Factors Influencing the Palatability of Hay

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*In cooperation with U. S. Dept. of Agriculture.
Factors Influencing the Palatability of Hay
By H. S. Willard*

INTRODUCTION

Palatability is one of the important factors influencing the value of a roughage for livestock feeding. The problems confronted in providing dairy cattle with a palatable hay are important ones, especially in irrigation-farming sections where most of the dairy cattle are fed solely on hay during winter months.

Factors most usually associated with the palatability of hay are variety, time of cutting, and method of curing. Grades for alfalfa hay (1928) used by the United States Department of Agriculture are based upon color and leafiness, which, in turn, are dependent upon time of cutting and method of curing. The grades of native and introduced grasses are based upon color. The standard hay grades have been formulated, through years of experience and observation, for the purpose of aiding the buyer in securing the quality of hay desired, and aiding the grower in obtaining better prices for the hay that the buyer demands. Many times, however, the best grade of hay is not the one most relished by cattle. Growers may disagree with hay-dealers as to the kind and quality of hay best suited for use on farm and ranch. Each rancher in the West may believe his hay to be the best but can give no particular reason based on a scientific investigation for his opinion. The need for a study of the factors influencing variation in palatability of hay is very apparent.

HISTORICAL

METHODS OF PROCEDURE

One of the major problems in testing palatability of hay is the adoption of a method of determining palatability. The literature reveals that several different methods have been in use. Waters (1915) and Hendry (1925) reported on palatability trials where free choice method was employed. Woll (1925) noted the relative consumption of cereal hays when corral fed dairy heifers were given no choice.

*The material in this bulletin was presented by the author in partial fulfillment of the requirements for the degree of Doctor of Philosophy at the University of Minnesota.
There have been a number of experiments conducted to determine the feeding value of hay cut at different dates and cured under various environmental conditions. In these experiments the hay was fed in such quantities as the animals would consume without much waste and the relative palatability was noted by the amounts of each hay consumed. However, no well defined methods of testing the relative palatability of hay had been developed before the work of Eckles (1932) and colleagues was begun in the winter of 1928-29.

FACTORS AFFECTING PALATABILITY OF HAY

In all experiments reported, the time of cutting of the hay was an important factor influencing the palatability. The earlier cut hays were the more palatable. Waters (1915) reported that milk cows, having grain and other roughage besides the hays under test, were not so discriminating as steers in their taste as regards the first three cuttings but they left the fourth and fifth cuttings almost untouched until the first, second, and third cuttings were eaten. Hendry (1925) reported that "dairy stock prefer White Australian wheat hay cut in blossom to hay of the same variety cut at later stages of development, and that such hay becomes less acceptable as complete maturity is approached." Mills (1896), Foster and Merrill (1889), after feeding beef steers on alfalfa in different stages of bloom, reported that the relative palatability decreased as the plant approached the fuller stages of bloom. Christensen and Hopper (1932) reported that prairie hay cut in July was more palatable for steers than the October cutting. Dawson et al. (1933), working with dairy cows in milk, showed that the palatability of Sudan grass hay decreased with the increase in maturity of the grass at the time of cutting.

There are differences of opinion as to the relative palatability of the different cuttings of alfalfa. It was noted by Carroll (1913) that dairy cows in milk refused more of the second cutting than the first or third crop alfalfa, and at times consumed the second crop alfalfa very reluctantly. Sotola (1927), reporting work with sheep fed first, second, and third cutting alfalfa, one-half bloom, noted that similar amounts of each cutting were consumed.
The feeding value of different varieties of hays has been subjected to investigation with beef, dairy cattle, and sheep. The conclusions from a few of these investigations are briefly summarized here. Snyder (1911) reported that the average daily amounts of hay consumed by beef cattle carried through three winters as calves, yearlings, and two-year-olds on various roughages, were as follows: Alfalfa and cane hay, 24.6 pounds; alfalfa and prairie hay, 22.4 pounds; alfalfa hay, 21.5 pounds; cane hay, 20.4 pounds; prairie hay and cane hay, 19.4 pounds; prairie hay, 16.8 pounds. Hultz (1923) reported that beef calves fed for 164 days on alfalfa or Wyoming native hay alone, consumed 16.34 pounds of alfalfa hay as compared with 10.22 pounds of Wyoming native hay per head daily. Faville (1910) observed that when two lots of lambs on fattening rations were fed on equal amounts of corn, the lot receiving alfalfa hay consumed 18.8 per cent more hay than the lot receiving Wyoming native hay. The data reported by Burnett (1900) showed that the lambs receiving alfalfa consumed 51 per cent more hay per head daily than did the lambs receiving Nebraska native hay. Willard (1926) reported that dairy cows consumed 25 per cent more alfalfa than they consumed of Wyoming native hay. Meigs and Converse (1932) reported that increased consumption of hay was a very apparent result of feeding alfalfa and timothy combined rather than either timothy or alfalfa hay as the sole roughage.

Stacking alfalfa in such conditions that it heats in the stack and turns to a brown or black color is a common practice in many sections of the United States. The data presented by Swanson et al. (1919) indicate that brown and green colored alfalfa were consumed in similar quantities by beef steers but that the steers consumed somewhat smaller quantities of the black alfalfa. In experiments reported by Reed (1929) the browning of alfalfa hay in the mow did not make the hay more palatable to dairy cows than green colored alfalfa hay. Reed (1931) reported that dairy cows consumed similar quantities of dehydrated alfalfa hay and sun cured alfalfa.

Guilbert et al. (1931), reporting a digestion trial with sheep, noted that bur clover hay unexposed to rain was more palatable than bur clover hay that had been thus exposed.
Woodward et al. (1930) reported that dairy cows consumed more of the better grades of alfalfa, timothy, and soybean hay than they did of the poorer grades.

Reed (1931) reported that dairy cows which were not accustomed to a ration of roughage alone would eat somewhat less of the roughage than they might have eaten otherwise.

Little attempt has been made to correlate relative palatability with any chemical constituent of the hay. Guilbert (1931) suggested that the reduction of soluble salts and of the soluble carbohydrates caused by leaching may have a marked effect on palatability of hay. Since the early-cut hays are higher in protein and lower in fiber content than are the late-cut hays, it might be inferred that the palatability of hay was linked with these chemical constituents.

It is generally conceded that the chemical composition of plants is influenced by species and by environmental conditions, such as soil, application of fertilizing elements, and seasonal rainfall or water supply. Greenhill and Page (1931) and Ferguson (1931), working in England, found that both the nitrogen and phosphorus content of pasture plants were closely linked together, decreasing during drought and increasing after rainfall. McCreary (1931) reported that there was a marked increase in the nitrogen and phosphorus of range grass following heavy rains. In contrast to these investigations, Widtsoe and Stewart (1912) reported that there was a slight decrease in the protein content of wheat, oats, barley, corn, three crops of alfalfa, timothy, brome grass, orchard grass, Italian rye grass (first and second crops) as the supply of irrigation water was increased.

Because many chemical changes take place during the curing of plants into hay, the chemical constituents responsible for making the plant in the field palatable may not be the same as those which influence the palatability of the plant when cured. Fleischmann (1911) concluded that hay cannot be considered grass which has lost only water; that grass undergoes many chemical changes during the process of curing into hay. The data presented by Fleischmann (1911) show that the protein content of grass hay cured under unfavorable conditions was higher than the protein content of grass hay cured under favorable conditions, because of
the decrease in the amounts of the more soluble portions of the plant. Swanson et al. (1919) and Honcamp (1922) reported higher protein-content in stack burnt alfalfa hay than in green colored alfalfa hay. Haeddon (1896) found that alfalfa hay which had lost its leaves contained less protein than leafy alfalfa hay. Collins and Spiller (1920) demonstrated that straw contains a lower sugar content after fermentation had taken place than before. Widstoee and Stewart (1898) stated that the stems of alfalfa were richer in reducing sugars, water soluble carbohydrates, and starch than the leaves. According to Shuey (1914) the diastatic power was greater in the stems than in the leaves of alfalfa. He found that the diastase content of alfalfa hay was correlated with good color and odor of the hay.

