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High Moisture and High Dry Matter Silages, Each Fed with Ear Corn Silage and a Dry Grain Mixture

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A. D. PRATT and H. R. CONRAD

INTRODUCTION

The use of high dry matter silage has gained wide acceptance by dairymen. This favorable reception is due to the preference of cows for this type of silage, the desirable characteristics of the silage, and the freedom from seepage.

There is a need to determine what sources of energy supplement high dry matter silage best. Clarification of the effects of silages high in relative amounts of acetic and lactic acids on milk production and on body weight gains would assist the dairyman in the most economical use of his forage crops.

REVIEW OF LITERATURE

Voelker and Bartle (21) found that dairy heifers made greater daily body weight gains when fed haylage, which is typically high in its lactic acid content, than when fed green chop from a similar forage. Perry (13) reported that steers made greater body weight gains when fed ensiled high moisture shelled corn or ground ear corn silage than when fed the corresponding dried products.

To increase the lactic acid content of corn silage, Klosterman *et al* (9) added 1 percent of high calcium carbonate limestone when ensiling. Fattening cattle made more daily gain on limestone-treated silage than on untreated silage.

The fact that haylage contains a higher percentage of lactic acid and less acetic acid than high moisture silage raises the question of the effect of variations in these organic acids on milk production and body weight gains of milking cows. Rook and Balch (17) superimposed acetic acid and propionic acid on a basal ration of hay and dairy cubes. Animals given intraruminal acetic acid produced milk of 3.89 percent fat compared to 2.96 for the control animals and showed definite increases in percentages of solids-not-fat, lactose, and protein.

To test the effect of increased lactic acid in the ration of milking cows, Byers *et al* (2) fed untreated and limestone-treated corn silage. They found no significant differences ($P > 0.05$) in dry matter consumption, milk yield, butterfat percentage of the milk, or change in body weight.

In studying this problem, Simpkins *et al* (18) found no significant effects ($P > 0.05$) of limestone treatment of corn silage on production of 4 percent fat-corrected milk (F.C.M.) or solids-not-fat but a lowered percentage of butterfat. Thus the effect of high lactic acid on milk production appears different than on body weight gains.

The effect of the level of moisture in the silage was studied by Owen and Howard (12). To direct-cut and to wilted alfalfa, they added amounts of cracked corn equal in dry matter content to that of the crop. Thus they produced silages of 32, 47, and 53 percent dry matter. The cows on high moisture (32 percent dry matter) silage were the only ones which lost weight. This group produced fewer pounds of milk than the others but the milk contained a higher butterfat percentage. When pellets of 50 percent corn and 50 percent alfalfa were added, the 4 percent F.C.M. increased. Wilted silage was highly efficient in production of 4 percent F.C.M. ($P < 0.05$) but losses in body weight occurred. Thus equal amounts of dry matter from silage and from cracked corn were not adequate to meet the needs for potential production when the corn had been fermented.

Pratt and Conrad (15) fed alfalfa-grass silage, ensiled with 10 percent of ground ear corn (furnishing 32.4 percent of the dry matter of the silage), in contrast to untreated alfalfa-grass silage 75 percent and ground ear corn 25 percent of the ration dry matter. A third group was fed untreated silage as 75 percent of the ration dry matter and a grain mixture containing 13.9 percent crude protein. The cows fed corn-treated silage did not produce as much 4 percent F.C.M. as those fed dry grain, although their dry matter intake was greater. It is significant that the digestibility of protein was 67.8 percent for silage and grain, 63.5 percent for silage with ground ear corn, and only 55.7 percent for corn-treated silage. The differences in digestibility of the two extremes may be due to differences in energy intake but they suggest a need for a greater amount of protein. Body weight gains of those fed extra protein and body weight losses of those fed corn-treated silage suggest that body protein was deaminized to yield energy in the latter case.

Wilson (25) found both increases and decreases in pH of silages due to wilting of alfalfa but no consistent change. However, Gordon and co-workers (6), who made direct-cut and wilted silages from alfalfa, found a pH of 4.9 for the former and 4.6 for the latter. Milking cows ate significantly ($P < 0.05$) more dry matter from the 45.5 percent dry matter haylage than from the 24.1 percent dry matter silage.

