THE COMPOSITION OF PASTURE GRASSES AT THE UNIVERSITY FARM VIIK

MAIJA-LIISA SALO

Department of Animal Husbandry, University of Helsinki

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The family *Gramineae* includes many species with a high sugar content. Some of these, the most notable being sugar cane, have large amounts of true sugars, especially sucrose. On the other hand, many cultivated ley and pasture grasses contain — in addition to sugars — fructosan, which, like sucrose, is water soluble and hydrolysable by weak acids or invertase (19). In the literature, sugars and fructosan are known by the common term water-soluble carbohydrates or are simply called sugars.

Ryegrasses are among the plants having the highest content of sugars and fructosan. The amount of water-soluble carbohydrates in Italian ryegrass can be as high as 35 % of the dry matter (5). In Scotland, France and Sweden the water-soluble carbohydrate content of perennial ryegrass, meadow fescue, timothy, meadow grass and cocksfoot in the early part of the summer is found to be in the range of 15—27 % of the dry matter (5, 8, 18).

Water-soluble carbohydrates are not uniformly distributed throughout grass plants; in fact, they are most abundant in the stems, followed by the inflorescences, the leaves, and finally the roots (13). The content in the stems may be as much as 3—4 times that of the leaves, and this difference is especially marked in the case of fructosan (10, 17). The amount of fructosan is not uniform in the stems, but is concentrated in to the lower parts (15). In overwintering grass plants the carbohydrate reserves are located in the stubble (2).

In the same plant species the sugar content fluctuates considerably under different conditions. The most important factor is the growth stage. The highest levels of fructosan and also of total water-soluble carbohydrates are found in the early phases of growth. According to MACKENZIE and WYLAM (10), the fructosan content in the stems of ryegrass shows two distinct phases of decline. The first occurs when the flowering stalks start to develop, the second at the onset of seed formation. In studies resembling actual pasture conditions, it has been found that in the early part of the summer, during the period when the stems would be producing inflorescences if they were allowed to continue growing, the amounts of water-soluble carbo-

hydrates are much greater than later in the summer, when the growing points of the plants are entirely vegetative. Lucerne and clover do not contain fructosan, but their levels of sucrose show similar differences between stems and leaves and likewise between different times of the season (4, 5).

A second important factor influencing the amounts of water-soluble carbohydrates is the weather. STEGER and PÜSCHEL (13) established that during the sunniest period of the summer, the content of invert sugar in ryegrass growing in the shade was more than 10 %-units lower than that of plants in the sunshine. According to the studies of MACKENZIE and WYLAM (10), shade has a marked lowering effect particularly on the sucrose content. Similarly, diurnal fluctuations in sugar level — which, however, amount to only 1—2 %-units — occur practically only in the sucrose fraction; the highest figures have been determined in the afternoon, the lowest early in the morning (3, 9, 14, 17). The different values of water-soluble carbohydrates found by the above authors in various years are evidently due to differences in weather conditions, as well as to the small differences dependent on the growth stage (8, 13, 18). The variations in climatic circumstances explain, at least partly, the widely diverging results obtained for the same plant species in different parts of the world. For example, PHILLIPS et al. (11) in northeastern United States and JOHNS (6) in New Zealand obtained considerably lower contents of water-soluble carbohydrates in gramineous plants, as did BAILEY (1) in New Zealand in the case of clover, than the above-mentioned European workers. In northern Finland YLLÖ (20) found rather low sugar contents in various grass species.

Fertilizers likewise have some effect on the levels of water-soluble carbohydrates. WAITE (16) observed that increasing the amount of fertilizer (NPK) resulted in an increase in the protein content, while the water-soluble carbohydrate content, and particularly that of the fructosan fraction, showed a corresponding decline. Likewise, YLLÖ (20) and JONES et al. (7) have confirmed the depressing influence of nitrogen applications on the sugar content of grasses. STEGER and PÜSCHEL (13) also found in their trials that nitrates lowered the sugar content, whereas applications of potassium or calcium, and also phosphorus in the intial period, caused an increase in the amounts of sugars.

