A41-322-7500-L

TEXAS AGRICULTURAL EXPERIMENT STATION

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
W. B. BIZZELL, President

BULLETIN NO. 291 FEBRUARY, 1922

DIVISION OF CHEMISTRY

DIGESTION EXPERIMENTS

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†As of February 1, 1922.
*In cooperation with School of Veterinary Medicine, A. and M. College of Texas
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BULLETIN NO. 291 FEBRUARY, 1922

DIGESTION EXPERIMENTS

BY

G. S. FRAPS.

This is the sixth bulletin in a series whose object is to ascertain the feeding value of Texas feeding stuffs by means of digestion experiments. Previous bulletins in the series are 104, 147, 166, 203, and 245.

The value of feeding stuffs for feeding purposes depends upon several things. These include its bulk, its palatability, its ash content, its suitability to the animal, its vitamine content, its digestible protein, and its productive value. The most important of these from the standpoint of animal nutrition are the digestible protein and the productive value.

DEFINITION OF TERMS.

Digestible Protein. Protein is the constituent of the feed which is used to form muscle, skin, hair, and similar portions of the body, secretions of the body which are necessary for life, and to replace and repair animal tissue. The protein is equal to nitrogen multiplied by 6.25.

The digestible protein is that which is digested and absorbed during the passage of the food through the animal's body. The amount of digestible protein represents the capacity of the food to furnish material for the production of lean meat, or for the repair or replacement of the tissue of the animal body.

It is made up of a variety of constituents and varies in character in the different feeding stuffs. In the same feeding stuff there are usually several different kinds of chemical compounds in the protein. The proteins of some feeding stuffs appear to lack part of the essential constituents for the proper replacement or the repair of the animal tissues, and for this reason are not as effective as they should be. The investigations along this line are not yet sufficiently definite to permit satisfactory statements with regard to the qualities of different protein constituents in feeding stuffs.

Productive Value. Productive value means the ability of the feeding stuff to furnish animals the material for heat, for work, or for the production of fat. Protein, when digested, may be burned for the production of heat, or energy, or its nitrogen may be spilt off and the residue be used for the formation of fat. Fats, when digested, may likewise be used for heat or energy, or may be stored up for fat. The same is true for the constituents of the nitrogen-free extract and for that portion of the crude fiber which is digested.

The work of digestion consumes a certain amount of energy which must be deducted from that of the feed digested. Energy is also used

for metabolic changes consequent on the digestion of the food. The energy remaining after these losses are deducted may be used for productive purposes and this is what is termed the productive value of a feeding stuff. It is the value of a feed for the purpose of producing fat, after all the requirements consequent on the consumption of the food have been deducted. The fat may be burned for heat or used for work, or for production of fat or milk.

Feeding stuffs vary considerably in the amount of loss in the processes consequent upon digestion. For example, the digested constituents of high-grade cottonseed meal have full value for the production of fat, but one pound of the digested constituents of wheat straw has only one-fifth the value of one pound of those of cottonseed meal. Feeding stuffs high in crude fiber suffer a great loss in digestion, and the productive value is consequently lowered.

The productive value is calculated from the results of tests with various feeds, in which the animal is first fed a measured ration sufficient to form a little fat and the quantity of fat formed is exactly determined. Then the animal is fed the same ration with the addition of the feed to be studied, and the quantity of fat produced is again measured. The additional quantity of fat produced is due to the addition of the feed to be studied and represents its fat-producing power. The productive value may be stated in terms of matter, such as fat, or in terms of energy, such as therms.

Ash. Ash of feeding stuffs is particularly important to growing animals, as it is necessary for the formation of bones, and certain portions of it are also required for the blood.

Vitamines. Vitamines are substances which are essential to the life of the animal. It is believed that there are three different groups. One group is chiefly present in seeds, and another chiefly in the leaves of plants, while milk contains all three.

Seed products highly milled for human use have their vitamines largely removed. For example, in the milling of rice, the vitamines are left in the bran and removed almost entirely from the grain. The relation of vitamines to animal feeding requires further investigations; at present vitamines appear of significance chiefly in connection with pigs and poultry, although they may possibly be important in connection with breeding animals, and also with animals fed upon certain rations. Ordinary rations fed animals contain an abundance of vitamines.

DIGESTION EXPERIMENTS.

The productive values and the values for digestible protein in this Bulletin have been calculated from the results of digestion experiments with sheep. The method of conducting the experiments is described in Bulletins Nos. 147 and 166 of this Station. The production coefficients were calculated as described in Bulletin No. 185.

COEFFICIENTS OF DIGESTIBILITY.

The coefficients of digestibility are used to calculate the digestible constituents of a feeding stuff, and until ten or fifteen years ago the

digestible nutrients were used exclusively for calculating rations in the feeding of animals. Developments in scientific knowledge concerning feeding stuffs have rendered the use of digestible constituents an antiquated method for calculating rations, although many people are still using them. The digestible nutrients do not show the real feeding value of the feeding stuffs, for the reason that the nutrients digested from different feeds are of different value to the animal body.

An illustration of this may be given by comparing the digestible nutrients of cottonseed meal and cottonseed hulls. The total digestible nutrients of 100 pounds cottonseed meal are 67.6, while for cottonseed hulls they are 35.3. One pound of cottonseed meal would therefore be equal to only 1.9 pounds of cottonseed hulls, based on the digestible nutrients. Any feeder knows that this is not correct, and scientific experiments have shown that it is highly incorrect, as cottonseed meal has a much higher feeding value. The productive value may be expressed in terms of fat which the feed is capable of producing, or therms as expressed by Armsby, that is, in terms of the heat or energy that it may produce. In either case, the productive value represents more closely the actual feeding value than the sum of the digestible nutrients. We can assume that the cottonseed meal referred to above has a productive value of 73.3 therms and the cottonseed hulls a productive value of 17.6 therms. One pound of cottonseed meal would, therefore, equal in feeding value 4.2 pounds of cottonseed hulls.

