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AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS

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BULLETIN NO. 290 FEBRUARY, 1922

DIVISION OF CHEMISTRY

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DIGESTIBILITY OF THE SUGARS, STARCHES, PENTOSANS, AND PROTEIDS OF SOME FEEDING STUFFS

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BULLETIN NO. 290 FEBRUARY, 1922

DIGESTIBILITY OF THE SUGARS, STARCHES, PENTOSANS, AND PROTEIN OF SOME FEEDING STUFFS

BY

G. S. FRAPS.

A knowledge of the composition and digestibility of the sugars, starches, pentosans, and other ingredients of feeding stuffs, is important for several reasons. It should throw some light upon the variations in the feeding values of different feeding stuffs. It may aid in solving the question why the digestible nitrogen-free extract of hays and fodders is less valuable to animals than the same quantity of digestible nitrogen-free extract in concentrates. It may throw some light upon the preference shown by animals for one feed over another.

A knowledge of the constituents of feeds is also important in feed control work, since it may aid in detecting illegal admixtures in feeds, or adulteration. It may aid in devising methods for the estimation of the quantity of certain feeds, or certain classes of feed in mixtures.

The work here described is a continuation of that published in Bulletins 175 and 196 of this Experiment Station. Bulletin 175 deals with the distribution and digestibility of the pentosans of feeds. Bulletin 196 deals with the digestibility of sugars, starches, and pentosans of roughages.

Comparatively little work has been done upon the composition and digestibility of the nitrogen-free extract of feeding stuffs. The writer has studied the digestibility of sugars and pentosans in Bulletin 172, North Carolina Experiment Station (1900), and given a review of the literature up to 1900. Further data are given by the writer in Bulletins 104, 175, and 196, of the Texas Experiment Station. Dr. William Frear has studied the composition of timothy hay in detail (Pennsylvania reports, 1903-04) and Dr. Headden has made quite extensive studies, which are described in Bulletin 124, Colorado Experiment Station, 1907. See also Fraps' Principles of Agricultural Chemistry, pages 374-8. The carbohydrates of the soy bean have been studied by Street and Bailey, J. Ind. Eng. Chem. 7, 853 (1915) and of the navy bean by Peterson and Churchill, Jour. Am. Chem. Soc. 43, 1180 (1921).

METHODS OF WORK.

The materials used in this work were secured in the digestion experiments described in detail in Bulletins 166, 203, and 245 of this Experiment Station.

In part of the work sugars were extracted with water, but later they were extracted with dilute alcohol, and determined by the usual method. When the sugars are extracted with water as described in Bulletin 196, some of the compound sugars are converted into reducing sugars.

Starch was determined by the diastase method in material which had been extracted with ether and with alcohol. This would include gums as well as starch.

Pentosans were determined in the usual way. The pentosans were determined in the crude fiber, prepared in the usual way. The differences between the total pentosans and the pentosans in the crude fiber are taken to be the pentosans in the nitrogen-free extract.

The sugars, starch, and pentosans in the nitrogen-free extract were added together, and the sum taken from the total nitrogen-free extract. The remainder is termed the "residual nitrogen-free extract."

The pentosans were determined in the residue insoluble in N/50 acid and N/50 alkali as in Bulletin 196. The pentosans in the crude fiber were subtracted, and the remainder is termed the "pentosans insoluble in nitrogen-free extract." The pentosans soluble in the nitrogen-free extract were secured by subtracting the pentosans insoluble in the nitrogen-free extract from the pentosans in the nitrogen-free extract.

The total residue insoluble in N/50 acid and N/50 alkali was determined as described in Bulletin 196. From this residue was subtracted the crude fiber, the pentosans insoluble in the nitrogen-free extract, and the protein insoluble in N/50 acid and alkali, determined on other preparations. The remainder is termed the "insoluble nitrogen-free extract, free from pentosans." This was subtracted from the residual nitrogen-free extract to secure the soluble residual nitrogen-free extract.

The "soluble residual nitrogen-free extract" is thus the residual nitrogen-free extract which is dissolved by N/50 acid and alkali.

The proteids were determined by copper hydroxide. The total protein less the proteids is termed the amides. This is not strictly correct, for the nitrogen factor for the amides is different from that for the proteids.

COMPOSITION OF FEEDS.

The composition of the feeds is shown in Table 1. The ordinary analysis is given in Bulletins 166, 203, and 245. The reducing sugars in some of the feeds are larger than should be the case, on account of reversion of sugars when extracted by water. The reducing sugar in alfalfa hay 9537 may be compared with that in alfalfa hay 7005. The difference is due to the method of extraction.

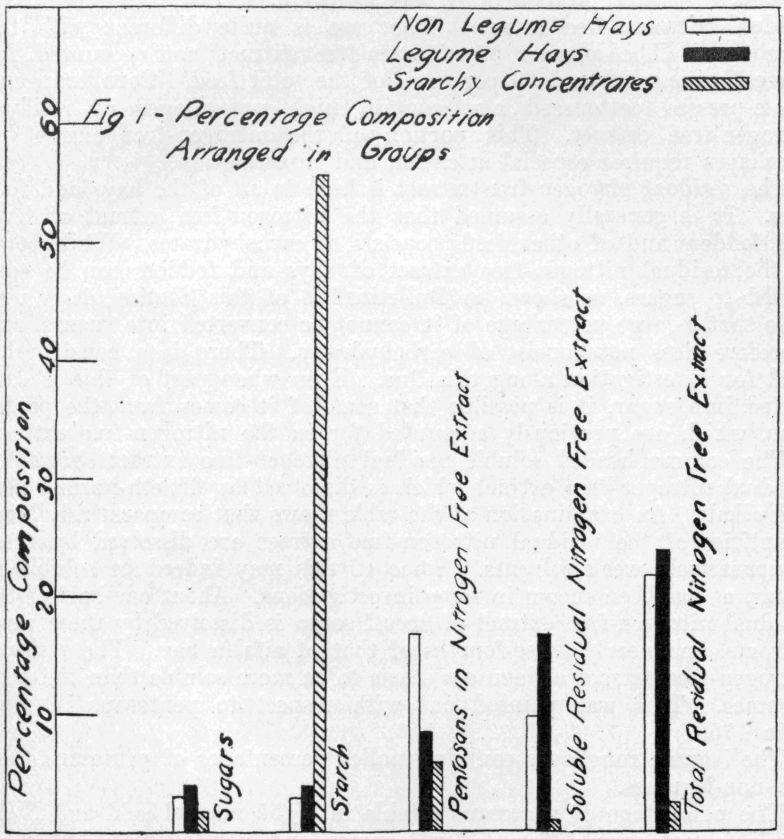
Table 1. Composition of feeds.

