NUTRITIVE VALUE OF THE PROTEIN IN VEAL AND CALF SWEETBREADS; IN BEEF CHEEK MEAT, LIPS, TONGUES, BRAINS, SPLEEN, AND TRIPE; AND IN HOG BRAINS AND TONGUES [1]

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INTRODUCTION

Veal is the most important of the several products investigated in the work covered by this paper. The per capita consumption of veal in this country in 1924 was 8.3 pounds, as compared with 5.3 pounds for mutton and lamb.[2] The total amount of the other tissues produced in a year is considerable, but the per capita consumption is small.

Sweetbreads (the thymus glands of the calf), are a highly prized and relatively expensive meat product. Beef cheek meat and lips, which are trimmed from cattle heads at the time of slaughter, are used chiefly in the manufacture of sausage. Ox spleens are used to only a limited extent as food. A few are sold fresh and some are used in the manufacture of sausage. Tripe, which is prepared from the walls of the first and second stomachs of cattle, is sold either fresh or pickled, or it is used in the manufacture of sausage. Ox tongues are sold fresh, pickled, smoked, or canned, and hog tongues are usually sold either as jellied tongue or as canned lunch tongues. Ox and hog brains are sold fresh.

All the above-named products are of value for food chiefly on account of their protein, and it was the purpose of this investigation to determine the relative nutritive values of the proteins in the several tissues.

There seems to be very little information in the literature concerning the nutritive values of the proteins in the tissues under investigation. Mitchell[3] determined the biological value of the protein in veal and certain other food products by feeding tests with albino rats. When protein was fed at a 5 per cent level, veal had a value of 97 as compared with 94 for milk and 92 for beef. When protein was fed at a level of 8 to 10 per cent, veal had a value of 84 as compared with 83 for milk and 81 for beef. It appeared that the protein in veal had practically the same value as that in milk or beef.

EXPERIMENTAL WORK

PROCEDURE

In the experiments reported in this paper, the nutritive value of the protein in each tissue was determined by means of feeding

[1] Received for publication Oct. 9, 1925; issued March, 1926.

[2] UNITED STATES DEPARTMENT OF AGRICULTURE, BUREAU OF ANIMAL INDUSTRY. MEAT PRODUCTION, CONSUMPTION, AND FOREIGN TRADE IN UNITED STATES, CALENDAR YEARS 1907–1924. Compiled by J. Roberts. 9 p. [1925?] [Mimeographed.]

[3] MITCHELL, H. H. THE PLACE OF PROTEINS IN THE DIET IN THE LIGHT OF THE NEWER KNOWLEDGE OF NUTRITION. Amer. Jour. Pub. Health 13: 17–23. 1923.

tests with young male albino rats.[4] The methods employed in this investigation are essentially the same as those followed by the writers in a previous study of the nutritive value of the protein in certain other animal tissues,[5] and they will not be described here.

With one exception, the products were purchased in fresh condition from local packinghouses. The ox lips were obtained in Chicago. The veal consisted of the forequarters from a good grade of veal calves. The muscle tissue was trimmed free from fat and connective tissue, ground, and dried in a current of air at a temperature approximating 60° C. The other tissues were trimmed free from extraneous material and dried in the same manner. All tests were conducted with the dried material. For comparison, the nutritive value of casein and of the combined proteins in milk was determined also. The casein was a highly purified product, and a well-known brand of dried, partially skimmed milk was the source of milk protein.

RESULTS OF 30-DAY FEEDING TESTS WITH RATIONS CONTAINING 10 PER CENT PROTEIN [6]

The detailed results of this series of experiments are presented in Table I, and the average results in Table II. In Table II are reported also the average values obtained for the protein in ox, hog, and sheep muscle in a previous investigation by the writers.[5] In the interpretation of the results of these experiments, the relation between the feed and protein intake, and the gain in weight of the rats, is of the greatest importance as an indication of the relative nutritive values of the protein in the several products. Gain in weight alone is not a correct basis for comparing the values of the various tissues as sources of protein.

On referring to Tables I and II, it appears that when protein was fed at a 10 per cent level of intake and the duration of the experiments was 30 days, the following products had approximately the same value as sources of protein for maintenance and growth in young albino rats, viz: Veal, ox brain, hog brain, ox tongue, hog tongue, ox spleen, ox muscle, hog muscle, sheep muscle, and milk.

