THE EFFECT OF AUREOMYCIN UPON THE GROWTH OF DAIRY CALVES WHEN ADMINISTERED ORALLY, SUBCUTANEOUSLY, AND INTRAMUSCULARLY

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INTRODUCTION

One of the major problems of the dairy industry today is that of raising sound and healthy herd replacements. It is generally conceded that there is approximately a 25 per cent turnover annually in dairy herds. Experienced dairymen prefer to raise their own replacements, since this has been proven to be the most profitable procedure in the long-run for obtaining the strong, healthy type of animal desired. The raising of calves is a complex problem which requires good sanitary feeding and management practices by the dairyman.

The most critical period in the life of the dairy calf is probably the first four to eight weeks of life. It is during this period that the calf is very susceptible to diarrhea, pneumonia, and various other disorders.

A study by Herman (25) illustrates the importance of good management of the young calf. In this work it was reported that a very high percentage of calves died after birth unless they received colostrum. A long-time study by Wing (66) revealed that of 644 calves born, 10.5% died under three months of age. A ten year average of the calf losses in the Cornell University dairy herd showed that 11% of the calves born in good condition soon died (53). Data from the Nebraska University dairy herd revealed that 14.7% of the calves died of disease during the first 2 years of life (17). It has been reported that there is a slightly higher mortality rate in female calves than in males (44). These studies illustrate the seriousness of calf losses on American dairy farms and emphasizes the desirability of developing calf raising methods which will produce stronger, more viable dairy calves.

Various antibiotics have been supplemented to calf rations in an attempt to produce an increased immunity and help the calf survive through the critical stages of early life. Such antibiotics as terramycin and

aureomycin have been shown to have a favorable effect upon dairy calves. As far as calf nutrition is concerned, aureomycin is the antibiotic under most intensive investigation by research workers at the present time.

This antibiotic has been shown to reduce the severity and incidence of scours as well as to stimulate the growth rate of young calves. The definite mode of action of aureomycin in producing a favorable effect upon growth is not known. While it has been shown that oral administration of aureomycin is effective in reducing scours and stimulating growth, there is a question as to whether or not aureomycin might result in the same effect when given parenterally.

The purpose of this trial was to study the effects of different levels of aureomycin when administered orally, subcutaneously and intramuscularly.

REVIEW OF LITERATURE

The antibiotic aureomycin was first described by Duggar (19) in 1948. It is derived from a species of the actinomycetes, which is designated Streptomyces aureofaciens and is an organism of the soil. The value of aureomycin as a chemotherapeutic agent in human medicine and as a growth stimulator in animal production has been investigated intensively during the past few years.

Many research workers (2, 9, 26, 33, 34, 37, 39, 49, 50) have shown that small amounts of aureomycin is effective in stimulating the growth rate of dairy calves.

The Effect of Aureomycin Upon Dairy Calves

McGilliard et al. (37) observed that daily bodyweight gains were twice as great during the first five weeks of life for calves receiving 70 mg. of aureomycin daily as compared to calves receiving no antibiotic. Loosli (34) reported that calves receiving aureomycin gained 22% more rapidly during the first eight weeks of life than calves which were not fed the antibiotic. The calves receiving aureomycin also required approximately 9% less feed to make a unit of gain and exhibited a reduced incidence and severity of scours. Rusoff (49) found that aureomycin stimulated the growth of 14 week old dairy calves by approximately 36% over the control animals for the first 6 weeks on trial. After 8 weeks the growth rate of the aureomycin fed calves decreased to 8% over controls and declined gradually until at the end of the 20 week experiment there was no difference in the total growth of calves receiving aureomycin and controls.

Murdock et al. (39) observed an increased gain in calves receiving aureomycin the first six weeks of life over calves not fed the antibiotic.

By the end of 12 weeks there was no significant difference in weight gains between the two groups. These investigators reported no difference in the incidence of scouring.

Morrison and Deal (38) obtained results that are not entirely in agreement with other studies. They observed no difference in weight gain, feed consumption, incidence of scours and general health in calves fed aureomycin at the rate of 1% of the dry matter content of the milk for two weeks. The fact that small gains are made by calves the first two weeks, and that scours were not a problem in the experiment were offered as a possible explanation for these results.

Bloom and Knodt (10) observed no great differences in the rate of bodyweight gains, in the consumption or utilization of feed by dairy calves when levels of aureomycin ranging from 20 to 154 mg. were added daily to milk replacement formulas and to calf starters.

Rusoff and Davis (48) reported that the growth of Jersey and Holstein calves through 16 weeks was increased approximately 20% over the controls by the feeding of aureomycin. The pure aureomycin prevented the onset of scours. Microscopic examination of the rumen contents failed to reveal any effect of aureomycin upon the flora of the rumen.

Bartley et al. (3) obtained an increase in the growth rate of calves when aurofac (containing 5 mg. of aureomycin per gram) was fed to the calves at the rate of 3 grams per 100 lb. bodyweight up to 12 weeks. These workers reported a lower incidence of scours and a better physical condition in the calves receiving the aurofac.

Voelker and Cason (60) reported more rapid gains in calves on pasture receiving an aureomycin -B_{12} supplement than control animals. No harmful effects were observed from the feeding of 250 mg. of pure aureomycin daily plus 2.5% aurofac in the grain. Bacteriological studies of the

colon material failed to show any consistent differences in the population of bacteria due to antibiotic feeding.

Murley and associates (40) observed beneficial results in growth and efficiency of feed utilization by supplementing 80 mg. of crystalline aureomycin daily per head to young calves on various practical and restricted diets.

Clawson et al. (14) obtained greater gains in calves fed 80 mg. aureomycin HCl the first ten weeks of life than in calves not receiving the antibiotic.

Hibbs and Conrad (26) found that feeding calves aureomycin up to 12 weeks resulted in greater weight gains, higher feed intake and more efficient utilization of feed. The calves receiving aureomycin maintained a higher blood sugar level than the controls from the eighth to the twelveth week.

Loosli and Wallace (32) obtained a significant increase in the growth rate of calves fed milk substitutes by the addition to the ration of either crystalline aureomycin HCl or an A P F supplement containing aureomycin. Both the A P F and crystalline aureomycin were effective in reducing the severity and incidence of scours during the 8 week trial. It appeared that the antibiotic was responsible for the beneficial effects obtained since the aureomycin alone gave essentially the same results as the A P F supplement. Bloom and Knodt (9) also obtained beneficial results from feeding an aureomycin -B_{12} supplement in the milk replacement formulas of dairy calves. These workers noted that the greatest increase in growth rate occurred during the first four weeks of life. They observed that pure B_{12} alone did not stimulate growth. MacKay et al. (35) observed an increased growth in calves receiving a supplement containing aureomycin and vitamin B_{12}.

Rusoff and Haq (50) found that a vitamin B_{12} supplement (Merk's A P F No. 3) had no apparent effect upon the growth rate of dairy calves weaned from milk at four weeks. The A P F apparently contained little or no aureomycin. Williams and Knodt (64) observed no effect upon the growth rate of dairy calves fed an A P F supplement containing only slight amounts of aureomycin.

A trial was conducted by Rusoff et al. (51) to observe whether the type of protein in an all vegetable protein calf starter would influence the effect of aureomycin on young calves. The animals fed a soybean-oil-meal-protein starter plus aureomycin showed greater average daily gains than calves receiving a cottonseed meal protein with aureomycin. The calves on each of the plant proteins showed a 10-20% increase in average daily gains when aureomycin was added to the ration.

Jacobson et al. (30) fed aureomycin to four-month old calves, some of which had received 80 mg. of aureomycin HCl from four days of age, and others which had not received aureomycin. These calves were fed 80 mg. aureomycin (aurofac A) in their concentrate mixture daily for 12 weeks. The aureomycin supplemented calves exhibited significantly greater growth rates than the controls. Although previous treatment had less effect than experimental treatment on changes in weight and various body measurements, the mean values in all instances were greater for calves not previously supplemented with aureomycin.

In a previous study by Jacobson (29) it had been demonstrated that the feeding of aureomycin and of an aureomycin supplement to calves up to 200 days of age resulted in increased growth by approximately 30% above the Ragsdale Standard. The weights of the control calves at 200 days were about equal to Ragsdale Standards.

