NUTRITIVE VALUE OF RICE BY-PRODUCTS IN DAIRY CALF MEAL

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INTRODUCTION

Herd replacement is one of the major problems in dairy farming. Since the cost of replacement animals is high, milk producing ability variable, and disease risks great, it is concluded that the safest and best way to obtain good dairy cows is to raise them on the farm.

On the fluid milk market, whole milk is often too expensive to feed to calves except for the first few weeks. A method that produces thrifty calves on a minimum of milk is being sought. In some areas where cream is the product sold from the farm, the skim milk left is an excellent partial feed for calves. Where skim milk is not available, the rearing of calves is a more difficult problem.

The question of how to rear calves economically and satisfactorily when skim milk is not available is a widely investigated subject. The use of powdered skim milk has proved satisfactory (Rupel and Bohstedt; 30, p. 81), but up to the present time there has been little powdered skim milk on the market at a price that justifies its use. Many studies have been made of the minimum of whole milk required to rear calves satisfactorily. It has been shown that fair growth may be obtained by feeding whole milk for two to three months only, and relying on grain and hay thereafter. The method of rearing calves which has received a large

amount of study and is considerably used is that of substituting for milk after the first few weeks, a special grain mixture, generally called a calf meal. For the most part, the grain mixtures were finely ground and were incorporated in the milk, or were mixed with warm water and fed as a gruel. The method proved very laborious and required a great deal of careful management, so that the gruel method of feeding calves has not been so popular recently as other methods.

During recent years, dry calf-starters, or calf meals, have come into extensive use as supplements to, or substitutes for milk. Several investigations show the values and advantages of the dry calf-starter method for raising calves with a minimum of milk. This method is economical, and the care and labor required in feeding are reduced to a minimum. After the first few weeks all of the feeds are given in dry forms, eliminating much of the labor connected with pail feeding. This method is effective in producing thrifty calves that are above normal size with large body capacity (Savage and McCoy; 36, p. 636).

Various formulas for dry calf-starters have been developed that have produced successful results. In most cases such formulas have contained a mixture of various grains and grain products, oil-seed meals and varying quantities of skim milk powder, blood meal or some source

of animal protein. Many kinds of good calf-starters are now being used. Many different formulas have been satisfactory. However, no one starter has proved to be consistently better than all others, or, there has not been any one best formula for all conditions. The development of formulas based on more economical and generally available ingredients appears desirable.

The major constituent of the calf-starters is grain or grain-products which are carbonaceous feeds. Ground oats, ground corn, wheat bran and ground grain sorghum have been used extensively. None of the calf-starters reported in the literature employs rice products as its major portion. Since rice is the most important grain crop of the coastal plain of the Gulf States and the rice industry furnishes as by-products a supply of feeds such as rice bran and rice polish, these feeds are usually cheaper, more readily available and require less transportation in many parts of the country than other similar feeds. Information on the values of these by-products is needed in order to use such materials to the best advantage, especially when they are used in dairy cattle feeding.

This paper reports the results of an experiment on raising of calves on a dry calf-starter in which rice products were included as the major ingredients.

REVIEW OF LITERATURE

From the beginning of the interest in rearing calves with a minimum of whole milk, a number of experiments have been carried out over the last fifty years in searching for a milk substitute that could replace whole milk partly or entirely in calf feeding. The common ingredients of calf meals used at present include ground grain and grain-products such as bran, oil-seed meals, protein supplements, such as blood meal and skim milk powder, mineral supplements, salt and many others. In formulating a calf meal, the nature of calf nutrition and properties of each ingredient to be used must be thoroughly studied. To understand the problem more clearly the literature on the development of calf meals or calf starters has been reviewed.

The Early Development of Calf Meals

In general the nineteenth century was quite lacking in the development of improved methods for feeding calves. Among the early substitutes for whole milk in calf feeding were skim milk and flaxseed meal. Steward (40, p. 649) in 1883 used a pint each of flaxseed and of linseed oil meal boiled with 10 quarts of water. This was mixed with one or two parts of skim milk and fed warm. He claimed calves could be reared by the above system as well as by feeding

milk.

In 1894, Haecker (11, p. 79) reared calves upon skim milk supplemented with flaxseed meal, bran and corn meal. In 1902, Hayward (12, p. 5-6) reported good results with some mixtures of feedstuffs fed as gruels. He fed a mixture of wheat flour 1 part, flaxseed meal 2 parts and linseed meal 3 parts. This was started when the calves were two weeks old and the gruel was made by adding 2½ pounds of the dry mixture to two gallons of boiling water. Another meal used by Hayward was wheat flour 30 pounds, coconut meal 25 pounds, dry skim milk 20 pounds, linseed meal 10 pounds and dried blood 2 pounds. Dried blood was supposed to check the scours and wheat flour was also supposed to keep the bowels from getting too loose. All of the calves fed the meal seemed to grow as well as other calves which were raised on skim milk, hay and grain. He admitted that the calf-meal was not as satisfactory as good whole milk for very young calves, and it was quite likely that for the first few weeks upon this ration the calves did not have the vigor or power of resistance to disease and adverse weather.

In 1915, Lindsey (20, p. 49-65) published a review of the calf meals in use up until that date. In these meals were such ingredients as locust bean meal, ground bean and peas, cocoa shells, cotton seed meal, salt, rice polishings,

starch, tapioca and sage. He concluded from the results obtained from feeding trials that calf meals may be prepared that will take the place of considerable amounts of whole milk and skim milk and not interfere with the normal growth of the calf.

A study on the formulation of calf meal mixture was carried out at Cornell by Savage and Tailby (34, p. 30-31). They found that many calf meals on test such as Schumacher's calf meal and Lactina Suisse did not appear from the trial to be a complete substitute for skim milk, yet the gains from these calf meals were good and the cost per pound of gain was fairly low. They also state that it is evident from results of experiments that good, healthy calves can be raised without milk of any kind after the first 30 days. Schumacher's calf-meal seemed to be the best commercial meal. Calves on this meal made a daily gain of 1.25 pounds. Blackford's calf-meal and Lactina Suisse gave fair results but were too expensive. Savage and Tailby found that soluble blood meal mixed with calf feed served to keep the bowels of the calf in better condition.

Spitzer and Carr (39, p. 315-339) developed Purdue calf meal which consisted of 8 parts corn meal, 1 part oil meal and 2 parts liquid blood meal and in addition two per cent of bone meal. The drying was done at 140° to 160°F. After drying, the meal was ground to pass a 30 to 40 mesh

sieve. This calf meal was diluted with water at 98° to 99°F when fed. This meal was reasonably successful as a substitute for feeding young calves, but it requires a large amount of labor.

Maynard and Norris (21, p. 483-508) in 1923 used a mixture of corn meal 25 per cent, ground oat groats 15 per cent, red dog flour 25 per cent, linseed oil meal 15 per cent, ground malted barley 10 per cent, soluble blood flour 10 per cent, limestone 1, bone meal 1, and salt 1 per cent. They obtained excellent results from feeding this calf meal made up into gruel, replacing the whole milk on the twentieth day.

Morrison and Rupel (24, p. 37-39) studied the value of calf meal which is composed of ground corn 25 parts, wheat flour 25 parts, ground oats 25 parts, linseed meal 12 parts, soluble blood flour 10 parts, and some salt, bone meal and ground limestone. This meal was fed as gruel. Calves fed this calf meal gained 1.54 pounds a head daily. Addition of 10 per cent tankage to this meal did not result in any improvement in growth of calves.

The Development and Improvement of Dry Calf Starters

In recent years the trend is away from calf meals and gruels to dry calf starters. In 1924 Mead and co-workers (22, p. 440-459) at the New Jersey Experiment Station

introduced a method that involved the feeding of a dry calf starter with a small amount of fluid milk. This was an important change because it meant doing away with liquid feeding except a small amount of whole milk. Thus, the labor of raising calves has been greatly reduced.

Bender and Perry (1, p. 1-4) developed a method of feeding calves with a dry calf starter at the New Jersey Experiment Station. Calves were started on whole milk, limited to 3 quarts a day, and at 3 weeks of age the milk was gradually reduced by diluting it with water. After the calf was a month old, it was fed only a dry calf starter, hay and water. The amount of calf starter was limited to six pounds daily, regardless of breed. The calf got the balance of its nutrients from the hay which was given free choice. The recommended calf meal mixture was composed of 25 per cent ground corn, 37.5 per cent ground oats, 12.5 per cent wheat bran, 12.5 per cent linseed oil meal, 12.5 per cent soluble blood flour, 1 per cent steamed bone meal, 1 per cent ground limestone and 1 per cent salt.