Among these products, ox spleen had the lowest value with a gain in weight of 2.75 grams for each gram of protein consumed, and ox muscle had the highest value with a gain in weight of 3.15 grams; but it is doubtful if the difference between these values is large enough to be significant.

On the other hand, the protein in the following products appeared to be of distinctly lower nutritive value, viz: Sweetbreads, beef cheek meat, ox lips, tripe, and casein. Of these products, sweetbreads and tripe had the lowest values, beef cheek meat the highest value, and casein and ox lips occupied an intermediate position. The gain in weight for each gram of protein consumed ranged from 1.73 grams for tripe to 2.36 grams for beef cheek meat.

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[4] The writers are indebted to Warren G. Briggs, of the Biochemic Division, for assistance in carrying on the feeding tests with rats.

[5] HOAGLAND, R., and SNIDER, G. G. NUTRITIVE VALUE OF PROTEIN IN VOLUNTARY MUSCLE, HEART, LIVER, AND KIDNEY FROM CATTLE, SHEEP AND HOGS. [Unpublished manuscript.]

[6] In this paper the term "protein" refers to the result obtained by multiplying the nitrogen content of a product by the factor 6.25.

TABLE I.—*Nutritive value of protein in animal tissues when fed at the 10 per cent level for 30 days to young male albino rats*

Source of protein	Rat No.	Age at start	Initial weight	Gain in weight in 30 days	Total intake		Intake per gram gain in weight		Gain in weight	
					Feed	Protein	Feed	Protein	Per gram feed	Per gram protein
		Days	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*
Veal	665A	28	41	90	295	29.5	3.3	0.33	0.31	3.05
Do	665B	28	44	79	273	27.3	3.5	.35	.29	2.90
Do	665C	28	40	57	197	19.7	3.5	.35	.29	2.90
Do	665D	28	44	56	187	18.7	3.3	.33	.30	2.99
Do	665E	28	44	83	284	28.4	3.4	.34	.29	2.92
Do	665F	28	41	51	201	20.1	4.0	.40	.25	2.53
Average		28	42	69	240	24.0	3.5	.35	.29	2.88
Ox brain	586A	26	44	94	305	30.5	3.2	.32	.31	3.08
Do	586B	26	39	86	288	28.8	3.3	.33	.30	2.99
Do	586C	24	40	68	248	24.8	3.6	.36	.27	2.74
Do	586D	24	43	71	253	25.3	3.6	.36	.28	2.81
Do	586E	25	45	99	315	31.5	3.2	.32	.31	3.14
Do	586F	25	38	80	261	26.1	3.3	.33	.31	3.07
Average		25	42	83	278	27.8	3.4	.34	.30	2.97
Hog brain	658A	27	44	79	264	26.4	3.3	.33	.30	2.99
Do	658B	27	40	79	243	24.3	3.1	.31	.33	3.25
Do	658C	27	39	56	184	18.4	3.3	.33	.30	3.00
Do	658D	27	38	48	179	17.9	3.7	.37	.27	2.68
Do	658E	30	41	72	245	24.5	3.4	.34	.29	2.93
Do	658F	30	42	62	248	24.8	4.0	.40	.25	2.50
Average		28	41	66	227	22.7	3.5	.35	.29	2.89
Ox tongue	671A	30	43	67	276	27.6	4.1	.41	.24	2.43
Do	671B	30	38	68	237	23.7	3.5	.35	.29	2.87
Do	671C	29	45	77	231	23.1	3.0	.30	.33	3.33
Do	671D	29	39	86	296	29.6	3.4	.34	.29	2.90
Do	671E	26	41	83	252	25.2	3.0	.30	.33	3.29
Do	671F	26	38	62	275	27.5	4.4	.44	.23	2.26
Average		28	41	74	261	26.1	3.6	.36	.29	2.85
Hog tongue	672A	26	39	93	367	36.7	3.9	.39	.25	2.53
Do	672B	29	44	107	363	36.3	3.4	.34	.29	2.95
Do	672C	29	42	73	249	24.9	3.4	.34	.29	2.93
Do	672D	29	41	86	282	28.2	3.3	.33	.30	3.00
Do	672E	28	39	102	324	32.4	3.2	.32	.31	3.15
Do	672F	28	41	82	315	31.5	3.8	.38	.26	2.60
Average		28	41	91	316	31.6	3.5	.35	.28	2.86
Calf sweetbreads (thymus gland)	576A	25	39	36	188	18.8	5.2	.52	.19	1.91
Do	576B	27	42	31	163	16.3	5.3	.53	.19	1.90
Do	576C	27	45	31	186	18.6	6.0	.60	.17	1.67
Do	576D	27	41	23	150	15.0	6.5	.65	.15	1.53
Do	576E	29	45	40	212	21.2	5.3	.53	.19	1.89
Do	576F	30	39	32	164	16.4	5.1	.51	.20	1.95
Average		28	42	32	177	17.7	5.6	.56	.18	1.81
Beef cheek meat	673A	28	42	45	181	18.1	4.0	.40	.25	2.49
Do	673B	29	38	68	238	23.8	3.5	.35	.29	2.86
Do	673C	30	44	55	230	23.0	4.2	.42	.24	2.39
Do	673D	30	40	52	223	22.3	4.3	.43	.23	2.33
Do	673E	30	43	43	224	22.4	5.2	.52	.19	1.92
Do	673F	30	39	50	229	22.9	4.6	.46	.22	2.18
Average		30	41	52	221	22.1	4.3	.43	.24	2.36
Ox lips	676A	30	41	57	234	23.4	4.1	.41	.24	2.44
Do	676B	30	40	44	202	20.2	4.6	.46	.22	2.17
Do	676D	30	45	51	229	22.9	4.5	.45	.22	2.23
Do	676E	30	45	57	251	25.1	4.4	.44	.23	2.27
Do	676F	27	42	53	224	22.4	4.2	.42	.24	2.36
Average		29	43	52	228	22.8	4.4	.44	.23	2.29

