A PELLETED COMPLETE RATION
FOR LACTATING DAIRY COWS

by

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INTRODUCTION

Need for means of decreasing the labor required in the dairy enterprise has been brought about by the narrowing margin between cost of production and gross income. This narrowing margin has influenced some dairymen to increase the size of their herds. Since feed costs are relatively inflexible, attention has turned to increasing efficiency of labor utilization to decrease production costs. Milking parlors, pipeline milking machines and bulk milk tanks have been used to lessen the work required in the milking operation. Semiautomatic grain feeding devices have been installed in milking parlors to further increase labor efficiency. Self feeding silos as well as silo unloaders and mechanized bunk feeders have been used to save labor in silage feeding.

With the exception of self feeding fences, little progress has been made in decreasing the labor requirement of hay feeding. Pelleted hay could be handled easily by mechanical means and would require considerably less storage space. The increased use of pelleted feeds for all classes of livestock has made economic and nutritional problems evident. A pellet may have almost any shape or size and contain almost any known ingredient. Consequently, their usage and effects vary widely. Pelleting of bulky feeds, such as roughages, decreases the space required for storage and provides for easier handling. Ruminants, particularly dairy cows, are capable of economically utilizing the nutrients of large quantities of roughage in its normal physical state. However, some problems with milk production and butterfat test have been encountered with the usage of pelleted feeds as the only source of roughage. Pelleted concentrate in the ration has also been reported to cause a decrease in butterfat test. The decrease in butterfat test has been attributed to the small particle size of the ingredients.

This experiment was conducted to determine the feasibility of feeding a pelleted, coarsely-ground, complete ration to lactating dairy cows.

REVIEW OF LITERATURE

Pelleting of certain feeds for livestock and poultry is an established practice. According to Bruhn (1958), 55 percent of all the feed manufactured in the United States is pelleted, of which 22 percent is crumblized. Stroup (1959) cited a document published by the U. S. Patent Office in 1860 which revealed that a veterinary surgeon of the French Army's Imperial Guard had succeeded in compressing crushed oats and corn with chopped hay and straw into small tablets which provided a more desirable feed for cavalry horses on the march. Probably the major reasons for pelleting are increased convenience of handling and less selective eating (Bruhn (1957, 1958)). Esplin and co-workers (1957) stated that pelleted feeds, particularly roughages, can be self-fed more efficiently and handled with less labor than in conventional form. Eaton and associates (1951) stated that a more concentrated product requires less storage space for the same quantity of nutrients. This reduction in space requirement reduces shipping costs, thereby facilitating feed production in one area and utilization in another according to Dolge and co-workers (1952).

Some reports indicate that the feeding value of hay is influenced by pelleting. Blaxter and co-workers (1956) reported that dried grass pellets passed through the digestive tract more rapidly and were digested less completely than the corresponding long grass. Meyer and associates (1959) obtained results which agreed with this and noted that digestible and metabolizable energy of hay was decreased by grinding and pelleting. However, the net energy content of the pelleted hay was equal to that of the chopped hay due to a reduction in the heat increment associated with pellet utilization.

Meyer and associates (1959), using dry matter and holocellulose contents of the digestive tract as indicators, reported that the only difference between pelleted hay and normal rations for sheep was the more rapid passage of ingesta from the reticulo-rumen. These workers postulated that the more rapid passage may be due to finer hay particle size, reduced bulk or both. Most of the adverse nutritional effects of fine grinding resulted from the rapid rate of passage of the fine particles through the rumen, which limited rumen bacterial digestion (Conrad and Hibbs, 1959).

Feed Consumption

Some disagreement concerning animal acceptance of pelleted rations exists in the literature. Bruhn (1958) reported that Holstein cows showed little preference as to size or hardness of wafers ranging in size from two to five inches in diameter. Ronning and associates (1959) found that only one of twelve cows had to be coaxed to eat the pellets, after an abrupt change to pellets. Conrad and Hibbs (1959) reported that an abrupt change to pellets resulted in wide variation in feed consumption by cows and that some shavings were consumed. Baker and co-workers (1955) stated that a craving for coarse roughage by beef calves was shown by consumption of the bedding and chewing of wooden fences in the lots when only finely ground or pelleted roughage was available. Conrad and Hibbs (1959) found that the addition of as little as three pounds of hay satisfied the desire for coarse roughage and increased the acceptability of pelleted dehydrated forage for Holstein and Jersey cows.

Pelleting of a poor quality ration or a high-roughage ration increases feed consumption of lambs. Cate and associates (1955) showed that consumption was nearly the same for a ration consisting of alfalfa meal and ground shelled corn, whether fed as meal or pelleted. However, when timothy hay was substituted for the roughage portion of the ration, consumption was increased nine to 14 percent by pelleting. Weir and co-workers (1959) stated that lambs consumed more pelleted feed than the similar unpelleted ration. Hartman and associates (1959) found that pelleting of a high-roughage ration increased consumption by fattening lambs, but not feed efficiency. Bringe and associates (1958) found no significant difference between four-inch wafers and baled hay occurring in feed intake, milk production or body weight change of cows. Ross and associates (1959), comparing wafers with baled alfalfa hay, found increased consumption and also less wastage with the wafer-fed cows.

Gardner and Akers (1955) found that calves consumed twice as much hay pelleted as when baled or chopped. Neumann and co-workers (1959) found, in trials with 425-pound beef calves, that pelleting a ration of two-thirds timothy and one-third alfalfa hay resulted in increasing the feed consumption one-third over that of the same ration fed either long or chopped. These workers found that alfalfa hay consumption increased 23 percent and lespedeza hay seven percent as the result of pelleting. Pelleting may increase intake up to 40 percent according to Neumann and co-workers (1959) and Wallace and Hubbert (1959).

Meyer and associates (1959) and Neumann and co-workers (1959) postulated that the increased feed intake resulting from grinding and pelleting hay is a direct result of the increased rate of passage through the digestive tract. According to Blaxter and Graham (1956)

Physical factors which change the rate of passage of food through the gut, change the rate and nature of microbial fermentation, and cause variation in the mechanical work involved in prehension and mastication are as important as the chemical composition of the food in determining its nutritional value.

Nutrient Digestibility

Lindahl and Reynolds (1959) stated that changes in digestibility due to pelleting of ground diets are relatively minor. Balch (1950) reported that the depression in the digestibility of the crude fiber of hay which occurs when hay is ground, or when highly digestible carbohydrates are added to rations of small amounts of hay, was not the result of faster passage. However, Blaxter and Graham (1956) found that the more rapid passage of food through the digestive tract had small effect on the digestibility of the constituents contained within the cell but a marked effect on the fibrous components of the cell wall.

Lindahl and Reynolds (1959) found a slight decrease in crude fiber content and a significant increase in ether extract content of pellets over those of unpelleted feed. Lack of difference in the gross energy values indicated that the increase in ether extract resulted largely from non-fat ether soluble materials. These workers stated that pelleting had no effect on the digestibility of dry matter, crude protein, crude fiber, nitrogen-free-extract or gross energy. Meyer and associates (1959) found that pelleted alfalfa did not differ from chopped alfalfa in digestibility of organic matter, holocellulose or lignin, but that the protein was slightly more digestible.