Finchman and Voelker (22) fed aureomycin to dairy heifers daily for

periods ranging up to approximately two and one-half years. They observed that the maximum growth stimulation from aureomycin feeding occurred during the period from birth to six months. Three lactating heifers which had received aureomycin continually from four days of age showed no abnormalaties nor advantages attributable to antibiotic feeding.

Bartley et al. (5) conducted studies in which the results indicated that the addition of a 1% level of Lederle's Aurofac 2 A in the grain ration of heifers from seven to sixteen months of age had no stimulatory effect upon growth.

In some instances it has been shown that a decrease in growth rate occurs following the removal of aureomycin from the ration of calves. Jacobson et al. (29) reported a slight decrease in growth rate following removal of aureomycin from the ration of dairy calves, but the decrease was not considered significant. Bartley and associates (3) also observed a decrease in growth rate in dairy calves when aureomycin supplement was removed from the ration. These calves maintained their previous growth rate for one week after the antibiotic had been removed from the diet, indicating a carryover effect.

McGilliard et al. (37) at the Oklahoma A & M Experiment Station found a slight decrease in growth rate following removal of aureomycin from the ration of calves at five weeks. This decrease in growth rate may have been due to some physiological disturbance or a readjustment of the microflora in the rumen to a different environment caused by the removal of aureomycin from the ration. These workers discovered that the decrease in growth rate was delayed by inoculating the calves with rumen material from mature animals.

The administration of other antibiotics has resulted in growth responses similar to that observed with aureomycin. Loosli (33) found

that an antibiotic supplement (Lederle) added to milk replacement formulas at the rate of 2% or fed in whole milk increased the average daily gain of dairy calves. The control animals exhibited a greater incidence and severity of scours and required more TDN per pound of gain than the calves receiving antibiotics.

Research workers (60, 36, 61) have obtained a growth stimulation in calves with the supplementation of terramycin to the ration. MacKay et al. (36) found that this antibiotic exhibited its greatest growth stimulus during the first two weeks of life. After eight weeks of feeding terramycin there was little difference observed in the rate of gain between supplemental calves and controls.

The Effect of Aureomycin on Other Domestic Animals

Research workers (34, 4, 24) have demonstrated that lactating cows were not affected by levels of 130 to 700 mg. aureomycin daily. Loosli (34) reported that the addition of 1000 mg. of aureomycin to the grain ration of cows resulted in complete refusal of the feed. It appeared that this amount of antibiotic rendered the feed decidely unpalatable.

Neuman et al. (41) found no beneficial results from feeding low levels of aureomycin to yearling beef heifers. A reduction in appetite was noted for a few days after the feeding of aureomycin was begun, but no unfavorable physiological disturbances were observed. Bacteriological data revealed that the normal rumen microflora had been disturbed.

Bell and associates (8) found that 200 mg. of aureomycin in the ration of steers caused a reduction in digestibility of dry matter and nitrogen free extract. Levels of 600 mg. produced a marked anorexia and diarrhea. These workers suggested that the antibiotic had a detrimental effect upon the cellulolytic microorgansims of the rumen.

Colby et al. (15) found that lambs went entirely off feed and lost 0.16 lb. bodyweight per day when fed 100 mg. of aureomycin daily.

Chance and associates (12) studied the influence of aureomycin on rumen digestion and the rate of passage of certain nutrients from the rumen. In a trial with two rumen fistulated steers the data indicated that aureomycin stimulated bacterial action in the rumen and may have caused a change in the permeability of the rumen wall which would facilitate faster absorption in that area. The number of bacteria in the rumen increased when 500 mg. of aureomycin was added to the ration. The total bacteria count was the same when 500 or 1000 mg. were fed, but since there was a decrease in the removal of nutrients from the rumen when 1000 mg. were fed, it is possible that this level may have inhibited some of the cellulose digesting bacteria without affecting the total count. These research workers (13) also found a smaller concentration of the ten essential amino acids in the rumen six hours after feeding 500 mg. of aureomycin. The data suggest that ingestion of 500 mg. of aureomycin accelerated the removal of amino acids from the rumen. The amount of riboflavin in the rumen was also found to be lower on the aureomycin ration. Data indicated that the antibiotic caused a reduction in the synthesis of nicotinic acid in the rumen.

This broad spectrum antibiotic has also been shown to have a stimulatory effect upon the growth rate of animals other than calves. An increased growth rate was obtained in chickens by the use of aureomycin and aureomycin supplements (45, 21). Research workers (27, 59) have stimulated growth in rats and mice by the use of this antibiotic.

Purdue workers (7, 43) have indicated that aureomycin stimulates the growth rate of growing and fattening swine. Gilts fed aureomycin farrowed more and heavier pigs than gilts not receiving the antibiotic (58).

Wallace et al. (62) studied the effects of reducing the level of aureomycin and its complete removal from the ration of fattening pigs. They concluded that the antibiotic supplement should not be discontinued during the growing-fattening period of pigs if optimum gains are to be obtained.

Wilson and associates (65) found that the percent lean cuts in hog carcasses was increased when aureomycin was added to low and medium protein diets. This increase was not observed when aureomycin was added to an 18% protein ration.

Noland et al. (42) produced an increased gain in weight by 11.3% in young pigs over the controls by the subcutaneous implantation of bacitracin pellets.

Becker (6) obtained a significant increase in rate of gain in pigs by the supplementation of aureomycin, neomycin, procaine penicillin and chloramphenicol.

Research workers (20, 1, 47) found also that penicillin and terramycin produced an increase in the growth rate of chickens.

Theories Relative to the Mode of Action of Aureomycin

The definite mode of action of aureomycin in stimulating growth is not known. Many theories have been offered as an explanation but as yet none have been proven.

Many workers (16, 23, 27, 28, 32, 55, 59) have indicated that aureomycin may produce its beneficial effect upon animals by some action upon the intestinal microflora.

Schoenbach et al. (54) have shown with in vitro studies that aureomycin possesses bacteriostatic and bactericidal activity against various gram positive and gram negative bacteria. In treatment of an infection

in man, Friedberg (23) found aureomycin to have only a bacteriostatic effect upon Streptococcus fecalis. The antibiotic merely inhibited these organisms when aureomycin was present at high levels and the organisms regained their activity when the antibiotic concentration decreased.

Sieburth and co-workers (55) found that antibiotics inhibit the Clostridium perfringens organism which has been shown to produce enterotoxemia in sheep. These workers suggested that antibiotics may promote growth by the prevention of enterotoxemia.

Elam et al. (21) also demonstrated that antibiotics decreased the number of clostridia organisms in the chick and subsequently increased growth. Previous work (Reyniers, Luckey and Gordon) had shown that antibiotics did not increase growth of birds under germ free conditions, but antibiotics did increase growth of chicks maintained under ordinary laboratory conditions.

Vijayaraghavan and associates (59) found that aureomycin had no effect upon the growth rate of mice fed rations in which casein was the sole source of protein. An increase in growth rate was observed when aureomycin was fed to mice receiving cottonseed meal and soybean meal as the sole dietary source of protein. These workers concluded that since a positive response of growth rate was obtained with plant proteins it appeared possible that antibiotics may promote development of the microflora which enhance availability of the intestinal synthesis of critical amino acids. While this may be true, it has been shown that aureomycin stimulates the growth rate of young calves on milk diets in which the major protein consumed is not of plant origin.

Rusoff (51) conducted a study of the intestinal microflora of young dairy calves receiving aureomycin. He concluded that the mode of action of antibiotics in stimulating calf growth apparently is not due to

selective bacterial inhibition of common bacterial groups of the intestines. This conculsion may be partially substantiated by the work of Stokstad and Jukes (56) in which they found that aureomycin still displayed growth-promoting activity after a sufficient treatment with alkali to destroy the antibacterial action against Staphylococcus aureus.

The Effects of Antibiotics Administered Parenterally

Although the mode of action of aureomycin in stimulating growth is not known, it has been shown that oral administration is effective in increasing growth rate. There is a question as to whether or not aureomycin would have the same effect if administered parenterally.

There has been a limited amount of work conducted in which antibiotics were administered parenterally. Only one study is available with dairy calves, although several studies have been conducted with pigs and chickens.

Results of contemporary investigations by Rusoff and associates (52) showed that weekly intramuscular injections of 400 mg. of aureomycin were effective in increasing the bodyweight gains of young dairy calves. These animals also showed greater gains over the controls than did calves receiving 50 mg. daily of aureomycin by oral administration.

