Major Thesis in Dairy Husbandry

for

Degree of Master of Science

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# SUBSTITUTES FOR WHOLE MILK AS A RATION FOR DAIRY CALVES

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## Introduction

One of the greatest problems in successful dairying is to obtain good cows. The fact that every year it is becoming more difficult to buy really efficient producers makes it clear that the surest, most economical, and most satisfactory way to build up an efficient dairy herd, or to keep it supplied with good cows after it is once established, is to raise the heifer calves from the best cows bred to a good purebred sire. Furthermore, unless a dairyman raises the heifer calves with which to replenish his herd, it is almost impossible to keep the herd free from tuberculosis and contagious abortion.

Many dairymen are not raising either the male or female calves from their best stock, but are selling them for veal, thereby making no provision for perpetuating their herds or the milking qualities of the best animals in them. The dairymen's reason for doing this is that he thinks if he raises the calf he must feed it whole milk. The success of his business depends upon the amount of milk sold, therefore he argues that he cannot afford to feed his milk to the calf. In the case of cheap grade animals this is true, but for high class animals, profits can be realized when whole milk is used as a partial or total ration. In many states, the use of whole milk as a calf food is

absolutely prohibitive. This lack of milk renders it very necessary that some substitute be provided if the dairyman is to raise his calves in a satisfactory way. Dairymen have long practiced raising calves on skimmilk, supplemented by grain, hay, silage, etc., and some have used numerous substitutes in the form of calf meals.

The object of the experiment herein reported was to gain some idea of the comparative value of various substitutes for whole milk as a ration for dairy calves.

In selecting substitutes to be used, special emphasis was placed on selecting feeds which could be easily obtained under Virginia conditions.

## Review of Literature Related to the Subject

In Bulletin No. 149 of Nebraska Experiment Station, Mr. Woodward makes the following statement: "It is now fairly well understood that calves properly raised on skimmilk are equally as growthy, thrifty, and vigorous as those raised upon whole milk or those allowed to run with their dams. In fact, the skimmilk calf will oftentimes show a more rugged framework than a calf raised on whole milk. It is usual, however, for the whole milk calf to appear smoother and more plump, due to the fact that it lays on a greater amount of body fat than the calf fed skimmilk". This author gives as a reason for this that skimmilk is identical in composition with whole milk, except for the fat that has been removed. When whole milk is taken into the calf's body, the fat of the milk is used to produce heat to keep the calf warm and also to form body fat. He says this same function can be performed very much more cheaply by starchy grains, such as corn, kafir corn, and oats.

The Massachusetts Agricultural Experiment Station reports as follows on an experiment conducted by that station three years ago: In the case of 10 calves fed during the first 235 days of their lives on a small amount of whole milk, liberal amounts of skimmilk, mixtures of ordinary grains, and what rowen they would

consume, the average feed cost was $22.08, the feed cost per pound gain was 7.7 cents, and the average daily gain was 1.22 pounds.

In the case of 48 calves fed during the first 139 days of their lives on a little whole milk, together with calf meals, or with a little whole milk, 4 to 5 quarts of skimmilk per day, calf meals, and what roven they would eat, the average feed cost was $13.90, with variations of from $11.34 to $20.44; the cost of feed per pound of gain was 9 cents, with variations of from 6.1 to 13.5 cents; and the average daily gain was 1.17 pounds, with extremes of .87 pound and 1.70 pounds. Thus they show, if we would judge from the figures given, that calf meals may be purchased or prepared that will take the place of a considerable amount of whole or skimmilk and not interfere with the normal growth of the calf. He says it is doubtful, however, if one will be able to find any article or combination of articles that will completely take the place of milk during the first two or three months of the calf's life.

In Bulletin No. 257 of the Michigan Agricultural Experiment Station, we find the following statement: "Whole milk feeding is necessarily expensive, and should not be continued longer than necessary to produce good results. When feeding for dairy heifers

to be kept and grown on the farm, the skimmilk supply may begin at two or three weeks of age, but where it is desired to produce heavier weights at an early age, it is better to feed whole milk up to four or five weeks before starting the substitution. The change should be made gradually so that the calf's stomach may adjust itself to the different conditions without trouble. Begin by replacing one pound of whole milk with an equal amount of skimmilk at each feed the first day, and replace two pounds the second day, and so on".

The Pennsylvania State College Agricultural Experiment Station conducted a number of experiments for the purpose of finding a satisfactory milk substitute for dairy calves. From these experiments the following conclusions were drawn:

1. There is little difficulty in raising prime dairy calves without milk after they are two weeks old.

2. The cost of raising calves on a milk substitute, up to the time they can be put on a hay and grain ration, or when they are between three and four months of age, need not exceed ten dollars, exclusive of care.