EXPERIMENTAL

PART I. METHOD OF DETERMINING PALATABILITY

A method to be satisfactory for this type of experiment should be one which would permit duplication, as the trials were to be extended over long periods of time. Because of this, the free choice method of determining palatability was not suited to this work. It was decided to determine palatability of hays by means of the total amount consumed.

In studying this method three groups of factors, other than quality of hay were considered. These are:

A. Effect of offering different amounts of the same hay.
B. Effect of the concentrate supplement.
C. Effect of including too few days in the test to obtain an accurate index of a cow’s intake of the hay.

A. Offering different amounts of hay.

Procedure: Twelve Holstein and Guernsey cows in different stages of lactation were fed one pound of grain for each 3.5 pounds of milk. Hay, either alfalfa or native, was fed as a sole roughage for periods ranging from two to ten days in length.

The alfalfa consisted of first and second cuttings in different stages of maturity; first cutting, 5 and 75 per cent bloom; second
cutting, 5, 25, and 100 per cent bloom. The hay was fed to 7 cows in such quantities as the cow would clean up, with only a small quantity of hay refused. The quantity of hay was then abruptly increased about five pounds daily per cow.

Wyoming native hay, consisting of four cuttings mowed during the course of the haying season, was fed to 5 cows at the rate of about three pounds of hay per day per hundred pounds live weight. The daily hay allowance was then dropped abruptly, three to ten pounds per cow.

The results were computed to the daily basis.

Results: The cows fed native hay refused larger quantities than the cows fed alfalfa. Table I summarizes the results secured when alfalfa was fed. Table II summarizes the results when native hay was fed. In both instances the hay consumed was increased with an increase in hay allowance and at the same time there was an increase in the percentage of hay refused.

<p>| TABLE I—Increased consumption of hays with increased allowances. Alfalfa hays with small refusals. |
|---|---|---|---|</p>
<table>
<thead>
<tr>
<th>No. Cows</th>
<th>No. Hays</th>
<th>Ave. amount hay offered</th>
<th>Ave. percent hay refused</th>
<th>Ave. amount hay consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>High allowances</td>
<td>7</td>
<td>5</td>
<td>38.43 lbs.</td>
<td>17.48 per cent</td>
</tr>
<tr>
<td>Low allowances</td>
<td>7</td>
<td>5</td>
<td>32.87 lbs.</td>
<td>12.04 per cent</td>
</tr>
</tbody>
</table>

<p>| TABLE II—Increased consumption of hays with increased allowances. Native hays with large refusals. |
|---|---|---|---|</p>
<table>
<thead>
<tr>
<th>Cows</th>
<th>Hays</th>
<th>Ave. amount hay offered</th>
<th>Ave. percent hay refused</th>
<th>Ave. amount hay consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>High allowances</td>
<td>5</td>
<td>4</td>
<td>34.30 lbs.</td>
<td>30.87 per cent</td>
</tr>
<tr>
<td>Low allowances</td>
<td>5</td>
<td>4</td>
<td>28.50 lbs.</td>
<td>27.50 per cent</td>
</tr>
</tbody>
</table>

Two cuttings of native hay included in Table II varied widely in palatability. As may be seen in Table III, the greatest difference in hay consumption for these two hays was in period 2, when the
smaller hay allowance was fed. Contrary to the results shown in Tables I and II, the percentage of the unpalatable hay refused was greater when the smaller allowance was fed than when the larger allowance was fed.

<table>
<thead>
<tr>
<th>TABLE III—Increased consumption of hays with increased allowance. Palatable versus unpalatable hays.</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. Cows</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>Palatable Hay</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Unpalatable Hay</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Comparing the consumption of the palatable hay in Table III period 2 with the consumption of the unpalatable hay in period 1, it would appear that the two hays were of similar palatability. However, there was 18.52 per cent of the palatable hay refused as compared with 34.08 per cent of the unpalatable hay refused. The data show also that with an increase in hay allowance of the unpalatable hay there was a much greater increase in hay consumed than with the increase of allowance of the palatable hay.

Conclusions: Results from this experiment indicate that cows will increase hay consumption when more hay is offered. The percentage of hay refused generally increases with the increase in hay allowance. However, when an unpalatable hay is fed in high and low quantities the hay consumed, when the higher quantities are fed, is much greater than when the lower quantities are fed. Also there is a much greater difference in hay consumption than when similar allowances of a palatable hay are fed. Cows may be made to consume as much of an unpalatable hay as a palatable one by offering more of such a hay. In such cases the measure of palatability should be the percentage hay refused rather than consumed. If the relative palatability of hays is to be measured by total consumption, then, the percentage refused should be fairly constant.
B. The concentrate supplement.

The general practice is to feed dairy cows a concentrate supplementing the roughage. The concentrate allowance recommended is one which is proportionate to the milk or butterfat yield. If palatability of roughages is measured by amounts consumed by cows in different stages of lactation, then the concentrate allowance should be so regulated as to make possible a repetition of such trials. Two experiments were conducted to determine the method of apportioning the concentrate allowance so that the results of palatability trials with different hays might be comparable.

Experiment I.—Procedure: Five Holstein cows were fed daily a constant quantity of Wyoming native hay for ninety days. The ninety days were divided up into six periods of 15 days each. Each period was divided into two sub-periods, a five-day preliminary and a ten-day experimental. During the first preliminary and experimental periods each cow was fed concentrates at the rate of one pound to two and one-half pounds of milk produced. During the second preliminary period the daily concentrate allowance was gradually increased five pounds per cow in the case of 3 cows and decreased five pounds with the remaining 2 cows. The concentrate allowance remained at that level during the experimental period of ten days. A second reduction or increase in grain allowance was made during the following preliminary five-day period and the concentrate allowance was held at that level for the ten-day experimental period. During the fourth preliminary period the amount of concentrates fed was gradually increased five pounds per day on those cows which received a decreasing concentrate allowance and decreased the same amount on those cows which received an increasing concentrate allowance. Two changes of the same kind were made during the five following preliminary periods. The concentrate allowance was held constant during each experimental period.

Results: The data from two cows are given in Table IV.
TABLE IV—Influence of concentrate supplement on hay consumption. A varying concentrate allowance with advance in lactation.

<table>
<thead>
<tr>
<th>Experiment period</th>
<th>Name of Cow</th>
<th>Concentrates fed daily</th>
<th>Hay consumed daily</th>
<th>Ratio of grain to milk yield</th>
<th>Concentrates fed daily</th>
<th>Hay consumed daily</th>
<th>Ratio of grain to milk yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lassie</td>
<td></td>
<td></td>
<td></td>
<td>Snowdrop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>10.0</td>
<td>34.1</td>
<td>2.60</td>
<td></td>
<td>16.0</td>
<td>31.9</td>
<td>2.51</td>
</tr>
<tr>
<td>2</td>
<td>5.0</td>
<td>34.6</td>
<td>4.15</td>
<td></td>
<td>21.0</td>
<td>30.1</td>
<td>1.81</td>
</tr>
<tr>
<td>3</td>
<td>0.0</td>
<td>32.9</td>
<td>...</td>
<td></td>
<td>26.0</td>
<td>27.3</td>
<td>1.45</td>
</tr>
<tr>
<td>4</td>
<td>5.0</td>
<td>33.0</td>
<td>3.42</td>
<td></td>
<td>21.0</td>
<td>26.8</td>
<td>1.68</td>
</tr>
<tr>
<td>5</td>
<td>10.0</td>
<td>27.3</td>
<td>1.81</td>
<td></td>
<td>16.0</td>
<td>27.5</td>
<td>1.59</td>
</tr>
<tr>
<td>6</td>
<td>15.0</td>
<td>24.3</td>
<td>1.15</td>
<td></td>
<td>11.0</td>
<td>30.0</td>
<td>2.43</td>
</tr>
</tbody>
</table>

As shown in Table IV, the hay consumption tended to increase with the increase in concentrate allowance and vice versa. It should be noted that the hay consumption of both cows in periods 1 and 5, 2 and 4, is not similar, even though the concentrate allowance was the same. Furthermore, during the same periods the ratio of concentrate to milk yield was quite variable. The ratio of concentrate to milk for Lassie in period 1 was 1:2.60, as compared with 1:1.81 in period 5, although ten pounds of concentrate was fed in both periods. Lassie consumed an average of 34.1 pounds of hay in period 1 and 27.3 pounds of hay in period 5.