Noland et al. (42) studied the effects of bacitracin when implanted subcutaneously in pellet form at the base of the ear in two to five day old pigs. At the end of 56 days the implanted pigs had gained 11.3% more than the controls.

Terrill and co-workers (57) concluded that the subcutaneous implantation of either bacitracin, penicillin or aureomycin pellets was not effective in increasing either the weaning weights of pigs or survival to weaning age.

Elam and co-workers (20) observed an increase in growth and a decrease

in mortality of chickens when penicillin was injected intravenously.

Becker et al. (6) found that intramuscular injections of procaine penicillin G produced a statistically significant increase in rate of gain in pigs.

Studies are limited as to the effect of aureomycin upon dairy calves when given parenterally. There has been observations made on humans, pigs and laboratory animals receiving aureomycin by parenteral administration.

Schoenbach and co-workers (54) observed that aureomycin injected intramuscularly into patients caused an acute pain lasting several minutes followed by a dull drawing pain which persisted for about one-half hour. These workers discovered a high urinary concentration of aureomycin after intramuscular injections, but difficulty was encountered in determining serum levels.

Dowling et al. (18) also reported a stinging sensation in patients injected intramuscularly with aureomycin. These workers found evidence by studying blood serum levels of aureomycin which indicated that 100 mg. of the antibiotic injected intramuscularly resulted in almost as high blood levels at the end of 3 hours as 700 mg. given orally. Welch (63) noted that aureomycin was absorbed rapidly from the gastro-intestinal tract and produced peak serum concentrations in approximately four hours.

Bryer and associates (11) found significant blood serum levels of aureomycin in rabbits fifteen minutes to one hour following intramuscular injection of 20 mg. per kilogram of bodyweight. No significant serum concentration could be detected later than one hour after injection. No antibiotic could be detected in the spinal fluid after the parenteral administration.

Robinson's (46) studies with man show that aureomycin, while generally

well tolerated, may produce certain adverse effects. Gastro-intestinal disturbances including nausea, vomiting, loose stools, and diarrhea, appear to be the most common side effects.

Larson and Carpenter (31) studied the concentration of aureomycin in the feces of pigs after oral and parenteral administration. The antibiotic was found in the feces 24 hours after injection and reached a peak within 72 hours. When aureomycin was given orally the maximum level in the feces was observed in 48 hours. These workers suggested that the injected aureomycin reached the intestinal tract by way of the bile.

Cole (16) has shown that aureomycin is readily excreted into the gastro-intestinal tract after intravenous administration. The gastric contents were found to contain low amounts of aureomycin one hour after administration and these concentrations seemed to be too high to be accounted for on the basis of contamination with swallowed saliva. The duodenum contents were relatively high in concentrations of the antibiotic. The bile appeared to provide the most concentrated source of aureomycin for excretion into the intestinal tract when it was given intravenously.

The above study is supported by Zaslow (67, 68) who found levels of 40-80 mcg. per ml. of aureomycin in the bile three hours after a single intravenous dose of 250 mg. These workers state that there is no doubt that intravenous doses as small as 25 mg. will give levels of aureomycin in the bile high enough to be effective against susceptible organisms.

EXPERIMENTAL

Various trials including a previous study at the Oklahoma A. & M. Experiment Station have shown an increase in growth rate of dairy calves given aureomycin by daily oral administration. This trial was designed to study further the effects of different levels of oral administration as well as subcutaneous implantations and intramuscular injections.

Male and female Guernsey, Ayrshire, and Holstein calves from the Oklahoma A. & M. College dairy herd were used in this study. All calves were removed from their dams 48 hours after birth and placed in individual tie-stalls for the duration of the trial. The stalls were bedded with sawdust and were cleaned daily. Each stall was equipped with a self-feeding hayrack, a grain bucket, and a water bucket. Fresh water was kept before the calves at all times.

The temperature of the section of the college dairy barn in which the calves were housed was thermostatically controlled. The temperature was maintained at approximately 65°F. during the fall and winter when experiment I was in progress. Experiment II was conducted during the spring and summer and the temperature of the barn during this period ranged from 80 to 85°F.

The calves were allotted to one of five groups in which the initial bodyweight and number of calves of each breed was kept as nearly constant as possible. All calves were fed a ration which consisted of one pound of Holstein herd milk per 12.5 lb. bodyweight daily fed by nipple pail and good quality prairie hay and a 16% protein calf starter offered *ad libitum*.

In the first of two experiments, five groups of calves were treated as follows: Group A served as untreated controls; calves in group B were administered *per os* a single capsule of 250 mg. crystalline

aureomycin HCl per week. This group was included in the experiment so that the effects of a weekly oral dose of the antibiotic might be studied; 250 mg. was arbitrarily chosen as the level for this trial.

Since previous work at the Arkansas Station had shown beneficial results from the subcutaneous implantation of bacitracin, it appeared desirable to subject a group of calves to a similar treatment with aureomycin. These animals were designated as group C and were implanted subcutaneously at the base of the ear with 60 mg. aureomycin hydrochloride pellets weekly. The pellets were approximately 0.4 of a cm. in length and 0.25 of a cm. in diameter. Each pellet contained 20 mg. of aureomycin. The pellets were implanted just under the calf's skin with a stilbesterol implant gun. Sixty mg. appeared to be the most reasonable dosage for a single implantation under the conditions of our study. Sixty mg. administered weekly by implant as compared to 250 mg. given orally is a 1:4 ratio of parenteral to oral administration. Results of studies with humans indicated that this dosage ratio should result in comparable blood levels.

Calves in group D were given a capsule containing 70 mg. of crystalline aureomycin HCl by oral administration daily and were used as a reference group in order to have a comparison between the present study and previous work.

In group E the calves were injected intramuscularly with 60 mg. aureomycin weekly for comparison with the implanted group. The injectable antibiotic consisted of an aureomycin-AlCl complex, dispersed in sesame oil.

Each group in experiment I consisted of 4 Guernseys, 2 Ayrshires, and 1 Holstein. There were 4 female and 3 male calves in groups A, B, and E; group C, 6 females and 1 male; group D, 4 males and 3 females.

Although the initial weights were kept as nearly constant as possible, some deviations occurred. Group E had the highest initial weight of 77.3 lb.; group B had the lowest beginning weight of 73.0 lb.; group C was second high with 76.6 lb.; group D was third high with 74.1 lb.; followed by group A with 73.4 lb.

The study was continued in a second experiment in which the levels of administration were altered. Groups A and D were continued as in experiment I to serve as control and reference groups, respectively. Group F was added to study the effect of a higher level of 500 mg. aureomycin weekly in a single oral administration. By studying the results of groups D and F, a comparison could be made between a single weekly administration of 500 mg. and 490 mg. given in 7 daily doses.

In order to determine whether or not calves would respond to even lower amounts of aureomycin, another group, H, was added in which calves received 125 mg. weekly in a single oral dose. Group G was added to study a higher level of intramuscular injection. The calves in this group were injected once a week with 250 mg. of aureomycin (aureomycin in sesame oil as AlCl complex).

The calves in group A consisted of 2 male Guernseys, 1 female Guernsey and 1 female Holstein. Group D had 2 male Guernseys, 2 male Ayrshires; group F, 2 female Guernseys, 1 male Guernsey, and 1 female Holstein; group G, 2 male Guernseys, 1 female Guernsey, and 1 female Ayrshire; group H, 2 male Guernseys and 2 female Ayrshires. The initial weights varied from 79.7 lb. in group F to 71.7 lb. in group G. The average initial weights for the other groups were as follows: group D, 76.7 lb.; group A, 77.5 lb.; group H, 74.4 lb.

The duration of each experiment was four weeks. This appeared to be the most optimum length for the trial since previous work has shown

that the major response from aureomycin occurs during the first few weeks of life. The length of the experiment also afforded an opportunity for a maximum number of calves to be included in the study.

The effects of the treatments in both four week experiments were measured by records of feed consumption and gain in bodyweight, change in height at withers and change in chest circumference. The total increase in growth from the initial day of the experiment until the termination of the trial at four weeks was used as the main criteria for determining the effects of the treatments. The calves were weighed and measured weekly to determine whether or not growth rate was affected at any specific interval between the initial and terminal days of the study.