Watson and Ferguson (24) reported as early as 1937 that most samples of silage with a pH near 4.5 would have low amounts of volatile bases. They found that the ratio of non-volatile to volatile fatty acids in the pH range of 3.8 to 4.8 agreed closely for molasses treated silage, untreated silage, and A.I.V. silage. They reported volatile bases and volatile fatty acids to be comparatively high in silages of a pH above 4.5 Although not stated, it is assumed that they worked largely with grass rather than legume silages.

Waldo *et al* (22) fed alfalfa hay in comparison with silage from a similar crop and found less efficient use of the nitrogen of silage. They stated: "Whether this lowered utilization of nitrogen is due to the form of nitrogen or to the increased ratio of nitrogen to energy can not be ascertained from nitrogen balance data." They suggested that high values for nitrogen retention may indicate a loss of tissue fat and an increase in tissue protein. Loss of tissue fat would account for the greater apparent efficiency of cows fed high moisture silage. They concluded: "A secondary cause of the lower nitrogen utilization may still be the form of nitrogen."

Gordon *et al* (5) found that the ammoniacal nitrogen content of alfalfa silage decreased with increasing dry matter content. They found a decreasing rate of dry matter intake as the dry matter content of haylage rose above 50 percent.

Roffler and co-workers (16) cut first growth alfalfa at the one-tenth bloom stage and stored it as wilted silage, low moisture silage, and hay. The respective dry matter intakes from the three forms were 1.7, 2.2, and 1.8 lb. per cwt. of body weight with 4 percent F.C.M. yields of 28.4, 33.8, and 30.6 lb. The lowest digestibility occurred when haylage was fed, when the dry matter intake per 100 lb. body weight was greatest, and when the fiber would leave the rumen most rapidly.

Gordon *et al* (7) found more sugar remaining in haylage than in direct-cut silage, indicating less fermentation. However, they found the dry matter digestibility of haylage generally lower than that of either high moisture silage or hay. The crude protein digestibility was lower for haylage than for direct-cut silage ($P<0.01$). They concluded that the true value of forages was affected as much by acceptability as by nutrient content.

Murdock (11) summarized research indicating that voluntary intake of forage was higher as the nutritive value of the forage increased. This viewpoint is consonant with the idea that forages low in content of indigestible fiber leave the rumen more rapidly and induce greater voluntary intake.

Waldo *et al* (23), studying rumen content, dry matter passage, and water intake, found that the wet and dry rumen contents of heifers fed silage ad lib were less than when they were fed hay. This suggested that silage intake was not restricted by lack of rumen capacity.

Dowden and Jacobson (4) administered fatty acid intravenously by constant drip over an 8-hour period with feed before the animals and noted the influence on feed consumption. When acetic acid or sodium acetate was administered, alfalfa consumption was negligible. Eating was resumed at a normal rate when injection ceased but the 24-hour intake was materially reduced. Administration of propionic acid also reduced feed intake but glucose did not. Injection of lactic acid resulted in a small mean reduction in feed intake which was variable in extent and thus was not of statistical significance.

Simpkins and co-workers (19) concluded that "results indicate a chemo-static mechanism, elicited by volatile fatty acids, is an important component of food intake regulation in ruminants."

Simpkins *et al* (20) found no glucostatic effect upon intake of a pelleted ration composed of 60 percent alfalfa meal and 40 percent ground corn. In contrast, infusions of acetate, propionate, and a V.F.A. mixture reduced intake.

EXPERIMENTAL PROCEDURE

Since many of the experiments comparing haylage and high moisture silage have been of short duration, the following experiment was planned to span most of a lactation.

Procedure

Haylage and silage were fed to similar groups of milking cows. Half of each group was fed ear corn silage and the other half was fed grain (ground corn, 500 lb.; ground oats, 355 lb.; soybean oilmeal, 125 lb.; iodized salt, 10 lb.; and steamed bonemeal, 10 lb.).

The cows were started on experiment right after calving. Mature equivalents were calculated for individual cows based on all previous 305-day production records. Production for the experimental year was predicted from the mature equivalents, using the age factors of the U.S.D.A. (8) in reverse for the age at which the cow calved for this lactation.

