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Effect of Different Environmental Conditions on the Pathways of Calcium, Phosphorus and Magnesium in Fayoumi Layers

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THIS WORK was performed to evaluate the effect of different environmental conditions on the pathways of calcium, phosphorus and magnesium in Fayoumi hens.

The heat stress lowered calcium retention by hens to the extent that negative balance occurred, this means less availability of calcium. The periodical variation showed that calcium may be the limiting factor for egg production and or the hen assess the amount of this mineral to keep it enough for covering the ovulatory activity. The regulation of calcium balance was achieved mainly via the excretion irrespective the treatment or the amount ingested.

Reversal relationship was shown between calcium and phosphorus regardless of the element uptake. The lighted treatment which showed the highest calcium retention recorded contrary result for the phosphorus. The periodical variations confirmed the opposite directions of both calcium and phosphorus to the extent that negative phosphorus balance occurred. It may be suggested that calcium utilization is the main factor determining the amount of excreted phosphorus.

Magnesium retention was similar to that of calcium since the heat stress group recorded the lowest value, assuring that the high temperature also increased the excretion via the excreta. The amounts of magnesium secreted in eggs were small and those kept by the body were high relative to the ingested amount. The periodical variations confirmed the effect of high air temperature in increasing the magnesium retention. It seems that the state of productivity affects to great extent the retention and excretion of magnesium.

Laying hen nutrition deals with nutrient requirements and the utilization of rations by the laying hen. From an assortment of feedstuffs in the daily ration the laying hen derives important nutrients

essential for maintenance of vital life processes for efficient production performance. A large share of the ration (about 66 to 75 percent) is needed to fulfill the hen's maintenance requirements and the remainder can be used for egg production and, in case of laying pullet that has not reached physical maturity, growth or tissue building.

Oshima and Nozaki (1964) showed that the amount of retained Ca decreased in the high temperature. The phosphorus level in the hen's diet had a marked influence on Mg metabolism in laying hens. High levels of phosphorus in the diet decreased Mg absorption from the small intestine and, stimulated secretion of endogenous Mg from the hens body into the gastrointestinal tract, high Ca levels in the diet appeared to hasten the development of Mg deficiency (Edwards *et al.*, 1962). Edwards and Nuagra (1968) noticed the same effect of phosphorus while high Ca levels did not appear to do so to the extent that phosphorus did in hastening the development of Mg deficiency.

Experimental

Thirty Fayoumi hens which had been in lay for about three months were randomly divided into three equal groups. The layers were housed individually in wire laying cages. The birds were fed a laying ration according to NAS-NRS (1977). The actual feed consumption for each hen was recorded. The formula of the ration fed was as follows :

Corn	50.0%
Wheat bran	20.0%
Corn gluten feed	9.0%
Cottonseed meal, dehulled	10.0%
Fish meal	5.0%
Limestone, ground	5.5%
Mineralised salt	0.5%

Laying hen vitamin premix was mixed with this ration according to the manufacturer «Pfizer» recommendations.

Crude protein and ether extracts were estimated according to A.O.A.C. (1975), phosphorus was determined after Fiske and Subbarow (1925), Ca and Mg were analysed after Campell (1975).

The chemical composition of the ration was as follows :

Crude protein	19.80%
Ether extract	3.83%
Calcium	2.7%
Phosphorus	0.89%
Magnesium	0.20%

The first group of hens «control one» was housed in the normal environmental conditions. The second group was confined in a light proof room, day light was prevented and white fluorescent light was used. A lighting of 12 hr daily was maintained from 6 a.m. to 6 p.m. The third group was located in a room under constant temperature of 35° during the whole experimental period using thermostatic controlled electric heaters, source of illumination was only the day light. Egg production and weights were recorded daily for all the birds.

Calcium, phosphorus and magnesium were determined in the eggs and the excreta using the aforementioned procedures.

