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Individual and combined effects of mycotoxins-cyclopiazonic acid and T₂-toxin-on growth rate of broiler chicken

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Abstract

The effect of feeding diets containing cyclopiazonic acid (CPA) and T₂-toxin has been assessed at the levels of 10 ppm and 1 ppm, respectively on growth rate in broiler chicken from 0 to 28 days of age. Body weights have been recorded at weekly intervals. Highly significant ($p < 0.01$) differences has been observed between the control and toxin treated groups in body weights. The CPA group differed significantly ($p < 0.01$) from other treatment groups and control. No significant difference has been observed between the T₂ and CPA-T₂ groups. There is a significant ($p < 0.01$) reduction in body-weight gain in toxin-treated groups when compared to the control. But, no significant difference has been observed between the T₂-group and CPA-T₂ group in body-weight gain. Highly significant ($p < 0.01$) CPA-T₂ interaction has also been observed. Thus, it has been concluded that CPA and T₂ either individually or in-combination adversely affect the health of broiler chicken as evident from their body-weight gains.

Key words: Broiler chicks, cyclopiazonic acid, T₂-toxin broiler chicken, growth rate, mycotoxin

Introduction

Mycotoxins are a group of structurally diverse fungal metabolites that elicit a wide spectrum of toxicologic effects. Approximately, 25 per cent of the world's food supply gets contaminated by mycotoxins annually. Cyclopiazonic acid (CPA), an indole tetramic acid, is a mycotoxin produced by several species of *Aspergillus* and *Penicillium* fungi (Dorner *et al.*, 1984). The T₂-toxin, a naturally occurring mycotoxin produced by several species of genus *Fusarium*, is a 3-hydroxy-4, 15 diacetoxy-8-(3-methyl butyryloxy), 12, 13-epoxytrichothec-9-ene metabolite. The cytotoxic and radiomimetic-like effects of T₂-toxin on rapidly dividing cells are caused by the impaired DNA and RNA synthesis, resulting indirectly from

inhibition of peptidyl transferase. By considering the importance of natural occurrence of these two toxins in poultry feeds and feedstuffs, this study was designed by employing low dose levels of CPA and T₂-toxin to study their effects on growth rate in broiler chicken.

Materials and Methods

Forty newly hatched, unsexed broiler chicks (VENCOBB) procured from M/s. Venkateshwara Hatcheries (P) Ltd, Chennai were wingbanded, weighed and housed in battery brooders with *ad libitum* supply of feed and water. They were randomly distributed into four groups of ten chicks each. The CPA produced in rice using *Penicillium griseofulvum* NRRL 3523, was quantified (Rathinavelu and Shanmugasundaram, 1984).

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The T₂-toxin was produced in the wheat using *Fusarium sporotrichioides* MTCC 1894 (Burmeister, 1971) and was quantified using thin layer chromatography (Tapia, 1985).

The experimental trials were approved by the Institutional Animal Ethics Committee, India, and were conducted as per its guidelines. The CPA and T₂-toxin containing culture materials were incorporated into the broiler mash to yield 10 ppm and 1 ppm, respectively and fed for 28 days from the day of hatch. Body weights (g) were recorded at weekly intervals. The data generated from the experimental study were subjected to statistical analysis, as per Snedecor and Cochran (1989). The results of the study were subjected in one or two way analysis of variance (ANOVA) and interactions (Steel and Torrie, 1960).

Results and Discussion

Weekly body weights, mean ± SE, of broilers fed with CPA and T₂-toxin singly and in combination are shown in Table 1. The gains in body weight shown in Table 2. Mean ± SE body weights (in grams) observed at the end of the experimental period were 700.45 ± 41.85, 309.00 ± 68.01, 494.50 ± 65.55 and 520.90 ± 47.75 for control, CPA, T₂ and CPA-T₂ groups respectively. The mean body-weight gains (in grams) at the end of the experimental trial were

652.91, 260.82, 446.60 and 472.54 for control, CPA, T₂ and CPA-T₂, respectively. A comparison of means revealed significant (p < 0.01) differences between the control and toxin-treated groups in body weights. The CPA group differed significantly (p < 0.01) from other treatment groups and control. No significant differences was observed between the T₂ and CPA-T₂ groups. There was a significant (p < 0.01) reduction in body-weight gain in toxin-treated groups as compared to the control. But, no significant differences was observed between the T₂ and CPA-T₂ groups in body-weight gain.

