0.18 ^{a}	93.53±0.18 ^{b}	83.60±0.30 ^{c}	75.43±0.23 ^{d}	**
	5	95.47±0.17 ^{a}	92.83±0.20 ^{b}	84.63±0.24 ^{c}	72.40±0.23 ^{d}	**
	Overall	94.75±0.11 ^{a}	94.08±0.21 ^{b}	87.46±0.23 ^{c}	81.44±0.16 ^{d}	**
Egg weight ; g	1	56.67±0.88	54.67±0.88	53.67±0.88	55.67±0.88	NS
	2	57.33±0.88	56.33±0.88	56.67v0.88	57.00±1.00	NS
	3	59.00±0.58	58.00±0.58	57.67±0.88	58.67±1.20	NS
	4	60.00±0.58	59.00±0.58	60.00±0.58	59.00±0.58	NS
	5	61.67±0.88	61.00±0.58	62.67±0.88	63.67±0.88	NS
	Overall	58.93±0.71	57.80±0.64	58.13±0.77	58.80±0.87	NS
Daily feed intake ; g	1	111.3±1.76	111.7±0.88	112.7±0.88	109.7±0.88	NS
	2	112.7±1.45	111.3±0.88	111.7±0.88	114.0±0.58	NS
	3	113.7±1.45	112.0±0.58	114.3±0.88	113.3±0.88	NS
	4	115.0±1.15	113.7±0.88	115.0±1.15	115.7±0.88	NS
	5	115.3±0.88	117.0±0.58	116.0±2.00	116.7±0.88	NS
	Overall	113.6±0.70	113.1±0.37	113.9±0.27	113.9±0.48	NS
Feed conversion (g feed /g eggs) :	1	2.12±0.00 ^{b}	2.18±0.03 ^{ab}	2.26±0.04 ^{a}	2.23±0.04 ^{a}	**
	2	2.02±0.03	2.07±0.05	2.23±0.05	2.23±0.03	NS
	3	2.06±0.06	2.06±0.03	2.24±0.04	2.36±0.05	NS
	4	1.99±0.02 ^{d}	2.06±0.02 ^{c}	2.29±0.02 ^{b}	2.60±0.01 ^{a}	**
	5	1.96±0.05 ^{c}	2.07±0.01 ^{bc}	2.17±0.05 ^{b}	2.53±0.05 ^{a}	*
	Overall	2.03±0.02	2.09±0.02	2.24±0.03	2.39±0.03	NS

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

Means in the same row with no common superscripts are differ significantly (P<0.05).

2- Egg quality:

The effects of both Ca and P sources on egg quality are shown in Table 5 . Results indicated that the average values of eggshell thickness and shell-less egg(%) were improved significantly ($P < 0.05$) by using of either inorganic source of Ca or organic source of P . While, Hough Units values were not affected due to this dietary treatments .

The effect of interaction due to dietary treatments are illustrated in Table 6. . Obtained results revealed that there were no significant effects of either Ca or P source on the interior egg quality as assessed by the Haugh Unit score .. However, data on percentage of shell-less eggs and eggshell thickness indicated that layers fed BM with LS (Tr 1) generally recorded the lowest percentage of shell-less eggs and produced eggs with thicker shells compared with those of the other treatments . On the other hand, the highest value of shell-less eggs was recorded for those layers received DCP and ESM (Tr 4), which also produced eggs having a somewhat thinner shells .

Tabel 5: Means ± SE of som parameters of egg quality of layers as affected by dietary treatments .

Item	Period	Source of calcium			Source of phorsphorus		
		Organic T2 & T4	Inorganic T1 & T3	Sig.	Organic T1 & T2	Inorganic T3 & T4	Sig.
Haugh Units	1	88.00±0.63	88.33±0.49	NS	88.33±0.49	88.00±0.63	NS
	2	87.33±0.56	87.67±0.49	NS	87.00±0.58	88.00±0.37	NS
	3	87.17±0.48	86.67±0.42	NS	87.00±0.58	86.83±0.31	NS
	4	86.00±0.37	87.17±0.48	NS	86.67±0.56	86.50±0.43	NS
	5	87.17±0.60	87.50±0.56	NS	87.50±0.43	87.17±0.70	NS
	Overall	87.13±0.20	87.47±0.26	NS	87.30±0.28	87.30±0.10	NS
Shell-less egg %	1	1.00±0.39	0.17±0.03	**	0.13±0.02	1.03±0.38	**
	2	1.32±0.43	0.22±0.04	**	0.28±0.07	1.25±0.46	**
	3	1.65±0.43	0.28±0.08	**	0.43±0.14	1.50±0.50	**
	4	1.78±0.46	0.50±0.17	**	0.45±0.15	1.83±0.44	**
	5	2.38±0.67	0.67±0.23	**	0.53±0.17	2.52±0.61	**
	Overall	1.63±0.47	0.37±0.01	**	0.37±0.10	1.63±0.47	**
Eggshell thickness ; mm x 100	1	37.17±0.95	39.00±0.37	*	39.00±0.37	37.17±0.95	*
	2	36.83±0.95	39.50±0.62	*	39.33±0.56	37.00±1.06	*
	3	36.33±1.33	37.83±0.60	NS	38.67±0.49	35.50±1.06	**
	4	36.17±0.87	38.50±0.76	*	38.83±0.70	35.83±0.70	**
	5	34.00±0.58	35.00±1.00	NS	35.83±0.70	33.17±0.48	*
	Overall	36.10±0.85	37.97±0.41	**	38.33±0.29	35.73±0.70	**