The misleading character of the comparison of the digestible nutrients is shown clearly when money values are compared. If the cottonseed hulls sell for $10 per ton, and the cottonseed meal for $40 per ton, one pound digestible nutrients in cottonseed meal would cost 3.0 cents and one pound in cottonseed hulls would cost 1.4 cents. Therefore, a pound of digestible nutrients in cottonseed hulls would be much cheaper than a pound of digestible nutrients in cottonseed meal. But if the cost of the units of productive value are compared one finds that one therm productive value of cottonseed meal costs 2.63 cents, while one therm productive value of cottonseed hulls costs 2.73. Therefore, the cottonseed hulls at $10 a ton are a slightly more expensive feed than the cottonseed meal at $40 a ton. The comparison of the digestible nutrients of cottonseed meal and of cottonseed hulls gives entirely misleading results.

DESCRIPTION OF FEEDS AND DISCUSSION OF RESULTS.

The composition of the feeds used is shown in Table 1, together with digestible protein and the productive value of the feeds expressed both as fat and as therms. The coefficients of digestibility are given in Table 2. Table 3 contains the production coefficients of the various feeding stuffs as found in these experiments, as therms. To convert therms into fat, multiply them by .231. The figures show the relative feeding values of the feeds, as shown in these experiments. A discussion of the individual feeding stuffs is given below.

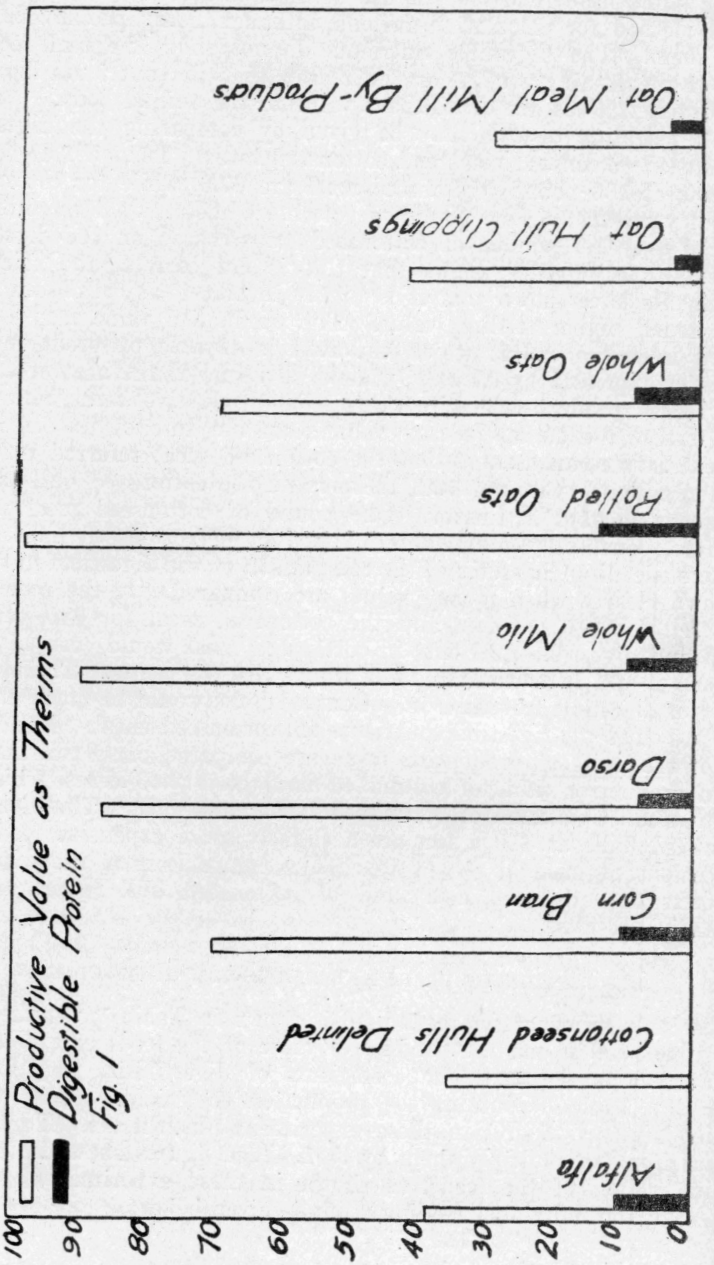

Productive Value as Therms
Digestible Protein
Fig. 1
100
90
80
70
60
50
40
30
20
10
0
Alfalfa
Cottonseed Hulls Delinted
Corn Bran
Darso
Whole Milo
Rolled Oats
Whole Oats
Oat Hull Clippings
Oat Meal Mill By-Products

Table 1. Composition and productive value of feeds used in the experiments.

