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Performance and Nutrient Utilization of Broilers Supplemented Mineral Premix without Cobalt, Iron and Copper

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ABSTRACT

Ninety, day old broiler chicks were arranged into 5X3X6 pattern to investigate the effect of exclusion of Cobalt, Iron and Copper from the mineral mixture. Five dietary groups (T1 to T5) were assigned basal diets containing 2800 kcal ME/kg and 22% CP (Starter) and 20% (Finisher) for a total duration of 6 weeks. The chicks in T1 were fed commercial mineral mixture, T2 were supplemented with mineral mixture prepared with laboratory reagent grade minerals while chicks of T3, T4 and T5 were fed laboratory reagent grade mineral mixture without Cobalt, Iron and Copper, respectively. No significant difference was observed in weight gain, feed intake, FER and PI of broilers fed various mineral supplements. Significantly ($p<0.05$) higher nitrogen and energy retention (%) was recorded in broilers (T5) fed mineral supplement without Copper compared to broilers fed (T1) commercial mineral supplement (77.18±0.28 vs. 70.50±2.70 and 81.86±1.04 vs. 75.71±2.36). It was concluded that Cobalt, Iron and Copper can be safely excluded from mineral supplement in areas where the feed resources are rich in these elements.

Keywords: Broilers, Cobalt, Iron, Copper, Exclusion, Performance, Nutrient utilization

Lately, minerals have received considerable attention due to their importance in bird's optimum performance. Microminerals such as Copper (Cu), Cobalt (Co), Iron (Fe), Manganese (Mn) and Zinc (Zn) are although required in very little amount but their role in bird's physiological and biochemical functions is very important (Underwood and Suttle, 1999). They predominantly act as catalysts and are present in many enzyme and hormonal systems. Feed ingredients such as cereals, mill by-products and oil cakes contain almost all the microminerals required by the poultry. The feed is generally supplemented with these minerals through inorganic or organic mineral premix to safeguard the birds against deficiency of any or all the microminerals.

Cobalt is an essential trace element needed as a component of vitamin B_{12} (Cyanocobalamin). Hill (1974) reported that when a highly available form of Co is added to the diet of poultry at higher level, it could result in Co toxicosis. Diaz *et al.* (1994) supplied 125, 250 and 500mg Co/kg DM to day old chicks for 14 days. The lowest level reduced feed intake, weight gain and gain: feed ratio, while the two higher levels caused pancreatic fibrosis, hepatic necrosis and muscle lesions. McDowell (1992) suggested that cobalt must be supplied in the diet of monogastric species in it's active form i.e. Vit. B_{12}. When the bird is supplemented adequate dietary Vit. B_{12} , there is no convincing evidence of a requirement for or benefit from dietary cobalt. This fact is responsible for low dietary Co requirement, which is 3-10 μg/kg DM feed (NRC, 1994). Further more, excessive Co is reported to suppress Fe absorption (Under wood, 1984).

McDowell (1992) reported most of the feedstuffs contain

Table 1. Performance attributes and nutrient utilization of broilers.