The experiment duration lasted for 112 days (16 weeks) initiated on Feb. 9 and continued until May, 31, this was divided into equal 4 periods. Atmospheric conditions during the experimental periods are listed below :

Period and date	Air temperature	Average day length
1. Feb., 2 — March, 8	14.8°C (Max., 21 — Min., 8.6)	11 hr, 10 min
2. March, 9 — April, 5	18.3°C (Max., 24.8—Min., 11.8)	11 hr, 46 min
3. April, 6 — May, 3	22.1°C (Max., 39.6—Min., 14.6)	13 hr, 11 min
4. May, 4 — May, 31	23.5°C (Max., 31.4—Min., 15.7)	14 hr, 1 min
Mean of the whole period	19.7°C (Max., 26.6—Min., 12.7)	12 hr 32 min

Statistical analysis was conducted according to Snedecor (1959).

Results and Discussion

Calcium pathways

Table 1 shows that the artificial light treatment recorded the highest values for all the items studied. For the three treatments, the differences between the amounts ingested were more wider than between those excreted. This caused the amounts retained approximately coincide with the amounts secreted or utilized in egg formation. Heat stress showed the lowest value and percentage of retention *i.e.*, 38%. This means that high temperature lowered the actual biological value and availability of Ca.

Table 1. Calcium pathways in Fayoumi hens under different environmental conditions.

Criteria	Experimental conditions		
	Normal environmental conditions	Artificial light	High constant temperature
	±		
1. Ingested (gm)	208.40 ± 6.24	246.80 ± 6.00	168.12 ± 6.78
2. Excreted (gm)	104.31 ± 4.57	105.50 ± 5.40	103.45 ± 4.90
3. Retained (gm)	104.09 ± 4.82	141.30 ± 4.40	64.67 ± 5.30
4. Retention%	49.95 ± 1.77	57.30 ± 1.60	38.47 ± 2.28
5. Secreted in eggs (gm)	95.75 ± 9.03	126.60 ± 7.10	67.23 ± 6.03
6. Utilized by the body (gm), (3 - 5)			

± Standard error.
±± Data are on hen basis.

Concerning the portion utilized or kept by the body, the heat stress treatment recorded negative Ca balance, meanwhile the balance was appreciably positive in the other two treatments. This is in agreement with that found by Oshima and Nozaki (1964) *i.e.*, the reduction of retention under high temperature occurred irrespective of the dietary Ca. It was concluded that it was a part of the reason of shell thickness reduction or laying rate in summer. There was a reduction in all items of heat stress treatment than both the other two ones, but the magnitude was higher in the second (lighted). It was concluded that the increase in the

The major effect of calcium loss is on the mechanism controlling rate of lay than on egg-shell thickness although poor shelled eggs indeed produced on a low Ca diet (Urist, 1959, Bell and Siller, 1962). The demand made upon the hen in relation to Ca metabolism is enormous (the amount secreted per shell) and even a small imbalance could not be tolerated for a long time (Bell and Siller, 1962).

The present work showed a change in balance from period to another to prevent the severe Ca debt which may lead to harmful effects. The regulation for balance was achieved mainly via the excreta. Guenther and Lenkeit (1964) cited that there was no regulation by terminating the Ca excretion via the egg. Gilbert (1969) suggested that there is a mechanism which enables the hen to assess calcium loss. Lake and Gillbert (1964) showed that the bird with surgical thread in the shell gland and Wood-Gush (1963) on birds with ligated oviduct, showed that the ovulation was higher than the controls. These findings were confirmed by Wood-Gush and Gilbert (1965).

There is little direct evidence to indicate that in case of Ca deficiency or unavailability a reduction in the number of developing follicles may occur. Injection of FSH into birds on a low Ca diet maintains oviposition (Morris and Nalbandov, 1958 and Taylor *et al.*, 1962). However, Taylor (1965) suggested that Ca loss affects FSH secretion, the direct mechanism for this is not known.

Phosphorus pathways

The ingestion of P differed and was proportional to feed intake (Table 3). The excretion was appreciably high in the artificial light treatment.

The retained amount of P was lowest in the lighted treatment and highest in the normal environmental conditions one. The percentage of retention was lowest in the lighted treatment and high in the normal and heat stress treatments. The amount of P secreted in eggs was high in the lighted treatment and low in the other ones. The amount of P utilized by the body in the lighted treatment is so small (0.9 g) to the extent that P as debt occurs, but it increased in other treatments.

Table 2. Effect of periodical variations on calcium pathways in Fayoumi hens under different environmental conditions.

