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THE USE OF CLAY IN POULTRY FEED*

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Abstract—Dietary clay supplements (bentonite and kaolinite) have been used as binding and lubricating agents in the production of pelleted feeds for chickens. The high-swelling and water absorbing capacity of some bentonites make them attractive dietrary additives for control of wet droppings in caged layers. In addition, experiments show that layers fed on these diets exhibit significant increases in body weight, egg size, and life expectancy even though their total caloric intake is less than that of the control group. Dietary kaolin improves caloric efficiency even more than bentonite but without apparent effect upon growth or carcass quality. Kaolins of smaller particle size are superior to those of larger size in improving caloric efficiency. The effective kaolins are estimated to be worth approximately two calories of metabolizable energy per gram. The major beneficial effect appears to be due to a slowing down of the rate of feed passage through the intestinal tract. Possible uptake of trace elements required for optimum nutrition has not yet been evaluated.

INTRODUCTION

THE USE of clay supplements in animal and poultry feed manufacturing is not new. Certain bentonites have long been used as a binding and lubricating agent in production of pelleted feeds. A number of early publications on the performance of animals receiving pelleted as compared with unpelleted feeds reported improved performance from animals receiving the pellets. Because the degree of improvement was related to the fiber level, increasing the density was thought to be the reason for improved performance. No doubt, this was partly true. However, experiments in which improved performance was obtained after re-grinding the pellets into mash suggested that other factors might be, in part, responsible. Hydrolysis of the starch in the grain portion of the feed was suspected of accounting for the additional improvement.

Recent studies involving the use of clays as dietary supplements have given results which suggest that some clay products may have direct beneficial effects upon animal performance. Few such studies have provided evidence that the clay products were themselves making nutritive contributions but most have demonstrated an improved caloric efficiency resulting from their use. If control diets were deficient in any one or more of the trace elements required for optimum nutrition of the particular type of animal under test, many clay supplements containing the suboptimum element might be expected to make a direct nutritive contribution.

Clay supplements have generally been used in animal diets for reasons other than the nutrients they supply. Recent reports have shown that low-level additions of selected bentonites (1–5 per cent) to poultry diets improved caloric efficiency and slowed down feed passage (Kurnick and Reid, 1960; Quisenberry and Bradley, 1964; Eshleman, 1966; Quisenberry, 1966; Almquist, 1967; and Ousterhout, 1967). Erwin *et al.* (1957) used 3 per cent sodium bentonite in cattle rations and reported no significant influence on rate of gain, feed efficiency, digestibility of dry matter or crude fiber, or hepatic vitamin A and carotene retention when the steers were fed a diet containing 25 per cent of dehydrated alfalfa. These workers concluded that sodium bentonite would probably have no deleterious effect on carotene use if the clay were incorporated into rations rich in this pigment. Rotermel *et al.* (1964) reported an increase in chest width and carcass fat of two groups of swine fed diets containing 1 per cent bentonite, suggesting an increase in calorie retention. Jordon (1953, 1954) reported an increase in rate of gain and feed efficiency for lambs fed diets containing supplementary bentonite. In the latter paper, he reported that pregnant ewes fed as much as $\frac{1}{3}$ lb of bentonite per day exhibited no toxic effects.

The remainder of this paper will be devoted to a summary of the experimental work, completed or in progress, with chickens.

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BENTONITES AND WASTE MANAGEMENT

Experiment 1

Where feasible to handle as part of the regular management program, dry droppings under cages in open houses are the most satisfactory method of solving the waste utilization problem. Dehydration of the droppings and water removal from environmentally controlled laying houses are problems of major concern to those engaged in the commercial egg business.

Water consumption and excretion rates are under partial genetic control. In 1962–64 certain commercial strains of laying birds were experiencing difficulty with wet droppings. A solution was sought with dietary bentonites. Diets with $2\frac{1}{2}$ and 5 per cent western bentonite were used. Percentage of moisture in the droppings was significantly ($P < 0{\cdot}05$) reduced in both winter and summer seasons and the consistency so changed that drying was speeded up. Performance data on the birds were also collected. Body weight and egg size were significantly ($P < 0{\cdot}05$) increased although the caloric value of the diets decreased from 945 kcal of productive energy per pound for the control to 932 and 918 for the $2\frac{1}{2}$ and 5 per cent bentonite diets, respectively. There was no significant effect on egg production but feed efficiency was improved. That less feed is required per unit of eggs produced on lower calorie diets substantiates the conclusion that the bentonite improved caloric efficiency. These and other data presented in this study assured the breeder involved and cage operators in general that sodium bentonite offered real promise for control of wet droppings and that it might also be of value to operators of environmentally controlled houses.

