sponge test or actual baking tests have been found most indicative in determining the value of a flour for bread purposes.

SUMMARY.

Crude gluten consists of about 75 per cent. of true gluten—gliadin and glutenin—together with small percentages of non-gluten proteid, mineral matter, fat, starch, fibre and other non-proteid matter.

The relation of the crude gluten content to that of total protein ($N \times 5.7$) varies with the character of the flour, the crude gluten content being greater than total protein for straight and low-grade flours, nearly the same for patent flours and less for whole wheat meal.

Crude gluten is an expression, in addition to the true gluten content of a flour, of the balance between the loss of non-gluten proteids and gain from the retention of non-proteid substances. The relation of the crude gluten content to the total protein content can thus be explained by the varying composition of the different flours in respect to nitrogenous compounds and non-proteids.

Crude gluten is a very rough expression of the gluten content of a flour or wheat and the determination has but little worth in the valuation of flours.

The determination of total nitrogen and gliadin nitrogen with expression of the ratio of gliadin to total protein ($N \times 5.7$) seems to be the best simple method at hand for estimating the gluten content and ascertaining the character of the gluten in the valuation of wheats or flours.

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[CONTRIBUTIONS FROM THE CHEMICAL LABORATORY OF THE UNIVERSITY OF ILLINOIS.]

THE CHEMISTRY OF FLESH.

(THIRD PAPER.)[1]

A STUDY OF THE PHOSPHORUS CONTENT OF FLESH.

BY A. D. EMMETT AND H. S. GRINDLEY.

Received November 13, 1905.

IN CONNECTION with the researches upon the chemistry of flesh which are being made in this laboratory, it seemed desirable

[1] This Journal, **26**, 1086 (1904); **27**, 658 (1905).

to include a somewhat detailed study of the amounts and also of the nature of the various phosphorus compounds occurring in flesh.

Recently much work has been devoted to the study of the changes which the phosphorus compounds of seeds undergo during germination. The investigators who have been most active in this field of research are Iwanoff,[1] Zaleski,[2] Hart and Andrews,[3] Schulze and Castoro,[4] and Patten and Hart.[5]

Important investigations have also been made in determining the character of the phosphorus compounds of certain classes of animal substances. In this connection, mention should be made of the work of Katz,[6] Macleod,[7] Percival,[8] and Koch.[9]

Notwithstanding the fact that valuable information has been obtained during the last decade regarding the phosphorus compounds of certain animal substances, as yet, so far as the authors have been able to find, no systematic study has been undertaken which has for its object the determination of the quantities, the distribution and the nature of the inorganic and the organic compounds of phosphorus occurring in the different species of animals, the flesh of which is used as food for man. This paper records the results which have been obtained thus far in an investigation having in view the above object.

PRELIMINARY STUDY OF METHODS.

The methods for the separation and estimation of the inorganic and the organic forms of phosphorus are as yet imperfect. Zaleski,[10] in studying the changes which the phosphorus compounds of seeds undergo during germination, used as a solvent a 0.2 per cent. solution of hydrochloric acid. In the extract thus obtained he determined the inorganic, the organic and the total phosphorus. Zaleski separated the soluble inorganic phosphorus from the soluble organic phosphorus by precipitating the former with the

[1] Ber. bot. Ges. 20, 366 (1902).
[2] Ibid. 20, 426 (1902).
[3] Am. Ch. J. 30, 470 (1903).
[4] Z. physiol. Chem. 41, 477 (1903).
[5] Am. Ch. J. 31, 564 (1904).
[6] Archiv. Ges. Physiol. 63, 1 (1896).
[7] Z. physiol. Chem. 28, 535 (1899).
[8] C. R. 135, 1005 (1902).
[9] Am. J. Physiol. 11, 303 (1904).
[10] Ber. bot. Ges. 20, 426 (1902).

regular acid ammonium molybdate solution. He apparently considered that none of the organic phosphorus compounds would be changed by the action of the free nitric acid, and consequently that only the phosphorus already oxidized would be thrown down. The organic phosphorus was obtained indirectly by subtracting from the total soluble phosphorus, the amount of inorganic phosphorus determined by direct precipitation.

Iwanoff[1] also determined the inorganic phosphorus directly by using the ordinary acid ammonium molybdate solution. He stated that the influence of the nitric acid in the precipitating reagent was insignificant and that the organic matter did not interfere with the precipitation of the phosphates.

Hart and Andrews,[2] as a result of their work, claimed that the presence of the free nitric acid in the molybdate solution causes a removal of some of the phosphorus from the organic compounds. Their results prove that such an action does take place when nucleic acid from wheat bran is treated with the acid ammonium molybdate solution. Hart and Andrews therefore modified the usual method by using a neutral solution of the molybdate and just enough of free nitric acid to cause a separation of the ammonium phosphomolybdate.

Schulze and Castoro[3] have called attention to the fact that the modified method of Hart and Andrews might be at fault in that all the inorganic phosphorus under such conditions may not be precipitated. Grete[4] found that in the presence of organic matter considerable nitric acid must be added to obtain the separation of the phosphoric acid in the form of the molybdic compound. However, Schulze and Castoro made no direct test of the Hart and Andrews method.

A detailed study of the results of the researches of the above investigators indicates that excess of free nitric acid causes the decomposition of the organic phosphorus compounds of ungerminated and of germinated seeds. This being true, the presence of a strong mineral acid like nitric may readily cause serious changes in such complex and unstable substances as those existing in the water-soluble constituents of meats. In

[1] Ber. bot. Ges. 20, 366 (1902).
[2] Am. Ch. J. 30, 470 (1903).
[3] Z. physiol. Chem. 41, 477 (1903).
[4] Konig's Unter. landwirts. u. gewerb. Stoffe. Ed. 2, p. 147.

the light of these considerations it was thought best in the first place to study the applicability of the method of Hart and Andrews in separating and determining inorganic phosphorus from organic phosphorus in water extracts of flesh; and as the objection of Schulze and Castoro to the method of Hart and Andrews is of import, it has been taken into consideration in the following experimental work.

Experimental Study of the Method of Hart and Andrews.—A water extract of a sample of raw lean beef round was prepared by the methods described in a former paper[1] from this laboratory. Portions of 250 cc. each of this extract were taken in triplicate and precipitated by the method described by Hart and Andrews. The measured portions of the extract were neutralized to litmus with ammonium hydroxide, 10 grams of crystallized ammonium nitrate were added, and the solutions were placed upon the water-bath. When the temperature of the solutions had reached 65° C., 2 cc. of nitric acid (sp. gr. 1.20) were added, and this addition was followed by 50 cc. of neutral ammonium molybdate solution.

Immediately, a heavy, yellow-green, flocculent precipitate began to separate. After stirring several times, this precipitate settled, leaving a clear filtrate which was of an emerald-green color. The precipitate did not resemble the usual ammonium phosphomolybdate compound, either in color or in form. After standing two hours at room temperature, the precipitate was filtered and washed with a solution of ammonium nitrate. It was then treated with dilute ammonium hydroxide (2.5 per cent.) and hot water. It turned green at once, and was found to be partially insoluble. The resulting solution was dark brown in color and not clear. Upon neutralizing the solution with hydrochloric acid, a grayish flocculent precipitate was produced which was difficultly soluble in strong ammonium hydroxide. Upon adding the magnesia mixture the precipitate formed was flocculent and not of the characteristic nature of the ammonium magnesium phosphate.

Repeated attempts to use the Hart-Andrews method directly upon the water extracts of flesh proved that it could not be so used with accuracy without some modifications. The preliminary experiments indicated that the soluble proteids of

[1] This Journal, 27, 661 (1905).

the extracts were the substances which interfered with the method. This being the case, attempts were made to remove the interfering organic matter by previous precipitation.

In the first place, the precipitant used was neutral ammonium molybdate. To 250 cc. portions of the cold neutral extract, 25 cc. of the neutral molybdate solution were added. A grayish, flocculent precipitate resulted which was removed by filtration after allowing the solution to stand for two hours. The organic matter thus separated was found to contain some phosphorus in every instance. The filtrate from the above, after the addition of 10 grams of ammonium nitrate, was heated to 65° C. Two cc. of nitric acid and 25 cc. of the neutral ammonium molybdate solution were then added. A pale yellow, flocculent precipitate resulted. This ammonium phosphomolybdate precipitate was filtered, washed, and treated as usual for the estimation of phosphorus. The filtrate from this last precipitate remained clear after standing for twenty-four hours. Heating it to 65° C., and then adding 25 cc. of neutral ammonium molybdate did not cause an additional precipitation. However, when 1 cc. of nitric acid was added, a small additional precipitate of ammonium phosphomolybdate was formed. This was removed by filtration and then treated as usual for the determination of phosphorus. The filtrate from this second precipitation gave only a trace of the yellow precipitate upon the addition of another cubic centimeter of nitric acid. It was removed and put with the second precipitate above. The addition of still another cubic centimeter of acid to this last filtrate produced no further separation. The analytical results are given in the table below.

In the second place, an attempt was made to remove the interfering soluble proteid matter by precipitation with ammonium nitrate at a temperature of 65° C. For this purpose 250 cc. portions of the extracts were each treated with 10 grams of ammonium nitrate. The solutions were then heated to 65° C. for fifteen minutes. The resulting gray, flocculent precipitate was separated by filtration after standing for several hours and then washed with ammonium nitrate. This precipitate containing the organic matter, separated by the ammonium nitrate, was treated with ammonium hydroxide and hot water and the amount of phosphorus in the solution was determined as usual. The results proved that there was practically no phosphorus in

combination with the separated organic matter. The filtrate from the above precipitate was heated to 65° C., and 2 cc. of nitric acid and 50 cc. of neutral ammonium molybdate solution were added. The characteristic yellow precipitate began to separate immediately. After allowing the solution to stand three hours, the precipitate was removed by filtration. The resulting filtrate was heated to 65° C., and 25 cc. of neutral ammonium molybdate solution were added. No additional precipitate resulted. The addition of 1 cc. of nitric acid caused the separation of more of the ammonium phosphomolybdate. After the solution had stood for three hours, the precipitate was separated by filtration. The clear filtrate was heated to 65° C., and 1 cc. of nitric acid was again added. A very slight precipitate formed which was removed and the filtrate tested further with another cubic centimeter of acid. The solution now remained perfectly clear. The detailed results of this experiment are given below in Table I.