		Reducing sugars	Di. sugars	Starch	Pentosans in N. F. E.	Residual N. F. E.	Soluble residual N. F. E.	Pentosans				Amides, etc.	Proteids
								Soluble in N. F. E.	Insoluble in N. F. E.	In crude fiber	Total		
11438– 9	Accuff sorgo forage, D. E. 81	0.17	0.39	1.50	19.75	22.05	11.16	6.86	12.89	5.39	25.14	.97	3.10
8316–17	Alfalfa hay, D. E. 54	1.16	1.47	1.76	9.72	19.98	15.34	4.64	5.08	5.00	14.72	1.73	8.46
6724–25	Alfalfa hay, No. 1	2.10	1.90	2.30	8.09	24.85	20.24	4.61	3.48	5.00	13.09	3.35	11.10
7005–06	Alfalfa hay, No. 2	2.28	1.29	2.29	8.21	24.74	17.70	5.57	2.64	5.00	13.21	2.99	11.96
9537–38	Alfalfa hay, D. E. 63	.80	2.12	2.65	10.82	18.79	13.79	5.72	4.10	4.92	14.74	4.12	8.20
8227–28	Alfalfa hay, D. E. 48	2.69	1.74	2.64	8.92	23.18	14.87	4.04	4.88	5.00	13.92	2.50	9.52
12601–02	Alfalfa hay, D. E. 84	0.97	2.33	1.84	10.03	23.33	19.39	5.80	4.23	5.00	15.03	4.01	8.10
12952– 3	Alfalfa hay, D. E. 88–92	0.91	1.67	2.09	9.12	20.30	14.16	4.75	4.37	5.80	14.92	2.20	9.18
8406–07	Argentine corn, D. E. 56	0.44	.72	62.82	5.61	1.82	.....	.....	.....	0.20	5.81	.....	.....
6027– 8	Bermuda hay	1.43	1.33	4.64	18.23	24.12	4.86	2.22	16.01	4.00	22.23	.69	4.85
10981– 2	Bermuda hay, D. E. 72	1.35	1.81	3.38	19.06	24.02	9.51	4.08	14.98	3.77	22.83	.59	5.41
6907–08	Corn bran	1.14	1.92	26.79	19.09	15.69	.....	.....	.....	4.00	23.09	.....	.....
8168– 9	Corn silage (dried), D. E. 46 S	2.41	.13	6.02	16.96	23.52	12.06	4.40	12.56	4.00	20.96	2.64	4.61
6747– 8	Cold pressed cottonseed No. 1	.01	5.25	0	12.09	12.62	.....	.....	.....	3.00	15.90	1.58	24.00
7034–35	Cold pressed cottonseed No. 2	.05	4.38	0	11.74	12.64	.....	.....	.....	3.00	14.74	.....	.....
12965–66	Cold pressed cottonseed, D. E. 89	.12	1.56	0	9.58	12.28	2.69	3.00	6.58	2.97	12.55	2.46	21.47
7048–49	Cottonseed hulls	.05	.19	1.25	16.92	16.30	.....	.....	.....	5.00	21.92	.....	.....
7050– 1	Cottonseed meal	.06	9.19	0	6.80	7.88	.....	.....	.....	1.00	7.80	.....	.....
8108–09	Dolichos lablab hay, D. E. 45	.65	.54	6.63	8.29	17.50	12.38	4.75	3.54	5.00	13.29	2.32	12.50
11127–28	Feterita forage, D. E. F. 4	0.58	.19	3.72	17.12	20.28	.....	.....	.....	5.34	22.46	.66	4.50
8318–19	Feterita seed, D. E 55	.35	.77	60.05	3.19	5.56	3.68	2.93	0.26	0.20	3.39	.16	13.67
8742–43	Jack beans	.07	1.86	32.59	8.36	5.13	.....	.....	.....	.....	8.86	.....	.....
7009–10	Kafir corn chops	0.58	.34	65.14	4.25	0.22	.....	.....	.....	0.20	4.45	.....	.....
7031–32	Kafir head chops	0.48	.90	54.18	6.75	5.11	.....	.....	.....	2.00	8.75	.....	.....
11299–300	Kafir forage, D. E. 79	1.01	.55	2.36	17.94	23.89	11.90	4.56	13.38	5.32	23.26	1.02	4.20
8590–91	Milo maize chops, D. E. 57	0.57	.63	54.21	10.06	3.75	.00	2.13	7.93	0.50	10.56	.....	.....
11352– 3	Milo Forage, D. E. 80	.55	.37	1.64	18.65	23.77	12.60	5.81	12.84	5.08	23.73	.51	2.83
8002– 3	Moth bean hay, D. E. 44	0.66	.29	4.55	6.76	22.01	9.86	3.12	3.64	5.00	11.76	2.29	12.50
11232– 5	Peanut hay, D. E. 77	1.44	1.55	4.79	8.65	25.78	16.88	5.07	3.58	3.88	12.53	1.15	8.55
9814–15	Peanut hay, D. E. 69	2.27	3.21	6.93	7.86	24.17	18.69	4.24	3.62	3.42	11.28	1.78	8.33
11212– 3	Peanut hay, D. E. 76	2.13	3.05	1.18	9.15	28.54	21.91	5.07	4.08	3.65	12.80	1.35	8.08
7964– 5	Peanut vines, D. E. 40	4.63	1.85	5.54	7.36	28.48	17.39	4.63	2.73	4.00	11.36	.93	6.66
7975– 6	Peanut vines	5.31	1.97	6.39	6.77	29.07	21.32	3.80	2.97	4.00	10.77	1.00	6.72
12919–20	Peanut hay, D. E 87	1.70	3.31	4.27	7.43	29.18	17.82	4.23	3.20	3.16	10.59	1.82	7.72
8275– 6	Peanut hulls, D. E. 52	1.40	.23	2.50	3.36	15.04	5.47	2.08	1.28	12.00	15.36	1.75	8.10
12976– 7	Peanut hulls, D. E. 90	1.06	2.72	2.52	5.25	11.86	7.03	2.64	2.61	11.90	17.15	1.28	6.20
11233–36	Peanut hulls, D. E. 77	.34	1.29	.95	5.07	6.84	0.60	3.62	1.45	10.79	15.86	.68	5.66
11234– 7	Peanut kernels, D. E. 77	.19	5.11	4.56	2.33	1.16	.00	2.06	.27	.36	2.69	1.72	26.73
9337– 8	Prairie hay, D. E. 61	2.21	.36	2.47	16.63	23.52	5.11	5.39	11.24	4.00	20.63	.23	5.22
7724– 5	Prairie hay, D. E. 38	1.85	1.35	1.77	16.92	25.40	13.23	2.69	14.23	3.06	19.98	.00	4.36

Table 1. Composition of feeds—Continued.