		Protein	Ether extract	Crude fiber	Nitrogen free extract	Water	Ash	Productive value		Digestible protein
								As fat	As therms	
17083– 4	Alfalfa, D. E. 111	14.40	1.94	27.31	36.42	12.10	7.83	9.10	38.99	10.89
17319–20	Alfalfa, D. E. 112	13.83	1.72	26.28	39.64	10.84	7.69			
17457– 8	Alfalfa, D. E. 114	16.47	2.18	23.76	41.46	7.14	9.02			
17489	Alfalfa, D. E. 115	15.54	2.18	28.92	38.49	7.42	7.45			
17595– 6	Alfalfa, D. E. 116	15.13	2.02	30.79	37.65	7.21	7.20	9.18	39.33	11.04
17407–8–9	Alfalfa hay, D. E. 113	15.73	2.18	25.61	39.00	8.94	8.54			
18685– 6	Alfalfa hay, D. E. 122	15.52	1.99	26.29	36.83	10.42	8.95	9.28	39.75	12.00
19018– 9	Alfalfa meal, D. E. 131	12.65	1.25	33.33	36.81	8.29	7.67	9.36	40.10	9.34
16150– 1	Bear grass, D. E. 106	6.57	2.37	38.47	39.21	8.12	5.26			
16270– 1	Cottonseed hulls, delinted, D. E. 107	3.49	.64	38.88	46.50	8.17	2.32	8.46	36.26	
16323– 4	Cottonseed meal, D. E. 108	42.74	6.91	11.36	26.71	7.06	5.22			
16352– 3	Cottonseed meal, D. E. 110	42.71	6.89	11.12	26.04	7.80	5.44			
13328 –9	Corn bran, D. E. 109	11.95	9.42	8.35	57.29	9.94	3.05	16.54	70.87	10.41
18971– 2	Darso, D. E. 129	11.00	3.40	2.10	70.74	11.31	1.45	20.37	87.27	7.98
19001– 2	Milo, whole, D. E. 130	11.26	3.02	2.25	70.72	10.95	1.80	21.22	90.91	9.90
19023– 4	Milo, ground, D. E. 132	11.32	2.75	2.06	72.13	10.02	1.72	21.02	90.08	9.51
18772– 3	Oats, rolled, D. E. 125	15.95	5.95	1.89	65.35	9.05	1.81	23.19	99.34	14.38
18867– 8	Oats, whole, D. E. 126	11.76	4.19	11.50	58.05	11.22	3.28	16.56	70.93	9.32
18748– 9	Oat hull clippings, D. E. 124	8.97	2.08	26.42	42.33	8.08	12.12	10.05	43.06	3.83
19125– 6	Oat meal mill by-products, D. E. 133	7.07	1.92	25.45	51.15	8.42	5.99	7.22	30.93	4.35
16319–20	Peanut hulls, D. E. 108	7.57	1.26	55.97	23.08	9.17	2.95	2.64	11.31	1.00
13330– 1	Peanut hulls, D. E. 109	7.20	1.18	56.24	23.57	8.87	2.94			
18932– 3	Pinto beans, D. E. 127	23.03	1.33	3.98	58.15	9.28	4.23	19.76	84.65	20.01
18944– 5	Pods of velvet beans	5.00	.93	27.55	48.08	12.00	6.44			
17773– 4	Sesame cake, D. E. 120	39.02	17.35	6.49	20.12	6.37	10.65	17.43	74.68	35.49
16350– 1	Sacchuista grass, D. E. 110	5.59	2.25	43.90	37.26	7.94	3.06			
17831– 2	Sorghum seed (Red Top), D. E. 121	9.85	2.91	3.21	72.40	10.12	1.51	17.73	76.77	5.57
18942– 3	Velvet beans, no pod	22.29	6.08	6.78	49.93	11.63	3.29			
18942–3–4–5	Velvet beans in pods, D. E. 128	17.19	4.56	12.91	49.38	11.74	4.22	16.50	70.68	12.90
17714– 5	Wheat, whole, D. E. 117	13.50	1.66	2.74	68.32	12.02	1.76	20.81	89.18	12.44
17321– 2	Wheat bran, D. E. 112	16.38	3.86	10.37	52.04	11.14	6.21	12.24	52.48	14.08
17459–60	Wheat bran, D. E. 114	16.05	3.66	10.66	54.75	8.94	5.95	13.17	56.42	13.25
17409–10–30	Wheat gray shorts, D. E. 113	18.48	5.04	4.79	57.76	10.37	3.56	19.06	81.65	16.43
17752– 3	Wheat brown shorts, D. E. 119	20.18	5.82	6.22	54.18	9.12	4.48	18.16	77.79	18.01
17767– 8	Wheat, cracked, D. E. 118	13.11	1.69	3.35	70.76	9.34	1.75			11.83
17488– 9	Wheat gray shorts, D. E. 115	19.21	5.25	4.51	58.42	8.84	3.77	18.42	78.90	15.86
18696– 7	Wheat white shorts, D. E. 123	16.52	2.54	1.45	67.25	10.81	1.43	21.55	92.31	14.54

ALFALFA HAY.

Alfalfa hay was used as a basal feed, for the feeding with other feeds to be tested. Three samples of alfalfa hay and one sample of alfalfa meal were used for this purpose. Preliminary digestion experiments were made on these.

DELINTED COTTONSEED HULLS.

Delinted cottonseed hulls consist of cottonseed hulls from which almost all of the cotton lint has been removed. As the cotton lint is high in fiber, the removal of the lint should decrease the percentage of fiber remaining with the hulls. The amount of lint removed is not large, although it may look like a large quantity. It is to be expected that the delinted cottonseed hulls should have a slightly better feeding value than ordinary cottonseed hulls, and this is found to be the case.

Table 2. Digestion coefficients secured in the experiments.