In the third place, an effort was made to remove the soluble proteid material by coagulation. To do this 500 cc. portions of the cold water extracts of flesh were evaporated upon the water-bath to about 50 cc. The solutions were filtered while hot, and washed thoroughly with hot water. The separated coagula were oxidized in the usual manner and tested for phosphorus. The results indicated clearly that the coagulated proteid matter contained at most only a trace of phosphorus. However, in order to prove conclusively the absence of phosphorus under such circumstances, three different portions of water extracts each from 100 grams of raw flesh were evaporated to about 250 cc., and then filtered. The filtrates were evaporated still further and any coagulable matter which separated was removed and added to the main portion. The coagula were oxidized and the solution tested quantitatively for phosphorus. The results proved that the average amount of phosphorus contained in the coagulated proteid equaled 0.003 per cent., calculated upon the basis of the fresh meat. Since the soluble proteids of flesh coagulable by heat amount to 2.5 per cent. of the fresh meat, the quantity of phosphorus in combination with the coagulated proteid matter equals only 0.12 per cent. of their weight. It is thus evident that the amount of phosphorus held mechanically

or otherwise in the coagula need not be further considered in this connection.

The filtrates from the coagula formed by the evaporation of 500 cc. portions of the original solution were made up to a volume of 200 cc. and neutralized to litmus with ammonium hydroxide. Ten grams of ammonium nitrate were added to the solutions which were then heated to 65° C. Two cc. of nitric acid (sp. gr. 1.20) and 50 cc. of the neutral ammonium molybdate solution were added. The characteristic yellow precipitate was produced, which was removed by filtration. The clear filtrates were heated to 65° C., and upon adding more of the neutral ammonium molybdate solution, they remained perfectly clear. The addition of 1 cc. of nitric acid produced no further precipitate. The addition of another cubic centimeter of acid produced no apparent change.

The following table gives a condensed summary of the results obtained in the preliminary work above described.

TABLE I.—RESULTS OF PRELIMINARY STUDY OF METHODS.

Laboratory No.	Method.	A, first precipitate. Per cent.	Filtrate from A. B plus 2 cc. HNO_3. Per cent.	Filtrate from B. C plus 1 cc. HNO_3. Per cent.	Filtrate from C. D plus 1 cc. HNO_3. Per cent.	Filtrate from D E plus 1 cc. HNO_3. Per cent.	Total inorganic phosphorus (5 cc. HNO_3). Per cent.
1811	Hart-Andrews regular	.....	0.044	0.062	none	none	0.106
1815		.....	0.045	0.052	trace	none	0.097
1818		.....	0.110	0.023	trace	none	0.133
	Average (3).....	.....	0.066	0.046	.....	.....	0.112
1811	Neutral molybdic solution	0.015	0.134	0.024	trace	none	0.173
1815		trace	0.029	0.070	trace	none	0.099
1818		trace	0.086	0.022	trace	none	0.108
	Average (3).....	0.005	0.083	0.039	.....	.....	0.127
1811	Ammonium nitrate	none	0.054	0.073	trace	none	0.127
1815		none	0.049	0.036	trace	none	0.085
1818		trace	0.089	0.036	trace	none	0.125
	Average (3).....	.....	0.064	0.048	.....	.....	0.112
1788	Evaporation and coagulation	none	0.125	none	none	none	0.125
1789		none	0.102	none	none	none	0.102
1811		0.014	0.097	none	none	none	0.111
1815		none	0.102	none	none	none	0.102
1818		none	0.111	none	none	none	0.111
	Average (last 3)	.....	0.103	.....	.....	.....	0.108

From a study of data given in this table, it can be seen first, that each of the four methods gives fairly concordant results so far as the amount of total inorganic phosphorus is concerned; second, that the precipitate resulting from the use of the neutral ammonium molybdate solution in the cold and the ammonium nitrate in the hot tends to carry down some phosphorus with it and this necessitates an additional determination; third, that in the method in which the bulk of the organic matter is removed by evaporation, the resulting coagulum contains but a trace of phosphorus; fourth, that the Hart-Andrews method, when applied to the filtrate from the above coagulum, gives the best results, being the only one of the four in which the separation is practically completed by one treatment of nitric acid and ammonium molybdate solution. The filtration of the yellow precipitate, when the latter method is used, is much better and the subsequent washing more rapid and complete than in any of the other methods above mentioned.

In consequence of the results obtained above it was deemed best to use in the future the method last mentioned, which involves the removal of the soluble interfering proteid matter by coagulation. However, a further study of the method was made before finally adopting it. In the first place, it seemed desirable, if possible, to do away with the tedious process of dissolving the pyrophosphate and reprecipitating the phosphorus with the magnesia mixture, which is, of course, necessary when there is any tendency toward reduction by the presence of organic matter. Accordingly, it was thought best to dissolve the yellow ammonium phosphomolybdate in the usual manner with ammonium hydroxide and hot water and then reprecipitate the same from acid solution, as recommended by Woy.[1] The ammoniacal solution of the yellow precipitate was neutralized with nitric acid and diluted to 200 cc. Five grams of ammonium nitrate were added to the solution which was heated to 60° C.; then, while stirring vigorously, 5 cc. of concentrated nitric acid and 20 cc. of acid ammonium molybdate solution were added. The yellow precipitate came down at once without any apparent contamination with organic matter. The filtration was rapid and the filtrate clear.

By this procedure the conditions for the precipitation of the

[1] Chem. Ztg. 21, 442.

phosphorus were brought back to those normally used and in this way no objection could be raised as to the precipitate being contaminated with molybdic acid or ammonium molybdate. Parallel test determinations of this method were made along with that of the official gravimetric method. The following table gives the results.

TABLE II.—RESULTS SHOWING THE INFLUENCE OF THE SOLUTION AND THE REPRECIPITATION OF THE AMMONIUM PHOSPHOMOLYBDATE.

Laboratory No.	Kind of meat.	Official method. Before dissolving. Per cent.	Official method. After dissolving. Per cent.	Modified method. Per cent.
1837_1	Beef rib, roast	0.095	0.087	0.089
1837_2	Beef rib, roast	0.095	0.091	0.088
1837_3	Beef rib, roast	0.097	0.089	.....
	Average (3)	0.096	0.089	0.089
1838_1	Beef rib, roast	0.146	0.106	0.104
1838_2	Beef rib, roast	0.122	0.106	0.104
1838_3	Beef rib, roast	0.118	0.102	.....
	Average (3)	0.128	0.104	0.104
	Average, all (6)	0.112	0.097	0.097

It will be seen by referring to the table, that there is practically no difference in the methods, and inasmuch as the modification makes the work simpler and also considerably shorter, it has been used throughout. Yet, it should be stated that when the ignited pyrophosphate was colored yellow, it was dissolved and reprecipitated.

Again, it was decided to test further the effect of varying amounts of nitric acid to see whether the organic compounds of flesh which contain phosphorus were as stable as the preliminary experiments indicated. For this purpose the following experiment was made upon a water extract of beef flesh. The inorganic phosphorus was precipitated as usual with the neutral ammonium molybdate solution. The filtrates were treated with 10 cc. of concentrated nitric acid, then heated to 60° C. and allowed to stand twenty-four hours. No yellow precipitate was produced. Twenty cc. more of the acid were added and the test repeated. There was no apparent effect produced by this amount of acid, showing that the organic matter was not easily oxidized. It is evident from this experiment that the soluble organic phosphorus compounds of flesh are indeed quite stable even in the presence of considerable excess of nitric acid. Not-

withstanding this fact, it was deemed advisable in the light of the experiment which follows to use the neutral ammonium molybdate solution in the work here reported.

At the same time another portion of the water extract was treated with an acid ammonium molybdate solution, after having removed the coagulum. In this way a direct comparison of the modified Hart-Andrews method was made with the regular official method. In this connection, exactly the same tests were made upon a solution of pure potassium acid phosphate in order to determine if the precipitation by neutral ammonium molybdate in the presence of only 3 cc. of nitric acid (sp. gr. 1.20) was complete.

The following table gives the data obtained in these experiments.

TABLE III.—COMPARISON OF THE OFFICIAL METHOD AND THE MODIFIED HART-ANDREWS METHOD.

		Official method (acid).		
Laboratory No.	Kind of material.	Before dissolving. Per cent.	After dissolving. Per cent.	Modified method (neutral). Per cent.
1921_1	Water extract of beef.....	0.0125	.....	0.0118
1921_2	Water extract of beef.....	0.0125	0.0120	0.0115
1921_3	Water extract of beef.....	0.0121	0.0117	0.0116
	Average (3).....	0.0124	0.0118	0.0116
1922_1	Potassium acid phosphate..	0.0237	.....	0.0233
1922_2	Potassium acid phosphate..	0.0235	.....	0.0233
1922_3	Potassium acid phosphate..	0.0230	.....	0.0234
	Average (3).....	0.0234	.....	0.0233

These results show that the ordinary acid ammonium molybdate solution and the neutral ammonium molybdate solution cause identically the same separation of phosphorus both in cold water extracts of flesh from which the coagulable proteids have been removed and in a solution of potassium dihydrogen phosphate containing no organic matter.

The amount of organic matter present in the above water extracts does not seem to have any more retarding action in the case of the neutral ammonium molybdate where only 3 cc. of nitric acid (sp. gr. 1.20) are present, than it does in the case of the ordinary ammonium molybdate, which is strongly acid. In order to determine still further the influence of the presence of organic matter upon the completeness of the precipitation of the ammonium phosphomolybdate the following test was

made. Two solutions, one of pure potassium acid phosphate and one containing the same amount of potassium acid phosphate mixed with lactic acid, peptone and lactose, were precipitated with neutral ammonium molybdate solution in the presence of only 3 cc. of nitric acid (sp. gr. 1.20). In the first case the average weight of the magnesium pyrophosphate obtained from duplicate determinations amounted to 0.0283 gram and in the latter case, where the precipitation was effected in the presence of organic matter the average weight of the magnesium pyrophosphate equaled 0.0285 gram. These results show that the organic substances above mentioned do not retard the formation of the yellow precipitate. They confirm the results obtained by Hans V. Juptner[1] who maintains that the presence of organic acids does not hinder the precipitation of the ammonium phosphomolybdate.

Methods Finally Adopted.—As a result of the above work the following methods were adopted for use in connection with this work. The total phosphorus in the meats and in the water extracts was determined by Neumann's[2] method which has been verified by Sherman.[3] The insoluble phosphorus was ascertained by difference, that is, by subtracting the total soluble phosphorus from the total phosphorus found in the flesh.

