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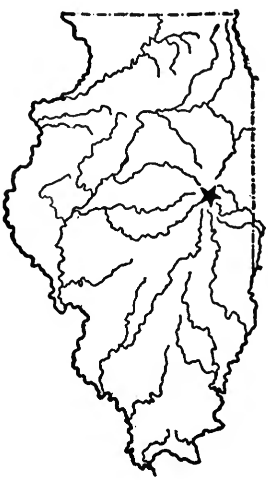
A STUDY OF THE FORMS OF NITROGEN IN GROWING PIGS

WITH SPECIAL REFERENCE TO THE INFLUENCE OF

THE QUANTITY OF PROTEIN CONSUMED

By W. E. JOSEPH



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Contents of Bulletin No. 173

A STUDY OF THE FORMS OF NITROGEN IN GROWING PIGS

WITH SPECIAL REFERENCE TO THE INFLUENCE OF THE QUANTITY OF PROTEIN CONSUMED[1]

By W. E. JOSEPH, Associate in Animal Husbandry

INTRODUCTION

The data thus far reported by other investigators indicate that the character or the quantity of the feed consumed exert no influence on the protein content of the animal body or any of its parts excepting the influence that depends on the rate of growth or fattening.[2] Friske,[3] and Pfeiffer and Friske[4] found no differences in the gains in protein made by mature wethers fed rations containing different amounts of protein. Müller[5] concludes from his own and Stockhausen's results that high-protein feeding of dogs produces a "Mastsubstanz" which is richer in nitrogen and poorer in carbon than the flesh of dogs fed a medium-protein ration. His conclusions are not warranted, however, by the meager data he presents. Abderhalden and Samuely[6] found no modification in the nature of the proteins of the blood serum in the horse after feeding proteins entirely different in composition from the serum proteins. Mendel[7] found that mice fed proteins which did not produce growth had the same gross composition as mice fed proteins that produced normal growth.

The ultimate object of the investigation of which this publication is a partial report was to determine the influence of different quantities of protein upon the nutrition of *young growing* pigs. This particular bulletin, which gives the experimental data relating to the forms of nitrogen in the animal body, is divided into two parts. The first part deals with the influence of the quantity of protein consumed

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1 The results presented in this bulletin formed part of a thesis submitted by the author to the Graduate School of the University of Illinois in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Animal Husbandry.

2 For a more complete bibliography and a brief summary of the literature, see Ill. Agr. Exp. Sta., Bul. 169.

3 Landw. Vers. Stat., 71, 441 (1909).

4 Landw. Vers. Stat., 74, 409 (1910-11).

5 Arch. ges. Physiol., 116, 207 (1907).

6 Ztschr. physiol. Chem., 46, 193 (1905-6).

7 Biochem. Ztschr., 11, 281 (1908).

upon the forms of nitrogen in the body, and the second part, with the average distribution of the forms of nitrogen in the bodies of pigs 40 to 43 weeks old.

THE EXPERIMENT

The plan of the experiment is given in detail in Bulletin 168 of this station. Briefly, it may be described as follows:

Twelve carefully selected Berkshire pigs weighing on an average 51 pounds were divided into three lots of four pigs each in such a way that the lots were as nearly alike as possible in regard to age, ancestry, weight, and condition. Lot I was fed a low-protein ration, Lot II, a medium-protein ration, and Lot III, a high-protein ration. Each ration consisted of ground corn, blood meal, and calcium phosphate. In the low-protein ration, one-half of the protein was derived from the ground corn, and one-half from the blood meal; in the medium-protein ration, 20 percent of the protein was furnished by the corn, and 80 percent by the blood meal; and in the high-protein ration, 14 percent of the protein came from the corn, and 86 percent from the blood meal. All of the pigs received the same amount of ground corn per 100 pounds live weight. The calcium phosphate[1] was so fed that the rations of Lots I, II, and III contained, respectively, 11.03, 9.65, and 8.73 grams of phosphorus per 100 pounds live weight. In addition, each pig was offered, once a week, about 35 grams of charcoal and 5 grams of salt. They did not seem to show any special desire for either, however, and often left a considerable portion.

The animals had free access to water at all times and were allowed the freedom of their paved pens. As they grew older and fatter, they were given additional exercise.

The average amounts of feeds, nutrients, and energy consumed per 100 pounds live weight are given in Table 1.

Effect of Rations.—The experiment lasted 174 days. During this time the differences in the general physical condition and appearance of the pigs became very noticeable. Briefly, the findings were as follows: The pigs of Lot I, the low-protein group, developed slowly, remained small, and appeared to be unthrifty and undernourished. As the experiment progressed, they became sluggish, and, toward the end of the experiment, walked with difficulty. Pig 2 became so ill that it was removed on the forty-first day and given the ration of the Station herd. It died a week later. Two of the three remaining pigs in this lot died before the close of the experiment. The kidneys of these pigs were small and in a pathological condition, showing a chronic state of parenchymatous nephritis. The remaining pig, No. 1, which at the beginning of the experiment was considered to be the most thrifty of the animals selected, made fair gains, averaging 0.64 pound per day. However, the kidneys of this animal were found to be small and in the same pathological condition as those of the other two. The livers were small, but otherwise normal.

Early in the experiment, when Pig 2 died, one pig was removed from each of Lots II and III in order to make the three lots directly comparable from the standpoint of merit of the animals, number of animals, and area per head in each pen.

The remaining pigs of the medium- and high-protein lots showed practically none of the unfavorable symptoms apparent in the pigs of Lot I, tho at times during very cold weather they were stiff in the hind quarters. In general, however, these animals were thrifty and active and had good appetites. Also, considering that they were kept in pens, they made good gains, Lot II averaging 0.96 pound per pig per day, and Lot III, 0.94 pound.

[1] According to the results of Hart, McCollum, and Fuller (Wis. Agr. Exp. Sta. Res. Bul. 1), calcium phosphates are as efficient in supplementing rations low in phosphorus as are organic phosphorus compounds. These investigators state that young growing pigs should receive per day at least 6 to 10 grams of phosphorus per 100 pounds live weight.

TABLE 1.—FEEDS, NUTRIENTS, AND ENERGY CONSUMED PER DAY PER 100 POUNDS LIVE WEIGHT

Lot	Animal	Feeds			Digestible nutrients						Ash	Phosphorus	Calcium[2]	Metabolizable energy[3]	Nutritive ratio
		Ground corn	Blood meal	Total	Dry substance	Protein (N x 6.25)			Carbohydrates	Fat					
						Ground corn	Blood meal	Total							
		lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*grams*	*grams*	*grams*	*therms*	
I	1	2.29	0.22	2.51	1.97	0.16	0.16	0.32	1.55	0.061	71.24	11.03	4.07	3.79	1:5.3
	3[1]	2.40	0.13	2.54	1.99	0.13	0.13	0.26	1.62	0.064	....	....	...	3.90	1:6.8
	4[1]	1.58	0.18	1.76	1.38	0.12	0.12	0.24	1.07	0.042	....	....	...	2.65	1:4.9
II	5	2.14	0.78	2.92	2.27	0.14	0.57	0.71	1.45	0.059	65.26	9.65	3.56	4.32	1:2.2
	7	2.11	0.76	2.87	2.23	0.14	0.55	0.69	1.43	0.059	63.42	9.65	3.56	4.24	1:2.3
	8	1.91	0.72	2.64	2.05	0.13	0.52	0.65	1.29	0.053	53.98	7.71	2.72	3.88	1:2.2
Average	..	2.05	0.75	2.81	2.18	0.14	0.54	0.68	1.39	0.057	60.88	9.00	3.28	4.14	1:2.2
III	16	1.92	1.10	3.02	2.34	0.13	0.80	0.93	1.29	0.055	57.45	8.73	3.22	4.41	1:1.5
	13	2.00	1.14	3.14	2.43	0.13	0.83	0.96	1.35	0.057	60.67	8.73	3.22	4.58	1:1.5
	15	1.82	0.92	2.75	2.13	0.11	0.68	0.79	1.23	0.052	55.34	8.16	3.22	4.02	1:1.7
Average	..	1.91	1.05	2.97	2.30	0.12	0.77	0.89	1.29	0.055	57.82	8.54	3.22	4.33	1:1.6

[1]Died before close of experiment.

