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Article

Enhancing Egg Quality in Molting Hens Through Dietary Manganese Supplementation

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Abstract: This study explores the application of a fasting program to enhance molting and vitality in Lohman brown hens, with a focus on the impact of dietary manganese on egg quality. Forced molting was induced in 120 hens, divided into five groups (T1, T2, T3, T4, T5), with manganese sulfate added to their feed at concentrations of 0, 25, 50, 75, and 100 mg/kg, respectively. The research aimed to determine the optimal manganese level for improving egg quality parameters such as eggshell relative weight, eggshell height, albumin index, yolk index, and the percentage of broken and abnormal eggs. The results showed significant improvements in all measured parameters in the manganese-supplemented groups compared to the control group, highlighting the beneficial effects of manganese on egg quality during the molting process. These findings suggest that incorporating manganese into the diet can effectively enhance egg production quality in molting hens, providing a practical approach for poultry management.

Keywords: Manganese, Egg quality, Forced molting, Laying hens.

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1. Introduction

As a hen gets older, her egg production decreases. The precise information and recommendations for molting programs have been released by several institutions [1,2,3]. Withholding food from hens is the primary method for causing them to molt and promoting several egg-laying cycles [4,5]. The complete withdrawal of feed and a reduction in photoperiod from 16 to 8 hours remain favored because the hens are only out of production for 10 to 14 days [4,6]. Additionally, feed removal durations of 4 to 5 days are used. These multiple methods aim to continue producing eggs for as long as possible by restoring the vitality and activity of their reproductive system. However, after the molting procedure, a decline occurs in the specific characteristics of the eggs.

For this reason, some mineral elements are used in order to improve the specifications of the eggshell and the internal characteristics of the egg, and among these elements are manganese (Mn), Arginase, pyruvate carboxylase, and manganese superoxide dismutase all enzymes that depend on manganese as a critical activator [7]. According to [8], adding 40 ppm of Mn improved eggshell quality. According to recent research, trace elements that have been chelated or complexed may increase the bioavailability of minerals for animals. Compared to inorganic salts, these metal-amino acid chelates or complexes provide trace elements that are more effectively absorbed from the gut and deliver easily absorbed amino acids [9,10]. Therefore, the current study aims to study the effect of manganese sulfate added to the diet of laying hens on egg quality after forced molting.

2. Materials and Methods

2-1 Experiment design and chicken management.

The farm experiment in the Faculty of Agriculture/Al-Qasim Green University poultry farm included a six-week molting period. This experiment used an 80-week-old Lohman brown chicken, and 120 laying hens were randomly divided into five groups. In each group, 24 chickens were divided into three replicates, each of which contained eight chickens (T1: control group, and T2, T3, T4, T5 add 25, 50, 75, 100 mg manganese/kg diet respectively), at four periods each period (P.) of 2 weeks.

2-1-1 molting program.

The molting program was applied, where the chickens were exposed to continuous lighting -24 hours- during the first five days, after which the herd fasted, and the number of lighting hours was reduced to 12 hours, with the weight of 100 hens to know the average weight of the birds - which was 2350 gm /hen - and after six days of fasting, he presented feed again for the chickens after the weight of the chickens decreases by about 15-20%, on the 21st day of molting, gradually increasing the number of lighting hours until reaching 16 hours/day at 35 days of molting.

2-2 Feed group.

The chickens were fed on the ration below (In molting, the feed was prevented during the fasting period, then 50, 80, and 90 g/hen were given for the third, fourth, and fifth weeks, respectively), then a feed ration of 115 gm/chicken/day after molting.

Table 1. Shows the percentages of diet components in the study and their chemical composition.

Ingredients	Within molting	After molting
yellow corn	30	36.5
wheat	15	12
barley	20	13.9
Soybean meal	20	25
*Premix	2	2.5
DCP Calcium Diphosphate	9	8.3
Sunflower oil	4	1.8
Total**	100	%100
Metabolic energy (kilocalories/kg feed)	2970	2758.68
Crud protein (%)	16	17.19
Crud fiber	5	3.24
Calcium%	2.28	3.81
Available phosphorus (%)	0.45	0.29
Methionine + cysteine (%)	0.45	0.73
Lysine (%)	0.45	0.95

** Chemical analysis computed according to [11].

2.3 studied traits

2.3.1 Shell thickness

Measure the thickness of a shell with the inner membranes according to the equation below:

$$\text{Shell thickness (Mm)} = \frac{\text{Shell Thickness of First End (mm)} + \text{Shell Thickness of Second End (mm)}}{2}$$

2.3.2 Shell Weight (g)

Calculated according to [12].