Savage and Crawford (33, p. 23-24) developed the first Cornell dry starter using a rather complex mixture. The Cornell starter (CS) had been used commercially for years and had given very fine results. It was fed with a minimum of 350 pounds of whole milk fed over a period of 7 to 10 weeks.

Jones and co-workers (15, p. 9) at Oregon State College in experimental work used O.S.C. calf meal which consisted of ground oats 150 pounds, ground yellow corn 100 pounds, wheat bran 50 pounds, linseed oil meal 50 pounds, soluble blood flour 50 pounds, steamed bone meal 5 pounds and salt 5 pounds. This calf starter is still in use, with little modification, at Oregon State College Dairy Farm.

The dry calf starter system of rearing calves has been established since 1935. The method, as outlined by Turk (43, p. 11-12) consists of feeding a minimum amount of whole milk (approximately 350 pounds) for a short period (7 to 10 weeks). The calf is then weaned and must grow after weaning on a diet of mixed ingredients, a calf starter, hay and grain. The calf starter is fed ad lib. as soon as the calf will eat it until it is 12 weeks of age, and then the amount of calf starter is limited to four pounds per day and a simple mixture of ingredients like ground corn and oats, wheat bran and linseed oil meal is added. At 16 weeks the calf starter is dropped from the ration because of its cost. Hay is fed ad lib. as soon as the calf will eat it and water is kept before the calf at all times.

Generally, all of the satisfactory calf starters are made from quality grains, grain products, oil seed meals, dried skim milk or dried whey, and sometimes blood meal, fish meal or other suitable materials. The mineral and

vitamin content is carefully worked out since the feed is used, in part at least, at a time when the rumen of the calf is not functioning extensively. The subsequent investigations have been aimed towards the improvement of the starters in both nutritional and economical aspects.

Krauss and co-workers (19, p. 45-51), in comparing blood flour, with skim milk powder, white fish meal and dry rendered tankage, found that blood meal could be replaced by any of the above feeds in a calf starter. The growth of the calves was comparable to those receiving liquid skim milk.

Elting and LaMaster (7, p. 19) found a simple mixture of 34 to 40 parts ground corn and 35 to 44 parts ground oats could be supplemented with 10 parts of fish meal or dried skim milk or 20 parts of cotton seed meal. A comparison of fish meal with cotton seed meal as a source of protein in the calf's ration indicated that cotton seed meal is more palatable, had no harmful effect and promoted larger average gains than the fish meal ration. The addition of skim milk powder to the ration of very young calves prevented the severe setback in growth immediately following the milk weaning period.

Williams and Bechdel (44, p. 20) compared dried skim milk with blood flour as a source of protein in calf starter. They reported that the dried skim milk fed calves

maintained a more thrifty appearance than the blood ration calves. At six months little difference between the two groups could be detected.

Trimberger and Davis (42, p. 22) reported that soybean oil meal was not a suitable protein supplement for calf starter when fed alone. They also found that animal protein supplements such as meat meal, dried whey plus blood meal, dried skim milk and blood meal were equally satisfactory as sources of protein in calf starter.

Norton and Eaton (26, p. 28) in comparing 12 calf starters with Cornell starter concluded that non-animal protein starter gave as good result as starters with animal protein supplement. They also stated that molasses and alfalfa meal improved palatability of the starters and caused no laxative effects.

Rusoff and Estess (31, p. 83) in a study on the effect of levels of animal protein in calf starter on growth found that a calf starter containing five per cent of animal protein made the same growth in calves as a 15 per cent animal protein starter would make. No significant differences occurred in calves in body weight gain, height at withers or grain consumed per pound of weight gain at 90 days of age.

Edgerly and Jensen (5, p. 95-96) at North Dakota Agricultural Station found that when young dairy calves

received whole milk for the first eight weeks of age and had available good quality alfalfa hay, the digestible protein content of the dry calf starters did not need to be more than 12 per cent. They suggested a formula of 12.3 per cent digestible protein which consisted of ground corn 350 pounds, wheat bran 250 pounds, ground oats 250 pounds, linseed oil meal 100 pounds, dried skim milk 50 pounds, dicalcium phosphate 10 pounds, trace mineralized salt 10 pounds, and vitamin A and D supplement 2 pounds.

Brown and co-workers (4, p. 1425-1433) in experimental feeding of calves with calf starters of different levels of protein ranging from 8.5 per cent to 24.3 per cent, found no significant differences in growth rates of calves receiving starters containing either 12.3, 16.6, 20.0, 20.2, or 24.3 per cent protein. A starter with 8.5 per cent protein gave the lowest gain. The most efficient gain as measured in terms of pounds of feed per pound gain were by 16.6 per cent protein starter.

In recent years, it has been found that a good calf starter is not necessarily a complex misture as given by many investigators. Kesler and Wilson (16, p. 10) at Pennsylvania Agricultural Experiment Station demonstrated that a simple concentrate mixture gave as good results as the more complicated starters. When good alfalfa hay is fed, 15 per cent crude protein in the concentrate is

sufficient to result in efficient growth.

Holter (13, p. 53-59) at Cornell compared a simple calf starter with a complicated starter in feeding calves up to four months of age on limited whole milk dry calf starter system. Calves fed the simple starter ate very similar amounts of feed and made gains comparable to those of the calves fed regular starter. No incidence or intensity of scours in the simple starter group were observed. Similar results were obtained by Murley and co-workers (25, p. 982-986) at North Carolina Agricultural Experiment Station in a comparison of a simple concentrate mixture containing soybean oil meal, maize, oats and molasses with a more complex mixture.

Rice Products as Constituents of Feed Mixture

Rice bran and rice polish are important by-products of milling rice. Commercial rice bran is composed primarily of the embryo and the outer seed coat layers. Rice polish is obtained in the later stages of the milling processes and is composed of the very thin inner seed coat layers covering the grain, together with some starchy material.

Although rice and rice products have been used extensively in feeding of livestock in many parts of the world, very little information on the value of rice products in dairy calf feeding is available. Samala and co-workers

(32, p. 49-77) of the Philippines, in a comparative study of different milk substitutes in calf feeding, used Araneta calf starter which is composed of copra meal 15 parts, rice bran 20 parts, yellow corn 5 parts, soybean meal 5 parts, distiller's yeast 5 parts, ipil-ipil 5 parts (Leucaena glauca), Man-o-mar 2 parts, molasses 5 parts, skim milk powder 10 parts, and 1 per cent salt, 1 per cent limestone and .15 per cent Vigofac and .10 per cent terramycin in addition. This calf starter contains about 30 per cent rice bran.

For dairy cattle, Morrison (23, p. 458) reports that rice polish forming one-fourth of the concentrate mixture is equal to ground corn, but it tends to produce soft butter.

According to Snell (38, p. 6) rice bran is the principal by-product of rice milling industry. It is a low price feed, medium in protein content, high in fat, and high in phosphorus but low in calcium. Rice bran contains about 84 per cent as much calculated digestible nutrients as No. 2 corn. The bran proteins are of good quality and appear to supplement the protein of corn in a desirable manner when corn and rice bran are fed together. The high oil content of bran makes it difficult to store, but this can be overcome by modern milling processes.

Rice polish is a concentrated and highly digestible feed of fine texture, quite palatable to livestock. Very

low in fiber, it contains more protein and fat than corn and a higher percentage of digestible nutrients. The proteins of rice polish are better balanced than the protein of corn.

Kik (17, p. 170-172) made an extensive study of nutritive values of rice bran and rice polish in Arkansas. Analysis data prepared by Kik showed that rice bran and rice polish are very rich in niacin and thiamine. They also contain fair amounts of many essential amino acids needed by young calves. The proximate analysis of rice bran and rice polish are as follows:

	Rice bran (per cent)	Rice polish (per cent)
Moisture	9.80	9.80
Protein (n x 5.95)	9.10	10.47
Fat	13.66	16.40
Ash	12.00	13.20
Carbohydrates	55.44	49.13

Most of the rice by-products are used in feeding of swine and beef cattle. Emasiri (8, p. 848-855) found that young pigs on 75 per cent rice bran ration were more efficient in rate and economy of gain than those raised on 75 per cent corn ration.