Briefly stated, the method used for the determination of the soluble inorganic phosphorus was as follows: 500 cc. portions of the water extract were evaporated upon the water-bath to 50 cc. The coagula were removed by filtration and thoroughly washed with boiling water. The filtrates were treated with 10 grams of ammonium nitrate and warmed upon the water-bath to 60° C. Three cc. of nitric acid (sp. gr. 1.20) and 50 cc. of neutral ammonium molybdate solution were added. During the precipitation the solutions were stirred vigorously. The solutions, after precipitation, were allowed to stand, with frequent stirring, upon the water-bath for fifteen minutes at a temperature of 60° C. They were then removed and allowed to stand in a warm place for two hours. At the end of this period, the precipitates were filtered and washed with a solution of ammonium nitrate as in the determination of the total phosphorus. The yellow precipitates of ammonium phosphomolybdate were dis-

[1] Oesterr. Zeit. Berg. u. Hütten., 1894, p. 471.

[2] Dubois Reymond's Archiv. (Physiol. Abth.), p. 552 (1897).

[3] This Journal, 24, 1106 (1902).

solved in ammonium hydroxide and hot water. The further details of the method are described above (page 32). The soluble organic phosphorus was obtained by difference, that is, by subtracting the soluble inorganic phosphorus as found immediately above from the total soluble phosphorus of the water extract.

It should be stated here that the volumetric method of Pemberton was tested along with the official gravimetric method, but it was found to be quite unsatisfactory for this work. It was difficult to obtain a definite end reaction with phenolphthalein as the indicator. The results were also found to be lower than those obtained by the use of the gravimetric method.

PHOSPHORUS CONTENT OF MEATS.

The methods for the determination of the different forms of phosphorus have been used upon samples of flesh, the chemical composition of which has been thoroughly studied in connection with other investigations of this laboratory. As a result, the data regarding the phosphorus content of flesh has been materially reinforced by the analytical results giving the complete composition of the meats. The tables give in detail the results so far obtained in this study.

DISCUSSION OF RESULTS.

The chemical composition of the meats will be discussed in this connection only so far as the results have to do directly with a consideration of the phosphorus content of flesh, since a paper will soon appear from this laboratory which will include a larger number of analyses of flesh than are presented at this time. Passing therefore directly to the consideration of the phosphorus of flesh it will be seen from the results given in Table VII, that the total phosphorus occurring in the fresh substance of uncooked beef round varies from 0.210 per cent. to 0.345 per cent., the average in the six samples here reported being 0.253 per cent. In these same samples of meat the total phosphorus soluble in cold water ranges from 0.146 to 0.257 per cent., averaging 0.193 per cent. The phosphorus in the form of compounds insoluble in cold water, in the fresh substance of uncooked beef round varies from 0.035 to 0.088 per cent., the average being 0.060 per cent. The soluble phosphorus in the form of inorganic substances, chiefly phosphates of potassium, ranges from 0.090 to 0.153 per cent. of the fresh substance of the beef round. The

average per cent. of phosphorus in this form equals 0.120. The phosphorus in the form of soluble organic matter varies from 0.043 to 0.104 per cent., the average being 0.073 per cent.

By referring to the same table, it will be seen that in nine different cuts of veal taken from the same animal, the total phosphorus varies from 0.168 to 0.269 per cent.; the total soluble phosphorus ranges from 0.112 to 0.157 per cent.; the insoluble phosphorus varies from 0.053 to 0.136 per cent.; the soluble inorganic phosphorus ranges from 0.075 to 0.118 per cent. while the soluble organic phosphorus varies from 0.018 to 0.041 per cent. The average results for the fresh substance of the nine samples of veal are as follows: Total phosphorus 0.202, total soluble phosphorus 0.128, insoluble phosphorus 0.074, soluble inorganic phosphorus 0.095, and soluble organic phosphorus 0.032 per cent.

From the average results given above for the beef and for the veal, it is evident that the phosphorus content of the samples of beef is greater than it is in those of the veal. This difference between the two kinds of meat is most marked in the case of the soluble organic phosphorus, which is 2.3 times greater in the beef than in the veal. All the other forms of phosphorus are greater in beef flesh than in veal flesh with one exception; namely, the insoluble phosphorus, which is somewhat greater in the veal than it is in the beef. These variations in the phosphorus content of the two kinds of flesh are not due to the difference in the quantities of water and fat which they contain. That this is true, may be readily observed by referring to Tables VIII and IX in which the results are calculated to the water-free basis and to the water-free and fat-free substance. In the former case, the average soluble organic phosphorus in the beef equals 0.285 per cent. while in the veal it amounts to only 0.110 per cent. That is to say, this form of phosphorus existing in the samples of beef is 2.6 times greater than that occurring in the samples of veal. Expressed upon the basis of the water-free and fat-free substance the total soluble phosphorus in the beef flesh is equal to 0.835 per cent. while it forms only 0.607 per cent. of the water-free substance of the veal.

At first sight, it would appear, perhaps, that this difference in the quantities of phosphorus in the two kinds of meat was due to the difference in the amount of fat which they contain; since

TABLE IV.—CHEMICAL COMPOSITION OF MEATS CALCULATED TO FRESH SUBSTANCE.

Laboratory No.	Kind of meat.	Water. Per cent.	Dry substance (direct.) Per cent.	Fat. Per cent.	Proteid. Soluble. Per cent.	Proteid. Insoluble. Per cent.	Proteid. Total. Per cent.	Organic extractives. Per cent.	Ash. Soluble. Per cent.	Ash. Insoluble. Per cent.	Ash. Total. Per cent.	Nitrogen. Soluble. Per cent.	Nitrogen. Insoluble. Per cent.	Nitrogen. Total. Per cent.
1788	Beef round, raw	73.42	27.40	3.15	2.42	17.96	20.38	2.78	0.87	0.22	1.09	0.7798	2.8732	3.6530
1789	Beef round, raw	74.53	26.10	3.59	2.42	16.35	18.77	2.68	0.95	0.11	1.06	0.7480	2.6170	3.3650
1823	Beef round, raw	75.61	24.41	2.14	2.42	15.97	18.39	2.80	1.00	0.08	1.08	0.7885	2.5555	3.3440
1828	Beef round, raw	75.69	24.95	2.52	2.21	16.40	18.61	2.76	0.94	0.12	1.06	0.7377	2.6243	3.3620
1849	Beef round, raw	74.22	26.29	2.46	2.97	16.61	19.58	3.15	0.99	0.11	1.10	0.8884	2.6566	3.5450
1850	Beef round, raw	74.89	25.26	2.24	2.93	15.67	18.60	3.34	0.99	0.09	1.08	0.8998	2.5062	3.4060
	Average (6)	74.73	25.74	2.68	2.57	16.49	19.06	2.92	0.96	0.12	1.08	0.8070	2.6388	3.4458
1853	Veal shank, raw	75.08	25.44	3.03	2.07	17.39	19.46	1.93	0.66	0.36	1.02	0.5687	2.7823	3.3510
1854	Veal chuck, raw	72.93	27.98	6.33	1.81	16.71	18.52	2.13	0.67	0.33	1.00	0.5536	2.6734	3.2270
1855	Veal ribs, raw	68.38	31.91	12.09	1.74	14.64	16.38	2.47	0.67	0.30	0.97	0.5904	2.3436	2.9340
1856	Veal shoulder, raw	71.00	29.29	8.57	1.88	15.43	17.31	2.37	0.74	0.30	1.04	0.5988	2.4682	3.0670
1857	Veal breast, raw	63.34	36.65	16.66	1.79	15.10	16.89	2.20	0.66	0.24	0.90	0.5367	2.4163	2.9530
1858	Veal loin, raw	68.08	31.40	10.95	1.79	15.24	17.03	2.44	0.74	0.24	0.98	0.6001	2.4389	3.0390
1859	Veal flank, raw	64.18	36.38	16.13	1.84	15.38	17.22	2.08	0.78	0.17	0.95	0.5889	2.4611	3.0500
1860	Veal leg, raw	73.40	26.04	3.76	1.83	16.28	18.11	3.08	0.89	0.20	1.09	0.6790	2.6050	3.2840
1861	Veal hind shank, raw	73.36	27.24	5.03	1.94	16.84	18.78	2.40	0.76	0.27	1.03	0.6257	2.6943	3.3200
	Average (9)	69.97	30.26	9.17	1.85	15.89	17.74	2.35	0.73	0.27	1.00	0.5935	2.5426	3.1361
1801	Beef round, boiled	61.26	39.69	3.54	0.14	34.43	34.57	1.00	0.34	0.24	0.58	0.1769	5.5091	5.6860
1807	Beef round, boiled	64.44	36.35	2.97	0.25	31.67	31.92	0.97	0.31	0.18	0.49	0.1816	5.0674	5.2490
1808	Beef round, boiled	61.70	39.00	3.65	0.33	33.45	33.78	1.01	0.42	0.14	0.56	0.2038	5.3512	5.5550

TABLE IV.—CHEMICAL COMPOSITION OF MEATS CALCULATED TO FRESH SUBSTANCE—*Continued.*

Laboratory No.	Kind of meat.	Water. Per cent.	Dry substance (direct). Per cent.	Fat. Per cent.	Proteid. Soluble. Per cent.	Proteid. Insoluble. Per cent.	Proteid. Total. Per cent.	Organic extractives. Per cent.	Ash. Soluble. Per cent.	Ash. Insoluble. Per cent.	Ash. Total. Per cent.	Ntirogen. Soluble. Per cent.	Ntirogen. Insoluble. Per cent.	Ntirogen. Total. Per cent.
1802	Beef round, boiled	59.54	41.44	3.92	0.18	35.65	35.83	1.12	0.31	0.26	0.57	0.1823	5.7037	5.8860
1824	Beef round, boiled	55.96	44.60	8.47	0.40	33.01	33.41	1.89	0.62	0.21	0.83	0.3046	5.3064	5.6110
1809	Beef round, boiled	60.61	40.12	3.53	1.04	33.72	34.76	1.21	0.44	0.18	0.62	0.3472	5.3948	5.7420
1803	Beef round, boiled	58.94	41.62	3.60	0.52	35.68	36.20	1.22	0.42	0.18	0.60	0.2534	5.7096	5.9630
	Average (7)	60.35	40.40	4.24	0.41	33.94	34.35	1.20	0.41	0.20	0.61	0.2357	5.4346	5.6703
1825	Beef round, pot roast	56.92	44.35	5.58	0.37	34.32	34.69	2.84	1.03	0.21	1.24	0.4783	5.4907	5.9690
1829	Beef round, pot roast	57.57	42.85	4.20	0.46	35.14	35.60	2.10	0.68	0.27	0.95	0.3953	5.6227	6.0180
1830	Beef round, pot roast	61.65	38 80	4.79	0.41	31.06	31.47	1.80	0.54	0.20	0.74	0.3365	4.9695	5.3060
	Average (3)	58.71	42.00	4.86	0.41	33.51	33.92	2.25	0.75	0.23	0.98	0.4034	5.3609	5.7643
1831	Beef rib, roast	44.78	55.08	36.84	0.52	15.30	15.82	1.59	0.65	0.18	0.83	0.3300	2.4490	2.7790
1833	Beef rib, roast	47.33	52.33	32.11	0.57	16.84	17.41	2.01	0.65	0.15	0.80	0.3678	2.6922	3.0600
1837	Beef rib, roast	53.33	47.07	25.21	0.48	18.56	19.04	1.93	0.77	0.12	0.89	0.3671	2.9709	3.3380
1838	Beef rib, roast	49.73	50.67	27.79	0.38	19.65	20.03	1.95	0.71	0.19	0.90	0.3520	3.1440	3.4960
1840	Beef rib, roast	42.35	58.07	37.16	0.33	18.04	18.37	1.77	0.66	0.11	0.77	0.3086	2.8874	3.1960
1848	Beef rib, roast	lost	....	lost	0.36	21.47	21.83	2.25	0.83	0.20	1.03	0.3981	3.4339	3.8320
1842	Beef rib, roast	45.73	54.64	35.19	0.31	16.44	16.75	1.82	0.67	0.21	0.88	0.3207	2.6303	2.9510
1844	Beef rib, roast	42.15	58.25	34.42	0.27	20.65	20.92	1.90	0.70	0.31	1.01	0.3271	3.3039	3.6310
1846	Beef rib, roast	45.63	55.10	27.60	0.25	23.59	23.84	2.60	0.44	0.62	1.06	0.3902	3.7748	4.1650
	Average (9)	46.38	53.90	32.04	0.39	18.94	19.33	1.98	0.68	0.23	0.91	0.3513	3.0318	3.3831