[2]Calculated from average composition of feeds.

[3]The metabolizable energy of a ration is the energy that can be liberated in the animal body, or the gross energy less the energy contained in the feces, urine, and intestinal gases. The metabolizable energy of the rations has been calculated by multiplying the weights of the digestible nutrients by the following factors: digestible protein, 1860; digestible carbohydrates, 1905; and ether extract, 3992. One therm equals 1000 calories.

Since the chief and essential difference between the rations given Lots I, II, and III was in their content of protein, it would seem that a deficiency of protein in the feed was the chief cause of the poor development of the animals of Lot I.

Attention should again be called to the fact that the pigs used in this investigation were young growing animals weighing on an average only 51 pounds at the beginning of the experiment, and that they were housed in small pens paved with brick. The reader is cautioned against assuming that similar results would have been obtained if they had been more mature.

Animals Slaughtered and Analyzed.—The pigs chosen for slaughter and chemical study at the close of the experiment were Nos. 1 of Lot I, 5 and 7 of Lot II, and 16 and 13 of Lot III. At the time they were slaughtered these animals weighed, respectively, 180.1, 249.4, 199.6, 248.4, and 189.3 pounds. Pigs 1, 5, and 16 were of the same age. They were also related, No. 1 being a litter mate of No. 5, and No. 16 being by the same sire as Nos. 1 and 5. Pigs 7 and 13 were litter mates and twenty days younger than Nos. 1, 5, and 16.

Seven composite samples were prepared from each pig of Lots I, II, and III. These were: (1) the offal, consisting of the organs of the respiratory, circulatory, and digestive systems, the brain, the spinal cord, the kidneys, the urinary organs, etc.; (2) the blood; (3) the skeleton; (4) the jowl, leaf, and intestinal fats; (5) the boneless meat of the ham cut; (6) the boneless meat of the side cut; and (7) the boneless meat of the shoulder cut. These samples represented integral parts of the entire body, and from the determinations of their weights and composition, the chemical composition of the boneless meat of the dressed carcass and entire body of each pig was calculated.

Methods of Analysis.—All samples were analyzed in the fresh condition. The following forms of nitrogen were determined by analysis: total nitrogen, water-soluble nitrogen, nitrogen coagulated by heat, nitrogen precipitated by tannic acid and potassium alum, nitrogen precipitated by phosphotungstic acid in hot solution, creatin nitrogen, and ammonia nitrogen. From the data thus obtained the following forms of nitrogen were calculated: soluble protein nitrogen, insoluble protein nitrogen, total protein nitrogen, extractive nitrogen other than creatin nitrogen, total extractive nitrogen, and total non-protein nitrogen.

The total nitrogen was determined by the Kjeldahl-Gunning-Arnold method, with the use of sulfuric acid, potassium sulfate, and mercury in the digestion.

The determinations of soluble nitrogen were made by the Kjeldahl-Gunning-Arnold method in an aliquot portion of a cold water extract of the sample. By "soluble nitrogen" is meant the nitrogen of those substances which are dissolved by repeated extractions with cold, distilled, ammonia-free water. In making the cold water extract, approximately 300 grams of the meat and offal, and 400 grams of the fat and bone samples were used. After the sample had been carefully weighed, it was divided about equally among four 500 cc. centrifuge bottles. Ignited and thoroly-washed sand was then added to each portion in order that the cells might be broken up as completely as possible in the mixing. The samples were then extracted six successive times, 100 cc. of water being used per bottle the first two times, and 50 cc. the remaining four times. The total extract was then made up to two liters and filtered thru S. and S. 602 hard filter paper.

The nitrogen of the coagulable protein of the cold-water extract was determined by a method previously described in a publication from this laboratory.[1]

The nitrogen precipitated by tannic and phosphotungstic acids was determined in the filtrate from the determination of coagulable protein nitrogen by the provisional method.[2]

The creatin nitrogen was determined by Folin's method as modified by Grindley and Emmett.[3]

For the determination of the ammonia nitrogen a modification of the method of Pennington and Greenlee[4] was used.

Each analysis was made in triplicate. In studying the data the triplicate determinations[5] for each animal were considered carefully with reference to the bearing of the differences between them on the question as to differences between the animals. In the case of the total nitrogen, the triplicate results were not in very close agreement for a number of samples so that small differences between the values for the individual pigs were not significant. In the case of the soluble nitrogen, coagulable protein nitrogen, and creatin nitrogen, the agreement between the triplicate determinations was so close that even small differences between the values for the individual pigs were significant insofar as the chemical analyses themselves were concerned.

INFLUENCE OF QUANTITY OF PROTEIN CONSUMED

Forms of Nitrogen in Boneless Meat of Shoulder Cut

The forms of nitrogen in the boneless meat of the shoulder cut in percent of the fresh substance are given in Table 2.

Total Nitrogen.—The difference between the values for Pig 1 of the low-protein lot and Pig 5 of the medium-protein lot was 0.042 percent, and that between the values for Pigs 5 and 7 of the medium-protein lot was 0.088 percent. Accordingly, Pig 1 was less widely different from Pig 5 than Pig 7 which belonged to the same lot as Pig 5. On comparing Lots I and III, it will be noted that the value for Pig 1 of the former fell between the values for Pigs 16 and 13 of the latter. In the case of Lots II and III, the values for Pig 5 of the medium-protein lot fell between the percentages for Pigs 16 and 13 of the high-protein lot, and the value for Pig 13 of the high-protein lot fell between the percentages for Pigs 5 and 7 of the medium-protein lot. Between the values for Pig 7 of the medium-protein lot and Pig 13 of the high-protein lot the difference was less than

[1] Grindley and Emmett, Jour. Amer. Chem. Soc., 28, 658 (1905).
[2] U. S. Bur. of Chem., Bul. 107 Rev. (1907), p. 108 (7e).
[3] Jour. Biol. Chem., 3, 491 (1907).
[4] Jour. Amer. Chem. Soc., 32, 561, (1910).
[5] These triplicate determinations have not been given in this bulletin. A typewritten copy may be obtained for a short period of time by addressing a request to the Director of the Illinois Agricultural Experiment Station, Urbana, Illinois.

TABLE 2.—FORMS OF NITROGEN IN BONELESS MEAT OF SHOULDER CUT

(Results expressed in percent of fresh substance)

Animal	Total nitrogen	Soluble nitrogen	Protein nitrogen								Non-protein nitrogen				
			Soluble					Insoluble	Total		Extractive			Ammonia	Total
			Coagulable	Precipitated: By tannic acid	Precipitated: By phosphotungstic acid	Precipitated: Total	Total soluble				Creatin	Other than creatin	Total		
Lot I.—Low protein															
1	2.219	0.530	0.259	....[1]	....[1]	0.034	0.293	1.689	1.982		0.093	0.112	0.205	0.032	0.237
Lot II.—Medium protein															
5	2.177	0.517	0.263	0.038	0.039	0.077	0.340	0.660	2.000		0.093	0.058	0.151	0.026	0.177
7	2.089	0.521	0.275	....[1]	....[1]	0.072	0.347	1.568	1.915		0.072	0.064	0.136	0.038	0.174
Average	2.133	0.519	0.269	....	....	0.074	0.343	1.614	1.957		0.082	0.061	0.143	0.032	0.175
Lot III.—High protein															
16	2.334	0.518	0.280	0.030	0.061	0.091	0.371	1.816	2.187		0.088	0.032	0.120	0.027	0.147
13	2.165	0.438	0.215	....[1]	....[1]	0.057	0.272	1.727	1.999		0.084	0.065	0.149	0.017	0.166
Average	2.249	0.478	0.247	....	....	0.074	0.321	1.771	2.093		0.086	0.048	0.134	0.022	0.156
Averages for the five pigs															
	2.197	0.505	0.258	....	....	0.066	0.325	1.692	2.017		0.086	0.066	0.152	0.028	0.180

[1]Not determined separately.

half that between the values for Pigs 16 and 13 of the high-protein lot. Between the values for Pigs 16 and 13, the difference was less than twice that between the values for Pigs 5 and 7. Hence, in the total nitrogen of the boneless meat of the shoulder cut there was no significant difference attributable to variations in the amounts of protein consumed.

