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MANGANESE REQUIREMENT OF GROWING FAYOUMI CHICKS

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Abstract. One hundred and eighty one-day old Fayoumi chicks with an average body weight of 30g were divided into 6 groups and were fed the same basal ration but supplemented with $MnSO_4$ so as to make 6 Mn levels as follows; 15, 30, 45, 60, 75 and 90 p.p.m. Feed intake and weight gain were recorded weekly for each group. Feed and water were offered *ad libitum*.

Body weight increased slightly with Mn in the ration up to 60 p.p.m. Higher Mn levels than 60 p.p.m. was without effect on body weight. Feed efficiency was similar in all groups. Results indicated that the Mn level of 60 p.p.m. reduced the perosis to 3.3%.

Mn in body tissues was significantly affected by dietary Mn. Tibia Mn increased with increasing dietary Mn up to the level of 45 p.p.m. Tissue P and Ca decreased with increasing dietary Mn level.

The manganese requirement of starting chicks listed by the American NRC[12] is 55 p.p.m. Wilgus *et al.*[16] found that the addition of 25 p.p.m. Mn to a basal ration containing 10 p.p.m. Mn prevented perosis in chicks. Gallup and Norris[8] reported that 30–50 p.p.m. Mn prevented perosis. Similar results were obtained by Morimoto *et al.*[11]

Using a basal ration containing 13 p.p.m. Mn Pilla[14] reported that raising the Mn level to 35 p.p.m. prevented perosis but did not allow full growth potentialities. The growth was not as good on 35 as on 80 p.p.m. Mn, although feed efficiency was similar in all the groups.

Among the factors affecting Mn requirement of poultry are the breed and strain of birds, level of production, and the Ca–P ratio in the diet.[15] He postulated that the Mn function in Ca and P metabolism was in facilitating the formation and activation of phosphatase enzyme. However, Parker *et al.*[13] reported that feeding high Mn levels did not affect Ca and P deposition in bone of chicks.

This paper reports on the addition of different Mn levels in chick rations and their effect on body weight, perosis as well as, Ca and P metabolism.

Experimental

In this experiment 180 1-day old Fayoumi chicks were used. Birds were divided into 6 groups equal in number and nearly equal in average body weight. Directly after hatching, chicks were wing-banded and vaccinated against Newcastle using the eye drop vaccine. Chicks were maintained in electrically heated batteries with raised wire floors up to 8 weeks of age. Feed and water were offered *ad libitum*. Chicks were weighed individually every week. Records were kept for feed consumption and perosis.

Chicks were considered perotic if showed these symptoms: enlargement of the tibio-metatarsal joint, twisting or bending of the distal end of the tibia and of the proximal end of the metatarsus, and, finally, splipping of the gastrocnemius tendon from its condyles.[15]

At the end of the 8th week, five chicks from each group were sacrificed. Composite samples of the five chicks of each group were taken from blood, liver, lung, heart, spleen and tibia for the analysis of Ca, P and Mn.

Chemical Analysis. Preparation of feed and tissue samples was carried out according to A.O.A.C.[1] Blood samples were prepared according to the methods recommended by A.O.A.C.[1] and Appleton *et al.*[2] The colorimetric method of Cook[3] was followed in the determination of Mn in all samples. The colorimetric method of Fiske and Subbarow[6] was used for P determination in all samples. The complexmetric method of Ca determination as recommended by Evans and Ali[5] was followed in all samples.

The basal ration was composed of 49.5% yellow corn, 35% broad beans, 8% decorticated cotton seed meal, 5% barley, 1% Na_3PO_4, 1% $CaCO_3$ and 0.5% NaCl. The S.V. and crude protein of this ration were 70.78 and 17.89% respectively. The Ca %, P % and Mn (p.p.m.) of the basal ration were: 1.2, 0.6 and 15 respectively. The basal ration was supplemented with $MnSO_4$ to give rations containing Mn levels of 30, 45, 60, 75 and 90 p.p.m. Vitamin AD_3 mixture was added to all rations to supply 5000 I.U. vit. A and 1000 I.C.U. vit. D_3 per kg of ration. All rations were isocaloric and isonitrogenous and contained the same Ca and P percentages.

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Results

Average Body Weight, Feed Efficiency and Incidence of Perosis

Table 1 shows that increasing Mn in the ration up to 60 p.p.m. was accompanied by a slight increase (statistically insignificant) in average body weight at 8 weeks of age. Higher levels than 60 p.p.m. are of no effect in relation to body weight. Similar findings were reported by Couch *et al.*[4] and Morimoto *et al.*[11]

The feed efficiency (grams of gain/gram of feed) did not seem to be affected by the level of dietary Mn used in this experiment. Gutonska and Parkhurst[9] and Pilla[14] arrived at the same conclusions using rations containing graded Mn levels ranging from 17 to 76 and from 13 to 80 p.p.m. respectively.