Particle size in the pellet is one of the most important considerations in the field of hay pelleting for both livestock feeders and machine designers, according to Dobie (1959). Heller and co-workers (1941) indicated that grinding a feed to a powdery state, besides being a costly process, contributes nothing to its nutritional value. Long and co-workers (1955) reported that grinding the ration tended to lower the coefficients of apparent digestibility of organic matter, crude fiber, crude protein and nitrogen-free-extract. However, pelleting the ground ration tended to increase these coefficients to the level of the natural ration. Blaxter and Graham (1956) found that the digestibility of the crude fiber in pellets made from material ground twice through a 1/16 inch screen was less than that of pellets made from the material ground once through a one-fourth inch screen.

Wallace and Hubbert (1959) found with beef cattle that the digestibility of pelleted mountain hay was significantly less than that of chopped hay, 56.8 and 66.7 percent, respectively. Conrad and Hibbs (1959) found in trials with lactating dairy cows that cellulose digestibility percentage dropped from 67.5 to 41.3 with the pelleting but greater consumption compensated for the reduced digestibility. Blaxter and Graham (1956) reported that crude fiber digestibility determined with sheep was decreased as much as 40 percent by grinding and pelleting. Bell and associates (1955) also found that fattening lambs digested the crude fiber much less completely in pelleted rations.

Reports concerning the effect of pelleting on protein digestibility of lamb rations vary. Bell and associates (1955a) reported that lambs digested protein in pelleted rations more efficiently than that in unpelleted rations. Bell and associates (1955) also found that digestibility of the protein in pelleted rations was greater and the proportion of nitrogen retained by lambs was greater than those of similar rations fed in their natural state. Meyer and associates (1959) reported that the nitrogen content of the rumina of sheep fed pelleted hay was greater at all times than that of sheep fed the non-pelleted rations.

Lindahl and Reynolds (1959) showed that pelleting alfalfa meal for lambs resulted in a significant increase in the digestibility of the ether extract. Bell and associates (1955) and Lindahl and Davis (1955), working with lambs, found slightly higher digestibility of the ether extract of pelleted rations than of non-pelleted rations, with very little difference in the total digestible nutrient content of the preparations.

Feed Efficiency

Bell and associates (1955) stated that lambs fed pelleted rations made larger and more efficient gains than lambs fed unpelleted rations of the same composition. Dobie (1959) stated that pelleted hay for meat producing animals is worth 20 to 100 percent more than the same hay in baled form. Loosli (1959) stated that the greatest favorable response from pelleting has been observed with poor quality roughages with both lambs and steers. Pelleted coarse or damaged alfalfa hay produced in irrigated valleys of New Mexico, according to Neale (1958), is ideal for self-fed lambs. Pelleting increases the feeding value of this poor quality hay nearly to that of higher grades of alfalfa. Cate and associates (1955) concluded that as the quality of the ration decreased, greater economy of feed utilization was obtained with pelleting.

Hartman and associates (1959) reported that pelleting was necessary to provide for maximum weight gains of fattening lambs fed high roughage rations. Physical balance between roughage and concentrate in pellets has more effect on gain of lambs than does the pellet size or fineness of grind. Church and Fox (1959) compared roughage ground through 3/32, 5/32, 3/16, 1/4 and 9/32 inch screens and then processed into pellets 1/4, 3/8 and 1/2 inch in diameter. These workers found no significant difference between fineness of grind or size of pellets in gain of fattening lambs. Neale (1955) found with lambs that the ratio of roughage to concentrates which seemed most efficient was 73:27. These pellets contained 15 to 20 percent crude fiber and more than 60 percent total digestible nutrients. This ratio of crude fiber to total digestible nutrients was greater than that generally approved for loose rations. Neale (1958) decided that 80 percent roughage produced the cheapest gain during three years of trials. Bell and associates (1955, 1955a) found that lambs fed pelleted rations with a 65:35 roughage to concentrate ratio gained faster and made more efficient use of their feed than lambs fed pelleted rations with a ratio of 55:45. Lindahl (1955), comparing lambs self-fed pellets containing 45 percent corn, five percent black strap molasses and 50 percent alfalfa hay with the same ration fed loose found that the average daily gain was 0.42 pound for pelleted feed and 0.34 pound for loose feed.

Hartman and associates (1959) found no significant advantage for pelleting rations containing 29 percent roughage and 71 percent concentrate or 59 percent roughage and 41 percent concentrate compared with the same ratios in unpelleted rations. Rations containing 55 percent roughage or less were found to be more efficient when fed unpelleted than if they were pelleted, according to Bell and co-workers (1955a). Thomas and associates (1955) obtained greater rate of gain with only the concentrate rations pelleted or with the complete ration pelleted than with a whole grain and long hay ration. Lindahl (1955) and Cate and associates (1955) agreed that lambs fattened more efficiently when fed pelleted rations than when fed similar feeds in a separate and loose form. These workers stated that the reasons for the more efficient gains were decreased waste, greater rate of gain with concurrent reduction in maintenance due to shorter fattening period. Esplin and associates (1957) supported this theory by finding that lambs limited to equal amounts of pelleted and loose feed gained similarly.

Neumann and co-workers (1959) found that daily gains of beef calves fed pelleted hay were nearly triple those fed long or chopped hay. Even with the cost of pelleting set at ten dollars per ton, costs of gain were reduced, according to these workers. They also demonstrated that pelleting increased daily gain more for good alfalfa hay than for poor lespedeza hay when fed to 425-pound beef calves. Ittner and co-workers (1958) found that steers whose ration contained pelleted hay gained 0.27 pound more per head daily than those whose ration contained long hay. Even though the increase in daily gain was due to increased consumption, these workers reported that the total feed per 100 pounds of gain was 35 pounds less for the pelleted hay ration. Webb and co-workers (1957) using alfalfa, timothy-alfalfa or Sericea lespedeza hay, found that pelleting increased average daily gain of steer calves over the same rations unpelleted. Efficiency of gain was also greater for the pelleted hays. Wallace and Hubbert (1959) compared three-fourths inch pellets and coarsely chopped mountain meadow hay for beef cattle and found that daily gain was 1.61 pounds for the pelleted and 0.31 pound for the chopped hay.

Kercher and Hilston (1958) found that pelleting a complete ration for beef cattle significantly increased daily gains. Even though pellet-fed steers consumed more feed, there was no significant difference in efficiency of gain. However, Baker and associates (1955) found that coarsely cracked corn and chopped hay produced significantly greater gains than did the same ration finely ground or pelleted. These workers also found that the feed efficiency of the pelleted ration was equal to that of the other two rations.