Soluble Nitrogen.—In the case of the soluble nitrogen in the shoulder cut, the value for Pig 1 of the low-protein lot differed from that for Pig 5 of the medium-protein lot by 0.013 percent, and from that of Pig 7 by 0.009 percent, while the values for Pigs 5 and 7 of the medium-protein lot differed from each other by 0.004 percent. The difference between the value for Pig 1 of the low-protein lot and that for Pig 13 of the high-protein lot was 0.092 percent, while the difference between the values for Pigs 16 and 13 of the high-protein lot was 0.080 percent. The values for Pigs 5 and 7 of the medium-protein lot were both nearly the same as the value for Pig 16 of the high-protein lot. From these facts it is evident that the differences between the lots were insignificant, and that variations in the amount of protein consumed had no effect upon the content of soluble nitrogen in the shoulder cut.

Protein Nitrogen.—From a study of the data in Table 2, it will be found that differences in the amounts of protein consumed produced no apparent variation in the percentages of coagulable protein nitrogen, nitrogen precipitated by tannic and phosphotungstic acids, soluble protein nitrogen, insoluble and total protein nitrogen in the boneless meat of the shoulder cut.

Non-Protein Nitrogen.—It is also apparent from the data in Table 2 that the differences between the lots for creatin nitrogen, total extractive nitrogen, ammonia nitrogen, and total non-protein nitrogen were not caused by differences in the amounts of protein consumed.

Nitrogen Expressed in Percent of Water-Free Substance, Fat-Free Substance, Water- and Fat-Free Substance, and Total Nitrogen.—Since the water and fat contents of meat vary with the age, condition, and perhaps the individuality of the animal, it seemed desirable to calculate the data given above to the basis of the water-free substance, fat-free substance, water- and fat-free substance, and total nitrogen.[1] On careful study it was found that the statements made above in regard to the apparent influence of differences in the amounts of protein consumed applied qualitatively equally as well to these data as to the data expressed on the basis of the fresh substance.

[1] These results have not been included in this bulletin. A typewritten copy may be obtained for a short period of time by addressing a request to the Director of the Illinois Agricultural Experiment Station, Urbana, Illinois.

Forms of Nitrogen in Boneless Meat of Side Cut

In Table 3 are given the percentages of the various forms of nitrogen in the boneless meat of the side cut. In the case of Pig 1 the data given were calculated from the values for the shoulder and ham cuts and the composite of the shoulder, side, and ham cuts, as the sample for the side cut was lost. Since this method of calculation may have introduced considerable error, there have been given also averages which do not include the data for Pig 1.

Because of the method of obtaining the values for Pig 1, the differences between Lots I and II and Lots I and III have little significance.

Total Nitrogen.—One value in each of Lots II and III fell within the range of the values in the other lot. Therefore it is evident that the differences in the amounts of protein consumed had no effect upon the total nitrogen in the side cut.

Soluble Nitrogen.—The difference between the values for the two pigs in the medium-protein lot was 0.018 percent. Between the averages for Lots II and III the difference was 0.033 percent. Accordingly, the difference between the values for the two animals in Lot II was more than half that between the averages for Lots II and III. From this fact it is evident that the differences between the lots were not due to differences in the amount of protein consumed.

Protein Nitrogen.—As in the case of the soluble nitrogen, it is found from a study of the data for the coagulable nitrogen given in Table 3, that the difference between the values for the two animals in one lot was more than half the difference between the lots. Also in the case of the nitrogen precipitated by tannic and phosphotungstic acids, it is evident from the differences between the values for the individual pigs that there was no significant difference between the lots. In the case of the insoluble protein nitrogen, the relation of the values for the lots to the values for the individual pigs was practically the same as that noted in the case of the soluble protein nitrogen. The lot values and the values within the lots for the total protein nitrogen stood in virtually the same relation to each other as those for the total nitrogen. It may therefore be concluded that in none of these cases was there any difference attributable to differences in the amounts of protein consumed.

Non-Protein Nitrogen.—The values representing the various forms of non-protein nitrogen in the side cuts of Lots II and III were practically the same. Therefore, the amount of protein consumed exerted no apparent influence.

TABLE 3.—FORMS OF NITROGEN IN BONELESS MEAT OF SIDE CUT
(Results expressed in percent of fresh substance)

Animal	Total nitrogen	Soluble nitrogen	Protein nitrogen								Non-protein nitrogen				
			Soluble								Extractive				
				Precipitated											
			Coagulable	By tannic acid	By phosphotungstic acid	Total	Total soluble	Insoluble	Total		Creatin	Other than creatin	Total	Ammonia	Total
Lot I.—Low protein															
1[1]	1.971	0.461	0.205	....[2]	....[2]	0.168	0.373	1.510	1.883		0.078	....[3]	....[3]	0.046	....[3]
Lot II.—Medium protein															
5	1.638	0.371	0.194	0.026	0.033	0.059	0.253	1.267	1.520		0.072	0.023	0.095	0.023	0.118
7	1.689	0.389	0.183	0.033	0.061	0.094	0.277	1.300	0.577		0.063	0.028	0.091	0.021	0.112
Average	1.663	0.380	0.188	0.029	0.047	0.076	0.265	1.283	1.548		0.067	0.025	0.093	0.022	0.113
Lot III.—High protein															
16	1.728	0.351	0.174	0.037	0.039	0.076	0.250	1.377	1.627		0.070	0.012	0.082	0.019	0.101
13	1.648	0.334	0.161	....[2]	....[2]	0.051	0.212	1.304	1.516		0.064	0.046	0.110	0.022	0.132
Average	1.688	0.347	0.167	....	....	0.063	0.231	1.340	1.571		0.067	0.029	0.096	0.020	0.116
Averages for the five pigs															
	1.735	0.383	0.183	....	....	0.090	0.273	1.352	1.625		0.069	....	....	0.026	....
Averages for four pigs (Nos. 5, 7, 16, and 13)															
	1.676	0.364	0.178	....	....	0.070	0.248	1.312	1.560		0.067	0.027	0.094	0.021	0.116

[1]Results for Pig 1 calculated by difference from data for ham, shoulder, and composite of ham, shoulder, and side.
[2]Not determined separately.
[3]Errors of several determinations accumulate here; calculated value negative.

Forms of Nitrogen in Boneless Meat of Ham Cut

The data for the forms of nitrogen in the boneless meat of the ham cut are given in Table 4.

Total Nitrogen.—The averages by lots of the percentages of total nitrogen varied inversely as the amount of protein consumed. The differences between the values within the lots, however, were relatively so great that the lot differences were not significant. The values for Pig 5 of Lot II and Pig 13 of Lot III were practically the same. When the data were calculated to the basis of the fat-free substance, the apparent lot differences practically disappeared.