The health and well-being of each animal was observed daily for the duration of the trial. In this study any looseness of the feces was considered as scours. The first treatment administered after the initial observation of scours was to cut the calf's daily allowance of milk in half. If improvement was not noted in 24 hours following the reduction of milk intake, 500 mg. of aureomycin was given by capsule. After sufficient recovery, the milk intake was gradually increased back to the original allowance before scouring occurred.

RESULTS

The effects of oral and parenteral administration of aureomycin upon the growth and feed consumption of the calves in experiment I are summarized in Table I. The data relative to the individual calves by groups are presented in Appendix Tables 1 through 5. The control calves in group A gained an average of 11.4 pounds from birth to four weeks of age, which is an average daily gain of 0.40 pounds. The calves in group D receiving 70 mg. of aureomycin in a daily oral administration gained an average of 15 pounds during the trial. This is an average daily gain of 0.53 pounds and is 0.13 of a pound greater than that of the control animals.

The animals in group B receiving 250 mg. of aureomycin in a single weekly oral administration exhibited greater bodyweight gains than any of the other groups in experiment I. These calves gained 15.8 pounds which is an average daily gain of 0.56 pounds. Groups D and B exhibited comparable growth responses over the control animals.

The calves in group C receiving 60 mg. of aureomycin pellets weekly by implant made an average gain of 10.8 pounds for the four week trial. Animals in group E which were administered 60 mg. of aureomycin weekly by intramuscular injection gained an average of 9.1 pounds. These two groups receiving aureomycin by parenteral administration obviously showed no beneficial response from the antibiotic. Actually the calves in these groups had somewhat lower bodyweight gains than the controls.

There was very little difference in the skeletal growth as measured by height at withers and chest circumference among all animals on trial. There appeared to be a tendency, however, for a slightly greater skeletal growth in the animals receiving aureomycin by oral administration. Groups B and D had an average gain in height at withers of 1.57 inches

Table I

The Effect of Aureomycin Administered Orally and Parenterally Upon Growth and Feed Consumption of Dairy Calves During the First 4 Weeks of Life,

Experiment I

Group[1]	Average growth gains by 4 weeks				Average Feed Consumed by 4 weeks		
	Ave. Initial Weight	Ave. Gain in Bodyweight	Ave. Gain in Ht. at Withers	Ave. Gain in Chest Circumference	Milk	Starter	Hay
	(lb.)	(lb.)	(inches)	(inches)	(lb.)	(lb.)	(lb.)
A	73.4	11.4	1.4	1.4	164.9	8.3	4.8
B	73.0	15.9	1.6	1.9	165.4	5.9	5.2
C	76.6	10.9	.9	1.4	153.9	5.6	4.6
D	74.1	15.0	1.6	1.8	165.2	9.6	5.6
E	77.3	9.1	1.0	1.4	166.0	5.2	4.6

[1]Each group consisted of 4 Guernseys, 2 Ayrshires, and 1 Holstein.

Group A, Control; B, 250 mg. aureomycin weekly by oral administration; C, 60 mg. implant weekly; D, 70 mg. daily by oral administration; E, 60 mg. weekly by intramuscular injection.

as compared to 1.35 inches for the controls. Groups C and E had an average gain in height at withers of 0.92 and 1.00 inch,respectively. Calves in groups B and D gained 1.85 and 1.78 inches,respectively,in chest circumference as compared to 1.35 inches for the animals in groups A, C, and E.

The average bodyweight gains for each group are represented graphically in Figure I. The growth curve as represented by gain in bodyweight was developed by plotting the average weekly gains in bodyweight for each group from the initial to the terminal weighing.

The control calves made an average gain of one pound the first two and one-half days. They made no gains for the next seven days, but then displayed a relatively constant rate of gain for the remainder of the experiment but they never attained the increase in bodyweight observed in groups B and D.

The animals in group D lost an average of 1.8 pounds during the first two and one-half days, but gained at a more rapid rate than calves in any of the other groups during the remainder of the trial. The low average of group D the first two and one-half days was largely due to the 10.0 pound loss by Guernsey No. 9 (a). If the average change in bodyweight for the other six calves in group D were used with Guernsey No. 9 (a) excluded the average loss would amount to less than one-half pound for the period.

The calves in group B exhibited the most uniform growth curve of all the groups. These calves made uniform gains from the initial day of the experiment and had the highest average gain of all groups when the study was terminated.

The implanted calves of group C made no appreciable gains during the first nine and one-half days. The next fourteen days they gained an average of slightly over 6.0 pounds, which was less than either the

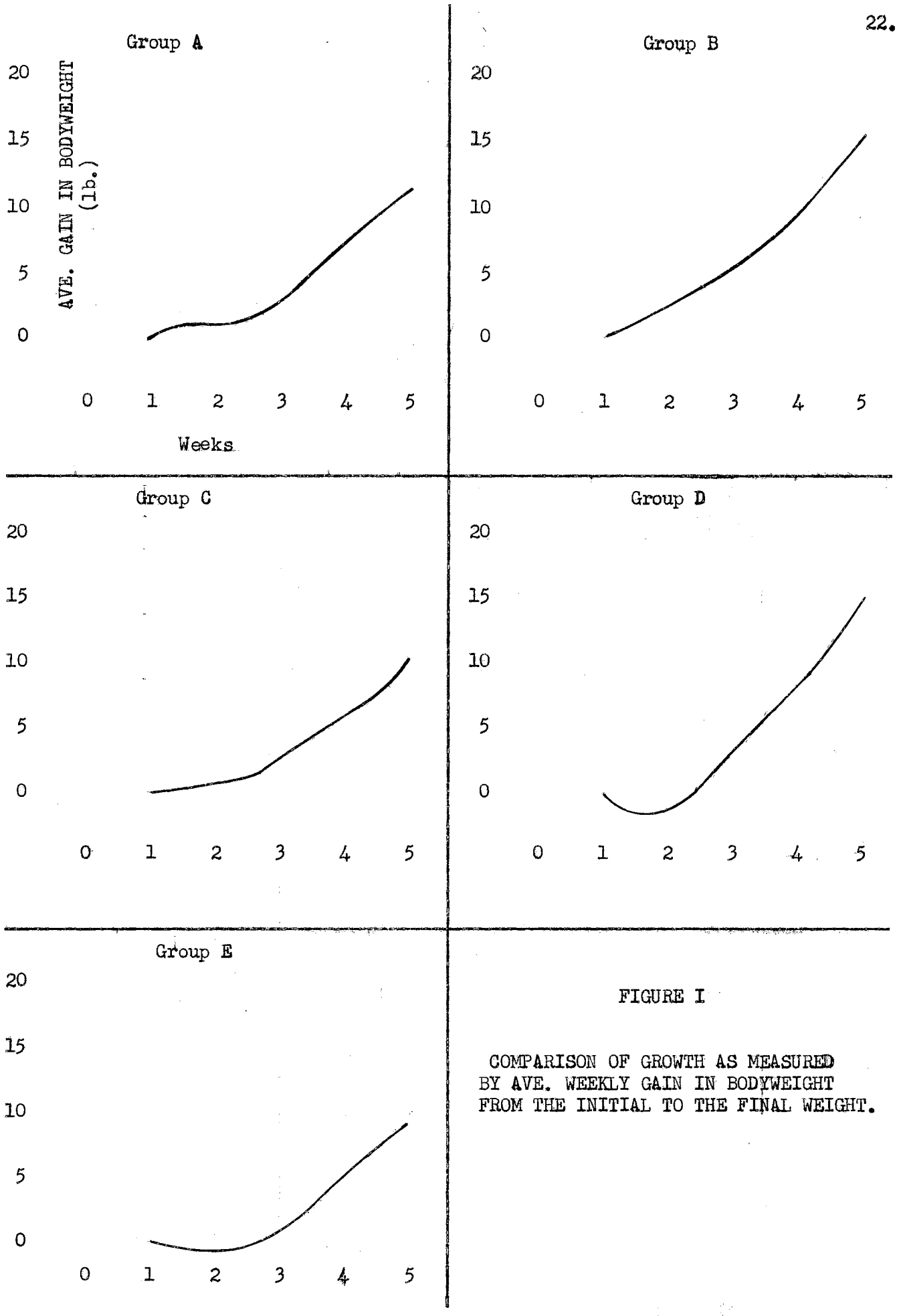

FIGURE I

COMPARISON OF GROWTH AS MEASURED BY AVE. WEEKLY GAIN IN BODYWEIGHT FROM THE INITIAL TO THE FINAL WEIGHT.

control calves or the calves receiving oral administrations of aureomycin during the same period. The rate of gain of the animals in group C increased above that observed in the controls during the last four and one-half days of the experiment but this was largely due to the 16.0 pounds gained by Holstein No. 5 during this period.

