ANTIBIOTICS IN DAIRY CATTLE NUTRITION. I.
THE EFFECT OF AN AUREOMYCIN PRODUCT (AUROFAC) ON THE
GROWTH AND WELL-BEING OF YOUNG DAIRY CALVES

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In 1949, Stokstad et al. (20) noted that an animal protein factor supplement
derived from cultures of Streptomyces aureofaciens would produce a growth
response in chicks which was greater than the maximum response obtainable
with vitamin B₁₂. The same year Cunha et al. (4) obtained similar results when
a residual fermentation product remaining from the manufacture of pure
aureomycin was fed to pigs. In early 1950, Stokstad and Jukes (19) found
that pure crystalline aureomycin would produce a growth response in chicks
similar to that obtained with products from aureomycin fermentation, thus
demonstrating the role of antibiotics as dietary growth stimulators. Later, in
1950, several workers reported (reviewed by Stokstad, 18) that aureomycin and
several other antibiotics were beneficial in the rations of non-ruminant animals,
such as chickens, turkeys and pigs. At that time it was conjectured that anti-
biotics possibly would interfere with the nutrition of ruminant animals by
destroying necessary rumen microorganisms. Since the newborn calf behaves
like a non-ruminant animal in the digestion of food, investigations were initiated
to determine whether or not aureomycin added to the diet would stimulate
growth in young calves.

In November, 1950, Bartley et al. (1), Rusoff (14), and Loosli and Wallace
(7) reported that pure aureomycin or products from aureomycin fermentation
would enhance calf growth. These and several more recent experiments have
shown that the feeding of aureomycin to young calves exerts a favorable in-
fluence on growth (1, 2, 5, 8, 12, 14, 15, 16, 17, 21), reduces the incidence of calf
scours (1, 7, 8, 16, 17), improves feed efficiency (8, 11, 12), stimulates the ap-
petite for grain (2, 8, 17) and improves physical appearance (12, 14, 15). Voelker
and Cason (21) found that the feeding of terramycin to young calves resulted
in increased growth. Bloom and Knodt (3) in a preliminary experiment found
that the feeding of potassium penicillin lowered the rate of growth of calves,
whereas aureomycin increased the growth rate and appeared to cause an earlier
and greater consumption of the calf starter ration. Murdock et al. (11) failed
to obtain any advantage in growth when calves were fed terramycin. When
aureomycin was fed, these workers noted a significant increase in the growth
rate of calves for the first 6 weeks of age, but failed to find any difference at
the end of 12 weeks. Morrison and Deal (10) fed an antibiotic feed supplement
(Lederle) to calves from 3 to 17 days of age. They noted no differences in

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Pearl River, N. Y. A portion of these data was presented at the 1950 Annual Meeting of the
American Society of Animal Production. Contribution no. 213, Department of Dairy Hus-
bandry, and no. 95, Office of Director.
incidence of scouring, general health, feed consumption or gain in weight between the supplement-fed and the control calves at 12 weeks of age.

The experiment reported herein pertains to the effects of a crude aureomycin fermentation product on the growth, feed consumption, incidence of scouring, rumination, and physical appearance of calves raised under somewhat unfavorable environmental conditions. Data are presented to show the effects of discontinuing aureomycin supplementation at an early age.

EXPERIMENTAL

Twenty-four newborn calves of four breeds (Ayrshires, Guernseys, Holsteins and Jerseys) were used. Starting at random, every other calf born within each breed was selected to receive aureomycin. Twelve calves received aureomycin and twelve served as controls. The calves selected to receive aureomycin were divided into 2 groups; those in group 1 received aureomycin for the first 7 weeks only, while those in group 2 received aureomycin for the duration of the experiment (12 weeks). The source of aureomycin was a residual fermentation product remaining from the manufacture of pure aureomycin (Lederle's A.P.F. No. 5, now called Aurofac) containing 5 mg. of aureomycin per gram and was ingested once daily, by capsule, at the rate of 3 g. per 100 lb. body weight. The product of aureomycin fermentation hereafter will be referred to as Aurofac. It was realized that the use of capsules for administering the Aurofac would not be a satisfactory method for practical feeding. Capsules were used to insure that all calves received a known amount of Aurofac daily from the beginning to the end of the experiment. The supplementation of Aurofac was started on the first day of each calf's life.