TABLE 1.—Analyses of Feeds (Dry Matter Basis).

	Crude Protein	Ether Extract	Crude Fiber
	(%)	(%)	(%)
Haylage	18.5	2.7	31.9
High moisture silage	19 0	2.4	28.9
Ear corn silage	9.6	4.6	5.2
Grain 83	17.3	3.4	3.4
Soybean oilmeal	45.8	1.7	6.5

The grain mixture with an estimated 16 percent protein was fed to half of each forage group as previous digestion trials (where no protein supplement was fed) had indicated inadequate protein for positive nitrogen balance in cows fed legume silage and ground ear corn and where the cows were in high milk production. Forage and grain were fed at a rate of 1.5 lb. of forage dry matter to each pound of grain dry matter, as a ratio of 2 to 1 was calculated to be too low in energy for cows milking 80 lb. or more.

Experimental Animals

Four groups of cows were selected which varied in average predicted production (305-day 4 percent F.C.M.) from 13,008 to 13,450 lb. per group. These groups were assigned at random to haylage and grain, haylage and ear corn silage, silage and grain, or silage and ear corn silage. Three of the groups contained four Holsteins and one Jersey and the fourth group was composed of five Holsteins.

Forages

Both haylage and silage were made from similar stands of alfalfa-grass mixtures.

The haylage was ensiled in a 14- x 50-foot gas-tight silo on May 29 to June 3. The amount of wilting varied widely, with the dry matter content ranging from 30 to 61 percent. On the top of the silo, several loads of wet crop (less than 30 percent dry matter) were used as a seal.

The crop ensiled in a 10- x 40-foot cement stave silo on May 28 and 29 was intended to be wilted to 30 or 35 percent dry matter. Ensiling was done on warm windy days and the dry matter content of the resulting silage actually varied from 30 to 51 percent.

Ear Corn Silage

Hybrid field corn was picked with most of the husks remaining. The ears were then put through a picker-grinder at the silo. The cobs were cut by the revolving blades, after which the materials passed through a screen into rollers which crushed it thoroughly. Some portion of each kernel was crushed, favoring high digestibility.

The ear corn was ensiled in an 8- x 40-foot stave silo. The dry matter content of the resulting silage varied from 45 to 60 percent. Enough additional cows were fed from the silo to keep the quality acceptable. An amount of soybean oilmeal was fed with the ear corn silage to raise the protein content of the ear corn silage to that of a dry matter equivalent of the grain mixture. Analyses of feeds appear in Table 1.

Dry Matter Analyses

Dry matter analyses of forages and grains were made twice each week so that the ratio of 1.5 lb. of forage dry matter to each pound of grain dry matter would be maintained.

TABLE 2.—Data for the Feeding Trial.