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

The consistency of egg production and shell thickness trends showed beneficial effects of BM , as an organic source of P and LS as an inorganic source of Ca . Increasing the efficiency of Ca utilization in laying hen diets resulted in improved egg production and shell quality (Kuchinski and Harms, 1997 and Scheideler and Robeson, 1997).

3- Digestibility coefficients and minerals retention:.

Effects of different sources of Ca and P and their interaction on the digestibility coefficients and minerals retention are presented in Tables 7 and 8. Obtained results revealed that using LS as a source of Ca with either BM or DCP (Tr 1,Tr 3) improved (P<0.05) the digestibility coefficients of OM , CP, and EE , as well as Ca and P retention , while using ESM with DCP (Tr 4) recorded the lowest (P<0.05) coefficients of nutrients digestibility. However, CF digestibility was not affected by the dietary treatments .

Tabel 6 : As affected by interaction between due to dietary treatments

Items	Pearlod	Experimental Treatments				
		Tr1 2.6%BM+8.5% LS	Tr2 2.6%BM+8.5% ESM	Tr3 1.8%DCP+9.5 %LS	Tr4 1.8%DCP+9.5 %ESM	Sig.
Haugh Units	1	88.00±0.58	88.67±0.88	88.67±0.05	87.33±0.88	NS
	2	87.33±0.88	86.67±0.88	88.00±0.58	88.00±0.58	NS
	3	86.67±0.88	87.33±0.88	86.67±0.33	87.00±0.58	NS
	4	87.33±0.88	86.00±0.58	87.00±0.58	86.00±0.58	NS
	5	87.00±0.58	88.00±0.58	88.00±1.00	86.33±0.88	NS
	Overall	87.27±0.48	87.33±0.41	87.66±0.24	86.93±0.07	NS
Shell-less eggs%	1	00.13±0.03^{b}	00.13±0.03^{b}	00.20±0.08^{b}	01.87±0.12^{a}	**
	2	00.20±0.06^{b}	00.37±0.12^{b}	00.23±0.07^{b}	02.27±0.09^{a}	**
	3	00.17±0.07^{c}	00.70±0.15^{b}	00.40±0.12^{bc}	02.60±0.12^{a}	**
	4	00.13±0.03^{c}	00.77±0.12^{b}	00.87±0.09^{b}	02.80±0.12^{a}	**
	5	00.17±0.03^{d}	00.90±0.06^{c}	01.17±0.09b	03.87±0.09^{a}	**
	Overall	00.16±0.03^{c}	00.57±0.09^{b}	00.57±0.05^{b}	02.68±0.06^{a}	**
Eggshell thickness Mmx100	1	39.00±0.58^{a}	39.00±0.58^{a}	39.00±0.58^{a}	35.33±0.88^{b}	*
	2	40.00±0.58^{a}	38.67±0.88^{a}	39.00±1.15^{a}	35.00±0.58^{b}	*
	3	38.33±0.88^{a}	39.00±0.58^{a}	37.33±0.88^{a}	33.67±1.20^{b}	*
	4	40.00±0.58^{a}	37.67±0.88^{ab}	37.00±0.58^{b}	34.67±0.88^{b}	*
	5	36.67±1.20^{a}	35.00±0.58^{ab}	33.33±0.88^{b}	33.00±0.58^{a}	*
	Overall	38..80±0.35^{a}	37.87±0.27^{ab}	37.13±0.18^{b}	34.33±0.66^{c}	*

Means in the same row with no common superscripts are differ significantly (P<0.05).