TABLE I.—*Nutritive value of protein in animal tissues when fed at the 10 per cent level for 30 days to young male albino rats*—Continued

Source of protein	Rat No.	Age at start	Initial weight	Gain in weight in 30 days	Total intake		Intake per gram gain in weight		Gain in weight	
					Feed	Protein	Fee	Protein	Per gram feed	Per gram protein
		Days	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*
Tripe	616A	27	39	30	150	15.0	5.0	.50	.20	2.00
Do	616B	27	39	27	170	17.0	6.3	.63	.16	1.60
Do	616C	28	41	31	167	16.7	5.4	.54	.19	1.86
Do	616D	25	42	30	159	15.9	5.3	.53	.19	1.88
Do	616E	23	39	28	138	13.8	4.9	.49	.20	2.03
Do	616F	23	39	11	107	10.7	9.7	.97	.10	1.03
Average		26	40	26	149	14.9	6.1	.61	.17	1.73
Ox spleen	593A	26	39	63	233	23.3	3.7	.37	.27	2.70
Do	593B	28	43	92	303	30.3	3.3	.33	.30	3.03
Do	593C	27	42	74	256	25.6	3.5	.35	.29	2.89
Do	593D	27	39	60	219	21.9	3.7	.37	.27	2.74
Do	593E	27	45	80	298	29.8	3.7	.37	.27	2.68
Do	593F	27	39	61	248	24.8	4.1	.41	.25	2.46
Average		27	41	72	260	26.0	3.7	.37	.28	2.75
Casein	667A	29	43	25	139	13.9	5.6	.56	.18	1.80
Do	667B	29	43	35	194	19.4	5.5	.55	.18	1.80
Do	667C	30	39	27	147	14.7	5.4	.54	.18	1.84
Do	667D	25	40	26	133	13.3	5.1	.51	.20	1.95
Do	667E	25	41	48	205	20.5	4.3	.43	.23	2.34
Do	667F	25	39	39	183	18.2	4.7	.47	.21	2.14
Average		27	41	33	167	16.7	5.1	.51	.20	1.98
Milk	621A	26	40	61	196	19.6	3.2	.32	.31	3.11
Do	621B	25	41	64	223	22.3	3.5	.35	.29	2.87
Do	621C	26	44	69	255	25.5	3.7	.37	.27	2.71
Do	621D	28	43	57	259	25.9	4.5	.45	.22	2.20
Do	621E	22	38	86	247	24.7	2.9	.29	.35	3.48
Do	621F	30	38	63	212	21.2	3.4	.34	.30	2.97
Average		26	41	67	232	23.2	3.5	.35	.29	2.89