Conclusion: This experiment indicates that if similar hay consumption is desired of a cow as the lactation advances, the same concentrate allowance should not be fed. There appears to be a relationship between the hay consumption and the ratio of concentrate allowance to milk yield.

Experiment 2.—If a relationship exists between hay consumption and ratio of concentrate to milk yield, then a similar hay consumption should be expected when the concentrate allowance is made in a definite proportion to the milk yield. This principle is taken into consideration when one uses the feeding standard as a guide in computing experimental rations, for the nutrient requirements decrease with the decrease in milk yield. If the hay allowance is kept constant then the nutrients remaining to be made up by concentrates will become less as the milk yield decreases. To
determine if the feeding standard could be used to secure similar hay consumption in repetition of palatability trials, two experiments were conducted.

Experiment (a)—Procedure: Three cows, 1 Guernsey and 2 Holsteins, were fed Wyoming native hay cut August 20 and sufficient concentrates to meet the requirements of the Haecker feeding standard. The hay allowance was gradually increased until about 10 per cent of the allowance was refused, then this amount was fed daily for a period of ten to thirteen days. Sufficient concentrates were fed to meet the requirements of Haecker’s feeding standard. The first trial was started October 3. Beginning February 25, after sufficient time had elapsed to allow for a decrease in milk yield the same concentrate and hay allowance as was fed in the previous trial was fed to the same cows. The hay was the same cutting as used in what may be termed the “original” trial. The cows were fed on this ration for seven days. The following eight days, beginning March 4, the hay allowance was the same as in the previous trials but the concentrate allowance was reduced so as to just satisfy nutrient requirements according to the Haecker feeding standard. The results are compared on the daily basis.

Results: The average daily concentrate, hay fed and hay consumed by the three cows is presented in Table V. The difference from the original trial in average daily hay consumption was reduced from 14.81 per cent (repetition trial I) to 7.38 per cent (repetition trial II) by reducing the concentrate allowance to the requirements of the Haecker feeding standard.

<table>
<thead>
<tr>
<th>Trial</th>
<th>Date at start</th>
<th>Ave. daily grain fed</th>
<th>Ave. daily hay fed</th>
<th>Ave. daily hay consumed</th>
<th>Difference in hay consumed from original trial</th>
<th>Difference in per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original</td>
<td>Oct. 3</td>
<td>8.60</td>
<td>26.3</td>
<td>22.88</td>
<td></td>
<td>14.81</td>
</tr>
<tr>
<td>Rep. II</td>
<td>March 3</td>
<td>3.36</td>
<td>26.3</td>
<td>21.19</td>
<td>1.69</td>
<td>7.38</td>
</tr>
</tbody>
</table>
Experiment (b)—Procedure: Four Holstein cows in four experimental periods were fed Wyoming native hay cut July 22. Forty-four days elapsed between the start of periods 1 and 2. There was no lapse of time between periods 2 and 3. Period 3 ended March 23 and period 4 began April 1. In period 1 the cows were allowed sufficient total digestible nutrients to meet the requirements of Haecker’s feeding standard, the hay being increased until there was about 10 per cent refused. In period 2, less hay was offered but the total digestible nutrients were kept the same as in period 1 in spite of the declining milk yield. In period 3, the total digestible nutrients were lowered to meet the feeding standard requirements, but the hay allowance was not as great as in period 1. In period 4, the total digestible nutrients were again lowered to meet the feeding standard requirements, but the hay allowance was made the same as in period 1.

Results: From Table VI it is seen that the amount of hay consumed in period 4 is more nearly like the amounts consumed in period 1 than are the amounts consumed in periods 2 and 3. The results indicate that cows will consume similar amounts of hay in different stages of lactation if the same amounts of hay are offered and sufficient concentrate allowance is made to satisfy the requirements of the feeding standard.

TABLE VI—The influence of the allowance of hay and concentrate on hay consumption by cows in different stages of lactation.

<table>
<thead>
<tr>
<th>Period</th>
<th>Date at start</th>
<th>Length experimental period</th>
<th>Ave. daily milk yield</th>
<th>Concentrates fed daily</th>
<th>Ave. hay fed daily</th>
<th>Ave. hay consumed daily</th>
<th>Difference in hay consumed from period 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jan. 25</td>
<td>8 days</td>
<td>35.67 lbs.</td>
<td>10.35 lbs.</td>
<td>32.25 lbs.</td>
<td>28.02 lbs.</td>
<td>2.47 lbs, 8.81%</td>
</tr>
<tr>
<td>2</td>
<td>Mar. 9</td>
<td>5 days</td>
<td>30.37 lbs.</td>
<td>12.35 lbs.</td>
<td>30.37 lbs.</td>
<td>25.55 lbs.</td>
<td>4.82 lbs, 19.31%</td>
</tr>
<tr>
<td>3</td>
<td>Mar. 19</td>
<td>6 days</td>
<td>30.75 lbs.</td>
<td>8.25 lbs.</td>
<td>29.65 lbs.</td>
<td>26.22 lbs.</td>
<td>3.43 lbs, 11.51%</td>
</tr>
<tr>
<td>4</td>
<td>Apr. 1</td>
<td>9 days</td>
<td>25.10 lbs.</td>
<td>6.62 lbs.</td>
<td>32.30 lbs.</td>
<td>29.17 lbs.</td>
<td>3.13 lbs, 9.87%</td>
</tr>
</tbody>
</table>

In experiments (a) and (b) 7 cows in two stages of lactation were fed sufficient nutrients to meet Haecker’s feeding standard requirements. There was a constant quantity of hay fed in both stages. The hay consumed by each cow and the difference in consumption in these two periods is shown in table VII.
TABLE VII—The difference of average daily hay consumption by seven cows in two stages of lactation.

<table>
<thead>
<tr>
<th>Name of cow</th>
<th>Ave. daily hay consumed Trial I</th>
<th>Ave. daily hay consumed Trial II</th>
<th>Difference in ave. daily hay consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zella</td>
<td>28.4 lbs.</td>
<td>28.3 lbs.</td>
<td>+0.1 lbs.</td>
</tr>
<tr>
<td>Snowdrop</td>
<td>29.7 lbs.</td>
<td>30.4 lbs.</td>
<td>+0.7 lbs.</td>
</tr>
<tr>
<td>Sylvia</td>
<td>27.2 lbs.</td>
<td>29.7 lbs.</td>
<td>+2.5 lbs.</td>
</tr>
<tr>
<td>Rose</td>
<td>26.8 lbs.</td>
<td>28.1 lbs.</td>
<td>+1.3 lbs.</td>
</tr>
<tr>
<td>Fayne</td>
<td>26.2 lbs.</td>
<td>24.8 lbs.</td>
<td>-1.4 lbs.</td>
</tr>
<tr>
<td>Belle</td>
<td>23.3 lbs.</td>
<td>20.9 lbs.</td>
<td>-2.4 lbs.</td>
</tr>
<tr>
<td>Adora 3d</td>
<td>19.1 lbs.</td>
<td>17.9 lbs.</td>
<td>-1.2 lbs.</td>
</tr>
<tr>
<td>Average</td>
<td>25.8 lbs.</td>
<td>25.7 lbs.</td>
<td>0.1 lbs.</td>
</tr>
</tbody>
</table>

**Conclusions:** The results of experiments (a) and (b) lead to the establishment of definite rules to follow in order to make possible repetition of palatability tests and thus increase their reliability. These rules are: 1. In the repetition trials make the same hay allowance as was made in the first trial; 2. In the repetition trial feed only enough concentrate to supply the remaining nutrients necessary to meet the feeding standard requirements.