The average bodyweight gains of group E were depressed slightly below the initial weight for the first nine and one-half days. During the remainder of the experiment, these calves grew at a rate similar to that observed in group C. The calves in group E exhibited a greater gain in weight than the control calves during the last four and one-half days of the study.

The amounts of hay and starter consumed by all animals in experiment I were relatively small and there was very little difference in the total consumption among all groups in the trial. The average starter consumption for the animals in experiment I was as follows: group A, 8.3 lb.; group B, 5.9 lb.; group C, 5.6 lb.; group D, 9.6 lb.; and group E, 5.2 lb. The calves in group D had the greatest average hay consumption of 5.6 lb. followed in descending order by group B with 5.2 lb.; group A, 4.8 lb.; and groups C and E with 4.6 lb. each.

The animals in group D consumed a greater amount of starter than the calves in group A and gained more in bodyweight. Whereas the controls in group A consumed more starter than group B but did not gain as much in bodyweight. The control calves also consumed more starter than groups C and E but gained at approximately the same rate. It would appear that a better utilization of feed occurred in group B. Due to the small amounts of feed consumed and the variations in the different groups, it is probable that little significance should be attached to dry feed consumption.

The average milk consumption of all animals was nearly constant with the exception of group C in which the amount consumed was about 10.0 pounds less per calf. This was apparently due to a greater incidence of scouring in this group and more frequent reductions in milk intake for the purpose of scour control.

A summary of all cases of scours is presented in Table II. Although scours were not considered a problem in this study, there was less scouring observed in those groups receiving aureomycin by oral administration. Groups B and D had 2 and 4 cases of scours observed, respectively, while groups A and E had 6 cases each and group C, 9 cases for the four-week-period. Of all the cases observed in experiment I, only four required medication.

The second experiment in this study was designed so as to have five calves in each of the five groups. Due to the limited number of calves that could be obtained in the time available, only preliminary data on four calves in each group will be reported here.

Preliminary data from experiment II are presented in Appendix Tables 6 through 10 and are summarized in Table III. The control animals lost one pound the first two days, but gained in weight at a steady rate thereafter, although they never attained the increase in bodyweight observed in any of the groups receiving aureomycin.

The calves in group D receiving 70 mg. of aureomycin per day made average daily gains of 0.65 pounds as compared to 0.32 pounds for the controls. Groups F and H receiving 500 mg. and 125 mg., respectively, in single oral doses per week made average daily gains of 0.41 pounds each for the four week trial. The calves in group F receiving 250 mg. weekly by intramuscular injection also exhibited an average daily gain of 0.41 pounds.

Table II

The Effect of Aureomycin Administered Orally and Parenterally Upon the Incidence, Duration and Severity of Scours During the First 4 Weeks of Life, Experiment I

Group	Number of Cases scours Per Group	Average duration of Scouring	Number of Cases requiring Treatment	Treatment
		(days)		
A	6	3.8	None	None
B	2	5	1	1000 mg. Aureo.
C	9	4.3	1	500 mg. Aureo.
D	4	4.2	2	1500 mg. Aureo.
E	6	2.8	None	None

Table III

The Effect of Aureomycin Administered Orally and Parenterally Upon Growth and Feed Consumption of Dairy Calves During the First 4 Weeks of Life,

Experiment II

Group	Average growth gains by 4 weeks				Average Feed Consumed by 4 weeks		
	Ave. Initial Weight	Ave. Gain in Bodyweight	Ave. Gain in Ht. at Withers	Ave. Gain in Chest Circumference	Milk	Starter	Hay
	(lb.)	(lb.)	(inches)	(inches)	(lb.)	(lb.)	(lb.)
A	77.5	9.0	1.50	1.00	167.5	7.2	8.5
D	76.7	18.2	0.87	1.75	175.1	12.7	7.7
F	79.7	11.5	2.12	1.25	176.1	9.3	6.9
G	71.7	11.5	1.70	1.25	163.5	8.7	8.9
H	74.7	11.7	1.12	1.12	169.5	9.5	8.7

The calves in group D exhibited the most uniform growth curve after the first two days as can be observed from Figure 2. These animals lost an average of one pound for the first two days then grew at a rapid and uniform rate for the remainder of the trial.

No gain was observed for the first nine days in group F, but a fairly constant gain of about 3.0 pounds per week prevailed from the ninth day until the trial terminated. When comparing group F to the control animals, it can be seen that there was a delay at the beginning of the growth curve as measured by average gain in bodyweight. The animals in group F gained less than any group on the experiment during the first sixteen days, but from the twenty-second day until the termination of the trial these animals gained at a more rapid rate than any of the other groups.

Calves in group G lost an average of 2.0 pounds the first two days of the trial. During the following week, these animals gained at a rate of 4.2 pounds, but from the tenth through the seventeenth day, these calves lost an average of 0.75 pounds apiece. Two of the four calves in this group gained a total of 9.0 pounds but the other two lost a total of 12.0 pounds. During the remainder of the experiment these animals gained at a rather constant rate.

There were considerable fluctuations in the average gain in height at withers and gain in chest circumference. Group F had the greatest increase in height at withers, but was largely due to the 3.0 inch gain of Holstein No. 161. Group G had a greater increase in height at withers than the controls, while groups D and H both had smaller increases than the control calves.

The average gain in chest circumference was greater for all the groups receiving aureomycin than it was for the controls. Group D