TABLE II.—*Average nutritive values obtained for protein in animal tissues when fed at the 10 per cent level for 30 days to young male albino rats.*

Source of protein	Number of rats	Age at start	Initial weight	Gain in weight in 30 days	Total intake		Intake per gram gain in weight		Gain in weight	
					Feed	Protein	Feed	Protein	Per gram feed	Per gram protein
		Days	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*
Veal	6	28	42	69	240	24.0	3.5	0.35	0.29	2.88
Ox brain	6	25	42	83	278	27.8	3.4	.34	.30	2.97
Hog brain	6	28	41	66	227	22.7	3.5	.35	.29	2.89
Ox tongue	6	29	41	74	261	26.1	3.6	.36	.29	2.85
Hog tongue	6	28	41	91	316	31.6	3.5	.35	.28	2.86
Thymus (sweetbread)	6	28	42	32	177	17.7	5.6	.56	.18	1.81
Beef, cheek meat	6	30	41	52	221	22.1	4.3	.43	.24	2.36
Ox lips	5	29	43	52	228	22.8	4.4	.44	.23	2.29
Tripe	6	26	40	26	149	14.9	6.1	.61	.17	1.73
Ox spleen	6	27	41	72	260	26.0	3.7	.37	.28	2.75
Casein	6	27	41	33	167	16.7	5.1	.51	.20	1.98
Milk	6	26	41	67	232	23.2	3.5	.35	.29	2.89
Ox muscle [a]	4	31	47	95	302	30.2	3.2	.32	.31	3.15
Hog muscle [a]	4	24	44	84	281	28.1	3.4	.34	.30	2.96
Sheep muscle [a]	4	24	41	85	274	27.4	3.2	.32	.31	3.12

[a] HOAGLAND, R., and SNIDER, G. G. NUTRITIVE VALUE OF PROTEIN IN VOLUNTARY MUSCLE, HEART, LIVER, AND KIDNEY FROM CATTLE, SHEEP, AND HOGS. [Unpublished manuscript.]

RESULTS OF 60-DAY FEEDING TESTS WITH RATIONS CONTAINING 10 PER CENT PROTEIN

The results of these experiments are reported in Tables III and IV. These tests, which are a continuation of those reported in Tables I and II, covered a total period of 60 days. Casein and tripe were not tested for the 60-day period.

Referring to Tables III and IV, there may be observed the same general differences in the nutritive values of the proteins in the various products as were noted in the 30-day experiments, but the differences are not so pronounced for the longer period as they were for the shorter one. It appears that veal, ox brains, hog brains, ox tongues, hog tongues, ox spleens, ox muscle, hog muscle, sheep muscle, and milk had practically the same value as sources of protein, and that beef cheek meat had a slightly lower value. Ox lips and sweetbreads, on the other hand, had decidedly lower protein values, although the differences are not as great as they were in the 30-day experiments.

TABLE III.—*Nutritive value of protein in animal tissues when fed at 10 per cent level for 60 days to young male albino rats*