TABLE V.—CHEMICAL COMPOSITION OF MEATS CALCULATED TO WATER-FREE SUBSTANCE.

Laboratory No	Kind of meat.	Dry substance (direct). Per cent.	Fat. Per cent.	Proteid. Soluble. Per cent.	Proteid. Insoluble. Per cent.	Proteid. Total. Per cent.	Organic extractives. Per cent.	Ash. Soluble. Per cent.	Ash. Insoluble. Per cent.	Ash. Total. Per cent.	Nitrogen. Soluble. Per cent.	Nitrogen. Insoluble. Per cent.	Nitrogen. Total. Per cent.
1788	Beef round, raw	100.00	11.50	8.83	65.55	74.38	10.15	3.18	0.80	3.98	2.846	10.486	13.332
1789	Beef round, raw	100.00	13.75	9.27	62.65	71.92	10.27	3.64	0.42	4.06	2.866	10.027	12.893
1823	Beef round, raw	100.00	8.77	9.91	65.42	75.33	11.47	4.10	0.33	4.42	3.230	10.467	13.699
1828	Beef round, raw	100.00	10.10	8.86	65.73	74.59	11.06	3.77	0.48	4.25	2.957	10.518	13.475
1849	Beef round, raw	100.00	9.36	11.30	63.18	74.48	11.98	3.76	0.42	4.18	3.379	10.105	13.484
1850	Beef round, raw	100.00	8.87	11.60	62.03	73.63	13.22	3.92	0.36	4.28	3.562	9.922	13.484
	Average (6)	100.00	10.39	9.96	64.10	74.06	11.36	3.73	0.47	4.20	3.140	10.255	13.395
1853	Veal shank, raw	100.00	11.91	8.14	68.36	76.49	7.59	2.59	1.42	4.01	2.235	10.937	13.172
1854	Veal chuck, raw	100.00	22.62	6.47	59.72	66.19	7.61	2.39	1.18	3.57	1.979	9.554	11.533
1855	Veal ribs, raw	100.00	37.89	5.45	45.88	51.33	7.74	2.10	0.94	3.04	1.850	7.344	9.194
1856	Veal shoulder, raw	100.00	29.26	6.42	52.68	69.10	8.10	2.53	1.02	3.55	2.044	8.427	10.471
1857	Veal breast, raw	100.00	45.45	4.88	41.20	46.08	6.00	1.81	0.65	2.46	1.464	6.593	8.057
1858	Veal loin, raw	100.00	34.87	5.70	48.54	54.24	7.77	2.36	0.76	3.12	1.911	7.767	9.678
1859	Veal flank, raw	100.00	44.34	5.06	42.28	47.34	5.72	2.14	0.47	2.61	1.619	6.765	8.384
1860	Veal leg, raw	100.00	14.44	7.03	62.52	69.55	11.83	3.42	0.77	4.19	2.608	10.003	12.611
1861	Veal hind shank, raw	100.00	18.47	7.12	61.82	68.94	8.81	2.79	0.99	3.78	2.297	9.891	12.188
	Average (9)	100.00	28.81	6.25	53.67	59.92	7.91	2.46	0.91	3.37	2.001	8.586	10.587
1801	Beef round, boiled	100.00	8.92	0.35	86.75	87.10	2.52	0.86	0.60	1.46	0.446	13.880	14.326
1807	Beef round, boiled	100.00	8.17	0.69	87.13	87.81	2.67	0.85	0.50	1.35	0.500	13.940	14.440
1808	Beef round, boiled	100.00	9.36	0.85	85.77	86.62	2.59	1.08	0.36	1.44	0.522	13.721	14.243

TABLE V.—CHEMICAL COMPOSITION OF MEATS CALCULATED TO WATER-FREE SUBSTANCE—*Continued.*

Laboratory No.	Kind or meat.	Dry substance (direct). Per cent.	Fat. Per cent.	Proteid. Soluble. Per cent.	Proteid. Insoluble. Per cent.	Proteid. Total. Per cent.	Organic extractives. Per cent.	Ash. Soluble. Per cent.	Ash. Insoluble. Per cent.	Ash. Total. Per cent.	Nitrogen. Soluble. Per cent.	Nitrogen. Insoluble. Per cent.	Nitrogen. Total. Per cent.
1802	Beef round, boiled	100.00	9.46	0.44	86.03	86.46	2.70	0.75	0.63	1.38	0.440	13.764	14.204
1824	Beef round, boiled	100.00	18.99	0.90	74.01	74.91	4.24	1.39	0.47	1.86	0.683	11.898	12.581
1809	Beef round, boiled	100.00	8.80	2.59	84.05	86.64	3.02	1.10	0.45	1.55	0.865	13.447	14.312
1803	Beef round, boiled	100.00	8.65	1.25	85.73	86.98	2.93	1.01	0.43	1.44	0.609	13.718	14.327
	Average (7)	100.00	10.34	1.01	84.21	85.22	2.95	1.01	0.49	1.50	0.581	13.481	14.062
1825	Beef round, pot roast	100.00	12.58	0.83	77.39	78.22	6.40	2.32	0.48	2.80	1.079	12.380	13.459
1829	Beef round, pot roast	100.00	9.80	1.07	82.01	83.08	4.90	1.59	0.63	2.22	0.922	13.122	14.044
1830	Beef round, pot roast	100.00	12.35	1.06	80.05	81.11	4.64	1.40	0.51	1.91	0.867	12.808	13.675
	Average (3)	100.00	11.58	0.99	79.81	80.80	5.31	1.77	0.54	2.31	0.956	12.770	13.726
1831	Beef rib, roast	100.00	66.88	0.94	27.78	28.72	2.89	1.18	0.33	1.51	0.600	4.445	5.045
1833	Beef rib, roast	100.00	61.36	1.09	32.18	32.27	3.83	1.24	0.29	1.53	0.703	5.145	5.848
1837	Beef rib, roast	100.00	53.54	1.02	39.43	40.45	4.10	1.64	0.25	1.89	0.780	6.312	7.092
1838	Beef rib, roast	100.00	54.85	0.75	38.78	39.53	3.85	1.40	0.38	1.78	0.694	6.205	6.899
1840	Beef rib, roast	100.00	63.99	0.57	31.07	31.64	3.05	1.14	0.19	1.33	0.531	4.973	5.504
1842	Beef rib, roast	100.00	64.43	0.57	30.09	30.66	3.33	1.23	0.38	1.61	0.587	4.814	5.401
1844	Beef rib, roast	100.00	59.09	0.46	35.45	35.91	3.27	1.20	0.53	1.73	0.562	5.672	6.234
1846	Beef rib, roast	100.00	50.09	0.45	42.81	43.27	4.72	0.80	1.13	1.93	0.708	6.851	7.559
	Average (8)	100.00	59.28	0.73	34.70	35.43	3.63	1.23	0.43	1.66	0.646	5.552	6.198

TABLE VI.—CHEMICAL COMPOSITION OF MEATS CALCULATED TO WATER- AND FAT-FREE SUBSTANCE.

Laboratory No.	Kind of meat.	Dry substance (direct). Per cent.	Proteid. Soluble. Per cent.	Proteid. Insoluble. Per cent.	Proteid. Total. Per cent.	Organic extractives. Per cent.	Ash. Soluble. Per cent.	Ash. Insoluble. Per cent.	Ash. Total. Per cent.	Nitrogen. Soluble. Per cent.	Nitrogen. Insoluble. Per cent.	Nitrogen. Total. Per cent.
1788	Beef round, raw	100.00	9.98	74.06	84.04	11.46	3.59	0.90	4.49	3.216	11.848	15.064
1789	Beef round, raw	100.00	10.75	72.63	83.38	11.91	4.22	0.49	4.71	3.323	11.626	14.949
1823	Beef round, raw	100.00	10.87	71.71	82.58	12.58	4.49	0.36	4.85	3.541	11.475	15.016
1828	Beef round, raw	100.00	9.85	73.12	82.97	12.30	4.19	0.54	4.73	3.289	11.700	14.989
1849	Beef round, raw	100.00	12.46	69.70	82.16	13.22	4.15	0.46	4.62	3.728	11.148	14.876
1850	Beef round, raw	100.00	12.73	68.07	80.80	14.51	4.30	0.39	4.69	3.909	10.887	14.796
	Average (6)	100.00	11.11	71.55	82.66	12.66	4.16	0.52	4.68	3.501	11.447	14.948
1853	Veal shank, raw	100.00	9.24	77.60	86.84	8.61	2.94	1.61	4.55	2.538	12.415	14.953
1854	Veal chuck, raw	100.00	8.36	77.18	85.54	9.84	3.09	1.52	4.62	2.557	12.348	14.905
1855	Veal ribs, raw	100.00	8.78	73.86	82.64	12.46	3.38	1.51	4.89	2.979	11.824	14.803
1856	Veal shoulder, raw	100.00	9.07	74.47	83.54	11.44	3.57	1.45	5.03	2.890	11.912	14.802
1857	Veal breast, raw	100.00	8.95	75.54	84.49	11.01	3.30	1.20	4.50	2.685	12.088	14.773
1858	Veal loin raw	100.00	8.75	74.52	83.27	11.93	3.62	1.17	4.79	2.935	11.926	14.861
1859	Veal flank, raw	100.00	9.09	75.95	85.04	10.27	3.85	0.84	4.69	2.908	12.154	15.062
1860	Veal leg, raw	100.00	8.21	73.07	81.28	13.82	3.99	0.90	4.89	3.048	11.692	14.740
1861	Veal hind shank, raw	100.00	8.74	75.82	84.56	10.81	3.42	1.22	4.64	2.817	12.131	14.948
	Average (9)	100.00	8.80	75.33	84.13	11.13	3.46	1.27	4.73	2.817	12.055	14.872
1801	Beef round, boiled	100.00	0.39	95.24	95.63	2.77	0.94	0.66	1.60	0.489	15.240	15.729
1807	Beef round, boiled	100.00	0.75	94.88	95.63	2.91	0.93	0.54	1.47	0.544	15.181	15.725
1808	Beef round, boiled	100.00	0.93	94.63	95.56	2.86	1.19	0.40	1.58	0.576	15.138	15.714

