



Nutritive Value of Feeds for Beef Cattle

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Objectives

- Discuss nutrient content of feeds.
- Present a table containing nutrient values for common Oklahoma feeds.

Animals require chemical elements and compounds to sustain bodily functions, for skeletal and tissue growth, and to support the reproductive process. The necessary chemical elements and compounds are referred to as nutrients and can be classified into six categories: water, carbohydrates, lipids or fats, proteins, minerals, and vitamins. Requirements for these nutrients are discussed in ANSI-3010. The process of rumen fermentation allows ruminant animals to consume, digest, and acquire these necessary nutrients from a wide range of feed resources. Livestock producers must ensure that the animal's diet includes the proper balance of the six essential nutrients in a physical form that maintains digestive system health and function. In order to accomplish this, knowledge of available feed nutrient composition, physical and digestive characteristics, and the animal's nutrient requirements are necessary.

Nutritive value is determined by nutrient concentration and nutrient digestibility. Nutrient concentration and digestibility data can be determined using digestion trials or by measuring chemical composition and applying this information to estimate digestibility. Table 1 contains average composition values for numerous feeds that are common in Oklahoma. Values in the table represent averages from numerous different sources, such as the National Research Council's Nutrient Requirements of Beef and Dairy Cattle publications, commercial laboratories, research trials, and other publications. Beef magazine also publishes a Feed Composition Guide that is updated annually. It is located at <http://images.beef-mag.com/files/13/feedcomp03.pdf>.

It is imperative that producers recognize that values published in any table are merely averages and that variation among feed commodities, oilseeds, and particularly forages and roughages can be extreme. For this reason, producers are advised to have their feeds and forages tested for nutrient composition by commercial laboratories. In an effort to improve quality control and standardization among commercial laboratories, the National Forage Testing Association (NFTA) provides a unique certification service. At <http://www.foragetesting.org>, one can also view NFTA's recommendations for laboratory procedures and equations for use in predicting energy availability for different forage types.

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Dry Matter

Dry matter expresses the proportion of the feed that is not water. The moisture concentration is determined by weighing the feed sample soon after the sample has been collected. Next, the sample is placed in a drying oven until all of the water has been evaporated. Finally, the dried sample is weighed again and the dry matter content is calculated by difference.

Fiber

The first method of determining carbohydrates in feeds separated carbohydrates into crude fiber and nitrogen free extract (NFE) fractions. The crude fiber portion of the feedstuff was intended to represent the indigestible fiber fraction and NFE was supposed to represent the more readily digestible carbohydrates, such as sugars and starches. However, it was soon discovered that this system had serious limitations, particularly for fibrous feeds like forages.

Because of the wide variation in chemical analyses for crude fiber and NFE, the detergent fiber system was developed, which better reflects true carbohydrate digestibility in ruminants. The neutral detergent solubles (NDS) fraction is comprised of cell contents and has digestibility of near 100%. The neutral detergent insoluble fiber (NDF) fraction is made up of primarily cell wall tissue, which consists of hemicellulose, cellulose, and lignin. The NDF fraction also contains small amounts of silica and fiber-bound or heat-damaged protein. The NDF fraction of feeds and forages is quite variable in digestibility. Using an acid solution, the NDF residue can be further separated into acid detergent solubles (primarily hemicellulose) and acid detergent insoluble fiber (ADF). The ADF fraction contains cellulose, which has variable digestibility, and lignin, which is nearly indigestible.

The digestibility of forage fiber is proportional to the amount of lignin in the plant material. This relationship explains why some forages and feeds contain high NDF concentrations, but remain high in digestibility, while others may contain moderate or low NDF concentrations yet are low in digestible energy.

Table 1. Typical composition of feeds and forages.