Soluble Nitrogen.—The percentages of soluble nitrogen in the boneless meat of the ham cut apparently were not influenced by the amount of protein in the ration. While there were appreciable differences between the lots, the differences within the lots were so great that they rendered the lot differences insignificant. Some error was probably introduced in determining the value for Pig 7, since it was not correlated with the other forms of nitrogen as were the values obtained for Pigs 1, 5, 16, and 13. Such an error would affect also the percentages for the insoluble and total protein nitrogen and the extractive and total non-protein nitrogen.

Protein Nitrogen.—In the content of coagulable protein nitrogen, the low-protein lot was intermediate, the medium-protein lot, highest, and the high-protein lot, lowest. The differences between the lots, however, did not seem to be significant. In the case of the nitrogen precipitated by tannic and phosphotungstic acids, the differences within the lots, especially in Lot III, made the lot differences insignificant as far as the influence of differences in the amount of protein consumed was concerned. The soluble protein nitrogen varied in the same manner as the coagulable protein nitrogen. The difference between the individual animals in Lot III was relatively large. Hence, the significance of the lot differences was slight. Also in the case of the percentages of insoluble and total protein nitrogen, the differences between the values for the individual animals rendered any apparent lot differences insignificant with respect to the influence of the character of the feed.

Non-Protein Nitrogen.—The values for the individual pigs for all forms of non-protein nitrogen in the boneless meat of the ham cut were so variable that no influence of the amounts of protein consumed on these constituents was apparent.

TABLE 4.—FORMS OF NITROGEN IN BONELESS MEAT OF HAM CUT

(Results expressed in percent of fresh substance)

Animal	Total nitrogen	Soluble nitrogen	Protein nitrogen								Non-protein nitrogen				
			Soluble					Insoluble	Total	Extractive			Ammonia	Total
			Coagulable	Precipitated			Total soluble			Creatin	Other than creatin	Total		
				By tannic acid	By phosphotungstic acid	Total								
Lot I.—Low protein														
1	2.538	0.651	0.306	0.039	0.079	0.118	0.424	1.887	2.311	0.097	0.102	0.199	0.028	0.227
Lot II.—Medium protein														
5	2.432	0.640	0.349	0.031	0.076	0.107	0.456	1.792	2.248	0.107	0.044	0.151	0.033	0.184
7	2.461	0.832	0.348	....[1]	....[1]	0.105	0.453	1.629	2.082	0.099	0.247	0.346	0.033	0.379
Average	2.446	0.736	0.348	....	....	0.106	0.454	1.710	2.165	0.103	0.145	0.248	0.033	0.281
Lot III.—High protein														
16	2.366	0.540	0.272	0.038	0.079	0.117	0.389	1.827	2.216	0.111	0.023	0.134	0.017	0.151
13	2.436	0.528	0.263	....[1]	....[1]	0.080	0.343	1.908	2.251	0.098	0.062	0.160	0.025	0.185
Average	2.401	0.534	0.267	....	....	0.098	0.366	1.867	2.233	0.104	0.042	0.147	0.021	0.168
Averages for the five pigs														
	2.447	0.638	0.308	....	....	0.105	0.413	1.809	2.222	0.102	0.096	0.198	0.027	0.225

[1]Not determined separately.

Forms of Nitrogen in Boneless Meat of Dressed Carcass

The percentages for the boneless meat of the entire dressed carcasses were calculated from the data for the forms of nitrogen in the boneless meat of the shoulder, side, and ham cuts, and the weights of these parts. The results are given in Table 5.

In general, the relations of the lot values and the values for the individual pigs were about the same as those of the boneless meat of the three cuts; that is, the differences between the lots were insignificant because of the magnitude of the differences within them.

Forms of Nitrogen in Bone and Marrow

The distribution of the different forms of nitrogen in the bone and marrow is given in Table 6.

Total Nitrogen.—The total nitrogen of the bone and marrow of Pig 1 was appreciably lower than that of the four other animals. The differences between the values for the pigs within Lots II and III, however, rendered this difference insignificant insofar as these data are concerned. The values for Lots II and III were practically the same.

Soluble Nitrogen.—The data for the soluble nitrogen of the bone and marrow showed no special tendency with respect to differences between the lots, since the differences between the values for the individual pigs were as great as the lot differences.

Protein Nitrogen.—The differences between the lots in the values for coagulable protein nitrogen were so small as to be practically insignificant. Both of the extreme values were found in Lot III. Also in the case of the other forms of protein nitrogen, no data were obtained to indicate that the amount of protein consumed influenced the percentage of these forms of nitrogen in the bone and marrow.

Non-Protein Nitrogen.—The amount of creatin in the bone and marrow was so small that it was impossible to determine it quantitatively by the method employed. In the percentages of none of the forms of non-protein nitrogen were there any differences which seemed to depend upon differences in the amounts of protein consumed.

TABLE 5.—FORMS OF NITROGEN IN BONELESS MEAT OF DRESSED CARCASS
(Results expressed in percent of fresh substance)

Animal	Total nitrogen	Soluble nitrogen	Protein nitrogen					Non-protein nitrogen				
			Soluble			Insoluble	Total	Extractive			Ammonia	Total
			Coagulable	Precipitated by acids[1]	Total			Creatin	Other than creatin	Total		
Lot I.—Low protein												
1	2.169	0.523	0.243	0.118	0.361	1.646	2.007	0.087	0.038	0.125	0.037	0.162
Lot II.—Medium protein												
5	1.945	0.486	0.245	0.074	0.319	1.479	1.798	0.085	0.035	0.120	0.027	0.147
7	1.977	0.526	0.247	0.090	0.337	1.451	1.788	0.074	0.086	0.160	0.029	0.189
Average	1.961	0.496	0.246	0.082	0.328	1.465	1.793	0.079	0.060	0.140	0.028	0.163
Lot III.—High protein												
16	2.035	0.439	0.224	0.089	0.313	1.596	1.909	0.084	0.021	0.105	0.021	0.126
13	1.966	0.411	0.198	0.059	0.257	1.555	1.812	0.077	0.056	0.133	0.021	0.154
Average	2.000	0.425	0.211	0.074	0.285	1.575	1.860	0.080	0.038	0.119	0.021	0.140
Averages for the five pigs												
	2.018	0.473	0.231	0.086	0.317	1.545	1.863	0.081	0.047	0.129	0.027	0.156

[1]Tannic and phosphotungstic acids.

TABLE 6.—FORMS OF NITROGEN IN BONE AND MARROW
(Results expressed in percent of fresh substance)

Animal	Total nitrogen	Soluble nitrogen	Protein nitrogen								Non-protein nitrogen			
			Soluble								Extractive			
				Precipitated										
			Coagulable	By tannic acid	By phosphotungstic acid	Total	Total soluble		Insoluble	Total	Creatin	Other than creatin	Ammonia	Total
Lot I.—Low protein														
1	3.543	0.369	0.119	0.037	0.041	0.078	0.197		3.174	3.371	Trace	0.096	0.076	0.172
Lot II.—Medium protein														
5	3.725	0.386	0.114	0.043	0.033	0.076	0.190		3.339	3.529	Trace	0.100	0.096	0.196
7	3.683	0.359	0.115	0.035	0.049	0.084	0.199		3.324	3.523	Trace	0.052	0.108	0.160
Average	3.704	0.372	0.114	0.039	0.041	0.080	0.194		3.331	3.526	Trace	0.076	0.102	0.173
Lot III.—High protein														
16	3.744	0.385	0.112	0.037	0.052	0.089	0.201		3.359	3.560	Trace	0.074	0.110	0.184
13	3.685	0.418	0.124	0.045	0.054	0.099	0.223		3.267	3.490	Trace	0.093	0.102	0.195
Average	3.714	0.401	0.118	0.041	0.053	0.094	0.212		3.313	3.525	Trace	0.083	0.106	0.189
Averages for the five pigs														
	3.676	0.383	0.117	0.039	0.046	0.085	0.202		3.293	3.495	Trace	0.083	0.098	0.181

Forms of Nitrogen in Composite Offal

The data for the forms of nitrogen in the composite offal are given in Table 7.