Tabel 7 : Digestibility coefficient of nutrients and retention of calcium and phosphorus as affected by the dietary treatments . (%)

Item		Source of calcium			Source of phosphorus		
		Organic T2 & T4	Inorganic T1 & T3	Sig.	Organic T1 & T2	Inorganic T3 & T4	Sig.
OM %		81.10±0.23	83.60±0.12	**	82.48±0.46	82.22±0.69	NS
CP %		90.65±0.40	92.85±0.11	**	92.08±0.36	91.42±0.69	NS
EE %		75.80±0.53	78.83±0.11	**	77.90±0.43	76.73±0.94	**
CF %		26.52±0.07	26.45±0.07	NS	26.52±0.07	26.45±0.07	NS
NFE %		84.92±0.27	86.73±0.09	**	86.15±0.31	85.50±0.52	**
Mineral Retention (gm)	Ca	02.78±0.02	03.21±0.02	**	03.00±0.09	02.99±0.11	NS
	P	00.24±0.01	00.34±0.01	**	00.30±0.02	00.28±0.03	NS

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

Table 8: Interaction effect of due to dietary treatments on the digestibility coefficients of nutrients and retention of calcium and phosphorus .(%)

Items / Treatment	OM %	CP %	EE %	CF %	NFE %	Mineral Retention	
						Ca	P
Tr1	83.470.20^{a}	92.870.12	78.83.20^{a}	26.500.12	86.800.17 a	3.180.01^{b}	0.330.01^{a}
Tr2	81.500.17^{b}	91.300.12	76.970.12^{b}	26.530.09	85.500.17^{b}	2.820.01^{c}	0.260.01^{b}
Tr3	83.730.12^{a}	92.830.20	78.830.15^{a}	26.400.06	86.670.09^{a}	3.250.03^{a}	0.350.01^{a}
Tr4	80.700.25^{c}	90.000.62	74.630.09^{c}	26.500.12	84.330.09^{c}	2.730.01^{d}	0.210.01^{c}
Sig .	*	NS	**	NS	**	**	**

Means in the same column with no common superscripts are differ significantly (P<0.05).

DISCUSSION

The present results showed that layers fed the diets containing combination of BM with either LS or ESM (Tr 1 and Tr 2) achieved a better performance for egg production and feed conversion , and produced eggs that had a better eggshell quality as evidenced by the shell thickness score , with a less number of shell-less eggs produced , versus DCP in combination with either LS or ESM (Tr 3 and Tr 4) . Regarding the same criteria , a similar trend was observed also when LS was incorporated in the diet in combination with either BM (Tr 1) or DCP (Tr 3), versus ESM (Tr 2 and Tr 4) . This better performance for egg production and feed conversion was attained by layers with nearly equal feed intakes , and in the absence of significant variations among treatments in egg wieght (Tabel 3) .

However , Vandepopuliere (1973) showed that substitution of ESM for LS in laying hen diets supported comparable egg production , egg weight , feed efficiency and eggshell breaking strength. Also , Arvat and Hinners (1973) stated that inclusion of LS , oyster shell (OS) or ESM at two Ca level (3.7 and 5.7 %) in the diet of laying hens , failed to show significant differences in eggshell thickness or internal egg quality parameters .

It is worthnoting that the experimental diets contained equal amounts of either Ca or available P at a ratio of 9-1 . With this respect , wider ranges were reported by N.R.C (1994) and El-Gindi (1999) who suggested Ca : P ratios of 13 : 1 and 10-1 , respectively , in laying hen diets , for normal egg production and maintenance of proper Ca metabolism . On the other hand , it is well known that Ca and available P are closely related physiologically to the extent that a deficiency or an overabundance of one mineral may likely interfere with the proper utilization of the other .

It was observed that , the availability of Ca and P from diets containing LS as a main inorganic source of Ca , with either BM (Tr 1) or DCP (Tr 3) were greater , versus those containing ESM as a main organic source of Ca (Tr 2 and Tr 4) ; as evidenced by values of Ca and P retention (Tables 7,) .

This may show that the availability of Ca derived from LS was greater than that of ESM . Similarly , Brister *et al* (1981) reported that the availability of Ca from LS was greater than that from OS . On the other hand , the availability of Ca and P derived from the diet containing a combination of BM as a main organic source of P , with ESM (Tr 2) were greater , compared with those of the diet containing DCP as a main inorganic source of P , and ESM (Tr 4) ; as evidenced by values of eggshell thickness (Table 6) , and Ca and P retention (Table 8) . This result may give a slight indication that the availability of P derived from BM was somewhat greater than that of DCP . Differences in the availability of P , from phosphoric acid and DCP (Miller , 1980), and even in that of P derived from various DCP sources (Potter *et al.* , 1995) , were reported .

Another part of causes of variation among treatments, in the performance of the experimental layers for egg production and feed conversion ; in favour of those fed diets containing BM and LS ; to some extent , may be attributed to differences in nutrients digestibility (Table 8) .

This makes one to speculated that the different sources of dietary Ca and P may had an effect on nutrients digestibility . However, such speculation should be taken cautiously , March and Amin (1981) stated that the sources (LS and OS) and amount of dietary Ca ingested by laying hens may affected the environment in the digestive tract , and thus digestion and nutrient absorption , in ways that are not understood .