Pelleted Dairy Rations

There is not too much known about the effects of pelleted rations on lactating dairy cows. Loosli (1959) stated that from the available data there is little justification for pelleting dairy concentrates except for uniformity of the feed and ease of handling. However, the use of pelleted concentrates for dairy cows is increasing and this trend will probably continue, according to Loosli (1959). Adams and Ward (1956) compared a conventional 16 percent protein, mash-type concentrate with the same ration in one-half inch pellets. Milk production was not affected by pelleting, but butterfat test, butterfat production and four percent fat corrected milk production were depressed significantly. This difference was not thought to be due to low palatability of the pellets. Feeding the same concentrate ration as a coarsely ground mixture or as three-eighths inch pellets to 27 Holstein cows, Tigges and Ward (1959) found no significant difference in milk production and four percent fat corrected milk, but the difference in butterfat test approached significance at the five percent level of probability.

Stroup (1959) stated that with the use of concentrate metering equipment, pelleted dairy concentrate rations have the advantage of consistent bulk density. Schneider (1958) found that differences in bulk density of the concentrate caused errors of as much as 18 percent in weight which result in costly under or over feeding. When cows are milked rapidly there is a tendency for all cows to be fed the same amount of concentrate, according to Stallcup and co-workers (1959). These workers observed that cows of all breeds ate faster in milking parlors than in stanchion barns. Stroup (1959) reported that Guernsey cows ate pellets 29 percent faster than they did the mash ration. However, Loosli (1959) stated that cows may eat pelleted concentrates slightly faster than meal rations but the differences are small.

Finely ground dehydrated roughage was found to be a poor substitute for concentrate mixture. Hope and associates (1950) found that their control concentrate ration was superior to rations in which a dehydrated grass-legume mixture was substituted at the rates of 15, 30 or 45 percent. Rumen atony and anorexia were observed at the 30 and 45 percent substitution levels. Brown and associates (1952) stated that milk production declined at a greater rate when cows were fed grain rations containing 20 percent dehydrated alfalfa meal or pellets than when fed the ration without the alfalfa. Blosser and associates (1952) found that small quantities of pelleted dehydrated alfalfa stimulated milk production significantly more than the same roughage finely ground or chopped. More cows went off feed when the latter preparations were fed.

Bartley and associates (1951) fed 0.5 pound of dehydrated alfalfa pellets per 100 pounds body weight as a supplement to the standard ration of grain fed according to production, alfalfa hay or prairie hay ad libitum and two pounds of sorgo silage per 100 pounds body weight. They found that consumption of hay equivalent per cow per day was increased 3.6 pounds and 4.4 pounds respectively by the addition of dehydrated alfalfa pellets. Increases of 0.86 and 1.2 pounds of four percent fat corrected milk per cow per day were associated with increased feed intakes. These results were substantiated by Warren and co-workers (1954) and were extended to a level of 1.5 pounds dehydrated alfalfa pellets per 100 pounds body weight. These workers found that for each 0.5 pound of pellets fed, milk production increased 2.7 ± 0.4 pounds.

Butterfat Depression

Balch and associates (1954) stated that a consistent and presumably essential characteristic of rations that depress the butterfat content of milk is the lack of fibrousness. These workers (1955a) found that a large intake of crude fiber in a finely divided form, lacking the physical property of fibrousness, will not maintain butterfat content. Large intakes of starch with ample fibrousness did not decrease butterfat content.

Shaw and associates (1957) reported that rumen bacterial metabolism is of major importance in controlling the butterfat content of milk. Balch and associates (1954) observed that there is a change in the activity of the flora of the reticulo-rumen at the time of the depression in butterfat content. This change in the bacterial flora may influence the digestion of the cellulose portion of the ration. According to McClymont (1950) this is one of the main factors involved with the decrease in butterfat test.

McClymont (1950) found that decreases in butterfat test of 30 to 40 percent could be produced experimentally. A very rapid and marked decrease in butterfat test was achieved on a ration containing pelleted hay and a small amount of heated corn by Ensor and co-workers (1959). The effect of the heated concentrate was greatly lessened when long hay was fed in the place of the pelleted hay. Powell (1938) reported that feeding cows ground and pelleted rations resulted in marked depression in the butterfat test of the milk. Limiting the forage to five pounds per day or less had the same effect as the pelleted rations. Balch and associates (1954) substantiated those results by showing that cows fed rations containing eight pounds or less of hay daily and considerable amounts of concentrated feeds produced milk of low butterfat content.

Loosli and co-workers (1945) found that gradually decreasing the amount of hay fed and subsequently maintaining a low level for a period of time tended to cause butterfat test to return to normal in cows in advanced stages of lactation. Shaw and associates (1957) reported that marked decreases in the fat content of milk are difficult to achieve in mid-lactation at hay levels as low as three pounds per day when the normal concentrate mixtures are fed, regardless of the physical state of the hay.

The nature of the concentrate can have a far greater influence on butterfat content than the level of roughage fed, according to Shaw and associates (1957). Balch and associates (1954, 1955a) found that the starch of flaked corn had more effect on butterfat content when coupled with a low roughage diet than other starch sources. Butterfat tests above four percent dropped to 2.99 percent for the flaked corn, to 3.50 percent for ground corn, and to 3.70 percent for cleaned corn when fed with rations containing small amounts of roughage, according to Balch and associates (1955a).

Coarsely Ground Rations

Loosli (1959) and Conrad and Hibbs (1959) observed from published data that forages to be pelleted for dairy cattle should be ground coarsely or chopped. However, according to Loosli (1959), it is not at all clear as to how fine hay can be ground without depressing the fat content of milk. When dehydrated roughage was used, Porter and associates (1953) found no significant difference in the production of four percent fat corrected milk. However, pelleting decreased the average butterfat test from 4.07 to 3.67 percent in the first trial and from 4.24 to 3.78 percent in the second trial. Fossland and Fitch (1958) reported that a pelleted complete ration fed to dairy cows decreased the butterfat test to 1.5 percent and apparently caused digestive upsets.

Ross and co-workers (1959) using twelve Jersey cows compared baled alfalfa hay and four inch wafers and obtained a significant reduction in butterfat test, 5.74 to 5.48 percent. Loosli (1959) stated that the use of wafered or pelleted forage for lactating dairy cows did not increase feed intake or milk yields. He concluded that the only potential advantages are in transportation, storage and ease of handling.

Ensor and co-workers (1959) reported that feeding pelleted hay alone did not result in a marked change in butterfat content of the milk. Ronning and co-workers (1959) found that feeding pelleted or chopped hay did not influence the butterfat test. Significantly more four percent fat corrected milk was produced with pelleted than with chopped alfalfa hay when no concentrate was fed. Butterfat test was not significantly changed by a ration consisting of three-fourths inch dehydrated hay pellets plus three to five pounds of long hay, according to Conrad and Hibbs (1959). Dobie (1959) and Ronning and co-workers (1959) suggested that variables in the ration other than pelleting, such as decreased feed intake and the relatively high rates of concentrate feeding, may have caused butterfat reductions in previously reported work.

