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Feeding Broilers on Finisher Diet of Low Trace Mineral Levels and its Effect upon Performance, Carcass Characteristics, Mineral Excretion and Net Profit

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Abstract: Growth experiment was carried out to examine the effect of feeding broilers on finisher diet (23 to 39 days of age) contained low levels of trace mineral premix. Two hundred male Ross broiler chicks were divided into four treatment groups, five replicates each. Four corn-soybean finisher diets were formulated to cover all the nutrient requirement and the trace mineral premix (TMP) was added at 100, 75, 50 or 25% of the recommended level. Performance, carcass characteristics, tibia ash, mineral excretion and economic efficiency were measured. The results showed that reducing trace mineral content in finisher diets did not affect chick performance ($p>0.05$). There were no significant differences in body weight gain, feed intake and feed conversion ratio. Also, carcass characteristics and tibia ash content did not significantly affect by lowering level of dietary TMP. Mineral excretion significantly ($p<0.05$) decreased with reduced trace mineral levels. Economic efficiency slightly improved with reducing dietary trace mineral content. It could be demonstrated that it is possible to reduce level of dietary TMP in finisher broiler diets with no adverse effects on performance, carcass characteristics or tibia ash content. It could help not only to maintain general performance, but also to reduce any potential environmental pollution for sustainable poultry production.

Key words: Trace mineral, broilers, mineral excretion, pollution, net profit

INTRODUCTION

In commercial poultry production, trace minerals are commonly added in the form of a premix to diets and used to supply more of these minerals than NRC recommendations, depending on the recommended requirement of the different strains of chicks (Inal *et al*., 2001).

Due to growing concerns about environmental pollution and to achieve a satisfactory economic return there has been considerable interest in reducing nutrient concentration in poultry litter. Attempts had been made in order to reduce environmental pollution and cost of production through withdrawal or reduction of trace mineral supplements in broiler diets during a part or all of the growing period.

Ferket *et al*. (2002) reported that nutrient excretion can be reduced by avoiding the overfeeding of specific nutrients or by using nutritional manipulation to enhance nutrient utilization. Removal of the trace mineral premix from broiler diets during the finisher week resulted in no negative effects on growth performance, bone, or carcass traits (Maiorka *et al*., 2002).

Several reports have indicated that broilers could produce well on lower than traditional industry levels during part or all of a growing period (Shelton and Southern, 2006). Shelton and Southern (2006) removed the trace mineral premix from broiler diets from 1 to 43 d and showed no effect on growth performance but decreased bone strength during the grower and finisher periods. Wang *et al*. (2008) reported that total removal of the trace mineral premix resulted in a significant reduction in body weight and feed intake at all ages, compared to birds fed the normal level of supplementation. This suggests that removal of the trace mineral premix influenced the appetite of the birds, resulting in reduced gain. Overall, birds fed diets with as little as 20% of the normal level of trace mineral supplementation did not differ in body weight, feed intake or feed conversion from those fed the diets with 100% of the normal supplemental level. Abudabos *et al*. (2013) concluded that it is possible to reduce the dietary minerals and vitamins premix up to 50% during the finisher period from 14-35 days without jeopardizing the performance which will decrease the cost of feed and as a result reduce the cost of production.

The objective of this study was to examine the effect of using low levels of the trace minerals premix (100, 75, 50 and 25%) on performance, carcass characteristics, tibia ash, mineral excretion and economic efficiency of male broiler chicks during finisher period (23 to 39 days of age).