In addition , the lower egg production rates of the experimental layers fed DCP-containing diets (Tr 3 and Tr 4) compared with those fed BM-containing diets (Tr 1 and Tr 2) , may in part be due to the characteristics of the commercial DCP that was used in the present study . In this connection , Sullivan *et al.* (1994) reported that commercial sources of DCP may have some impurities and contain other heavy metals at harmful levels .

Economic Efficiency (E . E)

Economic efficiency of egg production for laying hens fed the experimental diets , expressed as feed cost to produce one kg eggs during the entire experimental period , is shown in Table 9. Results indicated that the feed cost to produce one kg eggs was lower when laying hens were fed the diet containing BM and LS as sources of P and Ca respectively (Tr 1) than those of the other treatments . On the other hand, diet contaning DCP and ESM (Tr 4) was of higher cost and can not be recommended .

In conclusion , in practical diets for laying hens , it is preferable to apply dietary bone meal as an organic source of phosphorus together with limestone as an inorganic source of calcium to get the best performance and economical efficiency of laying hens .

Table (9). Economic efficiency values as of affected the dietary treatments .

Treat . No	Feed intake Kg / hen	Price of feed L.E /kg	Feed cost L . E	Egg mass Kg / hen	Feed cost / Kg egg mass
Tr 1 2.6%BM+8.5%LS	15.9	1. 078	17.14	7.80	2.20
T r 2 2.6%BM+8.5%ESM	15.8	1. 075	16.99	7.6	2.24
Tr 3 1.8%DCP+9.5%LS	16.0	1. 083	17.33	7.10	2.44
Tr 4 1.8%DCP+9.5%ESM	16.0	1. 078	17.25	6.7	2.57

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تأثير مصادر عضوية وغير عضوية للكالسيوم والفوسفور على أداء الدجاج البياض

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أجريت هذه الدراسة على عدد ٣٠٠ دجاجة بياضة عمر ٢٤ أسبوع من نوع البوفانز الأبيض ، قسمت الطيور إلى أربع مجا ميع متساوية العدد ،و قسمت كل مجموعة إلى ثلاث مكررات وكل مكرر به ٢٥ دجاجة . وذلك لدراسة استخدام تأثير مصادر عضوية وغير عضوية للكالسيوم والفوسفور على الأداء الإنتاجي للدجاج البياض وصفات جودة البيضة ومعاملات الهضم والمحتجز من الكالسيوم والفسفور وكذلك الكفاءة الاقتصادية لانتاج البيض وتم تربية الطيور تحت نفس الظروف من الرعاية والمعاملات البيطرية طول مدة التجربة حتى الأسبوع ٤٤ من العمر وصممت العلائق بحيث تحتوى على نفس المستوى من البروتين الخام والطاقة الممثلة والكالسيوم والفسفور المتاح ٠

وكانت المعاملات كالتالي :-

١ – المعاملة الأولى أعطيت عليقه تحتوي على مسحوق عظام بمستوى ٢,٦ % وحجر جيري بمستوى ٨,٥ % .

٢ – المعاملة الثانية أعطيت عليقه تحتوي على مسحوق عظام بمستوى ٢,٦ % وقشر بيض بمستوى ٨,٥ % .

٣ – المعاملة الثالثة أعطيت عليقه تحتوي على ١,٨ % داي كالسيوم فوسفات مع حجر جيري بمستوى ٩,٥ % .

٤ – المعاملة الرابعة أعطيت عليقه تحتوي على ١,٨ % داي كالسيوم فوسفات مع ٩,٥ % قشر بيض .

وأوضحت النتائج أن تغذية الدجاج البياض على علائق تحتوى على مسحوق العظام كمصدر عضوي للفسفور والحجر الجيري كمصدر معدني للكالسيوم أدى إلى زيادة إنتاج البيض وتحسين الكفاءة التحويلية للغذاء وحسن من سمك القشرة والمحتجز من الكالسيوم مقارنة بمجموعات الطيور المغذاة على علائق تحتوى على الداى كالسيوم فوسفات وقشر البيض كمصدر للفسفور والكالسيوم ٠ بينما لم يكن هناك تأثير معنوي على وزن البيض والغذاء المأكول وقيم وحدات هاوف ٠ كما تحسن كلا من المحتجز من الكالسيوم والفوسفور ٠ كذلك تحسن قيم معاملات الهضم لكلا من المادة العضوية والبروتين الخام ومستخلص الأثير وكذلك المستخلص الخالي من الازوت ٠ بينما لم يكن هناك اختلاف معنوي في معامل هضم الألياف ٠ كان هناك تأثير واضح لاستخدام علائق تحتوى على مسحوق العظام كمصدر للفوسفور والحجر الجيري كمصدر للكالسيوم على تكلفة الغذاء لإنتاج ١كجم من كتلة البيض٠