Research Bulletin No. 31 September, 1955

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IT HAS BEEN demonstrated that antibiotics contribute to the efficiency of feed utilization in the non-ruminant through two situations: Elimination of pathogenic or debilitating organisms and a sparing effect on water-soluble vitamins (10, 15, 17. 29, 37, 51).

REVIEW OF LITERATURE

Mechanism of Activities in the Digestive System.

Specific activities and functions of an antibiotic in the digestive system of the ruminant have not been completely established with clearly defined experimental procedures. Studies conducted on the various phases of the problem by different workers, each using a different procedure, have indicated that the performances of an antibiotic in the polygastric animal are somewhat similar to those in the monogastic. Hester *et al* (20) have demonstrated that an antibiotic moves rather rapidly through the stomach system to the intestines.

Chlortetracylcine (aureomycin) (54) appears to concentrate in the center portion of the small intestine regardless of whether it had been administered orally or intramuscularly. It was also found concentrated in the blood plasma, bile and urine of calves fed nutritional levels of the substance. Highest concentrations were found in the urine, with the lowest levels in the blood plasma (20). However, the feeding of an antibiotic to a lactating cow had no effect on the flora of milk (18). This would indicate that the center of activity of an antibiotic in the digestive system may be in the intestines of the ruminant. Chance *et al* (8) have shown that the level of intake of an antibiotic apparently determines the rate at which food passes through the stomach system. It has been observed that the rate of passage of dry matter, crude fiber, crude protein and nitrogen-free extract was greatest when 0.5 gram of chlortetracylcine was fed for a period of 15 days. When 1.0 gram was fed, there was an accumulation of dry matter, crude protein and nitrogen-free extract in the rumen (9).

Undoubtedly some changes occur in the stomach system of the ruminant receiving an antibiotic, since Bell *et al* (3) observed

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Lederle Laboratories Division, American Cyanamid Company, Pearl River, New York generously supplied the chlortetracylcine and Aurofac 2A (a commercial product containing 3.6 grams of chlortetracylcine per pound).

that a daily allowance of 0.2 gram of chlortetracylcine (aureomycin) in a fattening steer ration caused a marked reduction in the digestibility of dry matter, crude fiber and nitrogen-free extract. A daily allowance of 30 milligrams of chlortetracylcine per 100 pounds of body weight showed no differences in digestibility of dry matter, ash, protein, crude fiber, nitrogen-free extract or fat with calves under 8 weeks of age (48).

Chlortetracylcine fed at the rate of 0.5 gram per day or chlortetraclycine (0.5 gram per day) plus ethomid c/15 at the rate of 0.1 percent of dry matter had no effect upon the digestibility of dry matter, crude protein, ether extract or nitrogen-free extract (37). Chlortetracylcine apparently reduced the digestibility of the crude fiber (37). Eighteen wether lambs were used in a series of three digestion trials to study the effect of chlortetracylcine on the retention of nutrients (52). These studies showed there was no difference in nitrogen retention. The apparent digestibility of dry matter, nitrogen-free extract and energy was lower for the antibiotic supplemented rations.

A decrease in the amino acids and the riboflavin contents of the rumen 6 hours after the ingestion of 5 grams of chlortetracylcine by mature cows has been reported (8). A change in the rumen flora was observed by Luther *et al* (39) when oxytetracylcine (terramycin) was fed. The feeding of aurofac 2A showed no beneficial or deleterious effects on the normal functions of the lactating cow (2).

Chlortetracylcine was not detected in the rumen or caecum of ruminants and only small traces in the abomasum (43). Chlortetracylcine taken by mouth apparently does not act directly on rumen micro-organisms.

Antibiotic Growth Effect on Young Lambs and Calves.

As measured by rate of gain, beneficial effects of feeding an antibiotic to lambs and calves during the period previous to the complete development of the four divisions of the stomach have been reported (19, 27, 47). Investigators have obtained increased gains of suckling lambs fed chlortetracylcine over similar groups of lambs receiving the same feed treatment without the antibiotic. The antibiotic was administered by drench, implantation and in creep feed mixtures (19, 24, 25, 26, 27, 32, 33, 44, 50).

Data reported by different investigators on the feeding of chlortetracylcine to calves during the period from birth to 200 days of age are inconsistent. Supplementation by capsule, in milk, in reconstituted milk and in the dry ration at the rate of 70 to 150 milligrams daily or 0.5 to 10 grams per 100 pounds of milk gave conflicting results (1, 4, 21, 22, 23, 34, 35, 36, 40, 43, 45, 46, 48, 49). No unusual harmful effects were reported when chlortetracylcine supplementation was practiced.