Edwards (1958), in investigations of substandard milks in Scotland, found that the most frequent causes of substandard solids-not-fat level of milk were feeding and mastitis, with the mastitis being the most significant. The decrease of the solids-not-fat content was due almost equally to decreases in levels of protein and lactose in the milk. Edwards (1958) considered that the lower lactose content was due to mastitis and the decrease in protein level was the result of inadequate feeding. Balch and associates (1955, 1955a) found that when butterfat level was depressed there was an increase in the solids-not-fat percentage of the milk. McClymont (1950) reported no depression of solids-not-fat accompanying depression in butterfat test. Balch and associates (1955a) reported that different preparations of corn in the concentrate had little or no effect on the solids-not-fat content of the milk.

Loosli (1959) summarized,

> From the data available one is impressed with the possibility that the differences in responses obtained may be the result of the various kinds and quality of roughages fed, the fineness of chopping or grinding, the type of grain or concentrate, the ratio of roughage to concentrate, and other unrecognized factors.

EXPERIMENTAL PROCEDURE

A pelleted complete ration and chopped alfalfa hay and grain were compared as rations for lactating cows. Effects of these rations on feed consumption, body weight, general health, milk production, butterfat test and other fractions of milk of four breeds of lactating dairy cows were observed.

A complete ration containing 65 percent ground hay, 32.5 percent pulverized sorghum grain, 0.5 percent salt and two percent bentonite was processed into three-fourths inch pellets. The hay in the pellets was good quality, sun-cured alfalfa ground in a hammer mill through a three-fourths inch screen. Chopped sun-cured alfalfa hay and rolled sorghum grain were fed in the same ratio as contained in the pellets. Salt was added to the grain at feeding to approximate the 0.5 percent in the pelleted ration. Salt was also fed in block form free choice to all cows. Water was available in stall cups.

Eighteen cows--eight Holsteins, six Jerseys, two Ayrshires, and two Guernseys--were selected from the Kansas State University herd and assigned semi-randomly to three groups which received the following treatments:

	Period 1	Period 2	Period 3	Period 4
Group I	Pellets	Chopped hay & grain	Pellets	Pellets and chopped hay, *ad libitum*, group-fed outside
Group II	Chopped hay & grain	Pellets	Chopped hay & grain	Pellets + 1 lb. chopped hay
Group III	Pellets	Pellets	Pellets	Pellets

Groups I and II each were composed of two Jersey, one Ayrshire, one Guernsey and two Holstein cows and Group III, two Jerseys and four Holsteins. Groups I and II were used in a double reversal design for Periods 1, 2 and 3 with Period 4 used for testing leads obtained in previous periods. Group III was used to determine the effects of uninterrupted pellet feeding.

The cows were stanchioned in a separate barn for the duration of the experiment except the cows in Group I, which were kept in an outside yard for group feeding during the fourth period. Shavings were used for bedding during the first half of the experiment and to prevent its being eaten, bedding was not used during the last half. For the first half of the experiment milking was done by pipeline milker with daily milk weights obtained by use of the Milk-O-Meter. During the second half, in order to reduce chances of obtaining coarse feed, the cows were machine milked in their own stalls, and the milk was weighed in the experimental barn. Chemical analyses were made on weekly composite samples of two consecutive milkings of each cow. Butterfat tests were determined by the Chemical Service Laboratory of Kansas State University using A. O. A. C. methods (1955). Protein was calculated by multiplying nitrogen content by the factor 6.38.

Cows were weighed at 6 A. M. on two consecutive days of each week.

Feed consumption was measured by feeding an amount sufficient to obtain about 10 percent weight back. Feed was weighed back in the afternoon, and the amount to be fed for the next 24-hour period was calculated. The total amount to be fed was divided into approximately equal amounts for two feedings. Cows on the chopped hay and grain ration were fed grain according to the amount of hay consumed on the previous day in order to obtain a ratio of two parts hay to one part grain. The feeds were sampled daily and composite samples were analyzed by the Chemical Service Laboratory of Kansas State University. Nitrogen, ether extract, crude fiber, moisture and ash were determined by A. O. A. C. methods (1955).

RESULTS AND DISCUSSION

Two lots of three-fourths inch pellets[1] were processed, the first being used for Period 1, and the second for Periods 2, 3 and 4 (Figure 1). Lot two contained 750 grams of chromic oxide (Cr_2O_3) per ton. Due to the large proportion of coarsely ground roughage in the pellet mixture, the production of the pellet mill was cut to 25 to 40 percent of its usual rate. Movement of the coarsely ground alfalfa hay through the conventional bins and mixers was difficult due to bridging. A system of air conveyors, vertical side bins with agitating augers, and positive feed for the pellet mill would have to be employed to make practical the incorporation of large proportions of coarsely ground roughage in pellets.

Description of the individual cows used in the experiment is presented in Table 1.

Table 1. Composition of experimental groups:

Group	Cow	Breed	Date calved	Age at calving	Date Bred	Days in milk
I	122C	Holstein	10/6/58	2-2	open	135
	124C	Holstein	2/1/59	2-5	open	17
	281B	Ayrshire	9/27/58	2-11	3/19/59	145
	304C	Jersey	12/18/58	5-7	3/20/59	62
	311C	Jersey	10/18/58	4-8	1/20/59	123
	450B	Guernsey	1/26/59	5-1	5/18/59	23
II	118C	Holstein	10/17/58	2-4	open	125
	127C	Holstein	2/14/59	2-4	open	7
	296B	Ayrshire	11/1/58	2-2	3/18/59	109
	320C	Jersey	2/19/59	4-8	open	2
	344C	Jersey	1/27/59	2-4	5/12/59	22
	466B	Guernsey	12/10/58	2-5	4/9/59	70
III	117C	Holstein	10/12/58	2-4	1/14/59	129
	119C	Holstein	9/24/58	2-4	12/28/58	148
	121C	Holstein	11/30/58	2-4	open	80
	125C	Holstein	1/5/59	2-5	open	44
	397B	Jersey	10/12/58	5-9	open	129
	324C	Jersey	1/26/59	4-3	open	21

1. Produced by Teichgraeber Milling Company, Emporia, Kansas, with a California pellet mill.

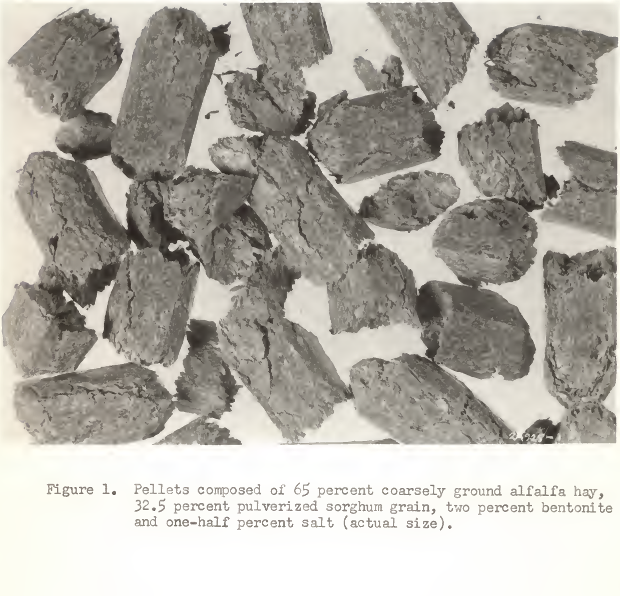

Figure 1. Pellets composed of 65 percent coarsely ground alfalfa hay, 32.5 percent pulverized sorghum grain, two percent bentonite and one-half percent salt (actual size).

