Effects of Addition of Fiber to Simplified and to Complex Starters Fed to Young Dairy Calves

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Abstract

Effects of adding fiber (10% cottonseed hulls) to simplified and to complex calf starters, fed as the only dry feed to four groups of eight calves each, were investigated. The simplified calf starter consisted of ground corn grain, soybean meal, and supplements of vitamins, minerals, and an antibiotic. The complex starter contained soybean meal, linseed meal, wheat bran, cracked corn, corn meal, crimped oats, alfalfa meal, cane molasses, dried whey, animal fat, and supplements of vitamins, minerals, and an antibiotic. Additions of fiber to the simplified and the complex starters resulted in increased feed consumption and weight gains. Estimated net energy requirements per unit of gain were similar. Weight gains and energy requirements per kilogram of gain were similar for calves fed either complex or simplified starters. General appearance and incidences of diarrhea were not affected by the dietary differences. Results of this research suggest that when a starter is used as a complete feed for young calves, too low a fiber level reduces weight gains.

There is a strong trend toward the use of complete feeds for cattle. To use feeds of this type most advantageously for young calves, additional information concerning performance on diets of different fiber content is needed.

When all factors, including labor, are considered, a starter made from corn grain and soybean meal plus vitamin, mineral, and antibiotic supplements usually is the most economical way of supplying the theoretical nutrient requirements of young calves. Those fed this type of starter ad libitum plus hay performed as well as those fed either a complex starter or a simplified starter plus a bulky-fibrous additive (4). When fed hay and starter, young calves were able to perform quite well over a substantial range of starter and total feed fiber contents (8).

In each of several studies, calves fed simplified starters performed as well as those fed complex starters (1-4, 7, 9). In these experiments however, some forage, containing appreciable fiber, was fed. Also, in most instances, the simplified starters contained some ingredient such as oats or citrus pulp (1-3, 7, 9), which are relatively high in fiber. Thus, effects of different levels of fiber in diets of young calves on their performance have not been established.

The first objective of the current study was to obtain comparative information on dietary effects of adding fiber to a simple low-fiber, high-density, corn-soybean meal based calf starter and to a complex commercial-type, when no supplemental forage was included in the regimen. A corollary objective was to compare, further, responses of young calves to the simple and to the complex starters.

Experimental Procedure

Thirty-two dairy calves, consisting of 16 Holstein heifers, 12 Holstein bulls, and four Jersey bulls, were assigned to eight replications on the basis of sex and breed. Calves within each replication were allotted randomly to four experimental starters representing a 2 × 2 factorial design in which fiber (10% cottonseed hulls) was added to simplified and to a complex starter at the expense of the respective starters. Cottonseed hulls were chosen as the source of fiber, inasmuch as this is a convenient high-fiber ingredient which effectively provides the fiber needs of complete feeds for dairy cows without reducing markedly the dry matter intake. A level of 10% cottonseed hulls was selected arbitrarily as one that would materially increase the fiber percentage of the entire ration without diluting other nutrients to a hazardous level. Also, this amount would be far less than would be expected to adversely affect calf performance due to inadequate net energy intake (8). The starters were similar to those used previously (4). The percentage composition for each was as follows: the simple—soybean oil meal, 27.8; ground corn meal, 69.5; trace-mineralized salt, 0.98; de-
fluorinated rock phosphate, 1.39; vitamin A, (30,000 IU/gram), 0.22; vitamin D supplement, (27,000 IU/gram), 0.03; and antibiotic supplement, (110 g of chlortetracycline/kilogram), 0.08; the complex—wheat bran, 15.0; cracked corn, 13.7; crimped oats, 10.0; ground corn meal, 19.2; alfalfa meal, 5.0; linseed meal, 7.5; soybean meal, 15.0; animal fat, 1.5; dried whey, 3.75; cane molasses, 7.5; ground limestone, 0.6; defluorinated phosphate, 0.4; salt, 0.5; trace minerals, 0.05; vitamins A-D₃ (stabilized), 0.275 (equivalent to 6,800 IU of vitamin A and 6,800 IU of vitamin D/kilogram of total feed); and antibiotic supplement, (110 g of chlortetracycline/kilogram), 0.045. The chemical composition of the diets, by analyses, is shown in Table 1.

After birth, calves were colostrum-fed (colostrum was obtained from fresh cows in the herd, but not necessarily the calf’s dam) six days. The seventh day marked the beginning of the experimental period, at which time milk replacer and starters were introduced into the diet. Each Holstein was given 4.1 kg of milk replacer per day for 30 days and each Jersey, 3.2 kg for 35 days. Previous research (4) revealed that this system of feeding constant daily amounts of milk replacer was as effective as that of adjusting amounts based on age and weight differences of calves. The milk replacer, containing 15% air-dry solids and 85% water, was fed in two equal feedings daily from open pails.