Experimental

The chief purpose of this investigation was to determine the content of water-soluble carbohydrates in pasture grasses at different times of the grazing season. Separate determinations were made of monosaccharides, sucrose and fructosan. In addition, crude protein and ash, and in 1961 also hemicellulose, cellulose, crude lignin, total membrane substances (Paloheimo's method), and crude fibre were determined.

Material and methods

Some of the pastures at the Viik Experimental Farm are long-term ones, with meadow grass as the dominating species, while others are short-term pastures, dominated by cocksfoot or meadow fescue. The pastures are located on low-lying

ground which was formerly the bottom of the sea. Store fertilization consisted of 10 tons ground limestone, 1000 kg Kotka phosphate (10 % P) and 300 kg 40 % potassium salt per hectare. Annual dressings consisted of 300 kg Kotka phosphate, 80 kg 50 % potassium salt and 800 kg nitrate of lime (15.5 % N) per hectare. The nitrate was applied in four portions of 200 kg/ha.

In addition to the above dominating plant species, some timothy and clover grew on the short-term pastures, and various kinds of weeds on all the pastures. The determinations in the present study, however, were made only on the dominating grasses. In 1961 analyses were made on cocksfoot (*Dactylis glomerata*) and meadow grass (*Poa pratensis*), in 1962 also on meadow fescue (*Festuca pratensis*), and in 1963 even on timothy (*Phleum pratense*). The latter was not taken from the actual pasture, but from an adjacent hay field having the same soil type as the pasture but receiving only 200 kg/ha nitro-chalk (25 % N) per year. The pasture grasses were generally sampled from paddocks at the grazing stage. In the early part of the summer when the grass grew rapidly, 2—4 samples were collected from the same paddocks before the first cut or grazing period; the final sample was sometimes taken at the heading stage. The ungrazed paddocks were cut for silage when they began to head. In 1961, during the entire grazing season, samples were taken from two paddocks at the beginning of each grazing period. In the years 1962 and 1963, the sampling was not so regular; samples were taken from different paddocks according to where there was available grass at the grazing stage.

The grass samples were taken at about 2 o'clock p.m. The grass was cut with scissors about 2 cm from the ground. A total of 250—500 g was collected from 7—10 spots and placed in plastic bags. Dead foliage, which was especially abundant in the spring, was removed. In the laboratory the grass was cut into small pieces and placed in a freeze-drying apparatus. The procedure was carried out so rapidly that at most 30 minutes elapsed between sampling on the field and the freeze-drying. In hot weather the plastic bags with their samples were transported immersed in an ice-salt mixture. The dried samples were subsequently ground in a Wiley mill using a sieve No. 40 (0.42 mm mesh) and kept in a refrigerator at about — 8°C.

Carbohydrates and other constituents were determined by methods described by the author in another paper (12). In determining fructosan it was extracted with 0.1 N hydrocloric acid. However, in the hemicellulose determinations the fructosan was extracted with cold water. In the present study, various different tests were carried out for the sake of comparison, and the results of those considered to be the most reliable were selected for inclusion in the tables. The crude lignin analyses included pepsin treatment.

Results and discussion

Of the three summers of this investigation, two were rainy and one was dry. The early part of the summer 1961 was hot, but the rest of the season was cool and rainy. The entire summer of 1962 was exceptionally cool and wet, while the following summer was dry and warm. The weather conditions in the middle part of the summer were unfavourable for crops in all three years. In 1963, the pastures were so dry

Table 1. Analytical data on the composition of some pasture grasses during the grazing seasons 1961