Total Nitrogen.—While the lot averages of the percentages of total nitrogen in the composite offal increased with the amounts of protein in the feed, the differences between the values for the individual pigs were relatively so large that the lot differences were not significant with respect to the influence of the amounts of protein consumed.

Soluble Nitrogen.—In the case of the soluble nitrogen, the highest and the lowest values were found in Lot III, and the value for Lot I fell between those in Lot II; hence, there were no apparent differences due to variations in the amounts of protein consumed.

Protein Nitrogen.—The differences between pigs were relatively so great in the various forms of protein nitrogen that the data were not significant with respect to the influence of the amount of protein in the feed.

Non-Protein Nitrogen.—The values for creatin nitrogen were lowest in Lot II, but this fact cannot be considered significant as the maximum lot difference was no greater than the difference within Lot III. In the case of the other forms of non-protein nitrogen, the differences between the values for the individual pigs were so great that they rendered the data of no practical significance with respect to differences between the lots.

Forms of Nitrogen in Composite Fat

The data on the distribution of nitrogen in the composite fat, including the internal fats and the head fat, are given in Table 8.

These values seem to indicate that the amount of protein consumed exerted no influence upon the distribution of nitrogen in the fat as the differences between the lots were relatively insignificant when compared with the differences within them.

TABLE 7.—FORMS OF NITROGEN IN COMPOSITE OFFAL

(Results expressed in percent of fresh substance)

Animal	Total nitrogen	Soluble nitrogen	Protein nitrogen								Non-protein nitrogen				
			Soluble					Insoluble	Total	Extractive			Ammonia	Total
			Coagulable	Precipitated			Total soluble			Creatin	Other than creatin	Total		
				By tannic acid	By phosphotungstic acid	Total								
Lot I.—Low protein														
1	3.366	0.697	0.181	0.078	0.118	0.196	0.377	2.669	3.046	0.016	0.174	0.190	0.130	0.320
Lot II.—Medium protein														
5	3.612	0.780	0.249	....[1]	....[1]	0.147	0.396	2.832	3.228	0.012	0.237	0.249	0.135	0.384
7	3.405	0.650	0.213	....[1]	....[1]	0.096	0.309	2.755	3.064	0.013	0.220	0.233	0.108	0.341
Average	3.508	0.715	0.231	....	....	0.121	0.352	2.793	3.146	0.012	0.228	0.241	0.121	0.362
Lot III.—High protein														
16	4.033	0.600	0.241	....[1]	....[1]	0.116	0.357	3.433	3.790	0.020	0.110	0.130	0.113	0.243
13	3.540	0.875	0.262	....[1]	....[1]	0.154	0.416	2.665	3.081	0.015	0.311	0.326	0.133	0.459
Average	3.786	0.737	0.251	....	....	0.135	0.386	3.049	3.435	0.017	0.210	0.228	0.123	0.351
Averages for the five pigs														
	3.591	0.720	0.229	....	....	0.142	0.371	2.871	3.242	0.015	0.210	0.226	0.124	0.349

[1]Not determined separately.

TABLE 8.—FORMS OF NITROGEN IN COMPOSITE FAT

(Results expressed in percent of fresh substance)

Animal	Total nitrogen	Soluble nitrogen	Protein nitrogen								Non-protein nitrogen			
			Soluble					Insoluble	Total	Extractive		Ammonia	Total
			Coagulable	Precipitated			Total soluble			Creatin	Total		
				By tannic acid	By phosphotungstic acid	Total							
Lot I.—Low protein													
1	0.412	0.064	0.021	0.010	0.003	0.013	0.034	0.348	0.382	Trace	0.025	0.005	0.030
Lot II.—Medium protein													
5	0.477	0.080	0.027	0.013	0.007	0.020	0.047	0.397	0.444	Trace	0.023	0.010	0.033
7	0.551	0.077	0.024	0.009	0.002	0.011	0.035	0.474	0.509	Trace	0.035	0.007	0.042
Average	0.514	0.078	0.025	0.011	0.004	0.015	0.041	0.435	0.476	Trace	0.029	0.008	0.037
Lot III.—High protein													
16	0.422	0.110	0.019	0.009	0.007	0.016	0.035	0.312	0.347	Trace	0.068	0.007	0.075
13	0.492	0.056	0.024	0.010	0.001	0.011	0.035	0.436	0.471	Trace	0.014	0.007	0.021
Average	0.457	0.083	0.021	0.009	0.004	0.013	0.035	0.374	0.409	Trace	0.041	0.007	0.048
Averages for the five pigs													
	0.471	0.077	0.023	0.010	0.004	0.014	0.037	0.393	0.432	Trace	0.033	0.007	0.040

Forms of Nitrogen in Blood

The data on the forms of nitrogen in the blood are given in Table 9.

TABLE 9.—FORMS OF NITROGEN IN BLOOD
(Results expressed in percent of fresh substance)

Animal	Total nitrogen	Protein nitrogen			Non-protein nitrogen			
		Coagulable	Precipitated by acids[1]	Total	Extractive: Creatin	Extractive: Total	Ammonia	Total
Lot I.—Low protein								
1	3.012	2.845	0.062	2.907	Trace	....	....	0.105
Lot II.—Medium protein								
5	2.896	2.755	0.053	2.808	Trace	0.085	0.003	0.088
7	2.911	2.789	0.054	2.843	Trace	0.042	0.026	0.068
Average	2.903	2.772	0.053	2.825	Trace	0.063	0.014	0.078
Lot III.—High protein								
16	3.161	2.968	0.041	3.009	Trace	0.149	0.003	0.152
13	3.199	3.050	0.056	3.106	Trace	0.084	0.009	0.093
Average	3.180	3.009	0.048	3.057	Trace	0.116	0.006	0.122
Averages for the five pigs								
	3.036	2.881	0.053	2.935	Trace	0.090	0.010	0.101

[1]Tannic and phosphotungstic acids.

Total Nitrogen.—On inspection of the data it will be seen that the values for the two pigs of Lot II were quite distinct from those of Lot III. The differences between Lots I and II and Lots I and III were insignificant. The difference between Lots II and III, when considered without reference to the value for Lot I, was sufficiently great to seem significant with respect to the influence of the amount of protein consumed.

Protein Nitrogen.—The coagulable protein nitrogen showed the same tendency as the total nitrogen; in this case, however, the differences within the lots were greater. The differences between the values within the lots for nitrogen precipitated by tannic and phosphotungstic acids were relatively so large that no influence of differences in feed was apparent. The total protein nitrogen varied in the same manner as the total nitrogen and the coagulable protein nitrogen, but the differences between the values for the individual pigs in the case of the total protein nitrogen were relatively somewhat greater.

Non-Protein Nitrogen.—There was but a trace of creatin nitrogen in the blood. The total extractive nitrogen was extremely variable and had no significance with respect to the influence of variations in the nature of the feed consumed. The data for the ammonia nitrogen and non-protein nitrogen also were variable and of little significance.

Nitrogen of Blood on Basis of Water-Free Substance.—When the data for the forms of nitrogen in the blood were calculated to the basis of the water-free substance,[1] the difference between the lots practically disappeared. Differences in the total nitrogen, coagulable protein nitrogen, and total protein nitrogen were not even suggested. The differences between the values for the other forms of nitrogen did not have much significance.

Summary.—In the case of the medium-and the high-protein lots, the total nitrogen and the nitrogen of the coagulable protein and total protein varied with the quantity of protein in the ration. The value for the low-protein lot, however, was intermediate, a fact which detracted from the significance of the differences between the medium-protein and the high-protein lots. If these differences depended on the amounts of protein consumed, it is probable that they would have been progressive. When the data were calculated to the basis of the solids of the blood the differences between the lots practically disappeared.