		Protein	Ether extract	Crude fiber	Nitrogen-free extract	Ash
17083- 4	Alfalfa, D. E. 111	75.52	42.57	49.78	72.22	51.51
17595- 6	Alfalfa, D. E. 116	72.96	47.15	46.74	72.76	47.54
18685- 6	Alfalfa hay, D. E. 122	77.29	32.06	49.29	71.66	60.40
	Alfalfa hay average (Bull. 245)	75.3	34.8	46.2	68.8	49.9
19018- 9	Alfalfa meal, D. E. 131	73.87	24.5	58.93	73.60	56.45
17831- 2	Sorghum cane seed (Red Top), D. E. 121	56.55	56.43	100	87.38	59.28
16270- 1	Cottonseed hulls, delinted, D. E. 107	0	76.1	46.1	63.0	0
	Cottonseed hulls (lint on), Bull. 166	14.1	68.4	49.0	47.7	25.2
16328- 9	Corn bran, D. E. 109	87.13	90.66	68.15	81.79	58.50
	Corn bran, average, Bull. 166	58.2	76.6	59.6	77.2	8.5
18971- 2	Darso seed, D. E. 129	72.50	87.20	80.65	92.20	46.12
	Darso, average of two (Okla. one)	64.5	78.1	40.4	88.2	.....
19001- 2	Milo seed, whole, D. E. 130	87.88	88.20	72.30	95.61	73.40
19023- 4	Milo seed, ground, D. E. 132	84.00	91.20	2.28	95.90	31.09
	Milo average Lindsay (Mass)	55.0	69.0	57.0	82.0	92.0
18772- 3	Oats, rolled, D. E. 125	90.16	95.66	79.95	98.10	41.65
18867- 8	Oats, whole, D. E. 126	79.26	89.66	59.63	84.45	20.50
	Oats, whole, Swedish select, average Lindsay (Mass.)	77	89.0	36	81	.....
18748- 9	Oat hull clippings, D. E. 124	42.70	57.80	76.15	68.55	13.03
19125- 6	Oat meal mill by-products, D. E. 133	61.55	74.72	30.48	55.84	23.11
	Oat feed, much hulls (Lindsay)	65	90	32	42	25
16319-20	Peanut hulls, D. E. 108	13.18	60.70	34.40	88.00	2.90
	Peanut hulls, average (Bull. 245)	52.8	89.0	12.0	57.6	20.8
18932- 3	Pinto beans, D. E. 127	87.15	64.75	61.64	95.65	59.62
17831- 2	Sorghum seed (Red Top), D. E. 121	56.55	56.43	100	87.38	59.28
18944-45	Velvet beans in pods	76.04	98.10	95.47	96.55	75.96
	Average Lindsay (Mass.)	75	79	70	88	42
17773- 4	Sesame cake, D. E. 120	90.94	61.15	39.48	29.55	19.58
17714- 5	Wheat, D. E. 117	92.17	91.04	90.14	96.00	79.23
17321- 2	Wheat bran, D. E. 112	85.97	77.21	42.66	74.63	49.46
17459-60	Wheat bran, D. E. 114	82.58	84.06	44.05	80.27	39.51
17409-10-30	Wheat brown shorts, D. E. 113	88.89	82.73	51.91	90.55	51.68
17752- 3	Wheat brown shorts, D. E. 119	89.25	83.63	70.65	83.35	37.99
17767- 8	Wheat, cracked, D. E. 118	90.31	86.46	88.15	96.15	82.12
17488- 9	Wheat gray shorts, D. E. 115	82.57	95.50	0	89.52	28.92
18696- 7	Wheat white shorts, D. E. 123	88.00	91.54	33.50	98.87	70.06

CORN BRAN.

Corn bran varies considerably in composition. The sample used in this experiment contains 11.95 per cent. protein and 9.42 per cent.

fat, with 8.35 per cent. fiber. It is, therefore, of good quality as regards protein and fat.

Table 3. Feeds D. E., production coefficients (Therms)

