Citrinin Toxicity in Growing Chicks[1]

T. S. NELSON, J. N. BEASLEY, L. K. KIRBY, Z. B. JOHNSON, G. C. BALLAM, and M. M. CAMPBELL

Department of Animal Sciences, University of Arkansas, Fayetteville, Arkansas 72701

(Received for publication February 2, 1981)

ABSTRACT Male broiler chicks, from day-old to 3 weeks of age, were fed diets containing 0, 100, 220, 330, and 440 ppm citrinin produced by *Penicillium lanosum* grown on whole corn. Body weight decreased ($P<.05$) when chicks were fed the diets containing 330 and 440 ppm citrinin. Average body weight of chicks fed the diet containing 220 ppm citrinin was 8% less than that of chicks fed no toxin. Feed utilization decreased ($P<.05$) with chicks fed the diet containing 440 ppm citrinin. Analysis of thigh muscle, kidney, liver, and blood for citrinin revealed detectable amounts in the liver and blood of chicks fed 440 ppm.

(*Key words:* chick, citrinin, fungal, toxicity, growth, feed efficiency, residues)

1981 Poultry Science 60:2165–2166

INTRODUCTION

Citrinin, a fungal metabolite, was isolated and identified by Hetherington and Raistrick (1931). It is a nephrotoxin which causes kidney degeneration and increased urine excretion. There is little evidence of a naturally occurring toxicity of citrinin in animals, and few experiments have been conducted to determine the minimum dietary level of this metabolite toxic to chicks. Ames *et al.* (1976) fed chicks diets containing 62.5, 125, 250, and 500 ppm citrinin. All levels of the toxin caused enlarged kidneys; there was a dose related increase in liver size but body weight was decreased only by 500 ppm citrinin. Roberts and Mora (1978) fed chicks diets containing 33, 65, 130, and 260 ppm citrinin. All levels of the toxin caused cellular infiltration in the liver, kidney, and pancreas. Growth was depressed by the diets containing 130 and 260 ppm citrinin.

The present study was conducted to determine the levels of citrinin which would affect the body weight of chicks and to determine if this toxin could be recovered from body tissues.

MATERIALS AND METHODS

Sterilized whole corn, inoculated with spores from a *Penicillium* spp.,[2] was incubated at room temperature for 8 weeks (Beasley *et al.*, 1980) air dried, ground, and assayed for citrinin (Nelson *et al.*, 1980). A second sample of sterilized corn containing no added mold spores was also incubated for 8 weeks. The inoculated corn was incorporated into a chick starter diet at levels to supply 110, 220, 330, and 440 ppm citrinin. The uninoculated corn replaced all of the untreated corn in one diet.

Male broiler chicks, 5 per pen, were allotted at random and each treatment was replicated four times. Feed and water were supplied *ad libitum,* and body weight and feed consumption records were maintained weekly. The experiment was terminated after 3 weeks and the livers, kidneys, a sample of thigh muscle and 5 ml of blood were taken from 2 chicks per pen. The blood sample was placed in 10 ml of .1 M H_3PO_4. The samples obtained from the chicks fed the highest level of inoculated corn were assayed fresh and the other samples were frozen until analyzed.

The individual liver, muscle, and blood samples were processed and citrinin analysis conducted by procedures described previously (Nelson *et al.*, 1980).

Body weight and feed consumption data were analyzed by analysis of variance and the differences between means were separated by Duncan's new multiple range test using the statistical analysis system of Barr *et al.* (1976).

[1] Published with the approval of the Director of the Arkansas Agricultural Experiment Station.

[2] Original culture identified as *Penicillium lanosum* (Beasley *et al.*, 1980); recent subcultures identified as *P.* citrinum by J. I. Pitts, Commonwealth Scientific and Industrial Research Organization, Division of Food Research, Food Research Laboratory, Delhi Road, North Ryde, New South Wales, Australia.

TABLE 1. *Effect of citrinin on growth, feed efficiency, and residues in tissues*

Citrinin	Body weight,[3] 3 weeks	Gain/feed consumed[3]	Residues in tissues[1]			
			Blood	Liver	Muscle	Kidney
(ppm)	(g)	(g/g)	(ng/ml)	(μg/g)		
0[2]	470[a]	.68[a]	–	–	–	–
0[3]	469[a]	.65[a]	–	–	–	–
110	485[a]	.68[a]	–	–	–	–
220	437[a]	.65[a]	–	–	–	–
330	359[b]	.63[a]	–	–	–	–
440	257[c]	.48[b]	215 ± 60	7.2 ± 1.4	–	–

[a,b,c]Means in a column with different letters differ significantly (P<.05).

[1]Mean ± SE; – indicates none detected.

[2]Untreated corn.

[3]Uninoculated, autoclaved corn incubated for 8 weeks.

RESULTS AND DISCUSSION

The results obtained in this experiment are presented in Table 1. No decrease in body weight occurred when the chicks were fed the diet containing 110 ppm citrinin. The diet containing 220 ppm resulted in an 8% decrease (P>.05) in chick weight. The average body weights of the chicks fed the diets containing 330 and 440 ppm citrinin were reduced (P<.05) at 3 weeks of age. Feed utilization was depressed (P<.05) only when the diet contained 440 ppm citrinin.

These data indicate that the level of citrinin that would decrease growth is somewhat less than 330 ppm. Roberts and Mora (1978) reported that growth depression occurred when chicks were fed 130 ppm citrinin. Ames *et al.* (1976) found that 500 ppm citrinin reduced chick growth significantly and that 250 ppm caused only a 2% reduction in body weight. Our value of 330 ppm citrinin is between the values of Roberts and Mora (1978) and Ames *et al.* (1976). Previous work (Nelson *et al.*, 1980) showed that measurable amounts of water were excreted by chicks fed 150 to 200 ppm citrinin. Increased water excretion is one of the symptoms of citrinin toxicity, evident in this study at all levels of the toxin.

Citrinin was detected only in the blood and livers of the chicks fed diets containing 440 ppm citrinin. These analyses were conducted on fresh samples, whereas the tissues from the chicks fed the other diets were frozen until analyzed.

REFERENCES

Ames, D. D., R. D. Wyatt, H. L. Marks, and K. W. Washburn, 1976. Effect of citrinin, a mycotoxin produced by *Penicillium citrinum*, on laying hens and young broiler chicks. Poultry Sci. 55:1294–1301.

Barr, A. J., J. H. Goodnight, J. P. Sall, and J. T. Helwig, 1976. A user's guide to SAS 76. SAS Inst. Inc., Raleigh, NC.

Beasley, J. N., L. D. Blalock, T. S. Nelson, and G. E. Templeton, 1980. The effect of feeding corn molded with *Penicillium lanosum* to broiler chicks. Poultry Sci. 59:708–713.

Hetherington, A. C., and H. Raistrick, 1931. Studies in the biochemistry of micro-organisms. Part XIV. On the production and chemical constitution of a new yellow coloring matter, citrinin, produced from glucose by *Penicillium citrinum* Thom Phil. Trans. Soc. (London) Ser. B. 220:269–296.

Nelson, T. S., J. N. Beasley, L. Kirby, Z. B. Johnson, and G. C. Ballam, 1980. Isolation and identification of citrinin produced by *Penicillium lanosum*. Poultry Sci. 59:2055–2059.

Roberts, W. T., and E. C. Mora, 1978. Toxicity of *Penicillium citrinum* AUA-532 contaminated corn and citrinin in broiler chicks. Poultry Sci. 57:1221–1226.