Periods	Criteria					
	Ingested (gm)	Excreted (gm)	Retained (gm)	Retention%	Secreted in eggs (gm)	Utilized by the body (gm)
			Normal environmental conditions			
1	49.05 ± 1.68	30.79 ± 1.82	18.26 ± 2.36	37.23 ± 4.04	18.07 ± 2.18	0.19 ± 2.71
2	51.60 ± 1.94	26.79 ± 2.34	24.81 ± 2.04	48.08 ± 3.77	21.54 ± 3.23	3.27 ± 2.74
3	54.65 ± 2.05	22.10 ± 1.13	32.55 ± 2.04	59.56 ± 2.19	29.69 ± 2.89	2.86 ± 1.81
4	53.11 ± 1.79	24.63 ± 1.88	28.48 ± 2.61	53.62 ± 4.28	26.67 ± 4.37	1.80 ± 3.81
			Artificial light			
1	61.52 ± 1.96	26.77 ± 0.99	34.75 ± 1.45	56.49 ± 1.05	25.41 ± 4.15	9.34 ± 2.95
2	61.56 ± 1.68	19.85 ± 1.50	41.71 ± 1.51	67.76 ± 1.98	34.95 ± 2.78	6.76 ± 2.39
3	61.44 ± 1.31	36.10 ± 3.54	25.34 ± 3.04	41.24 ± 5.24	32.81 ± 2.27	-7.47 ± 5.20
4	62.30 ± 1.78	24.71 ± 1.76	37.59 ± 1.33	60.34 ± 2.10	33.41 ± 3.67	4.18 ± 4.03
			High constant temperature			
1	43.34 ± 1.94	31.70 ± 1.09	11.73 ± 2.43	27.01 ± 5.29	17.11 ± 2.30	-5.38 ± 2.35
2	42.15 ± 2.00	25.39 ± 2.05	16.76 ± 2.08	39.76 ± 4.15	16.73 ± 1.03	0.03 ± 2.38
3	43.86 ± 2.26	22.31 ± 1.96	21.55 ± 1.66	49.13 ± 2.96	20.85 ± 2.56	0.70 ± 2.21
4	38.67 ± 1.62	24.05 ± 1.44	14.62 ± 1.63	37.81 ± 3.47	12.55 ± 2.20	2.07 ± 2.51

± Standard error.

±± Data are on hen basis.

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Table 3. Phosphorus pathways in Fayoumi hens under different environmental conditions.

Criteria	Experimental conditions		
	Normal environmental conditions	Artificial light	High constant temperature
	x		
1. Ingested (gm)	66.82 ± 2.01	79.10 ± 1.90	57.97 ± 2.17
2. Excreted (gm)	47.33 ± 2.29	65.20 ± 2.60	37.89 ± 2.26
3. Retained (gm)	19.49 ± 1.25	13.90 ± 1.50	15.98 ± 1.71
4. Retention%	29.17 ± 2.01	17.60 ± 2.00	29.66 ± 2.73
5. Secreted in eggs (gm)	7.87 ± 0.70	13.00 ± 0.70	5.57 ± 0.34
6. Utilized by the body (gm), (3 - 5)	11.62 ± 1.48	00.90 ± 2.00	10.41 ± 1.70

x Standard error.
xx Data are on hen basis.

It seems that the retention of P opposed that of Ca. In the present work, the lighted treatment showed the highest Ca retention and the lowest for P. Heat stress treatment recorded the lowest Ca and the highest P retention. This is an indication to the several relationships between Ca and P irrespective of the environmental conditions or the mineral intake. Nevertheless, the hense maintained a positive (general mean) P balance. Guenther and Lenkeit (1964) demonstrated that during the phase of excretion, Ca, Mg and P excretion via the egg that of P via feces increased.

Priodical variations of phosphorus pathways

For the normal environmental conditions treatment, retained amounts and percentages of retention in the third and fourth periods (Table 4). The amount secreted in eggs was highest in the third period which is considered the time of the highest reproductive activity. The portion utilized by the body showed a positive balance for all periods.

Negative P balance was shown in the second and fourth periods for the artificial light treatment. The negative balance of P may be met with liberation of the mineral from the skeleton to satisfy the requirements for shell formation and to conserve the amount suitable for vital metabolic functions including the synthesis of egg solids (Taylor and Kirkley, 1967).

