*Egypt. J. Anim. Prod.* 21, No. 1 pp. 23—32 (1981)

# Supplementation of Magnesium Oxide to Laying Hen Diet. A. Effect on Egg Production, Fertility, Hatchability and Blood Picture

**M.N. Makled, A.M. El-Gammal, and M.F. Raghib**

*Faculty of Agriculture, Assiut University, Assiut, Egypt.*

**THE EFFECT of dietary magnesium level (340; 465; 590 and 840 p.p.m.) on egg production, fertility, hatchability, mortality and blood picture was studied on 9-month-age crossbred laying hens (Dandarawi x Rhode Island Red). The experiment extended for 90-day period. Egg production did not significantly differ between the level of 340 and the level of 465 p.p.m. However, it was adversely affected at higher levels.**

**It was proved that magnesium supplementation significantly increased fertility. Hatchability was not significantly affected, but it tended to reduce at the levels of 590 and 840 p.p.m. of Mg.**

**Minimum mortality was obtained at 465 p.p.m. of Mg. However, increasing magnesium level to 590 or to 840 p.p.m. greatly increased mortality rate.**

**The blood picture indicated a relationship between the dietary Mg content and the RBCs count ; eosinophils percentage; basophils percentage, band cells percentage; lymphocytes percentage; hemoglobin and gamma-globulin fraction of serum protein. In spite of the higher content of the vitamin «C» in blood at the level of 465 p.p.m., the amount of the vitamin in blood was not found to be correlated with dietary Mg level.**

**It was concluded that the level of 465 p.p.m. of Mg is more proper for the laying hen.**

The quantitative requirement for magnesium by laying hens has not been established. The NRC of the United States of America in 1971 listed the growing chickens requirement as 500 p.p.m. of magnesium, but gave no estimate of the hen's requirement.

Halloran *et al.* (1961) reported an actual improvement in egg production in four of five experiments in which up to 485 p.p.m. of Mg, as MgO, was added to a practical-type diet containing about 2200 p.p.m. of magnesium. Moreover, Cox and Sell (1967)

reported that magnesium deficiency in the laying hen caused a decrease in egg production, hypomagnesia, reduced feed intake and decreased egg size.

It has been reported that the requirement for magnesium by chickens is influenced by different factors such as environmental temperature (Kohne and Jones, 1975); breed (McGillivray and Smidt, 1975); dietary phosphorus level (Edwards *et al.*, 1961); dietary calcium level (Cox and Sell, 1967); antibiotic supplementations (Keene and Combs, 1962) and others.

The marked decrease in shell weight and shell magnesium reported by Cox and Sell (1967) as a result of feeding low Mg rations is of interest since it was stated by Christensen *et al.* (1964) that the chick embryo utilizes shell Mg during development.

There appears to be a need for information concerning the dietary Mg level for a high rate of egg production and hatchability of eggs. Therefore, the studies reported in this paper were conducted to determine how magnesium levels of the diet influenced the egg production, mortality, fertility, hatchability and blood picture of the laying hen.

## Material and Methods

This research was carried out at Animal Production Department, Faculty of Agriculture, Assiut University, using a total number of one hundred and sixty crossbred hens of 9-months age (Dandarawi × Rhode Island Red) and 16 purebred cooks of one-year age (Rhode Island Red).

The birds were randomly assigned to four groups (each of 40 males + 4 males). The first group was considered as control and was fed the basal diet (Table 1) which contains 340 p.p.m. of magnesium as determined by the method of Lebedef and Oosovich (1969). The other three groups were fed the basal diet supplemented with 125; 250 or 500 p.p.m. of magnesium; respectively. Thus the treatments contained 340, 465, 590 and 840 mg total magnesium/kg diet. Magnesium was supplied in the form of magnesium oxide (MgO). The birds were maintained on their dietary treatments for 90 days during which food and water were provided *ad libitum*.