Oxytetracylcine (terramycin) fed at the rate of 20 to 30 milligrams per 100 pounds of liveweight and 24 grams per ton of feed increased gains of calves during the period between birth and 19 weeks of age (6, 7, 16, 31, 41, 42, 53). Penicillin fed at the rate of 0.5 gram per each 100 pounds feed failed to increase the gains of lambs over those fed the same ration without the antibiotic (34). The addition of a source of cobalamin to a ration containing an antibiotic did not increase the growth of young calves (42, 46, 48, 53).

Antibiotic Effect on Fattening Lambs.

Increased gains have been reported on fattening lambs fed rations containing from 5 to 10 milligrams of chlortetracylcine per pound of feed over lambs fed the same type of ration without the antibiotic (5, 6, 19, 25, 26, 28). Fattening lambs given 100 milligram capsules of chlortetracylcine gained less than the controls (11). Fattening lambs fed 100 milligrams of penicillin developed a diarrhea and made less gains than a similar group of lambs fed the same ration without the antibiotic (11, 12).

Antibiotic Effect on Fattening Steers.

Greater gains were reported on yearling steers fed chlortetracylcine at the rate of 63.5 to 190.5 milligrams daily over those fed the same ration without the antibiotic (46). However, it was observed that the water intake of the antibiotic-fed group was erratic. The addition of cyanocobalamin (vitamin B-12) to the ration with or without an antibiotic did not prove to be beneficial for fattening steers (4, 38).

Summary of the Literature Review

A brief resume of the results obtained indicates, first, that antibiotics may be beneficial to the young calf or lamb during the period previous to the complete development of the rumen, reticulum, omasum, and abomasum; second, that the feeding of an antibiotic tends to depress the digestibility of a feed, especially the crude fiber and protein; third, that the beneficial effect of an antibiotic takes place in the small intestine and not in the stomach; and, fourth, that there is limited available experimental information on the differences in the rates and economies of gains for lambs fed various rations with different ratios of grain to roughage with and without an antibiotic.

OBJECTIVES

The experiments reported herein (Tests 1 and 2) were designed to study the effects of feed chlortetracylcine (pure crystalline aureomycin HCl) and Aurofac 2A (a source of chlortetracylcine) on roughage utilization of growing lambs.

EXPERIMENTAL PROCEDURE

Sixty purebred ewe lambs of Suffolk, Hampshire, Rambouillet and Columbia breeding were selected for each test from the Experimental Station flock at the time of weaning off pasture. These lambs were divided on the basis of weight and breed into 6 groups of 10 each. Two groups of 10 lambs were fed each of the following roughage levels: 2 : 3, 1 : 1, or 3 : 2 parts of grain and alfalfa hay as outlined in Table 1. One group of ten lambs fed each ratio of grain to alfalfa hay received 10 milligrams of chlortetracylcine per pound of total feed. The grain mixture was composed of equal parts of ground barley and ground oats with 2 percent sodium chloride. The grain was pelleted to assure uniform distribution of the antibiotic[1]. All the antibiotic of each ration was fed in the grain pellet. Each lamb was fed twice daily all the total allotted ration she would consume in an individual stall.

Table 1—Plan of studies.

Ration of G:H*	Number Lambs	Antibiotic per lb. feed	Number lambs
		mg.	
2:3	20	10	10
		None	10
1:1	20	10	10
		None	10
3:2	20	10	10
		None	10

*Grain to hay ratio.

RESULTS

Test 1

Sixty purebred ewe lambs ranging in age and weight from 141 to 171 days and 62 to 114 pounds were selected for this test. Pure crystalline chlortetracylcine was fed at the rate of 10 mg. per pound of total feed (Table 2).

Table 2—Gains and feed requirements of lambs fed 3 ratios of concentrate to hay with and without chlortetracylcine (August 3 to September 21, 1953).

Lot No.	Number lambs	Antibiotic per lb. feed	Average Ratio of G:H**	Average Initial weight	Average Age days	Average Daily ration	Average Daily gain	Feed for 100 lb. gain
		mg.		lb.		lb.	lb.	lb.
1	10	10	2:3	91	166	2.30	.17	1359
4	10	None	2:3	88	164	2.63	.28	955
2	10-7*	10	1:1	89	159	1.94	.15	1301
5	10	None	1:1	89	164	2.76	.32	857
3	10-8*	10	3:2	91	163	1.91	.16	1173
6	10	None	3:2	87	168	2.33	.25	934

*The data of three lambs fed rations containing 1 part grain and 1 part alfalfa hay plus the antibiotic and two lambs fed the ration containing 3 parts grain and 2 parts alfalfa hay plus the antibiotic were not used in the summary because the failure to gain was believed to be due to factors other than those involved in the study. The experiment was concluded at the end of 49 days because those lambs fed the antibiotic had ceased to gain weight.

**Grain to hay ratio.

[1]Grain mixtures were mixed and pelleted with ½-inch die in a California Master pellet mill.

The lambs fed the pure crystalline chlortetracylcine consumed from 12 to 300 percent less total feed, made 36 to 53 percent less average gain, and required from 20 to 34 percent more feed per unit of gain. There was no relationship of gain and efficiency of feed utilization with the percentage of roughage intake as was observed by Elliot and co-workers (14).