2.3.3 Albumen index and Yolk index

Calculated according to [12].

2.3.4 Egg broken rate and abnormal rate

Calculated according to the equation below:

$$\text{Egg broken rate and abnormal rate} = \frac{\text{Egg broken and abnormal egg number.}}{\text{Total egg number}}$$

2.4 Statistical analysis

The Statistical Analysis System [13] and [14] was used according to the equation below:

$$Yij = \mu + Ʈi + Ɛij$$

3. Results and Discussion

1. Relative shell weight and eggshell height.

The effects of the dietary groups on relative shell weight are shown in the table; there was no significant difference in the first period, as well as in the second and fourth periods, there was a significant increase ($P\leq0.05$) for all manganese sulfate adding groups compared control group, meanwhile in the third period significant increased ($P\leq0.05$) for T2, T4, and T5 groups compared T1 and T3 groups.

In eggshell thick (table- 3) noted significant improvement ($P\leq0.05$) for T2 compared to T1, T3, and T5 in the first period, as well in second period significant increased ($P\leq0.05$) for T4 compared all groups, in third period significant increased ($P\leq0.05$) for T2 group compared all groups and significant for T3 and T5 groups compared T1 and T4 groups, meanwhile in fourth significant increased ($P\leq0.05$) for T5 group compared all groups.

Table 2: Effect of manganese supplementation in relative shell weight of laying hens exposed to

Groups	1 P.	2 P.	3 P.	3 P.
T1	9.46±1.20	8.56±0.74 b	8.66±0.08 b	7.98±0.17 c
T2	9.51±0.25	9.67±0.55 a	9.53±0.07 a	8.68±0.10 b
T3	9.62±0.22	9.50±0.30 a	8.47±0.20 b	9.12±0.08 a
T4	9.80±0.14	9.86±0.09 a	9.61±0.50 a	8.74±0.13 b
T5	9.40±0.31	9.31±0.21 a	9.35±0.44 a	9.31±0.20 a
Significant	NS	*	*	*

*Different letters indicate significance

Table 3: Effect of manganese supplementation in eggshell thick of laying hens exposed to force molting

Groups	1 P.	2 P.	3 P.	3 P.
T1	0.40±0.02 b	0.37±0.01 b	0.39±0.07 c	0.40±0.08 bc
T2	0.42±0.05 a	0.36±0.03 b	0.42±0.10 a	0.39±0.05 c
T3	0.38±0.07 c	0.39±0.12 b	0.40±0.01 b	0.41±0.07 b
T4	0.41±0.09 ab	0.40±0.03 a	0.38±0.04 c	0.41±0.03 b
T5	0.40±0.03 b	0.38±0.04 b	0.41±0.06 b	0.42±0.01 a
Significant	*	*	*	*

*Different letters indicate significance

2. Albumen index and yolk index

Table (4) shows the effect of study groups on albumen index; in the first period, there was a significant increase (P≤0.05) in all groups compared to the T1 group, and in the second period, there significant increase (P≤0.05) for T3 group on other groups and significant T2 and T5 groups on T4 group, as well as in third period significant increased (P≤0.05) for T1 and T3 groups and significant for T4 and T5 compared T2 group, meanwhile in fourth period significant improvement (P≤0.05) for T1 and T2 groups compared other groups.

The change of yolk index (table- 5) noted in the first period significantly increased (P≤0.05) for the T4 group and significant for the T1 and T2 groups compared to T3 and T5 groups; there was no significant difference in the second period, as well as in third-period significant improvement (P≤0.05) for T1 and T5 groups compared all groups, in fourth period significant increased (P≤0.05) for T3 group on T1, T2, and T4 groups.