**C. Length of trial to obtain accurate index of hay consumption.**

The amount of hay consumed by cows will vary from day to day. Consequently, it is highly desirable to conduct a palatability test of sufficient length that a fairly accurate index of the cow’s intake be secured. If a number of hays are to be tested for palatability during a single winter period, short feeding periods on each hay must be used. An experiment was conducted to obtain some information on the reliability of a 10-day period compared with a 30-day period.

**Procedure:** Six cows, 3 Guernseys and 3 Holsteins, were fed for a total of 16 periods of 30 days each. The hay allowance was constant throughout a 30-day period. Concentrates were fed at the rate of one pound to 2.5 pounds of milk produced. Wyoming native hay was fed as a sole roughage.

**Results:** The data were computed to the daily basis. The average hay consumption during a 30-day period was compared
with the average hay consumption in three consecutive 10-day periods during each 30-day period. A summary of the data and of the average daily hay fed and consumed during each 30-day period is shown in Table VIII. When the same hay allowed was fed to the same cow for two or more 30-day periods, the difference in the average hay consumption was calculated and is shown in column four. The difference in the extremes of the average hay consumption during three consecutive 10-day periods in each 30-day period was calculated and is presented in column five.

The greatest average daily variation in hay consumption between 30-day periods was 1.6 pounds of hay. The greatest average daily variation in hay consumption between 10-day periods was 2.1 pounds.

**TABLE VIII—Influence of duration of experiment on hay consumption. The difference in hay consumption between 30- and 10-day periods.**

<table>
<thead>
<tr>
<th>Cow No.</th>
<th>Hay allowed daily</th>
<th>Hay consumed daily</th>
<th>Widest difference</th>
<th>Widest difference of 10-day average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lbs.</td>
<td>lbs.</td>
<td>lbs.</td>
<td>lbs.</td>
</tr>
<tr>
<td>200</td>
<td>25.0</td>
<td>20.3</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>25.0</td>
<td>20.4</td>
<td>2.1</td>
<td></td>
</tr>
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<td></td>
<td>25.0</td>
<td>20.7</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>25.0</td>
<td>21.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>25.0</td>
<td>20.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>201</td>
<td>30.0</td>
<td>25.5</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>25.0</td>
<td>19.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>25.0</td>
<td>25.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>202</td>
<td>30.0</td>
<td>21.5</td>
<td>1.5</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td>25.0</td>
<td>20.1</td>
<td></td>
<td>1.1</td>
</tr>
<tr>
<td>204</td>
<td>35.0</td>
<td>31.6</td>
<td></td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>45.0</td>
<td>42.2</td>
<td></td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>45.0</td>
<td>42.2</td>
<td></td>
<td>0.8</td>
</tr>
<tr>
<td>205</td>
<td>35.0</td>
<td>31.3</td>
<td></td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>35.0</td>
<td>31.4</td>
<td></td>
<td>1.3</td>
</tr>
</tbody>
</table>

**Conclusion:** The close approximation of a 10-day average hay consumption to a 30-day average hay consumption indicates that average daily hay consumption for 10-day periods is a fairly reliable index of the cow's intake of the hay.
DISCUSSION OF METHODS

Experiments (a) and (b) showed that the use of the feeding standard was a convenient vehicle for securing maximum consumption of hay and for making a repetition of such hay consumption possible. The experiments which disregarded the feeding standard indicated that hay consumption could be increased by either offering more hay or less concentrates, or both. The same results were secured when the cows were fed by using the feeding standard as a guide. Experiment (a) indicated that as the hay allowance was increased there was also an increase in the percentage hay refused. It was concluded that the percentage hay refused should be fairly constant throughout palatability trials.

The logical method to use to obtain maximum hay consumption is the method suggested by Eckles in method 4 (1932):

The requirements of the cow for total digestible nutrients are estimated and a ration provided to supply one-half the nutrient in the form of grain and one-half in the hay to be tested. The ration is then slowly changed to increase the proportion of nutrients from the roughage, keeping the total at the point of her requirements. This is continued until a point is reached where she underfeeds herself about 10 per cent by leaving a portion of the hay.

Conclusion:

The following procedure may be used in palatability tests to assure reliable comparisons of the relative palatability of hay.

1. Step up the hay allowance according to the method described in Eckles’ Method 4 (1932).

2. When the maximum hay consumption limited by a 10 per cent refusal of the hay allowance has been reached the ration should be continued for about 10 days in order that a reliable index of the cow’s intake of hay may be secured.

3. Measure the results by the average daily hay consumed.

PART II.—FACTORS INFLUENCING THE PALATABILITY OF HAYS

The Problem: Having developed through experiments a method for determining the palatability of hays, work was started on determining a number of factors influencing palatability. The factors studied were:
November, 1933 Palatability of Hay

1. Factors influencing the palatability of Wyoming native hay. The effect of: (a) predominating species of plants, (b) time of cutting, (c) climatic conditions during the curing process, (d) irrigation water, and (e) moisture, crude protein, and sugar content of the hay.

2. Factors influencing the palatability of irrigated alfalfa. The effect of: (a) first and second cutting, (b) stage of bloom, (c) moisture, crude protein, and sugar content, and (d) commercial hay grades.

3. Factors which make native hay as palatable as alfalfa hay. The influence of: (a) predominating species of plants, (b) time of cutting, and (c) irrigation water.

Animals used: Fourteen registered cows, 10 Holstein and 4 Guernsey, comprising the whole milking herd, were used at some time during the experiments. Only the cows that were at least six weeks from freshening and milking sufficient quantities to enable them to underfeed themselves on hay alone were used in any one experiment. The maximum number of animals used in any one comparison was five, and at times the number of animals was limited to three in one comparison.

Calculation of rations: Rations were calculated on the basis of the Haecker feeding standard. Before an experiment was started the cows were weighed for three successive days and the average weight was used to calculate the maintenance requirement. The average daily milk yield during the previous week, and a butterfat test from a two-day composite sample of milk, were used to compute the nutrient requirements for the milk yield. The feeds used in the grain mixture varied in different trials but each grain mixture was calculated to contain 72 per cent total digestible nutrients. The mixture was composed of ground corn, oats, barley, bran, and cottonseed meal. The hay, both alfalfa and native, was estimated to contain 50 per cent total digestible nutrients.

Method of feeding hay: The daily hay allowance was weighed out into beet pulp sacks having a capacity of forty pounds of baled hay. Each sack was labeled with the name of the cow for which
it was intended. Part of the daily hay allowance was placed in three-foot iron mangers in the evening and the remainder fed before milking in the morning. The hay refused was weighed back at 9 a.m. The cows were allowed free access to water and salt from 8:30 a.m. until 4 p.m. in a dry lot just outside of the dairy barn.

Description of hay used: The alfalfa hay included in this study comprised eleven different cuttings during two years. The alfalfa was cut both years from the same plots of ground covering about 1.25 acres each. Frost prevented the second cutting from being mowed later than September 9. For the most part the mower was followed by a side-delivery rake and the hay was allowed to cure three days in the windrow. With the exception of the first cutting at early bloom, the hay was baled from the windrow the first season. The second year's crop was baled from the stack.

From each cutting of hay a sample was selected and shipped to Kansas City for official grading. At the same time another sample was sent to O. C. McCreary, Associate Station Chemist at the University of Wyoming, for a chemical analysis. The same chemical determinations were made for the native and alfalfa hays.