Feed No.	Type of Feed	Dry Matter Basis															
		Dry Matter	NDF %	eNDF % of NDF	CP %	DIP ^b % of CP	TDN %	NEM Mcal/cwt	NEG Mcal/cwt	EE %	Ca %	P %	K %	S %	Cu ppm	Mn ppm	Zn ppm
Roughage																	
1	Alfalfa Hay, early bloom	90	39	92	25	88	60	59	33	2.9	1.41	0.22	2.51	0.30	13	36	30
2	Alfalfa Hay, mid bloom	90	47	92	22	84	58	56	31	2.6	1.37	0.22	1.56	0.28	11	28	31
3	Alfalfa Hay, full bloom	90	49	92	17	82	55	52	26	2.3	1.19	0.24	1.56	0.27	10	28	26
4	Alfalfa Cubes	91	46	40	18	70	57	55	29	2.0	1.30	0.23	1.90	0.35	9	32	18
5	Alfalfa, Dehydrated 17% CP	92	45	6	19	41	61	61	35	3.0	1.42	0.25	2.50	0.24	9	34	21
6	Bermuda Hay, vegetative	90	69	80	15	80	57	55	29	2.3	0.59	0.28	1.90	0.30	12	170	36
7	Bermuda Hay, early bloom	90	75	90	10	72	53	49	24	1.9	0.51	0.20	1.60	0.25	10	140	31
8	Bermuda Hay, full bloom	90	79	98	8	68	47	39	15	1.8	0.43	0.18	1.40	0.21	8	110	26
9	Corn silage	35	46	70	8	72	72	77	49	3.1	0.28	0.23	1.10	0.12	4	24	22
10	Cotton Seed Hulls	90	87	100	4	55	45	45	3	1.9	0.15	0.09	1.10	0.05	13	119	10
11	Fescue Hay, early bloom	87	68	98	13	72	57	55	29	4.8	0.45	0.37	2.50	0.21	11	200	34
12	Fescue Hay, full bloom	88	73	98	9	68	50	52	16	3.5	0.40	0.26	1.70	0.17	7	100	23
13	Peanut Hulls	91	74	98	8	40	22	36	0	1.5	0.20	0.07	0.90				
14	Prairie Hay	91	73	98	6	63	52	50	12	2.0	0.40	0.15	1.10	0.06	4	59	34
15	Rice Hulls	92	81	90	3	45	13	35	0	0.9	0.14	0.07	0.50	0.08	3	320	24
16	Sorghum Silage	32	59	70	9	71	59	58	32	2.7	0.49	0.22	1.72	0.12	9	69	30
17	Sudan Grass Silage	31	64	61	10	72	58	56	31	3.0	0.58	0.27	2.40	0.14	37	99	29
18	Sunflower Seed Hulls	90	73	90	4	35	40	42	0	2.2	0.00	0.11	0.20	0.19			200
19	Wheat Silage	33	62	61	13	79	59	58	32	3.2	0.40	0.28	2.10	0.21	9	80	27
20	Wheat Straw	91	81	98	3	40	42	43	0	1.8	0.16	0.05	1.30	0.17	5	35	6
21	Wheat Straw, ammoniated	85	76	98	9	75	50	50	12	1.5	0.15	0.05	1.30	0.16	5	35	6
Grazed Forage																	
27	Bermuda, vegetative	30	68	80	16	85	65	67	40	3.0	0.46	0.31	1.90	0.33	13	185	32
28	Bermuda, boot stage	35	72	100	13	75	60	59	33	2.7	0.59	0.28	1.90	0.30	12	160	36
29	Bermuda, fall, mature	80	77	100	8	60	48	41	16	2.1	0.26	0.18	1.30	0.21	9	140	20
30	Bermuda, winter, mature	90	80	100	5	55	44	34	10	1.5	0.30	0.15	1.00	0.15	7	45	15
31	Bermuda, stockpiled, Sept.-Oct.35	70	70	100	13	70	57	55	29	2.5	0.66	0.24	0.88	0.26	6	151	27
32	Bermuda, stockpiled, Nov.-Dec. 85	74	74	100	11	65	54	50	25	2.1	0.52	0.22	0.55	0.27	5	117	26
33	Bermuda, stockpiled, Jan.-Feb. 90	77	77	100	7	60	47	39	15	1.5	0.48	0.18	0.32	0.25	4	116	26
34	Fescue, vegetative	29	60	40	18	80	64	65	39	4.5	0.50	0.40	2.50	0.24	13	175	36
35	Fescue, boot stage	33	65	100	12	75	57	55	29	3.8	0.45	0.30	1.80	0.21	10	150	32
36	Fescue, mature	70	74	100	8	70	49	42	18	3.2	0.38	0.20	1.40	0.18	7	120	26
37	Fescue, stockpiled, Nov.-Dec. 40	72	72	100	13	75	52	47	22	2.7	0.45	0.30	1.80	0.21	12	150	32
38	Fescue, stockpiled, Jan.-Feb. 60	60	75	100	11	68	40	27	3	2.2	0.38	0.20	1.40	0.18	7	120	26
39	Native Range, April-June	30	68	100	14	75	70	74	47	3.2	0.30	0.20	1.60	0.15	11		
40	Native Range, July-August	35	71	100	10	70	64	65	39	3.0	0.33	0.15	1.50				
41	Native Range, Sept.-Oct.	46	75	100	7	65	59	58	32	2.5	0.28	0.12	1.10				
42	Native Range, Nov.-Dec.	75	78	100	5	65	55	52	26	2.2	0.25	0.09	0.80				
43	Native Range, Jan.-March	85	80	100	4	55	49	42	18	1.7	0.23	0.07	0.60				