Table 4: Effect of manganese supplementation in albumen index of laying hens exposed to force molting

Groups	1 P.	2 P.	3 P.	3 P.
T1	0.70±0.01 c	0.75±0.03 bc	0.97±0.05 a	1.05±0.08 a
T2	0.75±0.05 b	0.81±0.07 b	0.89±0.07 c	1.09±0.01 a
T3	0.83±0.04 ab	0.92±0.01 a	0.96±0.02 a	0.97±0.05 b
T4	0.89±0.08 a	0.71±0.04 c	0.90±0.09 b	0.95±0.02 b
T5	0.85±0.07 ab	0.86±0.09 b	0.91±0.04 b	0.98±0.01 b
Significant	*	*	*	*

*Different letters indicate significance

Table 5: Effect of manganese supplementation in yolk index of laying hens exposed to force molting

Groups	1 P.	2 P.	3 P.	3 P.
T1	75.02±1.22 b	73.14±1.53	75.61±0.14 a	68.44±2.40 c
T2	78.02±0.89 b	75.21±0.75	69.81±3.41 c	71.55±1.52 b
T3	69.65±2.10 c	76.14±1.14	71.14±1.79 bc	79.61±0.74 a
T4	80.14±1.00 a	77.31±1.02	74.18±0.35 b	69.34±1.23 c
T5	76.14±0.51 c	75.52±2.20	76.47±0.74 a	76.55±1.01 ab
Significant	*	NS	*	*

*Different letters indicate significance

3. Egg broken rate and abnormal rate

Fig. 1 shows the effect of the study on egg broken rate and abnormal egg rate, with significant improvement (P≤0.05) for T2 and T5 groups compared to other groups.

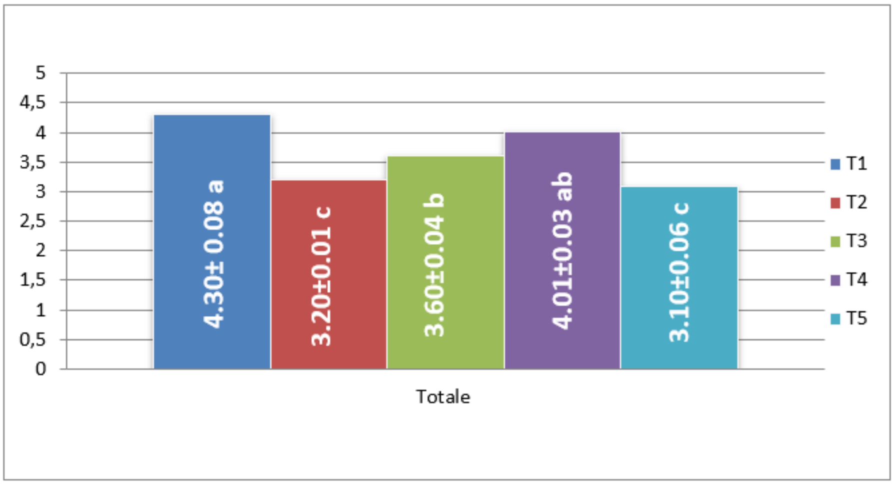

Figure 1 : Effect of manganese supplementation in totale egg broken rate % of laying hens exposed to force molting

*Different letters indicate significance

The improvement in the qualitative characteristics of eggs in manganese groups may be by encouraging the synthesis of mucopolysaccharides; manganese plays a significant influence in eggshell quality, [15] showed that eggshell thickness was increased in laying hens administered supplemental Mn (20, 40, or 80 mg/kg), as Mn-oxide. A dietary shortage of Mn reduces eggshell thickness [16]. Similarly, according to [17], fed Mn supplementation (25 or 100 mg/kg) enhanced eggshell quality indicators such as breaking strength and thickness in eggs from 50-week-old laying chickens. Regardless of the source, [18] observed that Mn supplementation at 120 mg/kg lowered the percentage of cracked eggs from 20-week-old laying chickens. The maximum eggshell thickness from laying hens fed a diet containing 200 mg/kg of Mn was recorded by [19].