For beef cattle, Jones and co-workers (14, p. 39-50) fed rice bran in place of ground corn at different levels to growing beef cattle. They found that the 26.5 per cent

rice bran-fed lot made the highest gain per day, 2.30 pounds, as compared to 2.11 pounds for the ration of corn alone.

Snell and co-workers (38, p. 12) on a study of the relative value of rice by-products found that rice products, especially rice polish, with the possible exception of rice bran, produced satisfactory gains in beef cattle. It was calculated that these products had feeding values varying from 76 to 81 per cent of that of corn.

Knox and co-workers (15) substituted 3.85 pounds of rice bran for part of the ground milo and cotton seed meal in a steer fattening ration. The rice bran amounted to 20 per cent of the concentrate ration. The gains increased 0.21 pounds per day and net profit increased $3.36 per steer. Evidently the rice bran made a good supplement to ground milo.

Rice by-products have been used in dairy cattle feeding in some areas where they are readily available at reasonable prices. Investigations on the value of rice products for the feeding of dairy cattle have been carried out in the Southern States. The early work of Emery (9, p. 444) at the North Carolina Experiment Station indicates that rice bran is inferior to wheat bran when fed to dairy cattle.

Sheets and Semple (37, p. 4) state that for cows giving milk rice bran is worth, in digestible nutrients, about

five per cent more than wheat bran and from 75 to 80 per cent as much as ground corn. Fresh rice bran seems to be as palatable as wheat bran when it makes up not more than one-third of the total grain ration. Rice polish appears to be equal or slightly superior to ground corn for the production of milk. They cited the statement made by workers at Arkansas that scouring of animals occurs when rice polish makes up 60 per cent or more of the ration.

Bray and Upp (2, p. 7) at Louisiana Experiment Station state that rice bran, when making up not more than one-third of the grain ration, is equal to wheat bran and worth about 90 per cent as much as ground corn. They also suggest concentrate formulas containing rice bran and rice polish for dairy cattle at different protein levels.

OBJECTS OF THE EXPERIMENT

Conclusions from experiments conducted at various places reveal that rice bran and rice polish can be used in stock feeding in substitution for other grain and grain products. This experiment was conducted to determine, first, if rice bran and rice polish could be incorporated up to 50 per cent of the calf starter; second, if calves raised on this starter would make normal growth; and third, the efficiency of feed use that calves would make on the ration containing rice products.

EXPERIMENTAL PROCEDURE

Experimental Animals

Calves used in this experiment were pure bred Holsteins and Jerseys dropped in the herds of Oregon State College, Corvallis. In the total of 16 calves studied were eight female Holsteins and eight female Jerseys. Though the calves were not placed on the experiment from the first day of their lives, the birth date and birth weight of all the calves were recorded. Age of calves at start ranged between 7 and 63 days, but the majority were about 25 to 30 days.

Sixteen calves were paired by breed. Attempt was made to match the calves of the closest age and weight. One of each pair was assigned at random to one of two starters.

From the third day of their lives up to the day the experiment began, the calves were fed whole milk twice a day at the rate of six pounds for Jerseys and eight pounds for Holsteins.

Housing and Management

The calves were kept in individual pens on a concrete floor with wood shavings. Each pen measuring 5 x 5 feet was provided with an automatic water cup and a metal feed box. A wooden hay box constructed in such a way that hay cannot be stolen by the calf in the other pen was placed at the corner of each pen.

All calves were fed liquid whole milk daily from a nipple pail at a rate of six pounds for Jerseys and eight pounds for Holsteins in two feedings, half in the morning and half in the evening. Whole milk was fed until the calves were at least 10 weeks old or longer depending on the health of the calves. Some of the Jersey calves received whole milk up to 20 weeks of age. The calves were allowed all the dry calf starters they would eat from the beginning of the trial until a maximum of four pounds daily were being consumed, then the starter allowance was limited to four pounds daily, regardless of breed. Five pairs of calves were given a medium quality oat hay and grass hay, and the remainder were fed pelleted alfalfa hay. Hay and

hay pellets were fed ad libitum throughout the experiment. The digestible nutrient content of the feeds used is presented in Appendix I.

Calf Starters Used

Two calf starters were used in the experiment. The O.S.C. calf starter No. 2 (12, p. 10) containing ground oats, ground corn and wheat bran as basal feeds was modified so that linseed oil meal was replaced by soybean oil meal. Ground oats was reduced to 25 per cent of the mixture. This resulting calf meal served as a control in the experiment.

The experimental starter was developed to utilize rice products up to 50 per cent in the mixture. The formula was different from the O.S.C. starter in that ground oats and wheat bran were replaced by rice polish and rice bran. Ground corn was also used but the amount was reduced to 15 per cent of the mixture.

The compositions and the calculated digestible nutrients of the starters are as follows:

	Modified O.S.C. Starter (per cent)	Experimental Starter (per cent)
Ground oats	25	-
Wheat bran	17	-
Ground corn	25	15
Rice polish	-	35
Rice bran	-	17
Soybean oil meal	15	15
Dried skim milk	15	15
Sterilized bone meal	1.5	1.5
Iodized salt	1.5	1.5
Total	100	100
Digestible protein*	15.72	15.87
Total digestible nutrients*	74.24	76.00

*Calculated using data from Morrison (22nd edition)

Both starters contained almost the same amount of digestible protein. According to Brown and co-workers (4, p. 1425-1433) it has been found that dairy calves do not require starters containing more than 12.0 to 16 per cent crude protein to maintain normal growth when a limited amount of whole milk and a medium to good alfalfa hay are fed. Starters used in this experiment had a higher protein content than that recommended by Brown.

Records Kept

Individual records were kept of all the feeds offered and refused each week. Total digestible nutrients consumption was calculated using figures from Morrison's "Feeds and Feeding" 22nd edition (23, p. 1000-1069).

Growth measurements, consisting of body weight, height at withers, and heart girth, were recorded at the beginning of the experimental period and at weekly intervals thereafter up to 16 weeks.

Health records were kept, noting all cases of scours and other abnormalities.

The studies reported in this paper began on December 22, 1959 and extended to September 1, 1960, covering a period of 254 days.

RESULTS AND DISCUSSION

Characteristics and Palatability of Starters

Since rice products constituted about 50 per cent of the experimental starter, its physical texture appeared to be very fine. It did not have any apparent sign of rancidity after having been stored for more than six months. Palatability was not a problem in this starter. Tables VIII and IX present the average weekly consumption of starters up to 16 weeks of the experimental period. The differences in the amount consumed each week between the control and the experimental groups were slight in both breeds. There is some evidence that the physical nature of the starter affects its palatability. Calves generally prefer coarsely ground feed. It was observed that the control starter was readily eaten by the calves at first offering, while the fine textured experimental starter was not willingly accepted until the calves were accustomed to it. Data in Tables VIII and IX show that in the first few weeks of the experimental period the calves consumed more of the control starter than of the experimental one in both Holsteins and Jerseys. If the statement made by Norton and Eaton (26, p. 25) is true that the test of the palatability of a calf starter is at early age, it is apparent that the control starter was superior in preference of the calves to

the experimental starter.

However, there might be greater differences in the total starter consumption between these two groups if the amount of starter given was not limited to four pounds per calf per day. The differences of the total starter consumption in this case do not indicate the palatability of the starters in any way.

Health of Calves

In general all calves, except Jersey No. 432 in the control group, appeared healthy and thrifty throughout the experiment. Scours were not a serious problem and those cases that did occur seemed not to be restricted to any particular group. Scours developed in some calves especially during the early part of the experiment, but the incidences were comparatively low throughout. There were no significant differences in the intensity of scours between the two groups, and scours did not seem to interfere with growth of the calves. It was also noted that scours occurred more frequently in some calves than in others.

Jersey calf No. 432 of the control group was very weak at the beginning of the experiment and lost body weight somewhat in the second week. However, it made a remarkable recovery in the third week and resumed increases in weight thereafter.