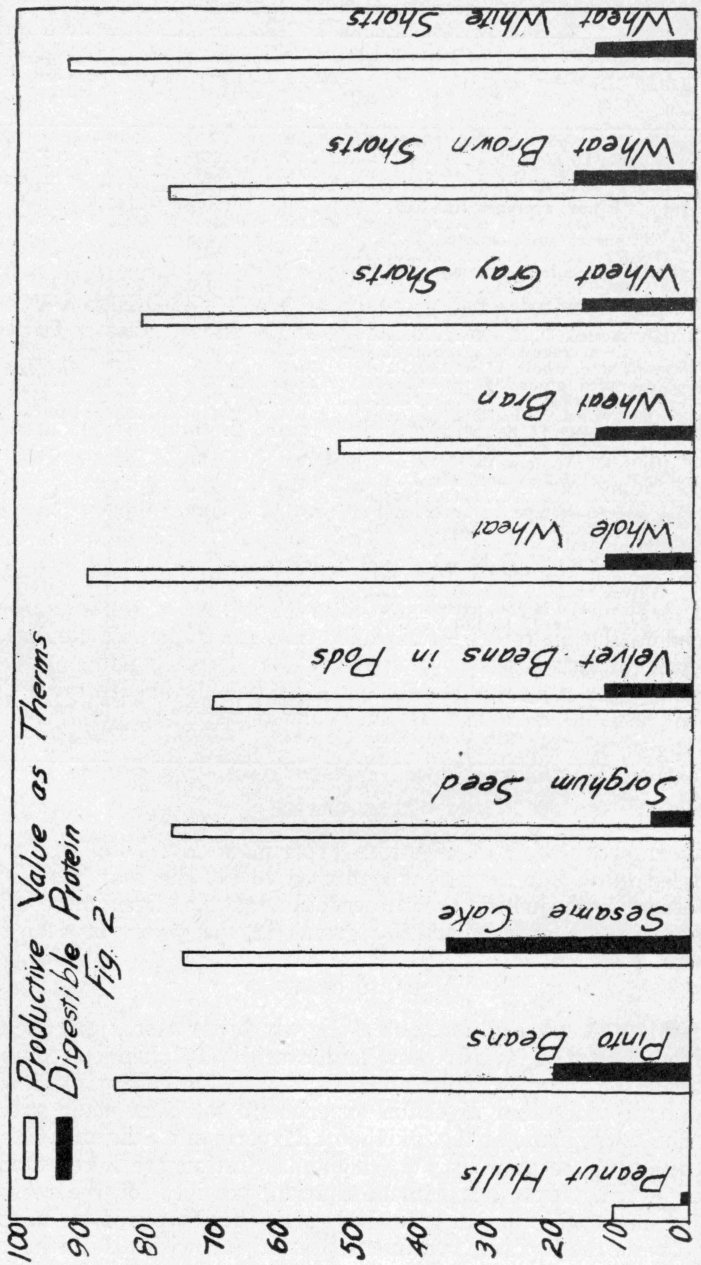
		Protein	Ether extract	Crude fiber	Nitrogen-free extract	Factor
17083- 4	Alfalfa, D. E. 111	.763	.864	—.067	.773	A
17595- 6	Alfalfa, D. E. 116	.737	.957	—.100	.779	A
18685- 6	Alfalfa hay, D. E. 122	.781	.651	—.073	.767	A
	Alfalfa hay, average, Bull. 245	.761	.706	—.102	.736	A
19018- 9	Alfalfa meal, D. E. 131	.746	.497	.031	.788	A
16270- 1	Cottonseed hulls, delinted, D. E. 107	0	1.545	.101	.674	A
	Cottonseed hulls, average, Bull. 166	.142	1.389	.076	.510	A
13328- 9	Corn bran, D. E. 109	.704	1.857	.583	.700	.80
	Corn bran, average, Bull. 166	.470	1.569	.510	.661	.80
18971- 2	Darso seed, D. E. 129	.732	2.232	.863	.987	1.00
	Darso, average two	.652	1.999	.432	.944	1.00
19001- 2	Milo seed, whole, D. E. 130	.888	2.258	.774	1.023	1.00
19023- 4	Milo seed, ground, D. E. 132	.848	2.335	.024	1.026	1.00
	Milo, average	.556	1.766	.610	.877	1.00
18772- 3	Oats, rolled, D. E. 125	.911	2.449	.856	1.050	1.00
18867- 8	Oats, whole, D. E. 126	.721	2.066	.574	.813	.90
	Oats, whole, average	.700	2.051	.347	.780	.90
18748- 9	Oat hull clippings, D. E. 124	.431	1.173	.215	.734	A
19125- 6	Oat meal mill by-products, D. E. 133	.622	1.517	—.274	.598	A
	Oat feed average	.657	.183	—.268	.449	A
16319-20	Peanut hulls, D. E. 108	.133	1.232	—.232	.942	A
	Peanut hulls, average	.533	.181	—.252	.616	A
18932- 3	Pinto beans, D. E. 127	.880	1.658	.660	1.024	1.00
17831- 2	Sorghum seed, red top, D. E. 121	.828	1.372	.102	.888	.95
	Velvet beans in pods, D. E. 128	.768	2.511	.421	1.033	A
	Velvet bean in pod, average	.758	2.020	.149	.942	A
17773- 4	Sesame cake, D. E. 120	.918	1.565	.422	.316	1.00
17714- 5	Wheat, D. E. 117	.931	2.331	.965	1.027	1.00
17321- 2	Wheat bran, D. E. 112	.669	1.522	.352	.615	.77
17459-60	Wheat bran, D. E. 114	.642	1.657	.363	.661	.77
17409-10-30	Wheat gray shorts, D. E. 113	.853	2.012	.528	.921	.95
17752- 3	Wheat brown shorts, D. E. 119	.838	1.991	.703	.829	.93
17488- 9	Wheat gray shorts, D. E. 115	.776	2.274	0	.891	.93
18696- 7	Wheat white shorts, D. E. 123	.889	2.343	.359	1.058	1.00

BEAR GRASS.

Bear grass was fed in digestion experiment No. 106, together with cottonseed meal, but the animals refused to eat the bear grass in sufficient amounts to justify the presentation of the digestion coefficients. The animals ate only about 200 grams in the seven days of the experiment.

DARSO GRAIN.

Darso is a sweet sorghum, has a slightly bitter taste, and one sample examined contained .42 per cent. tannic acid. In chemical composition it is similar to milo or kafir, and this is also the case with its digestibility. Only one other digestion experiment has been made with darso seed, which was made at the Oklahoma Experiment Station. The digestion coefficients secured by the Oklahoma Station are lower than those secured by the Texas Experiment Station, possibly for the reason that they fed darso with Sudan grass hay, and, therefore, fed an unbalanced ration, while the Texas Experiment Station fed with alfalfa hay, which formed a balanced ration. It is well known that in the absence of sufficient protein in the ration, the digestibility of the nitrogen-free extract and crude fiber will be less than otherwise would be the case.


Productive Value as Therms
Digestible Protein
Fig. 2
Peanut Hulls
Pinto Beans
Sesame Cake
Sorghum Seed
Velvet Beans in Pods
Whole Wheat
Wheat Bran
Wheat Gray Shorts
Wheat Brown Shorts
Wheat White Shorts
0
10
20
30
40
50
60
70
80
90
100

MILO GRAIN.