	1961								
Cocksfoot:									
Date	25/5	3/6[1]	3/7	3/8	30/8	24/9	18/5	26/5	2/6
Height of grass, cm	25—35	50—60	40—50	40—50	40—50	20—25	10—20	20—30	45—55
Monosaccharides	5.4	7.0	4.3	1.3	2.8	1.8	3.3	4.6	8.3
Sucrose	10.1	3.8	4.9	3.8	4.3	5.6	7.4	8.2	8.8
Fructosan	5.6	1.0	3.5	0.5	4.5	1.8	2.1	5.1	2.2
Total water-sol. carbohydrates	21.1	11.8	12.7	5.6	11.6	9.2	12.8	17.9	19.3
Crude protein	19.2	12.9	15.1	18.1	17.2	20.9	26.5	18.5	18.4
Ash	10.4	9.9	10.7	10.9	11.3	12.1	8.7	10.5	9.8
Meadow grass:									
Date	25/5	3/6[1]	3/7	3/8	30/8	24/9	18/5	26/5	2/6
Height of grass, cm	15—20	25—30	20—25	15—30	15—30	15—20	10—20	15—25	25—35
Monosaccharides	3.2	2.8	1.4	1.0	1.6	1.3	3.1	3.8	4.5
Sucrose	11.8	4.2	6.0	4.7	4.7	5.0	8.4	8.6	9.3
Fructosan	7.1	5.6	6.0	7.8	3.1	4.3	5.8	3.2	2.4
Total water-sol. carbohydrates	22.1	12.6	13.4	13.5	9.4	10.6	17.3	15.6	16.2
Crude protein	19.8	16.1	14.2	12.7	17.1	15.6	24.1	26.6	24.5
Ash	7.7	7.3	7.9	7.8	9.1	9.3	10.5	9.1	7.6
Meadow fescue:									
Date									
Height of grass, cm									
Monosaccharides									
Sucrose									
Fructosan									
Total water-sol. carbohydrates									
Crude protein									
Ash									
Timothy:									
Date									
Height of grass, cm									
Monosaccharides									
Sucrose									
Fructosan									
Total water-sol. carbohydrates									
Crude protein									
Ash									

[1] headed [2] partly headed

and bare that for a long period no samples could be taken. The samples of July 5, 1963, represented the sparse, withered grass which grew on the dried-up pastures. In terms of both rainfall and temperature, the season of 1961 as a whole was closest to normal.

The results from the three years are shown in Table 1 and the weather conditions in Figures 1—3 and Table 2. The weather observations were made by the Meteor-

—1963. (The figures are percentages of the dry matter).

1962						1963					
			2/8	31/8	21/9	17/5	25/5	4/6[2]	5/7	26/8	21/9
			30—45	15—35	20—40	20—25	30—40	60—70	20—25	15—30	30—55
			2.6	2.7	2.9	4.8	7.8	10.3	2.4	1.2	4.0
			6.0	5.4	3.2	9.5	4.4	5.5	3.9	4.9	8.4
			2.6	1.3	5.9	5.2	6.8	2.2	1.5	0.7	3.4
			11.2	9.4	12.0	19.5	19.0	18.0	7.8	6.8	15.8
			18.4	18.5	15.0	20.7	15.7	11.1	20.9	24.8	16.0
			12.5	13.2	11.7	10.1	9.3	7.5	10.8	10.4	11.6
15/6[2]	6/7	20/7	2/8	31/8	21/9	16/5	24/5	6/6[1]			19/9
20—45	25—30	15—30	10—30	10—20	10—25	10—20	25—30	40—50			5—20
4.2	2.0	1.8	1.7	2.2	2.6	3.9	3.7	5.6			1.5
10.0	5.5	6.2	4.0	5.0	4.7	8.8	4.6	5.7			6.5
6.2	1.5	1.9	1.3	3.7	4.3	6.4	8.4	1.8			2.0
20.4	9.0	9.9	7.0	10.9	11.6	19.1	16.7	13.1			10.0
17.8	20.8	18.5	18.7	19.9	20.0	24.5	17.7	14.7			19.8
7.1	7.8	9.1	9.3	9.0	9.5	8.8	7.4	6.3			10.4
15/6			2/8	31/8	21/9	16/5	25/5	4/6	5/7		21/9
15—40			15—35	15—35	15—30	15—20	30—35	45—50	25—30		20—40
4.6			1.4	2.0	1.7	3.9	4.2	8.1	2.3		2.0
9.5			4.5	5.7	3.8	9.2	6.1	6.0	5.1		11.3
8.7			3.7	6.0	5.8	6.0	8.8	3.1	2.0		3.9
22.8			9.6	13.7	11.3	19.1	19.1	17.2	9.4		17.1
12.9			18.4	16.0	17.0	21.7	15.7	15.9	20.7		17.3
8.3			13.0	11.9	11.1	9.6	9.4	8.9	8.9		10.2
						17/5	25/5	6/6	13/6[1]	26/8	19/9
						15—25	25—30	40—50	55—60	20—25	20—30
						3.7	4.9	7.4	5.9	1.5	1.6
						10.1	5.6	4.4	6.5	6.4	6.6
						7.0	11.6	5.0	3.6	13.4	8.7
						20.8	22.1	16.8	16.0	21.3	16.9
						25.7	14.4	10.9	9.2	11.3	12.5
						7.3	6.6	6.0	5.6	6.8	9.0