Holstein calves No. 732 and No. 735 had bloat several times during the trial, but cases were very mild and the condition never lasted longer than 24 hours. Both calves ate pelleted hay throughout the experimental period. According to Dougherty (10, p. 110) it is possible that the fine texture of pelleted alfalfa hay could be a contributing factor to the bloat in these cases.

No other abnormalities were observed.

Gain in Weight and Measurements

The initial and final weights and measurements of each calf are shown in Tables I and II for the Holstein and the Jersey calves respectively. For individual calves, the original weights of Holsteins ranged from 98 to 120 pounds. The average initial weight for the control group was 108.25 pounds and for the experimental group was 110.75 pounds. The average initial measurements of the experimental group were slightly higher than that of the control group. At the end of the trial the average weight of the calves in the control group was 324.75 pounds, and of those in the experimental group was 317.0 pounds. The average gain in weight per calf, as shown in Table XII, was 216.5 pounds for the control group and 206.25 for the experimental group. The difference of gain in weight was 10.25 pounds in favor of the control calves and was not statistically significant

(Table XIV). The average gains in height of both groups were almost the same, but there was some difference in the average gains in heart girth in favor of the control group following the same pattern of that of gain in weight.

The Jersey calves had wider variations in the initial weight than the Holsteins. The original weights of Jerseys ranged from 56 pounds to 97 pounds with an average of 70.5 pounds for the control group and 67.0 pounds for the experimental group. The average initial heights of both groups were not much different, but the average heart girth of the control group was slightly greater than that of the experimental group. The final weights of the Jersey calves also fell within a wider range especially in the control group that had one bigger calf (No. 426) at the beginning. The average final weight of the control group was 212.25 pounds and of the experimental group was 220.25 pounds. The average gain in weight of the control group was 141.75 pounds, while that of the experimental group was 153.25 pounds. The difference of gain in weight between the two groups was 11.50 pounds in favor of the experimental calves. Table XV shows the analysis of variance of gain in weight indicating no significant difference between the two groups. The experimental calves also apparently had higher heart girth average than the control calves. The average heights at withers of the two groups were identical.

To conclude, the significance of difference of weight gains between control and experimental calves, data of gains in weight in 16 weeks of experiment with both Holsteins and Jerseys were combined and analyzed. The analysis of variance in Table XVI indicates that there was no significant difference in weight gains between these two groups of calves with respect to the factors studied.

Analysis of variance for gain in each measurement was also carried out for both Holsteins and Jerseys. There were no significant differences in height at withers and heart girth between control and experimental calves.

It is apparent that the experimental, rice-supplemented diet was as satisfactory as the standard control diet in these experiments.

Table I. Initial and Final Body Weight, Height at Withers, and Heart Girth of Holstein Calves.

Calf No.	Age, days Initial	Age, days Final	Weight, lbs. Initial	Weight, lbs. Final	Height, in. Initial	Height, in. Final	Girth, in. Initial	Girth, in. Final
				Control Group				
727	22	134	110	336	30.0	37.5	35.0	47.5
729	37	149	109	312	30.5	39.0	31.0	46.0
734	29	141	98	332	29.5	38.0	32.0	46.5
735	21	133	116	319	31.0	37.5	34.0	46.5
Mean	27.25	139.25	108.25	324.75	30.25	38.0	33.0	46.62
S.D.	6.418	6.418	6.496	9.679	.559	.612	1.581	.545
				Experimental Group				
726	36	148	109	285	31.0	38.5	33.0	45.5
730	32	144	108	313	30.5	37.5	32.5	45.5
733	29	141	106	331	30.5	38.5	33.5	46.5
Mean	32.0	144.0	110.75	317.0	30.87	38.5	33.5	46.12
S.D.	2.55	2.55	5.448	6.557	.424	.224	.935	.205

Table II. Initial and Final Body Weight, Height at Withers, and Heart Girth of Jersey Calves.

Calf No.	Age, days Initial	Age, days Final	Weight, lbs. Initial	Weight, lbs. Final	Height, in. Initial	Height, in. Final	Girth, in. Initial	Girth, in. Final
				Control Group				
426	63	175	97	284	29.0	35.5	34.0	44.5
429	7	119	56	192	25.5	35.0	28.0	39.5
432	27	139	67	189	27.0	35.0	28.5	39.0
433	17	129	62	184	27.0	34.0	28.0	39.0
Mean	28.5	140.5	70.5	212.25	27.12	34.87	29.62	40.5
S.D.	21.137	21.137	15.788	41.523	1.244	.545	2.534	2.318
				Experimental Group				
427	28	140	67	239	26.0	34.0	29.0	41.5
428	17	129	65	211	27.5	34.5	29.0	40.0
431	27	139	70	206	27.0	35.0	28.5	40.0
434	15	127	66	225	27.5	35.5	27.5	42.0
Mean	21.75	133.75	67.0	220.25	27.0	34.75	28.5	40.88
S.D.	3.375	3.375	1.871	12.872	.612	.559	.612	.893

Table III. Average Weekly Body Weight, Height at Withers, and Heart Girth of Holstein Calves.

Age weeks	Control Group Weight lbs.	Control Group Height in.	Control Group Girth in.	Experimental Group Weight lbs.	Experimental Group Height in.	Experimental Group Girth in.
Birth	84.25			86.25		
1	-			-		
2	-			-		
3	-			-		
4	113.0	30.50	34.00	111.33	30.83	33.33
5	118.25	31.12	33.37	119.25	31.50	33.75
6	126.25	31.50	34.62	127.75	31.87	34.87
7	135.50	32.12	35.62	137.25	32.25	35.50
8	149.0	32.37	36.87	147.0	32.62	36.25
9	159.75	33.0	37.37	155.50	33.25	36.87
10	173.75	33.62	38.87	169.0	33.87	37.50
11	189.50	34.25	39.62	183.50	34.37	38.37
12	202.75	34.62	40.12	194.50	35.0	39.62
13	220.75	35.50	41.62	205.75	35.12	40.12
14	235.75	35.75	42.37	220.25	35.62	41.37
15	253.50	36.12	43.12	239.0	36.50	42.0
16	266.75	36.50	43.50	254.0	36.62	42.87
17	284.75	37.0	44.75	268.5	37.12	43.37
18	302.0	37.12	45.62	281.50	37.50	44.37
19	317.25	37.25	46.12	298.50	37.87	44.87
20	319.50	38.25	46.0	315.75	35.50	45.87

Average of less than three calves is omitted.

Table IV. Average Weekly Body Weight, Height at Withers, and Heart Girth of Jersey Calves.

Age weeks	Control Group Weight lbs.	Control Group Height in.	Control Group Girth in.	Experimental Group Weight lbs.	Experimental Group Height in.	Experimental Group Girth in.
Birth	53.25			62.50		
1	-					
2	59.50	26.25	28.00	65.50	27.50	28.25
3	63.50	27.00	28.25	70.00	28.00	28.75
4	69.00	27.33	28.67	73.25	27.37	29.25
5	71.00	27.83	28.83	79.00	27.87	29.62
6	78.00	28.17	29.50	85.00	28.12	30.25
7	84.67	28.50	30.50	91.75	28.50	31.00
8	90.00	29.00	31.30	99.00	29.37	32.00
9	96.25	29.37	32.62	109.00	29.87	32.75
10	105.25	29.75	33.00	120.50	30.50	33.87
11	112.75	30.12	33.62	129.75	31.12	34.87
12	122.50	30.75	34.37	140.00	31.50	35.50
13	133.25	31.25	35.12	150.50	32.00	36.50
14	144.25	31.87	36.00	160.75	32.25	37.37
15	153.50	32.25	36.87	175.25	33.00	38.12
16	168.75	32.75	38.00	187.75	33.37	38.75
17	178.00	33.50	38.52	199.75	34.12	39.62
18	183.30	33.50	37.17	209.50	34.37	40.25
19	198.00	33.50	40.25	215.50	33.87	40.50
20	208.50	33.87	40.50	222.50	34.50	40.75

