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Research Article
The Effects of Organic Trace Mineral Supplementation on Heritage Rhode Island Red Breeding Stock

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Abstract

Background and Objectives: Trace minerals are a crucial component of diets for all types of poultry. Although they are only used in small amounts, trace minerals are vital components to ensure optimal growth, performance, immune function and overall health of the birds. Most available research on organic trace minerals has focused on high-performing commercial poultry; little research has focused on heritage-type breeds. Therefore, this study aimed to evaluate the effects of organic trace minerals on heritage-type birds. **Materials and Methods:** For this trial, 68 heritage type Rhode Island Red birds were either fed a control diet (C) containing 100 ppm Zn and Mn from sulfates or the control diet supplemented with 40 ppm organic Zn and Mn (organic trace minerals) from day of hatch to 63 days of age. Weekly body weights, footpad lesion scores (28 and 56 day) and feather scores (28 day) were recorded throughout the nine-week experiment. **Results:** There were slight numerical increases in body weight as well as significant improvement ($p \leq 0.05$) on footpad lesion scores in the organic trace mineral (OTM) group compared to the C group. In addition, there was a numerical improvement in feather scores for the OTM group. **Conclusion:** Based on this data, OTM appear to deliver similar nutritional benefits in heritage-type birds as previously reported in commercial birds.

Key words: Organic trace mineral, zinc, manganese, rhode island red, poultry diet, footpad lesion

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Trace minerals such as Zinc (Zn) and Manganese (Mn) are essential components of all poultry diets due to their role in numerous biological processes and pathways that contribute to the production and overall health of the bird[1]. Zn plays a vital role in a variety of physiological functions in poultry including antioxidation, growth and bone development, immune function and serves as a cofactor for over 300 enzymes[2,3]. The main functions of Mn in poultry are catalyzing enzymatic activity and bone formation[4]. There are two main classes of trace minerals: inorganic and organic[5]. Inorganic forms include binding of the metal to an inorganic salt such as a sulfate, oxide, or chloride group compared to organic forms such as proteinates, propionate, glycinates which are commonly referred to as chelated minerals. The term chelated comes from the Latin word chele which means claw[6]. Chelation forms a special complex in which the organic molecule wraps around the metal much like a claw, forming two or more bonds and shields the mineral from antagonists during its journey to the intestines. There have been numerous reports demonstrating that organic forms of trace minerals have significantly higher bioavailability than inorganic forms of trace minerals[5,7,8]. Cao *et al.*[9] demonstrated significantly higher bioavailability of Zn Proteinate in chicks when compared to Zn acetate, as well as Zn methionine. Most research in poultry has been customized for commercial type poultry, mainly broilers. Zhao *et al.*[10] found that chelated organic trace minerals had positive effects on the production and health of broiler chickens. The study concluded that the chelated trace minerals increased body weight gain and breast meat yield in Cobb broilers along with improved footpad health and overall well-being of all birds tested[10]. Khatun *et al.*[11] compared inorganic trace minerals to three different forms of organic trace minerals: propionate, metho-chelated and proteinate to measure their effects on growth performance, edible meat yield, immunity and profitability. Growth performance in broilers fed propionate and proteinate organic trace minerals were comparable to each other and both demonstrated improved performance when compared to broilers fed metho-chelated organic trace minerals or inorganic trace minerals. The proteinate group had increased wing meat and the propionate group had the highest antibody titer levels against infectious bursal disease[11]. These findings indicate a positive effect of organic trace minerals on the performance and health of broiler chickens. While most research related to organic trace minerals has been focused on high-performance type chickens, there is little data on the effects of organic trace minerals on heritage-type birds. Commercially raised broilers have been selected to grow at rapid rates and thus reach target weights extremely quickly. Heritage breeds have not been selected for such purposes and take longer to reach target weights when compared to commercial broilers. McCrea *et al.*[12] found that broilers grew to a final body weight of 2.11 kg 2.5 times faster than the Delaware breed, a heritage breed raised for meat production. Interest in raising backyards flocks and heritage breeds has increased in recent years and data on the effects of organic trace minerals could be beneficial to a large number of farmers and producers. Therefore, this study was conducted to evaluate the effects of organic trace minerals on heritage-type birds, specifically Rhode Island Reds, to determine if they are affected positively in a manner similar to commercial poultry.

MATERIALS AND METHODS

A total of 108 Heritage Rhode Island Red eggs were obtained from a closed population at a local university (Prestage Dept. Poultry Science, NCSU, Raleigh, NC, 27606). All eggs were set in the same GQF 1202 incubator (GQF Manufacturing, Savannah GA) under standard incubation conditions for small incubators (37°C at 55% RH for 18 days then transferred to hatcher 37.5°C at 65% RH until hatching [21 day]). Upon hatching, 68 chicks were then randomly divided between one of two dietary treatment groups: (1) Control (C) or (2) Organic Trace Minerals (OTM). Chicks in the control group were fed a commercially available chick starter feed which contained 100 ppm Zn and Mn from sulfates (Table 1) while chicks in the OTM group were fed the same commercial diet supplemented with 40 ppm KeyShure Zinc and 40 ppm KeyShure Manganese (Balchem Corporation, New Hampton, NY, 10958). Chicks were neck tagged at hatch to ensure they remained in the proper treatment group.