Typical native hays of the Laramie River valley are made up mostly of the rushes and sedges. Three of the native hays tested for palatability were sent to the Bureau of Agricultural Economics hay laboratories for official grading. The official grades of these hays were as follows:

1. United States No. 1. Extra green grass hay, rushes and sedges. Color 95 per cent.
2. United States No. 1. Extra green grass hay, sedges. Color 100 per cent.

An attempt was made to select hay from meadows in which the predominating grasses were the bog sedges and the rushes. The predominating species of the bog sedge found in selected
meadows were Carex Nebraskensis and Carex aquatalis. These selected meadows were composed of from 65-75 per cent of these species. Both species are very much alike in appearance. The plant is described by Nelson (1906). In the meadows selected for rushes, the species Juncus Balticus, commonly called wire grass or Baltic rush made up from 70-85 per cent of the total weight of the hay.

The native hays fed were selected from four ranches in the Laramie valley. The hay meadows on these ranches were of such size as to require nearly a month for the haying season. Haying in the Laramie valley starts about the middle of July and ends about the first of September.

**Chemical Analysis**

O. C. McCreary, Associate Station Chemist, made all of the chemical analyses of these hays and is responsible for the inauguration of the analysis of their sugar content. The ordinary chemical analyses were made by the official methods. Analyses of the sugar in the hays were made by the special following method:

*Extraction of Sugar:* Twenty grams of ground air-dry material were covered with 200 cc. of 80 per cent alcohol, boiling hot, and left stand until needed. In cases in which green material was used, 50 grams of sample were used; the alcohol added was calculated so the final solution was about 200 cc. of approximately 80 per cent alcohol. Mason jars were used to hold the material as these can be very conveniently made air tight to prevent evaporation of the alcohol. When ready for the determination, the alcohol was filtered from the solids through paper filters into 1000 cc. volumetric flasks. The residue being returned to the Mason jars, 200 cc. of hot alcohol were added and allowed to stand over night and again filtered into the same 1000 cc. flask. This extraction was repeated until about 800 cc. were in the flask, then the residue and filter paper were washed with hot 80 per cent alcohol until the volumetric flasks were filled to the mark.

*Determination of Sugar:* The 1000 cc. flask of alcoholic solution was shaken until its contents were well mixed. Duplicate samples of 200 cc. from the 1000 cc. were pipetted into 400 cc. beakers and evaporated nearly to dryness (about 10 cc.). Ten cc. of water were added and evaporation continued until there was no odor of alcohol. Contents of the beaker were diluted to about 75 cc. and sufficient neutral lead acetate added to precipitate all possible (2 cc. or less of saturated solution). This was filtered and washed with cold H₂O; excess lead was precipitated with potassium oxalate. This was filtered into 200 cc. flask and washed with cold H₂O until filtrate filled the flask to mark.
Fig. 1. Carex Nebraskensis
Fig. 2. *Juncus Balticus*
An aliquot of 100 cc. was taken and the reducing sugar was determined by the Munson and Walker gravimetric method as described in Woodman "Food Analysis", page 238, and dextrose determined from weight of Cu₂O by table on page 241 of the same book.

**Total sugar:** To the 100 cc. of solution in the 200 cc. flask, remaining after the determination of reducing sugar, 10 cc. of concentrated HCl were added and left standing for 24 hours at room temperature. From this 100 cc. were taken, neutralized with Na₂CO₃ and sugar was determined by the gravimetric method the same as for the reducing sugar; the amount of sugar was given as per cent of dextrose.

**Factors which Influence the Palatability of Native Hays**

**Predominating species:** It may be seen in Table IX from Experiment I, that the sedge and wire-grass* hays cut early in the haying season were consumed by the cows in similar quantities. Experiment II shows, however, that almost 40 per cent less of the late cut wire-grass hay was consumed than that of the late cut sedge hay. Late cut wire-grass hay is not always unpalatable, however. Rating the relative palatability of a hay on the basis of the percentage consumed in terms of a more palatable hay, it will be seen in Table IX that sedge hay, cut August 25, was 19 per cent less palatable than wire-grass hay cut August 20. Table IX includes the determinations of moisture, total sugars, and crude protein. It should be noted that the moisture analysis gives little indication that moisture in hays might be a factor influencing the relative palatability. The crude protein determination is included in Table IX to show the relative stage of growth of the grasses in these hays. The protein content of the sedge hays was higher than that of the wire-grass hays except in Experiment III, where the reverse was true. The sedge and wire-grass hays showed the typical decrease in crude protein as the hay season advanced except in the case of the wire-grass in Experiment III, which showed a higher protein content than the other three wire-grass hays tested. The sugar content of the wire-grass hay in Experiment IV was about the same as that of the sedge hay to which it is compared and is also similar to the sugar content of the earlier cut wire-grass and sedge hays of Experiment I. The wire-grass hay fed in Experiment II showed a lower sugar content than any of the hays listed in Table IX.

*The common term "wire-grass" is used, although this is a rush (*Juncus Balticus*) rather than a true grass.
The method of irrigation of the meadows, on which these hays were grown, throws some light on the possible cause of the variation in sugar content. The meadows were flooded with irrigation water in the spring of the year. Irrigation water was shut off from the early-cut meadows about ten days before cutting in order to allow time for the ground to dry sufficiently to permit the movement of horses and machinery across them. Water in streams became lower as the season advanced, making late irrigation of some of the meadows impossible. Where bog sedges predominated the ground was wet and soggy, even late in the season when irrigation water was scarce. The meadow on which the wire-grass hay used in Experiment III was grown had the advantage of plenty of water up to within ten days before the hay was to be cut. The protein content of this hay indicates that it contained comparatively young vegetation. Its sugar content is as high as in the earlier cut hays. The color rated 95 per cent according to the United States Bureau of Agricultural Economics.

A plausible explanation of the greater palatability of the late-cut sedge hays over the wire-grass hays is that the sedges have a more plentiful water supply later in the season which keeps the plants in a younger stage of development. Wire-grass hays cut late in the season might be quite palatable if a more plentiful supply of irrigation water were available.

TABLE IX—The influence of predominating species of plants in Wyoming native hays on relative consumption by dairy cows.

<table>
<thead>
<tr>
<th>No. of Experiment</th>
<th>Predominate species</th>
<th>Date cut</th>
<th>Moisture</th>
<th>Crude protein M.F.B.*</th>
<th>Total sugars M.F.B.*</th>
<th>No. cows fed</th>
<th>Ave. daily hay consumed</th>
<th>Difference from more palatable hay</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>J.1 Balticus</td>
<td>7-20-31</td>
<td>10.35</td>
<td>8.98</td>
<td>7.71</td>
<td>3</td>
<td>29.50</td>
<td>.04 .13</td>
</tr>
<tr>
<td></td>
<td>J.3 Balticus</td>
<td>7-22-31</td>
<td>13.12</td>
<td>8.69</td>
<td>6.36</td>
<td>3</td>
<td>29.46</td>
<td>.04 .13</td>
</tr>
<tr>
<td></td>
<td>C.2 aquatalis</td>
<td>7-22-31</td>
<td>9.83</td>
<td>9.52</td>
<td>6.44</td>
<td>3</td>
<td>29.33</td>
<td>.17 .58</td>
</tr>
<tr>
<td>II</td>
<td>C.2 Nebraskensis</td>
<td>8-30-30</td>
<td>12.17</td>
<td>8.42</td>
<td>5.33</td>
<td>5</td>
<td>29.50</td>
<td>11.72 39.73</td>
</tr>
<tr>
<td></td>
<td>J.2 Balticus</td>
<td>9-1-30</td>
<td>9.91</td>
<td>6.89</td>
<td>3.80</td>
<td>5</td>
<td>17.78</td>
<td>4.44 19.39</td>
</tr>
<tr>
<td>III</td>
<td>J.2 Balticus</td>
<td>8-20-32</td>
<td>8.75</td>
<td>9.71</td>
<td>6.75</td>
<td>3</td>
<td>22.90</td>
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</tr>
<tr>
<td></td>
<td>C.2 Nebraskensis</td>
<td>8-25-32</td>
<td>9.56</td>
<td>8.07</td>
<td>6.68</td>
<td>3</td>
<td>18.46</td>
<td></td>
</tr>
</tbody>
</table>