The calves received their mothers’ colostrum for the first three days. On the fourth day they were placed in individual calf pens and fed whole milk at the daily rate of 1 lb. per 10 lb. body weight. At the end of the third week they were gradually changed over to skim milk, which was fed at the daily rate of 1 lb. per 10 lb. body weight, not to exceed 14 lb. daily. Good quality alfalfa hay and a grain mixture (equal parts by weight of whole corn and oats) were fed ad libitum starting at 1 week of age. The grain intake was limited to a maximum of 4 lb. for Jerseys and Guernseys, 4.5 lb. for Ayrshires, and 5 lb. for Holsteins. When weather permitted, the calves were exercised in dry lots adjacent to the calf barn.

The calves were weighed at weekly intervals. Records were kept of all feed consumed. At monthly intervals the calves were rated on their physical condition. Daily records were kept on the health of the calves. If a calf had scours or a cold accompanied by fever, either penicillin (intramuscularly) or sulfa drugs (per os) were administered. When calves had scours that were not accompanied by any rise in body temperature, treatment consisted only of omitting one or two milk feedings.

RESULTS AND DISCUSSION

The effect of Aurofac on calf health is illustrated in Table 1. Scours or colds were classified as mild if not accompanied by fever and severe if accompanied
### TABLE 1

**Health of young dairy calves when receiving Aurofac for 7 and 12 wk. and when receiving none**

<table>
<thead>
<tr>
<th>Group</th>
<th>Calf no.</th>
<th>Condition at birth</th>
<th>Type of scours and colds observed each week*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1  2  3  4  5  6  7  8  9  10  11  12</td>
</tr>
<tr>
<td>I</td>
<td>0217B</td>
<td>Good</td>
<td>* 0</td>
</tr>
<tr>
<td></td>
<td>0138B</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>Received Aurofac from birth through 7 wk.</td>
<td>0140B</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td></td>
<td>418B</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td></td>
<td>367B</td>
<td>Good</td>
<td>** * *</td>
</tr>
<tr>
<td></td>
<td>368B</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>0216B</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td></td>
<td>206B</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>Received Aurofac from birth through 12 wk.</td>
<td>102B</td>
<td>Good</td>
<td>* 0</td>
</tr>
<tr>
<td></td>
<td>0413B</td>
<td>Poor</td>
<td>** 0</td>
</tr>
<tr>
<td></td>
<td>417B</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0337B</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>0220B</td>
<td>Good</td>
<td>** ** *</td>
</tr>
<tr>
<td>(Control)</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0221B</td>
<td>Good</td>
<td>** * **</td>
</tr>
<tr>
<td></td>
<td>206B</td>
<td>Good</td>
<td>00</td>
</tr>
<tr>
<td></td>
<td>0139B</td>
<td>Good</td>
<td>00</td>
</tr>
<tr>
<td></td>
<td>0142B</td>
<td>Good</td>
<td>** * **</td>
</tr>
<tr>
<td></td>
<td>103B</td>
<td>Good</td>
<td>00 **</td>
</tr>
<tr>
<td>received no Aurofac</td>
<td>0414B</td>
<td>Good</td>
<td>** 00</td>
</tr>
<tr>
<td></td>
<td>0415B</td>
<td>Good</td>
<td>** * **</td>
</tr>
<tr>
<td></td>
<td>416B</td>
<td>Good</td>
<td>000 000 000</td>
</tr>
<tr>
<td></td>
<td>0339B</td>
<td>Good</td>
<td>** 00</td>
</tr>
<tr>
<td></td>
<td>366B</td>
<td>Good</td>
<td>** 00</td>
</tr>
<tr>
<td></td>
<td>370B</td>
<td>Good</td>
<td>000 000</td>
</tr>
</tbody>
</table>

*a Mild scours 0 Mild cold
** Medium scours 00 Medium cold
*** Severe scours 000 Severe cold

by fever. The designation of medium was given to scours or colds that could not readily be classified as mild or severe. It will be noted (Table 1) that there were considerably fewer cases of colds and scours in the calves receiving Aurofac than in those of the control group. The difference between the calves receiving
Aurofac and the control calves probably is even greater than is apparent from Table 1, since the control calves received medication when scouring severely, whereas the necessity for similar treatment did not arise in the groups receiving Aurofac.