Figure I. Curves of growth in weight of Holstein calves

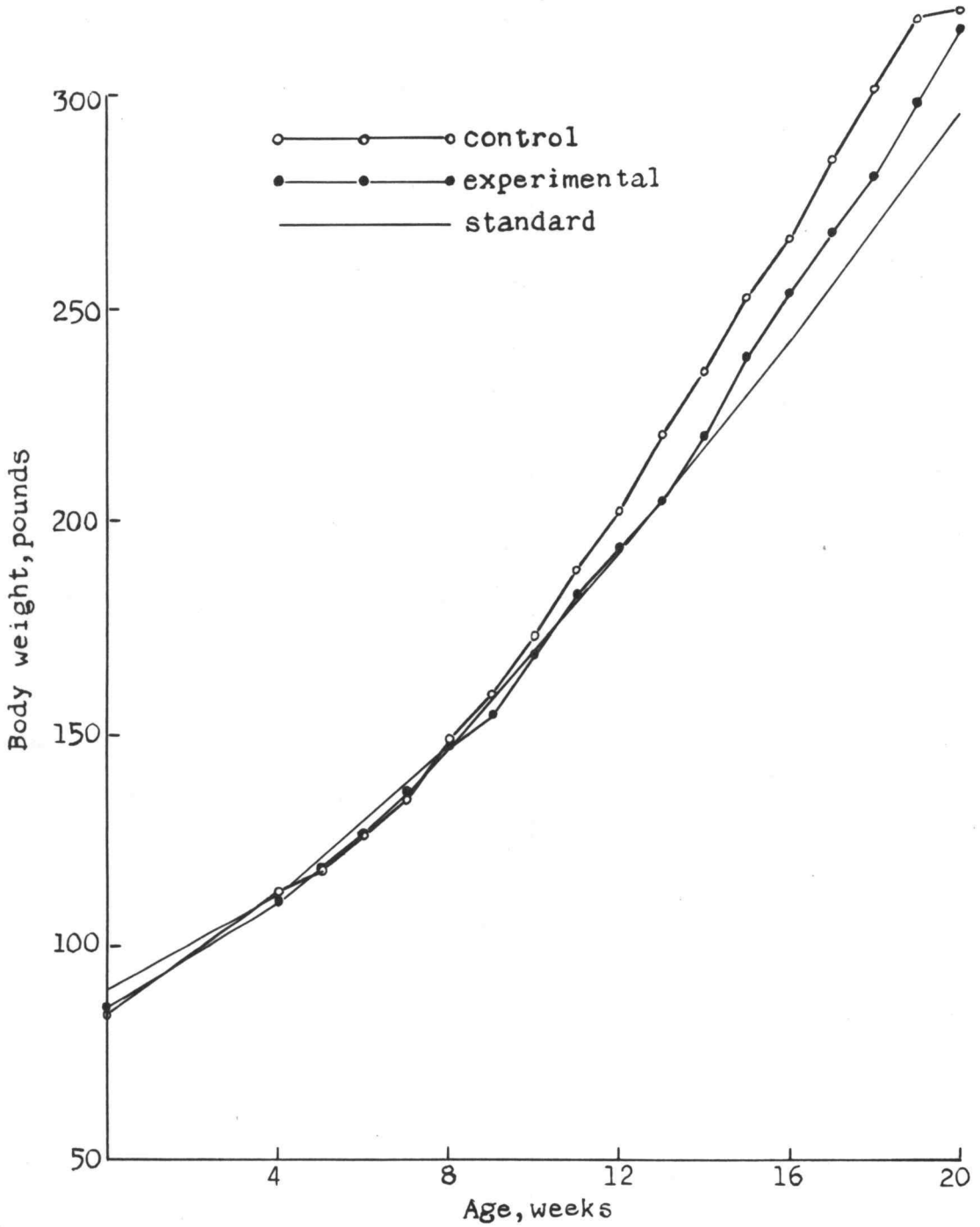
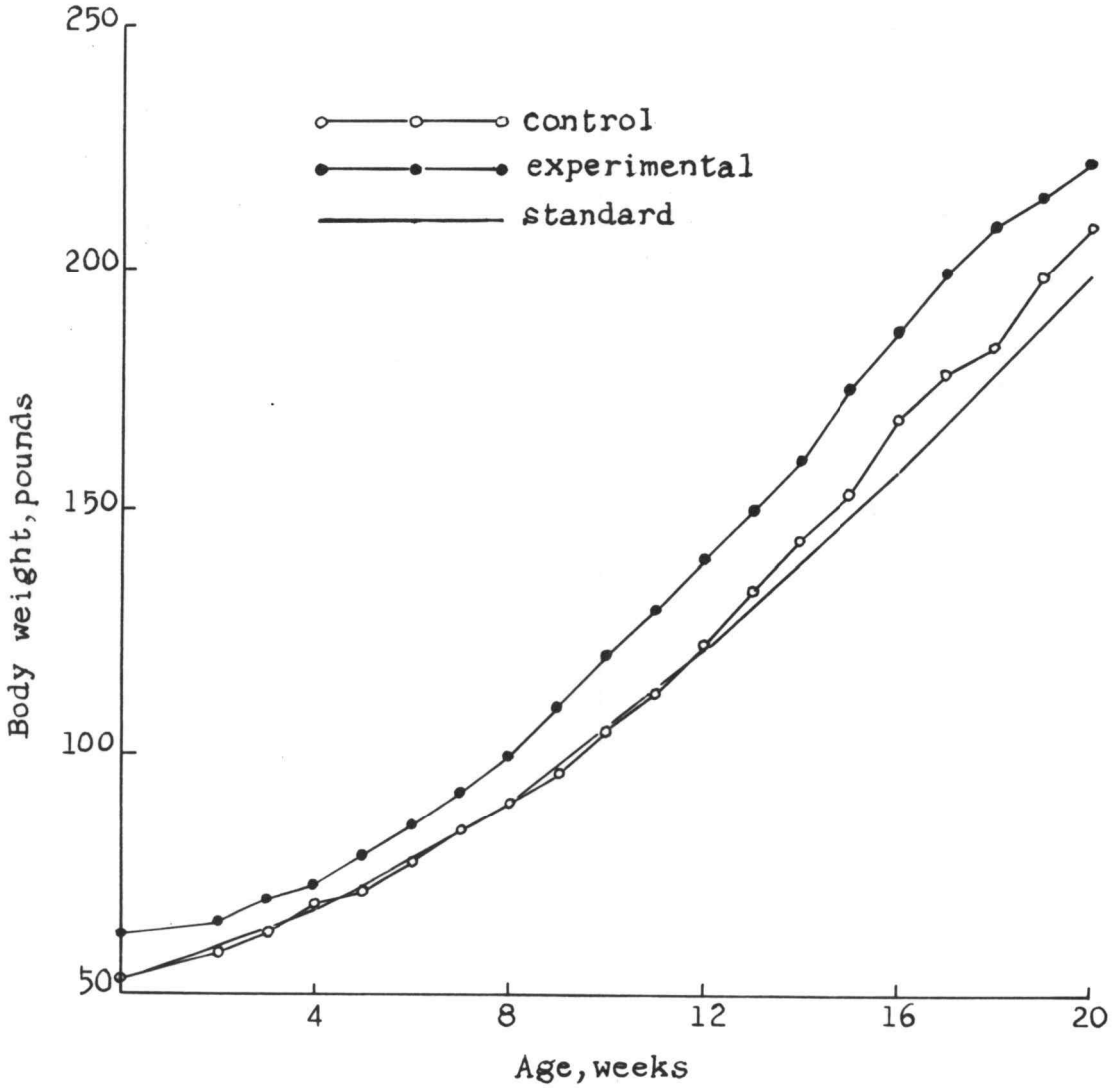


Figure II. Curves of growth in weight of Jersey calves



Daily Gains in Weight

The average daily gains in weight for each month are presented in Table V. Data indicate that the average daily gain increased with age in both Holsteins and Jerseys. The daily gain began to decline in the control group of Holsteins and in the experimental group of Jerseys in the fifth month. This coincided with the greater gains in the early months of these groups. It appears that calves that make better gains during the early months tend to decline in rate of gain sooner than those having the slower rate during the early period. Ragsdale (29, p. 8) shows that growth continues at a constant percentage rate until the end of the fourth month. Following this age in calves the growth rate declines at 4.5 per cent per month. The average daily gain for the first five months of Holstein calves was 1.680 pounds for the control group and 1.639 pounds for the experimental group. In Jerseys the average daily gain for the first five month period was 1.109 pounds for the control group and 1.143 pounds for the experimental group. The differences of daily gains in both Holsteins and Jerseys for the whole period were slight.