MATERIALS AND METHODS

Three hundred one day old male Ross broiler chicks were brooded in floor pen and fed a starter/grower diet contained 23% CP and 3050 Kcal ME/kg from 1 to 22 days of age. Birds were then individually weighed and 200 chicks with almost the same live body weight were

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divided into four groups (5 replicates of 10 chicks, each). The average initial live body weight of all replicates was nearly similar. Replicates were randomly allocated in a battery that has 20 compartments (5 replicates X 4 dietary treatments). A finisher diet was formulated to contain 19.5% protein and 3230 Kcal ME/kg and met the nutrient requirements of the chicks according to the strain guide except trace minerals premix. Four dietary treatments were prepared with mixing the trace minerals premix at 100, 75, 50 and 25% of recommended level. Composition and calculated nutrient content of the four dietary treatments are shown in Table 1. Light was provided 23 h daily during the experimental period and a common vaccination program against AI, ND, IB and IBD was adopted throughout the experimental period. Birds were fed the experimental diets for *ad libitum* consumption from 23 to 39 days of age.

At 39 days of age, after fasting overnight, birds were individually weighed and feed consumption was recorded per replicate. Body weight gain and feed conversion ratio were calculated. Samples of excreta were collected from all treatments to determine zinc, manganese and copper excretion based on the Official Methods of Analysis, AOAC (1990).

Four birds with body weight close to the group average were selected from each group and prepared for carcass characteristics. Chicks were individually weighed, slaughtered, feathered and eviscerated. Weights of carcass, liver, gizzard, heart and abdominal fat were recorded and calculated as percent of live body weight. The right tibia was removed and cleaned of all adhering flesh, extracted with ethanol and then with diethyl ether. The dried fat-free bones were ashed in a muffle furnace at 600 C for 6 h and tibia ash percent was calculated. The net profit was calculated from money input- output analysis. Data were statistically analyzed for analysis of variance using the General Linear Model of SAS (1990). Significant differences among treatment means were separated by Duncan's multiple rang test (Duncan, 1955).

Table 1: Formulation and nutrient composition of the finisher experimental diets

Ingredients (%)	Diet 1 100% TMP	Diet 2 75% TMP	Diet 3 50% TMP	Diet 4 25% TMP
Yellow corn	63.25	63.28	63.31	63.36
Soybean meal (48%)	30.00	30.00	30.00	30.00
Vegetable oil	3.00	3.00	3.00	3.00
Dicalcium phosphate	1.40	1.40	1.40	1.40
Limestone	1.30	1.30	1.30	1.30
Vitamin premix[1*]	0.15	0.15	0.15	0.15
Mineral premix[2]	0.15	0.113	0.075	0.038
Salt	0.25	0.25	0.25	0.25
L-lysine HCl	0.20	0.20	0.20	0.20
DL-methionine	0.20	0.20	0.20	0.20
Choline HCl	0.10	0.10	0.10	0.10
Total	100	100	100	100
Calculated composition[3] (%)				
Crude protein	19.80	19.80	19.80	19.80
ME (Kcal/kg)	3230	3230	3230	3230
Lysine	1.25	1.25	1.25	1.25
Methionine	0.52	0.52	0.52	0.52
Met+Cystine	0.88	0.88	0.88	0.88
Calcium	0.90	0.90	0.90	0.90
Available P	0.48	0.48	0.48	0.48

[1]Vitamin premix supplied per kg of diet 1: Vit. A, 14,000 IU, Vit. D3, 5000 IU, Vit. E, 75 mg, Vit. K3, 4 mg, Vit. B1, 3 mg, Vit. B2, 8 mg, Vit. B6, 4 mg, Vit. B12, 0.016 mg, Niacin, 70 mg, Pantothenic acid, 20 mg, Folic acid, 2 mg, Biotin, 0.15 mg

[2]Mineral premix supplied per kg of diet 1: Copper, 8 mg, Iodine, 1 mg, Iron, 80 mg, Manganese, 100 mg, Zinc, 80 mg and Selenium, 0.15 mg.