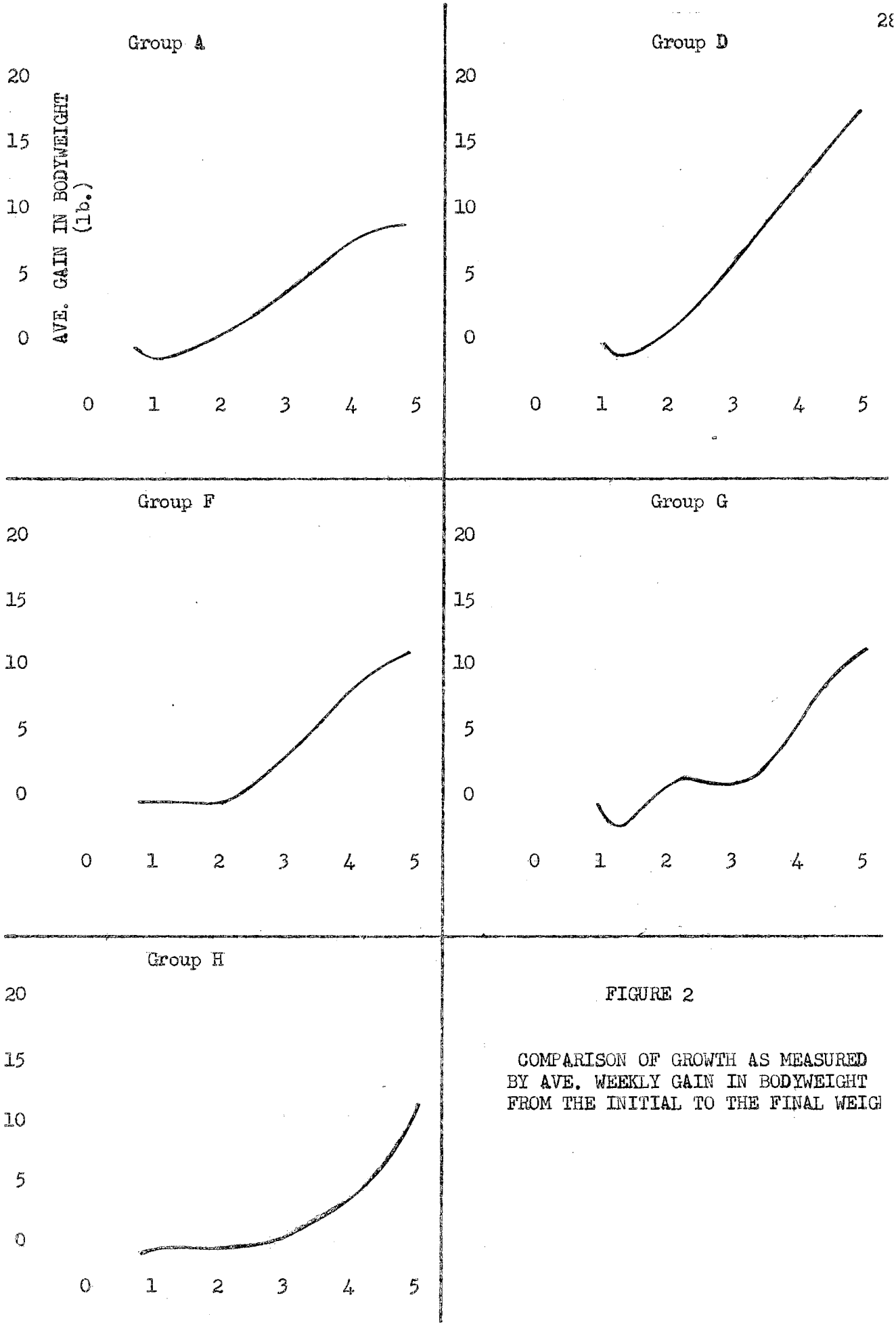

FIGURE 2

COMPARISON OF GROWTH AS MEASURED BY AVE. WEEKLY GAIN IN BODYWEIGHT FROM THE INITIAL TO THE FINAL WEIG

exhibited the greatest increase in chest circumference of 1.75 inches.

Milk consumption for all groups was relatively constant. The groups receiving aureomycin consumed more starter than the controls, with group D consuming the greatest amount. Hay consumption was small in all groups and very little individual differences among groups prevailed. The hay consumptions varied from 8.9 lb. in group G to 6.9 lb. in group F.

Scours again were not a problem in this experiment; only five cases occurred and they were not severe, with only one requiring treatment. Two cases occurred in groups A and F and one case in group D.

Table IV

The Effect of Aureomycin Administered Orally and Parenterally Upon the Incidence, Duration and Severity of Scours During the First 4 Weeks of Life, Experiment II

Group	Calf No.	No. Cases of Scours	Duration of Scouring	Treatment
			(days)	
A	G-86	1	2	None
	G-9 (b)	1	5	500 mg. Aureo
D	G-24	1	3	None
F	G-135	1	2	None
	G-23	1	2	None

DISCUSSION

The results obtained in experiment I indicate that 70 mg. of aureomycin administered daily was effective in increasing the bodyweight gains of dairy calves from birth to four weeks of age. These findings are in agreement with previous study at this station. The calves receiving 70 mg. of aureomycin gained 36% more in bodyweight than the control calves for the four week period. The greatest acceleration in growth of this aureomycin group over the controls was observed from the ninth day until termination of the trial.

The oral administration of 250 mg. of aureomycin in a single weekly dose resulted in a growth response similar to that observed when 70 mg. was administered daily. The calves in this group actually presented a more desirable growth curve than did the 70 mg. group. The group receiving 250 mg. gained at a constant rate from the initial weighing whereas the initiation of growth was slightly delayed in the group receiving 70 mg. This lag in the growth curve of group D was largely due to the 10 pound loss in bodyweight of Guernsey number 9 (a) during the first two days of the trial.

Calves in group C receiving 60 mg. of aureomycin weekly by implant had slightly lower bodyweight gains than the controls. Group C had a higher incidence of scouring than the controls as well as a longer average duration of each case of scours. This might account for lower bodyweight gains observed.

Group E, which received 60 mg. of aureomycin weekly by intramuscular injection had average daily bodyweight gains of 0.08 pounds less than the controls. The incidence of scouring in this group paralleled that observed in the control group. The fact that the calves in group E had a higher initial bodyweight of approximately 4.0 pounds more than the

controls may partially explain the slower rate of gain in bodyweight made by group E.

It appears from the data that no beneficial results were obtained from the subcutaneous implantation nor the intramuscular injection of 60 mg. of aureomycin under the conditions of this experiment. It was not possible to determine how much time was required for the aureomycin pellets to be absorbed into the blood stream after implantation. The pellets may have been absorbed at a rate which was too slow to facilitate concentrations which would be sufficiently high to be effective in stimulating growth. There is also a possibility that the level of antibiotic administered was too low. It would appear that this latter observation may have partially been the reason for the lack of response in the injected group, since preliminary results from experiment II indicate that a growth stimulation may result from higher levels of injection.

There has not been a very accurate method developed for measuring the skeletal growth of cattle. The major measurements used for estimating skeletal growth are height at withers and chest circumference. This method is subject to error, especially when used on young calves for a relatively short period. The small changes that did occur in the measurements of chest circumference and height at withers in this study could have been due to an increase in flesh rather than an increased skeletal growth. Although very little difference was observed in the skeletal growth of the calves in experiment I, there was a tendency for slightly greater increases in the calves receiving oral administrations of aureomycin. Since the skeletal structure may increase only one or two inches during the first month of life, it is probable that little significance should be placed upon the changes

observed during the period of this study.

During the first month of life calves exist basically upon milk. When dry feed is offered, small amounts may be consumed but the individual consumption will vary. An illustration of the variation in starter consumption can be noted from group B, in which Guernsey No. 1 consumed 6.1 pounds and Guernsey No. 3 consumed only 2.9 pounds for the four weeks. The calves in all groups consumed relatively small amounts of both hay and starter and it would appear that little significance could be placed upon any differences in feed consumption between treatment groups.

It was observed that there was a tendency for a slightly lower incidence of scours in all groups of calves receiving aureomycin by oral administration. This latter observation might tend to indicate that growth may have been partially stimulated by the control of scours, since a higher growth rate was obtained in those calves receiving oral administrations of aureomycin.

Although less scouring was observed in groups B and D, scours were not considered a problem in any of the groups due to the low incidence and mildness in nature. It appeared that most cases of scours that did occur were associated with errors in management and were not particularly related to the experimental treatments. This latter observation is substantiated by the fact that during the course of this study there were two definite periods when wet sawdust was inadvertantly used to bed the calves. It was during these two periods that the most serious outbreaks of scours occurred. During the early part of experiment I, when the first supply of wet sawdust was used, eight of eleven calves on trial at that time developed eleven cases of scours which persisted for an average of 4.2 days. Three of the cases required medication while the remainder were controlled by reducing the milk intake by one-half for a

few days.

Dry sawdust was obtained following this outbreak of scours. During the succeeding two and one-half months, eight of sixteen calves developed scours of only 2.0 days average duration. All cases were mild in nature and all responded to reduced milk intake with no medication.

Wet sawdust was inadvertantly used to bed the calves a second time and six of the seven calves in the barn at that time developed scours immediately. The bedding situation was remedied at once and the scour outbreak was brought under control very quickly, but not before one of the six calves had required medication.

Even though there was a slight tendency for less scouring in the groups receiving oral administrations of aureomycin, it should not be concluded that the complete growth stimulation observed in this study resulted from the control of scours. While this may have been partially responsible for the benefits observed it would appear likely that other factors were involved.

The levels of administration were altered in the second experiment to determine the effects of a higher parenteral administration as well as both higher and lower weekly oral administrations. This study has not been completed and only preliminary data are presented in this report. It should be noted that while these calves were managed the same and kept in the same stalls as the calves in experiment I, this study was conducted during the spring season while the first experiment was carried on during the fall and winter months.

Preliminary data from the second study reveals that the calves receiving 70 mg. of aureomycin by daily oral administration made twice as great average daily bodyweight gains as the control calves. This supports the results obtained in experiment I and is in accordance with previous

results at this station when the average daily gain of calves receiving 70 mg. aureomycin was twice that observed in the controls during the first five weeks of life.

Preliminary observations on calves receiving 125 or 500 mg. in single weekly oral doses indicate that while a growth response was observed neither of these levels were as effective as 70 mg. administered daily. In comparing these weekly levels to the 250 mg. oral administration in experiment I, it should be noted that a higher increase in growth rate was obtained when 250 mg. was given than when either 125 or 500 mg. were administered. This would appear to indicate that 125 mg. was too low a level to cause a marked stimulation in growth rate, while 500 mg. in a single oral dose may have been too great a level at one administration to allow an optimum growth response.

By observing groups F and D a comparison can be obtained between the administration of 500 mg. aureomycin in a single weekly oral dose and the administration of 490 mg. when given in seven equal daily doses for a week. The calves in group D receiving 70 mg. daily gained an average of 6.7 lb. more for the four week trial than the calves in group F receiving the 500 mg. in a single weekly dose. This appears to indicate that there is an optimum level that can be administered during weekly intervals to obtain the best growth response.