TABLE 1. Composition of the basal diet.

| Ingredient | % |
|---|---|
| Yellow corn | 49 |
| Wheat bran | 14 |
| Decorticated cottonseed meal | 10 |
| Rice bran | 15 |
| Meat meal | 3 |
| Blood meal | 2 |
| Yeast | 1 |
| Limestone | 5.4 |
| Common salt | 0.5 |
| Vitamin premix* | 0.1 |
| Calculated average composition:** | |
| Metabolizable energy, Kcal/Kg | 2430 |
| Crude protein, % | 16.32 |
| C / P ratio | 148.9 |

* Vitamin premix contained: 55 mg terramycin, 2200 I.U. Vit. A, 396 I.C.U. Vit. $D_3$, and 2 mcg Vit. $B_{12}$.

** Calculated average composition: values were calculated according to NRC (1971).

Records were maintained on egg production and mortality during the experimental period. Rate of laying was measured by percentage hen-day production.

Ten-day collection of set eggs were incubated at 3; 5; 7; 9 and 11 weeks of the experiment and both fertility and hatchability estimates were estimated.

At the end of the 90-day period, the birds were starved for 12 hr ,after which final weights were taken, and blood samples were collected from the wing vein. In blood samples, the following parameters were measured : red blood cells' count (RBCs), white blood cells count (WBCs) and thrombocytes by the method of Kod-

riavtsov *et al.* (1969); haemoglobin using Sahli's haemometer ; haematocrit value by the method of Wintrob (Shalm *et al.*, 1975) ; WBSs' differential count by Meander's method (Coles, 1967); percent of total proteins in blood serum by the method of Antonov and Elinov (1971); percent of different serum protein fractions through paper electrophoretic analysis according to the method of King and Wooton (1959); and vitamin "C" in the blood by the method of Roe and Kufther (1943).

The statistical analysis was done applying the methods of Snedecor and Cochran (1967) and Duncan (1955).

## Results and Discussion

*Egg production*

The analysis of variance showed that magnesium level significantly affected both laying rate percentage based on hen-day production and number of eggs laid by bird overall the 90-day period (Table 2). Egg production was better at the levels of 340 and 465 p.p.m. of Mg, but it was adversely affected at higher levels of Mg (590 and 840 p.p.m.). Our findings are in agreement with those of Hajj and Sell (1968), who found that the addition of Mg to the ration to a certain level (375 p.p.m.) improved hen-day egg production. Besides, the results of Adams *et al.* (1975) are in partial agreement with our results. They reported that the high levels of magnesium sulfate in drinking water significantly depressed hen day production. Nevertheless, Cox and Sell (1967) stated that under a Mg deficient regimen the hen attempted to maintain productivity and other body functions by drawing upon mobilizable Mg reserves, but the bone and other Mg reserves were not sufficient for hens fed low Mg rations to maintain egg production for more than approximately one week.

*Fertility and hatchability*

It was proved that magnesium supplementations significantly increased fertility, however, hatchability was not significantly affected, but it tended to reduce at the levels of 590 and 840 p.p.m. of Mg (Table 2). According to Hajj and Sell (1968), the maximum Mg requirements of the laying hen were : 155 p.p.m. to maintain

egg production, 275 p.p.m. to maintain a high rate of production and hatchability and 375 p.p.m. to maintain egg production, hatchability and egg weight. Therefore, it may be concluded from our findings and from those of Hajj and Sell that the Mg content of the basal diet (340 p.p.m.) was adequate for egg production and hatchability, but not for fertility. The level of 465 p.p.m. of Mg was more suitable for fertility. Bajpai and Brown (1964) reported that the fertility obtained with turkey semen diluted in monosodium glutamate solution containing magnesium chloride was significantly higher than the fertility obtained with semen diluted in monosodium glutamate, but no significant differences were observed in the hatchability of fertilized eggs.

*Mortality*

The maximum dietary Mg concentration that produced the minimal value of mortality was 465 p.p.m., while the highest mortality of 30% occurred in birds on the 840 p.p.m. Mg (Table 2). Mortality is a sensitive indicator of both deficiency and toxicity. Therefore, it seems that the level of 465 p.p.m. of Mg is more suitable for liveability than either lower level (340 p.p.m.) or higher

TABLE 2. Effect of the level of dietary magnesium on egg production, fertility, hatchability and mortality.