Source of protein	Rat No.	Age at start	Initial weight	Gain in weight 60 days	Total intake		Intake per gram gain in weight		Gain in weight	
					Feed	Protein	Feed	Protein	Per gram feed	Per gram protein
		Days	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*
Veal	665A	28	41	173	715	71.5	4.1	0.41	0.24	2.42
Do	665B	28	44	144	629	62.9	4.4	.44	.23	2.29
Do	665C	28	40	125	522	52.2	4.2	.42	.24	2.39
Do	665E	28	44	141	629	62.9	4.5	.45	.22	2.24
Do	665F	28	41	122	505	50.5	4.1	.41	.24	2.42
Average		28	42	141	600	60.0	4.3	.43	.23	2.35
Ox brain	586A	26	44	171	678	67.8	4.0	.40	.25	2.52
Do	586B	26	39	161	637	63.7	4.0	.40	.25	2.53
Do	586C	24	40	153	597	59.7	3.9	.39	.26	2.56
Do	586D	24	43	150	579	57.9	3.9	.39	.26	2.59
Do	586E	25	45	168	728	72.8	4.3	.43	.23	2.31
Do	586F	25	38	138	616	61.6	4.5	.45	.22	2.24
Average		25	42	157	639	63.9	4.1	.41	.25	2.46
Hog brain	658A	27	44	140	625	62.5	4.5	.45	.22	2.24
Do	658B	27	40	147	598	59.8	4.1	.41	.25	2.46
Do	658C	27	39	105	468	46.8	4.5	.45	.22	2.24
Do	658D	27	38	102	447	44.7	4.4	.44	.23	2.28
Do	658E	30	41	153	613	61.3	4.0	.40	.25	2.50
Do	658F	30	42	129	587	58.7	4.6	.46	.22	2.20
Average		28	41	129	556	55.6	4.4	.44	.23	2.32
Ox tongue	671A	30	43	129	634	63.4	4.9	.49	.20	2.03
Do	671B	30	38	132	557	55.7	4.2	.42	.24	2.37
Do	671C	29	45	118	500	50.0	4.2	.42	.24	2.36
Do	671D	29	39	154	648	64.8	4.2	.42	.24	2.38
Do	671E	26	41	135	534	53.4	3.9	.39	.25	2.53
Do	671F	26	38	112	551	55.1	4.9	.49	.20	2.03
Average		28	41	130	571	57.1	4.4	.44	23	2.28
Hog tongue	672A	26	39	160	789	78.9	4.9	.49	.20	2.03
Do	672B	29	44	196	808	80.8	4.1	.41	.24	2.42
Do	672C	29	42	112	539	53.9	4.8	.48	.21	2.08
Do	672D	29	41	148	645	64.5	4.4	.44	.23	2.29
Do	672E	28	39	169	672	67.2	4.0	.40	.25	2.51
Do	672F	28	41	163	739	73.9	4.5	.45	.22	2.21
Average		28	41	158	699	69.9	4.5	.45	.23	2.26

TABLE III.—*Nutritive value of protein in animal tissues when fed at 10 per cent level for 60 days to young male albino rats*—Continued

Source of protein	Rat No.	Age at start	Initial weight	Gain in weight 60 days	Total intake		Intake per gram gain in weight		Gain in weight	
					Feed	Protein	Feed	Protein	Per gram feed	Per gram protein
		Days	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*
Calf sweetbreads (thymus gland)	576A	25	39	73	429	42.9	5.9	.59	.17	1.70
Do	576B	25	42	70	381	38.1	5.4	.54	.18	1.84
Do	576C	27	45	67	405	40.5	6.0	.60	.16	1.65
Do	576D	27	41	60	374	37.4	6.2	.62	.16	1.60
Do	576E	25	45	59	414	41.4	7.0	.70	.14	1.42
Do	576F	30	39	63	396	39.6	6.3	.63	.16	1.59
Average		27	42	65	400	40.0	6.1	.61	.16	1.63
Beef cheek meat	673A	28	42	101	446	44.6	4.4	.44	.23	2.27
Do	673B	29	38	101	511	51.1	5.1	.51	.19	1.98
Do	673C	30	44	110	549	54.9	5.0	.50	.20	2.00
Do	673D	30	40	113	499	49.9	4.4	.44	.23	2.26
Do	673E	30	43	101	488	48.8	4.8	.48	.21	2.07
Do	673F	30	39	112	509	50.9	4.5	.45	.22	2.20
Average		29	41	106	500	50.0	4.7	.47	.21	2.13
Ox lips	676A	30	41	87	495	49.5	5.7	.57	.18	1.76
Do	676B	30	40	86	430	43.0	5.0	.50	.20	2.00
Do	676D	30	45	78	463	46.3	5.9	.59	.17	1.69
Do	676E	30	45	100	539	53.9	5.4	.54	.19	1.86
Do	676F	27	42	80	457	45.7	5.7	.57	.18	1.75
Average		29	43	86	477	47.7	5.5	.55	.18	1.81
Ox spleen	593A	26	39	135	555	55.5	4.1	.41	.24	2.43
Do	593B	28	43	172	654	65.4	3.8	.38	.26	2.63
Do	593C	27	42	147	586	58.6	4.0	.40	.25	2.51
Do	593D	27	39	122	513	51.3	4.2	.42	.24	2.38
Do	593E	27	45	117	591	59.1	5.1	.51	.20	1.98
Do	593F	27	39	123	593	59.3	4.8	.48	.21	2.07
Averafe		27	41	136	582	58.2	4.3	.43	.23	2.33
Milk	621A	26	40	117	467	46.7	4.0	.40	.25	2.50
Do	621B	25	41	133	520	52.0	3.9	.39	.26	2.56
Do	621C	26	44	114	530	53.0	4.6	.46	.22	2.15
Do	621D	28	43	102	543	54.3	5.3	.53	.19	1.88
Do	621E	22	38	149	569	56.9	3.8	.38	.26	2.62
Do	621F	30	38	122	499	49.9	4.1	.41	.24	2.44
Average		26	41	123	521	51.1	4.3	.43	.24	2.36

