the behavior of females when estrogens are systemically administered (Table II), i.e., no increase in adrenal weight occurs. Similar results with systemic administration of estradiol have been reported by Kitay(14). Apparently, the normal female is already responding maximally to the influence of estrogen on ACTH output and, consequently, cannot respond with a further increase.

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Aflatoxin Toxicity in Swine. (31719)

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Feeds contaminated with aflatoxins, metabolites of *Aspergillus* flavus, have been reported to be toxic to turkeys, ducklings and pheasants(1), young pigs(2), calves(3) and monkeys(4). Liver degeneration and fibrosis were the characteristic symptoms observed. High incidences of hepatic carcinomas have been reported in rats(5) and trout(6) fed aflatoxins. Carnaghan and Crawford(7) suggest aflatoxins may produce carcinomas in swine. They cite case histories of heavy mortality in pigs fed mixtures containing cottonseed and peanut meal. The lesions described were similar to those found in pigs fed toxic peanut meal by Loosemore and Harding(2); however, the pigs that survived the acute phase were found to have 100% incidence of hepatic carcinomas.

Aflatoxins are usually mixtures of 4 closely related compounds of known structure which have been named aflatoxins B_1, B_2, G_1 and G_2. Aflatoxin B_1 is the one usually found in greatest amounts and appears to be the most toxic(8).

Reported herein are the results of 2 feeding trials in which various levels of aflatoxin B_1 were fed to young pigs.

Methods and materials. In the first trial, 6 rations containing 15% peanut meal or soybean meal were fed to pigs 12-14 weeks old. The peanut meals contained 10, 50, 340, 700 or 1550 parts per billion (ppb) aflatoxin B_1 as determined by the chemical method described by Pons and Goldblatt(9). They also contained small amounts of aflatoxins B_2 and G_1. Only naturally occurring aflatoxins were present in the 4 lots of peanut meal containing 700 ppb or less of aflatoxin B_1. Each of these 4 lots of meal was thoroughly mixed in a ribbon mixer which was equipped with paddles on the center shaft to ensure homogeneity and uniform distribution of the aflatoxin. Capacity

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limitations of equipment necessitated batch-wise mixing of each lot of meal. Therefore, each bath was cross-blended and mixed until all the batches from a given lot had essentially the same aflatoxin content as determined by chemical assay(9). The meal containing 1550 ppb aflatoxin B_1 was prepared by spiking peanut meal with a special mold culture produced an a shredded wheat substrate.§ Shredded wheat substrate containing 970 γ/g of aflatoxin B_1 (approximately 750 g) was ball-milled with about 1 kg of the peanut meal containing 10 ppb of aflatoxin B_1. This aflatoxin-rich mixture was stepwise blended with about 20 kg of additional meal in 2 stages of tumble mixing. This was followed by one stage of mixing with more meal in a ribbon mixer. The resultant material was further mixed with additional meal and cross-blended until all the batches from this lot, totaling about 450 kg assayed between 1400 and 1700 ppb of aflatoxin B_1.

The composition of the basal ration, which contained soybean meal as a negative control, is shown in Table I. The rations contained 19-20% crude protein on a dry matter basis. There were 10 pigs (6 barrows and 4 gilts) per treatment except for the ration containing 700 ppb aflatoxin meal which was fed to 8 pigs (6 barrows and 2 gilts). The trial was conducted for 107 days.

In the second trial 5 rations were used. The basal ration was the same in trial 2 as in trial 1 except that 1333 IU of vit. A was added per kg of ration. The peanut meals contained 36, 3000, 4100 and 5400 ppb of aflatoxin B_1 and small amounts of aflatoxins B_2 and G_1. The meal containing 36 ppb of aflatoxin B, was produced by hammer milling a screwpressed peanut cake obtained from naturally infected peanuts. The meals containing 3000, 4100 and 54000 ppb of aflatoxin B_1 were formulated by spiking the meal containing 36 ppb of aflatoxin B_1 with about 24 kg of a rice substrate containing 526 γ/g of aflatoxin B_1.‖ This was hammermilled in 2 steps, with reblending following each hammermilling step to produce about 200 kg of a mixture assaying ca. 44,000 ppb of aflatoxin B_1. This aflatoxin-rich mixture was blended with additional 36 ppb meal and a hydraulic pressed peanut meal (prepared from pickouts at SRRL and assaying 3300 ppb of naturally occurring aflatoxin B_1) in predetermined ratios to produce the 3 meals containing 3000, 4100 and 5400 ppb of aflatoxin B_1 respectively, as determined by chemical assay (9). The 3 components were taken in such proportions that in all cases the rice substrate contributed 60% and the hydraulic pressed meal 40% of the total aflatoxin B_1 present. It was assumed that the third component, 36 ppb meal, contributed a negligible quantity of aflatoxin B_1.