TABLE VI.—CHEMICAL COMPOSITION OF MEATS CALCULATED TO WATER- AND FAT-FREE SUBSTANCE—*Continued.*

Laboartory No.	Kind or meat.	Dry substance (direct). Per cent.	Proteid. Soluble. Per cent.	Proteid. Insoluble. Per cent.	Proteid. Total. Per cent.	Organic extractives. Per cent.	Ash. Soluble. Per cent.	Ash. Insoluble. Per cent.	Ash. Total. Per cent.	Nitrogen. Soluble. Per cent.	Nitrogen. Insoluble. Per cent.	Nitrogen. Total. Per cent.
1802	Beef round, boiled	100.00	0.48	95.02	95.50	2.99	0.83	0.69	1 52	0.486	15.202	15.688
1824	Beef round, boiled	100.00	1.11	91.36	92.47	5.23	1.72	0.58	2.30	0.843	14.687	15.530
1809	Beef round, boiled	100.00	2.84	92.16	95.00	3.31	1.20	0.49	1.69	0.949	14.744	15.693
1803	Beef round, boiled	100.00	1.37	93.84	95.21	3.21	1.10	0.48	1.58	0.667	15.017	15.684
	Average (7)	100.00	1.12	93.88	95.00	3.32	1.13	0.55	1.68	0.650	15.030	15.680
1825	Beef round, pot roast	100.00	0.96	88.52	89.48	7.33	2.66	0.54	3.20	1.234	14.162	15.396
1829	Beef round, pot roast	100.00	1.19	90.92	92.11	5.43	1.76	0.70	2.46	1.023	14.548	15.571
1830	Beef round, pot roast	100.00	1.21	91.33	92.54	5.29	1.59	0.59	2.18	0.989	14.612	15.601
	Average (3)	100.00	1.12	90.26	91.38	6.02	2.00	0.61	2.61	1.082	14.441	15.523
1831	Beef rib, roast	100.00	2.85	83.88	86.73	8.72	3.56	0.99	4.55	1.809	13.427	15.286
1833	Beef rib, roast	100.00	2.82	83.28	86.10	9.94	3.21	0.75	3.96	1.819	13.315	15.134
1837	Beef rib, roast	100.00	2.20	84.90	87.10	8.83	3.52	0.55	4.07	1.679	13.591	15.270
1838	Beef rib, roast	100.00	1.66	89.88	91.54	8.52	3.10	0.83	3.93	1.538	13.741	15.279
1840	Beef rib, roast	100.00	1.58	86.28	87.86	8.46	3.15	0.53	3.68	1.476	13.809	15.285
1842	Beef rib, roast	100.00	1.59	84.52	86.12	9.36	3.44	1.08	4.52	1.649	13.523	15.172
1844	Beef rib, roast	100.00	1.13	86.66	87.79	7.97	2.94	1.30	4.24	1.372	13.865	15.237
1846	Beef rib, roast	100.00	0.91	85.78	86.69	9.45	1.60	2.25	3.85	1.419	13.726	15.145
	Average (8)	100.00	1.84	85.65	87.49	8.91	3.07	1.03	4.10	1.595	13.624	15.219

TABLE VII.—FORMS OF PHOSPHORUS IN MEATS CALCULATED TO FRESH SUBSTANCE.

Laboratory No.	Kind of meat.	Water. Per cent.	Dry substance (direct). Per cent.	Fat. Per cent.	Phosphorus. Soluble. Inorganic. Per cent.	Soluble. Organic. Per cent.	Soluble. Total. Per cent.	Insoluble. Per cent.	Total. Per cent.
1788	Beef round, raw	73.42	27.40	3.15	0.125	0.043	0.168	0.052	0.220
1789	Beef round, raw	74.53	26.10	3.59	0.102	0.044	0.146	0.064	0.210
1823	Beef round, raw	75.61	24.41	2.14	0.090	0.097	0.187	0.035	0.222
1828	Beef round, raw	75.69	24.95	2.52	0.102	0.048	0 150	0.060	0.310
1849	Beef round, raw	74.22	26.29	2.46	0.148	0.101	0.249	0.062	0.311
1850	Beef round, raw	74.89	25.26	2.24	0.153	0.104	0.257	0.088	0.345
	Average (6)	74.73	25.74	2.68	0.120	0.073	0.193	0.060	0.253
1853	Veal shank, raw	75.08	25.44	3.03	0.088	0.035	0.123	0.054	0.177
1854	Veal chuck, raw	72.93	27.98	6.33	0.087	0.036	0.123	0.070	0.193
1855	Veal ribs, raw	68.38	31.91	12.09	0.094	0.033	0.127	0.109	0.236
1856	Veal shoulder, raw	71.50	29.29	8.57	0.102	0.031	0.133	0.136	0.269
1857	Veal breast, raw	63.34	36.65	16.66	0.075	0.037	0.112	0.056	0.168
1858	Veal loin, raw	68.08	31.40	10.95	0.092	0.041	0.133	0.053	0.186
1859	Veal flank, raw	64.18	36.38	16.13	0.094	0.018	0.112	0.053	0.175
1860	Veal leg, raw	73.40	26.04	3.76	0.118	0.039	0.157	0.064	0.221
1861	Veal hind shank, raw	73.36	27.24	5.03	0.109	0.023	0.132	0.059	0.191
	Average (9)	69.97	30.26	9.17	0.095	0.032	0.128	0.074	0.202
1801	Beef round, boiled	61.26	39.69	3.54	....	....	0.075	0.087	0.162
1807	Beef round, boiled	64.44	36.35	2.97	....	....	0.067	0.076	0.143
1808	Beef round, boiled	61.70	39.00	3.65	....	....	0.068	0.094	0.162

TABLE VII.—FORMS OF PHOSPHORUS IN MEATS CALCULATED TO FRESH SUBSTANCE—*Continued.*

Laboratory No.	Kind of meat.	Water. Per cent.	Dry substance (direct.). Per cent.	Fat. Per cent.	Phosphorus. Soluble. Inorganic. Per cent.	Soluble. Organic. Per cent.	Soluble. Total. Per cent.	Insoluble. Per cent.	Total. Per cent.
1802	Beef round, boiled	59.54	41.44	3.92	....	....	0.073	0.094	0.167
1824	Beef round, boiled	55.96	44.60	8.47	0.085	0.041	0.126	0.087	0.213
1809	Beef round, boiled	60.61	40.12	3.53	....	....	0.081	0.080	0.161
1803	Beef round, boiled	58.94	41.62	3.60	....	....	0.081	0.086	0.167
	Average (7)	60.35	40.40	4.24	....	....	0.082	0.086	0.168
1825	Beef round, pot roast	56.92	44.35	5.58	0.122	0.059	0.181	0.083	0.264
1829	Beef round, pot roast	57.57	42.85	4.20	0.112	0.049	0.161	0.066	0.227
1830	Beef round, pot roast	61.65	38.80	4.79	0.104	0.018	0.122	0.103	0.225
	Average (3)	58.71	42.00	4.86	0.113	0.042	0.155	0.084	0.239
1831	Beef rib, roast	44.78	55.08	36.84	0.095	0.023	0.118	0.030	0.148
1833	Beef rib, roast	47.33	52.33	32.11	0.089	0.035	0.124	0.034	0.158
1837	Beef rib, roast	53.33	47.07	25.21	0 089	0.039	0.128	0.059	0.187
1838	Beef rib, roast	49.73	50.67	27.79	0.104	0.044	0.148	0.042	0.190
1840	Beef rib, roast	42.35	58.07	37.16	0.081	0.038	0.119	0.048	0.167
1848	Beef rib, roast	lost	....	lost	0.102	0.047	0.149	0.049	0.198
1842	Beef rib, roast	45.73	54.64	35.19	0.090	0.032	0.122	0.037	0.159
1844	Beef rib, roast	42.15	58.25	34.42	0.097	0.042	0.139	0.054	0.193
1846	Beef rib, roast	45.63	55.10	27.60	0.120	0.038	0.158	0.056	0.214
	Average (9)	46.38	53.90	32.04	0.096	0.038	0.134	0.045	0.179

TABLE VIII.—FORMS OF PHOSPHORUS IN MEATS CALCULATED TO WATER-FREE SUBSTANCE.