Milo seed were fed whole in experiment No. 130 and ground in experiment No. 132. The digestion coefficients are practically the same in each case. In this experiment, grinding the feed did not increase the digestion, but it is possible that when heavy rations are fed, the whole grain may be less digested.

ROLLED OATS.

The rolled oats used in this experiment were those used for breakfast food. They contained practically no hulls. The digestibility is high.

WHOLE OATS.

The whole oats were fed with alfalfa hay. The digestibility is very close to the average given by Lindsay of the Massachusetts Experiment Station.

OAT HULL CLIPPINGS.

Oat hull clippings are the clippings from the ends of the oats, which are cut off for the purpose of increasing the weight of the oats to the bushel. Sometimes oats are present. With the exception of the crude fiber, the digestibility of oat hull clippings is much lower than that of whole oats.

OAT MEAL MILL BY-PRODUCT.

Oat meal mill by-product consists of a mixture of hulls and oat dust obtained in the manufacture of rolled oats for human consumption. A large part of this material consists of oat hulls. The digestibility of the crude fiber and the nitrogen-free extract is less for this product than for oat hull clippings, although the protein and fat are somewhat more digested. The protein is slightly less digested, and the nitrogen-free extract is somewhat more digested than the average of Lindsay for oat feed.

PEANUT HULLS.

Peanut hulls seem to vary considerably in composition and digestibility. The nitrogen-free extract of this sample and also the crude fiber were digested much more than that of the average peanut hulls given in Bulletin 245.

PINTO BEANS.

Pinto beans are grown in Arizona, New Mexico, West Texas, and Mexico. The sample had a good digestibility.

SORGHUM SEED.

This was red top sorghum seed, which is a sweet sorghum. The digestibility was lower than that of darso.

VELVET BEANS IN PODS.

This consists of the entire velvet bean and the pod together. It is somewhat better digested in our experiments than the average of the experiments given by Lindsay.

SESAME CAKE.

Sesame seed is an oil-bearing seed grown in tropical countries but very little in the United States. The sesame cake used in this experiment came from Mexico. The protein has a high digestibility.

WHEAT BY-PRODUCTS.

The composition and digestibility of wheat by-products have been discussed in Bulletin 282. The digestion experiments there mentioned have been included in that bulletin. They are presented here for the sake of completeness.

WHOLE AND CRACKED WHEAT.

Missouri red wheat was used. Whole wheat was thoroughly digested in experiment No. 117, and the same wheat cracked was fed in experiment No. 118. There is practically no difference between the digestibility of the wheat fed whole and cracked. This result is similar to that secured with whole and cracked milo seed. It shows that in the quantities fed in these experiments, grinding the wheat has no effect upon its digestibility by sheep. However, in feeding experiments quoted in Bulletin 282, referred to above, it was shown that whole wheat has about 11 per cent. less feeding value than ground wheat.

Table 4. Composition of excrements.

		Protein	Ether extract	Crude fiber	Nitrogen-free extract	Water	Ash
16149	Sheep No. 1, D. E. 106.....	18.94	7.64	18.31	29.70	4.46	20.86
16272	Sheep No. 1, D. E. 107.....	11.39	.33	42.93	34.56	7.22	3.57
16273	Sheep No. 3, D. E. 107.....	19.72	3.34	23.36	27.97	7.81	17.84
16321	Sheep No. 1, D. E. 108.....	12.36	.62	53.94	18.20	10.45	4.43
16322	Sheep No. 2, D. E. 108.....	12.72	.81	50.74	18.42	10.32	6.99
16332	Sheep No. 1, D. E. 109.....	11.53	2.47	46.42	27.34	6.37	5.87
16333	Sheep No. 2, D. E. 109.....	11.52	2.52	48.44	25.80	5.61	6.11
16354	Sheep D. E. 110.....	19.90	1.82	33.75	30.00	8.00	6.53
17241	Sheep No. 1, D. E. 111.....	9.64	3.20	37.52	28.39	10.79	10.46
17242	Sheep No. 2, D. E. 111.....	10.56	3.25	36.62	29.36	9.37	10.84
17342	Sheep No. 1, D. E. 112.....	9.11	3.19	30.93	36.43	8.16	12.18
17343	Sheep No. 2, D. E. 112.....	9.60	2.95	31.96	34.70	7.91	12.88
17432	Sheep No. 1, D. E. 113.....	11.66	4.52	29.13	32.22	10.32	12.15
17433	Sheep No. 3, D. E. 113.....	11.56	3.79	30.43	31.77	11.64	10.81
17599	Sheep No. 1, D. E. 115.....	11.18	3.00	37.84	29.61	7.67	10.70
17600	Sheep No. 2, D. E. 115.....	14.07	2.51	33.98	29.65	8.31	11.48
17704	Sheep No. 1, D. E. 116.....	11.50	2.88	42.48	25.41	7.72	10.01
17705	Sheep No. 2, D. E. 116.....	9.85	2.69	42.88	26.78	8.12	9.68
17744	Sheep No. 1, D. E. 117.....	12.01	2.85	38.97	30.31	6.58	9.28
17745	Sheep No. 2, D. E. 117.....	12.59	2.68	31.08	39.20	6.85	7.61
17764	Sheep No. 1, D. E. 118.....	11.61	3.17	39.60	30.01	5.93	9.68
17765	Sheep No. 2, D. E. 118.....	13.37	3.16	35.98	30.69	6.50	10.30
17796	Sheep No. 1, D. E. 119.....	10.35	3.37	34.70	33.28	7.79	10.51
17797	Sheep No. 2, D. E. 119.....	12.62	3.77	28.18	34.66	8.09	12.68
17809	Sheep No. 1, D. E. 120.....	10.15	2.59	27.01	36.10	6.61	17.54
17810	Sheep No. 2, D. E. 120.....	11.48	2.34	27.58	33.40	7.38	17.82
18095	Sheep No. 1, D. E. 121.....	15.59	3.72	27.53	36.87	7.34	8.95
18096	Sheep No. 4, D. E. 121.....	17.64	2.98	29.10	35.34	7.14	7.80
17482	Sheep No. 1, D. E. 114.....	11.14	2.93	28.50	35.29	9.92	12.22
17483	Sheep No. 2, D. E. 114.....	10.53	2.78	28.28	35.48	9.85	13.08
18703	Sheep No. 1, D. E. 122.....	10.72	4.31	40.97	26.38	6.50	11.12
18704	Sheep No. 2, D. E. 122.....	11.86	4.49	38.02	27.53	6.98	11.12
18751	Sheep No. 1, D. E. 123.....	14.05	3.91	35.91	29.58	6.70	9.85
18752	Sheep No. 2, D. E. 123.....	15.73	4.56	30.95	29.74	7.47	11.55
18774	Sheep No. 1, D. E. 124.....	10.53	2.87	30.40	34.09	6.25	15.86
18775	Sheep No. 2, D. E. 124.....	12.35	3.55	27.93	32.30	7.51	16.36
18809	Sheep No. 1, D. E. 125.....	12.13	4.13	35.31	28.84	8.07	11.52
18810	Sheep No. 2, D. E. 125.....	13.70	4.08	32.71	30.00	8.69	10.82