ological Institute at the Viik Experimental Farm. The length of the grass presented in Table 1 was measured in the laboratory and shows that the major part of the grass shoots, measured from their base to the tip of the leaf, were within the limits shown. On the pasture the height of sword was considerably shorter because of the downward bending of the leaves.

In examining the results, a general feature to be seen is that the total content

of water-soluble carbohydrates is high during the first 1—4 weeks of the grazing season (even more than 20 % of the dry matter), but drops to nearly half this value when the grass reaches the heading stage. During the remainder of the season, a period of 3 to 3 ½ months, the figure is around 8–13 %. In many cases the highest sugar content is found in samples which were taken just before or at the very beginning of heading. Since, however, weather conditions affect the content of water-soluble carbohydrates, the maximum values sometimes occur prior to the above mentioned growth phase. The analyses of the samples of June 15, 1962, examined together with the weather conditions of the same period, indicate that even in very cool and cloudy periods, plants before heading are able to accumulate a reserve of water-soluble carbohydrates which amounts to 20—23 % of the dry matter. In the middle and latter parts of the summer the sugar contents are sometimes found to decrease below the previously mentioned 8—13 % average level, dropping to as low as 6 %. In the last cocksfoot and meadow fescue samples taken in the dry summer of 1963 there is a rise in the sugar content. This exceptional increase in the carbohydrate level is due to the vigorous vegetative growth of the grasses as a result of rains in the latter part of the summer. Such a phenomen is not observed in meadow grass, since it had already been grazed once before sampling and was shorter than normal.

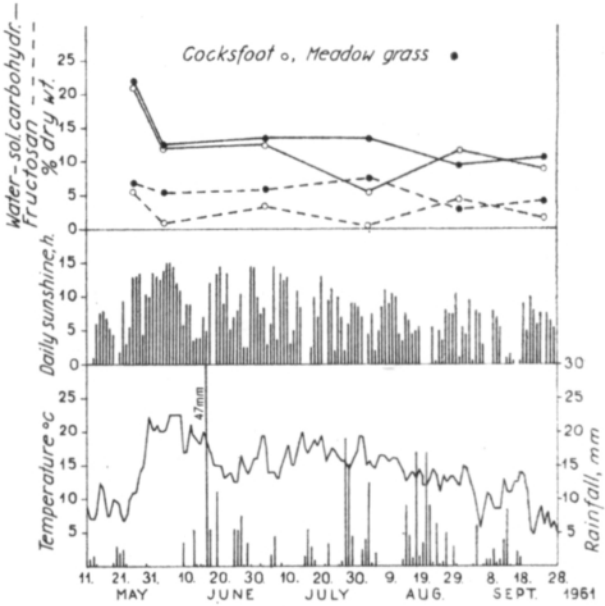

Fig. 1.