Forms of Nitrogen in Entire Body

The data for the forms of nitrogen in the entire body are given in Table 10.

It is apparent from a study of Table 10 that there were no essential lot differences in any of the forms of nitrogen in the entire body. While it is possible that there might have been a compensating effect of one sample on another—that is, that a low value in the case of one sample might have been balanced by a high value in another—it is more probable that any effect exerted by the differences in the amounts of protein consumed would have been cumulative in the body as a whole, and hence as evident in the body as a whole as in any one part. The absence of such differences may be regarded as a confirmation of the previous findings.

[1] These calculations have not been included in this bulletin. A typewritten copy may be obtained for a short period of time by addressing a request to the Director of the Illinois Agricultural Experiment Station, Urbana, Illinois.

TABLE 10.—FORMS OF NITROGEN IN ENTIRE BODY
(Results expressed in percent of fresh substance)

Animal	Total nitrogen	Soluble nitrogen	Protein nitrogen					Non-protein nitrogen				
			Soluble			Insoluble	Total	Extractive			Ammonia	Total
			Coagulable	Precipitated by acids[1]	Total			Creatin	Other than creatin	Total		
Lot I.—Low protein												
1	2.415	0.578	0.282	0.118	0.400	1.837	2.237	0.056	0.068	0.124	0.054	0.178
Lot II.—Medium protein												
5	2.291	0.566	0.307	0.081	0.388	1.725	2.113	0.056	0.074	0.130	0.048	0.178
7	2.327	0.582	0.299	0.085	0.384	1.745	2.129	0.051	0.099	0.150	0.048	0.198
Average	2.309	0.574	0.303	0.083	0.386	1.735	2.121	0.053	0.086	0.140	0.048	0.188
Lot III.—High protein												
16	2.419	0.518	0.286	0.087	0.373	1.901	2.274	0.058	0.046	0.104	0.041	0.145
13	2.353	0.565	0.289	0.076	0.365	1.788	2.153	0.051	0.102	0.153	0.047	0.200
Average	2.386	0.541	0.287	0.081	0.369	1.844	2.213	0.054	0.074	0.128	0.044	0.172
Averages for the five pigs												
	2.361	0.562	0.293	0.089	0.382	1.799	2.181	0.054	0.078	0.132	0.048	0.180

[1]Tannic and phosphotungstic acids.

AVERAGE DISTRIBUTION OF THE FORMS OF NITROGEN IN THE BODIES OF PIGS 40 TO 43 WEEKS OLD

From the data given in the first part of this bulletin it is evident that differences in the amounts of protein consumed had no influence upon the percentages of the various forms of nitrogen in the bodies of the pigs used in this experiment. Accordingly, the averages for the five animals may be regarded as representing the normal distribution of the forms of nitrogen in the bodies of pigs 40 to 43 weeks old, weighing from 180 to 250 pounds. These values have been summarized in Table 11, and, in part, plotted graphically in Fig. 1.

Distribution of Forms of Nitrogen in Percent of Fresh Substance

Total Nitrogen and Insoluble Protein Nitrogen.—The percentages of total nitrogen and insoluble protein nitrogen in the parts of the body tended to vary in the same direction. In other words, if the percentage of total nitrogen in the bone and marrow, for example, was high as compared with that in the boneless meat of the dressed carcass, the percentage of insoluble protein nitrogen was also high. In the boneless meat of the shoulder these constituents made up 2.197 and 1.692 percent of the fresh substance, respectively. In the side cut the percentages were appreciably less, and in the ham cut they were considerably higher. The percentages in the total boneless meat of the dressed carcass were slightly less than those found in the shoulder. The highest points were reached in the bone and marrow in which the total nitrogen made up 3.676 percent of the fresh substance, and the insoluble protein nitrogen, 3.292 percent. In the offal the percentages of total nitrogen were slightly less than those in the bone and marrow, and the percentages of insoluble protein nitrogen were appreciably less. The total nitrogen of the blood was somewhat less still than that in the offal, amounting to 3.036 percent. In the entire body the percentages of total nitrogen and insoluble protein nitrogen were about the same as those found in the boneless meat of the ham.

Soluble Nitrogen and Coagulable Protein Nitrogen.—In general, the variations in the soluble nitrogen and the coagulable protein nitrogen were very similar. In the case of the samples of boneless meat they varied in the same direction as the total nitrogen and the insoluble protein nitrogen. In the other samples, however, the variations in the two cases were rather markedly different. In the boneless meat of the shoulder the soluble protein made up 0.505 percent of the fresh substance, and the coagulable protein nitrogen, 0.258 percent. The percentages in the side were markedly less, those in the ham, considerably greater, while those in the total boneless meat were a little less

TABLE 11.—DISTRIBUTION OF FORMS OF NITROGEN IN THE BODIES OF PIGS 40 TO 43 WEEKS OLD
(Results expressed in percent of fresh substance)

	Total nitrogen	Soluble nitrogen	Protein nitrogen								Non-protein nitrogen				
			Soluble					Insoluble	Total		Extractive			Ammonia	Total
			Coagulable	Precipitated			Total soluble				Creatin	Other than creatin	Total		
				By tannic acid	By phosphotungstic acid	Total									
Boneless meat of shoulder cut	2.197	0.505	0.258	....	....	0.066	0.325	1.692	2.017		0.036	0.066	0.152	0.028	0.180
Boneless meat of side cut[1]	1.676	0.364	0.178	....	....	0.070	0.248	1.312	1.560		0.067	0.027	0.094	0.021	0.116
Boneless meat of ham cut	2.447	0.638	0.308	....	....	0.105	0.413	1.809	2.222		0.102	0.096	0.198	0.027	0.225
Boneless meat of dressed carcass	2.018	0.473	0.231	....	....	0.086	0.317	1.545	1.863		0.081	0.047	0.129	0.027	0.156
Bone and marrow	3.676	0.383	0.117	0.039	0.046	0.085	0.202	3.293	3.495		Trace	0.083	0.073	0.098	0.181
Composite offal	3.591	0.720	0.229	....	....	0.142	0.371	2.871	3.242		0.015	0.210	0.226	0.124	0.349
Composite fat	0.471	0.077	0.023	0.010	0.004	0.014	0.037	0.393	0.432		Trace	....	0.033	0.007	0.040
Blood	3.036	....	2.881	....	....	0.053	....	....	2.935		Trace	....	0.090	0.010	0.101
Entire body	2.361	0.562	0.293	....	....	0.089	0.382	1.799	2.181		0.054	0.078	0.132	0.048	0.180

[1] Average of values for four pigs (Nos. 5, 7, 16, and 13).