		Reducing sugars	Di. sugars	Starch	Pentosans in N. F. E.	Residual N. F. E.	Soluble residual N. F. E.	Pentosans				Amides, etc.	Proteids
								Soluble in N. F. E.	Insoluble in N. F. E.	In crude fiber	Total		
6064–65	Prairie hay, South Texas, cut before frost	2.36	.78	2.72	16.64	25.49	14.27	3.12	13.52	4.00	20.64	.28	4.09
6143– 4	Prairie hay, South Texas, cut after frost	1.71	.40	1.70	17.17	25.38	13.18	4.51	12.66	4.00	21.17	.28	3.42
12716– 7	Prairie hay, D. E. 85–6	1.30	.90	1.92	16.02	25.76	13.01	4.74	11.28	5.08	21.10	.82	4.49
9748– 9	Peat	.09	.03	.53	2.25	32.00	12.52	1.28	.97	0.37	2.62	1.90	15.22
11504– 5	Rhodes grass hay	1.83	.86	1.38	18.89	20.11	8.47	4.20	14.69	4.18	23.07	1.18	4.26
12508– 9	Rhodes grass hay, D. E. 83	1.50	.99	0.64	19.41	19.76	9.68	4.13	15.28	4.44	23.85	1.54	4.13
6770– 1	Rice bran	0.25	5.77	26.81	6.98	6.11				2.00	8.98		
11259–60	Rice hay, D. E. 78	1.17	.82	6.80	15.30	15.82	6.39	3.33	11.97	3.61	18.91	.41	5.25
6879–80	Rice polish	.63	4.35	47.33	5.34	.11				0.20	5.54		
13192– 3	Rice hulls, D. E. 91	.08	.40	3.52	11.23	13.37	4.02	1.10	10.13	6.55	17.78	.31	2.66
8245– 6	Rough rice No. 1, D. E. 49	0.20	.69	61.16	5.10	.06	0	1.69	3.41	0.50	5.60	.40	8.28
8251– 2	Rough rice (X), D. E. 50	0.48	.38	61.30	5.02	.00	.00	1.73	3.29	0.50	5.52	.21	8.34
8269–70	Rough rice, D. E. 51	0.40	.60	57.56	5.32	4.01				0.50	5.82		
11138– 9	Shallu forage, D. E. 75	0.63	.39	1.47	20.61	22.44	10.00	6.10	14.54	5.43	26.07	.20	2.50
6033– 4	Sorghum hay	8.06	.65	3.68	14.52	23.36	12.66	2.22	12.30	5.00	19.52	.39	3.84
7991–92	Sorghum hay, D. E. 43	8.93	.30	3.42	13.32	20.35	11.10	1.41	11.91	5.00	18.32	.69	5.33
6998– 9	Silage (dried) sorghum and cowpeas	2.61	1.82	15.70	11.50	21.57					16.59		
8223– 4	Sorghum silage (dried), D. E. 47	3.7	0.03	23.56	10.26	20.39		0.48			15.26	.08	5.66
10987– 8	Sudan grass, D. E. 75	3.31	1.47	3.94	14.76	19.57	10.54	3.53	11.23	4.15	18.91	.97	6.85
9408– 9	Sudan grass, D. E. 62	4.01	.45	1.68	15.23	19.22	6.71	2.85	12.38	5.00	20.23	3.38	7.92
9290– 1	Sudan grass, D. E. 60	2.01	.25	1.21	15.26	19.50	1.29	3.54	11.72	4.00	19.26	1.97	8.78
7763– 4	Sudan grass, D. E. 39	3.88	1.94	3.15	15.16	23.77	13.68	1.42	13.74	4.00	19.16	.37	4.05
7980–81	Sudan grass, D. E. 42	2.44	.36	1.19	16.02	22.84	9.86	3.60	12.42	5.00	21.02	2.26	5.54
6288– 9	Tabosa grass hay, D. E.	1.76	1.10	2.28	17.33	23.63	10.60	2.61	14.72	5.00	22.33	.22	3.30
5912– 3	Tabosa grass, D. E. 19	1.30	.84	2.72	18.42	22.32	7.29	3.55	14.87	5.00	23.42	.95	2.75

The quantity of sugars in most of the feeds is comparatively small. With many of them, the total quantity is less than 3 per cent. The sample of cottonseed meal contains about 9 per cent, mostly consisting of raffinose. Peanut vines and peanut hay contain 5 to 7 per cent. of sugar, which is considerably more than that present in alfalfa. The samples of rice bran and rice polish contain nearly 5 per cent. (See also Bulletin 191 of this Station.) Sorghum hay contains 8 to 9 per cent. Sudan grass contains about 5 per cent.



The quantity of starch, as could be expected, is low with the roughages and high with the concentrates, such as feterita seed, milo, corn, rice bran, and rice polish. The amount of starch in the sorghum silage is comparatively high, especially when compared with sorghum hay, in which the starch is very low. The pentosans are high in the carbohydrate roughages such as sorgo forage, bermuda hay, feterita forage, kafir or milo forage, Rhodes grass hay, rice hay, sorghum hay, and Sudan grass hay. They are somewhat lower in the legume forages, such as alfalfa hay or peanut hay. Concentrates, such as corn, kafir, milo, rice polish, and rough rice, are still lower in pentosans. After adding together the sugars, starch, and pentosans in the nitrogen-free

extract, and subtracting the sum from the total nitrogen-free extract, we secure the residual nitrogen-free extract.

The sugars, starches, and pentosans in the nitrogen-free extract account very nearly for all the nitrogen-free extract of many of the concentrates, leaving only a comparatively small amount of the residual nitrogen-free extract. For example, with Argentine corn, there is only 1.82 per cent. residual nitrogen-free extract. With the sample of Jack beans, there is 5.13 per cent., feterita seed 5.56, kafir corn 0.22, milo 3.75, peanut kernels 1.16, rice polish 0.11, and rough rice 0.06 residual nitrogen-free extract. The case is quite different with the roughages. The amount of nitrogen-free extract not accounted for ranges between 20 and 30 per cent. of the total feed. Corn bran and whole-pressed cottonseed also contain high percentages of residual nitrogen-free extract. This portion of the nitrogen-free extract of roughages requires especial attention and investigation.

The residual nitrogen-free extract is high in all of the hays and fodders. It is generally assumed that the nitrogen-free extract of hays and fodders and of other feeds consists of carbohydrates. While some of the residual nitrogen-free extract of hays and fodders can be converted to sugars, as shown in Bulletin 196 of this Station, it is possible that a large percentage of it cannot be converted into sugars, and therefore does not consist of carbohydrates. There is a considerable field for investigation along this line. Even when part of this is converted into sugar, it is possible that some of it comes from the pentosans, which are previously accounted for in the nitrogen-free extract.

The column headed soluble residual nitrogen-free extract shows the residual nitrogen-free extract which is dissolved by fiftieth-normal acid and alkali. An examination of the table shows that comparatively large quantities of the residual nitrogen-free extract are dissolved by these comparatively weak solvents. Some of this may indeed be soluble in water, as has been shown in some investigations. About one-half of the residual nitrogen-free extract of accuff sorgo is dissolved by these weak solvents, and nearly three-fourths of that of alfalfa hay. The residual nitrogen-free extract of legumes seems to be more soluble than the non-legumes. This was pointed out with respect to pentosans in Bulletin 175.

The legume roughages contain smaller percentages of pentosans than the non-legumes.

The percentage of pentosans soluble in N/50 normal acid and N/50 alkali is not very different for legumes and non-legumes, but since there is a much larger percentage of pentosans in the non-legumes, the proportions dissolved are greater for the legumes. These figures are given in the table.

An examination of the figures for amides and proteids shows that while the amount of amides is usually small, it may sometimes make up a considerable proportion of the total protein. With alfalfa hay, one-third of the protein may be amide. The peanut vines contain a smaller proportion of proteids than the alfalfa.

COMPOSITION BY GROUPS.

Table 2 contains the average composition of the feeds arranged by groups. Group 1 includes non-legume hays and forage, such as sorgo,

bermuda, feterita, corn silage, prairie hay, Rhodes grass hay, Sudan hay, rice hulls and rice hay. Group 2 contains legume hays, such as alfalfa, dolichos lablab, moth bean and peanut. Group 3 contains starchy concentrates, such as corn, feterita, kafir, milo, rough rice, rice polish, and Jack beans. Group 4 includes corn bran, rice bran, cold-pressed cottonseed, and kafir head chops.

Table 2. Percentage composition arranged in groups.