Preliminary results indicate that an increased growth rate may result from weekly intramuscular injections of 250 mg. of aureomycin. This latter observation would not preclude the intestinal tract as the site of aureomycin activity since work with humans has demonstrated that aureomycin is readily re-excreted into the gastro-intestinal tract. There was an unexplainable lag in the growth curve of the calves in

group G from the tenth through the seventeenth day.

Comparison of this group to group B in experiment I in which the calves received 250 mg. by oral administration show that the oral dosage produced a much greater growth stimulation over the controls than that when the same amount was injected.

The gain in height at withers and gain in chest circumference was small in all groups. It would appear that small unavoidable errors in measuring may have had more effect on the observed differences than did experimental treatments. The average gain in chest circumference was greater in all calves receiving aureomycin.

The milk and hay consumption were relatively constant for all groups. More starter was consumed by the animals receiving aureomycin than by the controls. The calves receiving 70 mg. of aureomycin daily consumed the greatest amount of starter which might be expected since they had considerable higher daily gains.

A summary of the scours occurring in the second experiment are presented in Table IV. Scours appeared to have little, if any, effect on the results obtained in this experiment, since only five cases occurred in the twenty calves on trial. The calves in groups A and F exhibited two cases of scours each and one case occurred in group D. Only one case in group A required medication while the other calves responded to reductions in milk intake.

SUMMARY

Studies were conducted to determine the effects of different levels of aureomycin when administered orally, subcutaneously, and intramuscularly, upon the growth rate, feed consumption, and general health of dairy calves during the first four weeks of life.

The oral administration of 70 mg. of aureomycin daily or the oral administration of 250 mg. in a single dose weekly appeared to stimulate an increase in the rate of gain in bodyweight. Although errors in management probably were more directly associated with scours than experimental treatments, there was a slightly lower incidence of scours observed in the two groups receiving oral administration of aureomycin. The skeletal growth as measured by height at withers and chest circumference was slightly greater in the groups receiving aureomycin orally. It is probable that little significance should be attached to these gains observed in skeletal growth since all changes were small and might not necessarily represent an accurate measure of skeletal growth.

On the basis of preliminary data it appears that while a growth response was observed, neither 125 nor 500 mg. of aureomycin in single oral weekly doses were as effective as 70 mg. administered daily.

There were no apparent growth benefits obtained by weekly intramuscular injections nor subcutaneous implantations of 60 mg. of aureomycin. Neither were these levels of any apparent value in reducing the incidence or severity of scours. Preliminary results indicate, however, that an increased growth rate may result from weekly intramuscular injections of 250 mg. of aureomycin.

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APPENDIX

APPENDIX

TABLES PAGE

Table I

Growth and Feed Consumption Records of Calves
Receiving no Aureomycin, Experiment I

GROUP A

Calf No.	Bodyweight Initial	Gain	Ht. at Withers Initial	Gain	Chest Cir. Initial	Gain	Feed Consumption Milk	Starter	Hay
	(lb.)		(in.)		(in.)			(lb.)	
G-14	55	± 10	26.5	± 1.0	25.5	± 1.5	119.0	3.3	3.2
G-4	72	± 9	27.0	± 1.0	28.0	± 1.0	166.5	5.2	3.9
G-8	69	± 8	28.5	± 1.0	28.5	± 1.5	165.5	6.5	5.2
G-17	75	± 4	28.0	± 1.0	28.0	± 1.0	156.0	4.6	2.5
A-2	77	± 10	27.5	± 1.5	28.0	± 1.0	158.0	11.7	4.7
A-8	70	± 20	26.0	± 2.5	28.0	± 2.0	156.3	9.4	4.4
H-111	96	± 19	29.0	± 1.5	30.5	± 1.5	233.0	17.4	9.4
$\bar{X}$	73.4	± 11.4	27.5	± 1.35	28.0	± 1.35	164.9	8.30	4.75

TABLE 2

Growth and Feed Consumption Records of Calves
Receiving 250 mg. Aureomycin Orally per Week, Experiment I

GROUP B

Calf No.	Bodyweight Initial	Gain	Ht. at Withers Initial	Gain	Chest Cir. Initial	Gain	Feed Consumption Milk	Starter	Hay
	(lb.)		(in.)		(in.)		(lb.)		
G-1	74	+ 25	30.0	+ 2.0	29.0	+ 1.5	192.0	6.1	7.2
G-3	61	+ 1	27.0	+ 1.0	27.5	+ 0.0	100.5	2.9	4.2
G-10	85	+ 11	30.0	+ 1.0	30.5	+ 0.0	187.5	5.7	4.1
A-3	74	+ 11	27.5	+ 1.0	27.0	+ 2.0	168.0	5.0	4.9
G-18	80	+ 12	28.0	+ 2.0	28.0	+ 3.0	170.0	3.6	4.4
A-10	69	+ 19	27.0	+ 2.0	27.5	+ 2.5	168.0	9.5	6.7
H-9	68	+ 32	26.0	+ 2.0	28.0	+ 4.0	172.0	8.6	4.6
$\bar{X}$	73.0	+ 15.8	27.9	+ 1.57	28.2	+ 1.85	165.4	5.91	5.15

Table 3

Growth and Feed Consumption Records of Calves
Receiving 60 mg. Aureomycin by Implant Weekly, Experiment I

GROUP C

Calf No.	Bodyweight Initial	Gain	Ht. at Withers Initial	Gain	Chest Cir. Initial	Gain	Feed Consumption Milk	Starter	Hay
	(lb.)		(in.)		(in.)			(lb.)	
G-13 (a)	75	+ 9	28.0	+ 1.0	30.0	+ 1.0	151.0	6.7	5.8
G-2	65	+ 9	28.5	+ 1.0	28.0	+ 1.0	132.0	3.4	3.8
G-7	57	+ 8	25.5	+ 1.0	26.5	+ 1.0	105.0	2.5	1.6
G-12	74	+ 9	29.0	+ 1.0	27.5	+ 3.0	166.0	2.7	2.8
A-6	90	+ 10	29.5	0.0	30.5	+ 2.0	179.0	4.7	3.1
H-5	97	+ 16	29.0	+ 1.5	30.0	+ 1.0	204.0	12.5	9.8
A-13	78	+ 15	27.5	+ 1.0	29.0	+ 0.5	140.5	6.6	5.1
$\bar{X}$	76.5	+ 10.8	28.1	+ 0.92	28.7	+ 1.35	153.9	5.58	4.57

Table 4

Growth and Feed Consumption Records of Calves
Receiving 70 mg. Aureomycin Daily by Oral Administration, Experiment I

GROUP D

Calf No.	Bodyweight		Ht. at Withers		Chest Cir.		Feed Consumption		
	Initial	Gain	Initial	Gain	Initial	Gain	Milk	Starter	Hay
	(lb.)		(in.)		(in.)		(lb.)		
G-15	70	+ 17	26.0	+ 1.5	24.5	+ 3.0	137.5	6.3	4.9
G-5	75	+ 20	28.0	+ 2.0	27.5	+ 2.0	149.5	13.0	4.4
A-1	67	+ 11	26.5	+ 0.5	28.0	+ 2.0	164.5	7.0	3.7
G-9 (a)	69	+ 7	27.5	+ 1.5	27.0	+ 0.5	161.0	10.0	4.8
G-19	105	+ 6	27.5	+ 1.5	27.5	+ 1.0	147.5	4.5	5.8
A-7	64	+ 19	28.0	+ 1.5	28.5	+ 2.0	168.0	10.5	4.6
H-34	69	+ 25	29.5	+ 2.5	31.0	+ 2.0	229.0	16.2	11.1
$\bar{X}$	74.1	+ 15.0	27.5	+ 1.57	27.7	+ 1.78	165.2	9.64	5.61

Table 5

Growth and Feed Consumption Records of Calves
Receiving 60 mg. Aureomycin Intramuscularly per Week, Experiment I