The three-week trial periods were divided into an 11-day change-over period and a ten-day experimental period. The data obtained during the ten-day period were summarized by individual cows and are recorded in Table 6 of the Appendix. Body weights are an average of four weights taken during the ten-day period. Results of two determinations during the ten-day periods of levels of butterfat, total solids, solids-not-fat and protein in the milk were averaged. Chemical analyses of the feeds used by periods are presented in Table 7 in the Appendix. Tables 8 and 9 in the Appendix contain the data collected on Groups I and II, averaged by period.

The Jersey cows being fed the pellet ration went completely off-feed during the third week. This occurred in spite of the fact that their previous pellet consumption per unit weight equaled that of the other cows on the experiment. Attempts to force one Jersey cow in Group III to eat the pellets resulted in apparent starvation-type acetonemia, which terminated in death of the cow. Addition of three to five pounds of either long or chopped hay to the ration for two to three days resulted in normal pellet consumption. The hay feeding "treatment" had to be repeated at ten to fourteen day intervals to alleviate the off-feed condition. Even Jersey cows consuming 35 to 40 pounds of pellets daily required the "treatment" during the latter part of the three week periods. Consequently, Jersey cow data were excluded from summary and analysis. Conrad and Hibbs (1959) found previously that the addition of three pounds of hay increased the acceptability of pelleted dehydrated forage for Holstein and Jersey cows.

Summary of the comparison made between the chopped hay and grain ration, and the pellet ration with Groups I and II is recorded in Table 2. The double reversal trial was analyzed according to the method described by Brandt (1938).

Table 2. Summary of double reversal trial - Groups I and II.

	Adjusted Means		Probability
	Pellets	Hay and grain	of Difference
Butterfat (%)	3.5	3.9	<.20
Total Solids (%)	12.67	12.90	<.40
Solids-not-fat (%)	9.3	9.0	<.30
Protein (%)	3.37	3.25	<.05
Actual Milk Prod. (lb)	34.1	32.3	<.20
4% FCM (lb)	31.2	31.1	>.90
Body weight (lb)	1037	1041	<.90
Feed consumption (lb/1000 lb)	34.0	33.9	<.80

Feed consumption, four percent fat corrected milk production and body weight changes were essentially the same for the pelleted and nonpelleted rations. Pellet feeding resulted in decreased butterfat percentage in the milk. Protein content of milk from the pellet-fed cows was significantly greater along with the associated greater percentage of solids-not-fat. However, total solids content of milk from pellet-fed cows was decreased due to the net result of the differences in butterfat and solids-not-fat percentages.

California investigators (Dobie, 1959; Ronning and co-workers, 1959), attributed the lower level of butterfat in milk of pellet-fed cows to decreased feed intake alone or in conjunction with greater concentrate intake. The data in this experiment do not bear this out since feed intakes were practically the same, and the hay:grain ratio was the same in the two treatments.

The data obtained with Group III, fed pellets continuously for 12 weeks, are summarized in Table 3. Variance among periods was analyzed and a sequential method of determining significance of individual differences between means was used (Snedecor, 1957). Pellet consumption varied only slightly among periods. The cows on this ration were highly persistent in milk production and gained an average of ten pounds body weight per week. These results are not in agreement with those of Fossland and Fitch (1958) who reported that their pelleted complete ration supported gain in body weight of cows concurrently with a decrease in milk production.

Table 3. Continuous pellet feeding trial--Group III.

	Period				Probability of Differences
	1	2	3	4	
Butterfat (%)	3.6^{a}	3.0^{b}	2.9^{b}	2.7^{b}	<.025
Total solids (%)	13.16^{a}	12.34^{c}	12.60^{bc}	12.79^{b}	<.005
Solids-not-fat (%)	9.5^{c}	9.4^{c}	9.7^{b}	9.9^{a}	<.005
Protein (%)	3.35^{b}	3.43^{b}	3.67^{a}	3.76^{a}	<.01
Actual Milk Prod. (lb)	33.0	31.6	31.3	30.9	>.50
4% FCM (lb)	31.6	26.8	26.2	24.8	<.25
Body weight (lb)	1021^{c}	1058^{b}	1065^{b}	1110^{a}	<.005
Feed consumption (lb/1000 lb)	38.3	35.3	34.8	36.6	<.25

a>b>c--The means with like superscript letters are not significantly different while those with unlike are significantly different ($p < .05$).

Butterfat percentage was significantly lower during Periods 2, 3 and 4 than during Period 1. This decreased butterfat percentage is in agreement with most of the reports in the literature except that the depression was not as great as that reported by Fossland and Fitch (1958). Study of the data collected indicates that to obtain a decrease in butterfat percentage with the pellets used in this experiment, at least five weeks of continual feeding was required before a significant decrease is evident.

Ensor and co-workers (1959) reported that there was no decrease in butterfat percentage during a four week trial with pelleted hay. However, their later studies indicated that a depression occurred between four and six weeks on the rations used which was associated with changes in rumen micro-organism populations. Ronning and associates (1959) found no significant decrease in butterfat percentage due to pellet feeding in experimental periods of four weeks duration. Most of the reports of either a slight or no decrease in butterfat percentage did not include periods of sufficient length to produce this effect.

The protein content of the milk produced by pellet-fed cows increased about 0.4 percentage units during 12 weeks of pellet feeding. This was reflected in increased solids-not-fat content of the milk. However, the greater decrease in butterfat percentage overshadowed the increase in protein level with a net decrease in percentage total solids.

Since the Jersey cows went off feed after being fed the pelleted ration for a period of time, and since a decrease in butterfat percentage was associated with the feeding of the pellets, a fourth period was added to the original experiment. Group I, including the Jerseys, was group fed in an outside lot, ad libitum quantities of pellets and chopped alfalfa hay during Period 4. Cows in Group II were fed pellets ad libitum plus one pound of chopped alfalfa hay daily during this period. Group III was fed pellets continuously as previously indicated. Results obtained with Group I during Period 4 are presented in Table 4. These data were compared with those of Period 2 during which hay and grain were fed.

Table 4. Effect of feeding ad libitum hay and pellets.

Treatment: Period:	Hay and grain: 2	Hay and pellets: 4	Probability of difference
Butterfat (%)	4.0	4.0	NS
Total Solids (%)	13.46	13.39	< .80
Solids-not-fat (%)	9.4	9.4	NS
Protein (%)	3.67	4.04	< .02
Actual Milk Prod. (lb)	28.4	26.9	< .30
4% FCM (lb)	27.0	25.8	< .20
Body Weight change (lb)	22	68	< .05

Average daily feed consumption for this group was 41.6 pounds per 1000 pounds body weight during Period 4 as compared to 33.0 pounds during Period 2. These averages include the data from two Jersey cows which were not included in analysis of the double reversal trial due to their abnormal eating behavior during pellet feeding periods. Since the cows were group fed during Period 4, no test of the significance of this difference in feed consumption is provided. Of the 41.6 pounds feed consumed daily per 1000 pounds body weight, 8.0 pounds was hay and 33.6 pounds was pellets. The hay intake of these cows averaged 29.9 pounds per 1000 pounds body weight during this time. The increase in feed consumption may have been due to the opportunity to choose between hay and pellets, to the freedom of the cows in the lot, the competition at the feed bunk or some combination of these factors.