Attributes	TREATMENT GROUPS T1	T2	T3	T4	T5	SEM	CD
0-4 Weeks							
Feed Intake (g/bird)	1412.99 ±42.59^{a}	1463.44 ±2.53^{a}	1450.38 ±28.15^{a}	1456.71 ±13.83^{a}	1430.27 ±45.16^{a}	31.13	98.08
Weight Gain (g/bird)	726.17 ±21.89^{b}	799.28 ±9.33^{a}	774.56 ±5.22^{a}	759.83 ±7.40^{ab}	785.10 ±11.24^{a}	12.45	39.23
Feed Efficiency Ratio	0.5138 ±0.0002^{b}	0.5461 ±0.0060^{a}	0.5343 ±0.0066^{ab}	0.5216 ±0.0052^{ab}	0.5498 ±0.0175^{a}	00.01	00.03
Performance Index	373.15 ±11.25^{c}	436.59 ±9.87^{a}	413.72 ±2.37^{ab}	396.39 ±6.93^{bc}	431.77 ±16.08^{a}	10.36	32.65
4-6 Weeks							
Feed Intake (g/bird)	1088.88 ±34.86^{a}	1109.32 ±14.01^{a}	1117.76 ±34.90^{a}	1135.54 ±14.58^{a}	1131.93 ±29.19^{a}	27.19	85.67
Weight Gain (g/bird)	645.21 ±41.35^{a}	640.65 ±9.82^{a}	611.11 ±26.22^{a}	645.89 ±15.60^{a}	666.00 ±20.69^{a}	25.16	79.29
Feed Efficiency Ratio	0.5913 ±0.2090^{a}	0.5774 ±0.0068^{ab}	0.5463 ±0.0068^{ab}	0.5686 ±0.0065^{ab}	0.5883 ±0.0100^{a}	00.01	00.36
Performance Index	383.22 ±37.78^{a}	369.95 ±9.07^{a}	334.10 ±18.37^{a}	367.45 ±13.14^{a}	392.04 ±16.92^{a}	21.47	67.66
0-6 Weeks							
Feed Intake (g/bird)	2501.87 ±18.07^{a}	2572.76 ±15.49^{a}	2568.14 ±56.58^{a}	2592.26 ±11.45^{a}	2562.20 ±60.53^{a}	38.39	122.60
Weight Gain (g/bird)	1371.38 ±19.63^{b}	1439.84 ±1.04^{ab}	1385.67 ±29.97^{ab}	1405.72 ±9.40^{ab}	1451.10 ±30.84^{a}	21.56	67.95
Feed Efficiency Ratio	0.5482 ±0.0102^{a}	0.5596 ±0.0029^{a}	0.5395 ±0.002^{a}	0.5422 ±0.0043^{a}	0.5667 ±0.0144^{a}	00.01	00.03
Performance Index	752.16 ±24.48^{ab}	805.77 ±3.69^{ab}	747.61 ±16.35^{b}	748.36 ±18.94^{b}	822.78 ±33.26^{a}	21.66	68.25
Nitrogen Retention (%)	70.50^{b}	74.57^{ab}	72.87^{ab}	76.41^{a}	77.18^{a}	1.678	5.28
Energy Retention (%)	75.71 ±2.36^{b}	80.20 ±0.46^{ab}	76.95 ±2.41^{a}	80.63 ±0.56^{ab}	81.86 ±1.04^{a}	1.61	5.09

sufficient iron (Fe) to meet the nutritional requirements of poultry. Under wood and Suttle (1999) reported that Iron is absorbed according to need and is therefore affected by factors such as the iron status of the body and age. They further suggested that uniformly high provision i.e. 80mg Fe/kg DM for broilers upto 8 weeks of age recommended by NRC (1994) seems to be overgenerous. Mohanna and Nys (1998) reported that in commercial chicks, for the period of 0-40 days, the percentage of retention was only 10%. They also suggested that nutritional approaches such as reduction in dietary trace mineral supplementation may alleviate the risks of phytotoxicity in the soil. Cao *et al.* (1996) supplemented 400,600 or 800 mg/kg added Fe as reagent grade $FeSO_4.7H_2O$ to chicks of 1, 2 or 3 weeks of age along with basal corn: soy diet. They reported that excess Fe depressed ($P<0.01$) feed intake and body weight gain at 3 weeks.

The requirement of copper, being 8 mg/kg DM of feed as per NRC (1994) is generally supplied by dietary sources and thus do not require supplementation (Underwood and Suttle, 1999). Johnson *et al.* (1985) suggested that broiler performance may be independent of dietary copper content. Mohanna and Nys (1998) reported retention of copper in broiler chicken by 6% and suggested for a modified supplementation strategy either by excluding the minerals or by lowering the safety margin of supplementation. Latymer and Coates (1981) studied the effects of incorporation of copper sulphate supplying 250 mg copper/kg semi purified diet with graded amounts of calcium pantothenate in chicks. They suggested that high dietary supplements of $CuSO_4$ induce pantothenic acid deficiency through interference in the biosynthesis of CoA.