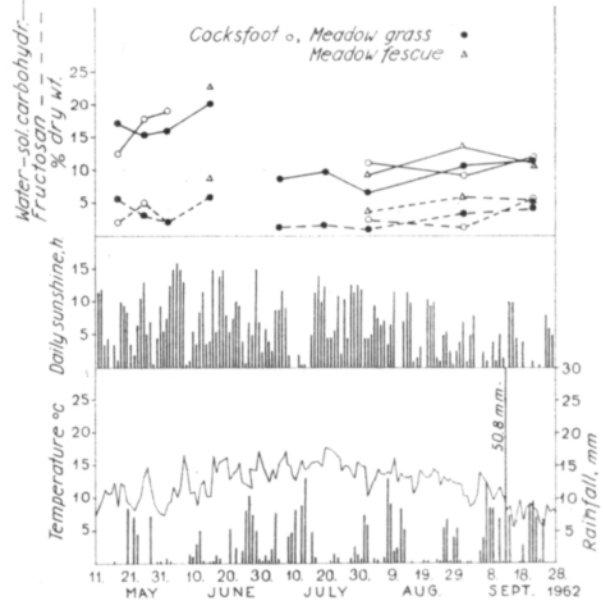

Fig. 2.

The total content of water-soluble carbohydrates in the various grass species

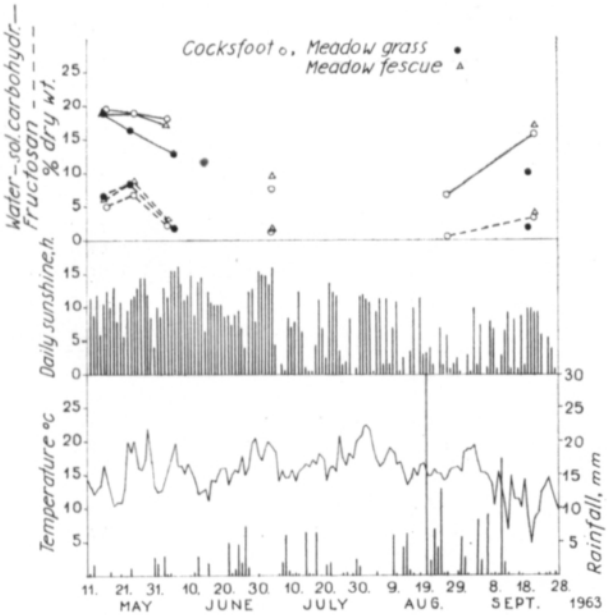

Fig. 3.

Fig. 1—3. Meteorological data and the water-soluble carbohydrates and fructosan contents of pasture grasses during the grazing seasons 1961—1963.

is quite similar. There are some conflicting results, but in general the order of the grasses arranged according to sugar content is as follows: meadow fescue highest, meadow grass intermediate, and cocksfoot lowest. These differences are small, however. Among the various water-soluble carbohydrates, the sucrose fraction is the major one in most of the samples. Cocksfoot is generally considered as a fructosan-deficient species, and in these trials its fructosan content is as a rule lower than that of the other grasses. The level of monosaccharides in cocksfoot at the time of heading was surprisingly high.

Timothy, which was investigated only in 1963, had received less nitrogen fertilizers than the other grasses and consequently is not entirely comparable with them. Furthermore, the samples were only from the two main growth periods: the first four samples were taken from the first growth of hay at different stages, and the last two from a drought affected aftermath. The values found in the early part of the summer are slightly higher than those in the pasture grasses on the same days of sampling, but in the aftermath samples the amounts of water-soluble carbohydrates, and particularly that of fructosan, were quite high.

Comparisons between the results from the various years reveal no great differences. Admittedly in 1962 the high springtime level of sugars continued for a unusually long period, but this was due to the cool weather which delayed the development of the grasses by about 2—3 weeks as compared to the previous year. There are relatively few samples available from the middle period of the summer; this applies especially to the dry year 1963, when the grass simply did not grow at all. The withered grass was found to have a very low sugar content (samples of July 5, 1963). In viewing these results in their entirety, the conclusion can be drawn

Table 2. Meteorological data during the grazing seasons 1961—1963.