Experiment 2

For this experiment calcium bentonite from a Texas source and a sodium bentonite from a western source were compared. The bentonites were fed at the 5 per cent level only. As for Experiment 1, the control diet contained 945 kcal of productive energy and the bentonite diets contained only 918 kcal/lb. Birds that received the bentonite diets gained more body weight and produced larger eggs than the controls. Thirteen per cent more commercially designated "large" eggs were produced by birds on the calcium bentonite diet and 15 per cent more by the sodium bentonite. group. Egg production was higher for the bentonite group, particularly for those on the western bentonite. Mortality was also lower than for the controls. Feed efficiency however, favored the controls in this experiment, in contrast to Experiment 1.

Experiment 3

Encouraged by results of the first two experiments, a third one was devised to test the efficacy of two montmorillonite clays, one from California (Cal-Min) and one from Texas (BMC), calcium bentonite from a Texas source and a western bentonite supplied by the Magnet Cove Barium Corporation, Houston, Texas. Each of these was fed at $2\frac{1}{2}$ and 5 per cent levels. As for Experiment 1, all of the clay additives at both levels resulted in a significant ($P < 0{\cdot}05$) gain in body weight over the controls, an increase in egg size, and a reduction in water of the droppings. Egg production was improved by the Cal-Min, the lower level of BMC, and both levels of western bentonite. Feed efficiency was measurably improved by the $2\frac{1}{2}$ per cent level of cal-min and slightly improved by the higher level of cal-min and the lower level of western bentonite. The other additives were no better or poorer than the controls.

The value of these clays and bentonites in assistance with the solution of wet droppings problem was again demonstrated.

BENTONITES AS CALORIE EXTENDERS

The role of bentonites as calorie extenders has been previously reported in this paper as observed at Arizona State University, Texas A&M University, California, and Rhode Island. Further evidence of this role is given in Table 1.

Table 1. Western bentonite and montmorillonite clay (cal-min) as calorie extenders in laying hen diets (9 periods, 9/22/66–5/31/67)

Clay additive Type	(%)	HDP* (%)	Egg size (g)	F.E.† (#/#)	Mortality (%)
Control		74·09	60·4	2·63	12·5
WB	2·5	79·15	60·3	2·59	5·0
WB	5·0	79·96	60·9	2·53	2·5
C-M	2·5	75·61	60·7	2·70	7·5
C-M	5·0	78·71	61·1	2·57	7·5

*HDP = Hen-day production.

†F.E., #/# = Feed efficiency, lb of feed/lb of eggs produced.

If the performance levels given in Table 1 continue for the 12 months of the planned experiment, it appears that both the western bentonite and the montmorillonite clay (cal-min) will again have had a beneficial effect upon egg production, feed efficiency, mortality and possibly, upon egg size.

In a paper given at the recent annual Poultry Science Association meeting in Durham, New

Hampshire (August 22, 1967), Ousterhout (1967) compared the effects of dietary kaolin, sodium bentonite, calcium bentonite, and a diatomaceous earth compound on the performance of boiler chicks. He reported that the inclusion of various kaolins at levels as high as 16 per cent in practical broiler rations improved caloric efficiency with no apparent effect upon growth or carcass quality. Ousterhout concluded that if kaolins could be obtained a a cost lower than 75 per cent of the normal ration ingredient cost, broiler production costs could be lowered. Kaolins improved pellet quality and ease of pelleting, but pelleting was not necessary to obtain the improvement in caloric efficiency.

All kaolins tested were not of equal value in improving caloric efficiency, but those of smaller particle size were superior to those of larger size. The effects on caloric efficiency were similar to those reported for bentonites and diatomaceous earth but these products were not as effective as the kaolins tested. Results reported showed the kaolins to improve caloric efficiency approx 2·0 calories of metabolizable energy per gram or 900/lb. The major beneficial effect appeared due to a slowing down of the rate of feed passage through the intestinal tract. Adsorption of nutrient elements from the kaolin particles might also have improved the efficiency of absorption.