Laboratory No.	Kind of meat.	Dry substance (direct). Per cent.	Fat. Per cent.	Phosphorus. Soluble. Inorganic. Per cent.	Soluble. Organic. Per cent.	Soluble. Total. Per cent.	Insoluble. Per cent.	Total. Per cent.
1788	Beef round, raw.....	100.00	11.50	0.456	0.157	0.613	0.190	0.803
1789	Beef round, raw.....	100.00	13.75	0.391	0.169	0.560	0.245	0.805
1823	Beef round, raw.....	100.00	8.77	0.369	0.397	0.766	0.143	0.909
1828	Beef round, raw.....	100.00	10.10	0.409	0.192	0.601	0.240	0.841
1849	Beef round, raw.....	100.00	9.36	0.563	0.384	0.947	0.236	1.183
1150	Beef round, raw.....	100.00	8.87	0.606	0.411	1.017	0.348	1.366
	Average (6).....	100.00	10.39	0.466	0.285	0.751	0.234	0.985
1853	Veal shank, raw.....	100.00	11.91	0.346	0.138	0.484	0.212	0.696
1854	Veal chuck, raw.....	100.00	22.62	0.311	0.129	0.440	0.250	0.690
1855	Veal ribs, raw.....	100.00	37.89	0.295	0.103	0.398	0.341	0.740
1856	Veal shoulder, raw.....	100.00	29.26	0.349	0.106	0.455	0.465	0.920
1857	Veal breast, raw.....	100.00	45.45	0.205	0.101	0.306	0.152	0.458
1858	Veal loin, raw.....	100.00	34.87	0.293	0.131	0.424	0.168	0.592
1859	Veal flank, raw.....	100.00	44.34	0.258	0.049	0.307	0.174	0.481
1860	Veal leg, raw.....	100.00	14.44	0.453	0.150	0.603	0.246	0.849
1861	Veal hind shank, raw ..	100 00	18.47	0.400	0.084	0.484	0.217	0.701
	Average (9).....	100.00	28.81	0.323	0.110	0.433	0.248	0.681
1801	Beef round, boiled.....	100.00	8.92	....	....	0.189	0.219	0.408
1807	Beef round, boiled.....	100.00	8.17	....	....	0.184	0.209	0.393
1808	Beef round, boiled.....	100.00	9.36	....	....	0.174	0.241	0.415
1802	Beef round, boiled.....	100.00	9.46	....	....	0.176	0.227	0.403
1824	Beef round, boiled.....	100.00	18.99	0.191	0.092	0.283	0.195	0.478
1809	Beef round, boiled.....	100.00	8.80	....	....	0.202	0.199	0.401
1803	Beef round, boiled.....	100.00	8.65	....	....	0.195	0.207	0.401
	Average (7).....	100.00	10.34	....	....	0.200	0.214	0.414
1825	Beef round, pot roast...	100.00	12.58	0.275	0.133	0.408	0.187	0.595
1829	Beef round, pot roast...	100.00	9.80	0.261	0.114	0.375	0.154	0.529
1830	Beef round, pot roast...	100.00	12.35	0.268	0.046	0.314	0.265	0.580
	Average (3).....	100.00	11.58	0.268	0.098	0.366	0.202	0.568
1831	Beef rib, roast.....	100.00	66.88	0.172	0.042	0.214	0.055	0.269
1833	Beef rib, roast.....	100.00	61.26	0.170	0.067	0.237	0.064	0.301
1837	Beef rib, roast.....	100.00	53.54	0.189	0.083	0.272	0.126	0.398
1838	Beef rib, roast.....	100.00	54.85	0.205	0.087	0.292	0.083	0.375
1840	Beef rib, roast.....	100.00	63.99	0.139	0.066	0.205	0.083	0.288*
1842	Beef rib, roast.....	100.00	64.43	0.165	0.058	0.223	0.068	0.291
1844	Beef rib, roast.....	100.00	59.09	0.167	0.072	0.239	0.092	0.331
1846	Beef rib, roast.....	100.00	50.09	0.218	0.069	0.287	0.101	0.388
	Average (8).....	100.00	59.27	0.178	0.068	0.246	0.084	0.330

TABLE IX.—FORMS OF PHOSPHORUS IN MEATS CALCULATED TO WATER- AND FAT-FREE SUBSTANCE.

Laboratory No.	Kind of meat.	Dry substance (direct). Per cent.	Phosphorus. Soluble. Inorganic. Per cent.	Soluble. Organic. Per cent.	Soluble. Total. Per cent.	Insoluble. Per cent.	Total. Per cent.
1788	Beef round, raw	100.00	0.516	0.177	0.693	0.214	0.907
1789	Beef round, raw	100.00	0.453	0.196	0.649	0.284	0 933
1823	Beef round, raw	100.00	0.404	0.436	0.840	0.157	0.997
1828	Beef round, raw	100.00	0.455	0.214	0.669	0.267	0.936
1849	Beef round, raw	100.00	0.621	0.424	1.045	0.260	1.305
1850	Beef round, raw	100.00	0.665	0.451	1.116	0.382	1.499
	Average (6)	100.00	0.519	0.316	0.835	0.261	1.096
1853	Veal shank, raw	100.00	0.393	0.156	0.549	0.241	0.790
1854	Veal chuck, raw	100.00	0.400	0.167	0.568	0.324	0.892
1855	Veal ribs, raw	100.00	0.474	0.166	0.640	0.550	1.191
1856	Veal shoulder, raw	100.00	0.492	0.150	0.642	0.656	1.298
1857	Veal breast, raw	100.00	0.375	0.185	0.560	0.280	0.840
1858	Veal loin, raw	100.00	0.450	0.200	0.650	0.259	0.909
1859	Veal flank, raw	100.00	0.464	0.089	0.553	0.311	0.864
1860	Veal leg, raw	100.00	0.530	0.175	0.705	0.287	0.992
1861	Veal hind shank, raw	100.00	0.491	0.103	0.594	0.266	0.860
	Average (9)	100.00	0.452	0.155	0.607	0.353	0.960
1801	Beef round, boiled	100.00	....	....	0.207	0.241	0.448
1807	Beef round, boiled	100.00	....	....	0.201	0.228	0.428
1808	Beef round, boiled	100.00	....	....	0.192	0.266	0.458
1802	Beef round, boiled	100.00	....	....	0.195	0.251	0.446
1824	Beef round, boiled	100.00	0.235	0.114	0.349	0.241	0.590
1809	Beef round, boiled	100 00	....	....	0.221	0.219	0.440
1803	Beef round, boiled	100.00	....	....	0.213	0.226	0.439
	Average (7)	100.00	....	....	0.225	0.239	0.464
1825	Beef round, pot roast	100.00	0.315	0.152	0.467	0.214	0.681
1829	Beef round, pot roast	100.00	0.290	0.127	0.417	0.171	0.588
1830	Beef round, pot roast	100.00	0.306	0.053	0.359	0.303	0.662
	Average (3)	100.00	0.303	0.111	0.414	0.230	0.644
1831	Beef ribs, roast	100.00	0.521	0.126	0.647	0.164	0.811
1833	Beef ribs, roast	100.00	0.440	0.173	0.613	0.168	0.781
1837	Beef ribs, roast	100.00	0.407	0.178	0.586	0.270	0.855
1838	Beef ribs. roast	100.00	0.455	0.192	0.647	0.183	0.830
1840	Beef ribs, roast	100.00	0.387	0.182	0.569	0.230	0.799
1842	Beef ribs, roast	100.00	0.463	0.164	0.627	0.190	0.817
1844	Beef ribs, roast	100.00	0.407	0.176	0.583	0.227	0.810
1846	Beef ribs, roast	100.00	0.436	0.138	0.574	0.204	0.778
	Average (8)	100.00	0.440	0.166	0.606	0.204	0.810

in Table VIII, where the results are calculated to the water-free basis, the average amount of fat in the beef round is 10.39 per cent., with a maximum of 13.75 and a minimum of 8.77, while the average result for the veal is 28.81 per cent., varying from 11.91 per cent. in the shank cut, to 45.45 per cent. in the breast cut. However, from the results as calculated to the water and fat-free basis (see Table IX), it can be seen that this difference in the fat content of the beef and veal samples does not account for the greater amount of phosphorus in the flesh of beef.

While the data here presented are not sufficient to warrant a final conclusion, they do tend to indicate definitely that the flesh of beef contains a greater proportion of phosphorus than does the flesh of veal.

Again, in referring to the results given in Table VII, it will be noted that the amounts of phosphorus in the different cuts of veal from the same animal vary decidedly, the maximum being 0.269 per cent. in the shoulder cut and the minimum being 0.168 per cent. in the breast cut. These differences are just as pronounced when the results are calculated to the water-free basis (see Table VIII), the maximum being 0.920 per cent. in the shoulder and the minimum being 0.458 per cent. in the breast. Apparently, from the data presented in this table the amount of fat has but little influence upon the phosphorus content of the veal. The shank cut, for example, has 11.91 per cent. of fat and 0.696 per cent. of phosphorus; the shoulder, 29.26 per cent. of fat and 0.920 per cent. of phosphorus; and the breast, 45.45 per cent. of fat and 0.458 per cent. of phosphorus. In the first and second cases, the percentage of phosphorus varies directly with the fat content, while in the first and third instances the variation is indirect. There seems to be no definite relation between the amount of fat and the quantity of phosphorus found in the several cuts of veal.

By referring again to Table VII, it is apparent that the phosphorus content of the fresh substance of boiled beef round is considerably less than that of uncooked beef round, notwithstanding the fact that there is decidedly less water in the former than in the latter. The total phosphorus occurring in the fresh substance of boiled beef round varies from 0.143 to 0.213 per cent., the average in the seven samples being 0.168 per cent. In these same samples of boiled beef, the total phosphorus soluble

in cold water ranges from 0.067 to 0.126 per cent., averaging 0.082 per cent. The phosphorus in the form of compounds insoluble in cold water, in the fresh substance of boiled beef round varies from 0.076 to 0.094 per cent., the average being 0.086 per cent. Unfortunately in the analysis of the boiled meats, the determinations of the soluble inorganic phosphorus and of the soluble organic phosphorus were not made.

The difference in the amounts of phosphorus contained in uncooked beef and in boiled beef may be seen better from the data given in Tables VIII and IX in which the results of the analyses are calculated to the water-free basis and to the water-free and fat-free substance respectively. Under the former conditions, the average results for the uncooked beef round are as follows: Total phosphorus 0.985, total soluble phosphorus 0.751 and insoluble phosphorus 0.234 per cent. Upon the same basis the average results from the boiled beef round are as follows: Total phosphorus 0.414, total soluble phosphorus 0.200 and the insoluble phosphorus 0.214 per cent. In other words, the dry substance of uncooked beef round contains 2.4 times as much total phosphorus, 3.8 times as much soluble phosphorus and 1.1 times as much insoluble phosphorus as does the dry substance of the same beef round after it has been cooked in hot water by the method known as boiling. The average amounts of fat contained in the uncooked and in the cooked meat are practically the same, so that the results when calculated to the water-free basis and fat-free substance show the same relations to exist between the several forms of phosphorus in the meats as those indicated above for the water-free substance of the same.