Growth of Calves as Compared to Standard Growth

Tables III and IV present the average weekly gains in

Table V. The Average Daily Gains of Holstein and Jersey Calves.

	Holstein Calves		Jersey Calves	
	Control lbs/day	Experimental lbs/day	Control lbs/day	Experimental lbs/day
1st month	1.027	.896	.562	.384
2nd month	1.286	1.234	.750	.920
3rd month	1.920	1.696	1.161	1.464
4th month	2.286	2.125	1.152	1.705
5th month	1.884	2.205	1.420	1.241
Average gain from birth to 5 months	1.680	1.639	1.109	1.143

body weight, height at withers and heart girth of Holsteins and Jerseys from four weeks to twenty weeks of age. The average birth weights are also given. It has been found useful to have a normal standard as a basis of comparison for the growth of experimental animals, and Ragsdale's standard values are presented in Tables VI and VII. The average body weights of Holsteins and Jerseys in both groups were above normal from the eighth week upward when compared with Ragsdale's growth rate standard. At 20 weeks of age the Holstein calves in the control group were 107.57 per cent normal in body weight, 101.46 per cent normal in height, and 100 per cent normal in heart girth. The

corresponding figures for the calves in the experimental group were 106.31 per cent normal for body weight, 102.12 per cent normal for height and 99.72 per cent normal for heart girth. Growth of the Jersey calves in the control group at 20 weeks of age were 104.77 per cent normal for body weight, 98.17 per cent normal for height and 99.02 per cent normal for heart girth, while growth of those in the experimental group were 111.81 per cent normal for body weight, 100 per cent normal for height and 99.63 per cent normal for heart girth. These comparisons indicate that the growth rate of calves receiving either the control or the experimental starter were above average for the breed. It has also been noted that only the body weight of calves is above normal, while the height and heart girth are close to the standard.

In order to follow the course of growth of each group of calves more closely, graphs of the average weekly increase in body weight were plotted and are shown in Figure I for Holsteins and Figure II for Jerseys.

Feed Consumption

The amount of the different feeds consumed by the Holstein and Jersey calves were recorded weekly and the total amounts are presented in Tables XII and XIII.

Table VI. Average Body Weight, Height at Withers and Heart Girth at Different Ages of Holstein Heifer Calves Comparing with Standard Growth*.

Age weeks	Control Group Weight lbs.	Control Group Height in.	Control Group Girth in.	Experimental Group Weight lbs.	Experimental Group Height in.	Experimental Group Girth in.
Birth	84.25			86.25		
Normal	90.00			90.00		
% Normal	93.61			95.83		
One month	113.00	30.50	34.00	111.33	30.83	33.33
Normal	112.00	30.60	33.90	112.00	30.60	33.90
% Normal	100.89	99.67	100.29	99.40	100.75	98.32
Two months	149.00	32.37	36.87	147.00	32.62	36.25
Normal	148.00	32.30	37.00	148.00	32.30	37.00
% Normal	100.67	100.22	99.65	99.32	100.99	97.97
Three months	202.75	34.62	40.12	194.50	35.00	39.62
Normal	193.00	34.30	39.90	193.00	34.30	39.90
% Normal	105.05	100.93	100.55	100.78	102.04	99.30
Four months	226.75	36.50	43.50	254.00	36.62	42.87
Normal	243.00	36.20	42.90	243.00	36.20	42.90
% Normal	109.77	100.83	101.40	104.52	101.16	99.93
Five months	319.50	38.25	46.00	315.75	38.50	45.87
Normal	297.00	37.70	46.00	297.00	37.70	46.00
% Normal	107.57	101.46	100.00	106.31	102.12	99.72

*Ragsdale's Growth Standard

Table VII. Average Body Weight, Height at Withers and Heart Girth at Different Ages of Jersey Heifer Calves Comparing with Standard Growth*.

Age weeks	Control Group Weight lbs.	Control Group Height in.	Control Group Girth in.	Experimental Group Weight lbs.	Experimental Group Height in.	Experimental Group Girth in.
Birth	53.25			62.50		
Normal	53.00			53.00		
% Normal	100.47			117.94		
One month	69.00	27.33	28.67	73.25	27.37	29.25
Normal	67.00	27.00	29.80	67.00	27.00	29.80
% Normal	102.98	101.22	96.21	109.33	101.37	98.15
Two months	90.00	29.00	31.30	99.00	29.37	32.00
Normal	90.00	28.90	32.50	90.00	28.90	32.50
% Normal	100.00	100.35	96.31	110.00	101.63	98.46
Three months	122.50	30.75	34.37	140.00	31.50	35.50
Normal	121.00	30.60	35.40	121.00	30.60	35.40
% Normal	101.24	100.49	97.09	115.70	102.94	100.28
Four months	168.75	32.75	38.00	187.75	33.37	38.75
Normal	158.00	32.60	38.10	158.00	32.60	38.10
% Normal	106.80	100.46	99.74	118.83	102.36	101.71
Five months	208.50	33.87	40.50	222.50	34.50	40.75
Normal	199.00	34.50	40.90	199.00	34.50	40.90
% Normal	104.77	98.17	99.02	111.81	100.00	99.63

*Ragsdale's Growth Standard

Milk Consumed. The average amounts of milk consumed by the control and the experimental calves were practically the same in both Holsteins and Jerseys. The average milk consumed by the Holstein calves during the experimental period was 432 pounds in the control group and 440.5 pounds in the experimental group. The Jersey calves in both control and experimental groups consumed 521 pounds of milk on the average. The amount of milk fed including pre-experimental feeding was far greater than the amount described by Turk (42, p. 11) for the limited whole milk dry starter system of rearing, but the amounts given to the calves in both groups were the same. However, the animals in this experiment had the advantage of a larger amount of whole milk. It has been noted that the calves in this experiment were heavier than normal at the corresponding ages. The heavier weight of these calves might be due to the amount of milk they received.

Starter Consumed. The average weekly starter consumption data are presented in Table VIII for Holsteins and Table IX for Jerseys. Since the starter was limited to four pounds per calf per day, this also affected total consumption. During milk feeding period the amount of starter consumed was affected greatly. The calves that were fed whole milk for an extended period usually consumed less

starter. The amount of starter consumed increased greatly when milk feeding had stopped. It is obvious that starter consumption could be hastened or increased by proper adjusting of the amount and period of milk feeding.

The weekly increases in starter consumption in both groups were almost the same. In Holsteins the level of 26 pounds per week was reached in 10 weeks, but the Jerseys took about 15 weeks to reach this level.

There were some differences in the average starter consumption between control and experimental groups. In Holsteins the average starter consumption was 291.42 pounds for the control group and 274.40 pounds for the experimental group. The control calves consumed 17 pounds more starter than those in the experimental group. The Jersey calves in the experimental group ate 23.52 pounds more starter than those in the control group. It is apparent that the calves on the higher starter level made greater gain than the calves receiving smaller amount of starter, although the difference was not statistically significant.

Hay Consumed. The average weekly consumption of hay is presented in Table VIII for Holsteins and Table IX for Jerseys. The amount of hay consumed increased steadily from the beginning toward the end of the experiment. There were wide variations in hay consumption among the calves. It has been noted that the calves receiving pelleted hay

consumed more hay than those getting long hay. It has also been observed that the calves preferred pelleted hay and usually ignored starter whenever the pelleted hay is available. There were some differences in the average hay consumption between the control and the experimental groups. The Holsteins in the control group ate 318.9 pounds of hay on the average, while those in the experimental group ate 299.27 pounds. The average hay consumption of the Jerseys in the control group was 174.02 pounds and of those in the experimental group was 149.9 pounds. The control calves consumed more hay than the experimental calves in both breeds, but the differences in hay consumption between these two groups were not significant.

Total Digestible Nutrients Consumed. The consumption of total digestible nutrients by the calves in the two groups has been calculated and presented in Tables XII and XIII. Although there were wide variations in feed consumption among the calves, the T.D.N. consumption seemed to be much less variable. This might indicate the capability of the calves to balance their own requirement for T.D.N. intake. The average T.D.N. consumption of the Holstein calves was 444.19 pounds for the control group and 429.04 pounds for the experimental group. The difference of 15.15 pounds in T.D.N. consumption was not significant. The Jersey calves

in the experimental group consumed more T.D.N. than those in the control group. The average of the control group was 325.59 pounds, while of the experiment group it was 333.01 pounds. The higher T.D.N. intake in the control Holstein calves and the experimental Jersey calves could be reflected in the greater gain in these two groups.