The experimental starters were fed ad libitum as the only dry feed for the eight-week experimental period. Refusals were weighed daily. Water was offered ad libitum. The animals were weighed two consecutive days at the beginning and at the end of the eight-week period and one day biweekly during the interim.

Each calf was observed daily to detect any abnormalities. When diarrhea was observed, calves were treated twice daily with one tablespoonful of an astringent powder² as a drench.

Estimates of the relative densities (grams/100 ml) of the experimental starters, measured by pouring air-dry samples into 100-ml graduated cylinders without shaking, were a) simplified starter, 65; b) simplified starter plus 10% cottonseed hulls, 58; c) complex starter, 52; and d) complex starter plus 10% cottonseed hulls, 49.

Results
Effects of the experimental starters on feed intake (Fig. 1), weight gains (Fig. 2), feed efficiency, and health of the calves were evaluated.

Table 1. Chemical analysis of diets.

<table>
<thead>
<tr>
<th>Diets</th>
<th>Dry matter (%)</th>
<th>Crude protein (%)</th>
<th>Mineral matter (%)</th>
<th>Ether extract (of dry matter)</th>
<th>Crude fiber (%)</th>
<th>Estimated net energy (Therm/kg of dry matter)²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simplified</td>
<td>88.8</td>
<td>23.8</td>
<td>6.6</td>
<td>2.4</td>
<td>3.2</td>
<td>1.961</td>
</tr>
<tr>
<td>Simplified + cottonseed hulls</td>
<td>88.8</td>
<td>22.7</td>
<td>6.3</td>
<td>2.6</td>
<td>6.9</td>
<td>1.842</td>
</tr>
<tr>
<td>Complex</td>
<td>88.6</td>
<td>21.8</td>
<td>6.6</td>
<td>6.3</td>
<td>5.2</td>
<td>1.821</td>
</tr>
<tr>
<td>Complex + cottonseed hulls</td>
<td>89.1</td>
<td>20.3</td>
<td>6.5</td>
<td>5.8</td>
<td>8.9</td>
<td>1.702</td>
</tr>
</tbody>
</table>

² Manufactured by Jensen-Salsbury Laboratories, Division of Richardson-Merrell, Inc., Kansas City, Missouri.
Calves fed the starters containing supplemental fiber consumed more dry matter than those not given supplemental fiber (Fig. 1). The effect of the supplemental fiber on dry matter intake was larger for calves fed the simplified starter than for those given the complex starter. During all periods, the order of intake among the four treatment groups from largest to smallest dry matter consumption was as follows: complex + fiber, simplified + fiber, complex, and simplified. When evaluated statistically at the 5% probability level, the following results were obtained: For Weeks 1 through 4, calves fed supplemental fiber with either the simplified or the complex starter consumed more dry matter than those fed the simplified starter without supplemental fiber but not significantly more than those fed the complex starter. For Weeks 1 through 6, calves fed the simplified starter without supplemental fiber consumed significantly less than any other group. For Weeks 1 through 8 or Weeks 5 through 8, calves fed the complex starter plus supplemental fiber ate significantly more dry matter than those given either starter without added fiber; whereas, those given the simplified starter + fiber consumed significantly more than those fed the simplified starter, but not significantly more than those given the complex starter.

Weight gains of calves given the simplified and the complex starters, respectively, when fed either with or without supplemental fiber, were quite similar (Fig. 2) throughout the eight-week period. Calves fed supplemental fiber gained more weight than those not given the supplemental fiber. This effect was present throughout the study, with perhaps the sharpest difference occurring the fifth and sixth weeks of the experiment. When the weight gain data were evaluated statistically, the following results were obtained: For Weeks 1 through 4, gains of calves fed the complex starter + fiber were significantly (5% level) greater than those of animals given the simplified starter without added fiber. For Weeks 1 through 6, calves fed either starter with supplemental fiber gained significantly (5% level) more than those fed either starter without added fiber. During the entire eight-week period, calves fed either starter with supplemental fiber gained significantly (5% level) more than those fed the simplified starter without added fiber, and somewhat more (only significant at the 10% level) than those fed the complex starter without supplemental fiber. For Weeks 5 through 8, calves fed each of the starters with added fiber gained significantly (5% level) more than those given the complex starter, but not significantly more than those receiving the simplified starter without added fiber.

Feed efficiency was calculated both in terms of kilograms of dry matter consumption and as therms of estimated net energy consumed per kilogram of weight gains. Throughout the study, calves fed the simplified starter without supplemental fiber consumed somewhat less dry matter per kilogram of gain than those fed any other starter. For Weeks 1 through 4, this effect was not significant at the 5% level. For Weeks 1 through 6 and Weeks 1 through 8, calves fed the simplified starter without supplemental fiber required significantly (5% level) less dry matter per kilogram of gain than those fed the complex starter without supplemental fiber. No other treatment differences were significant for these periods. During Weeks 5 through 8, calves fed the simplified starter without added fiber consumed significantly less dry matter per kilogram of gain (5% level) than any other group.