[3]Calculated values based on feed composition Tables of NRC (1994)

[*]Vitamin premix contained Xylam and Phytase enzymes which provided 100 Kcal and 0.1% available P/kg diet, respectively

Table 2: Trace mineral (mg\kg) requirements suggested by the NRC (1994), Ross nutritional guide and those provided by experimental diets

Item	Mn	Zn	Cu	Se
	---------- mg/kg ----------			
NRC (1994)	60	40	8	0.15
Ross requirement	100	100	15	0.15
100%	117	108	15	0.20
75%	92	88	13	0.16
50%	67	68	11	0.13
25%	42	48	9	0.09

RESULTS

Trace mineral premix (TMP) levels recommended by the NRC (1994), Ross guideline and those provided in the experimental diets (100, 75, 50 and 25%) are shown in Table 2. The trace mineral levels recommended by Ross guideline are higher than that for NRC (1994) requirements for Mn, Zn and Cu. Birds fed on diet 1 (100% TMP) had higher levels of Mn, Zn and Se compared to NRC (1994) requirements. Birds received diet 4 (25% TMP) had lower levels of Mn, Zn, Cu and Se compared to the Ross guideline but had lower levels of Mn and Se compared to the NRC (1994) requirements.

Performance measurements: Differences in response to reduce dietary TMP level on growth performance are shown in Table 3. Body weight (BW), body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR) were not influence ($p>0.05$) by treatments. The recorded values of BWG ranged from 1196 to 1206 g and those of FCR ranged from 1.77 to 1.79. These results proved that the recommended level of trace mineral premix supplement during finisher period is higher than the actual requirement of broiler chicks.

Carcass characteristics: Table 4 shows the influence of dietary treatments on carcass characteristics and tibia ash percent. Feeding lower dietary trace mineral level did not affect dressing, liver, heart, gizzard and abdominal fat of broiler chicks (as % of live body weight) compared with chicks fed 100 % trace minerals during the experimental period ($p>0.05$). These results indicated that reducing trace mineral premix in finisher broiler diets did not affect carcass characteristics or tibia ash percent.

Table 3: Effect of trace mineral levels on broiler performance from 23 to 39 days of age

Mineral premix*%	Initial BW (g)	Final BW (g)	BWG (g)	FI (g)	FCR (g/g)
100	1021	2217	1196	2130	1.78
75	1012	2213	1201	2140	1.78
50	1014	2212	1198	2136	1.79
25	1014	2220	1206	2137	1.77
SE of means	±4.07	±9.34	±7.37	±13.49	±0.01
Significantly	NS	NS	NS	NS	NS

Mean within each column with no common superscript differ significantly (p<0.05). NS: Not significant (p>0.05). *percent of the recommended level

Table 4: Effect of trace mineral levels on carcass characteristics (% live body weight) and tibia ash content of broiler chicks at 39 day of age

Mineral premix* (%)	Dressing (%)	Liver (%)	Heart (%)	Gizzard (%)	Abdominal fat (%)	Tibia ash (%)
100	73.00	1.89	0.46	1.78	1.54	44.24
75	72.32	2.09	0.47	1.71	1.54	44.17
50	72.29	2.15	0.48	1.69	1.58	44.24
25	72.56	1.99	0.48	1.65	1.49	45.29
SE of means	±0.29	±0.05	±0.01	±0.03	±0.03	±0.31
Significantly	NS	NS	NS	NS	NS	NS

Mean within each column with no common superscript differ significantly (p<0.05). NS = Not significant (p>0.05). *Percent of the recommended level

Table 5: Effect of trace mineral levels on mineral excretion (mg\kg dry excreta) of broiler chicks at 39 day of age

Mineral premix* (%)	Mn mg\kg	Cu mg\kg	Zn mg\kg
100	364^{a}	35^{a}	505^{a}
75	326^{b}	27^{b}	465^{b}
50	265^{c}	25^{b}	424^{c}
25	173^{d}	23^{b}	386^{d}
SE of means	±21.96	±1.52	±13.90
Significantly	***	*	***

$^{a-d}$Mean within each column with no common superscript differ significantly (p<0.05). NS = Not significant (p>0.05). *Percent of the recommended level

Minerals excretion: Influence of dietary treatments on minerals excretion is shown in Table 5. There were significant (p<0.05) reductions in excreted minerals associated with reduction in dietary mineral contents. Reducing the amount of trace minerals in the diet of broilers would therefore reduce mineral pollution to the environment.