*Moisture Free Basis.
1Juncus.
2Carex.
<table>
<thead>
<tr>
<th>Date cut</th>
<th>No. of Expt. ment</th>
<th>Species</th>
<th>Total M. F. R.*</th>
<th>Crude Moisture</th>
<th>Difference from more palatable hay</th>
<th>Avg. daily consumed</th>
<th>Per cent</th>
<th>No. of days fed</th>
<th>Per cent</th>
<th>Hos.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>Carex aquatilis</td>
<td>7.26-31</td>
<td>8.69</td>
<td>0.64</td>
<td>30.28</td>
<td>3</td>
<td>3</td>
<td>28.88</td>
<td>3</td>
<td>20.58</td>
</tr>
<tr>
<td>II</td>
<td>Carex aquatilis</td>
<td>7.39</td>
<td>8.39</td>
<td>0.96</td>
<td>30.28</td>
<td>3</td>
<td>3</td>
<td>28.88</td>
<td>3</td>
<td>20.58</td>
</tr>
<tr>
<td>III</td>
<td>Carex aquatilis</td>
<td>7.23-31</td>
<td>8.69</td>
<td>0.64</td>
<td>30.28</td>
<td>3</td>
<td>3</td>
<td>28.88</td>
<td>3</td>
<td>20.58</td>
</tr>
<tr>
<td>IV</td>
<td>Juncus Boliens</td>
<td>7.39</td>
<td>8.39</td>
<td>0.96</td>
<td>30.28</td>
<td>3</td>
<td>3</td>
<td>28.88</td>
<td>3</td>
<td>20.58</td>
</tr>
<tr>
<td>V</td>
<td>Juncus Boliens</td>
<td>7.26-31</td>
<td>8.69</td>
<td>0.64</td>
<td>30.28</td>
<td>3</td>
<td>3</td>
<td>28.88</td>
<td>3</td>
<td>20.58</td>
</tr>
<tr>
<td>VI</td>
<td>Juncus Boliens</td>
<td>7.39</td>
<td>8.39</td>
<td>0.96</td>
<td>30.28</td>
<td>3</td>
<td>3</td>
<td>28.88</td>
<td>3</td>
<td>20.58</td>
</tr>
<tr>
<td>VII</td>
<td>Juncus Boliens</td>
<td>7.26-31</td>
<td>8.69</td>
<td>0.64</td>
<td>30.28</td>
<td>3</td>
<td>3</td>
<td>28.88</td>
<td>3</td>
<td>20.58</td>
</tr>
<tr>
<td>VIII</td>
<td>Juncus Boliens</td>
<td>7.39</td>
<td>8.39</td>
<td>0.96</td>
<td>30.28</td>
<td>3</td>
<td>3</td>
<td>28.88</td>
<td>3</td>
<td>20.58</td>
</tr>
</tbody>
</table>

*Moisture Free Basis
Time of cutting: Further evidence which indicates that the supply of water in the meadows influences the palatability of the hays may be found in Table X. Experiment VII shows that 13.18 per cent less wire-grass hay cut August 1 was consumed than wire-grass hay cut August 3 from a different meadow. The meadow on which the wire-grass hay cut August 1 was grown was a difficult one to irrigate and the supply of irrigation water that year was low. In Experiment VIII two wire-grass hays are included which were cut about one month apart, yet the cows consumed similar amounts of each hay. The method of irrigating the meadow from which the hay was cut August 20 has been previously described (Juncus Balticus, Experiment III, Table IX).

Time of cutting of the sedge hays made much less difference in their relative palatability than it did with the wire-grass hays. From 27 to 41 per cent less late-cut wire-grass hay was consumed than of the early-cut wire-grass hays in Experiments IV, V, and VI.

The relative consumption of sedge hays in Experiments Ia, IIa, and IIIa, Table X, varied from 7.36 to 0.64 per cent. In general, the crude protein content of the wire-grass hays varied in the same direction as the sugar content and the relative palatability. In the sedge hays there was no such correlation.

Unfavorable curing conditions: Table XI shows the results of two palatability tests which may appear contradictory to the general trend of previous experiments. The sedge hay cut July 28 (Experiment Ib) was 12.57 per cent less palatable than the sedge hay cut a month later. The earlier cut sedge hay, however, came from a boggy meadow that was very wet, and it was not possible to cure the hay properly before stacking. The hay was very dusty at the time of baling. The sugar content of this early-cut sedge hay was lower, but the protein higher than the sedge hay cut later. In Experiment IIb the cows consumed 34.02 per cent less of one wire-grass hay than of the other, although the date of cutting was the same. The less palatable hay was rained on while in the swath and again received a thorough soaking when in a small, poorly built stack. Its sugar content ran the lowest of any of the native hays tested but its protein content was higher than that of the hay with which it is compared for palatability.
TABLE XI—The influence of unfavorable curing conditions of Wyoming native hays on relative consumption by dairy cows.

<table>
<thead>
<tr>
<th>No. of Experiment</th>
<th>Predominate species</th>
<th>Date cut</th>
<th>Moisture per cent</th>
<th>Crude protein per cent</th>
<th>Total sugars per cent</th>
<th>No. cows</th>
<th>Ave. daily consumption</th>
<th>Diff. from more palatable hay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ib</td>
<td>Carex Nebraskensis</td>
<td>8-30-30</td>
<td>12.17</td>
<td>8.42</td>
<td>5.33</td>
<td>5</td>
<td>25.62</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carex aquatilis</td>
<td>7-28-30</td>
<td>11.21</td>
<td>9.44</td>
<td>4.04</td>
<td>5</td>
<td>22.40</td>
<td>3.22 12.57</td>
</tr>
<tr>
<td>IIb</td>
<td>Juncus Balticus</td>
<td>8-1-30</td>
<td>10.95</td>
<td>9.04</td>
<td>5.00</td>
<td>5</td>
<td>37.88</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Juncus Balticus</td>
<td>8-1-30</td>
<td>13.13</td>
<td>9.45</td>
<td>1.77</td>
<td>5</td>
<td>24.86</td>
<td>12.82 34.02</td>
</tr>
</tbody>
</table>

*Moisture Free Basis

Factors Influencing the Relative Palatability of Irrigated Alfalfa Hay

Influence of first and second cuttings: Table XII presents the results of five tests, each test conducted with different cows.

In Experiments Ic and IIC the first cutting at early bloom was more palatable than the second cutting at early bloom. In the next three experiments, the second cutting at late bloom was more palatable than the first cutting at late bloom. The percentage of crude protein, in the cuttings compared, shows considerable uniformity except in the hays used in Experiment IIIb. The first cutting in this experiment was slightly moldy, showing that it had not been sufficiently cured before baling. The sugar content of the less palatable hays was lower than that of the more palatable hays with the exception of the first cutting early bloom fed in Experiment IIC. This cutting shows the same decrease in sugar content as did the native hay when stacked too green. It graded No. 2 because of lack of color. There is no relationship between palatability and grade of the hays tested.

Influence of stage of bloom: Six comparisons on palatability are shown in Table XIII. In each experiment but one (Vb) the palatability decreased with the increase in percentage of bloom. The protein content shows the typical decrease as the stage of
November, 1933  
Palatability of Hay

TABLE XII—The influence of first and second cutting of irrigated alfalfa on relative palatability.