| Criteria | Groups | | | |
|---|---|---|---|---|
| | I | II | III | IV |
| Final live body weight(gm) | 1361 | 1412 | 1347 | 1321 |
| Egg production (eggs/bird/ 90-day period)* | $33^{a}$ | $30.3^{ab}$ | $26.3^{c}$ | $28.2^{bc}$ |
| Laying rate, %* | $36.4^{a}$ | $33.6^{ab}$ | $28.8^{c}$ | $31.1^{bc}$ |
| Fertility, %* | $57.8^{b}$ | $73.1^{a}$ | $71.6^{a}$ | $67.0^{a}$ |
| Hatchability , % | $67.1^{a}$ | $68.8^{a}$ | $60.6^{a}$ | $59.4^{a}$ |
| Mortality, % | 12.5 | 5 | 20 | 30 |

* The analysis of variance showed a significant effect of treatment at 5% level.

(a,b,c)Any two means not having the same letter are significantly different at 5% level.

levels (590, and 840 p.p.m.). In harmony with our findings, Harland *et al.* (1974) working on young Japanese quail found that the mortality rate was 67%; 14% and 42% at 200; 250 and 2000 p.p.m.; respectively.

*Blood picture*

The blood picture indicated a relationship between the Mg content in the feed and the RBCs count; eosinophils percentage, basophils percentage, band cells percentage; lymphocytes percentage ; hemoglobin and gamma globulin fraction of serum protein (Table 3). RBCs number; hemoglobin, lymphocytes percentage, and gamma globulin percentage were significantly higher at 465 p.p.m. of Mg than at 340; 590 or 840 p.p.m. (Table 3).

TABLE 3. Effect of the level of dietary magnesium on blood picture.

| Criteria | Groups | | | |
|---|---|---|---|---|
| | I | II | III | IV |
| RBC$^{x}$ ($10^6$/cm$^3$) | 3.01$^{ab}$ | 3.11$^{a}$ | 2.89$^{b}$ | 2.96$^{ab}$ |
| WBC ($10^3$/cm$^3$) | 41.68$^{a}$ | 42.22$^{a}$ | 39.45$^{a}$ | 40.18$^{a}$ |
| Thrombocytes ($10^3$/cm$^3$) | 70.51$^{a}$ | 70.15$^{a}$ | 68.77$^{a}$ | 70.42$^{a}$ |
| Hemeglobin$^{x}$, mg% | 9.15$^{b}$ | 9.31$^{a}$ | 8.95$^{c}$ | 9.16$^{b}$ |
| Hematocrit value | 31.8$^{a}$ | 31.6$^{a}$ | 31.5$^{a}$ | 31.5$^{a}$ |
| WBCs' differential count: | | | | |
| Eosinophils,$^{x}$ % | 5.3$^{bc}$ | 4.4$^{c}$ | 7.2$^{a}$ | 6.2$^{ab}$ |
| Basophils,$^{x}$% | 0.8$^{b}$ | 0.5$^{b}$ | 1.6$^{a}$ | 1.4$^{a}$ |
| Band cells,$^{x}$ % | 1.6$^{b}$ | 0.7$^{c}$ | 3.1$^{a}$ | 2.5$^{a}$ |
| Neutrophils, % | 24.0$^{a}$ | 25.2$^{a}$ | 23.5$^{a}$ | 23.6$^{a}$ |
| Manocytes, % | 6.1$^{a}$ | 5.7$^{a}$ | 6.7$^{a}$ | 6.7$^{a}$ |
| Lymphocytes$^{x}$, % | 62.$^{ab}$ | 64.6$^{a}$ | 59.4$^{b}$ | 58.9$^{b}$ |
| Total serum protein, gm% | 4.32$^{a}$ | 4.42$^{a}$ | 4.40$^{a}$ | 4.40$^{a}$ |
| Albumin in blood serum %, | 34.58$^{a}$ | 30.36$^{a}$ | 36.18$^{a}$ | 36.44$^{a}$ |
| Alpha globulin in blood serum, | 17.32$^{a}$ | 13.32$^{a}$ | 19.32$^{a}$ | 16.10$^{a}$ |
| Beta globulin " " ", % | 16.58$^{a}$ | 16.80$^{a}$ | 13.72$^{a}$ | 14.64$^{a}$ |
| Gamma globulin$^{xx}$, " " ", % | 31.52$^{a}$ | 39.52$^{b}$ | 30.78$^{a}$ | 32.82$^{a}$ |
| Vitamin C in blood, mg%. | 1.95$^{a}$ | 2.06$^{a}$ | 1.62$^{b}$ | 1.89$^{a}$ |

x The analysis of variance showed a significant effect of treatment at 5% level.

xx (a, b, c) Any two means not having the same letter are significantly different at 5% level.