Calves fed the simplified starter without added fiber required less (significant at 5% level) estimated net energy per unit of gain than those fed the complex starter without supplemental fiber during Weeks 5 through 8 and for Weeks 1 through 6. Likewise, for Weeks 1 through 6, those fed the complex starter + fiber required less estimated net energy per kilogram of gain than those fed this starter without added fiber. No other differences in energy efficiency were significant at the 5% level. Average therms of net energy consumed per kilogram of weight gain for Weeks 1 through 8 for the four groups were as follows: simplified, 3.70; simplified + fiber, 3.92; com-

![Fig. 2. Accumulated total weight gains of calves fed the four experimental starters. Seven days of age is 0 time. Standard error is one standard error of a treatment mean with eight animals per treatment.](image-url)
plex, 3.98; and complex + fiber, 3.67. Comparable values in the same order of treatments for Weeks 5 through 8 were 3.89, 4.30, 4.63, and 4.14.

In each experimental treatment group of eight calves, three had diarrhea. Average days of diarrhea per calf were: simplified, 0.5; simplified + fiber, 0.8; complex, 1.8; and complex + fiber, 1.0. With a standard error of a treatment mean of 0.5 day, there were no significant differences among dietary treatment groups. Most of the diarrhea occurred during the first two weeks of the experimental treatments, with a large portion in one outbreak in the barn. No apparent differences in the general appearance of the calves associated with the experimental starter treatments were observed.

Discussion

Results from this research are in accord with previous studies, indicating that a simplified calf starter that is nutritionally complete will give as good performance as a complex one, in which all had hay as a part of the feed (1,4, 7, 9). However, if no forage is to be fed, it would appear that too low a fiber content of the complete starter feed for young calves should be avoided.

Addition of supplemental fiber to the calf starters materially increased dry matter intake and weight gains. The influence of the supplemental fiber on feed intake was somewhat larger with the simplified starter. In contrast, the effect on weight gains was essentially equal with either the simplified or the complex starter.

The composition of the increased weight gains resulting from adding supplemental fiber is unknown. While degree of ill possibly could account for the increased weight, such does not appear to be probable. However, further research is needed to define the nature of the weight changes.

The beneficial effects of the supplemental fiber on increased gains of the calves are attributable to the increased feed intake. In fact, less feed dry matter and estimated net energy were required per kilogram of gain in calves fed the simplified starter without added fiber than for those fed this starter with added fiber. Small differences in the opposite direction were present, especially for estimated net energy requirements, for those receiving the complex starter. The over-all average therm of estimated net energy required per kilogram of gain for animals fed the two starters without supplemental fiber was very similar to that of those given the two starters with added fiber.

While no supporting data are available, it appears reasonable to speculate that the increased feed intake and weight gains which resulted from feeding supplemental fiber may have been associated with metabolic changes. There were no obvious indications of any ill effects on the health of the calves fed the starters without added fiber. Likewise, there is no reason to suspect any borderline nutritional deficiency. It is well established that feeding older cattle a diet inadequate in fiber content, or one in which all the fibrous feed is finely ground may reduce feed intake and weight gains (5). This reduced performance in the older cattle has been associated with changes in rumen microorganisms, reduced rumen pH, changes in rumen volatile fatty acid ratios, changes in rumination time, and others (5).

The results of the current work lead to the suggestion that borderline changes, similar to the metabolic problems which tend to develop in older cattle fed too little unground roughage, may also occur in young calves. Since the rumen in the calf, initially, functions relatively little, it seems reasonable to speculate that alterations in metabolism, when too little fiber is fed, might affect performance of calves to at least as great a degree as they become older. However, the data from this study are not completely definitive in this respect. While the total cumulative differences in feed consumption and weight gains due to supplemental fiber increased progressively with time, the percentage differences did not change greatly. There is also the possibility that other phenomena, such as adaptation to the rations or any undesirable metabolic effects, might increase or decrease in importance at older ages.

Fiber is relatively nonspecific, inasmuch as chemical and physical make-up varies widely (5), depending upon sources. Correspondingly, effects of different fibers on animal performance and metabolism vary widely, with that from some sources being much more effective in effecting either desirable or undesirable changes than that from other sources. Also, the metabolic problems in older cattle resulting from feeding all or nearly all concentrates vary with the ingredients used. Thus, it appears probable that the effects of adding supplemental fiber to calf starters might vary both with the source of fiber and with the ingredients used in the concentrate ration.

While the current work strongly suggests that too little fiber adversely affects the performance of young calves, the optimum fiber level has not been established; however, it ap-
pears probable that there is a considerable range over which performance would be affected relatively little. As discussed more fully elsewhere (5), at high fiber levels, the limiting factor in cattle performance, normally, is their inability to meet energy needs.

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References