Weight gains were greater during Period 4 than Period 2, probably due to greater feed consumption, and possibly, to more residue in the digestive tract.

Milk production was slightly lower during the hay and pellet feeding period. This was to be expected since this period was several weeks later than that with which it was compared. The percentage of butterfat in the milk produced on the hay and pellet ration was equal to that on the hay and grain ration. The protein content of the milk was significantly greater as a result of including pellets in the ration.

The results obtained with the cows in Group II during Periods 3 and 4 are compared in Table 5. The "t" test was used to determine the relative significance of differences between period means. One pound of hay daily, in addition to ad libitum pellets, was not enough to enable the Jersey cows to stay on feed. Consequently, they were excluded from this comparison.

There was very little difference in the effect of the two rations on feed consumption, body weight change, four percent fat corrected milk production and total solids percentage of the milk. A decrease of 0.4 percentage units in butterfat was accompanied by an equivalent increase in protein content as the result of feeding the pelleted ration. One pound of hay daily did not prevent these changes in milk composition. However, actual milk production of cows in Group II was significantly greater in Period 4 than in Period 3, even though that of Groups I and II decreased during this period.

Table 5. Effect of adding one pound of hay to the pelleted ration.

Treatment: Period :	Hay & Grain: 3 :	Pellets + 1 lb. hay: 4	Probability of Difference
Butterfat (%)	4.0	3.6	<.10
Total Solids (%)	12.88	12.90	<.90
Solids-not-fat (%)	8.9	9.2	<.20
Protein (%)	3.19	3.60	<.02
Actual Milk Prod. (lb)	33.4	34.6	<.05
4% FCM (lb)	32.4	32.2	<.70
Body Weight Change (lb)	21	20	>.90
Feed Consumption (lb/1000 lb)	37.8	39.1	<.50

Milk from cows fed pellets continuously developed some abnormal characteristics as the experiment progressed. No cream line formed on the milk, although the fat rose partially as indicated by butterfat tests of milk from different levels in the bottle. Considerable difficulty was encountered in churning cream from pellet-fed cows during the later stages of the experiment. Butter from these cows was white and contained considerable curd-like material. Butter oil obtained from this butter was colorless even though the hay in the pellets had considerable color.

Eating habits of the cows varied with the ration being fed. Pellet-fed cows were observed eating throughout the day with little activity at feeding time. Cows fed hay and grain ate the grain immediately and ate a large portion of their hay soon after feeding. Those fed hay and pellets ad libitum ate like pellet-fed animals. Previously, Mochrie and co-workers (1956) and Rakes and associates (1957) demonstrated the favorable effect of many small feedings of hay on rate of gain of dairy heifers. Shaw (1958) suggested that since the rate of fermentation in the rumen is greater for only two or three hours after eating a normal ration, a real increase in ruminant efficiency could be achieved by maintaining the fermentation at the increased rate for longer periods of time. Feeding pellets, which are consumed intermittently, may be one way of increasing the efficiency of dairy cows.

Cows fed hay and pellets consumed 26 percent more feed than when pellets were not included in their ration. This increase in consumption may be due to their eating habits or to more rapid passage through the digestive tract of ingesta from finely ground feeds as indicated by work of Meyer and associates (1959).

The inability of the Jersey cows to tolerate continuous pellet feeding may be associated with the inherent high level of butterfat in their milk. The depression of butterfat percentage in milk from cows fed finely ground feeds is associated with a decrease in ratio of acetic to propionic acids in the rumen (Tyznik and Allen, 1951; Shaw and associates, 1957; Ensor and associates, 1959). Since acetate has been found to be a precursor of a large portion of the fatty acid fraction of butterfat (Smith, 1959), it would seem logical that Jersey cows would have relatively greater requirement for acetate than breeds which secrete proportionately less butterfat in their milk. Continued pellet feeding with an associated decrease in acetic to proprionic acid ratio may embarrass an essential metabolic process of the cow or the microorganisms which requires acetate.

All trials with cows that included pellets in the ration increased the percentage protein in their milk. Even with <u>ad libitum</u> amounts of chopped hay consumed along with the pelleted ration there was an increase in the protein content of the milk. Shaw (1958) hinted that feeding and nutrition can change the amount or quality of milk substances other than butterfat, such as protein. The protein of the milk was not characterized as to the source of the increase. A possible source might be the blood serum proteins or non-protein nitrogen.

SUMMARY

Three-fourths inch pellets, composed of two parts sun cured alfalfa hay ground through a three-fourths inch hammer mill screen and one part ground sorghum grain, were produced in a California pellet mill. The coarsely ground pelleted ration was compared with the same ratio of chopped alfalfa hay and grain.

Eighteen cows of four dairy breeds were semi-randomly assigned to three groups of six cows each. Two groups were used in a double reversal trial, and one was fed pellets continuously for twelve weeks. Effects on feed consumption, milk production, body weight change, butterfat percentage, total solids, solids-not-fat and protein of the milk were determined.

Jersey cows on the pelleted complete ration went off feed the latter part of the third week and had to be treated with some long or chopped hay to prevent death. One pound of chopped hay fed with the pellets was not sufficient to prevent the Jersey cows from going off feed. Cows of the three other dairy breeds were not affected in this way.

Feed consumption was not enhanced significantly by pelleting the ration. However, feeding ad libitum amounts of chopped hay and pellets resulted in a large increase in total feed consumption.

Butterfat percentage was decreased by feeding the coarsely ground pelleted complete ration alone or with the addition of one pound of chopped hay to

the ration. However, *ad libitum* consumption of both chopped hay and pellets maintained butterfat percentage at normal levels.

Significant increases occurred in protein content of the milk from all cows fed pellets. This also was reflected in an increase in solids-not-fat percentage. These increases could be of economic importance to dairymen whose price for milk is based on total solids.

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APPENDIX

Table 6. Individual cows arranged by groups and their data summarized by periods.