Thus, keeping in view all the facts and possibilities, a study was planned in broilers to asses the effect of exclusion of Cobalt, Iron and Copper from mineral premix of broilers on their performance and nutrient utilization.

MATERIALS AND METHODS

Ninety day old vencobb broiler chicks were randomly divided in 5 dietary treatments (T1, T2, T3, T4 and T5), having 3 replicates with 6 birds each. The basal diet was common to all and contained 2800 kcal ME/kg and 22% CP (Starter diet) and 20% CP (finisher diet) as per recommendation of ICAR (1998). Dietary treatment T1 was fed commercial mineral mixture while laboratory reagent grade mineral mixture was offered to broilers of dietary treatment T2. The broilers of T3 groups were offered lab reagent grade mineral premix without Cobalt (Co), while those of T4 received lab reagent grade mineral premix without Iron (Fe). Birds of T5 group received mineral premix without Copper (Cu). All the premix was added at the rate of 2.5% of basal diet. The broilers were reared on metabolic cages to avoid coccidial threat for a total duration of 6 weeks divided in two phases viz. 0-4 weeks (Starter phase) and 4-6 weeks (Finisher phase). The birds were duly vaccinated against Ranikhet disease (at 7 ad 21 day) and for IBD (at 14 day). During the experiment, no antibiotics were provided. Only medication provided to birds are Zeetress and Liver tonic. Daily weighed amount of feed was offered and leftover and body weight gain was recorded on weekly basis. The Feed Efficiency Ratio (FER) and Performance Index (PI) were calculated as per formulae of Bird (1955). At the end of 4^{th} week a 3 day metabolic trial was conducted to asses the nutrient balance. The feed and feces were analyzed for nitrogen by method prescribed by AOAC (1990) and for energy by method of O'Shea and Maguire (1962). Calculation for energy retention and ME values were done as per Hill and Anderson (1958). The design of experimentation was completely randomized design as prescribed by Snedcor and Cochran (1962).

RESULTS AND DISCUSSION

The data on performance and nutrient utilization are presented in Table: 1.

Nutrient utilization and performance at 0 - 4 weeks

The feed intake ranged from 1463.44 ± 2.53 (T_2) to 1412.99 ± 42.59 g (T_1). The feed intake did not differ significantly among the treatments.

The body weight gain ranged from 799.28 ± 9.33 (T_2) to 726.17 ± 21.89 g (T_1). Non significant differences were observed between T_2, T_3, T_4 and T_5. Similarly, body weight gain of T_1 and T_4 did not differ. However, significant ($P < 0.5$) difference was observed between weight gain of T_1 compared to T_2, T_3 and T_5 (726.17 ± 21.89 vs. 799.28 ± 9.33, 774.56 ± 5.22, 785.10 ± 11.24).

The feed efficiency ratio ranged from 0.5498 ± 0.0175 (T_5) to 0.5138 ± 0.0002 (T_1). The feed efficiency ratio did not differ significantly between T_2, T_3, T_4 and T_5. Similarly, no significant ($p < 0.05$) difference was observed between broilers of T_1 compared toT_3 and T_4. However, significant difference ($p < 0.05$) was observed between FER of group T_1 and T_2 (0.5138 ± 0.0002 vs.0.5461 ± 0.0060) and between group T_1 and T_5 (0.5138 ± 0.0002 vs. 0.5498 ± 0.0175).

The performance index ranged from 431.77 ± 16.08 (T5) to 373.15 ± 11.25 (T_1). The PI values did not differ from each other in T_2, T_3, T_4 and T_5. No significant differences were noticed between T_3 and T_4. The PI values were significantly ($P < 0.05$) lower in T_1 than all the other treatments.

Nutrient utilization and performance at 4 - 6 weeks

The feed intake ranged from 1135.54 ± 14.58 (T_4) to 1088.88 ± 34.86 g (T_1). No significant difference was observed amongst the dietary groups.