The data show that the level of 60 p.p.m. Mn practically prevented perosis (being 3.33%) and that increasing Mn up to 75 p.p.m. was beneficial in reducing perosis to zero. Morimoto *et al.*[11] using a ration containing 10 p.p.m. Mn reported that chicks developed perosis but when 0.2 $MnSO_4$ was added, raising the total Mn to 63 p.p.m., there was no perosis.

Results of the body weight suggest that Mn requirement of Fayoumi chicks up to 8 weeks of age is in the range from 30 to 60 p.p.m. However, Mn requirement is little higher if based on perosis being in the range of 60–75 p.p.m.

Manganese Distribution in Tissues

Table 2 shows that Mn level in the ration had a profound effect on its level in the tissues and organs of chicks. It was observed that the supplemented groups tended to contain the highest amount of Mn while the deficient group had the lowest.

Of the tissues tested, the tibia contained the greatest amount of Mn followed by the liver, spleen and heart with the serum and lung containing only very small amounts which agreed with the findings of Fore and Morton[7] and Underwood.[15]

The increase in tissue Mn as a result of increasing dietary Mn from 15 to 90 p.p.m. was as follows: heart 22.48, tibia bone 29.56, spleen 36.60, liver 36.40, lung 37.62 and serum 395.24%. It should be noted, however, that although the maximum response to dietary Mn was that of serum but the Mn concentration of serum is very low. Serum Mn is of limited value as far as its absolute amount and due to its highly variable and even contradictory estimates.[15]

Liver ability to store Mn is limited as compared to its storage ability of other elements. On the other hand, the high concentration of Mn in bone and its great mass in the body makes the bone an important storage place of Mn and consequently any change in its Mn concentration reflects the dietary status of Mn.[15]

Tibia Mn showed an increase up to the level of 45 p.p.m. dietary Mn. Therefore, Mn requirement, based on bone Mn, of Fayoumi chicks up to 8 weeks old, lies between 45 and 60 p.p.m. (Table 2).

Phosphorus Distribution in Tissues

Phosphorus content in selected tissues and bone of Fayoumi chicks fed different levels of Mn is shown in Table 3. It is evident that dietary Mn had a paramount effect on the P content of all these tissues. The decrease in tissue P as a result of increasing dietary Mn from 15 to 90 p.p.m. was as follows: liver 6.99, heart 12.87, bone 13.10, spleen 14.24 lung 14.90 and serum 21.85%.

Phosphorus content was 52.59 and 4.93 mg/g dry-fat free tibia and dry heart respectively for the group given 15 p.p.m. Mn. The corresponding figures for the group given 90 p.p.m. were: 45.70 and 4.30 mg./g.

These results were similar to those obtained by Kulikova,[10] who found that the high level Mn group (250 mg/day) of albino rats showed a marked decrease of P in all tissues, and that in the group received no Mn, P contents in liver and bone increased.

TABLE 1. BODY WEIGHT, FEED EFFICIENCY AND PEROSIS OF FAYOUMI CHICKS FED DIFFERENT LEVELS OF MN AT 8 WEEKS OF AGE.

Mn level (p.p.m.)	Average body weight (g)	Feed efficiency	Perosis %
15	175.3 (±11.3)[1]	0.23	20.0
30	187.3 (±13.9)[1]	0.26	16.6
45	187.2 (± 9.8)[1]	0.24	6.6
60	194.3 (±12.1)[1]	0.26	3.3
75	182.9 (±13.0)[1]	0.24	0.0
90	180.2 (±11.4)[1]	0.23	0.0

1 Standard error of the mean.

TABLE 2. MANGANESE DISTRIBUTION[1] IN THE TISSUES OF FAYOUMI CHICKS FED DIFFERENT MN LEVELS.

Dietary Mn	15 p.p.m.		30 p.p.m.		45 p.p.m.		60 p.p.m.		75 p.p.m.		90 p.p.m.	
	A	R	A	R	A	R	A	R	A	R	A	R
Serum[2]	0·021	100	0·033	157·14	0·04	190·78	0·065	309·52	0·072	342·86	0·083	395·24
Heart	0·61	100	0·63	102·44	0·66	107·49	0·70	114·01	0·72	116·45	0·75	122·48
Liver	4·62	100	5·42	117·44	5·52	119·61	5·88	127·30	6·16	133·59	6·30	136·40
Spleen	0·70	100	0·79	111·91	0·82	117·02	0·85	121·13	0·88	124·68	0·96	136·60
Lung	0·10	100	0·11	105·94	0·12	114·85	0·12	123·76	0·13	129·70	0·14	137·62
Tibia bone[3]	5·92	100	6·36	107·43	7·00	118·24	7·22	121·96	7·53	17·20	7·67	129·56

1. p.p.m. Mn on dry basis for all tissues except serum and tibia; 2. mg Mn/ml. serum; 3. p.p.m. Mn/dry fat-free-basis; A=Absolute: R = Relative to group I (15 p.p.m. Mn).