No. of Samples		Reducing sugars	Di. sugars	Starch	Pentosans in N. F. E.	Soluble residual N. F. E.	Total residual N. F. E.
27	Group 1. Non-legume hays and forage.....	2.14	0.72	2.67	16.79	9.73	21.83
15	Group 2. Legume hays...	1.98	1.92	3.73	8.48	16.78	23.99
9	Group 3. Starchy concentrates.....	0.41	1.15	55.79	5.81	0.92	2.29
6	Group 4. Cottonseed products, corn bran, rice bran.....	0.34	3.30	17.96	11.04	2.69	10.74

This table helps to bring out the differences just discussed.

PERCENTAGE DISTRIBUTION OF THE CONSTITUENTS.

Table 3 contains the percentage distribution of the constituents of the feeds. The sugars, starches, pentosans in the nitrogen-free extract, residual nitrogen-free extract, and soluble residual nitrogen-free extract are expressed in percentages of the total nitrogen-free extract. The soluble and insoluble pentosans, and pentosans in the crude fiber, are expressed in percentages of the total pentosans. The non-proteids are expressed in percentages of the total protein.

Table 3. Percentage distribution of sugars, etc.

		Reducing sugars	Di. sugars	Nitrogen-free extract as 100				Pentosans as 100			Protein as 100	
				Starch	Pentosans in N. F. E.	Residual N. F. E.	Soluble residual N. F. E.	Soluble in N. F. E.	Insoluble in N. F. E.	In crude fiber	Amides, etc.	Proteids
11438– 9	Accuff sorgo forage, D. E. 81	.39	.89	3.42	45.03	50.27	25.51	27.28	51.28	21.44	23.8	76.2
8316–17	Alfalfa hay, D. E. 54	3.40	4.31	5.16	28.51	58.61	45.00	31.52	34.51	33.97	17.0	83.0
6724–25	Alfalfa hay, No. 1	5.35	4.84	5.86	20.62	63.33	51.58	35.22	26.59	38.20	23.2	76.8
7005–06	Alfalfa hay, No. 2	5.87	3.32	5.90	21.15	63.75	45.61	42.16	19.98	37.86	20.0	80.0
9537– 8	Alfalfa hay, D. E. 63	2.27	6.03	7.53	30.76	53.41	39.20	38.80	27.82	33.38	33.4	66.6
8227– 8	Alfalfa hay, D. E. 48	6.87	4.44	6.74	22.77	59.18	37.96	29.02	35.06	35.92	20.8	79.2
12601–02	Alfalfa hay, D. E. 84	2.52	6.05	4.78	26.05	60.60	50.36	38.59	28.14	33.27	33.1	66.9
12952– 3	Alfalfa hay, D. E. 88–92	2.67	4.90	6.13	26.75	59.55	41.54	31.83	29.29	38.88	19.3	80.7
8406–07	Argentine corn, D. E. 56	.62	1.01	87.96	7.86	2.55						
6027– 8	Bermuda hay	2.87	2.67	9.33	36.64	48.48	9.77	9.99	72.09	17.99	12.5	87.5
10981– 2	Bermuda hay, D. E. 72	2.72	3.65	6.81	38.41	48.41	19.17	17.87	65.62	16.51	9.8	90.2
6907– 8	Corn bran	1.76	2.97	41.45	29.54	24.28				17.32		
8168– 9	Corn silage, D. E. 46	4.91	.27	12.28	34.58	47.96	20.42	20.99	59.93	19.08	36.4	73.6
6747– 8	Cold pressed cottonseed No. 1	.03	17.52	0	40.34	42.11				18.87	6.2	93.8
7034–35	Cold pressed cottonseed No. 2	.17	15.21	0	40.75	43.87				20.35		
12965–66	Cold pressed cottonseed, D. E. 89	.51	6.63	0	40.70	52.17	11.43	23.90	52.43	23.67	10.3	89.7
7048– 9	Cottonseed hulls	.14	.55	3.60	48.75	46.96				22.81		
7050– 1	Cottonseed meal	.25	38.40	0	28.42	32.93				1.28		
8108– 9	Dolichos lablob hay, D. E. 45	1.93	1.61	19.73	24.67	52.07	36.83	35.74	26.64	37.62	15.7	84.3
11127–28	Feterita forage, D. E. 4	1.38	.45	8.88	40.87	48.41				23.78	12.8	87.2
8318–19	Feterita seed, D. E. 55	.50	1.10	85.88	4.56	7.95	5.26	86.40	7.70	5.90	1.2	98.8
7009–10	Kafir corn chops	.82	.48	92.36	6.03	.31				4.49		
7031–32	Kafir head chops	.71	1.33	80.36	10.01	7.58				2.29		
11299–300	Kafir forage, D. E. 79	2.21	1.20	5.16	39.21	52.22	26.01	19.60	57.52	22.88	19.5	80.5
8590–91	Milo maize, D. E. 57	.82	.91	78.32	14.53	5.42		20.20	74.03	4.77		
11352– 5	Milo forage, D. E. 80	1.22	.82	3.65	41.46	52.85	48.24	24.50	54.10	21.40	15.3	84.7
8002– 3	Moth bean, D. E. 44	1.93	.85	13.28	19.73	64.21	28.77	26.53	30.95	42.52	15.5	84.5
11232– 5	Peanut hay, D. E. 77	3.41	3.67	11.35	20.49	61.08	39.99	40.46	28.57	30.97	11.9	88.1
9814–15	Peanut hay, D. E. 69	5.11	7.22	15.59	15.44	54.39	42.06	37.59	32.09	30.32	17.6	82.4
11212– 3	Peanut hay, D. E. 76	4.83	6.92	2.68	20.77	64.79	49.74	39.42	31.50	28.08	14.3	85.7
7964– 5	Peanut vines, D. E. 40	9.67	3.87	11.58	15.38	59.51	36.33	40.76	24.03	35.21	12.3	87.7
7975– 6	Peanut vines	10.73	3.98	12.91	13.67	58.72	43.06	35.28	27.58	37.14	13.0	87.0
12919–20	Peanut hay, D. E. 87	3.70	7.21	9.30	16.19	63.59	38.83	39.94	30.22	29.84	19.1	80.9
8275– 6	Peanut hulls, D. E. 52	6.21	1.02	11.10	14.91	66.76	24.28	13.54	8.33	78.13	17.8	82.2
12976– 7	Peanut hulls, D. E. 90	4.53	11.62	10.76	22.43	50.66	3.12	15.39	15.22	69.39	17.1	82.9
11233– 6	Peanut hulls, D. E. 77	2.35	8.90	6.56	34.99	47.20	4.14	22.82	9.15	68.03	10.7	89.3
11234– 7	Peanut kernels, D. E. 77	1.42	38.28	34.16	17.45	8.69		76.6	10.0	13.4	6.1	93.9
9337– 8	Prairie hay, D. E. 38	4.89	.80	5.47	36.80	52.05	11.31	26.13	54.48	19.39		
6064– 5	Prairie hay, South Texas, cut before frost	4.92	1.63	5.67	34.67	53.12	29.74	15.12	65.50	19.38	6.4	97.6
6143– 4	Prairie hay, South Texas, cut after frost	3.69	.86	3.67	37.04	54.74	28.43	21.30	59.80	18.90	7.6	92.4

Table 3. Percentage distribution of sugars, etc—Continued.