As a result, the diet's source and Mn intake impact the quality of eggshells. Additionally, organic Mn significantly impacts eggshell quality more than inorganic sources. According to, dietary supplementation with 100 mg/kg of organic Mn increased eggshell-breaking strength, while supplementing with inorganic Mn increased eggshell thickness in aged laying hens. In research on broiler breeders, Mn supplementation boosted eggshell-breaking strength without changing the thickness of the shell (120 and 240 mg/kg) [20]. However, according to other research findings, adding Mn to diets did not affect eggshell quality metrics. For instance, [21] showed that adding extra Mn did not affect the eggshell quality of laying 22 to 24-week-old chickens. The eggshell quality metrics of laying hens fed a diet containing Mn at 15, 30, 45, 60, or 70 mg/kg in an organic or inorganic form for 12 weeks did not change. However, the MnBioplex supplement decreased the percentage of damaged eggs compared to the inorganic Mn-sulphate.

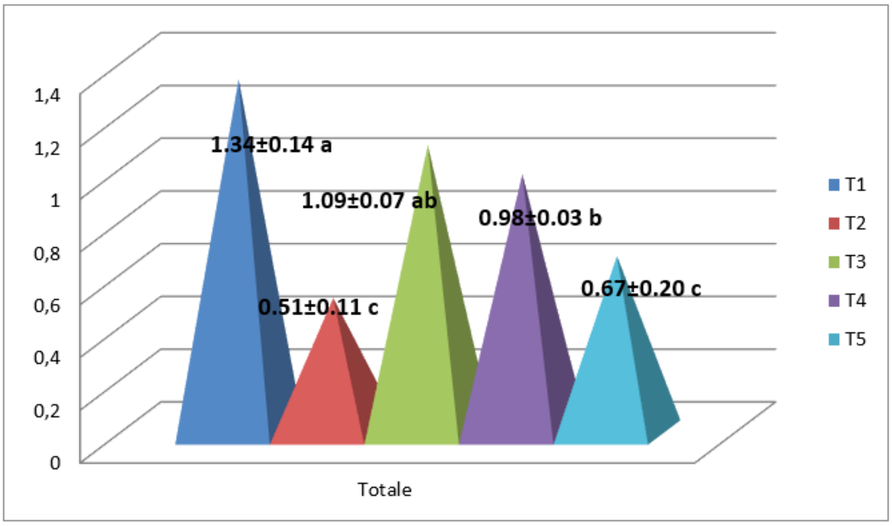

Figure 2: Effect of manganese supplementation in totale abnormal rate % of laying hens exposed to force molting

*Different letters indicate significance

4. Conclusion

The findings of this study demonstrate that the application of a fasting program combined with dietary manganese supplementation significantly enhances the qualitative characteristics of eggs in Lohman brown hens post-molting. Specifically, hens receiving manganese sulfate in their diet exhibited improved eggshell relative weight, eggshell height, albumen index, yolk index, and reduced rates of broken and abnormal eggs. These results underscore the beneficial role of manganese in poultry feed to bolster egg quality, suggesting a practical strategy for poultry farmers to optimize production. The implications of this research extend to better management practices in poultry farming, enhancing both the economic viability and quality of egg production. Further research is recommended to explore the long-term effects of varying manganese levels on overall hen health and productivity, as well as to verify these findings across different breeds and environmental conditions.

REFERENCES

[1] J.T. Brake and J.B. Carey, "Induced Molting of Commercial Layers," North Carolina Agricultural Extension Service Poultry Science and Technical Guide No. 10, North Carolina State University, Raleigh, NC, 1983.

[2] R.H. Harms, "Influence of Protein Level in the Resting Diet upon Performance of Force Rested Hens," *Poultry Science*, vol. 62, pp. 273-276, 1983.

[3] K.W. Koelkebeck, C.M. Parsons, R.W. Leeper, and J. Mostaghian, "Effect of Duration of Fasting on Postmolt Laying Hen Performance," *Poultry Science*, vol. 72, pp. 2229-2235, 1992.

[4] J. Brake, "Recent Advances in Induced Molting," *Poultry Science*, vol. 72, pp. 929-931, 1993.