Body weight gain ranged from 666.00 ± 20.59 (T_5) to 645.21 ± 41.35 g (T_1). No significant difference was observed between the treatments

The feed efficiency ratio ranged from 0.5913 ± 0.0209 (T_1) to 0.5463 ± 0.0068 (T_3). The feed efficiency ratio in T_1, T2, T4 and T_5; T_2, T_3 and T_4 were similar. The FER values of T_1, T_5 were significantly more than T_3 (0.5913 ± 0.0209, 0.5883 ± 0.0100 vs. 0.5463 ± 0.0068).

The performance index values ranged from 392.04 ± 16.92 (T_5) to 334.19 ± 18.31 (T_3). The performance index did not differ significantly between the treatments.

Overall performance at 0-6 weeks

The overall feed intake ranged from 2592.26 ± 11.45(T_4) to 2501.8 ± 18.07 (T_1). The overall feed intake did not differ significantly between the dietary treatments.

The overall body weight gain ranged from 1451.10 ± 30.84 (T_5) to 1371.38 ± 19.63 (T_1). The body weight gain did not differ significantly between treatments except between T_1 and T_5 (1371.38 ± 19.63 vs.1451.10 ± 30.84).

The feed efficiency ratio ranged from 0.5667 ± 0.0144 (T_5) to 0.5395 ± 0.002 (T_3). No significant difference was observed between the dietary treatments.

The performance index ranged from 822.78 ± 33.26 (T_5) to 747.61 ± 16.35 (T_3). No significant difference was observed between T_1, T_2, T_3 and T_4. The P.I. was significantly ($P < 0.05$) better in T_5 than that of T_3 and T_4 (822.78 ± 33.26 vs. 747.61 ± 16.35, 748.36 ± 18.94).

The percent retention of nitrogen ranged from 77.18 ± 0.28 (T_5) to 70.50 ± 2.70 (T_1). The percent retention of nitrogen was significantly ($P < 0.05$) lower in T_1 compared to T_4 and T_5 (70.50 ± 2.70 vs. 76.41 ± 0.41 and 77.18 ± 0.28). No significant differences were observed between T_2, T_3, T_4 and T_5 and between T_1, T_2 and T_3.

The percent retention ranged from 81.86 ± 1.04 (T_5) to 75.71 ± 2.36 (T_1). The percent retention was significantly ($P<0.05$) higher in T_5 than T_1 (81.86 ± 1.04 vs. 75.71 ± 2.36) but did not differ significantly from T_2, T3 and T_4. Further, retention percentage did not differ significantly between T_1 T_2, T_3 and T_4. However, no significant effect of exclusion of Co, Fe or Cu was observed on energy retention compared to control.

Critical perusal of above findings revealed that broilers fed mineral mixtures excluding Cobalt, Copper and Iron performed at par with those fed mineral mixture with Cobalt, Copper and Iron and no harmful effect was observed on performance and nutrient utilization of broilers by exclusion of Cobalt, Iron or Copper from mineral premix. This finding is supported by earlier workers (Johnson *et al.*, 1985), who suggested that broiler performance may be independent of dietary copper content. Furthermore, present findings also supports the findings and suggestions of workers (McDowell, 1992), who suggested that when the bird is supplemented adequate dietary Vit. B_{12}, there is no convincing evidence of a requirement for or benefit from dietary cobalt and reported that most of the feedstuffs contain sufficient iron (Fe) to meet the nutritional requirements of poultry.

CONCLUSION

Therefore, on the basis of present findings, it is concluded that Cobalt, Copper and Iron can be safely excluded from mineral premix fed to broilers, provided adequate Vit B_{12} is added to the diet and no deficiency of Copper and Iron content of feedstuffs used for feeding broilers is reported in the region. No adverse effects on performance and nutrient utilization of broilers were observed because of exclusion of Cobalt, Copper and Iron from the mineral premix offered to broilers. This factor may contribute to economy of production as well as may reduce the potential soil pollution by mineral excretion in poultry droppings.

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