3. Calves from high class, well bred dairy stock, when raised in this way, are worth much more than they cost, and afford the only means by which a milk dairyman can raise his herd to a high standard of excellence.

New Hampshire College Agricultural Experiment Station conducted experiments for the purpose of determining the cost of raising dairy calves. Comparisons were made between cooked ground flaxseed, and cooked middlings as a substitute for the fat in milk, and also between rations including the cooked food and those without it. The middlings proved to be a satisfactory substitute for the ground flaxseed, the cost being less and the gain in weight large enough for the purpose, though a little smaller than on the flaxseed.

The substitution of dry grain lessened the cost and the gain was sufficiently large, although smaller than in the previous period.

These experiments show that for calves several months old, there is no object in using anything but dry grain and hay along with the skimmilk, unless the greatest possible amount of growth is desired.

The University of Illinois Experiment Station conducted some experiments for determining the value of skimmilk as compared with whole milk for calf feeding. The conclusions drawn from this work are that the important thing in the raising of calves is to give them a fairly good start on whole milk during the first three weeks, and that after this, whole milk may be successfully replaced with skimmilk if the skimmilk is fed sweet and warm as it comes from the

separator. The calves should be continued on twelve pounds of skimmilk a day until they are about seven weeks old, and thereafter the amount may be rapidly reduced, so that by the time they are eight weeks old they will be receiving no milk at all. At this age, their digestive organs have normally reached a stage of development which permits the feeding of grain and hay without causing serious digestive disturbances.

From an experiment conducted by J. R. Fain and M. P. Jarnagin of the Virginia Agricultural Experiment Station in 1907, the following conclusions were drawn:

1. The following rules were observed in feeding the calves and were found quite satisfactory: Ten pounds of milk for the first 100 pounds of live weight, 5 pounds of milk for the second 100 pounds of live weight, and 2.5 pounds of milk for the third 100 pounds of live weight. Until the calf was three months old, 1 pound of grain to 10 pounds of milk was fed. From 3 to 6 months old, 1 pound of grain to 5 pounds of milk was fed.

2. The importance of hay for young calves cannot be emphasized too strongly; they should have access to good, clean hay at all times.

3. The grain consumed per day varied from 2.04 pounds with the group receiving shelled corn and bran, to 2.25 pounds with the group receiving shelled corn alone.

4. The calves fed whole milk made the largest gain, but at the highest cost per day and per pound gain. They presented a better appearance before weaning, but at eight months of age

there was little difference either in weight or appearance between those developed on whole milk and those on skimmilk.

5. Bran was used to great advantage in teaching the calves to eat grain, but no advantage was secured from adding bran to a ration of shelled corn to supplement the skimmilk, either in rate of gain or the appearance of the calf.

6. The best results were obtained from shelled corn. The calves did not consumed as much corn meal per day as shelled corn, nor did they make as large a rate of gain. It did not require as much shelled corn as corn meal per pound of gain.

7. Barley was found to be an excellent grain to supplement skimmilk, but owing to the high market price of the barley as compared with corn, it did not show as good returns financially. However, it must be borne in mind that barley can be produced pound for pound as the corn.

Nebraska reports as follows on an experiment made for the purpose of testing calf rations: "It is safe to say that linseed meal is not only an excellent food for replacing butterfat in skimmilk for calf feeding, but also an economic food in comparison with others.

"Corn oil meal gave about as good results as linseed meal and may be recommended as a calf feed.

"Corn oil meal in this test proved to be expensive and required too much work for profitable calf raising. A two percent oil mixture proved rather laxative for obtaining the best results.

"The calves fed linseed meal and germ oil meal were in good condition at the end of the test and most of them were weaned".

In Bulletin No. 304 of Cornell, the writers say that they do not wish to put themselves on record as maintaining that it does not matter how calves are fed, that the results when they become two or three years old will be the same in any case. Rather, it is intended to show that the heredity of the animal is of more consequence than any moderate influence in the care or feeding for a short time at the beginning of the development of the individual. If the calf is not stunted permanently by continuing poor feed for too long a time, the lack of thrift which might result from using a substitute for milk from the time the calf is ten days or two weeks old until it is on hay and grain entirely, may be overcome in the later development of the animal if the dry food given from the time he is five months old is proper and sufficient in amount.