Group	Cow	Haylage Lb.	Haylage D.M.	Silage Lb.	Silage D.M.	Hay Lb.	Hay D.M.	Grain D.M. Lb.	Total D.M. Intake Lb./Day	Av. Body Weight Lb.	Days on Test	D.M. Intake 1000 Lb.	4% F.C.M. Lb.	4% F.C.M. 1000 Lb.	Gain or Loss
Haylage and Grain 83															
	H-1591	53.6	24.3			0.5	0.4	18.2	43.0	1332	181	32.3	43.8	32.9	144
	H-1361	57.6	24.6			0	0	18.4	43.0	1506	227	28.5	60.3	40.0	30
	H-1398	57.2	26.1			0	0	19.5	45.7	1433	187	31.8	55.8	38.9	114
	H-1625	42.1	23.1			0.4	0.4	17.9	41.4	1296	115	31.9	65.4	50.5	50
	J-1587	36.7	15.9			0.2	0.2	12.3	28.4	942	210	30.1	40.7	43.2	—45
Average		49.4	22.8			0.2	0.2	17.3	40.3	1302	184	30.9	53.3	40.9	59
Haylage, Ear Corn Silage, and Soybean Oilmeal															
	H-1634*	46.1	16.4			2.2	1.9	12.1	30.7	1155	32	26.6	49.0	42.4	0
	H-1564	41.3	17.7			0.2	0.2	13.9	31.8	1369	219	23.2	39 8	29.1	1
	H-1531	51.4	22.2			0.4	0.4	17.5	40.2	1414	228	28.4	47.1	33.3	31
	H-1588	40.5	17.7			0.5	0.5	13.8	32.1	1142	193	28.1	37.2	32.6	146
	H-1580	55.0	23.7			0	0	17 9	41.7	1359	227	30.7	52.1	38.3	50
	J-1597	38.9	17.1			0.3	0.3	13.6	31.1	1081	211	28.8	45.3	41.9	—54
Average		45.5	19.1			0.6	0.5	14.8	34.6	1253	185	27.6	45.1	36.0	30
Silage and Grain 83															
	H-1604			43.2	19.8	0.5	0.4	15.4	35.7	1264	151	28.2	49.6	39.2	—44
	H-1584			42.4	19.2	0	0	15.0	34.3	1339	163	25.6	46.4	34.7	0
	H-1646			40.4	18.4	0	0	14.4	32.8	1116	142	29.4	48.5	43.4	15
	H-1614			43.2	20.1	0.5	0.4	15.5	36.1	1225	139	29.5	43.2	35.3	47
	J-1631			37.4	17.2	0.4	0.3	13.7	31.3	944	145	33.2	37.8	40.0	18
Average				41.3	19.0	0.3	0.2	14.8	34.0	1178	148	29.2	45.1	38.3	7
Silage, Ear Corn Silage, and Soybean Oilmeal															
	H-1634			42.1	19.8	0	0	16.3	36.1	1150	96	31.4	48 1	41.8	65
	H-1545			47.9	21.8	0.4	0.4	17 5	39.8	1180	151	33.7	53.1	45.0	128
	H-1496			48.6	22.5	0	0	17 8	40.4	1215	144	33.3	55.4	45 6	65
	H-1439			46.2	21.5	0.5	0.4	17 1	39.1	1279	139	30.6	54.6	42.7	—2
	H-1533			51.6	24.2	0.3	0.3	18 8	43 4	1451	129	29.9	47.8	32.9	33
Average				47.3	22.0	0.2	0.2	17.5	39 8	1255	132	32.0	51.8	41.3	58

*Changed to silage to balance groups.

The grain mixture and the soybean oilmeal were oven dried at 100° C., as were the forages and ear corn silage. Dry matter analyses were also made by the toluene distillation method for the three silages to determine the feeding ratios. Proximate analyses were made on composites of the respective oven dry samples.

Duration of Experiment

Feeding from the gas-tight silo began June 15 and continued until March 30. The silage from the stave silo was fed out completely by March 5 and the two groups on silage were changed to an alfalfa-grass silage of high dry matter content and containing a high amount of volunteer wheat. The feeding of this silage continued until March 30.

Management of Cows

The cows were stanchioned and were provided with an enclosed manger which prevented scattering of their feed.

They were fed grain followed by forage in early morning. The same feeding sequence was followed in the afternoon. Refusal was weighed back the next morning before grain was fed. Grain was seldom refused but when it was the proportion was estimated.

Small amounts of alfalfa hay were fed to those cows which did not readily become adjusted to the experimental ration. They were fed about 5 lb. daily at first. The amount was reduced as soon as the ration was consumed readily and was eliminated as soon as the cow ate the basic ration well.

The cows were turned out for exercise and checking of heat 6 days each week. They had access to salt and to steamed bonemeal in separate containers. The cows were bedded with shavings.

EXPERIMENTAL RESULTS AND DISCUSSION

Because of the variation in body weight of the experimental cows, both milk production (on a 4 percent F.C.M. basis) and dry matter intake were calculated to a 1000 lb. body weight basis for purposes of comparison.

The data on feed intake, milk production, and other pertinent data are presented in Table 2. When cows had no refusal, feed increases were made on the basis of 1.5 : 1 roughage to grain ratio. When refusal exceeded 3 lb., reductions were made according to the same ratio. The relation of the actual forage dry matter intake to that of the grain for the four groups shows ratios around 1.3 to 1 and reflects refusal of forage in excess of refusal of grain.