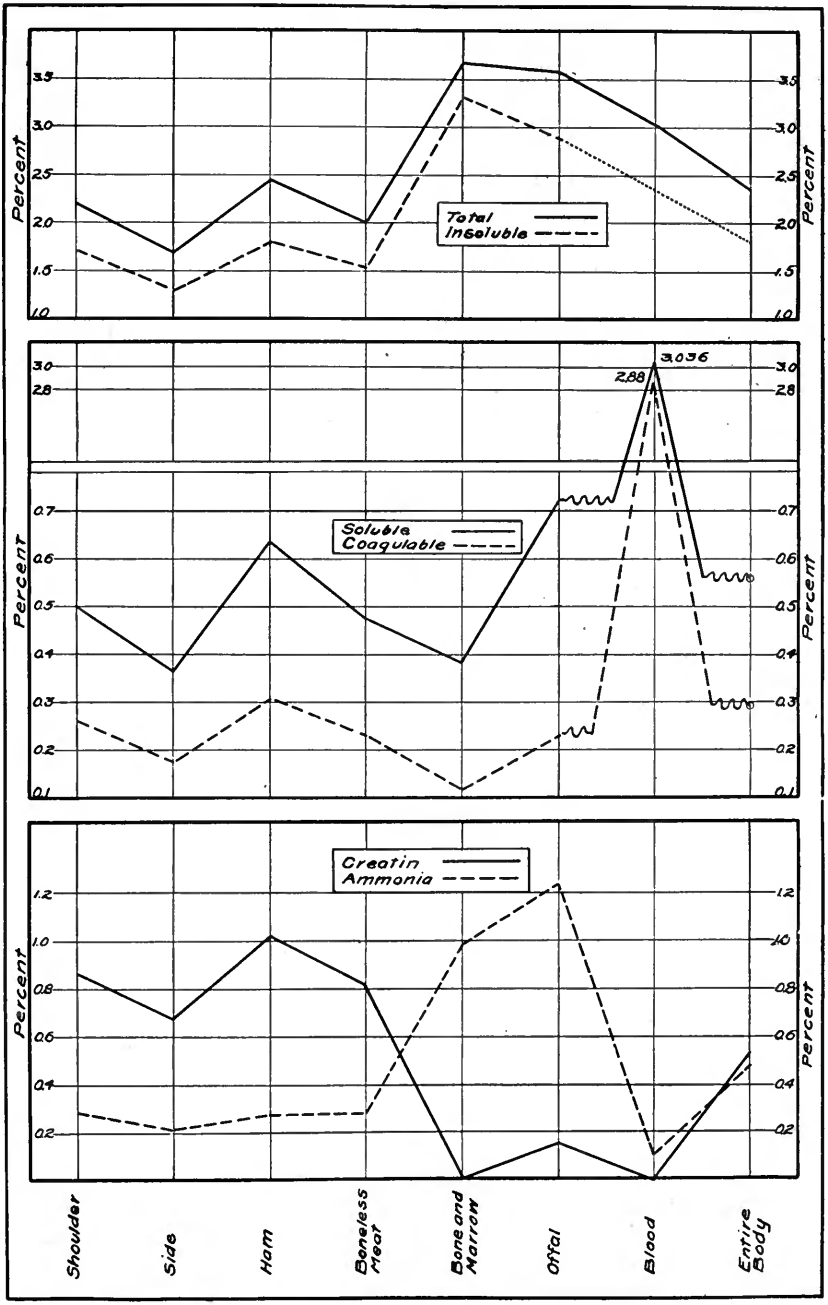

FIG. 1.—PERCENTAGE DISTRIBUTION OF FORMS OF NITROGEN AMONG THE PARTS OF THE BODY

than those in the shoulder. With the exception of the fat samples, the percentages of soluble nitrogen and coagulable protein nitrogen reached their lowest points, i.e., 0.383 and 0.117 percent, respectively, in the bone and marrow. In the offal, there was a large increase in the soluble nitrogen over that in the bone and marrow. The highest point in both forms was reached in the blood sample, in which the soluble nitrogen made up 3.036 percent of the fresh substance, and the coagulable protein nitrogen 2.881 percent. In this case the total nitrogen has been given as soluble nitrogen, and any nitrogen that was insoluble has been included in the coagulable protein nitrogen. In the entire body the soluble nitrogen made up 0.562 percent, and the coagulable protein nitrogen, 0.293 percent. The latter value was comparable to that found in the ham, while the former was appreciably lower than that of the ham.

Nitrogen Precipitated by Tannic and Phosphotungstic Acids.—In the case of the nitrogen precipitated by tannic and phosphotungstic acids, the highest value, 0.142 percent, was found in the offal. As will be noted also in regard to the percentages of all of the other forms of nitrogen, the lowest value was found in the composite sample of the fats.

Soluble and Total Protein Nitrogen.—The soluble protein nitrogen varied in almost the same manner as the coagulable protein nitrogen, and the total protein nitrogen in the same manner as the total nitrogen.

Creatin Nitrogen.—The creatin nitrogen of the meat samples varied in the same direction as the other forms of nitrogen. Only a trace was found in the bone and marrow and the blood, and only a small amount in the offal. The percentage amount in the entire body was appreciably below that in the meat of the side cut.

Ammonia Nitrogen.—There was no appreciable variation in the percentages of ammonia nitrogen in the three meat samples. The highest percentage was that in the offal, and the next highest, that in the bone and marrow. The blood contained only a very small amount. The percentage in the body as a whole was appreciably above that of any of the meat samples.

Distribution of Forms of Nitrogen in Percent of Total Nitrogen

In Table 12 is given the distribution of the forms of nitrogen in the various parts of the pigs expressed in percent of the total nitrogen in each part.

TABLE 12.—DISTRIBUTION OF FORMS OF NITROGEN IN THE BODIES OF PIGS 40 TO 43 WEEKS OLD

(Results expressed in percent of total nitrogen)

	Soluble nitrogen	Protein nitrogen					Non-protein nitrogen			
		Soluble					Extractive			
		Coagulable	Precipitated by acids[1]	Total	Insoluble	Total	Creatin	Total	Ammonia	Total
Boneless meat of shoulder cut	23.00	11.77	3.02	14.79	77.00	91.79	3.91	6.94	1.27	8.21
Boneless meat of side cut[2]	21.72	10.62	4.16	14.78	78.27	93.05	4.03	5.68	1.27	6.94
Boneless meat of ham cut	26.05	12.57	4.32	16.89	73.95	90.83	4.20	8.06	1.11	9.17
Boneless meat of dressed carcass	23.43	11.48	4.24	15.72	76.57	92.29	4.03	6.38	1.33	7.71
Bone and marrow	10.43	3.18	2.31	5.50	89.57	95.06	Trace	2.26	2.68	4.94
Composite offal	20.19	6.38	3.99	10.37	79.81	90.18	0.42	6.35	3.47	9.82
Composite fat	16.74	4.90	3.08	7.98	83.26	91.24	Trace	7.22	1.54	8.76
Blood	....	94.93	1.76	96.68	....	96.68	Trace	3.00	0.28	3.32
Entire body	23.81	12.41	3.78	16.19	76.18	92.37	2.30	5.61	2.02	7.63

[1]Precipitated by tannic and phosphotungstic acids.

[2] Average of values for four pigs (Nos. 5, 7, 16, and 13).

Soluble Nitrogen.—From 20 to 26 percent of the nitrogen of the meat samples, the offal, and the entire body was soluble in cold water. The boneless meat of the ham cut contained the largest percentage of its total nitrogen in the soluble form, and the bone and marrow, the smallest.

Coagulable Protein Nitrogen.—Excluding the blood, the proteins coagulated by heat from cold water solution contained from 3.18 to 12.57 percent of the total nitrogen of the samples analyzed. Here again the percentage in the meat of the ham cut was the largest, and that of the bone and marrow, the smallest. In the case of the blood it was assumed that all of the nitrogen was soluble. Of this, 95 percent was coagulable protein nitrogen.

Nitrogen Precipitated by Tannic and Phosphotungstic Acids.—The nitrogen precipitated by tannic and phosphotungstic acids and the nitrogen of the soluble protein varied in about the same manner as the nitrogen of the coagulable protein.

Insoluble Nitrogen.—Exclusive of the nitrogen in the blood, the nitrogen insoluble in cold water made up from 74 to 90 percent of the total nitrogen, the highest value being that for the bone and marrow, and the lowest that for the meat of the ham.

Total Protein Nitrogen.—The blood contained the largest percentage of its total nitrogen in the form of protein nitrogen, and the offal, the smallest. The respective values for these two samples were 96.68 and 90.18 percent.