Efficiency of Feed

The T.D.N. consumption per pound of body weight gain has also been calculated. These data are presented in Tables X and XI. The amount of T.D.N. required to produce one pound gain increased with age. The efficiency of feed in producing one pound of body weight varied somewhat among the calves in the same group. Wider variation occurred in the Jersey calves. Tables XII and XIII present the average T.D.N. requirement per pound of gain in weight. The Holstein calves in the control group required 2.063 pounds of T.D.N. for each pound of gain, while the calves in the experimental group required 2.095 pounds of T.D.N. The small difference in T.D.N. requirement per pound of gain was not significant. The Jersey calves required more T.D.N. per pound of gain than the Holsteins. The control Jersey calves consumed 2.280 pounds T.D.N. per pound of gain and the experimental calves required 2.202 pounds T.D.N. The difference was also not significant. It appears that the effects of feed on the

efficiency of these two groups of calves to produce body weight gains were not different.

Table VIII. Average Weekly Starter, Hay and T.D.N. Consumption* of Holstein Calves (by 16 weeks of experimental period).

	Control Group			Experimental Group		
Week	Starter lbs.	Hay lbs.	T.D.N. lbs.	Starter lbs.	Hay lbs.	T.D.N. lbs.
1	4.80	2.02	13.53	4.02	4.32	13.46
2	6.07	5.02	15.98	3.72	6.90	15.40
3	5.65	4.92	15.77	4.90	5.20	15.43
4	7.92	8.27	19.12	6.32	7.12	17.48
5	9.42	10.25	21.24	6.90	11.82	20.28
6	11.42	14.55	20.96	11.00	15.00	21.05
7	14.80	11.95	21.49	18.35	11.60	24.29
8	21.17	13.35	27.99	20.32	15.25	27.59
9	22.77	17.52	30.16	21.02	16.97	28.98
10	26.04	22.00	33.37	24.20	16.62	31.28
11	27.47	24.17	34.63	26.97	20.45	33.34
12	24.77	27.15	32.84	24.22	25.20	31.95
13	24.92	31.05	33.77	24.47	29.92	32.94
14	27.50	35.92	38.06	25.80	32.45	35.61
15	28.62	43.32	42.63	26.82	39.40	39.90
16	27.72	44.75	42.64	25.37	42.02	40.13
Total	291.42	318.21	444.19	274.40	299.24	429.10

*Calculated from values of Morrison (23, p. 1000-1069)

Table IX. Average Weekly Starter, Hay and T.D.N. Consumption* of Jersey Calves (by 16 weeks of experimental period).

	Control Group			Experimental Group		
Week	Starter lbs.	Hay lbs.	T.D.N. lbs.	Starter lbs.	Hay lbs.	T.D.N. lbs.
1	3.38	2.62	10.31	4.83	1.85	11.44
2	4.55	4.15	12.24	5.68	2.25	12.28
3	7.05	3.77	13.93	6.23	2.42	12.79
4	9.35	5.92	16.70	7.10	4.15	14.29
5	8.83	4.92	15.81	7.45	3.50	14.22
6	9.13	5.35	16.23	8.75	4.52	15.70
7	8.60	6.27	16.27	8.97	6.25	16.72
8	11.25	7.27	18.82	12.53	6.32	19.48
9	11.08	10.78	20.29	12.35	9.47	20.93
10	12.53	8.42	20.27	16.90	6.67	22.97
11	14.98	9.45	22.58	19.40	7.72	25.38
12	16.53	11.47	22.77	20.73	10.70	25.91
13	18.55	17.77	25.94	21.88	15.55	27.72
14	19.18	18.87	26.44	23.13	17.80	29.29
15	26.02	26.87	32.52	27.95	23.77	32.98
16	26.40	30.10	34.44	27.05	26.92	33.88
Total	207.41	174.02	325.59	230.93	149.86	336.01

*Calculated from values of Morrison (23, p. 1000-1069)

Table X. Average Weekly Weight Gains, T.D.N. Consumption* and Feed Efficiency of Holstein Calves (by 16 weeks of experimental period).

	Control Group			Experimental Group		
Week	Gain lbs.	T.D.N. lbs.	T.D.N./Gain per lb.Gn.	Gain lbs.	T.D.N. lbs.	T.D.N./Gain per lb.Gn.
1	7.50	13.53	1.805	9.00	13.46	1.459
2	8.50	15.98	1.880	10.75	15.40	1.433
3	10.50	15.77	1.502	8.25	15.43	1.870
4	12.00	19.12	1.593	10.00	17.48	1.748
5	11.25	21.24	1.888	10.75	20.28	1.886
6	10.50	20.96	1.996	12.50	21.05	1.684
7	15.25	21.49	1.409	13.75	24.29	1.767
8	15.75	27.99	1.777	11.75	27.59	2.348
9	18.00	30.16	1.675	11.25	28.98	2.576
10	16.25	33.37	2.054	14.25	31.28	2.195
11	12.25	34.63	2.827	19.00	33.34	1.754
12	18.75	32.84	1.752	16.50	31.95	1.997
13	14.75	33.77	2.289	12.75	32.94	2.584
14	18.25	38.06	2.085	12.25	35.61	2.907
15	13.25	42.63	3.217	21.00	39.90	1.900
16	13.75	42.64	3.101	12.50	40.13	3.210

*Calculated from values of Morrison (23, p.1000-1069)

Table XI. Average Weekly Weight Gains, T.D.N. Consumption* and Feed Efficiency of Jersey Calves (by 16 weeks of experimental period).

	Control Group			Experimental Group		
Week	Gain lbs.	T.D.N. lbs.	T.D.N./Gain per lb.Gn.	Gain lbs.	T.D.N. lbs.	T.D.N./Gain per lb.Gn.
1	2.00	10.31	5.156**	4.75	11.44	2.408
2	7.75	12.24	1.580	7.50	12.28	1.638
3	6.75	13.93	2.064	6.75	12.79	1.895
4	6.25	16.70	2.672	6.75	14.29	2.118
5	8.00	15.81	1.976	8.25	14.22	1.723
6	9.00	16.23	1.804	7.75	15.70	2.027
7	6.25	16.27	2.603	9.75	16.72	1.715
8	10.50	18.82	1.792	11.75	19.48	1.658
9	9.00	20.29	2.255	9.25	20.93	2.262
10	10.00	20.27	2.027	9.75	22.97	2.356
11	10.25	22.58	2.203	12.50	25.38	2.025
12	10.50	22.77	2.168	12.25	25.91	2.115
13	13.00	25.94	1.995	12.25	27.72	2.263
14	13.00	26.44	2.034	12.25	29.29	2.391
15	11.00	32.52	2.957	14.50	32.98	2.275
16	8.50	34.44	4.051	7.25	33.88	4.674

*Calculated from values of Morrison (23, p. 1000-1069)
**One sick calf lost weight.

Table XII. Summary of Gain in Growth and Feed Consumption of Holstein Calves (by 16 weeks of experimental period).

Calf No.	Gain in Weight lbs.	Gain in Height in.	Gain in Girth in.	Feed Consumed Starter lbs.	Feed Consumed Hay lbs.	Feed Consumed Milk lbs.	Feed Consumed T.D.N. lbs.	Feed Consumed T.D.N./ lb. Gain
				Control Group				
727	226	7.5	12.5	323.2	266.5	632	469.70	2.078
729	203	8.5	15.0	340.0	271.1	520	466.63	2.297
734	234	8.5	14.5	234.0	359.7	288	403.27	1.723
735	203	6.5	12.5	268.7	375.7	288	437.16	2.153
Mean	216.5	7.75	13.62	291.47	318.25	432	444.19	2.063
S.D.	13.794	.829	1.139	42.377	49.799	149.345	26.827	.211
				Experimental Group				
726	176	7.5	12.5	276.9	225.7	618	419.12	2.381
730	205	7.0	13.0	305.7	206.4	568	423.59	2.066
733	225	8.0	13.0	283.5	391.0	288	460.95	2.049
732	219	8.0	12.0	231.7	374.0	288	412.50	1.883
Mean	206.25	7.62	12.62	274.45	299.27	440.5	429.04	2.095
S.D.	18.912	.415	.415	26.889	83.72	153.521	18.841	.180

Table XIII. Summary of Gain in Weight and Feed Consumption of Jersey Calves (by 16 weeks of experimental period).