Year and month	Mean temperature, °C	Av. daily sunshine, hours	Rainfall, mm	Cloudiness, (0—8)	Relative humidity, %
1961					
May	10.0	6.8	34.7	4.1	69.8
June	17.6	9.4	95.7	3.3	68.2
July	16.6	7.3	64.0	4.3	76.8
August	14.2	5.4	101.0	4.9	82.6
September	9.4	4.5	29.3	4.6	82.5
1962					
May	8.8	6.2	44.1	4.4	66.8
June	12.7	8.2	55.3	4.2	69.3
July	15.1	5.9	66.1	4.8	77.3
August	13.0	5.1	79.0	5.3	81.2
September	9.2	2.6	140.4	6.1	88.8
1963					
May	13.0	9.2	20.8	3.4	61.3
June	15.3	11.0	31.8	3.3	60.3
July	17.0	7.0	32.8	4.6	68.7
August	16.8	4.8	84.5	5.0	76.0
September	12.5	4.7	49.5	4.4	77.6
Average from years 1954—1963[1]					
May	9.8	7.7	36.2	3.9	67.0
June	14.7	9.6	45.5	3.8	67.5
July	17.1	7.3	77.2	4.2	73.4
August	15.3	5.2	87.1	4.8	78.6
September	10.1	4.1	65.0	4.8	82.1

[1] The averages of sunshine and humidity are from 4 to 6 years only.

that the contents of water-soluble carbohydrates in pasture grasses are similar in different years, in spite of the differences in weather conditions. On the basis of the results it seems that the first cut for silage should be made at the latest when the first heads on the grass become visible.

In comparing the present results with those of other investigators, it can be seen that the values for the contents of water-soluble carbohydrates are very similar to those found in France, Scotland and Sweden. The highest values were obtained by JARRIGE (5) in France; they were partly higher than those of the author, although the differences are not very great. Jarrige found low contents of crude protein. However, he did not study his grasses under true pasture conditions, but instead analysed 4 samples from the first crop and 2—3 from the second. Furthermore, he says nothing about the fertilizers used. WAITE and BOYD (18) carried out experiments resembling actual pasture conditions and made cuts at a height of 8—10 inches.

This height evidently means that of the sward so that the actual length of the grass was greater and not very different from that in the present studies. In general, the contents of water-soluble carbohydrates in the samples of Waite and Boyd were slightly lower than those of the author, and, correspondingly, the contents of crude protein somewhat higher. The higher cutting level used by the above workers (1—2 in.) would tend to lower to a certain extent the sugar content, and the same effect would be produced by the nitrogen fertilization, which in their trials was considerably greater than that used in the present studies. Their higher rates of nitrogen also explain the high levels of protein obtained.

The results of KIVIMÄE (8) from the years 1954—55 are rather similar to those of the author, although Kivimäe did not observe a high sugar level in the spring of the first year. The level of nitrogen fertilization in his study was similar to that in the present investigation. In northern Finland there appear to be smaller amounts of water-soluble carbohydrates in grasses than in the south. YLLÖ (20) found there (66.5 °N) for timothy the sugar contents of 2.8—13.2 % of the dry matter (averaging 9.6 %). In contrast, six samples analysed by the author (60.1 °N.) gave values of 16.0—22.1 %. In the study of Yllö the timothy fields received 250 kg/ha nitrochalk (25 % N) and in that of the author 200 kg/ha. Even greater differences appear in Italian ryegrass; Yllö found sugar percentages of 2.7—12.0 (av. 6.7 %) in 8 samples, while JARRIGE (5) in France obtained values in the early part of the summer as high as 27.0—34.5 %. As was mentioned in the review of the literature, in warm regions, such as New Zealand (6) and the United States (11), particularly low contents of water-soluble carbohydrates have been found in grasses.

Table 3. Composition of cell wall substances of two pasture grasses during the grazing season 1961 (% of dry matter).