Table 4. Effect of periodical variations on phosphorus pathways in Fayoumi hens under different environmental conditions.

Periods	Criteria					
	Ingested (gm)	Excreted (gm)	Retained (gm)	Retention%	Secreted in eggs (gm)	Utilized by the body (gm)
			Normal environmental conditions			
1	15.76 ± 0.55	12.30 ± 0.77	3.46 ± 0.67	21.95 ± 4.32	2.07 ± 0.25	1.39 ± 0.77
2	16.53 ± 0.60	12.60 ± 0.95	3.93 ± 0.61	23.77 ± 3.84	1.86 ± 0.20	2.07 ± 0.70
3	17.53 ± 0.64	10.55 ± 0.56	6.98 ± 0.62	39.82 ± 2.78	2.37 ± 0.36	4.61 ± 0.67
4	17.00 ± 1.73	11.88 ± 1.06	5.12 ± 0.99	30.12 ± 5.68	1.68 ± 0.21	3.45 ± 1.09
			Artificial light			
1	19.71 ± 0.63	15.56 ± 0.64	4.15 ± 0.57	21.06 ± 0.22	2.33 ± 0.22	1.82 ± 0.54
2	19.73 + 0.54	17.46 + 0.84	2.27 + 0.79	11.51 + 3.99	3.37 + 0.22	-1.10 + 0.77
3	19.69 ± 0.42	14.35 ± 0.90	5.34 ± 0.72	27.12 ± 3.71	3.09 ± 2.25	2.25 ± 0.90
4	19.96 ± 0.57	17.82 ± 1.06	2.14 ± 0.64	10.72 ± 3.43	4.17 ± 0.41	-2.03 ± 0.93
			High constant temperature			
1	13.92 ± 0.62	10.74 ± 0.38	3.18 ± 0.62	22.80 ± 4.06	1.35 ± 0.13	1.83 ± 0.53
2	13.51 ± 0.64	9.71 ± 0.77	3.80 ± 0.57	28.13 ± 3.91	1.68 ± 0.13	2.12 ± 0.64
3	14.06 ± 0.72	8.81 ± 1.23	5.25 ± 1.05	27.34 ± 6.84	1.57 ± 0.16	3.71 ± 1.03
4	12.39 ± 0.52	8.64 ± 0.49	3.75 ± 0.59	30.27 ± 4.29	1.01 ± 0.14	2.79 ± 0.53

x Standard error.
xx Data are on hen basis.

In the high constant temperature treatment, the ingested amounts of P were lower than that of the other treatments. There was gradual decrease in the excreted amounts across the four periods. The amounts secreted in eggs were small, while those utilized by the body were of larger magnitude than Ca in proportion to the amount ingested. The higher percentage of retention of P in this treatment than the other ones may be due to the excretion of Ca under heat stress.

In general, it may be suggested that Ca utilization is the main factor determining the amount of excreted P. The more egg production requires more Ca for shell formation and this will be accompanied by high excretion of P (Common, 1933 and 1936). Taylor and Willcox (1942) showed that egg shell formation in hens is associated with decreased excretion of Ca and often with increased excretion of P. The P excreted has been shown to be mainly of urinary origin (Fussell, 1960).

It seems probable that the major factors governing not only the excretion of P but also the general pattern of excretion of all minerals ions and also ammonia during shell calcification are (a) the requirements of the shell gland for Ca and bicarbonate ions, (b) the need to excrete the P resulting from the skeletal resorption (Taylor and Kirkley, 1967).

Magnesium pathways

The lighted treatment was higher in all items than the normal conditions one except for the amount excreted (Table 5).

The percentage of decrease of the heat stress treatment than the normal conditions one are ordered in a descending manner as follows : portion utilized by the body, retained, secreted in eggs, ingested and excreted.

The amount of magnesium utilized by the body was of greater magnitude in proportion to the ingested amount if it was compared with that of calcium. This proportion showed also wide differences between treatments. This may be due to differences in productivity under different treatments.

Magnesium retention showed obvious similarities to calcium retention, since it was the lowest under heat stress and highest under the lighted one. This indicates that the high temperature also increased the excretion of magnesium as it did with calcium.

Table 5. Magnesium pathways in Fayoumi hens under different environmental conditions.