The small amount of Aurofac used in this experiment appeared to be effective in controlling the severe types of scours and colds, since there were no occurrences of these types in the calves receiving Aurofac. However, in other experiments to be reported later the authors observed that there apparently are certain types of infectious scours that are not controlled by low levels of Aurofac administration. This, of course, is to be expected because of the variety of organisms responsible for infectious calf scours. It is interesting to note that although calves in group 1 received Aurofac from birth through 7 weeks of age only, they remained as free from calf diseases from then through the twelfth week as did the calves in group 2, which received Aurofac throughout the 12-weeks period, whereas in the control calves there was a high incidence of scours and colds.

Previously, when relatively large numbers of calves were raised in the barn used in this experiment, the incidence of scours and colds and associated death losses were considered extremely high. In many large dairies where special calf quarters are provided, the premises apparently become seeded with many organisms responsible for calf mortality. Even with the most careful cleaning and disinfecting procedures, the control of calf diseases is most difficult. The previous history of conditions in the barn used for this experiment indicated an opportunity to test the efficacy of aureomycin in checking or controlling

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**Fig. 1.** Comparative growth response of calves receiving 3 g. Aurofac (equivalent to 15 mg. aureomycin) daily per 100 lb. body wt. for periods of 7 and 12 wk., of control calves and of Ragsdale growth standard weighted by breed and sex.
disease and mortality among calves where the existing trouble magnifies the need for some control aid.

From birth through 7 weeks of age, gains made by both groups of calves that received Aurofac were superior to gains made by the control animals (Figure 1 and Table 2). The average weight at the end of 7 weeks for the two groups of calves receiving Aurofac was 155 per cent of the average birth weight for calves in group 1 and 159 per cent for those in group 2. At the end of 7 weeks the control calves averaged 138 per cent of birth weight. The Ragsdale growth standard (13), weighted by breed and sex, indicates an expected increase of 150 per cent. When Aurofac was taken out of the diet of the calves in group 1 at the end of the seventh week, there was a noticeable decrease in rate of gain. The average weight for calves in group 1 at the end of 12 weeks was 199 per cent of their average birth weight, and the calves in group 2, receiving Aurofac for 12 weeks, had an average weight of 228 per cent of their average birth weight. At the end of the twelfth week the control calves averaged 199 per cent of birth weight; for the same period, the Ragsdale growth standard indicates an increase of 207 per cent. To determine whether the gains of the calves in groups 1 and 2 (excluding the growth data for group 1 calves when not receiving Aurofac) were significantly different from the controls, the slope of the log of the weight versus age straight lines (not shown) were treated statistically from 3 through 12 weeks of age. This period was used because the lines were straight during this period. The slopes of the lines were found to diverge significantly (the difference between the regression coefficients was 6.9 times the standard error of the difference), indicating that the gain of the Aurofac-fed calves was significantly greater than that of the controls.

Although the calves in group 1 slowed down in rate of gain after Aurofac was taken out of the diet (8 through 12 weeks), they did not lose weight and at 12 weeks of age were in better condition (Table 2) than the controls. From birth through 12 weeks of age, there was no statistically significant difference

### TABLE 2

**Body weight, physical condition, feed intake and efficiency of gain of dairy calves receiving Aurofac for 7 and 12 wk. and when receiving none**

<table>
<thead>
<tr>
<th>Amt. of Aurofac received</th>
<th>Group I 1st 7 wk.</th>
<th>Group II 1st 7 wk.</th>
<th>Group III (Control) 1st 7 wk.</th>
<th>Group I 8-12 wk.</th>
<th>Group II 8-12 wk.</th>
<th>Group III (Control) 8-12 wk.</th>
</tr>
</thead>
<tbody>
<tr>
<td>/100 lb. calf wt. daily...</td>
<td>3g.</td>
<td>3g.</td>
<td>None</td>
<td>None</td>
<td>3g.</td>
<td>None</td>
</tr>
<tr>
<td>No. of calves</td>
<td>6</td>
<td>6</td>
<td>12</td>
<td>6</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Av. actual daily gain (lb.)</td>
<td>0.78</td>
<td>0.83</td>
<td>0.52</td>
<td>0.87</td>
<td>1.35</td>
<td>1.02</td>
</tr>
<tr>
<td>Av. expected daily gain (lb.)</td>
<td>0.78</td>
<td>0.74</td>
<td>0.75</td>
<td>1.19</td>
<td>1.19</td>
<td>1.18</td>
</tr>
<tr>
<td>Condition rating</td>
<td>70</td>
<td>65</td>
<td>48</td>
<td>63</td>
<td>77</td>
<td>50</td>
</tr>
<tr>
<td>Av. weekly intake/100 lb. body wt.</td>
<td>1.32</td>
<td>1.95</td>
<td>1.67</td>
<td>2.43</td>
<td>2.02</td>
<td>4.32</td>
</tr>
<tr>
<td>Hay (lb.)</td>
<td>3.38</td>
<td>3.86</td>
<td>2.17</td>
<td>7.59</td>
<td>10.35</td>
<td>8.47</td>
</tr>
<tr>
<td>Grain (lb.)</td>
<td>1.76</td>
<td>1.72</td>
<td>2.20</td>
<td>2.39</td>
<td>1.83</td>
<td>2.08</td>
</tr>
<tr>
<td>Lb. TDN/lb. gain</td>
<td>0.41</td>
<td>0.39</td>
<td>0.53</td>
<td>0.57</td>
<td>0.39</td>
<td>0.48</td>
</tr>
<tr>
<td>Lb. dig. protein/lb. gain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Computed from Ragsdale growth standard (weighted average).*
between the gain of the calves in group 1 and the controls, indicating that the
growth advantage gained from feeding Aurofac for the first 7 weeks was largely
lost by the time the calves were 12 weeks of age. It is of interest to note that
the calves in group 1 maintained their previous rate of growth for 1 week after
the administration of Aurofac was stopped. This indicates that one or more
administrations of Aurofac may have sufficient carry-over effect in growth
response to make it feasible to administer Aurofac only once each week.