Iowa Station, in Bulletin No. 14, concludes that a ration of skimmilk and ground flaxseed compares favorably with a new milk ration for young calves.

The larger gain came from whole milk but a part of it was probably due to the individuality of the calves, and good results and a thrifty growth were made on skimmilk and ground flaxseed.

The skimmilk calves were interrupted less in their growth by weaning than the whole milk calves.

A saving in value of butterfat alone of $1.11 per month on each calf was effected by substituting the ground flaxseed.

## General Plan of Feeding

The feeds selected for this experiment were whole milk, skimmilk, finely ground corn meal, high grade blood meal, linseed meal, cocomut meal, and Purina calf chow.

Description of Animals. - Twenty calves were selected, five Jerseys, two Guernseys, and fourteen Holstein-Friesians. These were divided into seven lots of 3 calves each, except one lot which contained only 2 calves. Their ages varied from 3 months to two weeks at the time they entered the experiment. In Lot I were put 1 Jersey, No. 6, and 2 Holstein-Friesians, Nos. 8 and 93; in Lot II were placed 1 Guernsey, No. 2, and 2 Holstein-Friesians, Nos. 30 and 92; in Lot II were 1 Guernsey, No. 3, and 2 Holstein-Friesians, Nos. 24 and 96; in Lot IV were 2 Jerseys, Nos. 10 and 4, and one Holstein-Friesian No. 97; in Lot V were 3 Holstein-Friesians, Nos. 9, 94, and 12; in Lot VI were one Jersey No. 7, and 1 Holstein-Friesian No. 95.

To Lot I was fed whole milk only. Lot II received a half ration of whole milk and a half ration of Purina calf chow. Lot III received a half ration of skimmilk together with a half ration of Purina. Lot IV received Purina calf chow only. Lot V received a half ration of whole milk and a half ration of a mixture consisting of 2 parts linseed meal, 2 parts cocomut meal, 4 parts corn meal and 1/2 part blood meal. Lot VI received a half ration of skimmilk and a half ration of the mixture. Lot VII received the mixture only.

Method of Working Rations. The Ormsby Standard for calculating rations was used. This standard is given below. The ration for each calf was changed every two weeks. The standard which Armsby recommends for dairy cattle was not thought to be enough, therefore all rations have been calculated by the beef standard.

Armsby Feeding Standard

| Age Months | Digestible Protein required per day per head | Net Energy required per day per head |
|---|---|---|
| 1 | .70 lbs. | 3.7 therms |
| 2 | .85 " | 4.2 " |
| 3 | .90 " | 4.2 " |
| 6 | 1.15 " | 5.0 " |

The skimmilk used was fresh from the seperator each day and was warmed to about the temperature of milk just from the cow before feeding it. The whole milk used was always fed before cooling. Water used for making the mixture and the calf chow into a gruel was about the temperature of fresh milk. Materials were weighed at each feeding according to the ration required by the Armsby feeding standard.

Time of feeding. - Animals were fed twice daily, about 7 o'clock in the morning, and again at 5 o'clock in the afternoon.

Water and salt. - Salt was allowed to remain in the manger at all times. All animals were watered once daily at about the same hour every day.

Methods of Stalling and Bedding. - Each lot of calves was kept in a large box stall well bedded with straw. Occasionally, on warm days, they were allowed to run in a small lot for a few hours at the time.

Weighing Methods.- All animals were weighed weekly at the same time each week. Weights were taken at the time the experiment was begun and again when it was finished.

The time of experiment. - This work was conducted for a period of ten weeks.

The following table shows the age in weeks, lot number, ear number, and ration fed each animal. This ration was increased every two weeks in proportion to the age of the calf.

In the case of the calves fed Purina alone, and those fed mixture alone, it was about two weeks before they would eat a full ration.

| Age in weeks | Lot No. | Number of animals. | Ration consumed daily |
|---|---|---|---|
| 7 | I | 6 | 21 lbs. whole milk |
| 4 | I | 8 | 20 " " " |
| 11 | I | 93 | 26 " " " |
| 10 | II | 2 | 13 " " " 1.5 lbs. Purina Calf Chow |
| 3 | II | 30 | 10.5" " " 1.2 " " " |
| 18 | II | 92 | 14 " " " 1.5 " " " |
| 10 | III | 3 | 12 " " " 1.5 " " " |
| 7 | III | 24 | 10.5" " " 1.2 " " " |
| 10 | III | 96 | 12 " " " 1.5 " " " |
| 5 | IV | 10 | 2 lbs. Purina 10 lbs. water |
| 7 | IV | 4 | 3 " " 12 " " |
| 10 | IV | 97 | 3.5 " " 13 " " |
| 4 | V | 9 | 10.0 " whole milk 2.0 lbs. mixture |
| 10 | V | 94 | 14 " " " 2.3 " " |
| 5 | V | 12 | 10 " " " 1.8 " " |
| 16 | VI | 1 | 14 " Skimmilk 2.3 " " |
| 8 | VI | 5 | 12 " " 2.0 " " |
| 6 | VI | 11 | 10 " " 1.8 " " |
| 7 | VII | 7 | 3.5 " mixture. 13.0 " water |
| 12 | VII | 95 | 4.5 " " 14.0 " " |