SUMMARY AND CONCLUSION

1. Dietary clay supplements are used as binding and lubricating agents in the production of pelleted feeds.

2. They are effective as calorie extenders and effective ones are estimated to be worth approximately 2 calories of metabolizable per gram.

3. The high-swelling and water absorbing capacity of some bentonites make them attractive dietary additives for control of wet droppings in caged layers.

4. Continued research on ways of maximally utilizing clay products as feed additives seems warranted.

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Résumé—Des suppléments d'argile diététique (bentonite et kaolin) ont été utilisés comme agents liants et lubrifiants dans la production de produits alimentaires en pastilles pour les poulets. La grande capacité de gonflement et d'absorption d'eau de certaines bentonites en font des additifs diédétiques de grand intérêt pour le contrôle des fientes humides chez les poules pondeuses en cage. En outre, des tests ont montré que les pondeuses nourries selon ce régime augmentent sensiblement leur poids, la grosseur de leurs oeufs et leur durée de vie même si le total de calories absorbées est inférieur à celui du groupe de contrôle. Le kaolin diététique améliore le rendement calorifique plus encore que la bentonite, mais sans effet apparent sur la croissance ou la qualité de la carcasse. Les kaolins à plus petites particules sont supérieurs à ceux à plus larges particules pour améliorer le rendement calorifique. Les kaolins efficaces sont estimés valoir environ deux calories d'énergie métabolisable par gram. L'importance de l'effet bénefique semble être dû à un ralentissement du taux de passage de la nourriture dans la voie intestinale. On n'a pas encore calculé le niveau de consommation possible d'éléments de trace pour assurer une nutrition optimale.

Kurzreferat—Diätetische Tonzusatzstoffe (Bentonit und Kaolinit) sind als Binde- und Gleitmittel für die Zubereitung tablettierter Hühnerfutter verwendet worden. Das hohe Quell- und Wasserabsorptionsvermögen gewisser Bentonite macht dieselben wünschenswerte Zusatzstoffe für die Kontrolle des Feuchtmistes von Käfigleghennen. Darüber hinaus zeigen die Versuche, dass die mit dieser Diät gefütterten Leghennen deutliche Zunahmen in Körpergewicht, Eigrösse und Lebenserwartung aufweisen, obwohl ihre kalorische Gesamtaufnahme geringer ist als die der Kontrollgruppe. Diätetischer Kaolin verbessert den kalorischen Nutzeffekt sogar noch mehr als Bentonit, jedoch ohne merkliche

Wirkung auf das Wachstum oder die Fleischqualität. Kaoline mit kleinerer Teilchengrösse tragen mehr zur Verbesserung des kalorischen Nutzeffektes bei als die mit grösseren Teilchen. Es wird geschätzt, dass die wirksamen Kaoline ungefähr zwei Kalorien metabolisierbarer Energie pro Gramm entsprechen. Der Hauptnutzeffekt scheint auf einer Verlangsamung in der Durchgangsrate des Futters durch den Darmkanal zu beruhen. Die etwaige Aufnahme von für optimale Ernährung erforderlichen Spurenelementen ist bisher noch nicht beurteilt worden.

Резюме—Глинистые добавки к пищевым продуктам (бентонит и каолинит) применялись в качестве связующих и смазывающих веществ при изготовлении гранулированного корма для кур. Благодаря высокой набухаемости и абсорбционной способности, некоторые бентониты являются хорошими добавками для борьбы с влажным пометом несушек в клетках. Кроме того доказано опытами, что при таком пищевом режиме несушки показали значительное увеличение веса и размера яиц, а также продлена вероятная продолжительность жизни, хотя общий прием калорий меньше, чем у контрольной группы. Принимаемый в корме каолин повышает калорийность даже в большей степени, чем бентонит, но повидимому без того, чтобы подействовать на качество роста мш тушки. Каолины с частицами меньшего размера улучшают калорийность в большей степени чем каолины с большими частицами. Действующие каолины считают равными прибл двум калориям энергии, преобразующейся в ходе обмена веществ на граммы. Главное полезное следствие повидимому результат замедления прохода корма по кишечному тракту. Возможность поглощения малых элементов, требуемых для наилучшего питания еще не исследована.