<table>
<thead>
<tr>
<th>No. of Experiment</th>
<th>Cutting</th>
<th>Stage of bloom</th>
<th>Crude protein</th>
<th>Total sugars</th>
<th>Leaves</th>
<th>Color</th>
<th>Grade</th>
<th>Ave. daily hay consumed</th>
<th>Diff. from more palatable hay</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>per cent</td>
<td>per cent</td>
<td>per cent</td>
<td>per cent</td>
<td></td>
<td>lbs.</td>
<td>lbs.</td>
<td>per cent</td>
</tr>
<tr>
<td>Ie</td>
<td>1st</td>
<td>5</td>
<td>18.33</td>
<td>5.58</td>
<td>30</td>
<td>85</td>
<td>2</td>
<td>32.80</td>
<td>6.24</td>
</tr>
<tr>
<td></td>
<td>2nd</td>
<td>5</td>
<td>18.12</td>
<td>4.55</td>
<td>35</td>
<td>93</td>
<td>2</td>
<td>26.56</td>
<td></td>
</tr>
<tr>
<td>IIC</td>
<td>1st</td>
<td>5</td>
<td>18.19</td>
<td>3.83</td>
<td>48</td>
<td>30</td>
<td>2</td>
<td>23.18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2nd</td>
<td>5</td>
<td>16.50</td>
<td>5.09</td>
<td>42</td>
<td>100</td>
<td>1</td>
<td>19.38</td>
<td>3.80</td>
</tr>
<tr>
<td>IIb</td>
<td>1st</td>
<td>100</td>
<td>16.64</td>
<td>5.47</td>
<td>35</td>
<td>90</td>
<td>2</td>
<td>30.06</td>
<td>17.90</td>
</tr>
<tr>
<td></td>
<td>2nd</td>
<td>100</td>
<td>15.23</td>
<td>5.50</td>
<td>36</td>
<td>100</td>
<td>1</td>
<td>21.10</td>
<td>6.34</td>
</tr>
<tr>
<td>IVA</td>
<td>1st</td>
<td>100</td>
<td>15.46</td>
<td>5.05</td>
<td>42</td>
<td>100</td>
<td>1</td>
<td>14.76</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2nd</td>
<td>100</td>
<td>16.64</td>
<td>5.47</td>
<td>35</td>
<td>90</td>
<td>2</td>
<td>30.06</td>
<td>27.23</td>
</tr>
</tbody>
</table>

*Sample grade

bloom increases. The sugar content does not bear a close relationship to the relative palatability in these tests. The first cutting early bloom was the same hay fed in Experiment IIc (Table VII.) Again, there is no relationship shown between the grade and palatability.

TABLE XIII—The influence of stage of bloom on palatability of irrigated alfalfa hay.

<table>
<thead>
<tr>
<th>No. of Experiment</th>
<th>Cutting</th>
<th>Stage of bloom</th>
<th>Crude protein</th>
<th>Total sugars</th>
<th>Leaves</th>
<th>Color</th>
<th>Grade</th>
<th>Ave. daily hay consumed</th>
<th>Diff. from more palatable hay</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>per cent</td>
<td>per cent</td>
<td>per cent</td>
<td>per cent</td>
<td></td>
<td>lbs.</td>
<td>lbs.</td>
<td>per cent</td>
</tr>
<tr>
<td>Id</td>
<td>1st</td>
<td>5</td>
<td>18.33</td>
<td>5.58</td>
<td>30</td>
<td>85</td>
<td>2</td>
<td>33.80</td>
<td>5.57</td>
</tr>
<tr>
<td></td>
<td>1st</td>
<td>75</td>
<td>15.45</td>
<td>4.26</td>
<td>34</td>
<td>85</td>
<td>2</td>
<td>27.23</td>
<td>11.20</td>
</tr>
<tr>
<td>IIId</td>
<td>1st</td>
<td>5</td>
<td>18.19</td>
<td>3.83</td>
<td>48</td>
<td>30</td>
<td>2</td>
<td>23.06</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1st</td>
<td>50</td>
<td>15.72</td>
<td>4.72</td>
<td>41</td>
<td>100</td>
<td>1</td>
<td>18.66</td>
<td>4.49</td>
</tr>
<tr>
<td></td>
<td>1st</td>
<td>100</td>
<td>15.42</td>
<td>5.05</td>
<td>42</td>
<td>100</td>
<td>1</td>
<td>12.16</td>
<td>10.90</td>
</tr>
<tr>
<td>IIC</td>
<td>1st</td>
<td>5</td>
<td>18.19</td>
<td>3.83</td>
<td>48</td>
<td>30</td>
<td>2</td>
<td>23.18</td>
<td>11.86</td>
</tr>
<tr>
<td></td>
<td>1st</td>
<td>50</td>
<td>15.72</td>
<td>4.72</td>
<td>41</td>
<td>100</td>
<td>1</td>
<td>21.32</td>
<td></td>
</tr>
<tr>
<td>IVb</td>
<td>1st</td>
<td>50</td>
<td>15.72</td>
<td>4.72</td>
<td>41</td>
<td>100</td>
<td>1</td>
<td>22.05</td>
<td>11.86</td>
</tr>
<tr>
<td>Vb</td>
<td>2nd</td>
<td>100</td>
<td>16.79</td>
<td>5.47</td>
<td>35</td>
<td>90</td>
<td>2</td>
<td>30.06</td>
<td>6.78</td>
</tr>
<tr>
<td></td>
<td>2nd</td>
<td>5</td>
<td>18.12</td>
<td>4.55</td>
<td>35</td>
<td>93</td>
<td>2</td>
<td>26.56</td>
<td>3.50</td>
</tr>
<tr>
<td>VIb</td>
<td>2nd</td>
<td>50</td>
<td>16.15</td>
<td>5.86</td>
<td>39</td>
<td>100</td>
<td>2</td>
<td>21.70</td>
<td>2.96</td>
</tr>
</tbody>
</table>

*Sample grade
Discussion of results: The sugar content of alfalfa is not as highly correlated with palatability as is the case with Wyoming native hays. There may be two factors interfering with such a correlation, namely (1) that alfalfa burned in the stack retains its palatability but decreases in sugar content, and (2) that alfalfa leaves contain less sugar than the stems. Leafiness in alfalfa is associated with high-grade hay because such hay will have a high percentage of protein, and probably also has been well cured and carefully handled.

The fact that the same grade of alfalfa may show wide differences in palatability is no reflection on the present methods of hay grading which are based on color and leafiness, but rather indicates that there are other factors which influence palatability. The United States grades of hay are based on quality factors which can be easily measured and on those qualities which the buyer demands. Brown alfalfa is very likely to be moldy, hence should be discriminated against at the hay markets. On the other hand, brown alfalfa is palatable when not moldy and will be eaten readily by dairy cattle on the farm.

Alfalfa vs. Native Hay:

It is generally conceded that alfalfa hay is more palatable to dairy cows than is Wyoming native hay. In a previous experiment Willard (1926) found that the cows consumed 25 per cent less of the native hay than they consumed of alfalfa. Many ranchers, however, have no alfalfa and must rely upon their native hay to feed their milk stock. In order to note those cuttings of Wyoming native hay which come close to alfalfa hay in palatability, a comparison was made with the same group of cows fed both native and alfalfa hays. Four comparisons, with a different group of cows in each experiment, are shown in Table XIV.

It is interesting to note that in Experiments II and IV the cows actually consumed more of some cuttings of native hay than they did of the most palatable alfalfa. The difference is not great, however. Of more importance is the fact that it was the early and late cut sedge hays and the early-cut wire-grass hays that were consumed with almost equal relish with the best alfalfa.
November, 1933  
Palatability of Hay

TABLE XIV—Relative palatability of irrigated alfalfa and Wyoming native sedge and wire-grass hays.