The body-weight gain showed reduction in all toxin treated birds from the first week onwards. The CPA group gained lesser weight throughout the experimental period. At the end of the trial, CPA group gained 56 per cent less weight than control and 26 per cent less than T₂ group. The relative body-weight gain of the CPA group stood at 39.95 per cent, which was 28.45 per cent less than that of T₂ group. This indicated that CPA was deleterious throughout the experimental trial. The reduction in weight-gain in broiler chicken due to experimental CPA-toxicosis has been reported from 12.5 ppm onwards (Dorner *et al.*, 1983; Dwyer *et al.*, 1997 and Balachandran and Parthasarathy, 1998).

The T₂-toxin treated birds showed significant (p < 0.01) reduction in body weights from second

Table 1. Mean (± SE) weekly body weights (g) of broilers fed with cyclopiazonic acid and T₂-toxin alone and in combinations (number of observations = 10)

CPA (ppm)	T ₂ (ppm)	Hatch weight (g)	Mean (± SE) body weight (g) after different weeks			
			1	2	3	4
0	0	47.54 ± 3.49	145.09 ^a ± 13.13	302.70 ^a ± 40.24	510.90 ^a ± 36.79	700.40 ^a ± 41.85
10	0	48.18 ± 3.42	84.50 ^b ± 15.95	139.00 ^b ± 22.74	204.50 ^b ± 45.19	309.00 ^b ± 68.01
0	1	47.90 ± 3.70	131.60 ^a ± 12.55	230.00 ^a ± 41.77	383.60 ^a ± 72.64	494.50 ^a ± 65.55
10	1	48.36 ± 3.17	126.72 ^{a1} ± 38.34	228.10 ^{a1} ± 27.57	405.40 ^{a1} ± 55.16	520.90 ^{a1} ± 47.75

Table 2. Mean (±SE) body weight gain (g) of broilers fed with cyclopiazonic acid and T₂-toxin singly and in combination (number of observations = 10)

CPA (ppm)	T ₂ (ppm)	Hatch weight (g)	Mean (± SE) body weight (g) after different weeks				Mean body weight gain (g)	Relative body weight gain (g)
			1	2	3	4		
0	0	47.54 ± 3.49	97.55 ^a ± 13.21	157.61 ^a ± 18.99	208.20 ^a ± 21.90	189.50 ^a ± 31.21	652.91 ^a	100.00
10	0	48.18 ± 3.42	36.32 ^b ± 18.19	54.50 ^b ± 15.51	65.50 ^b ± 19.98	104.50 ^b ± 21.23	260.82 ^b	39.95
0	1	47.90 ± 3.70	83.73 ^a ± 14.43	98.37 ^a ± 15.51	153.60 ^a ± 20.20	110.90 ^a ± 20.98	446.60 ^a	68.40
10	1	48.36 ± 3.17	78.36 ^a ± 14.20	101.46 ^a ± 16.28	177.20 ^a ± 25.31	115.40 ^a ± 28.19	472.54 ^a	72.37

The values with same superscripts (a, b and c) within a column did not differ significantly (p < 0.01)
¹ Represents significant (p < 0.01) cyclopiazonic acid and T₂-toxin interaction, CPA = Cyclopiazonic acid

week onwards at 1 ppm level. At the end of the trial, T₂ group gained 30 per cent less weight than control. The relative body-weight gain of the T₂ group did not differ significantly from the combined toxicity group. The reduction in weight-gain in broiler chicken due to experimental T₂-toxicosis has been reported from 4 ppm onwards (Wyatt *et al.*, 1972; Kubena *et al.*, 1989).

The CPA-T₂ group showed significant ($p < 0.01$) reduction in body weights from second week onwards as compared to the control and CPA groups, but did not differ significantly from the T₂-group. The birds of combined toxicity-group gained 26 per cent less weight than the control group and 4 per cent more weight than the T₂-group. This indicated a less than additive toxic effect of CPA and T₂ in combination in affecting the growth rate. These findings concurred with those of Kubena *et al.* (1994) who reported a less than additive toxicity in broiler chicken fed with 34 ppm CPA and 6 ppm T₂ for 3 weeks. Reduced weight gain induced by CPA, T₂ or their combinations could be attributed to the reduced feed consumption, as observed in this study, and inhibition of protein synthesis in CPA and T₂-toxicosis (Corrier, 1991). This was also indicated by hypoproteinaemia encountered in the toxin-fed groups. Also, a significant CPA-T₂ interaction was observed.

To conclude, the co-occurrence of CPA and T₂ adversely affects the health of broiler chicken as is evident from its effect on body-weight gain. However, further studies are required to arrive at their minimal individual and combined levels affecting the performance and health of broiler chicken.

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