The average weekly intake of hay and grain by the calves receiving Aurofac
and those used as controls is shown in Table 2. For purposes of comparison, the
intakes are expressed on an equal weight basis, computed by using the log of
the weekly weights for each calf and averaging them to obtain the average log
weight for the period. The average log weight then was converted into the
geometric mean by determining the anti-log. Then these mean weights were
used to compute the average weekly intake of hay or grain on a 100 lb. body
weight basis. During the first 7 weeks there appeared to be no consistent dif-
ference in the hay consumption by the calves receiving Aurofac and by the
control calves. An analysis of variance of the data showed, with considerable
confidence (P > 0.50), that there was no important difference in hay con-
sumption at this age. From 8 through 12 weeks the control calves ate 115 per
cent more hay than did the calves that received Aurofac. An analysis of variance
of the data showed no significant differences among the groups. However, since
the F ratio approached the conventional point at which the difference would
be considered significant, the assumption that Aurofac feeding does not depress
hay consumption at this age is accepted only tentatively.

During the first 7 weeks, the calves receiving Aurofac consumed 67 per cent
more grain on the average than did the control calves, and 22 per cent more
during the period from 8 to 12 weeks, inclusive. However, an analysis of
variance of these data failed to show that the observed differences in average
grain intakes of the groups were statistically significant.

At 2, 3, and 4 weeks of age, the average grain consumption per calf for both
control calves and those receiving Aurofac was similar in amount (data not pre-
sented). Starting at 5 weeks, however, the calves receiving Aurofac ate more
grain on the average than the control calves and continued to have a greater
appetite for grain for the remainder of the experiment. The average weekly
grain consumption per calf for the two groups of calves receiving Aurofac and
for the control group during the fifth week was as follows: Group 1, 4.7 lb.;
group 2, 4.2 lb.; control, 2.0 lb. It is interesting to note also (Figure 1) that
the divergence of the average growth curve of the calves receiving Aurofac from
that of the control calves began at about 5 weeks of age. It would, therefore,
appear that the stimulated growth of the calves receiving Aurofac is, at least
partially, the result of an increased appetite for grain at an earlier age. This
deduction cannot be fully supported since, as previously stated, statistical
analysis of the grain consumption data showed no significant differences among
groups due to Aurofac feeding. Again, it might be well to emphasize that sick-
ness prevailed in the control calves, which may have affected grain consumption.
Reports in the literature concerning the effect of aureomycin on grain or starter consumption are conflicting. MacKay et al. (9) found no evidence of increased calf starter consumption resulting from the feeding of aureomycin. Loosli et al. (8) found that calves fed aureomycin consumed approximately 40 per cent more grain than did control calves. Rusoff et al. (17) also noted that aureomycin-fed calves consumed more calf starter than control calves and inferred from this that the stimulated appetite results in increased growth. It is not clear whether the grain or starter consumption data in the latter two experiments were tested statistically.