	Group I			
Treatment :	Pellets	:Hay & Grain:	Pellets	:Hay & Pellets
Period :	1 :	2 :	3 :	4
122C - Holstein				
Butterfat (%)	4.0	3.8	3.5	3.5
Total Solids (%)	13.72	13.44	13.45	13.50
Solids-not-fat (%)	9.7	9.6	10.0	10.0
Protein (%)	3.70	3.52	3.81	3.99
Actual Milk Prod. (lb)	35.5	32.5	35.6	34.1
4% FCM (lb)	37.1	31.8	32.8	31.6
Body Weight (lb)	1150	1135	1170	1245
Feed (lb/1000 lb)	39.4	31.6	38.6	
124C - Holstein				
Butterfat (%)	3.0	3.3	2.6	3.0
Total Solids (%)	11.74	11.94	11.86	12.20
Solids-not-fat (%)	8.7	8.6	9.2	9.2
Protein (%)	2.91	3.00	3.43	3.86
Actual Milk Prod. (lb)	45.0	44.2	47.1	45.1
4% FCM (lb)	38.6	39.6	37.5	38.0
Body Weight	1100	1130	1180	1255
Feed (lb/1000 lb)	35.4	31.6	38.6	
281B - Ayrshire				
Butterfat (%)	3.9	3.8	2.8	3.6
Total Solids (%)	13.48	13.20	12.42	13.32
Solids-not-fat (%)	9.6	9.4	9.6	9.8
Protein (%)	3.62	3.60	3.66	3.78
Actual Milk Prod. (lb)	28.0	24.8	25.0	23.3
4% FCM (lb)	27.5	21.4	20.5	21.8
Body Weight (lb)	1035	1065	1070	1085
Feed (lb/1000 lb)	34.4	32.4	30.3	
450B - Guernsey				
Butterfat (%)	4.7	3.8	3.5	3.5
Total Solids (%)	13.50	12.46	13.26	13.06
Solids-not-fat (%)	8.8	9.2	9.1	8.8
Protein (%)	3.25	3.26	3.33	3.42
Actual Milk Prod. (lb)	27.8	24.9	22.4	20.0
4% FCM (lb)	30.7	22.3	22.9	20.7
Body Weight (lb)	1080	1120	1050	1120
Feed (lb/1000 lb)	23.3	23.8	21.1	

Table 6. Continued

Group I				
Treatment	Pellets	Hay & Grain	Pellets	Hay & Pellets
Period	1	2	3	4
304C - Jersey				
Butterfat (%)	4.4	4.6	4.0	4.3
Total Solids (%)	13.74	14.28	13.84	13.34
Solids-not-fat (%)	9.2	9.7	9.8	9.0
Protein (%)	3.86	3.81	4.02	4.21
Actual Milk Prod. (lb)	27.2	28.7	28.7	26.1
4% FCM (lb)	29.0	31.4	28.9	27.4
Body Weight (lb)	870	900	870	925
Feed (lb/1000 lb)	42.2	37.8	44.3	
311C - Jersey				
Butterfat (%)	6.2	5.4	5.5	5.4
Total Solids (%)	15.95	15.45	15.90	14.92
Solids-not-fat (%)	9.8	10.1	10.4	9.5
Protein (%)	4.65	4.81	4.60	5.00
Actual Milk Prod. (lb)	16.5	13.1	9.1	12.8
4% FCM (lb)	21.8	15.7	11.2	15.5
Body Weight (lb)	980	1000	880	990
Feed (lb/1000 lb)	31.8	32.4	17.6	

Group II				
Treatment	Hay & Grain	Pellets	Hay & Grain	Pell. + 1 lb hay
Period	1	2	3	4
320C - Jersey				
Butterfat (%)	7.2	7.1	4.8	4.4
Total Solids (%)	14.66	14.88	13.59	13.42
Solids-not-fat (%)	7.5	7.8	8.8	9.0
Protein (%)	3.12	2.78	3.30	3.76
Actual Milk Prod. (lb)	34.3	16.9	22.8	26.4
4% FCM (lb)	50.5	24.7	25.4	28.0
Body Weight (lb)	840	750	725	720
Feed (lb/1000 lb)	24.6	7.8	25.2	37.8
344C - Jersey				
Butterfat (%)	4.2	3.3	4.3	3.8
Total Solids (%)	12.58	12.78	13.50	12.83
Solids-not-fat (%)	8.4	9.5	9.2	9.0
Protein (%)	2.65	3.41	3.35	3.80
Actual Milk Prod. (lb)	24.6	23.6	19.4	22.6
4% FCM (lb)	25.2	21.3	20.3	21.9
Body Weight (lb)	550	580	590	600
Feed (lb/1000 lb)	32.0	34.8	38.8	43.4

Table 6. Continued

	Group II			
Treatment	Hay & Grain	Pellets	Hay & Grain	Pell. + 1 lb hay
Period	1	2	3	4
466B - Guernsey				
Butterfat (%)	5.2	4.9	5.3	4.7
Total Solids (%)	14.28	14.49	14.56	13.85
Solids-not-fat (%)	9.1	9.6	9.2	9.1
Protein (%)	3.26	3.62	3.44	4.00
Actual Milk Prod. (lb)	23.0	27.2	23.6	24.6
4% FCM (lb)	27.0	30.8	28.3	27.4
Body Weight (lb)	790	825	835	835
Feed (lb/1000 lb)	31.2	40.3	38.3	41.4
296B - Ayrshire				
Butterfat (%)	4.0	3.0	3.4	2.9
Total Solids (%)	12.77	12.16	12.32	12.61
Solids-not-fat (%)	8.8	9.1	8.9	9.7
Protein (%)	3.17	3.46	3.26	3.70
Actual Milk Prod. (lb)	25.6	29.0	28.7	30.3
4% FCM (lb)	25.6	24.8	26.1	25.3
Body Weight (lb)	905	915	940	980
Feed (lb/1000 lb)	33.6	35.0	37.4	37.6
118C - Holstein				
Butterfat (%)	4.0	3.1	4.1	3.8
Total Solids (%)	12.80	12.19	12.89	13.20
Solids-not-fat (%)	8.8	9.1	8.8	9.3
Protein (%)	3.11	3.28	3.26	3.54
Actual Milk Prod. (lb)	29.9	33.0	29.0	30.9
4% FCM (lb)	29.9	28.7	29.4	30.2
Body Weight (lb)	1070	1065	1080	1110
Feed (lb/1000 lb)	35.4	33.7	33.5	37.9
127C - Holstein				
Butterfat (%)	4.4	2.9	3.2	3.2
Total Solids (%)	12.87	10.81	11.76	11.94
Solids-not-fat (%)	8.4	8.9	8.6	8.8
Protein (%)	2.89	2.78	2.80	3.16
Actual Milk Prod. (lb)	51.7	50.2	52.2	52.4
4% FCM (lb)	55.0	41.8	45.9	45.7
Body Weight (lb)	1035	1070	1110	1120
Feed (lb/1000 lb)	34.9	32.1	42.0	39.4