The level of vitamin "C" in the fowl blood varies from 1.92 to 2.56 mg % under normal physiological conditions (Kodriavtsov *et al.*, 1969). Therefore, it can be said that the vitamin "C" amount in blood was normal at 340-465 p.p.m. of dietary Mg, but subnormal at the higher levels (Table 3). However, it tended to increase at 465 p.p.m. level.

It may be assumed that the increase in both lymphocytes and gamma globulin fraction of serum protein at the level of 465 p.p.m. Mg were responsible for the least percentage of mortality (Table 2), since these elements have a relationship with the immunological power of the bird. This assumption may be confirmed by the finding of a higher amount of vitamin "C" in blood at the level of 465 p.p.m. Mg (Table 3). In 1975, Harland *et al.* reported increased mortality and reduced hemoglobin and hematocrit values due to dietary Mg deficiency.

According to our data the Mg requirement of the laying hen were : 340 p.p.m. to maintain a better rate of egg production, and 465 p.p.m. to maintain a better rate of egg production, fertility, hatchability, liveability and blood picture.

The adverse effect of high levels of Mg in this experiment may be due to the fact that the excess amounts of dietary Mg decrease the availability of other minerals such as zinc (Lease and Williams, 1967) and manganese (Woorpel and Balloun, 1964). It was not clear for us why the adverse effects obtained at the higher two levels of Mg, were more pronounced at 590 than at 840 p.p.m.

Based on the above mentioned, 465 p.p.m. of Mg may be considered more proper to meet the laying hen's requirement under the conditions of this experiment.

## References

**Adams, A.W., Cunningham, F.E. and Munger, L.L. (1975)** Some effects on layers of sodium surfate and magnesium sulfate in their drinking water. **Poultry Sci. 54, 707.**

**Antonov, V.Y. and Elinov, P.N. (1971)** Laboratory researches in veterinary work. Kolos, Moscow, U.S.S.R.

**Bajpai, P.K. and Brown, K.I. (1964)** Effects of potassium and magnesium chlorides on the metabolic activity and fertility of turkey spermatozoa. **Poultry Sci. 43,** 459.

**Christensen, D.A., Nesheim, M.C., Hutt, F.B. and Cole, R.K. (1964)** Genetic differences in magnesium utilization by White Leghorn chicks. **Poultry Sci. 43,** 1307.

**Coles, L.H. (1967) «Veterinary Clinical Pathology»,** W.B. Saunders Co., Philadelphia and London.

**Cox, A.C., and Sell, J.L. (1967)** Magnesium deficiency in the laying hen. **Poultry Sci. 46,** 675.

**Duncan, D.B. (1955)** Multiple range and multiple F tests. **Biometrics, 11,** 1.

**Edwards, H.M., Jr., Nugara, D. and Drigers, J.C. (1961)** Effect of calcium and phosphorus levels in the diet on magnesium metabolism in chickens. The use of radioisotopes in animal biology and medical sciences. Academic Press, N.Y., pp. 83-93.

**Hajj, R.N. and Sell, J.L. (1968)** Dietary magnesium requirement of the laying hen. **Poultry Sci. 47,** 1677.

**Halloran, H.R., Lyle, J.B., and Nakaue, H.S. (1961)** Magnesium for laying pullets. **Feedstuffs, July, 15,** 40.

**Harland, B.F., Fox, M.R.S. and Fry, B.E. (1974)** Magnesium requirement of the young Japanese quail. **Poultry Sci. 53** (1932).

**Keene, O.D., and Combs, G.F. (1962)** Magnesium requirement of chicks and poults. **Poultry Sci. 41,** 1655.

**King, E.J., and Wooton, I.D. (1959) «Microanalysis in Medical Biochemistry»,** 3rd, Ed., J.A. Churchill, London.

**Kodriavtsov, A.A., Kodriavtseva, L.A. and Prevalneer, T.E. (1969) «Hematology of Animals, Birds and Fish»,** Kolos, Moscow, U.S.S.R.