44	Wheat Forage, vegetative	21	50	41	22	84	71	76	48	4.0	0.35	0.36	3.10	0.22	10	85	35	
By-product Feeds																		
47	Barley Malt Pellets with Hulls	90	50	34	18	64	68	71	44	1.4	0.19	0.68	0.27	0.85	6	32	61	
48	Corn Gluten Feed	90	40	36	24	75	80	88	59	3.2	0.07	0.15	0.27	0.43	7	22	73	
49	Distillers Grains with Solubles, corn	90	46	4	30	27	92	104	73	10.6	0.32	0.83	1.10	0.40	11	28	80	
50	Distillers Grains with Solubles, sorghum	92	46	4	31	47	88	99	68	10.0	0.25	0.65	0.50	0.40			68	
51	Grain Screenings	90			14	65	65	67	40	5.5	0.25	0.34					30	
52	Rice Bran, full fat	91	23	0	14	70	72	77	49	19.0	0.07	1.70	1.80	0.19	12	396	40	
53	Rice Mill By-product	91	60	0	7	60	42	43	0	5.7	0.40	0.31	2.20	0.30			31	
54	Soybean Hulls	90	64	28	12	72	77	84	55	2.6	0.53	0.18	1.40	0.12	18	10	38	
55	Wheat Bran	89	46	4	17	72	70	74	47	4.5	0.13	1.29	1.40	0.24	14		96	
56	Wheat Middlings	89	36	2	19	78	79	87	58	4.6	0.15	1.00	1.40	0.24	11	128	96	
57	Wheat Mill Run	90	37	0	17	72	75	81	53	4.4	0.12	1.00	1.20	0.22	21		90	
58	Wheat Shorts	89	30	0	20	75	80	88	59	5.4	0.10	0.95	1.10	0.20	13		118	
Feed Grains																		
64	Corn Grain, whole	88	9	60	10	42	88	99	68	4.3	0.02	0.30	0.40	0.12	3	8	18	
65	Corn Grain, steam flaked	85	9	40	10	41	93	106	74	4.1	0.02	0.27	0.40	0.12	3	8	18	
66	Wheat, cracked, rolled, or ground	89	12	0	14	77	89	100	69	2.3	0.05	0.44	0.40	0.14	6	37	40	
67	Milo, cracked, rolled, or ground	89	16	5	11	45	82	91	61	3.1	0.04	0.32	0.40	0.14	5	15	18	
68	Milo, steam flaked	82	20	38	11	38	90	102	70	3.1	0.04	0.28	0.40	0.14	5	15	18	
High Protein Meals and Seeds																		
69	Cottonseed, whole	91	47	100	23	62	95	108	76	17.8	0.16	0.62	1.22	0.26	8	12	38	
70	Cottonseed Meal, 41%	90	25	23	48	58	77	84	55	1.8	0.22	1.25	1.70	0.44	17	57	66	
71	Peanut Meal, solvent	91	27	23	50	73	77	84	55	3.6	0.24	0.58	1.00	0.30	16	29	38	
72	Soybean Meal, 48%	91	9	23	54	64	87	98	67	1.2	0.28	0.71	2.20	0.47	23	41	61	
73	Soybeans, whole	88	15	100	40	72	93	106	74	18.8	0.27	0.64	2.00	0.34	15	35	59	
74	Sunflower Seeds, high oil	91	24	80	19	75	122	142	103	42	.71	.51	1.06	0.21	20	35	53	
75	Sunflower Seed Meal with Hulls	91	40	23	26	80	60	68	42	2.9	0.45	1.02	1.27	0.33	4	20	105	
76	Mung Beans	90			23	25	79	87	58	1.19	0.68							
77	Feather Meal	92	44	23	86	27	69	73	45	6.5	0.60	0.62	0.20	1.85	14	12	95	