[5] P.S. Holt, "Horizontal Transmission of Salmonella Enteritidis in Molted and Unmolted Laying Chickens," *Avian Diseases*, vol. 39, pp. 239-249, 1995.

[6] D. Bell, "Historical and Current Molting Practices in the U.S. Table Egg Industry," *Poultry Science*, vol. 82, pp. 965-970, 2003.

[7] C.K. Klasing, "Minerals," in *Comparative Avian Nutrition*, New York, USA: CAB International, 1998, pp. 234-276.

[8] F.R. Lima, I. Mabe, and R. Albuquerque, "Zinc and Manganese Additional Supplementations May Benefit Egg Production and Quality," *Poultry Science*, vol. 79, p. 46 (Abstract), 2000.

[9] S. Aoyagi and D.H. Baker, "Protective Effect of Copper Amino Acid Complexes against Inhibitory Effects of L-Cysteine and Ascorbic Acid," *Poultry Science*, vol. 72, suppl. 1, p. 82 (Abstract), 1993.

[10] S. Aoyagi and D.H. Baker, "Nutritional Evaluation of Copper-Lysine and Zinc-Lysine Complexes for Chicks," *Poultry Science*, vol. 72, pp. 165-171, 1993.

[11] NRC, *Nutrient Requirements of Poultry*, 9th rev. ed., Washington, DC: National Research Council, National Academic Press, 1994.

[12] H.H.D. Aljebory and S.A.H. Naji, "Effect of Pelleted Fermented Feed in Egg Quality of Laying Hens," *Diyala Agricultural Sciences Journal*, vol. 13, no. 1, pp. 41-57, 2021. [Online]. Available: https://dx.doi.org/10.52951/dasj.21130105

[13] SAS, *Statistical Analysis System, User's Guide. Statistical*, Version 9.1, Cary, NC, USA: SAS Institute Inc., 2012.

[14] D.B. Duncan, "Multiple Range and Multiple F-test," *Biometrics*, vol. 11, pp. 4-42, 1955.

[15] H.M. Sazzad, A.G. Bertechini, and P.T.C. Nobre, "Egg Production, Tissue Deposition, and Mineral Metabolism in Two Strains of Commercial Layers with Various Levels of Manganese in the Diet," *Animal Feed Science and Technology*, vol. 46, pp. 271-275, 1994.

[16] R.M. Leach and J.R. Gross, "The Effect of Manganese Deficiency upon the Ultrastructure of the Eggshell," *Poultry Science*, vol. 62, pp. 499-504, 1983.

[17] J.F. Xiao, Y.N. Zhang, S.G. Wu, H.J. Zhang, H.Y. Yue, and G.H. Qi, "Manganese Supplementation Enhances the Synthesis of Glycosaminoglycan in Eggshell Membrane: A Strategy to Improve Eggshell Quality in Laying Hens," *Poultry Science*, vol. 9, pp. 380-388, 2014.

[18] K. Venglovska, L. Gresakova, I. Placha, M. Ryzner, and K. Cobanova, "Effects of Feed Supplementation with Manganese from Its Different Sources on Performance and Egg Parameters of Laying Hens," *Czech Journal of Animal Science*, vol. 59, pp. 147-155, 2014.

[19] E.J. Fassani, A.G. Bertechini, B.L. De Oliveira, T. De M. Goncalves, and E.T. Fialho, "Manganese in Nutrition of Leghorn Hens in the Second Cycle of Production," *Ciencia e Agrotecnologia*, vol. 24, pp. 468-478, 2000.

[20] J. Xie, C. Tian, Y. Zhu, L. Zhang, L. Lu, and X. Luo, "Effects of Inorganic and Organic Manganese Supplementation on Gonadotropin-Releasing Hormone-I and Follicle-Stimulating Hormone Expression and Reproductive Performance of Broiler Breeder Hens," *Poultry Science*, vol. 93, pp. 959-969, 2014.

[21] A.Ö. Yildiz, O. Olgun, and Y. Cufadar, "The Effect of Manganese and Phytase in the Diet for Laying Hens on Performance Traits and Eggshell Quality," *Journal of Animal and Veterinary Advances*, vol. 9, pp. 32-36, 2010.