The calculated percentage of dry matter of the silage actually consumed by the four groups was 45.1, 42.0, 46.0, and 46.5 percent respectively for the groups fed haylage plus grain, haylage plus ear corn silage plus soybean oilmeal, silage plus grain, or silage plus ear corn silage plus soybean oilmeal. Comparison then should be made on dry matter content rather than the structure in which the forage was stored.

The group fed haylage and grain produced a daily average of 40.9 lb. of 4 percent F.C.M. per 1000 lb. body weight while the group fed silage and ear corn silage with soybean oilmeal produced 41.3 lb. or essentially the same. The milk production of the other two groups fell between these, with the group fed silage and grain producing more than the group fed ear corn silage. Since the difference in protein of the two basic rations was equalized by addition of soybean oilmeal, protein does not account for the differences in performance.

The daily dry matter intake per 1000 lb. body weight was greatest (32.0 lb.) for the group fed silage and ear corn silage with soybean oilmeal. The group fed haylage and grain was lowest with 30.9 lb. Again the other two groups fell between and in the same order as before.

The average daily gains in body weight were 0.44 lb. for the group fed silage and ear corn silage with soybean oilmeal, 0.32 lb. for the group fed haylage and grain, 0.15 lb. for the group fed haylage and corn silage with soybean oilmeal, and only 0.05 lb. for the group fed silage and grain. The group which made the greatest daily gain was fed both silage of 46.5 percent dry matter content (8.2 percent lactic acid content) and ear corn silage also high in lactic acid. It has been shown that lactic acid does not limit appetite (4) and favors body weight gain (9, 13, 21).

Because the above comparison did not contrast high dry matter and low dry matter silages as intended, the following plan was adopted. The data were arranged according to whether the dry matter content of the silage was above or below 40 percent dry matter, regardless of the type of silo from which it came. To make comparison more meaningful, two adjustments were made in preparing the data for statistical analysis: all milk production was multiplied by an animal age factor (8) to convert to a mature equivalent basis and a lactation factor (10) was applied to make each month's production equivalent to the second month of lactation, which is usually the highest.

When adjusted, the milk production for the cows fed silage of more than 40 percent dry matter was 46.7 lb. per day while that for the cows fed silage of less than 40 percent dry matter was 43.6 lb. Because of rather wide differences in production of individual cows, this difference was not statistically significant.

The analysis of variance for cows fed grain vs. ear corn silage was significant ($P < 0.01$). The production on unfermented grain was 46.2 lb. compared with 44.1 lb. for ear corn silage.

Silage Analyses

The organic acids of the silages were determined by means of a silica gel column (1) and are presented in Table 3.

In a previous experiment (14), four untreated legume-grass silages harvested at early bloom (June 7) averaging 24 percent dry matter (because of partial wilting) contained only 47 percent of the organic acids as lactic. In the experiment described here, lactic acid makes up 67 percent of the organic acids of the conventional silage because of the higher dry matter content (average 43 percent). In this experiment, the three samples of untreated silage made in the stave silo averaging 43 percent dry matter contained 2.8 percent acetic and 9.8 percent lactic acid, with lactic acid 67 percent of the total organic acids. No analyses of legume-grass silage with as high lactic acid as these have come to the authors' attention.

Milk production and dry matter intake were not significantly different when the cows were changed from the silage made in the stave silo to another alfalfa-grass silage also made in a stave silo but made from a new seeding alfalfa with a large amount of volunteer wheat. The total organic acids were slightly lower than for the silage not containing wheat and the proportion of lactic acid in the total organic acids was also slightly lower.

The haylage made in a gas-tight silo contained about two-thirds as much total organic acids as the silage made in the stave silo, where air was not as well excluded.

In all of the analyses of legume-grass silages presented in Table 3, the propionic and butyric acids were not eluted in distinctly separated tubes and appeared to be overlapping. So all acids were reported as butyric. The amount of propionic acid was estimated to be extremely small.

The ear corn silage was treated with 5 lb. of Silotracin per ton of ears. The low content of lactic acid (3.0+ percent) is believed due to the high density of the settled silage and a consequently high degree of exclusion of air. Previous work (14) had shown that bacitracin resulted in a marked increase in acetic acid content of legume-grass silage. No such effect is evident in this ear corn silage. This difference may be due to differences in pH and the rate at which a low pH is attained in ear corn silage.