Economic efficiency: Results of economic efficiency (EE) and relative economic efficiency (REE) summarized in Table 6. The results indicated that reduction of trace mineral premix from finisher broiler diet gave slightly better relative economic efficiency (REE) than the diet 1 that contained (100% TMP). Economic efficiency values were improved by 1, 1 and 6% for the chickens fed diets contained 75, 50 and 25%TMP, respectively, compared to diet 1 (100%TMP). These results concluded that reducing trace minerals premix lead to reduce the relative cost per unit of body weight and more economical to obtain maximum profitability from broiler production.

Table 6: Effect of dietary treatments on economic efficiency at the end of the experimental period

	---------- Mineral premix (%) ----------			
Item	100	75	50	25
Body weight (g)	1196	1201	1198	1206
Feed Intake/chick (g)	2130	2140	2136	2137
Feed cost/chick (LE)	8.52	8.54	8.51	8.50
Fixed cost/chick (LE)*	6.00	6.00	6.00	6.00
Total cost/chick (LE)	14.52	14.54	14.51	14.50
Sale price/bird (LE)**	16.74	16.81	16.77	16.88
Net profit (LE)	2.22	2.27	2.26	2.38
Economic efficiency (EE)***	0.133	0.135	0.135	0.141
Relative EE (%)	100	101	101	106

Total price for feeds was calculated according to the price of different ingredients available in the market at experimental time.
*Included chick price, cost of management, vaccines and medicated cost, ... **Live body weight X 14.00 LE/kg. ***EE = Net profit/Total cost/chick (LE)

DISCUSSION

The results of the present study confirmed the early finding of Skinner *et al.* (1992) who suggested that the amount of TMP supplements usually exceeds two and three times the requirements for broiler. Teeter and Dehyhim (1996) showed that trace mineral withdrawal from the grower diet failed to impact live production performance. Leeson and Summers (1997) explained that mineral and vitamins premix deficiency requires long periods to demonstrate clinical signs on the birds. Maiorka *et al.* (2002) indicated that minerals and vitamins premix withdrawal at 42 days of age significantly affected the FCR but it had no effect on FI or BWG. Sayadi *et al.* (2005) and Siahpour *et al.* (2010) showed that removal of vitamins and minerals premix at later stages of the growth had no influence on weight gain, feed intake and feed efficiency. Peric *et al.* (2007) concluded that trace mineral levels in broiler feed can be reduced to at least 1/3 of the original levels using organic forms without compromising performance. Sunder *et al.* (2008) reported that supplemental Zn did not influence body weight gain, feed intake, feed efficiency, leg scores, or tibia weight at 4 wk of age. They added that dietary 29 ppm Zn was adequate to support optimum performance of broilers up to 4 wk of age. Obviously, this level was lower than 40 ppm recommended by NRC (1994) for broiler chicks. The absence of any difference in performance between groups fed diets with or without supplemental Zn could be due to slower rate of Zn utilization, necessitating no further replenishment in diets (Emmert and Baker, 1995). Also, the results of this study supported the previous findings of Ogunwole *et al.* (2011), Shahrasb and Gerami (2011) and Moravej *et al.* (2012), who observed that reducing or eliminating of the minerals and vitamins premix from finisher broiler diets did not cause on adverse effect on the performance. They suggested that it is possible to remove minerals and vitamins premix from commercial broiler diets at the last week of production.

Regarding the effect of dietary treatments on carcass characteristics and tibia ash content, the obtained results proved those reported by Siahpour *et al.* (2010) who found no effect of vitamins and trace minerals withdrawal on carcass parameters. Earlier, Skinner *et al.* (1992) suggested that the lack of a withdrawal effect could be related to the availability in the body of vitamins and minerals for further growth, as the amount of these supplements usually exceeds two or three times the recommended broiler chicken requirement in poultry diet. Wang *et al.* (2008) who reported that withdrawal of vitamin and mineral premix had no effect on tibia ash.