Table 4. Composition of excrements—Continued.

		Protein	Ether extract	Crude fiber	Nitrogen-free extract	Water	Ash
18934	Sheep No. 1, D. E. 126	10.16	3.08	33.00	34.84	7.44	11.48
18935	Sheep No. 2, D. E. 126	11.67	3.58	30.19	35.66	7.71	11.19
18967	Sheep No. 1, D. E. 127	13.92	4.91	31.64	29.56	7.56	12.41
18968	Sheep No. 2, D. E. 127	15.00	3.37	34.11	28.62	7.67	11.23
18973	Sheep No. 1, D. E. 128	14.31	3.90	34.74	26.52	8.40	12.13
18974	Sheep No. 2, D. E. 128	13.74	3.33	33.91	29.74	8.38	10.90
18994	Sheep No. 1, D. E. 129	13.55	4.23	28.91	34.88	7.91	10.52
18995	Sheep No. 2, D. E. 129	14.99	3.66	28.06	34.57	8.26	10.46
19015	Sheep No. 1, D. E. 130	11.58	4.74	35.34	33.20	6.77	8.37
19016	Sheep No. 2, D. E. 130	12.42	3.69	33.15	33.11	7.15	10.48
19025	Sheep No. 1, D. E. 131	9.86	2.88	41.55	29.01	7.14	9.56
19026	Sheep No. 2, D. E. 131	9.97	2.78	40.46	29.20	7.16	10.43
19085	Sheep No. 1, D. E. 132	11.28	2.93	38.60	28.82	7.33	11.04
19086	Sheep No. 2, D. E.	11.70	2.56	40.62	28.36	7.27	9.49
19153	Sheep No. 1, D. E. 133	6.58	1.60	37.61	37.64	7.60	8.97
19154	Sheep No. 2, D. E. 133	7.61	1.74	35.61	38.13	7.24	9.67

Table 5. Residues from digestion experiments.

		Protein	Ether extract	Crude fiber	Nitrogen-free extract	Water	Ash
16301	D. E. 107, Sheep No. 1	3.30	.49	36.65	46.23	10.00	3.33
16302	D. E. 107, Sheep No. 3	3.22	.89	37.86	44.11	10.04	3.88
16326	D. E. 108, Sheep No. 1	8.30	.72	56.50	15.88	15.96	2.59
16327	D. E. 108, Sheep No. 2	8.94	.56	57.25	14.37	16.05	2.83
16368	D. E. 110	6.51	2.19	43.90	36.54	8.16	2.70
17243	D. E. 111	9.96	.....	43.52	.....	.....	.....
17244	D. E. 111	9.31	0.80	44.94	26.93	9.23	8.72
17743	Sheep No. 2, D. E. 117	8.97	1.20	46.33	30.32	7.15	6.03
17811	Sheep No. 2, D. E. 120	10.13	1.40	43.03	32.06	7.40	5.98
18097	Sheep No. 4, D. E. 121	13.55	2.00	21.25	47.30	8.47	7.43
18700	Sheep No. 1, D. E. 122	9.00	1.18	42.87	32.93	7.03	6.99
18701	Sheep No. 2, D. E. 122	9.30	.90	43.57	32.00	7.11	7.12
18750	Sheep No. 2, D. E. 123	10.67	1.19	36.72	37.75	7.30	6.37
18776	Sheep No. 1, D. E. 124	11.56	2.22	17.58	37.17	7.02	24.45
18777	Sheep No. 2, D. E. 124	11.45	2.21	20.94	39.40	6.70	19.30
18936	Sheep No. 2, D. E. 126	9.43	1.08	41.60	34.22	7.65	6.02
18975	Sheep No. 1, D. E. 128	5.66	.56	31.19	47.51	8.53	6.55
18976	Sheep No. 2, D. E. 128	9.58	1.18	40.62	33.92	8.55	6.15
19156	Sheep No. 2, D. E. 133	11.01	2.00	22.14	47.18	9.75	7.92

Table 6. Digestion coefficients obtained with each sheep.