GROUP E

Calf No.	Bodyweight		Ht. at Withers		Chest Cir.		Feed Consumption		
	Initial	Gain	Initial	Gain	Initial	Gain	Milk	Starter	Hay
	(lb.)		(in.)		(in.)		(lb.)		
G-16	71	+ 11	30.0	+ 1.0	28.0	+ 1.5	155.0	7.0	7.0
G-6	71	+ 10	28.0	+ 1.0	27.5	+ 2.0	158.0	5.5	4.0
G-11	70	0	27.0	0.0	27.0	0.0	125.0	4.6	2.5
G-21	88	+ 5	29.0	+ 1.0	30.5	+ 0.5	179.5	2.2	1.3
A-5	77	+ 15	28.0	+ 2.0	30.0	+ 1.5	170.5	3.8	4.7
H-3	94	+ 16	29.5	0.0	31.0	+ 2.0	207.1	5.9	5.2
A-11	70	+ 7	26.5	+ 2.0	27.5	+ 2.0	167.5	7.5	7.3
$\bar{X}$	77.2	+ 9.1	28.2	+ 1.00	28.7	+ 1.35	166.0	5.21	4.57

Table 6

Growth and Feed Consumption Records of Calves
Receiving no Aureomycin, Experiment II

GROUP A

Calf No.	Bodyweight Initial	Gain	Ht. at Withers Initial	Gain	Chest Cir. Initial	Gain	Feed Consumption Milk	Starter	Hay
	(lb.)		(in.)		(in.)		(lb.)		
G-22	81	± 10	29.0	± 2.5	30.0	± 1.0	178.5	4.8	6.6
H-1	75	± 22	27.5	± 1.0	29.0	± 1.5	180.0	6.6	5.4
G-86	64	0	27.5	± 1.0	27.0	± 1.0	135.0	7.3	9.1
G-9 (b)	90	± 4	29.0	± 1.5	29.5	± 0.5	177.0	10.2	12.0
$\bar{X}$	77.5	± 9.0	28.2	± 1.50	28.8	± 1.00	167.5	7.22	8.52

Table 7

Growth and Feed Consumption Records of Calves
Receiving 70 mg. Aureomycin Daily by Oral Administration, Experiment II

GROUP D

Calf No.	Bodyweight		Ht. at Withers		Chest Cir.		Feed Consumption		
	Initial	Gain	Initial	Gain	Initial	Gain	Milk	Starter	Hay
	(lb.)		(in.)		(in.)		(lb.)		
G-24	69	± 24	27.5	± 1.0	28.5	± 2.5	151.5	14.5	5.3
A-15	90	± 11	28.5	0.0	29.5	± 1.0	197.0	7.5	5.8
A-16	76	± 22	26.5	± 2.0	28.0	± 2.5	170.5	18.0	8.8
G-108	72	± 16	29.0	± 0.5	28.5	± 1.0	181.5	10.8	11.0
$\bar{X}$	76.7	± 18.2	27.8	± 0.87	28.6	± 1.75	175.1	12.7	7.72

Table 8

Growth and Feed Consumption Records of Calves
Receiving 500 mg. Aureomycin Orally per Week, Experiment II

GROUP F

Calf No.	Bodyweight		Ht. at Withers		Chest Cir		Feed Consumption		
	Initial	Gain	Initial	Gain	Initial	Gain	Milk	Starter	Hay
	(lb.)		(in.)		(in.)		(lb.)		
G-23	99	± 15	29.5	± 2.5	31.0	± 1.5	222.0	13.6	4.1
G-135	60	± 6	26.0	± 2.0	26.0	± 2.0	127.5	6.2	4.5
G-13 (b)	82	± 12	28.0	± 1.0	28.0	± 0.5	167.0	9.5	7.0
H-161	78	± 13	27.0	± 3.0	29.0	± 1.0	191.0	8.0	12.1
$\bar{X}$	79.7	± 11.5	27.6	± 2.12	27.6	± 1.25	176.8	9.32	6.92

Table 9

Growth and Feed Consumption Records of Calves
Receiving 250 mg. Aureomycin Intramuscularly per Week, Experiment II

GROUP G

Calf No.	Bodyweight Initial	Gain	Ht. at Withers Initial	Gain	Chest Cir. Initial	Gain	Feed Consumption Milk	Starter	Hay
	(lb.)		(in.)		(in.)			(lb.)	
G-140	76	± 19	26.5	± 1.0	28.0	± 1.5	181.5	12.8	12.0
G-127	61	± 7	26.0	± 2.0	26.0	± 1.5	132.5	4.4	3.4
A-177	75	± 12	27.0	± 1.5	29.0	± 0.5	171.0	9.6	10.6
G-96	75	± 8	27.5	± 2.5	28.5	± 1.5	169.0	7.9	9.5
$\bar{X}$	71.7	± 11.5	26.7	± 1.75	27.7	± 1.25	163.5	8.67	8.87

Table 10

Growth and Feed Consumption Records of Calves
Receiving 125 mg. Aureomycin Orally per Week, Experiment II

GROUP H

Calf No.	Bodyweight		Ht. at Withers		Chest Cir.		Feed Consumption		
	Initial	Gain	Initial	Gain	Initial	Gain	Milk	Starter	Hay
	(lb.)		(in.)		(in.)		(lb.)		
G-29	78	± 14	28.5	± 1.0	28.0	± 1.5	168.0	11.9	8.2
G-165	62	± 14	27.5	± 1.5	27.5	± 1.5	144.8	6.6	7.8
A-17	88	± 16	28.5	± 1.0	30.5	± 1.0	190.0	10.3	6.7
A-140	75	± 3	26.5	± 1.0	28.5	± 0.5	176.0	9.0	12.1
$\bar{X}$	74.4	± 11.7	27.7	± 1.12	28.5	± 1.12	169.5	9.45	8.70

VITA

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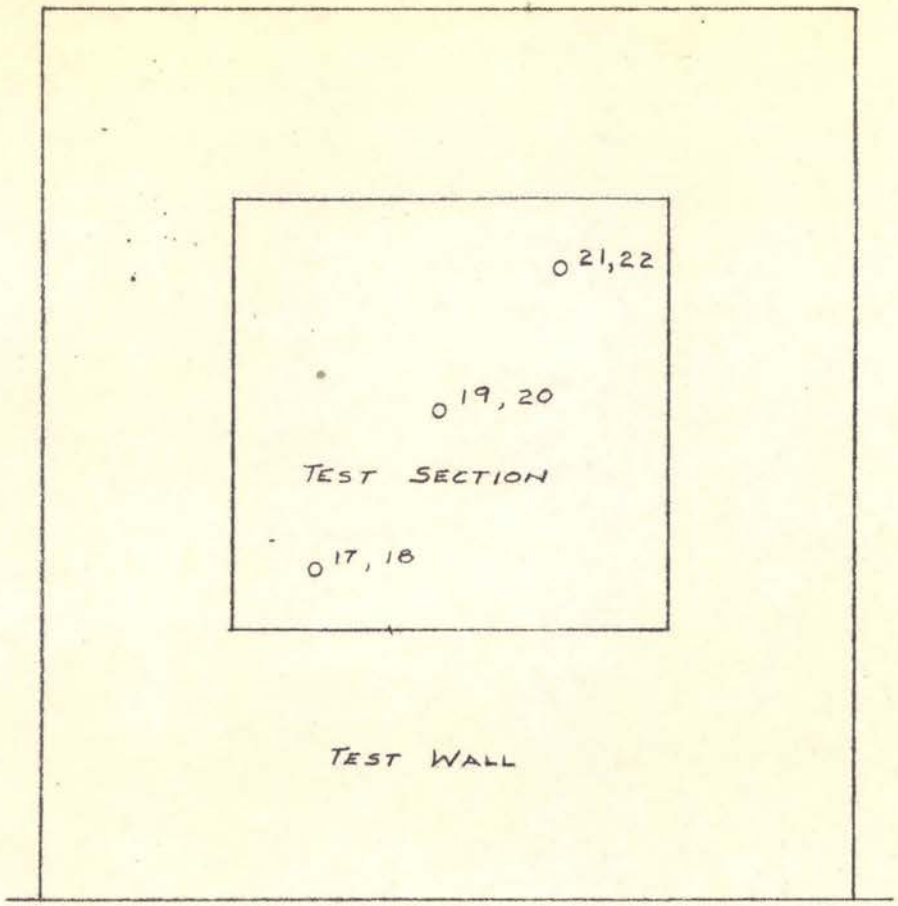

NOTE: O INDICATES LOCATION OF THERMOCOUPLES

FRONT VEIW
SCALE: 3/4" = 1'-0"

TEST WALL
FIGURE 3