Brooding: All chicks were brooded under standard research conditions. Each pen contained fresh pine shavings as bedding and a 250-watt heat lamp. The pens were kept at 30°C for the first week, 27°C for the second week, 25°C for the third week, then reduced to 23°C for the remainder of the trial. Birds were placed on 24 h of light for the first 3 weeks, then reduced to 20 h of light and 4 h of dark for the remainder of the trial. All birds in each treatment were provided ad lib feed and water from a single hanging plastic feeder as well as a plastic water trough for the duration of the trial.

Data collection: Starting at 14 days of age, all birds were weighed weekly for 9 weeks (every 7 days). Birds were caught, neck tag recorded, then placed in a small bucket on a digital scale. The bucket was utilized to keep the birds calm to ensure an accurate weight was measured. At 28 and 56 days of age, approximately two thirds of the birds (10 birds per treatment) were randomly selected and foot pad scores were recorded. Feather scores were recorded only on the 28th day. The scoring was based on the rubrics listed in Table 2 and 3, respectively.

Table 1: Starter diet formulation

Crude protein	20.00%
Lysine	1.00%
Methionine	0.35%
Crude fat	3.50%
Crude fiber	4.00%
Calcium (min)	0.95%
Calcium (max)	1.45%
Phosphorus	0.50%
Salt (min)	0.25%
Salt (max)	0.75%
Sodium	0.15%

Statistics: Data was analyzed using the statistical analysis program JMP-14 (2019, SAS, Cary, NC). All data was analyzed using one-way analysis of variance (ANOVA) and means were compared using the Tukey-Kramer comparison. Significance were set at $p = 0.05$.

Table 2: Heritage breed feather scoring rubric

Score	Description
0	Wings and back fully feathered
1	Wings or back partially feathered (less than 1 square inch bare)
2	Wings or back partially feathered (less than 1 square inch bare on each)
3	Wings and back partially feathers (more than 1 square in bare)

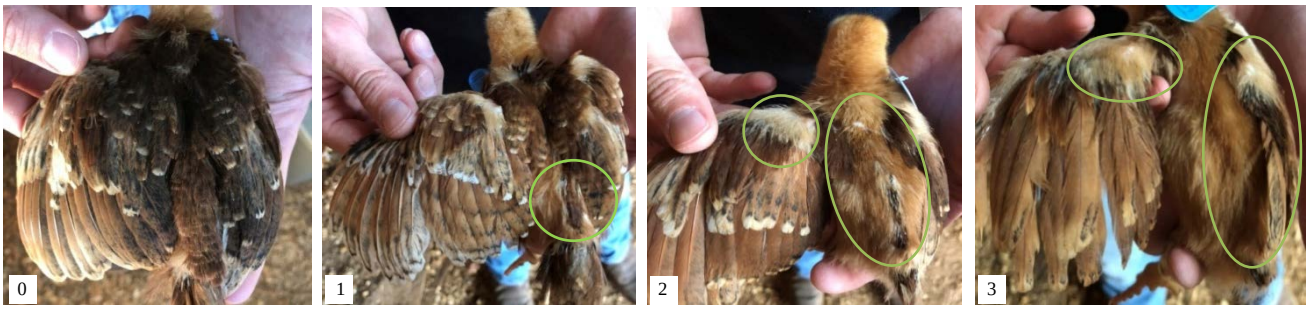
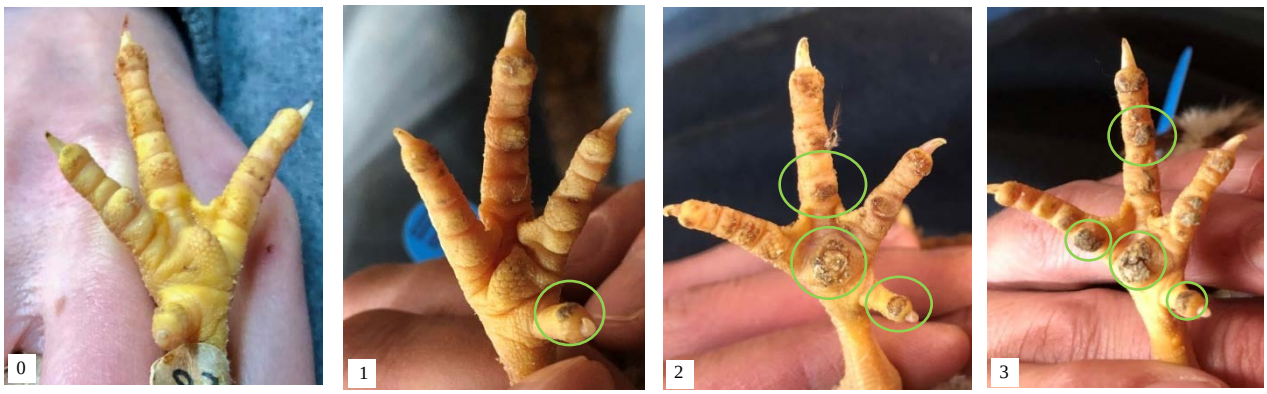