Date	Hemicellulose neutral sugar anhydrides	Hemicellulose uronic anhydrides	Cellulose	Crude lignin	Total cell-wall substances	Membrane substances (Palo-heimo's method)	Crude fibre
Cocksfoot							
May 25	15.3	4.4	15.0	4.0	38.7	23.8	17.7
June 3	17.3	4.8	21.6	4.5	48.2	38.1	26.5
July 3	17.1	4.5	20.7	3.9	46.2	35.3	25.0
Aug. 3	16.3	4.8	21.5	4.1	46.7	38.0	27.7
Aug. 30	16.2	4.8	20.2	4.4	45.6	34.8	24.6
Sept. 24	14.6	5.2	18.8	5.0	43.6	33.7	22.9
Meadow grass							
May 25	14.4	3.9	16.7	3.2	38.2	29.9	19.2
June 3	19.0	4.5	22.2	4.6	50.3	41.9	25.4
July 3	18.4	4.2	24.6	5.4	52.6	45.0	28.2
Aug. 3	18.7	4.4	24.3	5.7	53.1	44.9	29.6
Aug. 30	17.1	4.1	23.1	5.8	50.1	45.6	26.6
Sept. 24	18.1	4.2	22.7	6.8	51.8	44.6	26.5

Table 1 also gives the contents of crude protein and ash. The protein content proved to be very dependent upon the growth stage with a definite correlation between the protein level and the length of grass. Plants which had reached the heading stage had small amounts of protein. No appreciable differences in crude protein content were found between cocksfoot, meadow grass and meadow fescue. The lower content in timothy may be due to the fact that this species is not as leafy as the others, but it may also be a result of the lower amounts of nitrogen dressings. The ash contents of the three pasture grasses were practically the same, while that of timothy was lower.

In 1961 the samples were also analysed for hemicellulose, cellulose, crude lignin, total membrane substances (Paloheimo's method), and crude fibre. These results are shown in Table 3.

The contents of the above cell-wall constituents showed very little fluctuations during the grazing season, excluding samples taken at exceptionally young growth stages (the first samples as well as the final cocksfoot sample). Grass at the heading stage (June 3) did not have more cell-wall substances than later in the summer when the samples were in the leafy phase of growth. Meadow grass had slightly higher contents of cell-wall materials than cocksfoot. Furthermore, in the membrane-determination process of Paloheimo, only an average of 15 % of the meadow grass cell-wall substances dissolved, while the figure for cocksfoot was about 25 %. This difference in solubility may be due to the sligthtly higher content of xylan and crude lignin in meadow grass (Table 4). No differences in the relative proportions of neutral

Table 4. Proportions of different neutral sugar anhydrides in the hemicellulose of pasture grasses (% of the total neutral sugar anhydrides).

Grass	galactose anhydride	glucose anhydride	arabinose anhydride	xylose anhydride
Cocksfoot	10	20	20	50
Meadow grass	10	10	20	60
Meadow fescue	10	20	20	50
Timothy	10	15	25	50

sugar anhydrides of hemicellulose were observed during the course of the grazing season; the only exception to this were the samples taken at the heading stage, in which the amounts of xylose anhydride were slightly higher than the values given in Table 4.

Summary

During the grazing seasons of the years 1961—63 determinations were made on the contents of monosaccharides, sucrose, fructosan, crude protein and ash in various grass species. In 1961 cocksfoot and meadow grass were investigated, in 1962 meadow fescue was included and in 1963 also timothy. Weather observations were also made during the seasons. The following results were established:

At the beginning of the grazing season the contents of water-soluble carbohydrates in all the grasses were at a high level, reaching a maximum of slightly over 20 % of the dry matter. This high-sugar level lasted from one to four weeks, depending on the temperature, until the plants began to form flowering heads. At the heading stage the total amount of water-soluble carbohydrates decreased to nearly half of the previous level. During the remainder of the grazing season, or for 3—3½ months, the total sugar content was about 8—13 % of the dry matter, dropping sometimes, however, to as low as 6 %. At the end of the dry summer of 1963, higher contents than usual were determined.

There were no great differences in the total contents of water-soluble carbohydrates between the different grass species. From the highest to the lowest sugar content, the species were: meadow fescue, meadow grass, cocksfoot. In fact timothy should be ranged as the first but this grass was not sampled from the pasture paddocks.

Of the various water-soluble carbohydrates, the sucrose fraction was the largest in most of the samples. Cocksfoot contained less fructosan than the other grasses, and at the heading stage its content of monosaccharides was very high.