<table>
<thead>
<tr>
<th>No. of experiment</th>
<th>Variety</th>
<th>Cutting of alfalfa</th>
<th>Date cut or stage of alfalfa</th>
<th>Average daily hay consumption</th>
<th>Difference from most palatable hay</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Alfalfa</td>
<td>1st</td>
<td>5 per cent</td>
<td>32.80</td>
<td>2.74 per cent</td>
</tr>
<tr>
<td></td>
<td>Alfalfa</td>
<td>2nd</td>
<td>100 per cent</td>
<td>30.96</td>
<td>8.35 per cent</td>
</tr>
<tr>
<td></td>
<td>Wire grass</td>
<td></td>
<td>July 22</td>
<td>27.80</td>
<td>15.24 per cent</td>
</tr>
<tr>
<td></td>
<td>Wire grass</td>
<td></td>
<td>July 20</td>
<td>27.60</td>
<td>15.85 per cent</td>
</tr>
<tr>
<td></td>
<td>Alfalfa</td>
<td>2nd</td>
<td>75 per cent</td>
<td>27.23</td>
<td>16.98 per cent</td>
</tr>
<tr>
<td></td>
<td>Alfalfa</td>
<td>2nd</td>
<td>5 per cent</td>
<td>26.56</td>
<td>19.02 per cent</td>
</tr>
<tr>
<td></td>
<td>Wire grass</td>
<td></td>
<td>August 3</td>
<td>23.76</td>
<td>27.50 per cent</td>
</tr>
<tr>
<td></td>
<td>Wire grass</td>
<td></td>
<td>August 24</td>
<td>19.50</td>
<td>40.54 per cent</td>
</tr>
<tr>
<td>II</td>
<td>Sedge</td>
<td></td>
<td>July 25</td>
<td>23.44</td>
<td>4.52 per cent</td>
</tr>
<tr>
<td></td>
<td>Sedge</td>
<td></td>
<td>August 20</td>
<td>22.38</td>
<td>4.2 per cent</td>
</tr>
<tr>
<td></td>
<td>Alfalfa</td>
<td>2nd</td>
<td>50 per cent</td>
<td>21.70</td>
<td>7.42 per cent</td>
</tr>
<tr>
<td></td>
<td>Wire grass</td>
<td></td>
<td>August 20</td>
<td>20.72</td>
<td>11.60 per cent</td>
</tr>
<tr>
<td></td>
<td>Alfalfa</td>
<td></td>
<td>100 per cent</td>
<td>18.74</td>
<td>20.05 per cent</td>
</tr>
<tr>
<td>III</td>
<td>Alfalfa</td>
<td>1st</td>
<td>5 per cent</td>
<td>22.22</td>
<td>10.58 per cent</td>
</tr>
<tr>
<td></td>
<td>Sedge</td>
<td></td>
<td>July 25</td>
<td>19.87</td>
<td>10.80 per cent</td>
</tr>
<tr>
<td></td>
<td>Wire grass</td>
<td></td>
<td>August 1</td>
<td>19.82</td>
<td>11.03 per cent</td>
</tr>
<tr>
<td></td>
<td>Alfalfa</td>
<td></td>
<td>50 per cent</td>
<td>19.77</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>Sedge</td>
<td></td>
<td>August 20</td>
<td>24.90</td>
<td>1.08 per cent</td>
</tr>
<tr>
<td></td>
<td>Sedge</td>
<td></td>
<td>July 25</td>
<td>24.63</td>
<td>1.14 per cent</td>
</tr>
<tr>
<td></td>
<td>Wire grass</td>
<td></td>
<td>August 20</td>
<td>23.76</td>
<td>4.57 per cent</td>
</tr>
<tr>
<td></td>
<td>Alfalfa</td>
<td>2nd</td>
<td>50 per cent</td>
<td>23.36</td>
<td>6.18 per cent</td>
</tr>
<tr>
<td></td>
<td>Alfalfa</td>
<td>2nd</td>
<td>100 per cent</td>
<td>21.10</td>
<td>15.26 per cent</td>
</tr>
<tr>
<td></td>
<td>Alfalfa</td>
<td>1st</td>
<td>50 per cent</td>
<td>20.23</td>
<td>18.75 per cent</td>
</tr>
<tr>
<td></td>
<td>Wire grass</td>
<td></td>
<td>August 12</td>
<td>19.46</td>
<td>21.84 per cent</td>
</tr>
<tr>
<td></td>
<td>Alfalfa</td>
<td>1st</td>
<td>100 per cent</td>
<td>14.76</td>
<td>40.72 per cent</td>
</tr>
</tbody>
</table>

According to Experiment II and IV, the wire-grass hay cut August 20, mentioned heretofore as coming from the meadow which was irrigated late in the season, had about the same palatability as the second cutting 50 per cent bloom alfalfa.

SUMMARY AND CONCLUSIONS OF METHOD

1. A study has been made of a method of determining relative palatability of hay by comparing the consumption of the same hay by the same cow in different stages of lactation. The factors which prevented similar consumption of hay were offering different amounts of hay, feeding the same allowance of concentrates, and using too short periods to secure an accurate index of a cow's intake of hay.
2. Evidence has been presented to show that the feeding standard may be used as a guide in securing maximum consumption of hay and to obtain similar consumption of hay in repetition trials.

3. By increasing the hay allowance more hay was consumed and also a greater percentage of hay was refused. To obtain a similar hay consumption in repetition trials the same hay allowance must be fed as was fed in the original trial.

4. Limiting the hay allowance to a definite percentage refused makes the relative consumption of two or more hays more comparable.

5. The following method of testing relative palatability of hay is recommended:

(a) Any time after a cow can consume her nutrient requirements as specified by the Haecker feeding standard, feed her a ration sufficient to supply one-half the nutrients in the form of concentrates and one-half in the hay to be tested.

(b) If the cow consumes the hay readily for two consecutive days increase the proportion of hay and decrease the proportion of concentrates in the ration. As long as the cow consumes the hay offered, continue to increase the hay allowance and decrease the concentrate allowance by definite proportions until more than 10 per cent of the hay offered is being refused.

(c) Feed for about ten days that proportion of concentrates to hay on which there is approximately 10 per cent of the hay refused.

(d) The average daily hay consumed during this ten-day period may be used as the index of the cow's intake of the hay.

(e) Cows should be producing sufficient milk to make possible underfeeding on hay alone.
SUMMARY AND CONCLUSIONS OF FACTORS INFLUENCING PALATABILITY OF HAY

1. A total of 32 cuttings of hay were tested for palatability by the above method. Twenty-one cuttings were Wyoming native hay and 11 cuttings were alfalfa hay.

2. The predominating variety of Wyoming native hay was not found to be so much a factor influencing the relative palatability of hays as was the amount of irrigation previous to the time of cutting the hay. Wire-grass hays decreased in palatability as the season advanced except where the meadows had irrigation water applied until shortly before cutting. Sedge hays showed little decrease in palatability as the season advanced because of the wet nature of the soil in which they grew.

3. Unfavorable curing conditions produced a decrease in consumption of Wyoming native hays.

4. Wyoming native hays cut early in the haying season or those that had plenty of water late in the season were found to be as palatable as the best alfalfa.

5. The second cutting of irrigated alfalfa cut in early bloom was not as palatable as the first cutting at the same stage of bloom. The second cutting mowed in later stages of bloom was more palatable than the first cutting in the same stages of bloom.

6. The palatability of alfalfa decreased with the advance in bloom with the exception of the second cutting early-bloom which was less palatable than the later cutting in fuller bloom. Further study will be necessary to ascertain the cause of the lack of palatability of the early-bloom second cutting alfalfa hay.

7. The relative palatability of Wyoming native hay was closely associated with its sugar content. Alfalfa hay did not show this close relationship because alfalfa that is browned in the stack retains its palatability but decreases in sugar content and also alfalfa leaves contain less sugar than the stems.

8. Early and late-cut sedge hays, early-cut wire-grass hays, and late-cut wire-grass hays, having a plentiful water supply shortly before cutting, were as palatable as the best grades of alfalfa.
ACKNOWLEDGMENTS

The writer takes pleasure in expressing his indebtedness to Director J. A. Hill, Doctor Fred S. Hultz, and Doctor O. C. McCreary of the Wyoming Experiment Station, and to the late Doctor C. H. Eckles and Doctor W. E. Petersen of the University of Minnesota for their valuable suggestions relative to the planning and completion of these experiments.

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