Table 3: Scoring legend for chicken foot pads

Score	Scoring criteria
0	No dermal lesions observed on center or toe pads
1	Lesion on center pad, with no toe lesions
2	Lesion on center pad and ≤2 toe pad lesions
3	Large Lesion on center or anywhere on foot pad
3	Any pad with evidence of current or prior bleeding/large lesion



RESULTS AND DISCUSSION

There have been numerous commercial broiler trials indicating significant improvements in body weight and breast yield when birds are supplemented with organic trace minerals1[10,13]. However, those birds have been selected to grow at incredibly rapid rates. Backyard or heritage-type birds do not grow at this same accelerated rate and may proportion nutrients in differing manners. From the data reported herein, there still appears to be a measurable trend for improved performance in heritage-type breeds that are supplemented with OTM. The average weekly body weights for each treatment are presented in Table 4. No notable differences (±5 g) were observed during the first few weeks of life (D0-42). This lack of difference could be due to the slower growth of this type breed compared to modern broilers. Schmidt *et al*.[14] found that there was a major difference in body composition (primarily breast) between heritage breeds and modern broilers (9% vs 18% respectively). At day 49, the OTM group was significantly ($p \leq 0.01$) larger by 29.5 g when compared to the Control group. Though not significantly different, the same increased body weight trend was observed through 9 weeks of age. The trend for improved body weights are to be expected from the increased bio-availability of the chelated minerals. Minerals are involved with many different pathways ranging from gene expression, vitamin metabolism and enzyme function. Since these minerals are more readily available for absorption by the animal in a chelated form, it also makes them more available for the numerous vital processes within the animal.

It has long been known that a common sign of zinc deficiency is poor feathering. Over 60 years ago, Young *et al*.[15] demonstrated zinc deficient chicks had extremely poor feathering; in fact, there was almost a complete lack of barbules on the feathers of the zinc deficient group. In the experiment described herein, feathering scores were numerically improved in the OTM group when compared to the control group (1.2 vs 1.7) as seen in Table 5. Though these scores were not significantly different, heritage-type birds appear to follow similar trends as commercial broilers in regard to feathering when fed OTM's. Lai *et al*.[16] demonstrated improvement of feather condition scores in broilers fed supplemental Zinc (0, 40 or 60 ppm addition Zn) primarily during times of heat stress. There is much more variation in heritage type birds for many traits compared to commercially produced birds due to the lack of selection. This could help explain why only trends for improved feather growth were observed in this trial.

Average paw scores for each treatment are summarized in Table 6. The OTM group had a significantly lower paw score than the control group at 28 days of age (0.9 vs 2.2, respectively) and at 56 days of age (1.0 vs 2.1, respectively). These data agree with previously published data in commercial broilers where broilers fed OTM's had significantly lower paw scores than control birds[10]. Organic trace mineral supplementation has been demonstrated to play an integral role in regard to the building and maintenance of skin integrity in numerous species through various pathways[17] which could explain the improvement in paw scores observed in this experiment.

Table 4: Weekly average body weights by treatment (g)

Treatments	D14	D21	D28	D35	D42	D49	D56	D63
Control	92.66	140.630	202.950	300.93	449.770	538.070^{B}	723.990	889.180
OTM	92.38	137.970	201.180	291.50	444.390	567.660^{A}	732.150	896.380
SE	1.85	3.063	4.028	5.96	9.231	11.673	16.225	22.162

^{A,B}Superscripts within column denote significant difference at the ($p \leq 0.05$) level. Lack of superscript denotes no significant difference

Table 5: Average feather scores by treatment

Treatments	Day 28 score	n	SE
Control	1.7	10	0.295
OTM	1.2	10	0.295

^{A,B}Superscripts within column denote significant difference at the ($p \leq 0.05$) level. Lack of superscript denotes no significant difference

Table 6: Average paw scores by treatment

Treatments	Day 28 score	n	SE	Day 56 score	n	SE
Control	2.2^{A}	10	0.264	2.1^{A}	10	0.0267
OTM	0.9^{B}	10	0.264	1.0^{B}	10	0.0267

^{A,B}Superscripts within column denote significant difference at the ($p \leq 0.05$) level. Lack of superscript denotes no significant difference

CONCLUSION

Diets supplemented with organic trace minerals appear to have positive effects on improving foot pad lesions in heritage-type birds. Though not significant, there is a measurable trend for improved body weights with OTM supplementation during the last 3 weeks of development. There is a positive trend in feather scores for organic trace mineral supplemented birds.

SIGNIFICANCE STATEMENT

This study explored the use of Organic Trace Minerals (OTM's) in heritage type Rhode Island Reds. OTM's are commonly used in commercial type poultry, however little research is available on the use of OTM's in heritage type breeds. Based on the data from this trial OTM's appear to elicit similar effects in heritage type breeds as previously observed in commercial poultry.

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