Criteria	Experimental conditions		
	Normal environmental conditions	Artificial light	High constant temperature
	x		
1. Ingested (gm)	14.79 ± 0.44	17.50 ± 0.40	11.92 ± 0.48
2. Excreted (gm)	11.13 ± 0.50	10.10 ± 0.30	9.72 ± 0.36
3. Retained (gm)	3.66 ± 0.28	7.40 ± 0.30	2.20 ± 0.44
4. Retention%	24.75 ± 1.92	42.30 ± 1.00	18.46 ± 3.45
5. Secreted in eggs (gm)	1.50 ± 0.11	2.30 ± 0.10	1.14 ± 0.09
6. Utilized by the body (gm), (3 - 5)	2.16 ± 0.31	5.10 ± 0.20	1.06 ± 0.42

x Standard error.
xx Data are on hen basis.

Retention may be related to the magnitude of the amount ingested. Sell (1969) showed that a linear relationship existed between the quantity of Mg retained and the amount ingested.

Periodical variations of magnesium pathways

For the normal conditions treatment the Mg retention showed the lowest value in the first period, reached the highest level in the third period, began to decline again in the fourth period. The amount kept or utilized by the body was positive in all periods except the first one which showed a slight negative balance (Table 6). In this connection Guenther and Lenkeit (1964) stated that hens retained from 6 to 9% of Mg consumed. A low retention of Mg was recorded in the studies of Sell (1969).

In the artificial light treatment, the fourth period recorded the relative higher value in excretion and there was a similarity between the first and third periods. The amounts secreted in eggs were very close in values in the first and fourth periods

and identical in the second and third periods. The decline occurred in the fourth period which showed a great individual variations reflects the effect of raising air temperature. The portion kept or utilized by the body was high in proportion to the amount ingested or retained.

In the high constant temperature treatment, there was slight differences in the ingested amounts except that the fourth period which was appreciably lower. Concerning excretion, period one showed the highest value. This period was considered the phase of excretion in which a negative balance occurred. The same phase was shown by Guenther and Lenkiet (1964). After this period the hens reassessed their need of this mineral and increased the retention till the third period but with a lower magnitude than the other treatments.

References

A.O.A.C. (1975) Official Methods of Analysis, 12th Ed., Washigton, D.C.

Bell, D.J. and Siller, W.G. (1962) Cage layer fatigue in Brown Leghorns. **Res. Vet. Sci., 3 : 219-230.**

Campell, W.R. (1975) The estimation of Ca and Mg. **Canada J. Biochem. Physiol. 35, 1032-1046.**

Common, R.H. (1933) Observation on the mineral metabolism of pullets. **J. Agric. Sci., 23, 555-570.**

Common, R.H. (1936) Observation on the mineral metabolism of pullets. **J. Agric. Sci., 26, 85-100.**

Edwards, H.M. and Nugara, D. (1968) Magnesium requirement of the laying hen. **Poultry Sci., 47 (3) 963-966.**

Edwards, H.M., Nugara, D. and Driggers, J.C. (1962) Fate of endogenous Mg (28) in laying hens. **Poultry, Sci., 41, 1975-1976.**

Fiske, C.H. and Subbarow, Y. (1925) The colorimetric determination of phos-Phorus. **J. Biol. Chem., 66, 375-400.**

Fussell, M.H. (1960) Collection of urine and faeces from chickens. **Nature London, 185, 332-333.**

Gilbert, A.B. (1969) Effect of a foreign object in the shell gland on egg production of hens fed a calcium deficient diet. Brit. Poult. Sci., 10 : 83-88.

Guenther, K. and Lenkeit, W. (1964) Long term studies of the calcium, phosphorus and magnesium metabolism of laying hen. **Ztier Physiol Tiernahr Fotter Mittler Unde 19 (2), 265-290.**

Lake, P.E. and Gilbert, A.B. (1964) The effect on egg production of a foreign object in the lower oviduct regions of the domestic fowl. **Res. Vet. Sci.**, 6, 39-45.

Morris, T.R. and Nalbandov, A.V. (1958) The induction of ovulation in starving pullets using mammalian and avian gonadotropins. **Endocrinology** 68, 687-697.