D. E. No.		Sheep No.	Protein	Ether extract	Crude fiber	Nitrogen-free extract	Ash
106	Bear grass	1	0	0	84.0	68.1	0
107	Delinted cottonseed hulls	1	0	76.1	46.1	63.0	0
108	Peanut hulls (with cottonseed meal)	2	1.9	55.8	30.5	88.0	0
108	Peanut hulls	1	24.4	65.3	38.2	88.1	5.7
109	Corn bran (with peanut hulls)	2	87.0	90.8	67.3	82.8	58.4
109	Corn bran (with peanut hulls)	1	87.3	90.6	69.0	80.8	58.6
110	Sacchuista grass (with cottonseed meal)	1	0	0	3.9	0	71.3
111	Alfalfa hay	1	77.0	43.4	52.0	73.3	54.1
111	Alfalfa hay	2	74.0	41.7	47.6	71.2	48.9
112	Wheat bran (with alfalfa)	1	86.6	74.9	44.1	78.2	39.7
112	Wheat bran (with alfalfa)	2	85.4	79.5	41.2	81.0	59.2
113	Wheat brown shorts (with alfalfa)	1	87.5	77.3	45.8	89.2	35.4
113	Wheat brown shorts (with alfalfa)	3	90.3	88.2	58.0	91.9	68.0
114	Wheat bran (with alfalfa)	1	81.4	81.8	43.4	80.4	44.0

Table 6. Digestion coefficients obtained with each sheep—Continued.

D. E. No.		Sheep No.	Protein	Ether extract	Crude fiber	Nitrogen-free extract	Ash
114	Wheat bran (with alfalfa)	2	83.8	86.3	44.7	80.1	35.0
115	Wheat gray shorts (with alfalfa)	1	86.4	91.0	0	89.2	32.8
115	Wheat gray shorts (with alfalfa)	2	78.7	100.0	0	89.8	25.1
116	Alfalfa hay	1	71.5	46.5	48.1	73.4	47.8
116	Alfalfa hay	2	74.5	47.8	45.4	72.1	47.3
117	Whole wheat (with alfalfa hay)	1	92.2	91.0	90.1	96.0	79.2
117	Whole wheat (with alfalfa hay)	2	41.5	26.1	0	78.4	0
118	Cracked wheat (with alfalfa)	1	94.8	86.2	76.3	97.1	89.1
118	Cracked wheat (with alfalfa)	2	85.8	86.8	100.0	95.3	75.2
119	Wheat brown shorts (with alfalfa)	1	90.6	84.9	41.3	83.4	48.7
119	Wheat brown shorts (with alfalfa)	2	87.9	82.4	100.0	83.4	27.3
120	Sesame cake (with alfalfa)	1	93.0	61.3	73.1	30.6	25.0
120	Sesame cake (with alfalfa)	2	88.9	61.0	5.9	28.5	14.1
121	Red top cane seed (with alfalfa)	1	66.1	75.8	100.0	89.9	68.1
121	Red top cane seed (with alfalfa)	4	56.6	56.4	100.0	87.4	59.3
122	Alfalfa hay	1	77.5	29.3	48.4	76.6	59.3
122	Alfalfa hay	2	77.1	33.8	49.2	76.7	61.5
123	Wheat white shorts (with alfalfa)	1	87.9	92.7	45.2	98.2	76.9
123	Wheat white shorts (with alfalfa)	2	88.1	90.4	21.9	99.5	63.2
124	Oat hull clippings (with alfalfa)	1	43.2	58.3	63.3	61.2	8.1
124	Oat hull clippings (with alfalfa)	2	42.2	57.2	89.0	75.9	18.0
125	Rolled oats (with alfalfa)	1	95.2	98.2	100.0	100.0	71.3
125	Rolled oats (with alfalfa)	2	85.1	93.1	59.9	96.2	12.0
126	Whole oats (with alfalfa)	1	82.3	91.7	57.5	84.9	15.0
126	Whole oats with alfalfa)	2	76.2	87.6	61.7	84.0	26.0
127	Pinto beans (with alfalfa)	1	90.3	49.6	100.0	97.0	63.0
127	Pinto beans (with alfalfa)	2	84.0	79.9	23.3	94.3	56.3
128	Cracked velvet beans and pod (with alfalfa)	1	80.8	96.2	100.0	100.0	78.6
128	Cracked velvet beans and pod (with alfalfa)	2	71.3	100.0	90.9	93.1	72.3
129	Cracked darso (with alfalfa)	1	81.7	88.9	100.0	94.5	80.6
129	Cracked darso (with alfalfa)	2	63.4	85.5	61.3	89.9	11.6
130	Whole milo (with alfalfa)	1	91.7	84.1	85.5	96.6	100.0
130	Whole milo (with alfalfa)	2	84.0	92.2	59.1	94.6	46.7
131	Alfalfa meal	1	74.9	25.7	59.8	74.6	59.9
131	Alfalfa meal	2	72.8	23.2	58.1	72.6	53.0
132	Ground milo with alfalfa meal	1	88.6	91.1	4.5	97.2	33.5
132	Ground milo with alfalfa meal	2	79.4	91.3	0	94.6	28.7
133	Oat meal mill by-product with alfalfa meal	1	64.1	74.9	22.0	53.5	22.3
133	Oat meal mill by-product with alfalfa meal	2	59.0	74.5	38.9	58.2	23.9

ACKNOWLEDGMENT.

Chemical analyses and other work involved in the preparation of this Bulletin have been taken part in by S. E. Asbury, W. H. Walker, John B. Smith, Velma Graham, Gussie Brockman, and other members of the staff.