The results given in Table VII, show that the total amount of phosphorus contained in the fresh substance of beef round cooked by pot-roasting is slightly less than that which was found in raw beef round; but, on the other hand, it is considerably greater than that contained in boiled beef round. In the fresh substance the average total soluble phosphorus in the pot-roasted beef is markedly lower than it is in raw beef round. This is due mainly to the greater amount of soluble organic phosphorus which occurs in the uncooked meat. In discussing these differences, it will be better to consider the data obtained after calculating the results to the water-free substance (see Table VIII) so that the variations due to the difference in the water content

of the different kinds of meat may be eliminated as far as possible. Upon this basis the average results for the pot-roasted beef round are as follows: Total phosphorus 0.568, total soluble phosphorus 0.366, insoluble phosphorus 0.202, soluble inorganic phosphorus 0.268 per cent., and soluble organic phosphorus 0.098 per cent. Upon the same basis the average results, so far as available for the boiled beef round, are total phosphorus 0.414, total soluble phosphorus 0.200, and insoluble phosphorus 0.214 per cent. The corresponding average results for the uncooked beef round are total phosphorus 0.985, total soluble phosphorus 0.751, insoluble phosphorus 0.234, soluble inorganic phosphorus 0.466, and soluble organic phosphorus 0.285 per cent. Since the average amounts of fat in the three varieties of meat are so nearly similar, the results above given are, practically speaking, strictly comparable with each other. It is thus evident that the dry substance of pot-roasted beef round contains 1.4 times as much total phosphorus, 1.8 times as much total soluble phosphorus, and only 0.9 times as much insoluble phosphorus as does the water-free substance of boiled beef round. Further, it is also plainly evident that the water-free substance of pot-roasted beef round contains only about 0.6 times as much total phosphorus, about 0.5 times as much total soluble phosphorus, a little more than 0.9 times as much insoluble phosphorus, somewhat less than 0.6 times as much soluble inorganic phosphorus, and a little more than 0.3 times as much soluble organic phosphorus as does the dry substance of uncooked beef round.

The analytical data presented in Table VII, also show that the total phosphorus occurring in the fresh substance of roasted beef ribs varies from 0.148 to 0.214 per cent., the average in the nine samples being 0.179 per cent. In these same samples of meat the total phosphorus soluble in cold water forms from 0.118 to 0.158 per cent., averaging 0.134 per cent. The phosphorus existing in the form of compounds insoluble in cold water, in the fresh substance of beef ribs cooked by roasting, varies from 0.030 to 0.059 per cent., the average being 0.045 per cent. The soluble phosphorus in the form of inorganic substances ranges from 0.081 to 0.120 per cent. of the fresh substance of the roasted beef ribs. The average per cent. of phosphorus in this form equals 0.096 per cent. The phosphorus in the form of

soluble organic matter varies from 0.023 to 0.047 per cent., the average being 0.038 per cent.

The averages given above, when calculated to the water-free substance of the roasted meat, give the following results: Total phosphorus 0.330, total soluble phosphorus 0.246, insoluble phosphorus 0.084, soluble inorganic phosphorus 0.178, and soluble organic phosphorus 0.068 per cent. From the data here given it is evident that the dry substance of the roasted beef contains a smaller amount of each of the forms of phosphorus than does the water-free substance of any of the other kinds of flesh here considered. This higher content of fat accounts for the much smaller quantity of phosphorus in its several forms in the water-free substance of the roasted beef ribs. When the results are calculated to the water-free and fat-free basis (see Table IX), the roasted beef ribs contain decidedly more of each of the forms of phosphorus with one exception, namely, the insoluble phosphorus, than does the water and fat-free substance of the pot-roasted beef round and the boiled beef round. On the other hand, the water and fat-free substance of roasted beef ribs contains much less of all of the several forms of phosphorus than does the uncooked lean beef round, when considered upon the same basis.

DISTRIBUTION OF THE TOTAL PHOSPHORUS IN FLESH.

In order to show plainly the distribution of the total phosphorus content of flesh between the soluble and the insoluble forms and between the inorganic and the organic forms the results of the analyses have been calculated so as to express these different forms of phosphorus in per cents. of the total and total soluble phosphorus respectively. The data so obtained are presented in Table X.

It is apparent from the results given in Table X that from 69.52 to 80.07 per cent. of the total phosphorus occurring in raw beef round exists in compounds which are soluble in water. The phosphorus forming insoluble compounds varies from 19.93 to 30.48 per cent. of the total phosphorus found in the raw beef round. In the six samples of raw beef round here reported the soluble inorganic phosphorus varies from 40.54 to 56.82 per cent. and the soluble organic phosphorus ranges from 19.54 to 38.29 per cent. of the total phosphorus which these

TABLE X.—FORMS OF PHOSPHORUS IN MEATS EXPRESSED IN PER CENTS. OF THE TOTAL AND TOTAL SOLUBLE PHOSPHORUS, RESPECTIVELY.

Laboratory No.	Kind of meat.	Total phosphorus. Per cent.	Total soluble phosphorus. Per cent.	Total phosphorus.					Total soluble phosphorus.		
				Soluble.							
				Inorganic. Per cent.	Organic. Per cent.	Total. Per cent.	Insoluble. Per cent.	Total. Per cent.	Inorganic. Per cent.	Organic. Per cent.	Total. Per cent.
1788	Beef round, raw	0.220	0.168	56.82	19.54	76.36	23.64	100.00	74.41	25.59	100.00
1789	Beef round, raw	0.210	0.146	48.57	20.95	69.52	30.48	100.00	69.86	30.14	100.00
1823	Beef round, raw	0.222	0.187	40.54	38.29	78.83	21.17	100.00	51.43	48.57	100.00
1828	Beef round, raw	0.210	0.150	48.57	22.86	71.43	28.57	100.00	68.00	32.00	100.00
1849	Beef round, raw	0.311	0.249	47.59	32.48	80.07	19.93	100.00	59.44	40.56	100.00
1850	Beef round, raw	0.345	0.257	44.35	30.14	74.49	25.51	100.00	59.54	40.46	100.00
	Average (6)	0 253	0.193	47.74	27.38	75.12	24.88	100.00	63.78	36.22	100.00
1853	Veal shank, raw	0.177	0.123	49.75	19.74	69.49	30.51	100.00	71.54	28.46	100.00
1854	Veal chuck, raw	0.193	0.123	45.12	18.63	63.75	36.25	100.00	70.73	29.27	100.00
1855	Veal ribs, raw	0.236	0.127	39.80	14.02	53.82	46.18	100.00	74.02	25.98	100.00
1856	Veal shoulder, raw	0.269	0.133	37.92	11.54	49.46	50.54	100.00	76.69	23.31	100.00
1857	Veal breast, raw	0.168	0.112	44.65	22.02	66.67	33.33	100.00	66.96	33.04	100.00
1858	Veal loin, raw	0.186	0.133	49.45	21.98	71.43	28.57	100.00	69.17	30.83	100.00
1859	Veal flank, raw	0.175	0.112	53.70	10.30	64.00	36.00	100.00	83.93	16.07	100.00
1860	Veal leg, raw	0.221	0.157	53.43	17.64	71.07	28.93	100.00	75.16	24.84	100.00
1861	Veal hind shank, raw	0.191	0.132	57.07	12.04	69.11	30.93	100.00	82.58	17.42	100.00
	Average (9)	0.202	0.128	47.88	16.43	64.31	35.69	100.00	74.53	25.47	100.00
1801	Beef round, boiled	0.162	0.075	....	....	46.29	53.71	100.00	....	....	100.00
1807	Beef round, boiled	0.143	0.067	....	....	46.85	53.15	100.00	....	....	100.00
1808	Beef round, boiled	0.162	0.068	....	....	41.98	58.02	100.00	....	....	100.00

TABLE X.—FORMS OF PHOSPHORUS IN MEATS EXPRESSED IN PER CENTS. OF THE TOTAL AND TOTAL SOLUBLE PHOSPHORUS, RESPECTIVELY—*Continued.*

Laboratory No.	Kind of meat.	Total phosphorus. Per cent.	Total soluble phosphorus. Per cent.	Total phosphorus. Soluble. Inorganic. Per cent.	Soluble. Organic. Per cent.	Soluble. Total. Per cent.	Insoluble. Per cent.	Total. Per cent.	Total soluble phosphorus. Inorganic. Per cent.	Organic. Per cent.	Total. Per cent.
1802	Beef round, boiled.....	0.167	0.073	....	....	43.71	56.29	100.00	....	....	100.00
1824	Beef round, boiled.....	0.213	0.126	39.91	19.24	59.15	40.85	100.00	67.46	32.54	100.00
1809	Beef round, boiled.....	0.161	0 081	....	....	50.31	49.69	100.00	....	....	100.00
1803	Beef round, boiled.....	0.167	0.081	....	....	48.50	51.50	100.00	....	....	100.00
	Average (7).....	0.168	0.082	....	....	48.11	51.89	100.00	....	....	100.00
1825	Beef round, pot rsast....	0.264	0.181	46.21	22.35	68.56	31.44	100.00	67.40	32.60	100.00
1829	Beef round, pot roast....	0.227	0.161	49.34	21.59	70.93	29.07	100.00	69.57	30.43	100.00
1830	Beef round, pot roast....	0.225	0.122	46.21	8.00	54.22	45.78	100.00	85.25	14.75	100.00
	Average (3).....	0.239	0.155	47.26	17.31	64.57	35.43	100.00	74.07	25.93	100.00
1831	Beef ribs, roast.....	0.148	0.118	64.19	15.54	79.73	20.27	100.00	80.51	19.49	100.00
1833	Beef ribs, roast.....	0.158	0.124	56.33	22.15	78.48	21.52	100.00	71.77	28.23	100.00
1837	Beef ribs, roast.....	0.187	0.128	47.59	20.86	68.45	31.55	100.00	69.53	30.47	100.00
1838	Beef ribs, roast.....	0.190	0.148	54.74	23.15	77.89	22.11	100.00	70.27	29.7	100.00
1840	Beef ribs, roast.....	0.167	0.119	48.50	22.76	71.26	28.74	100.00	68.07	31.93	100.00
1848	Beef ribs roast.....	0.198	0.149	51.52	23.73	75.25	24.75	100.00	68.46	31.54	100.00
1842	Beef ribs, roast.....	0.159	0.122	56.60	20.13	76.73	23.27	100.00	73.77	26.23	100.00
1844	Beef ribs, roast.....	0.193	0.139	50.26	21.76	72.02	27.98	100.00	69.78	30.22	100.00
1846	Beef ribs, roast.....	0.214	0.158	56.07	17.76	73.83	26.17	100.00	75.95	24.05	100.00
	Average (9).....	0.179	0.134	53.98	20.87	74.85	25.15	100.00	72.01	27.99	100.00

meats contain. The average results for the six samples of raw beef round show that the total phosphorus is distributed as follows: Soluble inorganic 47.74 per cent., soluble organic 27.38 per cent., total soluble 75.12 per cent. and insoluble 24.88 per cent.