Burrell *et al.* (2004) found that increased dietary supplemental zinc concentration significantly increased zinc excretion. This low body retention resulted in excess of trace minerals in poultry manure, causing accumulation in the soil (Mohanna and Nys, 1998). The most reasonable solution to reduce the excretion of trace minerals is to make them more available, so that lower doses can be applied in the feed. Reduction of trace mineral inclusion rate had a significant effect on excreta mineral content, providing an opportunity to reduce the environmental impact of commercial poultry operations. It is apparent in the current study that the reduced dietary supplemental minerals resulted in reduced excretion.

Leeson and Caston (2008) indicated that lower doses of Fe, Cu, Mn and Zn can be used without any loss in the performance of broilers and with the possible advantage of reducing mineral excretion and consequent pollution in the environment. Aksu *et al.* (2011) showed that trace minerals can be used at a much lower concentration than the current recommended as inorganic minerals, without a negative impact on performance, while also decreasing the excess mineral excretion.

The results of the economic evaluation were in agreement with Khajali *et al.* (2006), Maiorka *et al.* (2002) and Abudabos *et al.* (2013) who shown that minerals and vitamins premix can be removed totally or partially from broiler diets for a short period particularly during later stage of growth as a way to reduce the costs of broiler chicken production. Removal of vitamin and trace mineral mixes reduced growing costs with no adverse effects on performance in broilers from 28 to 49 days (Skinner *et al.*, 1992). Abudabos *et al.* (2013) concluded that reduce the dietary minerals and vitamins premix up to 50% during the finisher period decrease the cost of feed and as a result reduce the cost of production.

It could be concluded therefore that reducing level of trace mineral premix in the finisher broiler diet to be 25% of the recommended levels did not cause any adverse effect on performance. It could help not only to maintain general performance, but also to reduce any potential environmental pollution for sustainable poultry production.

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REFERENCES

Abudabos, A.M., G.M. Suliman, E.O. Hussien, M.Q. Al-Ghadi and A. Al-Oweymer, 2013. Effect of mineral-vitamin premix reduction on performance and certain hemato-biochemical values in broiler chickens. Asian J. Anim. Vet. Adv., 8: 747-753.

Aksu, T., B. Ozsoy, D. Saripinar Aksu, M.A. Yoruk and M. Gul, 2011. The effects of lower levels of organically complexed zinc, copper and manganese in broiler diets on performance, mineral concentration of tibia and mineral excretion. Kafkas Univ. Vet. Fak. Derg., 17: 141-146.

AOAC, 1990. Official methods of analysis of the Association of Official Analytical Chemists. 15th edition. Washington, DC, Association of Official Analytical Chemists.

Burrell, A.L., W.A. Dozier, A.J. Davis, M.M. Compton, M.E. Freeman, P.F. Vendrell and T.L. Ward, 2004. Responses of broilers to dietary zinc concentrations and sources in relation to environmental implications. Br. Poult. Sci., 45: 255-263.

Duncan, D.B., 1955. Multiple Range and Multiple F Tests. Biometric, 11: 1- 42.

Emmert, J.L. and D.H. Baker, 1995. Zinc stores in chickens delay the onset of zinc deficiency symptoms. Poult. Sci., 74: 1011-1021.

Ferket, P.R., E. van Heugten, T.A.T.G. van Kempen and R. Angel, 2002. Nutritional strategies to reduce environmental emissions from nonruminants. J. Anim. Sci., 80: E168-E182.

Inal, F., B. Coskun, N. Gulsen and V. Kurtoglu, 2001. The effects of withdrawal of vitamin and trace mineral supplements from layer diets on egg yield and trace mineral composition. Br. Poult. Sci., 42: 77-80.

Khajali, F., E. Asadi Khoshoei and M. Zamani, 2006. Effect of vitamin and trace mineral withdrawal from finisher diets on growth performance and immunocompetence of broiler chickens. Br. Poult. Sci., 47: 159-162.

Leeson, S. and J.D. Summers, 1997. Commercial Poultry Nutrition. 2nd Ed., University Books, Guelph, ON, Canada.