In Table No. II will be found the initial weight, final weight, total gain, average daily gain, cost per pound gain, average cost per hundred pounds increase in weight, average daily gain per group, average cost per pound gain per group, and average cost per hundred pounds gain per group, and feed used for each animal.

The price list of feeds used is given below to serve as an explanation of the extreme cost connected with the experiment. The feeds were purchased while war prices were at their highest.

Prices paid for feeds used:

| | |
|---|---|
| Coconut meal, | $60.00 per ton. |
| Corn meal, | 85.00 " " |
| Blood meal, | 120.00 " " |
| Linseed meal, | 65.00 " " |
| Purina calf chow, | 100.00 " " |
| Skimmilk, | 10.00 " " |
| Whole milk, | 60.00" " |

Table II

| Number of animal | Initial weight lbs. | Final weight lbs. | Total gain lbs. | Average daily gain of each animal lbs. | Cost per pound gain | Average cost per 100 lbs. increase in weight of each animal. | Average daily gain per group lbs. | Average cost per pound gain per group. | Average cost per 100 lbs. gain per group. | Number of group. | Feed used. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 120 | 247 | 127 | 1.81 | $0.396 | $39.60 | 1.90 | $0.406 | $40.60 | I | Whole milk |
| *6 | 57 | 111 | | | | $41.70 | | | | | |
| 93 | 209 | 350 | 141 | 2.00 | .417 | | | | | | |
| 2 | 139 | 247 | 108 | 1.54 | .305 | $30.50 | 1.42 | .346 | 34.60 | II | Purina Whole milk |
| 30 | 96 | 183 | 87 | 1.24 | .354 | $35.40 | | | | | |
| 92 | 295 | 400 | 105 | 1.50 | .380 | $38.00 | | | | | |
| 3 | 119 | 159 | 40 | .57 | .280 | $28.00 | 1.02 | .185 | 18.50 | III | Purina Skim-milk |
| 24 | 140 | 210 | 70 | 1.00 | .140 | $14.00 | | | | | |
| 96 | 162 | 245 | 83 | 1.04 | .135 | $13.50 | | | | | |
| 97 | 164 | 231 | 75 | 1.09 | .186 | $18.60 | .92 | .183 | 18.30 | IV | Purina |
| 4 | 110 | 168 | 58 | .83 | .181 | $18.10 | | | | | |
| **10 | 60 | | | | | | | | | | |
| 9 | 97 | 150 | 53 | .75 | .607 | $60.70 | 1.53 | .372 | 37.20 | V | Whole milk, Mixture |
| 94 | 253 | 434 | 177 | 2.53 | .207 | $20.70 | | | | | |
| ***12 | 129 | 156 | 27 | 1.32 | .301 | $30.10 | | | | | |
| 1 | 223 | 300 | 77 | 1.70 | .233 | $23.30 | 1.57 | .182 | 18.20 | VI | Skim-milk, Mixture |
| 5 | 135 | 244 | 109 | 1.44 | .132 | $13.20 | | | | | |
| **11 | 120 | | | | | | | | | | |
| *7 | 85 | 120 | 35 | .50 | .212 | $21.20 | .95 | .186 | 18.60 | VII | Mixture |
| 95 | 197 | 310 | 106 | 1.41 | .160 | $16.00 | | | | | |

*Deformed calf. Results not good.
**Taken off.
***On experiment only 21 days.

## Conclusions

1. To obtain the greatest possible gain, it is necessary to feed a full ration of whole milk.

2. The least cost per pound gain can be obtained by feeding skimmilk with a mixture of grain as recommended for this experiment.

3. Whole milk and Purina calf chow, or whole milk and the mixture, gave satisfactory results, though not the greatest gains.

4. Satisfactory results cannot be obtained unless a calf has either skimmilk or whole milk for at least a half ration.

5. A calf should have whole milk until four weeks old, at the least, if good results are to be obtained.

## Bibliography


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