		Reducing sugars	Di. sugars	Nitrogen-free extract as 100				Pentosans as 100			Protein as 100	
				Starch	Pentosans in N. F. E.	Residual N. F. E.	Soluble residual N. F. E.	Soluble in N. F. E.	Insoluble in N. F. E.	In crude fiber	Amides, etc.	Proteids
12716– 7	Prairie hay, D. E. 85–6	2.83	1.96	4.18	34.90	56.12	28.35	22.46	53.46	24.08	15.4	84.6
9748– 9	Peat	.26	.09	1.52	6.45	91.69	35.87	48.88	37.02	14.10	11.1	88.9
11504– 5	Rhodes grass hay	4.25	2.00	3.20	43.86	46.69	19.67	18.20	63.68	18.12	21.7	78.3
12508– 9	Rhodes grass hay, D. E. 83	3.55	2.34	1.51	45.89	46.71	.....	17.31	64.07	18.62	27.2	72.8
6770– 1	Rice bran	.54	12.57	58.38	15.20	13.31	.....	.....	.....	2.23	.....	.....
11259–60	Rice hay, D. E. 78	2.93	2.05	17.04	38.34	39.64	16.01	17.61	63.30	19.09	7.2	92.7
6879–80	Rice polish	1.09	7.53	81.94	9.25	.19	.....	.....	.....	.36	.....	.....
13192– 3	Rice hulls, D. E. 91	.28	1.40	12.31	39.27	46.75	14.06	6.19	56.97	36.84	.....	.....
8245– 6	Rough rice, No. 1, D. E. 49	.30	1.03	91.00	7.59	.09	.....	30.20	60.90	8.90	4.6	95.4
8251– 2	Rough rice (X), D. E. 50	.72	.57	91.23	7.48	0	.....	31.3	59.6	9.1	2.6	97.4
11138– 9	Shallu forage, D. E. 75	1.38	.86	3.23	45.29	49.24	21.94	23.40	55.77	20.83	10.4	89.6
6033– 4	Sorghum hay	16.03	1.29	7.32	28.88	46.47	25.18	11.37	63.01	25.62	9.2	90.8
7991– 2	Sorghum hay, D. E. 43	19.28	.65	7.38	28.76	43.93	23.96	7.70	65.01	27.29	11.5	88.5
6998– 9	Silage, sorghum and cowpeas	4.84	3.43	29.48	21.75	40.50	.....	.....	.....	.....	.....	.....
8223– 4	Sorghum silage, D. E. 47	6.53	.05	40.60	17.68	35.14	.....	3.15	.....	.....	1.4	98.6
10987– 8	Sudan grass, D. E. 75	7.69	3.41	9.15	34.29	45.46	24.48	18.67	59.39	21.95	12.4	87.6
9408– 9	Sudan grass, D. E. 62	9.88	1.11	4.14	37.52	47.35	16.53	14.09	61.20	24.72	29.9	70.1
9290– 1	Sudan grass, D. E. 60	5.26	.65	3.16	39.92	51.01	3.37	18.38	60.85	20.77	18.3	81.7
7763– 4	Sudan grass, D. E. 39	8.10	4.05	6.58	31.65	49.62	28.56	7.41	71.71	20.88	8.4	91.6
7980–81	Sudan grass, D. E. 42	5.69	.84	2.78	37.39	53.30	23.01	17.13	59.09	23.79	29.0	71.0
6288– 9	Tobosa grass hay, No. 2	3.82	2.38	4.95	37.59	51.26	22.99	11.69	65.93	22.39	6.2	93.7
5912– 3	Tobosa grass, D. E. 19	2.85	1.84	5.96	40.40	48.95	15.99	15.16	63.49	21.35	25.7	74.3

For example, the starch in accuff sorghum forage is 3.42 per cent. and the pentosans 45.03 per cent. of the nitrogen-free extract. The residual nitrogen-free extract is 50.27 per cent. of the total nitrogen-free extract. Of the pentosans, 27.28 per cent. is soluble in N/50 hydrochloric acid and alkali, 51.28 is insoluble in the weak acid and alkali, but present in the nitrogen-free extract, and 21.44 per cent. is found in the crude fiber; 23.8 per cent. of the nitrogen is present as non-proteids.

An examination of this table leads to the same conclusions as those reached by examination of Table 1, although the results are stated in a different way. Thus, the sugars make up only small percentages comparatively of the nitrogen-free extract. The starches also make up small percentages of the nitrogen-free extract with the roughages but large percentages with the concentrates. Of the nitrogen-free extract of Argentine corn, 87.96 per cent. consists of starch and 7.86 per cent. of pentosans. The pentosans make up a large percentage of the nitrogen-free extract of the grass-like roughages and a smaller percentage of the nitrogen-free extract of alfalfa hay, peanut hay, and similar legume roughages. The residual nitrogen-free extract is a large per cent. with the hays and fodders, but is only a small per cent. with the concentrates such as Argentine corn, kafir, milo, peanut kernels, etc. Some concentrates are really a mixture of a true concentrate with larger or smaller amounts of the roughage material. This is the case with corn bran. In corn bran, 41.45 per cent. of the nitrogen-free extract consists of starch, 29.54 of pentosans, and there is a residue of 24.28. Rice bran is partly a concentrate, but contains some rice hulls. The sample examined contains 58.3 per cent. of the nitrogen-free extract as starch, 15.20 per cent. as pentosans, and has a residual nitrogen-free extract of 13.31.

DIGESTIBILITY OF THE FEEDS.

The digestibility of the feeding stuffs has been calculated, and the digestible coefficients are given in Table 4.

Table 4. Average digestion coefficients.