^a Effective neutral detergent insoluble fiber.

^b Degradable intake protein.

Effective NDF

The effective NDF (eNDF) value shown in Table 1 is a measure of the feed NDF that is effective in stimulating rumen motility or churning. The table expresses eNDF as a percentage of NDF. The layman term for eNDF is the “scratch” value of the feed. If the rumen stops churning, acidic gasses build up causing the pH to drop. The result is bloat, acidosis, and/or founder, as well as reduced diet digestibility. This value is determined by several factors including particle size, density, hydration, and degree of lignification. In order to maintain optimal forage digestion, the diet should contain a minimum of 20% eNDF on a dry matter basis.

Protein

Requirements for metabolizable, degradable, and crude protein (CP) were discussed in ANSI-3010. Protein values in the table reflect CP, which is simply nitrogen concentration multiplied by 6.25. The degradable intake protein (DIP) column is an estimate of the proportion of the crude protein that is actually degradable in the rumen and is expressed as a percentage of CP. Undegradable protein (% of CP) can be calculated by subtracting the DIP value from one.

Feed Energy Values

Feed energy values are expressed on a dry matter basis as percent total digestible nutrients (TDN), net energy for maintenance (NE_m), and net energy for gain (NE_g) units (mega calories per 100 lb of feed). TDN is determined by carrying out a digestion trial and summing the digestible protein and carbohydrates plus 2.25 times digestible ether extract. Ether extract (EE) is the fat or lipid portion of the feed. The net energy system is generally thought to be more precise in estimating the energy value of feeds, particularly roughages. The net energy of feed is the portion that is available to the animal for maintenance or various productive purposes. The portion used for maintenance (NE_m) is used for muscular work, maintenance and repair of tissues, maintaining a stable body temperature, and other body functions. Most of this energy will leave the animal's body as heat. The energy that

is used for productive purposes (NE_g) may be recovered as retained energy in the tissues or in some product, such as milk.

Minerals

Minerals that are needed by animals in larger quantities are referred to as macro minerals. These minerals are shown in Table 1 and feed concentration is expressed on a percent of DM basis. Minerals that are needed by animals in much smaller quantities are referred to as micro minerals and feed concentration is expressed in parts per million (ppm) in the table. To convert ppm to percent, simply move the decimal place four places to the left. For example, if a feed contained 12 ppm copper, the copper concentration expressed as a percentage would be 0.0012%.

Conclusion

Producers have to ensure that their animals' diets include the proper balance of the six essential nutrients in a physical form that maintains digestive system health and function. To accomplish this, producers must have good knowledge of available feed nutrient composition, physical and digestive characteristics, and the animal's nutrient requirements.

Nutrient concentration and digestibility data can be determined by using digestion trials or measuring chemical composition and applying this information to estimate digestibility. It is imperative that producers recognize that values published in any table are merely averages and that variation among feed commodities, oilseeds, and particularly forages and roughages can be extreme. For this reason, producers are advised to have their feeds and forages tested for nutrient composition by commercial laboratories.

References

- 2003 Feed Composition Guide. (2003) Beef. Retrieved from <http://images.beef-mag.com/files/13/feedcomp03.pdf>.
- NRC. (2000) Nutrient Requirements of Beef Cattle (7th Ed.). National Academy Press, Washington, DC.

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