TABLE I. Composition of Basal Ration.

Ingredient	%
Ground barley	75.0
Meal (soybean or peanut)	15.0
Meat and bone meal (50% protein)	4.0
Alfalfa meal	5.0
Salt	.5
Vitamin-mineral mixture*	.5

* Supplies 100 mg $ZnSO_4$ and 66 IU vitamin D /kg.

There were 10 pigs (6 barrows and 4 gilts) per treatment. The pigs were 13-14 weeks old and the trial was conducted for 117 days.

Results. The aflatoxin levels used in the first trial did not adversely affect rate of gain or feed conversion (Table II). However, it was found the alfalfa meal contained low levels of carotene and therefore the rations contained only 60% of the N.R.C.(11) requirement for carotene. Therefore, it is possible that an effect of aflatoxin was obscured because decreased growth rates may have been caused by the low level of carotene. Complete autopsies of all animals were performed and no gross or microscopic lesions attributed to treatment were found.

In trial 2 the ration containing 450 ppb aflatoxin B_1, which was higher than anly level in trial 1, did not cause a decreased rate of

§ The aflatoxin produced on shredded wheat was supplied by Miss Ruth Mayne, Southern Regional Research Lab., New Orleans, La., and duckling bioassays of the meals were conducted by M. S. Masri, Western Regional Research Lab., Albany, Calif.

‖ The aflatoxin was produced on a rice substrate at the Northern Regional Research Lab., Peoria, Ill., by O. L. Shotwell, C. W. Hesseltine, R. D. Stubblefield and W. G. Sorenson(10).

TABLE II. Effect of Aflatoxin on Rate of Gain and Feed Conversion.

Kind of meal	Aflatoxin content of ration B_1	B_2	G_1	Avg daily gain*	Gain/feed
	(ppb)			(kg)	
		Trial 1			
Soybean	ND†	ND	ND	.58	.24
Peanut	<2	ND	ND	.67	.24
"	<8	ND	ND	.69	.25
"	51	ND	ND	.65	.25
"	105	52	15	.62	.26
"	233	ND	70	.62	.24
		Trial 2			
Soybean	ND	ND	ND	.75[a]	.26
Peanut	<6	ND	ND	.71[ab]	.26
"	450	ND	30	.68[ab]	.27
"	615	105	45	.60[b]	.27
"	810	135	60	.47[c]	.23

* Values with unlike superscript letters are significantly different ($P < .05$).
† ND = none detected.

gain which indicates the results of the first trial were not confounded by the low level of carotene. When the ration contained 615 ppb aflatoxin B_1, rate of gain was significantly decreased; increasing the aflatoxin B_1 content to 810 ppb resulted in an additional decrease in rate of gain and appeared to decrease feed efficiency. One of the pigs fed the ration containing 810 ppb aflatoxin died and severe liver degeneration was observed. Complete autopsies of all animals were performed by the Pathology Departments of the School of Veterinary Medicine, University of California, Davis, and Western Regional Research Laboratory, and the results will be reported by those workers.

Discussion. Abrams(12) recommended that rations of pigs under 8 weeks of age should be free of aflatoxin and the rations of pigs older than 8 weeks contain no more than 150 ppb aflatoxin. British workers(13) reported that a ration containing 410 ppb aflatoxin decreased weight gains and feed conversion when pigs were in the growing stage (18-64 kg) but had no effect in the finishing stage (65-90 kg). However, in our studies, rations containing 450 ppb aflatoxin B_1, did not significantly affect weight gains or feed conversion when the pigs were at least 12 weeks old at the start of the trial. Therefore, Abram's recommendations appear to be on the conservative side for market pigs. Additional studies are now in progress to determine if continued feeding of 450 ppb aflatoxin affects reproduction or produces liver tumors in swine.

Summary. Two trials were conducted with 108 pigs, 12-14 weeks old, to study the effects of feeding various levels of aflatoxin. Under the conditions of tthese experiments, rations containing up to 450 ppb aflatoxin B_1 did not significantly affect weight gains or feed conversion of growing-finishing pigs. Rations containing 615 ppb aflatoxin B_1 slightly decreased weight gains, and rations containing 810 ppb aflatoxin B_1 greatly decreased weight gains and appeared to decrease feed conversion. One of the 10 pigs fed the 810 ppb aflatoxin ration died and severe liver degeneration was observed.

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