Test II.

Sixty purebred ewe lambs ranging in age and weight from 130 to 162 days and 68 to 100 pounds were selected for Test II. The plan of the study was the same as Test I, however, Aurofac 2A containing 3.6 gm. of chlortetracylcine per pound was fed as the source of the antibiotic. Each supplemented lamb was allotted 10 mg. of chlortetracylcine per pound of total feed. These lambs were fed a period of 63 days. A summary of average weights, gains and feed requirements is shown in Table 3.

Table 3.—Gains and feed requirements of lambs fed 3 ratios of concentrate to hay with and without Aurofac 2A (July 20 to September 21, 1954).

Lot No.	Number lambs	Antibiotic per lb. feed	Ratio of G:H**	Average Initial weight	Average Age days	Daily ration	Daily gain	Feed for 100 lb. gain
		mg.		lb.		lb.	lb.	lb.
1	10-9*	10	2:3	79	153	2.92	.35	867
4	10	None	2:3	79	148	2.88	.35	837
2	10	10	1:1	83	157	2.95	.35	832
5	10	None	1:1	81	152	2.76	.38	722
3	10	10	3:2	83	152	2.56	.30	841
6	10-9*	None	3:2	80	152	2.28	.29	821

*The data on lamb No. 8 of Lot 1 and lamb No. 3 in Lot 6 were not included in the summary since both failed to gain because of pathological conditions unrelated to the treatments used in the experiment.

**Grain to alfalfa hay ratio.

The addition of Aurofac 2A as a source of chlortetracylcine to a ration composed of alfalfa hay, and a grain mixture of barley and oats, did not increase or decrease the rate of economy of gains with any of the three levels of roughage intakes.

SUMMARY

The data and results of the effect of feeding chlortetracylcine and Aurofac 2A (3.6 mg. of chlortetracylcine per lb.) to growing and fattening lambs reared on pasture previous to the experimental feeding are reported.

When pure chlortetracylcine was fed at the rate of 10 mg. per lb. of feed, the rate of gain of fattening lambs previously run on pasture was lowered and the feed requirements per unit of gain were increased.

No significant differences in rate of gain and feed economy were observed among growing and fattening lambs receiving a ration containing Aurofac 2A as the source of chlortetracylcine which had been reared on pasture previous to the experimental feeding.

It is noted that the ratios of grain to roughage used in this study did not contribute to an increase in rate and economy of gains of the lambs when there was an increase in the ratios of grain to alfalfa hay, as had been observed in previous studies (13, 30). The reason for the rate and economy of gains of the lambs fed the 3:2 ratio of grain to alfalfa hay being lower than the gains of lambs fed the ratios of 1:1 and 2:3 in this study is believed to be due to the fact that the grain pellets used were too large and too firm for convenient eating. These lambs receiving the 3:2 ratio of grain to alfalfa hay had greater quantities of their ration in the form of pellets. Since it was observed that the lambs were having difficulty in crushing these pellets during mastication, it seems logical to assume that the outcome of the results of the tests were affected by the firmness and size of pellet. However, it was concluded that the abnormal physical condition of the ration had no effect on the outcome of the measure of the value of the antibiotic.

It is also noted that the results of this study indicate that the feeding of 10 mg. of pure chlortetracylcine per pound of feed to lambs showed a different rate and economy of gain than was observed among those lambs fed the same quantity of chlortetracylcine in the form of Aurofac 2A. It appears, therefore, that it cannot be assumed that chlortetracylcine is the only factor responsible for the results obtained when Aurofac 2A was fed to the lambs or perhaps that the quantity of chlortetracylcine fed in the Aurofac 2A was not the same as that fed in the pure form.

Apparently chlortetracylcine did not contribute to the well-being of the lambs used and reared under the environmental conditions of the area of the Idaho Agricultural Experiment Station flocks of the years 1953 and 1954.

The results obtained in the study of the effect of chlortetracylcine on rate of gain in lambs support the findings of workers studying the effect of an antibiotic on the digestion of organic nutrients (3, 9, 20). Since it has been observed that an antibiotic reduces the coefficient of digestibility of dry matter, crude fiber and nitrogen-free extract, it would not be logical to assume that chlortetracylcine would increase the rate of gains of lambs fed a high roughage ration.

CONCLUSIONS

1. Lambs fed chlortetracylcine (pure aureomycin HCl) consumed 12 to 30 percent less total feed, made 36 to 53 percent less average daily gain and required from 20 to 34 percent more feed per unit of gain than those receiving the same ration without the antibiotic.

2. Lambs fed the chlortetracylcine in Aurofac 2A made approx-

imately the same gains as those fed the same ration without the Aurofac 2A. Little difference was observed in feed required per unit of gain among any of the comparisons.

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