Table 6. Continued

	Group III			
Treatment	Pellets	Pellets	Pellets	Pellets
Period	1	2	3	4
117C - Holstein				
Butterfat (%)	3.4	2.5	2.6	2.4
Total Solids (%)	13.57	12.37	12.66	12.78
Solids-not-fat (%)	10.2	9.8	10.1	10.4
Protein (%)	3.64	3.65	3.77	4.04
Actual Milk Prod. (lb)	28.6	26.4	27.2	25.9
4% FCM (lb)	26.0	20.6	21.5	19.6
Body Weight (lb)	1030	1060	1065	1110
Feed (lb/1000 lb)	35.2	30.5	32.5	33.7
119C - Holstein				
Butterfat (%)	3.3	3.0	2.8	3.2
Total Solids (%)	12.75	12.46	12.58	12.98
Solids-not-fat (%)	9.4	9.4	9.8	9.8
Protein (%)	3.38	3.44	3.58	3.65
Actual Milk Prod. (lb)	33.6	33.6	34.1	35.0
4% FCM (lb)	30.3	28.8	28.1	20.7
Body Weight (lb)	1015	1045	1070	1110
Feed (lb/1000 lb)	37.1	37.1	36.9	39.4
121C - Holstein				
Butterfat (%)	3.6	3.2	3.1	3.0
Total Solids (%)	12.82	12.28	12.56	12.60
Solids-not-fat (%)	9.2	9.1	9.5	9.6
Protein (%)	3.24	3.38	3.43	3.62
Actual Milk Prod. (lb)	27.9	29.4	27.1	29.7
4% FCM (lb)	26.2	25.6	23.4	25.2
Body Weight (lb)	980	1040	1050	1120
Feed (lb/1000 lb)	42.0	40.1	35.6	42.4
125C - Holstein				
Butterfat (%)	4.3	3.2	3.1	2.2
Total Solids (%)	13.50	12.26	12.62	12.79
Solids-not-fat (%)	9.2	9.1	9.6	9.9
Protein (%)	3.14	3.26	3.89	3.74
Actual Milk Prod. (lb)	41.8	36.8	36.7	33.0
4% FCM (lb)	43.9	32.1	31.6	23.9
Body Weight (lb)	1060	1085	1075	1105
Feed (lb/1000 lb)	39.0	33.5	34.3	30.8

Table 6. Continued

	Group III			
Treatment :	Pellets :	Pellets :	Pellets :	Pellets
Period :	1 :	2 :	3 :	4
397B - Jersey				
Butterfat (%)	4.2	6.4	5.2	4.6
Total Solids (%)	13.60	15.14	14.38	14.06
Solids-not-fat (%)	9.3	8.7	9.2	9.4
Protein (%)	3.62	3.40	3.47	3.54
Actual Milk Prod. (lb)	21.6	15.9	14.2	14.9
4% FCM (lb)	22.4	21.7	16.9	16.4
Body Weight (lb)	970	870	950	850
Feed (lb/1000 lb)	33.0	16.1	14.7	29.9
324C - Jersey				
Removed from experiment.				

Table 7. Chemical analyses of feed (dry basis).

Feed	Period	Protein (N X 6.25)	Ether Extract	Crude Fiber	Ash	N-Free Extract
		%	%	%	%	%
Hay	1	13.6	1.2	31.6	7.0	29.3
Hay	2	13.3	1.4	28.6	7.7	31.8
Hay	3	15.6	1.1	27.4	8.6	29.6
Hay	4	14.0	1.4	27.6	8.0	31.4
Grain	1	8.2	2.4	2.3	1.5	64.9
Grain	2	8.3	2.6	2.1	1.6	65.2
Grain	3	8.7	2.7	2.3	1.8	64.6
Pellets	1	11.6	1.7	18.2	7.2	44.0
Pellets	2	12.0	1.9	18.2	7.9	43.4
Pellets	3	12.6	1.8	18.9	7.9	42.6
Pellets	4	12.5	1.8	18.5	8.0	42.6

Table 8. Data obtained with Group I, summarized by periods.

Treatment	Pellets	Hay & Grain	Pellets	Pellets & Hay
Period	1	2	3	4
Butterfat (%)	3.9	3.6	3.2	3.6
Total Solids (%)	13.11	12.76	12.75	13.02
Solids-not-fat (%)	9.2	9.2	9.5	9.5
Protein (%)	3.37	3.35	3.56	3.76
Actual Milk Prod. (lb)	34.1	31.6	32.5	30.6
4% FCM (lb)	33.5	28.8	28.4	28.0
Body Weight (lb)	1091	1112	1118	1176
Feed (lb/1000 lb)	33.1	32.0	32.4	41.6*

* Includes two Jersey cows not previously considered.

Table 9. Data obtained with Group II, summarized by periods.

Treatment	Hay & Grain	Pellets	Hay & Grain	Pell. + 1 lb hay
Period	1	2	3	4
Butterfat (%)	4.4	3.5	4.0	3.6
Total Solids (%)	13.18	12.41	12.88	12.90
Solids-not-fat (%)	8.8	9.2	8.9	9.2
Protein (%)	3.11	3.28	3.19	3.60
Actual Milk Prod. (lb)	32.6	34.8	33.4	34.6
4% FCM (lb)	34.4	31.5	32.5	32.2
Body Weight (lb)	950	969	991	1011
Feed (lb/1000 lb)	33.8	35.3	37.8	39.1

A PELLETED COMPLETE RATION
FOR LACTATING DAIRY COWS

by

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This experiment was devised to compare the effects of a coarsely ground pelleted complete ration with chopped hay and grain fed in the same ratio as that in the pellets, for lactating dairy cows. Eighteen cows of four breeds were selected from the Kansas State University dairy herd and semi-randomly assigned to three groups. Groups I and II were used in a double reversal trial and Group III was used to determine the effect of uninterrupted pellet feeding on milk production, feed consumption, body weight change, butterfat percentage and other fractions of milk.

The pellets, composed of two parts sun-cured alfalfa hay ground through a three-fourths inch hammer mill screen and one part ground sorghum grain, were produced in a California pellet mill using a three-fourths inch die. Even though the hay contained in the pellets was coarsely ground, the Jersey cows used in this experiment could not tolerate the pelleted complete ration without the addition of long or chopped hay. One pound of chopped hay was not sufficient to maintain normal consumption in the Jersey cows while the consumption of pellets by other breeds was not affected.

The three-fourths inch grind used for the hay contained in these pellets was not coarse enough to maintain butterfat percentage at a normal level. Addition of one pound of chopped hay to the all pelleted ration was not enough coarse roughage to support normal butterfat percentage in the milk. However, observations of the data collected from the uninterrupted pellet fed group indicate that a minimum period of five weeks is required to detect a significant decrease in butterfat percentage. This may be a reason for lack of agreement on this point in the literature. Ad libitum consumption of both chopped hay and pellets provided for normal percentage of butterfat for six cows, including four breeds.

Protein content of the milk was increased with feeding of the pelleted complete ration. This was true not only in the double reversal trial but also in the group fed pellets continuously indicating that the increase in milk protein is real and is associated with consumption of pellets. This increase in protein was probably the reason for the increase in the level of solids-not-fat of the milk. The significant increase of solids-not-fat and protein in the milk could be of economic importance to dairymen whose milk is priced on the basis of its total solids content.

Consumption of the pelleted ration fed alone was not significantly different from that of chopped hay and grain. *Ad libitum* feeding of both chopped hay and pellets, however, increased total feed consumption to an amount greater than either that of chopped hay and grain ration or the pelleted complete ration. Milk production was not consistently increased or decreased by feeding the pelleted complete ration.