No differences were found among the groups in regard to the age at which the calves started to consume hay. The calves receiving Aurofac consumed less total digestible nutrients (TDN) and digestible protein per pound of gain than did the control calves (Table 2). An analysis of variance of the data showed that these differences were not significant. The analysis of the TDN data from birth through 7 weeks, however, produced an $F$ value that approached significance ($P = .07$). Rusoff et al. (17) reported no significant differences between aureomycin-fed and control calves in regard to feed efficiency. MacKay et al. (9) noted that calves fed aureomycin used more TDN per pound of gain than did control calves. This difference was not significant. In preliminary reports where apparently the data were not tested statistically, Loosti et al. (8) and Murley et al. (12) indicated that aureomycin-fed calves used less TDN per pound of gain than did control calves.

Calves receiving Aurofac obtained a higher condition rating than did the control calves (Table 2). They appeared to be more thrifty, had sleeker hair coats and more solid muscular appearance. Rusoff (15) observed similar results.

In order to obtain information concerning the effect of Aurofac feeding on rumination, the left flanks of certain control animals and calves receiving Aurofac were palpated periodically to determine the number of rumen movements per minute, the strength of the movements, and the apparent tone of the rumen. Since eating will affect rumination, the calves always were checked at the same time of day. The number of movements were counted during 5-minute intervals and expressed as movements per minute. Rumen tone was classified and scored as follows: quite soft, 1; soft, 2; medium, 3; hard, 4, and quite hard, 5. In previous studies at this station (6) it had been observed that when cows were fed large quantities of finely ground roughage they ceased ruminating and had very soft, flabby rumen tone. Tone such as this was indicated by a score of 1. Cows in normal health and fed normal rations usually had a firmer tone, averaging a score of 3 to 4. The strength of the movements was classified and scored as follows: quite weak, 1; weak, 2; medium, 3; strong, 4, and quite strong, 5. On this basis cows ruminating normally received a score of about 3 when not eating and about 4 when eating.

No great differences were noticeable between controls and calves receiving Aurofac in regard to the strength and number of rumen movements and rumen tone. At 12 weeks of age five randomly selected control calves averaged 2 rumen movements per minute and had an average score of 2.2 for strength of move-
ment and 2.8 for tone. At this age five calves receiving Aurofac averaged 1.9 movements per minute and had an average score of 2.6 for strength of movement and 3.6 for tone. No difference was observed between the groups in regard to age when the calves started ruminating. A few control calves and some receiving Aurofac were observed chewing cuds at 3 weeks of age. In a few instances rumen movements were felt both in calves receiving Aurofac and in controls at 2 weeks of age. On the other hand, rumen movements were not felt in some instances until the calves were 6 and 7 weeks of age. It seemed that, under the conditions of this experiment, Aurofac administration did not affect rumination.

SUMMARY

Twenty-four newborn calves of four breeds were randomly divided into three groups. Six calves in group 1 were fed a normal diet supplemented with a product from aureomycin fermentation (Lederle's Aurofac) for the first 7 weeks and six calves in group 2 were supplemented for the duration of the experiment (12 weeks). Twelve control calves (group 3) received only a normal diet. Aurofac contained 5 mg. of aureomycin per gram and was ingested once daily, by capsule, at the rate of 3 g. per 100 lb. body weight. The experiment was conducted in a barn that had proved unfavorable for successful calf raising.

At the end of the experiment the weight of the calves receiving Aurofac for 12 weeks (group 2) averaged 228 per cent of birth weight, whereas the weight of the control calves averaged 190 per cent. This difference was statistically significant. When Aurofac was taken out of the diet of the calves in group 1 at the end of the seventh week, there was a decrease in rate of gain. However, the calves in group 1 maintained their previous rate of growth for one week after the administration of Aurofac was stopped, indicating a possible carryover effect.

The administration of Aurofac resulted in a considerable reduction in the incidence of scours and colds, and the calves were in better physical condition than the control calves. During the first 7 weeks, calves receiving Aurofac consumed 67 per cent more grain than did control calves and 22 per cent more from 7 through 12 weeks. These differences, however, were not statistically significant. During the first 7 weeks there appeared to be no consistent difference in the hay consumption by the calves receiving Aurofac and by the control calves. From 7 through 12 weeks the control calves ate 115 per cent more hay than did the calves that received Aurofac. Again, the difference was not statistically significant. The calves receiving Aurofac consumed less TDN and digestible protein per pound of gain than did the control calves. These differences also were not statistically significant.

Under the conditions of this experiment, Aurofac supplementation did not affect rumination, rumen tone, or rumen movements.

REFERENCES

ANTIBIOTICS AND GROWTH OF CALVES