TABLE IV.—*Average nutritive values obtained for protein in animal tissues when fed at the 10 per cent level for 60 days to young male albino rats*

Source of protein	Number of rats	Age at start	Initial weight	Gain in weight in 60 days	Total intake		Intake per gram gain in weight		Gain in weight	
					Feed	Protein	Feed	Protein	Per gram feed	Per gram protien
		Days	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*
Veal	5	28	42	141	600	60.0	4.3	0.43	0.23	2.35
Ox brain	6	25	42	157	639	63.9	4.1	.41	.25	2.46
Hog brain	6	28	41	129	556	55.6	4.4	.44	.23	2.32
Ox tongue	6	28	41	130	571	57.1	4.4	.44	.23	2.28
Hog tongue	6	28	41	158	699	69.9	4.5	.45	.23	2.26
Thymus	6	28	42	65	400	40.0	6.1	.61	.16	1.63
Beef cheek meat	6	30	41	106	500	50.0	4.7	.47	.21	2.13
Ox lips	5	29	43	86	477	47.7	5.5	.55	.18	1.81
Ox spleen	6	27	41	136	582	58.2	4.3	.43	.23	2.33
Milk	6	26	41	123	521	52.1	4.3	.43	.24	2.36
Ox muscle [a]	4	31	47	170	667	66.7	3.9	.39	.25	2.55
Hog muscle [a]	4	24	44	137	554	55.4	4.1	.41	.25	2.46
Sheep muscle [a]	4	24	41	152	611	61.1	4.1	.41	.25	2.48

[a] HOAGLAND, R., and SNIDER, G. G., NUTRITIVE VALUE OF PROTEIN IN VOLUNTARY MUSCLE, HEART, LIVER, AND KIDNEY FROM CATTLE, SHEEP, AND HOGS. [Unpublished manuscript.]

RESULTS OF 30-DAY FEEDING TESTS WITH RATIONS CONTAINING 12.5 PER CENT PROTEIN

Only a few of the tissues previously tested were fed in rations containing 12.5 per cent protein for the 30-day period. The results of these experiments, together with data previously obtained for ox and hog muscle, are reported in Table V. It will be noted again, as in the experiments with the rations containing 10 per cent protein, that the protein in veal has practically the same nutritive value as that in ox and hog muscle; that the beef cheek meat and ox lips have considerably lower protein values, and that tripe protein has the lowest value of all. Comparing the data in Table V with those in Table I, the rats fed the ration containing 12.5 per cent tripe protein for a period of 30 days made slightly less growth than those fed the ration containing 10 per cent of tripe protein for the same length of time.

TABLE V.—*Nutritive value of protein in animal tissues when fed at the 12.5 per cent level for 30 days to young male albino rats*