Of the three years of the study, two were rainy and one was dry. In spite of the differing weather conditions, however, no noteworthy differences in the water-soluble carbohydrate contents were observed.

The crude protein content was found to be dependent upon the growth stage. No appreciable differences were observed between cocksfoot, meadow grass and meadow fescue. Timothy, on the other hand, had a lower content of both protein and ash than the three pasture grasses.

Contents of cell-wall substances were generally alike during the pasture season. Notable exceptions were evident only in the cases where the samples represented grass at an early growth stage. Meadow grass contained slightly more cell-wall constituents than cocksfoot, e. g. its xylan and crude lignin contents were somewhat higher. Furthermore, the solubility of such constituents in weak acid was slightly less for meadow grass than for cocksfoot.

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SELOSTUS:

LAIDUNRUOHON KOOSTUMUKSESTA VIIKIN KOETILALLA.

MAIJA-LIISA SALO

Yliopiston kotieläintieteen laitos, Helsinki.

Tutkimuksessa selviteltiin laidunruohojen monosakkaridi-, sakkaroosi-, fruktosaani-, raakaproteiini- ja tuhkapitoisuutta laidunkausina 1961—1963. V. 1961 tehtiin näytteistä myös erilaisia solu seinämäainemäärityksiä. Koekasveja olivat v. 1961 koiranheinä ja niittynurmikka, v. 1962 lisäksi nurminata ja v. 1963 neljäntenä pellossa kasvava timotei. Koeajalta esitetään myös päivittäiset säähavainnot.

Ruohojen sokeripitoisuus todettiin laidunkauden alussa korkeaksi. Vesiliukoisten hiilihydraattien yhteismäärä saattoi olla yli 20 % kuiva-aineesta. Sokeririkasta kautta kesti sään lämpimyydestä riippuen 1—4 viikkoa, ts. siihen saakka, kun kasvit tulivat tähkälle. Tähkälle tulo pudotti vesiliukoisten hiilihydraattien pitoisuudet lähes puoleen entisestä. Koko laidunkauden loppuajan eli 3—3½ kk oli vesiliukoisten hiilihydraattien määrä noin 8—13 % k.a:sta, alentuen kuitenkin joskus jopa 6 %:iin. Poutakesän lopussa todettiin tavallista korkeammat pitoisuudet.

Eri laidunruohojen välillä ei vesiliukoisten hiilihydraattien yhteismäärissä ilmennyt suuria eroja. Järjestys sokeririkkaimmasta köyhimpään näytti olevan: nurminata, niittynurmikka ja koiranheinä. Mikäli timotein tulokset katsotaan vertailukelpoisiksi, on se luettelossa ensimmäisenä. Vesiliukoisten hiilihydraattien osaryhmistä sakkaroosiryhmä oli useimmissa näytteissä suurin. Koiranheinä oli muita fruktosaaniköyhempi ja sen monosakkaridipitoisuus oli tähkälletulo vaiheessa sangen korkea.

Koekaudeksi osui kaksi sateista ja yksi poutakesä. Mitään huomattavia eroja vesiliukoisten hiilihydraattien pitoisuuksissa eri vuosina ei silti todettu.

Proteiinipitoisuus oli riippuvainen kasvuasteesta. Koiranheinän, niittynurmikan ja nurminadan välillä ei siinä todettu mainittavia eroja. Timotein sekä proteiini- että tuhkapitoisuus oli alempi kuin laitumella kasvavien ruohojen.

Eri tavoin määritetyissä soluseinämäaineryhmissä todettiin laidunkauden aikana merkittäviä eroja vain silloin, kun näyte edusti tavanomaista nuorempaa kasvuastetta. Niittynurmikassa soluseinämäaineita oli hiukan enemmän kuin koiranheinässä, mm. sen ksylaani- ja raakaligniinipitoisuus oli vähän korkeampi. Soluseinämäaineiden liukoisuus laimeassa happokeitossa oli siinä myös vähän pienempi kuin koiranheinässä.