	Reducing sugars	Di. sugars	Starch	Pentosans in N. F. E.	Residual N. F. E.	Soluble residual N. F. E.	Pentosans				Amides, etc.	Proteids
							Soluble in N. F. E.	Insoluble in N. F. E.	In crude fiber	Total		
Accuff sorgo forage, D. E. 81	73.5	95.8	66.6	56.8	32.2	33.6	70.0	64.1	55.2	73.9	64.6	2.0
Alfalfa hay, D. E. 54	94.4	92.0	89.7	50.4	66.4	71.6	92.9	12.3	43.8	48.1	68.8	67.6
Alfalfa hay, D. E. 58	98.3	100.0	79.7	54.7	65.6	71.1	67.9	43.0	42.8	52.5	78.1	65.5
Alfalfa hay, D. E. 24	100.0	99.1	82.2	41.2	76.4	77.7	71.8	19.3	69.5	52.0	88.7	74.6
Alfalfa hay, D. E. 29	98.4	99.7	79.4	56.5	77.1					55.9		
Alfalfa hay, D. E. 31	98.8	99.6	75.9	56.7	71.3	70.1	87.0	89.2	52.5	55.0	88.8	70.6
Alfalfa hay, D. E. 37	99.3	99.0	73.3	56.5	72.4					54.3		
Alfalfa hay, D. E. 63	95.6	99.8	98.9	65.2	65.7	71.0	75.3	42.7	44.1	55.8	90.1	59.7
Alfalfa hay, D. E. 68	95.0	100.0	86.8	64.4	64.8	74.1	69.7	43.5	42.5	54.4	83.7	59.7
Alfalfa hay, D. E. 48	98.3	98.4	83.5	55.1	72.5	92.5	29.1	63.7	46.2	51.2	70.9	66.7
Alfalfa hay, D. E. 53	97.5	95.0	85.2	47.0	72.2	90.3	59.9	36.6	38.1	39.5	84.7	61.4
Alfalfa hay, D. E. 84	92.1	99.3	87.9	62.2	73.2	89.6	77.7	40.6	40.4	54.9	85.5	63.2
Alfalfa hay, D. E. 88	95.9	98.9	87.5	30.8	58.8	61.4	73.2	6.6	49.3	38.0	84.8	56.4
Alfalfa hay, D. E. 92	96.3	99.2	90.7	55.0	63.2	68.5	75.0	28.4	42.9	48.9	83.0	62.8
Argentine corn, D. E. 56	100.0	100.0	93.1	96.7	49.7				22.8	91.0		
Bermuda hay, D. E. 20	97.0	98.6	91.8	40.9	41.8	5.6	27.8	43.7	33.6	39.6	83.1	37.0
Bermuda hay, D. E. 72	96.2	100.0	88.6	47.6	53.9	56.4	61.3	47.7	52.4	48.4	37.4	47.9
Corn bran, D. E. 28	99.3	99.6	98.9	92.5	65.0					89.8		
Corn silage, D. E. 46	98.7	93.8	97.4	76.5	67.6	65.5	89.0	72.1	72.0	56.2	98.0	42.3
Cold pressed cottonseed, D. E. 25	50.0	99.9		96.7	36.9					92.0	100.0	78.7
Cold pressed cottonseed, No. 2	100.0	100.0		77.2	57.2					78.0		
Damaged cold pressed cottonseed, D. E. 89	64.7	95.5		84.4	29.7	50.0	0	81.1	38.6	74.6	53.7	55.1
Cottonseed hulls	100.0	100.0		88.4	31.0					82.0		
Cottonseed meal	100.0	100.0		87.6	38.1					84.1		
Dilichos lablab hay, D. E. 45	94.2	100.0	92.4	48.7	63.0	94.3	72.5	16.8	67.8	56.0	79.6	68.8
Feterita forage, D. E. 74	94.2	97.0	89.2	64.1	54.4				71.2	62.6	59.8	43.7
Feterita seed, D. E. 55	100.0	100.0	99.2	90.9	72.5	79.2	103.5	50.0	50.0	84.6	55.6	90.1
Jack beans, D. E. 59	100.0	100.0	100.0	96.9	78.3					94.9		
Kafir corn chops, D. E. 32	95.3	100.0	97.2	88.8	0					74.7		
Kafir head chops, D. E. 33	99.9	88.2	87.7	63.7	2.6					56.9		
Kafir forage, D. E. 79	94.2	97.1	95.2	43.3	41.6	45.0	41.5	43.8	53.6	45.6	69.1	
Milo maize head chops, D. E. 37	100.0	100.0	99.4	91.6	3.0	0	100.0	66.0	0	69.7		
Milo forage, D. E. 80	80.6	79.3	60.3	56.8	40.5	38.3	67.7	50.5	67.8	61.83	46.2	
Moth bean fodder, D. E. 44	85.0	94.1	93.1	47.1	62.8	80.6	63.2	49.3	74.4	58.7	73.0	65.7
Peanuts, whole, D. E. 77	83.8	99.9	100.0	49.7	0	0	61.2	0	28.0	39.9	100.0	83.9
Peanut hay, D. E. 77	96.7	99.8	93.5	60.7	31.0	46.3	78.0	29.2	90.3	53.2	90.3	77.1
Peanut hay, D. E. 69	98.5	99.7	95.2	67.2	69.3	79.1	88.0	42.8	43.1	59.9	94.3	74.6
Peanut hay, D. E. 76	98.4	99.7	84.1	64.3	74.1	88.8	86.4	39.0	42.7	59.1	76.1	61.4
Peanut vines	51.7	88.1	92.4	64.4	75.5	89.8	84.9	38.0	65.6		81.4	60.8
Peanut hay with nuts, D. E. 77	83.8	99.9	100.0	49.7	0	0	61.2	0	28.0	39.9	100.0	83.9
Peanut hay, D. E. 87	97.8	98.7	92.7	70.9	71.9	83.1	87.1	49.3	53.8	65.8	92.1	59.9

Table 4. Average digestion coefficients—Continued.

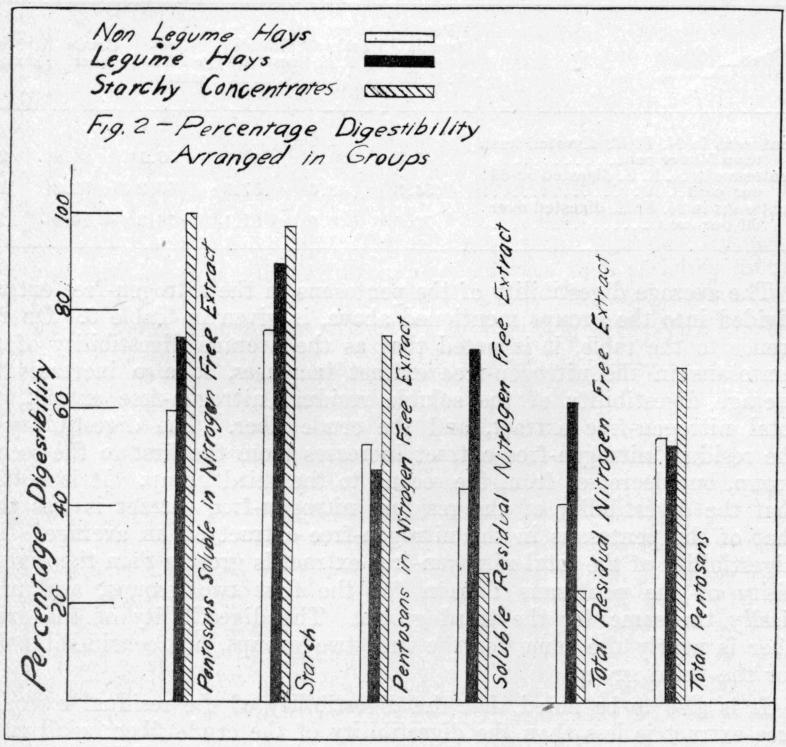
	Reducing sugars	Di. sugars	Starch	Pentosans in N. F. E.	Residual N. F. E.	Soluble residual N. F. E.	Pentosans				Amides, etc.	Proteids
							Soluble in N. F. E.	Insoluble in N. F. E.	In crude fiber	Total		
Peanut hulls, D. E. 52	97.2	100.0	95.1	0	83.0	25.4	79.5	22.0	60.1	27.1	81.8	58.1
Peanut hulls, D. E. 90	96.1	99.5	81.4	20.7	45.6	30.5	56.2	10.2	19.5	20.3	11.8	38.3
Prairie hay, D. E. 28	96.0	96.3	82.4	54.2	46.3	57.4	56.8	37.4	32.1	50.9		
Prairie hay, D. E. 61	98.8	79.2	72.6	54.2	37.8	50.9	68.4	45.4	38.0	52.7	50.0	24.4
Prairie hay, South Texas, cut before frost	95.8	98.8	86.2	39.9	20.9	52.0	47.3	42.6	42.1	43.0	67.6	62.8
Prairie hay, South Texas, cut after frost	98.0	98.4	83.2	63.4	28.6	44.5	67.1	52.8	56.9	64.7	57.1	7.0
Prairie hay, D. E. 85	95.7	96.9	63.6	47.3	37.2	39.3	66.1	31.4	39.6	41.3	46.3	19.5
Prairie hay, D. E. 86	97.0	94.5	75.1	50.0	37.0	55.8	68.3	50.0	46.0	50.0	81.6	20.6
Rhodes grass hay, D. E. 82	97.4	94.2	80.7	59.1	47.6	43.1	65.7	57.2	63.8	59.9	66.2	33.1
Rhodes grass hay, D. E. 83	97.2	99.8	41.4	64.8	78.8	54.8	70.5	62.8	64.4	64.7	78.8	33.5
Rice bran, D. E. 26	94.5	99.9	99.9	67.3						49.0		
Rice hay, D. E. 78	94.3	94.9	86.3	45.5	25.6	16.1	51.2	44.0	50.2	46.4	70.2	29.6
Rice polish, D. E. 27	95.1	100.0	99.6	79.1	0					60.5		
Rice hulls, D. E. 91		80.5	88.4	43.3	24.2	27.5	62.4	32.7	42.9	49.3	7.1	0
Rough rice No. 1, D. E. 49	84.4	99.6	99.1	17.5	0	0	100.0	48.3	0	58.7	14.2	79.7
Rough rice (S), D. E. 50	89.2	100.0	99.3	50.2	0					44.1		
Rough rice (X), D. E. 51	90.3	100.0	99.3							51.8		
Shallu forage, D. E. 75	93.5	100.0	73.4	56.1	40.5	42.5	62.7	53.3	65.2	58.1	86.8	88.2
Sorghum hay, D. E. 21	99.1	97.6	80.0	42.0	48.2	59.4	62.9	59.8	62.5	50.8	51.4	9.1
Sorghum hay, D. E. 43	99.5	87.7	86.4	56.8	46.8	55.0	82.8	53.6	67.7	59.7	53.1	35.8
Silage sorghum and cowpeas, D. E. 30	94.5	96.7	89.6	28.3	31.5					36.3		
Sorghum silage, D. E. 47, Sp. 1	98.3	100.0	91.5	40.2	46.2					48.9		29.2
Sudan grass, D. E. 73	99.1	99.2	81.5	54.6	49.3	80.1	35.9	60.6	60.0	55.8	59.1	55.1
Sudan grass, D. E. 62	99.5	99.0	77.0	53.1	31.2	30.8	61.3	73.4	63.8	55.7	91.2	50.3
Sudan grass, D. E. 60	98.8	28.5	78.9	52.6	27.2			59.5	49.8	52.0	99.6	52.2
Sudan grass, D. E. 39	98.7	99.8	94.6	56.0	43.7	49.9	53.1	56.3	55.7	56.2	64.7	83.1
Sudan grass, D. E. 42	98.4	91.3	53.2	50.9	39.7	61.3	69.8	45.3	59.2	52.8	78.1	32.6
Tabosa grass hay, No. 24	98.7	99.5	83.2	49.7	43.6	52.2	43.2	50.8	59.5	52.0	33.2	23.2
Tabosa grass, D. E. 19	96.9	99.2	74.3	46.3	28.5	13.0	53.7	43.5	46.1	46.7	84.4	89.4
Average	94.0	96.2	86.2	58.0	45.3	52.2	64.6	44.9	49.4	56.6	71.1	51.7