Digestion Trials

Total collection digestion trials were conducted with one cow on each ration in their own stalls (3). The data are presented in Table 4. The dry matter digestibility of haylage and silage were essentially the

TABLE 3.—Analyses of Silages Fed (Dry Basis).

Silage	Sample No.	Dry Matter	Organic Acids: Propionic	Butyric	Acetic	Formic	Lactic	Undeter-mined	Total	Lactic / Total
		(%)								
Ear corn*	1	58.0	0.3	0	0.7	0.1	3.1	0.8	5.0	62
	2	56.0	0.2	0	0.9	0	3.8	0.5	5.4	70
Silage	1	46.5	0	0.4	2.2	0.2	8.2	1.5	12.5	66
	2	45.0	0	0.7	2.3	0.1	9.7	0.9	13.7	71
	3	39.0	0	0.8	3.8	0	11.6	1.6	17.8	65
Silage with wheat	1	35.0	0	0.6	2.5	0	7.9	1.5	12.5	63
Haylage	1	55.3	0	0.6	1.8	0.1	4.6	1.9	9.0	51
	2	57.0	0	0.3	1.5	0.1	5.1	1.2	8.2	62

*Ear corn was treated with 5 lb. Silotracin per ton.

TABLE 4.—Digestibility of Dry Matter of the Four Rations Fed.

	Haylage*		Silage†	
	Grain 83	Ear Corn Silage‡	Grain 83	Ear Corn Silage‡
Dry matter intake (lb./d.)	35.4	29.4	35 4	20.9
Dry matter intake (lb./1000 lb /d.)	39.2	28.9	36.8	22.6
Dry matter digestibility (%)	69.9	67.2	70.4	67.3

*55.4% dry matter.
†48.8% dry matter.
‡56.0% dry matter.

same. However, the rations containing grain were more digestible than those containing ear corn silage.

The dry matter intake per 1000 lb. body weight is definitely greater during the digestion trial for the cows fed haylage than for those fed silage. The lower dry matter intake of those fed ear corn silage as compared with grain suggests that the organic acid content of the silage and ear corn silage together inhibited appetite. These results are in contrast with those appearing in Table 2, where the data were not arranged with respect to high vs. low dry matter content of the silage.

SUMMARY AND CONCLUSIONS

Four similar groups of milking cows were fed haylage and grain (17.3 percent protein); haylage, ear corn silage, and soybean oilmeal to make the protein equivalent to the grain; silage and grain; and silage, ear corn silage, and soybean oilmeal. The forage dry matter to grain dry matter ratio was kept to 1.5 : 1 by semi-weekly dry matter analyses of all components of the ration, followed by adjustments in grain and forage allowances. The cows which calved earlier were given haylage and were on experiment for 7.5 months.

When the silage from a concrete stave silo was fed, another alfalfa-grass silage containing volunteer wheat was substituted without a measurable change in production.

The silage was higher in dry matter content than was planned and a direct comparison of the four groups lacked significance. The data were then compared by an analysis of variance comparing milk production and dry matter intake for the periods when the dry matter content of the forage was above or below 40 percent. Factors were applied to the production of individual cows to correct all records to a mature equivalent. Lactation factors were applied to each month's production of each cow to make production in different stages of lactation comparable.

The corrected production was 46.7 lb. per 1000 lb. of body weight per day for those fed silage of more than 40 percent dry matter and 43.6

lb. for those fed silage of less than 40 percent dry matter. This difference was not statistically significant because of large variations in milk production and small numbers of animals.

The production of cows fed grain was 46.2 lb. per 1000 lb. of body weight per day as compared with 44.1 lb. for those fed ear corn silage. This difference was significant at the 1 percent level.

The silages contained 67 percent of the total organic acids as lactic acid. The silage made in the gas-tight silo contained about two-thirds as much total organic acids as that made in a concrete stave silo, indicating less oxidation.

Of the total organic acids of ear corn silage, lactic was 62 percent and acetic 14 percent. The relatively low proportion of acetic acid is believed to be due to the rapid production of lactic acid, bringing the pH quickly to the level where bacterial action is inhibited.