Non-Protein Nitrogen.—The highest values for creatin nitrogen in a part of the body in percent of the total nitrogen in that part were those found for the meat samples. The highest values for ammonia nitrogen were those for the offal. The percentages of ammonia nitrogen in the blood were relatively small. The blood contained the lowest percentage of non-protein nitrogen, i.e., 3.32 percent. The highest value for non-protein nitrogen, 9.82 percent, was found in the composite offal. The meat samples also, and particularly the ham, contained comparatively large amounts of non-protein nitrogen.

SUMMARY

1. *Plan of Experiment.*—Twelve carefully selected Berkshire pigs weighing on an average 51 pounds were divided into three lots of four pigs each in such a way that the lots were as nearly alike as possible in regard to age, ancestry, weight, and condition. During the experiment, which lasted 174 days, Lot I was fed a low-protein ration (0.32 pound of digestible protein per day per 100 pounds live weight); Lot II, a medium-protein ration (0.70 pound of digestible protein per day per 100 pounds live weight); and Lot III, a high-protein ration (0.94 pound of digestible protein per day per 100 pounds live weight). Each ration consisted of ground corn, blood meal, and calcium phosphate. All of the pigs received the same amounts of corn protein per 100 pounds live weight. The blood-meal protein made up 50 percent of the total protein received by the pigs of Lot I, 80 percent of that received by Lot II, and 86 percent of that received by Lot III. Lot I received 3.79 therms of metabolizable energy per 100 pounds live weight per day; Lot II, 4.28 therms; and Lot III, 4.49 therms. The calcium phosphate was so fed that the rations of Lots I, II, and III contained, respectively, 11.09, 9.69, and 8.73 grams of phosphorus per 100 pounds live weight per day. The pigs of the three lots were kept and fed under exactly the same conditions thruout the experiment. Each pig was fed separately. At the end of the experiment the bodies and parts of one pig of Lot I and two pigs of each of Lots II and III were analyzed for nitrogen.

INFLUENCE OF QUANTITY OF PROTEIN CONSUMED

2. *Total Nitrogen.*—The percentages of total nitrogen in the bodies and the parts of the bodies of the low-, medium-, and high-protein lots, respectively, were as follows: boneless meat of dressed carcass, 2.169, 1.961, and 2.000; bone and marrow, 3.543, 3.704, and 3.714; blood, 3.012, 2.903, and 3.180; and entire body, 2.415, 2.309, and 2.386. The differences between the values for the individual pigs, however, were of such size that the differences between the averages for the lots cannot be regarded as significant.

3. *Soluble Nitrogen.*—The percentages of soluble nitrogen in the bodies and the parts of the bodies of the low-, medium-, and high-protein lots, respectively, were: boneless meat of dressed carcass, 0.523, 0.496, and 0.425; bone and marrow, 0.369, 0.372, and 0.401; and entire body, 0.578, 0.574, and 0.541. However, the differences between the lots were too small relative to the differences between the values for the individual pigs to be of any great significance with respect to the influence of the amounts of protein consumed.

4. *Protein Nitrogen.*—The percentages of protein nitrogen in the bodies and the parts of the bodies of the low-, medium-, and high-protein lots, respectively, were: boneless meat of dressed carcass, 2.007, 1.793, and 1.860; bone and marrow, 3.371, 3.526, and 3.525; blood, 2.907, 2.825, and 3.057; and entire body, 2.237, 2.121, and 2.213. Here again, the lot differences were relatively too small to indicate that the differences in the feed exerted any effect.

5. *Non-Protein Nitrogen.*—The percentages of non-protein nitrogen in the bodies and the parts of the bodies of the low-, medium-, and high-protein lots, respectively, were: boneless meat of dressed carcass, 0.162, 0.168, and 0.140; bone and marrow, 0.172, 0.173, and 0.189; blood, 0.105, 0.078, and 0.122; and entire body, 0.178, 0.188, and 0.172. Again, as in the case of the total nitrogen, the soluble nitrogen, and the protein nitrogen, the differences between the values for the individual pigs rendered the differences between the lots insignificant.

AVERAGE DISTRIBUTION OF FORMS OF NITROGEN IN THE BODIES OF PIGS 40 TO 43 WEEKS OLD

6. *Boneless Meat of Dressed Carcass.*—The percentages of total nitrogen, soluble nitrogen, protein nitrogen, and non-protein nitrogen, respectively, in the dressed carcasses of the five pigs were as follows: 2.018, 0.473, 1.863, and 0.156. The forms of nitrogen in the dressed carcass expressed in percent of the total nitrogen were: total protein nitrogen, 92.29; insoluble protein nitrogen, 76.57; soluble nitrogen, 23.43; total soluble protein nitrogen, 15.72; coagulable protein nitrogen, 11.48; total non-protein nitrogen, 7.71; total extractive nitrogen, 6.38; soluble protein nitrogen precipitated by tannic and phosphotungstic acids, 4.24; creatin nitrogen, 4.03; and ammonia nitrogen, 1.33.

7. *Bone and Marrow.*—The percentages of total nitrogen, soluble nitrogen, protein nitrogen, and non-protein nitrogen, respectively, in the bones and marrow of the five pigs were as follows: 3.676, 0.383, 3.495, and 0.181. The forms of nitrogen in the bone and marrow expressed in percent of the total nitrogen were: total protein nitrogen, 95.06; insoluble protein nitrogen, 89.57; soluble nitrogen, 10.43; total soluble protein nitrogen, 5.50; total non-protein nitrogen, 4.94; soluble coagulable protein nitrogen, 3.18; ammonia nitrogen, 2.68; total extractive nitrogen, 2.26; soluble protein nitrogen precipitated by tannic and phosphotungstic acids, 2.31; and creatin nitrogen, a trace only.

8. *Blood.*—The percentages of total nitrogen, protein nitrogen, and non-protein nitrogen, respectively, in the blood of the five pigs were as follows: 3.036, 2.935, and 0.101. The forms of nitrogen in the blood expressed in percent of the total nitrogen were: total protein nitrogen, 96.68; total soluble protein nitrogen, 96.68; soluble coag-

ulable protein nitrogen, 94.93; total non-protein nitrogen, 3.32; total extractive nitrogen, 3.00; soluble protein nitrogen precipitated by tannic and phosphotungstic acids, 1.76; ammonia nitrogen, 0.28; and creatin nitrogen, a trace only.

9. *Entire Body.*—The percentages of total nitrogen, soluble nitrogen, protein nitrogen, and non-protein nitrogen, respectively, in the entire bodies of the five pigs were as follows: 2.361, 0.562, 2.181, and 0.180. The forms of nitrogen in the entire body expressed in percent of the total nitrogen were: total protein nitrogen, 92.37; insoluble protein nitrogen, 76.18; soluble nitrogen, 23.81; total soluble protein nitrogen, 16.19; soluble coagulable protein nitrogen, 12.41; total non-protein nitrogen, 7.63; total extractive nitrogen, 5.61; soluble protein nitrogen precipitated by tannic and phosphotungstic acids, 3.78; creatin nitrogen, 2.30; and ammonia nitrogen, 2.02.

CONCLUSIONS

1. Variations of from 0.32 to 0.94 pound per 100 pounds live weight per day in the amounts of protein consumed by growing pigs do not seem to affect the nature of the nitrogenous material produced during growth. While it is possible that, within narrow limits, slight variations may result from differences in the amounts of protein consumed, it seems much more probable that variations in the composition of the nitrogenous constituents are due to causes inherent in the animal itself which normally are independent of the character of the feed consumed. Apparently, under given experimental conditions, the only way in which the influence of these individual variations may be reduced is in selecting the experimental animals carefully and including a considerable number of animals in each group.

2. When the supply of protein is deficient either quantatively or qualitatively, it seems that only the *amount* of the body protein is affected, while the *character* of the proteins formed in the various tissues remains unchanged.

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