**Kohne, H.J. and Jones, J.E. (1975)** Acid-base balance, plasma electrolytes and production performance of adult turkeys hens under conditions of increasing ambient temperature. **Poultry Sci.** 54, 2038.

**Lebedef, P.T. and Oosovich, A.T. (1969)** Metodi isledovania Karmov, organov; tkani zivotnikh. Roccelkhozezdat, Moscow.

**Lease, J.G. and Williams, W.P. (1967)** The effect of added magnesium on the availability of zinc with some high-protein feedstuffs. **Poultry Sci. 46,** 242.

**McGillivary, J.J. and Smidt, M.J. (1975)** Biological evaluation of magnesium sources. **Poultry Sci. 54,** 1792.

**National Academy of Sciences-National Research Council (1971)** Nutrient Requirements of Poultry. Sixth edition, Washington, D.C.

**Roe, J.H., and Kufther, C.A. (1943)** The determination of ascorbic acid in whole blood and urine by 2, 4 dinitrophenyle hydrazine derivatives of dihydro ascorbic acid. **J. Biol. Chem. 147,** 399.

**Schalm, O.W., Jam., N.C. and Carroll, E.M. (1975) « Veterinary Hematology», 3rd** Ed. Lea and Febiger, Philadelphia.

**Snedecor, G.W. and Cochran, W.S. (1967) «Statistical Methods».** Oxford and Ibn. Publishing Co. Calcutta, Bombay and New Delhi.

**Wooprel, H.R., and Balloun, S.L. (1964)** Effect of iron and magnesium on manganese metabolism. **Poultry Sci. 43,** 1134.

## اضافة اكسيد الماغنسيوم الى علائق الدجاج البياض
## أ ـ تأثيره على انتاج البيض والخصوبة ونسبة الفقس وصورة الدم

**محمد نبيل مقلد ، عبد الله الجمال ، ومحمد فاروق راغب**
كلية الزراعة ـ جامعة اسيوط .

درس تأثير مستويات الماغنسيوم فى الغذاء ( ٣٤٠ ، ٤٦٥ ، ٥٩٠ ، ٨٤٠ جزءا فى المليون ) على انتاج البيض والخصوبة ونسبة الفقس ونسبة النفوق وصورة الدم فى دجاجات خليطة ( دندراوى × رود ايلاند احمر ) عمرها حوالى تسعة شهور واستمرت التجربة لمدة ثلاثة شهور .

وقد وجد ان انتاج البيض لم يختلف اختلافا معنويا بين مستوى ٣٤٠ ومستوى ٤٦٥ جزءا فى المليون ولكنه تأثر تأثيرا سالبا عند المستويات الاعلى ..

وقد امكن اثبات ان اضافة الماغنيسيوم قد حسنت من الخصوبة ، بينما لم تتأثر نسبة الفقس لذلك . وعلى الرغم من ذلك فقد لوحظ اتجاه للانخفاض فى نسبة الفقس عند مستويات ٥٩٠ ، ٨٤٠ جزءا فى المليون .

وقد وجد ايضا أن اقل نسبة نفوق كانت عند مستوى ٤٦٥ جزءا فى المليون من الماغنيسيوم بينما ادت زيادة مستوى الماغنيسيوم الى ٥٩٠ او ٨٤٠ جزءا فى المليون الى زيادة كبيرة فى نسبة النفوق . واوضحت صورة الدم وجود علاقة بين محتوى الغذاء من الماغنيسيوم وبين كل من عدد كرات الدم الحمراء ونسبة الايوسينوفيل اليازوفيل والكرات اللمفاوية والهيموجلوبين ونسبة الجاما جلوبيولين الموجود فى مصل الدم وعلى الرغم من ارتفاع مستوى فيتامين ( C ) فى الدم عند مستوى ٤٦٥ جزءا فى المليون من ماغنيسيوم الغذاء الا انه لم تثبت علاقة بين مستوى الماغنيسيوم فى العليقة وبين كمية الفيتامين فى الدم .

وعموما يمكن القول ان مستوى ٤٦٥ جزءا فى المليون من الماغنيسيوم فى عليقة الدجاج البياض كان انسب من باقى المستويات المدروسة .