The digestibilities of the dry matter of haylage of 55 percent dry matter and of silage of 49 percent dry matter were the same within experimental error.

The dry matter intake of the cows on digestion trial was considerably greater for the cows fed haylage (34 lb.) than for the cows fed silage (30 lb.) when compared on a 1000 lb. weight basis. The dry matter intake of all cows fed grain was 38 lb. per 1000 lb. body weight per day, compared with 25.8 lb. when they were fed ear corn silage supplemented with soybean oilmeal. This confirms earlier research which indicated that cows need unfermented forage or grain for maximum production.

LITERATURE CITED

1. Bulen, W. A., J. A. Varner, and R. C. Burrell. 1952. Separation of organic acid from plant tissues. Anal. Chem. 24: 187.

2. Byers, J. H., C. L. Davis, and C. E. Baylor. 1964. Feeding value of limestone-treated corn silage for lactating dairy cows. J. Dairy Sci. 47: 1062.

3. Conrad, H. R., J. W. Hibbs, and A. D. Pratt. 1960. Nitrogen metabolism in dairy cattle. Ohio Agri. Exp. Sta. Res. Bull. 861.

4. Dowden, Donald R. and Don R. Jacobson. 1960. Inhibition of appetite in dairy cattle by certain intermediate metabolites. Nature, 188 (47-45): 148.

5. Gordon, C. H., J. C. Derbyshire, W. C. Jacobson, and J. L. Humphrey. 1965. Effects of dry matter in low-moisture silage on preservation, acceptability, and feeding value for dairy cows. J. Dairy Sci. 48: 1062.

6. Gordon, C. H., J. C. Derbyshire, C. G. Melin, E. A. Kane, J. F. Sykes, and D. T. Black. 1960. The effect of wilting on the feeding value of silages. U.S.D.A., Agr. Res. Serv. 44-76.

7. Gordon, C. R., J. C. Derbyshire, H. G. Wiseman, E. A. Kane, and C. G. Melin. 1961. Preservation and feeding value of alfalfa stored as hay, haylage and direct-cut silage. J. Dairy Sci. 44: 1299.

8. Kendrick, J. F. 1955. Standardizing dairy-herd-improvement-association records in proving sires. U.S.D.A., Agri. Res. Serv. 52-1.

9. Klosterman, Earle W., Ronald R. Johnson, A. L. Moxon and Harold W. Scott. 1963. Feeding value of limestone treated corn silages for fattening cattle. Ohio Agri. Exp. Sta. Res. Bull. 934.

10. Madden, D. E., L. D. McGilliard, and N. P. Ralston. 1959. Relations between test-day milk production of Holstein cows. J. Dairy Sci. 42: 319.

11. Murdock, J. C. 1964. Some factors affecting the efficient utilization of conserved grass. Proc. Nutr. Soc. 23: 99.

12. Owen, F. G. and W. T. Howard. 1965. Effect of ration moisture level on value of alfalfa plus cracked corn as a complete-feed silage for lactating cows. J. Dairy Sci. 48: 1310.

13. Perry, T. W. 1963. Haylage and high moisture grain. Paper presented before Harvestore Research Forum, Nov. 7-8.

14. Pratt, A. D. and H. R. Conrad. 1961. Bacitracin as a preservative for legume-grass silage. Ohio Agri. Exp. Sta. Res. Bull. 893.

15. Pratt, A. D. and H. R. Conrad. 1965. The need for unfermented grain or forage with high moisture grass-legume silage for dairy cattle. Ohio Agri. Res. and Dev. Center Res. Bull. 979.

16. Roffler, R. E., R. P. Niedermeier, and B. R. Baumgardt. 1963. Evaluation of alfalfa-brome forage stored as wilted silage, low moisture silage and hay. Abs., J. Dairy Sci. 46: 632.

17. Rook, J. A. and C. C. Balch. 1959. The effects of intraruminal infusions of acetic and propionic acids on the yield and composition of the milk of the cow. Proc. Nutr. Soc. 18: XXXIV.

18. Simpkins, K. L., B. R. Baumgardt, and R. P. Niedermeier. 1965. Feeding value of calcium carbonate-treated corn silage for dairy cows. J. Dairy Sci. 48: 1315.