The digestibility of the sugars is generally high, and is usually practically 100 per cent. This confirms our conclusions in Bulletin 196. We would be safe in considering the sugars as practically completely digested.

Table 5. Average digestibility of starch and total nitrogen-free extract.

	Starch.	Nitrogen-free extract	Number of samples
Starch below 80 per cent digested	69.6	54.2	15
Starch 80 to 90 per cent digested	85.3	61.0	23
Starch over 90 per cent digested	96.2	73.2	27

The digestibility of the starch is more variable than that of the sugars, but is usually high. Table 5 shows the average digestibility of the starch compared with the average digestibility of the total nitrogen-



free extract. With 15 samples, the digestibility of the starch was less than 80 per cent. These are all roughages, containing comparatively small amounts of starch, so that a small amount of starch undigested would cause a considerable decrease in the percentage of digestibility. For these 15 samples, the digestibility of the starch averaged 69.6, and for the nitrogen-free extract 54.2. With only one of these feeds, Rhodes grass hay, 12508-09, is the starch apparently digested less than the

total nitrogen-free extract. In spite of the small percentage of starch present, it is digested in considerably higher percentages than the total nitrogen-free extract.

With 23 of the samples, 80 to 90 per cent. of the starch was digested. The digestibility of the starch was 85.3, and that for the total nitrogen-free extract 61.0.

With 27 of the samples, the starch was more than 90 per cent. digested. The average digestibility of the starch in these feeds was 92.2, and for the nitrogen-free extract it was 73.2.

The digestibility of the pentosans in the nitrogen-free extract is more variable than that of the starch, and is generally lower. With 22 of the samples, this digestibility was less than 50 per cent., with 20 samples it was between 50 and 60 per cent., and with 26 samples it was over 60 per cent.

Table 6. Average digestibility pentosans in nitrogen-free extract, etc.

	Pentosans in N. F. E.	Residual N. F. E.	Soluble residual N. F. E.	Nitrogen-free extract	Crude fiber	No. samples
Pentosans in N. F. E. digested less than 50 per cent.	41.7	39.0	42.9	55.1	44.0	22
Pentosans in N. F. E. digested 50-60 per cent.	54.8	48.6	57.3	60.2	53.8	20
Pentosans in N. F. E. digested over 60 per cent.	76.5	46.8	61.1	76.3	56.3	26

The average digestibility of the pentosans in the nitrogen-free extract, divided into the groups mentioned above, is given in Table 6. On reference to the table, it is noted that as the average digestibility of the pentosans in the nitrogen-free extract increases, so also increases the average digestibility of the soluble residual nitrogen-free extract, the total nitrogen-free extract, and the crude fiber. The digestibility of the residual nitrogen-free extract increases from the first to the second group, but decreases from the second to the third group. It is noticed that the digestibility of the residual nitrogen-free extract is less than that of the pentosans in the nitrogen-free extract on an average. The digestibility of the total nitrogen-free extract is greater than the digestibility of the pentosans therein for the first two groups, and practically the same for the third group. The digestibility of the crude fiber is nearly the same for the first two groups, but considerably less for the third group.

It is also to be noted that the digestibility of the residual nitrogen-free extract is less than the digestibility of the crude fiber in all cases. We have previously pointed out that there is a possibility that the fermentation will so affect the crude fiber as to cause it to be soluble in the acid and alkali, and thereby cause it to appear as nitrogen-free extract in the excrement of the animal. The lower digestibility of the residual nitrogen-free extract compared with the crude fiber seems to be evidence that such may occur.

Table 7. Average digestibility of residual nitrogen-free extract, etc.

	Residual N. F. E.	Pentosans in N. F. E.	Total N. F. E.	No. of samples
Residual N. F. E. digested below 40 per cent..	21.7	58.4	59.4	26
Residual N. F. E. digested 40-50 per cent.....	45.1	51.9	59.8	14
Residual N. F. E. digested over 50 per cent...	68.8	59.6	69.5	28

Table 7 shows the average digestibility of the residual nitrogen-free extract arranged in groups. With 26 of the samples the digestibility was less than 40 per cent. It must be observed that some of these samples, such as rice bran, rice polish, rough rice, and whole peanuts, contain very little residual nitrogen-free extract and this has a digestibility of 0. The average would be higher if these were excluded. The digestibility of the residual nitrogen-free extract is less than the digestibility of the pentosans in the nitrogen-free extract for the first two groups, but greater for the third group. It is also less for the total nitrogen-free extract for the first two groups, but practically the same for those over 50 per cent. digested. The residual nitrogen-free extract had a digestibility of more than 50 per cent. chiefly with alfalfa hay, peanut hay, and other legumes.