Source of protein	Rat No.	Age at start	Initial weight	Gain in weight in 30 days	Total intake		Intake per gram gain in weight		Gain in weight	
					Feed	Protein	Feed	Protein	Per gram feed	Per gram protein
		Days	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*
Veal	666A	29	42	97	269	33.6	2.8	0.35	0.36	2.89
Do	666B	29	45	109	305	38.1	2.8	.35	.36	2.86
Do	666C	29	40	107	289	36.1	2.7	.34	.37	2.96
Do	666D	29	40	92	260	32.5	2.8	.35	.35	2.83
Do	666E	29	40	93	257	32.1	2.8	.35	.32	2.90
Do	666F	29	39	102	275	34.4	2.6	.34	.37	2.97
Average		29	41	100	276	34.5	2.8	.35	.36	2.90
Beef cheek meat	674A	30	38	76	263	32.9	3.5	.43	.29	2.31
Do	674B	30	42	82	236	29.5	2.9	.36	.35	2.78
Do	674C	29	41	72	250	31.3	3.5	.43	.29	2.30
Do	674D	29	43	98	308	38.5	3.1	.39	.32	2.55
Do	674E	29	39	84	270	33.8	3.2	.40	.31	2.49
Do	674F	29	39	121	330	41.3	2.7	.34	.37	2.93
Average		29	40	89	276	34.6	3.2	.39	.32	2.56
Ox lips	677A	27	38	70	237	29.6	3.4	.42	.29	2.37
Do	677B	28	38	57	205	25.6	3.6	.45	.28	2.23
Do	677C	28	39	61	197	24.6	3.2	.40	.31	2.48
Do	677D	24	38	70	261	32.6	3.7	.47	.27	2.15
Do	677E	24	40	104	310	38.8	3.0	.37	.34	2.68
Do	677F	23	42	104	330	41.3	3.2	.40	.32	2.52
Average		26	39	78	257	32.1	3.4	.42	.30	2.41
Tripe	628A	28	41	20	133	16.6	6.7	.83	.15	1.20
Do	628B	24	40	29	153	19.1	5.3	.66	.19	1.52
Do	628C	24	39	14	127	15.9	9.1	1.14	.11	.88
Do	628D	24	38	15	117	14.6	7.8	.97	.13	1.03
Average		25	40	20	133	16.6	7.2	.90	.15	1.16
Ox muscle [a]		30	50	107	313	39.1	2.9	.37	.34	2.73
Hog muscle [a]		27	43	108	308	38.5	2.9	.36	.35	2.82

[a] HOAGLAND, R., and SNIDER, G. G. NUTRITIVE VALUE OF PROTEIN IN VOLUNTARY MUSCLE, HEART, LIVER, AND KIDNEY FROM CATTLE, SHEEP AND HOGS. [Unpublished manuscript.]

RESULTS OF 60 DAY FEEDING TESTS WITH RATIONS CONTAINING 12.5 PER CENT PROTEIN

Only veal, beef cheek meat and ox lips were fed in rations containing 12.5 per cent protein for the 60-day period. The results of these tests, together with those previously obtained for ox and hog muscle, are presented in Table VI. These data indicate relatively small differences in the nutritive values of the protein in the several tissues, although beef cheek meat and ox lips have slightly lower values than the other tissues.

TABLE VI.—*Nutritive value of protein in animal tissues when fed at the 12.5 per cent level for 60 days to young male albino rats*

Source of protein	Rat No.	Age at start	Initial weight	Gain in weight in 60 days	Total intake		Intake per gram gain in weight		Gain in weight	
					Feed	Protein	Feed	Protein	Per gram feed	Per gram protein
		Days	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*
Veal	666A	29	42	157	592	74.0	3.7	0.47	0.27	2.15
Do	666B	29	45	172	680	85.0	3.9	.49	.25	2.02
Do	666C	29	40	169	638	79.8	3.8	.48	.26	2.12
Do	666D	29	40	141	570	71.3	4.0	.51	.25	1.98
Do	666E	29	40	163	623	77.9	3.8	.48	.26	2.09
Do	666F	29	39	177	628	78.5	3.5	.44	.28	2.25
Average		29	41	163	622	77.8	3.8	.48	.26	2.10
Beef cheek meat	674A	30	38	137	590	73.8	4.3	.54	.23	1.86
Do	674B	30	42	143	550	68.8	3.8	.48	.26	2.08
Do	674C	29	41	147	560	70.0	3.8	.48	.26	2.10
Do	674D	29	43	158	647	80.9	4.1	.51	.24	1.95
Do	674E	29	39	155	625	78.1	4.0	.50	.25	1.98
Do	674F	29	39	190	706	88.3	3.7	.46	.27	2.15
Average		29	40	155	613	76.7	4.0	.49	.25	2.02
Ox lips	677A	27	38	124	534	66.8	4.3	.54	.23	1.86
Do	677B	28	38	112	435	54.4	3.9	.49	.26	2.06
Do	677C	28	39	120	487	60.9	4.1	.51	.25	1.97
Do	677D	24	38	138	643	80.4	4.7	.58	.21	1.72
Do	677E	24	40	161	663	82.9	4.1	.51	.24	1.94
Do	677F	23	42	193	748	93.5	3.9	.48	.26	2.06
Average		26	39	141	585	73.2	4.2	.52	.24	1.94
Ox muscle[a]		30	50	194	718	89.8	3.8	.47	.26	2.14
Hog muscle[a]		27	43	174	668	83.5	3.9	.49	.26	2.08

[a] HOAGLAND, R., and SNIDER, G. G. NUTRITIVE VALUE OF PROTEIN IN VOLUNTARY MUSCLE, HEART, LIVER, AND KIDNEY FROM CATTLE, SHEEP AND HOGS. [Unpublished manuscript.]

