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Adsorbing Charcoals in Chick Diets.

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It has long been a common practice to add charcoal to poultry feeds, under the impression that charcoal improves the health and reduces the mortality rate of chickens. Acceptable evidence for these alleged attributes has been lacking. Charcoal is claimed to act by adsorbing undesirable products from the digestive tract, for example, one manufacturer of poultry charcoal lists the following substances as removed: carbon dioxide, ammonia, bacteria, pigments, poisons and enzymes.

Charcoal is known to cause a bleaching of poultry flesh and of egg yolk by reducing the deposition of carotenoid pigments from the diet. This bleaching effect suggests the possibility that carotene and other vitamins in the diet might also be removed or inactivated by charcoal. For example, former experience in this laboratory showed that vitamin K is adsorbed strongly on charcoal and that it cannot later be removed without much destruction. The vitamin K-deficient chicken fed vitamin K adsorbed on charcoal seems unable to remove and utilize the vitamin.¹

A diet was formulated to provide optimum amounts of vitamins A, K, G (riboflavin) and the chick gizzard factor, without the considerable margins of safety that exist in most good commercial chick mashes. This diet was found capable of promoting normal growth and health of chicks.

The diet was composed of the following:

Sardine fish meal	20.0
Dried brewer's yeast	2.0
Dried skim milk	2.0
Dried alfalfa	0.5
Sardine oil, fortified*	0.05
Calcium carbonate	0.5
Wheat bran	10.0
Ground polished rice	62.0
Granite grit	2.0
Salt	0.05

In the first experiment, day-old chicks were fed the basal diet with and without 2% of an adsorbing charcoal. Results are given in Table I.

*This oil contained at least 400 chick units of vitamin D and 3000 U.S.P. units of vitamin A per gram.

¹ Unpublished data of the senior author.

TABLE I.
Results of Experiment I.

Diet	Basal	Basal + 2% charcoal 1
No. of chicks	20	20
Mortality	2	3
Avg wt at 34 days	294.6 g	181.3 g
Cases of vitamin A deficiency	0	15
Avg blood clotting time	2.4 min	over 30 min
Condition of gizzard linings	normal	all eroded

Vitamin A deficiency occurring in the charcoal-fed group was diagnosed from the typical paralysis and incoördination, keratinization of the nictitating membrane, and poor growth. All cases recovered after daily oral administration of vitamin A in fish oil. Severe vitamin K deficiency was identified by the presence of subcutaneous hemorrhages in some birds and a prolonged blood clotting time in all birds fed charcoal. Gizzard factor deficiency was in evidence in the case of the severely eroded gizzard linings.² Three distinct deficiencies had, therefore, been produced by the addition of an adsorbing charcoal to the diet.

In Experiment II a second sample of adsorbing charcoal was tested. Results are given in Table II.

In this experiment, vitamin A deficiency was not in evidence. There was in the charcoal group, however, a slight prolongation of the blood clotting time, indicating some loss of vitamin K, and a moderate occurrence of gizzard erosion, indicating some loss of the gizzard factor. Another deficiency became manifest in the development of "curled-toe paralysis" a symptom of vitamin G (riboflavin) deficiency. Four of the 6 cases developed in the charcoal group were treated with synthetic riboflavin orally and all 4 cases were promptly cured. The lack of evident vitamin A deficiency and the appearance of vitamin G deficiency in Experiment II as compared to Experiment I may have been due to differences in the reserve stores of these vitamins in the different lots of chicks.

TABLE II.
Results of Experiment II.

Diet	Basal	Basal + 2% charcoal 2
No. of chicks	20	20
Mortality	0	0
Avg wt at 34 days	310.5 g	314.2 g
Cases of vitamin A deficiency	0	0
Avg blood clotting time	4.2 min	8.4 min
Condition of gizzard lining	normal	several eroded
Cases of "curled-toe" paralysis	0	6

² Almquist, H. J., and Meechi, E., *J. Biol. Chem.*, 1938, **126**, 407.

TABLE III.
Results of Experiment V.

Diet	Practical mash	Practical mash + 2% charcoal ²
No. of chicks	35	35
Mortality	0	2
Avg wt at 10 days	67.6 g	67.6 g
'' '' '' 52 ''	521.6	545.8
'' gain per unit of feed	0.328	0.332

A repetition of Experiment II gave similar results. In Experiment IV, both samples of charcoal were fed simultaneously to separate groups of chicks from the same lot. Results were again similar to those obtained with each charcoal sample separately, while chicks in the same lot receiving no charcoal maintained the best growth and normal health. In a fifth experiment, charcoal 2 was added at a level of 2% to a practical chick rearing mash fed to a pen of carefully selected chicks. A similar pen received only the mash. This practical mash was richly supplied with all the factors in question and it is not surprising that no outward deficiency symptoms were noted. Results are given in Table III.

The results of this last test are typical of attempts to demonstrate any beneficial effect from feeding charcoal to chicks. Differences in growth are slight and usually not significant. Results from other tests (Exp. IV) have yielded slight differences in the opposite direction; and it seems impossible to confirm these differences one way or the other. This same difficulty has been encountered by others in investigations of charcoal in chick rations.³

In conclusion, it may be stated that a chick diet adequate for normal growth and health was rendered, in effect, deficient in vitamins A, G, K and the gizzard factor by the addition of an adsorbing charcoal. These findings point to the possibility of some measure of this effect in practical rations supplemented with charcoal if the mash does not contain more than adequate levels of these factors, or if the mash consumption is reduced by heavy scratch grain feeding, or if the birds have unlimited access to charcoal. The adsorbing power of charcoals in poultry rations is not necessarily a completely beneficial property.

³ Private communication from Professor G. F. Heuser concerning the thesis of George C. Hodgson, Cornell University, 1938.