Leeson, S. and L. Caston, 2008. Using minimal supplements of trace minerals as a method of reducing trace mineral content of poultry manure. Anim. Feed Sci. and Tech., 142: 339-347.

Maiorka, A., A.C. Laurentiz, E. Santin, L.F. Araujo and M. Macari, 2002. Dietary vitamin or mineral mix removal during the finisher period on broiler chicken performance. J. Appl. Poult. Res., 11: 121-126.

Mohanna, C. and Y. Nys, 1998. Influence of age, sex and cross on body concentrations of trace elements (zinc, iron, copper and manganese) in chickens. Br. Poult. Sci., 39: 536-543.

Moravej, H., M. Alahyari-Shahrasb, M.R. Baghani and M. Shivazad, 2012. Withdrawal or reduction of the dietary vitamin premix on bone parameters of broiler chickens in two rearing systems. S. Afr. J. Anim. Sci., 42: 169-177.

NRC, 1994. Nutrient requirement of poultry. 9th Rev. Edn., National Academy Press, Washington, DC., USA.

Ogunwole, O.A., E.O. Kolade, M.O. Olumide, A.O. Akinsoyinu, A.A. Mako, O. Abiola-Olagunju and O.A. Adebiyi, 2011. Evaluation of five proprietary vitamin-mineral premixes in Ibadan, Nigeria for broiler production. Proceedings of the Annual Meeting of Poultry Science Association, July 16-19, 2011, St. Louis, MO., USA., pp: 83-83.

Peric, L., L. Nollet, N. Milosevic and D. Zikic, 2007. Effect of Bioplex and Sel-Plex substituting inorganic trace mineral sources on performance of broilers. Arch. Geflugelk., 71: 122-129.

SAS Institute, 1990. SAS®/STAT User's Guide: Statistics,Version 6, 4th edition. SAS Institute Inc, Cary, NC.

Sayadi, A.J., B. Navidshad, A. Abolghasemi, M. Royan and R. Seighalani, 2005. Effects of dietary mineral premix reduction or withdrawal on broilers performance. Int. J. Poult. Sci., 4: 896-899.

Shahrasb, M.A. and A. Gerami, 2011. Study of possible reduction or withdrawal of vitamin premix during finisher period in floor and battery cage broiler raising systems. Afr. J. Biotechnol., 10: 6337-6341.

Shelton, J.L. and L.L. Southern, 2006. Effects of phytase addition with or without a trace mineral premix on growth performance, bone response variables and tissue mineral concentrations in commercial broilers. J. Appl. Poult. Res., 15: 94-102.

Siahpour, S., M.A.K. Torshizi, F. Shariatmadari and F. Niknafs, 2010. Effect of vitamin and mineral premixes withdrawal time on growth and economic performance of broiler chickens. J. Vet. Res., 65: 13-18.

Skinner, J.T., A.L. Waldroup and P.W. Waldroup, 1992. Effect of removal of vitamin and trace mineral supplements from grower and finisher diets on live performance and carcass composition of broilers. J. Appl. Poult. Res., 1: 280-286.

Sunder, G.S., A.K. Panda, N.C.S. Gopinath, S.V. Rama Rao, M.V.L.N. Raju, M.R. Reddy and C.H. Vijay Kumar, 2008. Effects of higher levels of zinc supplementation on performance, mineral availability and immune competence in broiler chickens. J. Appl. Poult. Res., 17: 79-86.

Teeter, R.G. and F. Dehyhim, 1996. Vitamin withdrawal effects on performance, carcass composition and tissue vitamin concentration of broilers exposed to various stress types. BASF Technical Symposium-Poultry Nutrition Update, Atlanta GA, Jan. 1996.

Wang, Z., S. Cerrate, F. Yan, P. Sacakli and P.W. Waldroup, 2008. Comparison of different concentrations of inorganic trace minerals in broiler diets on live performance and mineral excretion. Int. J. Poult. Sci., 7: 625-629.