RESULTS OF 30 AND 60 DAY FEEDING TESTS WITH RATIONS CONTAINING 20 PER CENT OF TRIPE PROTEIN

The reults of these experiments are reported in Table VII. Somewhat better results were obtained with the ration containing 20 per cent tripe protein than had been obtained previously with rations containing smaller proportions of this protein, but growth was still subnormal and irregular. Referring to Table VII, it will be noted for the rats which were fed tripe for the 60-day period, that the gains in weight of the 4 rats were as follows: 18, 30, 90, and 104 grams, average 61 grams; whereas the rats which were fed the ration containing 12.5 per cent veal protein for the same period (Table VI) made gains in weight ranging from 141 to 177 grams, average 163 grams.

TABLE VII.—*Nutritive value of protein in tripe when fed at the 20 per cent level for 30 and 60 days, respectively, to young male albino rats*

Source of protein	Rat No.	Age at start	Initial weight	Duration of test	Gain in weight	Total intake		Intake per gram gain in weight		Gain in weight	
						Feed	Protein	Feed	Protein	Per gram feed	Per gram protein
		Days	*Grams*	*Days*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*
Tripe	655 A	28	45	30	37	148	29.6	4.0	0.80	0.25	1.25
Do	655 B	28	38	30	33	131	26.2	4.0	.80	.25	1.26
Do	655 C	26	39	30	20	108	21.6	5.4	1.08	.19	.93
Do	655 D	25	38	30	56	173	34.6	3.1	.62	.32	1.62
Average		27	40	30	37	140	28.0	4.1	.83	.25	1.27
Tripe	655 A	28	45	60	90	357	71.4	4.0	.79	.25	1.26
Do	655 B	28	38	60	30	243	48.6	8.1	1.62	.12	.62
Do	655 C	26	39	60	18	200	40.0	11.1	2.22	.09	.45
Do	655 D	25	38	60	104	381	76.2	3.7	.73	.27	1.36
Average		27	40	60	61	295	59.1	6.7	1.34	.18	.92

DISCUSSION AND SUMMARY

In this paper are reported the results of a study of the nutritive value of a number of animal tissues as sources of protein for maintenance and growth in young male albino rats.

Protein was fed at three levels of intake, viz: 10, 12.5, and 20 per cent, but most of the products were tested at the lowest level, since it has been found that 10 per cent of an animal protein of good quality is somewhat less than is required for optimal growth in rats during a period of 30 to 60 days.

It was found that the protein in the following products had practically the same nutritive value when fed in rations containing 10 per cent protein for periods of 30 and 60 days, respectively: Veal, ox and hog brains, ox and hog tongues, ox spleens, and dried milk. The values obtained for these products agree very closely with those previously obtained by the writers for a number of other animal tissues, including ox, hog, and sheep muscle.

The proteins in the following products were found to have distinctly lower values when fed at the 10 per cent level for periods of 30 and 60 days, respectively: Sweetbreads, tripe, beef cheek meat, ox lips, and casein.

When protein was fed at a 12.5 per cent level for periods of 30 and 60 days, respectively, veal was found to have a somewhat higher value than beef cheek meat or ox lips, and practically the same value as had previously been obtained for ox and hog muscle.

The protein in tripe, even when fed at a 20 per cent level, was far from adequate for optimal growth in rats.

The poor quality of the protein in sweetbreads and tripe is presumably due to a deficiency of one or more of the essential amino acids, but information as to the nature of these deficiencies is lacking. The low nutritive value of the protein in beef cheek and ox lips is undoubtedly due to the presence of considerable connective tissue, which is known to be lacking in several essential amino acids. The low value of casein, when fed at the 10 per cent level, is due to

its well-known deficiency in cystine. This deficiency is made up, however, when casein is fed at a level of 18 to 20 per cent, and optimal growth then results.

Although the proteins in sweetbreads, tripe, beef cheek meat, and ox lips were found to be of relatively poor quality when any one of these products constituted the only source of protein in the diet, it is possible that the deficiencies of these proteins may be made up when they are fed in combination with other animal or vegetable proteins.