TABLE 3. PHOSPHORUS DISTRIBUTION[1] IN THE TISSUES OF FAYOUMI CHICKS FED DIFFERENT Mn LEVELS.

Dietary Mn	15 p.p.m.		30 p.p.m.		45 p.p.m.		60.p.p.m.		75 p.p.m.		90 p.p.m.	
	A	R	A	R	A	R	A	R	A	R	A	R
Serum[2]	6·82	100	6·81	99·85	6·75	98·97	6·51	95·45	6·49	95·16	5·33	78·15
Heart	4·94	100	4·82	97·57	4·48	90·68	4·40	89·16	7·39	89·06	4·30	87·13
Liver	8·14	100	7·92	97·18	7·56	92·76	7·70	94·48	7·66	93·99	7·58	93·01
Spleen	6·46	100	6·38	98·76	6·14	95·05	6·11	94·58	5·93	91·80	5·54	85·76
Lung	5·57	100	5·48	98·38	5·26	94·44	4·98	89·41	4·89	87·79	4·74	85·10
Tibia bone[3]	52·59	100	49·92	94·92	48·49	92·20	47·48	90·28	46·72	88·27	45·70	86·90

1. mg P/g on dry basis for all tissues except serum and tibia bone, 2 . mg P/100 ml. serum; 3. mg P/mg dry fat free tibia bone; A = Absolute; R = Relative to group I (15 p.p.m. Mn).

TABLE 4. CALCIUM DISTRIBUTION[1] IN THE TISSUES OF FAYOUMI CHICKS FED DIFFERENT Mn LEVELS.

Dietay Mn	15 p.p.m.		30 p.p.m.		45 p.p.m.		60 p.p.m.		75 p.p.m.		90 p.p.m.	
	A	R	A	R	A	R	A	R	A	R	A	R
Serum[2]	9·20	100	9·31	98·80	9·12	99·13	8·04	98·74	7·92	98·61	7·33	97·97
Heart	0·384	100	0·366	95·31	0·354	92·45	0·344	89·58	0·328	85·68	0·314	81·77
Liver	0·302	100	0·284	94·06	0·279	92·41	0·276	91·42	0·264	87·13	0·248	81·85
Spleen	0·223	100	0·221	99·10	0·201	99·01	0·196	98·79	0·187	98·39	0·179	98·03
Lung	0·2263	100	0·204	99·03	0·191	98·45	0·181	98·01	0·176	97·79	0·186	98·23
Tibia bone[3]	55·22	100	52.73	95·49	51·62	93·48	51·16	92·65	49·97	90·49	49·66	89·93

1. mg Ca/g on dry basis; 2. mg Ca/100 ml serum; 3. mg Ca/g dry fat-free basis; A = Absolute; R = Relative to group I (15 p.p.m. Mn).

Calcium Distribution in Tissues

Table 4 shows the Ca content of selected tissues and bones of Fayoumi chicks fed different Mn levels. It can be seen that dietary Mn level had a marked effect on Ca content in all tissues and organs particularly bones, tending to be the highest in the low Mn level and the least in high Mn level.

Calcium of serum and tibia decreased by 2.03 and 10.07% respectively as a result of increasing dietary Mn from 15 to 90 p.p.m. Reduction of Ca content of other tissues was also evident but its absolute value was of low magnitude making it of limited significance.

In this respect, Kulikova[10] reported that Mn supplementation decreased Ca contents in bones of rats.

Discussion

From the body weight data, it was concluded that the requirement of Fayoumi chicks up to 8 weeks of age was in the range from 30 to 60 p.p.m. However, considering the incidence of perosis shows that the Mn requirement was more close to the 60 p.p.m. or higher. From practical point of view, the incidence perosis in the group fed 60 p.p.m. Mn was very close to nil, though one could not deny the fact that increasing dietary Mn above 60 p.p.m. might help in avoiding any perotic cases. Similar results were reported by the American NRC,[12] Wilgus *et al.*[16] and Morimoto *et al.*[11]

Dietary Mn was shown to have a significant effect on Mn concentration in tissues. Tibia Mn increased with increasing dietary Mn up to the level of 45 p.p.m. The high concentration of Mn in bone makes it the most important storage place of Mn.[15]

Considering the figures of Mn requirement based on body weight, perosis, Mn concentration in tibia, it becomes clear that the level of 60 p.p.m. is to be recommended for Fayoumi chicks up to 8 weeks of age.

The effect of dietary Mn on metabolism of Ca and P was also studied. Results showed that there was a negative relationship between dietary Mn and both Ca and P in all tissues. This result agrees with that of Kulikova[10] but disagrees with findings of Parker *et al.*[13]

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