19. Simpkins, K. L., J. W. Suttie, and B. R. Baumgardt. 1965. Effect of glucose and volatile fatty acids on feed intake in ruminants. J. Dairy Sci. 48: 799.

20. Simpkins, K. L., J. W. Suttie, and B. R. Baumgardt. 1965. Regulation of food intake in ruminants. 4. Effect of acetate, propionate, butyrate, and glucose on voluntary food intake in dairy cattle. J. Dairy Sci. 48: 1635.

21. Voelker, H. H. and E. Bartle. 1960. Feeding values of alfalfa haylage, silage, green chop, pasture and artificially dried hay. Abs., J. Dairy Sci. 43: 869.

22. Waldo, D. R., R. W. Miller, M. Okamoto, and L. A. Moore. 1965. Ruminant utilization of silage in relation to hay, pellets and hay plus grain. I. Composition, digestion, nitrogen balance, intake and growth. J. Dairy Sci. 48: 910.

23. Waldo, D. R., R. W. Miller, M. Okamoto, and L. A. Moore. 1965. Ruminant utilizaztion of silage in relation to hay, pellets and hay plus grain. II. Rumen content, dry matter passage and water intake. J. Dairy Sci. 48: 1473.

24. Watson, S. J. and W. S. Ferguson. 1937. The chemical composition of grass silage. J. Agri. Sci. 27: 1-42.

25. Wilson, J. K. 1948. The pH and sugar content of forage crops before and after wilting as related to the making of silage. J. Amer. Soc. Agron. 40: 541.

APPENDIX TABLE I.—Information Used in Grouping Cows.

Group	Cow	Age	Body Weight	Predicted 4% F.C.M.	Milking	Prior Lactations No.	Prior Lactations M.E.	Days Since Calving
		(yr.-mo.)	(lb.)	(lb.)	(lb.)		(lb.)	
Haylage, Grain 83								
	H-1591	3-7	1331	13,716	—	1	15,500	4
	H-1361	7-9	1507	14,322	65	5	14,466	12
	H-1398	7-4	1433	15,016	37	4	15,167	8
	H-1625	3-3	1297	15,624	—	1	17,967	4
	J-1587	3-6	943	8,047	—	1	9,174	4
Average		5-1	1302	13,345		2.4	14,455	6
Haylage, Ear Corn Silage, Soybean Oilmeal								
	H-1634*	3-1	1156	11,658	—	1	13,640	4
	H-1564	3-11	1370	13,482	—	1	14,966	5
	H-1531	4-6	1414	14,441	70	2	15,163	39
	H-1588	3-7	1142	11,207	—	1	12,552	4
	H-1580	3-7	1359	13,670	—	1	15,584	18
	J-1597	3-5	1082	12,243	—	1	13,713	4
Average		3-10	1273	13,008		1.2	14,396	14
Silage, Grain 83								
	H-1604	3-6	1265	15,174	—	1	16,995	4
	H-1584	3-9	1339	13,910	—	1	15,580	4
	H-1646	2-10	1116	13,043	—	1	15,651	4
	H-1614	3-6	1225	11,813	—	1	13,231	4
	J-1631	3-1	944	13,310	—	1	15,579	4
Average		3-4	1178	13,450		1.0	15,407	4
Silage, Ear Corn Silage, Soybean Oilmeal								
	H-1634	3-2	1150	11,658	62	1	13,640	40
	H-1545	4-6	1180	12,760	—	2	13,399	4
	H-1496	5-7	1422	13,967	—	3	13,967	4
	H-1439	6-8	1280	15,586	—	3	15,586	4
	H-1533	4-9	1451	13,231	58	2	13,761	9
Average		4-11	1297	13,440		2.2	14,071	12

*Changed to silage to balance groups. Group average is for five animals.

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North Central Branch, Vickery, Erie County: 335 acres

Northwestern Branch, Hoytville, Wood County: 247 acres

Southeastern Branch, Carpenter, Meigs County: 330 acres

Southern Branch, Ripley, Brown County: 275 acres

Vegetable Crops Branch, Marietta, Washington County: 20 acres

Western Branch, South Charleston, Clark County: 428 acres