Calf No.	Gain in Weight lbs.	Gain in Height in.	Gain in Girth in.	Feed Consumed Starter lbs.	Feed Consumed Hay lbs.	Feed Consumed Milk lbs.	Feed Consumed T.D.N. lbs.	Feed Consumed T.D.N./ lb. Gain
				Control Group				
426	187	6.5	10.5	373.3	224.5	480	462.29	2.472
429	136	9.5	11.5	194.8	120.7	480	278.98	2.051
432	122	8.0	10.5	119.6	209.2	582	289.67	2.374
433	122	7.0	11.0	141.8	141.7	582	271.42	2.225
Mean	141.75	7.75	10.87	207.37	174.02	531	325.59	2.280
S.D.	26.743	1.146	.415	99.616	43.799	51.0	79.189	.503
				Experimental Group				
427	172	8.0	12.5	292.0	143.9	480	368.82	2.144
428	146	7.0	11.0	265.3	128.0	480	340.96	2.334
431	136	8.0	11.5	156.1	209.4	582	319.67	2.351
434	159	8.0	14.5	210.2	118.3	582	314.60	1.979
Mean	153.25	7.75	12.37	230.9	149.9	531	336.01	2.202
S.D.	13.553	.433	1.341	52.298	35.547	51.0	21.370	.482

Table XIV. Analysis of Variance of Gain in Weight of Holstein Calves (Control vs. Experimental).

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Replication	981.375	3	327.125	
Treatment	210.125	1	210.125	0.5028
Error	1,210.375	3	403.458	
Total	2,401.875	7	343.125	

Table XV. Analysis of Variance of Gain in Weight of Jersey Calves (Control vs. Experimental).

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Replication	2,851.38	3	950.46	
Treatment	276.13	1	276.13	1.2659
Error	654.37	3	218.12	
Total	3,781.88	7	540.27	

Table XVI. Analysis of Variance of Gain in Weight of Holstein and Jersey Calves Combined (Control vs. Experimental).

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Replication	20,216.44	7	2,888.06	
Treatment	1.56	1	1.56	.00462
Error	2,363.94	7	337.70	
Total	22,581.94	15	1,505.46	

Table XVII. Summary of Growth in Body Weight, Height at Withers, and Heart Girth and Feed Consumption of Holstein Calves (by 16 weeks of experimental period).

	Control Group	Experimental Group
Number of calves	4	4
Growth		
Initial weight, lbs.	108.25 ± 6.496	110.75 ± 5.448
Final weight, lbs.	324.75 ± 9.679	317.0 ± 6.557
Gain in weight, lbs.	216.5 ± 13.794	206.25 ± 18.912
Initial height, in.	30.25 ± 0.559	30.87 ± 0.424
Final height, in.	38.0 ± 0.612	38.5 ± 0.224
Gain in height, in.	7.75 ± 0.829	7.62 ± 0.415
Initial heart girth, in.	33.0 ± 1.581	33.5 ± 0.935
Final heart girth, in.	46.62 ± 0.545	46.12 ± 0.205
Gain in heart girth, in.	13.62 ± 1.139	12.62 ± 0.415
Feed Consumption		
Whole milk, lbs.	432.0 ±149.345	440.0 ±153.521
Hay, lbs.	318.25 ± 49.799	299.0 ± 83.72
Starter, lbs.	291.47 ± 42.377	274.0 ± 26.889
T.D.N. consumed, lbs.	444.19 ± 26.827	429.04 ± 18.841
Lbs. T.D.N./lb.wt. gain	2.063± 0.211	2.095± 0.180

Table XVIII. Summary of Growth in Body Weight, Height at Withers, and Heart Girth and Feed Consumption of Jersey Calves (by 16 weeks of experimental period).

Number of Calves	Control Group 4	Experimental Group 4
Growth		
Initial weight, lbs.	70.5 ±15.788	67.0 ± 1.871
Final weight, lbs.	212.25±41.523	220.25± 12.874
Gain in weight, lbs.	141.75 ±26.743	153.25± 13.553
Initial height, in.	27.12 ± 1.244	27.0 ± 1.871
Final height, in.	34.87 ± 0.545	34.75 ± 0.559
Gain in height, in.	7.75 ± 1.146	7.75 ±.0.433
Initial heart girth, in.	29.62 ± 2.534	28.5 ± 0.612
Final heart girth, in.	40.5 ± 2.318	40.88 ± 0.893
Gain in heart girth, in.	10.87 ± 0.415	12.37 ± 1.341
Feed consumption		
Whole milk, lbs.	531.0 ±51.0	531.0 ±51.0
Hay, lbs.	174.02 ±43.799	149.0 ±35.547
Starter, lbs.	207.37 ±99.616	230.0 ±52.278
T.D.N. consumed, lbs.	325.59 ±79.189	306.01 ±21.370
Lbs. T.D.N./lb.wt.gain	2.280± 0.503	2.202± 0.482

SUMMARY

Experiments were carried out to determine the nutritive values of rice polish and rice bran in feeding dairy calves as major constituents of the starter rations. Four pairs of female Holstein calves and four pairs of female Jersey calves were placed on the experiment when they were about 25 to 30 days old and continued through 16 weeks of the experimental period.

The experiment demonstrated that satisfactory growth can be obtained in dairy calves when a calf starter containing 52 per cent of rice products is fed. The data indicate that growth of the Holstein and Jersey calves receiving this starter was equal to that of the calves getting the regular starter and was also above the normal for the breed.

The Holstein calves receiving regular starter made a slightly greater gain in weight than did those receiving the rice product starter. But the Jersey calves fed on the rice product starter also made greater gain than did the control calves. The greater gain might be due to the higher intake of total digestible nutrients in these calves. However, the differences in growth between these two groups of calves were not statistically significant.

The average daily gains during the first five months in the control and experimental Holstein calves were 1.680

pounds and 1.639 pounds, respectively. The Jersey calves gained 1.109 pounds daily on the regular starter and 1.143 pounds on the experimental. The effects of starters on daily gain were very slight and not significantly different.

The height at withers measurement was taken and there appeared to be no differences between the calves as far as skeletal measurement could reveal them. The gain in heart girth did seem to show slight differences between the two starters but these were not believed to be significant.

There were some differences in feed consumption between the calves fed on the regular starter and the experimental starter calves, but the differences were slight and not statistically significant. It is apparent that the calves were capable of balancing their requirements for total digestible nutrients by adjusting feed consumption.

The calves fed on the rice product starter consumed practically the same amount of total digestible nutrients to make one pound of gain as did the calves fed on the regular starter. The Jersey calves appeared to be less efficient in converting total digestible nutrients to body weight than the Holstein calves.

The rice product starter had a very fine texture and this might affect its palatability. It did not exert more laxative effect on the calves than did the other ingredients in the regular starter.

The economic aspect of using rice products in raising calves is not considered in this report because these products are not ordinarily available in quantity in this area.

The experiment reveals that the rice products could be incorporated in calf starter up to 50 per cent without any harmful effect. These products have been approximately equal in nutritive value to wheat bran and ground oats when fed to the dairy calves.

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APPENDIX

APPENDIX I

Digestible Protein and Total Digestible Nutrients of Ingredients Used in Calf Starters

(From Morrison's Feeds and Feeding, 22nd Ed.1957)

Ingredients	Digestible Crude Protein	Total Digestible Nutrients
	Per Cent	Per Cent
Ground Oats	7.0	72.2
Ground Corn	6.9	82.5
Rice Polish*	9.7	81.5
Rice Bran*	8.4	67.4
Wheat Bran	13.1	70.1
Soybean Oil Meal	37.0	77.9
Dried Skim Milk	29.8	79.8
Bone Meal	7.5	
Oat Hay	4.9	47.3
Mixed Hay	4.5	47.8
Alfalfa Hay Pellet	10.9	47.8
Milk (3.5%)	3.3	16.3

*Rice polish and rice bran were obtained from Rice Growers Association of California, Sacramento, California.