NATIONAL ACADEMY OF SCIENCES-NATIONAL RESEARCH COUNCIL, (1977) «**Nutrient Requirements of Poultry**». Washington, D.C. : NAS-NRC No. 1, 7th rev. ed.,

Oshima, M. and Nozaki, H. (1964) An observation on the influence of high ambient temperature on calcium metabolism in laying hens. **Bull. Nat. Inst. Anim. Ind.** 5, 39-48.

Sell, J.L., (1969) Magnesium nutrition of the hen : Influence on retention of magnesium, calcium and nitrogen on ration metabolizable energy value. Poult. Sci., 48, 1437-1442.

Snedecor, G.W. (1959) «**Statistical Methods**». Iowa State College Press, Ames, Towa.

Taylor, T.G. (1965) Calcium-endocrine relationships in the laying hen. **Proc. Nutr. Soc.**, 24, 49-54.

Taylor, T.G., Morris, T.R. and Hertelendy, F. (1962) The effect of pituitary Hormones on ovulation in calcium deficient pullets. **Vet. Res.** 74, 123-125.

Taylor, T.G. and Kirkley, J. (1967) The absorption and excretion of minerals by laying hens in relation to egg formation. **Br. Poult. Sci.**, 8, 289-295.

Taylor, C. and Willcox, J.S. (1942) Calcium and phosphorus balance with laying birds. **J. Agric. Sci.**, 2, 43-61.

Urist, M.R., (1959) The effect of calcium deprivation upon blood adrenal cortex, ovary and skeleton in domestic fowl. **Recent Prog. Horm. Rec.**, 15, 455-477.

Wood-Gush, D.G.M., (1963) The control of nesting behaviour of the domestic hen. The role of the oviduct. **Anim. Behav.** 11, 298-299.

Wood-Gush, D.G.M. and Gilbert, A.B. (1965) Observations on the relationship between the ovary and oviduct in the domestic hen. **Nature, London**, 207, 1210-1211.

تأثير الظروف البيئية المختلفة على مسار الكالسيوم والفوسفور والماغنسيوم فى الدجاج الفيومى

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اجريت هذه الدراسة بغرض الوقوف على تأثير الظروف البيئية المختلفة على مسار العناصر المعدنية الكالسيوم ، الفوسفور والماغنسيوم فى الدجاج الفيومى . تبين الاجهاد الحرارى خفض من كميات الكالسيوم المحتجزة بالدجاج بدرجة حدوث ميزان سالب ، وذلك يعنى خفض معدل الاستفادة بالكالسيوم . ولقد أظهرت فترات الانتاج أن الدجاجة قد تحدد الكمية من هذا العنصر بحيث تكفى لتغطية نشاط الرحم . وتنظيم ميزان الكالسيوم كان يتحصل عليه عن طريق الافراز بصرف النظر عن المعاملة أو الكمية المأكولة .

ظهرت علاقة عكسية بين الكالسيوم والفوسفور بصرف النظر عن كمية العنصر . أظهرت المعاملة التى عرضت فيها الطيور للضوء الصناعى والتى سجلت أعلى معدل احتجاز للكالسيوم نتيجة عكسية فيما يتعلق بالفوسفور . ولقد أظهرت فترات الانتاج الاتجاه العكسى لكلا من الكالسيوم والفوسفور بدرجة حدوث ميزان فوسفورى سالب .
وقد يقترح أن الاستفادة بالكالسيوم يعتبر العامل المحدد فى كمية الفسفور المفرزة .

ولقد كان احتجاز الماغنسيوم مثلما الحال بالنسبة للكالسيوم حيث أن مجموعة الاجهاد الحرارى سجلت أقل قيمة ، وذلك يؤكد أن درجة الحرارة المرتفعة أدت الى زيادة الافراز من هذا العنصر عن طريق الخرج . وكميات الماغنسيوم التى تفرز فى البيض تكون صغيرة والتى يحتفظ بها الجسم تكون عالية اذا نسب ذلك الى الكمية الماكولة من هذا العنصر . ولقد اكدت فترات الانتاج تأثير درجة الحرارة المرتفعة فى زيادة احتجاز الماغنسيوم . ويبدو ان الحالة الانتاجية تؤثر بدرجة كبيرة فى الاحتفاظ وافراز الماغنسيوم .