DIGESTIBILITY BY GROUPS OF FEEDS.

Table 8 gives the average digestion coefficients by groups. The first group consists of non-legume hays and forages, such as Sudan grass, sorghum hay, and so on. The second group includes legume hays. The third group includes starchy concentrates such as kafir, rough rice, Jack beans, and feterita. The fourth group includes some miscellaneous products, rice bran, corn bran, and cold-pressed cottonseed.

Table 8. Average digestion coefficients by groups.

	Non-legume hay and forage	Legume hays	Starchy Concentrates	Cotton-seed products, rice bran, corn bran
Starch	76.2	89.7	97.4	94.4
Pentosans in N. F. E.	52.7	47.4	75.1	83.6
Total residual N. F. E.	40.8	61.4	22.9	47.2
Soluble residual N. F. E.	43.9	72.3	26.4	50.0
Pentosans soluble in N. F. E.	59.7	74.4	100.0	0
Pentosans insoluble in N. F. E.	54.6	34.9	54.8	81.1
Pentosans in crude fiber	56.5	54.1	18.2	38.6
Pentosans, total	54.2	52.4	68.7	76.7
Non-proteids	66.2	85.7	34.9	76.9
Proteids	37.9	68.1	84.8	66.9

Starch is digested about completely from the starchy concentrates, next largest in the cottonseed-rice-bran group, next in the legume hay, and least in the non-legume hays and forages.

The pentosans in the nitrogen-free extract are digested to the greatest extent in the cottonseed products, next in the starchy concentrates, third in the non-legume hays, and fourth in the legume hay. The residual nitrogen-free extract is digested to a large extent in the legume

hays, and to the smallest extent in the starchy concentrates. This group of materials is found only in small amounts in the starchy concentrates; so here is a much greater possibility of error. The soluble residual nitrogen-free extract digested to the greatest extent in the legume hays, and next in the cottonseed products.

The pentosans soluble in nitrogen-free extract are digested to the greatest extent in the starchy concentrates, and next in the legume hays. The proteids are digested to the largest extent in starchy concentrates, next in the cold-pressed cottonseed group, then in the legume hays, and least in the non-legume hays and forages. The amides are digested to the greatest extent in the legume hays.

The averages in some of these cases are composed of rather varying figures, especially for some of the substances occurring only in small quantity. It is believed, however, that some of them show quite suggestive differences in the classes of feeds. A closer classification cannot be made on account of the limited number of samples examined. If a larger number of samples had been examined, it would be possible to split up some of the groups and examine them more in detail.

PROTEIDS AND NON-PROTEIDS.

Proteids were determined in the feeds and excrements used in these experiments by Stutzer's method. The percentage of proteids and non-proteids in the feeds is shown in Table 1. The distribution of the proteids is shown in Table 3, and their digestibility in Table 4. The determinations of proteids and non-proteids were also made in the feeds and excrements used in the digestion experiments 1 to 18, and the results are given in Table 9.

Table 9. Occurrence and digestibility of proteids in feeds used in experiments 1 to 18.

		Per cent proteids	Per cent Non-protein	Proteids—100		Coefficient digestibility	
				Proteids	Non-proteids	Non-proteids	Proteids
3277– 8	Alfalfa hay	12.36	3.81	76.4	23.6	88.4	69.2
4252– 3	Bermuda hay	5.48	0.95	85.0	15.0	87.3	42.1
3609–10	Bur clover	14.88	8.55	63.5	36.5	96.7	71.6
3883– 4	Buffalo grass	5.93	1.12	84.0	16.0	84.4	47.4
4557– 8	Corn shucks	2.66	0.54	83.0	17.0	32.4	0
3220– 1	Cowpea hay	9.11	5.55	62.0	38.0	94.1	58.5
4552– 3	Guam grass	7.98	0.45	94.7	5.3	38.3	52.4
3587– 8	Johnson grass hay	6.57	0.87	88.3	11.7	88.2	34.4
4238– 9	Johnson grass hay	6.06	0.86	87.6	12.4	78.7	47.9
4546– 7	Kafir fodder	6.21	3.69	62.7	37.3	83.2	50.6
4247– 8	Millet	3.89	0.33	92.2	7.8	89.1	25.2
3595– 6	Oat hay	7.65	0.39	95.2	4.8	8.0	61.3
4259–60	Peanut hay	11.96	1.60	88.2	11.8	88.4	77.3
4277– 8	Para grass	3.01	0.33	90.1	9.9	82.9	9.7
3625– 6	Rice straw, Japan	3.24	0.68	82.7	17.3	71.9	7.5
3625– 6	Rice straw, Honduras	3.17	0.81	79.6	20.4	68.1	22.5
4663– 4	Sorghum hay	5.14	0.44	92.1	7.9	61.0	29.0
3649–50	Vetch hay	11.05	3.95	73.7	26.3	92.0	67.9

Table 8 shows the percentage of proteids and non-proteids in the feeds as averaged by groups.

An examination of Table 3 shows that one sample of alfalfa contained as high as 33 per cent. of the protein in the form of non-proteids.

On the other hand, feterita seed contains only 1.2 per cent. of the protein as non-proteids.

An examination of the table of digestibility shows that the amides or non-proteids are almost always digested to a greater extent than the proteids. It must be recalled that this is apparent digestibility, and not real digestibility. Metabolic products in the excrements must be in the nature of proteids.

The importance of the distinction between proteids and non-proteids in feeding stuffs is not as great as it was formerly thought to be, now that we know that animals utilize some of these amides as structural material in building up body protein. In the process of digestion, the proteids are split up into amides and other products to some extent, and from these the animal organism selects the materials for building body proteids. The nutritive ratio, or relation between protein and non-protein in a ration, is important to secure thorough digestion, but non-proteids seem to be as effective in this respect as proteids.

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SUMMARY AND CONCLUSIONS.

This Bulletin deals with the quantity of sugars, starches, pentosans, and residual nitrogen-free extract of the nitrogen-free extract, and their digestibility.

The quantity of sugars in most feeds is comparatively small. Many of them contain less than 3 per cent.

The sugars are digested almost completely.

The quantity of starch, as could be expected, is low with the roughages and high with the concentrates, such as corn, or rice bran. The digestibility of the starch is high in all feeds.

The sugars, starches, and pentosans account for nearly all of the nitrogen-free extract of many of the concentrates.

Sugars, starches, and pentosans account for only a small part of the nitrogen-free extract of roughages. It is probable that part of the nitrogen-free extract of roughages does not consist of carbohydrates. The legume roughages contain smaller percentages of pentosans than the non-legume roughages.

While the amount of amides is usually small, it may sometimes make up a considerable portion of the protein.

The digestibility of the pentosans in the nitrogen-free extract is more variable than that of the starch, and is generally lower. With 22 of the samples, this digestibility was less than 50 per cent; with 20 samples it was between 50 and 60 per cent., and with 26 samples it was over 60 per cent.

The digestibility of the residual nitrogen-free extract was less than 40 per cent. with 26 of the samples, but some of the samples contained very little residual nitrogen-free extract. The digestibility of the residual nitrogen-free extract was more than 50 per cent. with alfalfa hay, peanut hay, and other legumes.