The average results for the nine samples of veal show that the total phosphorus in this kind of flesh is distributed as follows: Soluble inorganic 47.88 per cent., soluble organic 16.43 per cent., total soluble 64.31 per cent. and insoluble 35.69 per cent. It is thus apparent that in veal flesh a considerably greater proportion of the total phosphorus exists in the form of insoluble compounds than occurs in this form in beef flesh. The proportion of the total phosphorus in the soluble organic form in the two kinds of flesh is practically the same but there is a marked difference in the proportion of the soluble organic phosphorus.

In the boiled beef round from 41.98 to 59.15 per cent. of the total phosphorus is found in soluble compounds, the average for the seven samples being 48.11 per cent. The phosphorus existing in insoluble compounds ranges from 40.85 to 58.02 per cent. of the total phosphorus found in the boiled beef round, the average being 51.89 per cent. It is obvious from the data given in the above table that there is a remarkable difference in the nature of the phosphorus content of raw beef round and boiled beef round. In the former case 75.12 per cent. of the total phosphorus is soluble and 24.88 per cent. is insoluble in cold water, while in the latter case only 48.11 per cent. of the total phosphorus is soluble and as much as 51.89 per cent. is insoluble in cold water.

The average results for the three samples of beef round cooked by pot-roasting, show that the total phosphorus in beef flesh thus cooked is distributed as follows: Soluble inorganic 47.26 per cent., soluble organic 17.31 per cent., total soluble 64.57 per cent., and insoluble 35.42 per cent.

In the roasted beef ribs from 68.45 to 79.73 per cent. of the total phosphorus occurring in the cooked meat exists in compounds which are soluble in cold water. The phosphorus forming insoluble compounds varies from 20.27 to 31.55 per cent. of the total phosphorus found in the roasted beef ribs. In the nine samples of roasted beef here reported, the soluble inorganic phosphorus varies from 47.59 to 64.19 per cent. and the soluble

organic ranges from 15.54 to 23.73 per cent. of the total phosphorus which these meats contain. The average results for the nine samples of roasted beef ribs show that the total phosphorus is distributed as follows: Soluble inorganic 53.98 per cent., soluble organic 20.87 per cent., total soluble 74.85 per cent., and insoluble 25.15 per cent. It thus seems that the forms of phosphorus in roasted beef resemble somewhat closely those of uncooked beef but differ decidedly from the forms of phosphorus occurring in boiled and pot-roasted meats.

Again, in referring to the results given in Table X, it will be noted that the total soluble phosphorus of the different kinds of flesh is distributed between the organic and the inorganic compounds as follows: Raw beef round, inorganic phosphorus 63.78 per cent., and organic phosphorus 36.22 per cent.; raw veal, inorganic phosphorus 74.53 per cent., and organic phosphorus 25.47 per cent.; pot-roasted beef round, inorganic phosphorus 74.07 per cent. and organic phosphorus 25.93 per cent.; and roasted beef ribs, inorganic phosphorus 72.01 per cent., and organic phosphorus 27.99 per cent.

RELATION OF THE VARIOUS FORMS OF PHOSPHORUS TO THE TOTAL AND SOLUBLE ASH.

In Table XI, results are given which indicate the relation existing, in the different kinds of flesh, between the several forms of phosphorus and the total and total soluble ash.

A study of the contents of Table XI shows that the forms of phosphorus in raw beef round expressed in percentage of the total ash give the following average data: Soluble inorganic phosphorus 11.11, soluble organic phosphorus 6.55, total soluble phosphorus 17.66, insoluble phosphorus 5.77, and total phosphorus 23.43 per cent. Upon the same basis the average results for the nine samples of raw veal are as follows: Soluble inorganic phosphorus 9.55, soluble organic phosphorus 3.28, total soluble phosphorus 12.83, insoluble phosphorus 7.49, and total phosphorus 20.22 per cent. From these results, it appears that the mineral constituents of veal contain less phosphorus than those of beef. There are also other noticeable differences between the phosphorus content of veal and beef when considered from this standpoint. The total soluble phosphorus in raw beef upon this basis is about 1.4 times as great as it is in the raw veal

TABLE XI.—FORMS OF PHOSPHORUS IN MEATS EXPRESSED IN PER CENTS. OF THE TOTAL AND TOTAL SOLUBLE ASH, RESPECTIVELY.

Laboratory No.	Kind of meat.	Total ash. Per cent.	Total soluble ash. cent.	Total phosphorus.					Total soluble phosphorus.		
				Soluble.							
				Inorganic. Per cent.	Organic. Per cent.	Total. Per cent.	Insoluble. Per cent.	Total. Per cent.	Inorganic. Per cent.	Organic. Per cent.	Total. Per cent.
1788	Beef round, raw	1.090	0.874	11.47	3.94	15.41	4.77	20.18	14.30	4.92	19.22
1789	Beef round, raw	1.060	0.947	9.62	4.15	13.77	6.04	19.81	10.77	4.65	15.42
1823	Beef round, raw	1.080	1.002	8.33	7.87	16.20	4.36	20.56	8.98	8.48	17.46
1828	Beef round, raw	1.060	0.940	9.62	4.53	14.15	5.66	19.81	10.85	5.11	15.96
1849	Beef round, raw	1.110	0.988	13.46	9.18	22.64	5.63	28.27	14.98	10.22	25.20
1850	Beef round, raw	1.080	0.991	14.17	9.63	23.80	8.14	31.94	15.44	10.49	25.93
	Average (6)	1.080	0.960	11.11	6.55	17.66	5.77	23.43	12.55	7.32	19.87
1853	Veal shank, raw	1.018	0.666	8.64	3.44	12.08	5.30	17.38	13.41	5.34	18.75
1854	Veal chuck, raw	0.995	0.667	8.74	3.62	12.36	7.04	19.40	13.04	5.40	18.44
1855	Veal ribs, raw	0.968	0.667	9.71	3.41	13.12	11.26	24.38	14.09	4.95	19.04
1856	Veal shoulder, raw	1.041	0.737	9.80	2.98	12.78	13.06	25.84	13.84	4.21	18.05
1857	Veal breast, raw	0.897	0.655	8.36	4.13	12.49	6.25	18.67	11.45	5.65	17.10
1858	Veal loin, raw	0.978	0.735	9.41	4.19	13.60	5.42	19.02	12.52	5.58	18.10
1859	Veal flank, raw	0.947	0.778	9.93	1.90	11.83	6.65	18.48	12.08	2.32	14.40
1860	Veal leg, raw	1.094	0.887	10.79	3.56	14.35	5.85	20.20	13.30	4.40	17.70
1861	Veal hind shank, raw	1.029	0.761	10.59	2.24	12.83	5.73	18.56	14.32	3.03	17.35
	Average (9)	0.996	0.727	9.55	3.28	12.83	7.39	20.22	13.12	4.54	17.66
1801	Beef round, boiled	0.580	0.340	....	....	12.93	15.00	27.93	....	....	22.06
1807	Beef round, boiled	0.490	0.310	....	....	13.67	15.51	29.18	....	....	21.61
1808	Beef round, boiled	0.560	0.420	....	....	12.14	16.79	28.93	....	....	16.19

TABLE XI.—FORMS OF PHOSPHORUS IN MEATS EXPRESSED IN PER CENTS. OF THE TOTAL AND TOTAL SOLUBLE ASH, RESPECTIVELY—*Continued.*

Laboratory No.	Kind of meat.	Total ash. Per cent.	Total soluble ash. Per cent.	Total phosphorus.					Total soluble phosphorus.		
				Soluble.							
				Inorganic. Per cent.	Organic. Per cent.	Total. Per cent.	Insoluble. Per cent.	Total. Per cent.	Inorganic. Per cent.	Organic. Per cent.	Total. Per cent.
1802	Beef round, boiled	0.570	0.310	....	....	12.81	16.49	29.30	....	....	23.55
1824	Beef round, boiled	0.830	0.620	10.24	4.94	15.18	10.82	26.00	13.71	6.61	20.32
1809	Beef round, boiled	0.620	0.440	....	....	13.07	12.90	25.97	....	....	18.41
1803	Beef round, boiled	0.600	0.420	....	....	13.50	14.33	27.83	....	....	19.28
	Average (7)	0.610	0.410	....	....	13.33	14.55	27.88	....	....	20.20
1825	Beef round, pot roast	1.240	1.030	9.84	4.76	14.60	6.69	21.29	11.84	5.73	17.57
1829	Beef round, pot roast	0.950	0.680	11.79	5.16	16.95	6.95	23.90	16.47	7.21	23.68
1830	Beef round, pot roast	0.740	0.540	14.05	2.44	16.49	13.92	30.41	19.26	3.33	22.59
	Average (3)	0.980	0.750	11.89	4.12	16.01	9.19	25.20	15.86	5.42	21.28
1831	Beef rib, roast	0.830	0 650	11.45	2.77	14.22	3.61	17.83	14.62	3.53	18.15
1833	Beef rib, roast	0.800	0.650	11.13	4.37	15.50	4.25	19.75	13.69	5.39	19.08
1837	Beef rib, roast	0.890	0.770	10.00	4.38	14.38	6.63	21.01	11 56	5.06	16.62
1838	Beef rib, roast	0.900	0.710	11.55	4.89	16.44	4.67	21.11	14.65	6.20	20.85
1840	Beef rib, roast	0.770	0.660	10.52	4.93	15.45	6.24	21.69	12.27	5.76	18.03
1848	Beef rib, roast	1.030	0.830	9.90	4.56	14.46	4.76	19.22	12.29	5.66	17.95
1842	Beef rib, roast	0.880	0.670	10.23	3.63	13.86	4.20	18.07	13.43	4.78	18.21
1844	Beef rib, roast	1.010	0.700	9.60	4.16	13.76	5.35	19.11	13.86	6.00	19.86
1846	Beef rib, roast	1.060	0.440	11.32	3.59	14.91	5.28	20.19	27.27	8.64	35.91
	Average (9)	0.910	0.680	10.63	4.15	14.78	5.00	19.78	14.85	5.67	20.52

while the insoluble phosphorus is somewhat less than 0.8 as much. Further, the amount of phosphorus, in the ash coming from the soluble organic compounds containing phosphorus, is twice as much in the ash from the beef as it is in the ash from the veal.

In the boiled beef round, the total soluble phosphorus equals 13.33 per cent., the insoluble phosphorus equals 14.55 per cent. and the total phosphorus equals 27.88 per cent. of the total ash existing in this kind of flesh. It is thus apparent that the ash of boiled beef, which is much less than the ash of uncooked beef and of veal, contains a somewhat greater proportion of phosphorus than does the ash of raw flesh.

The forms of phosphorus in pot-roasted beef round, in terms of per cent. of the total ash of the same, are as follows: Soluble inorganic phosphorus 11.89, soluble organic phosphorus 4.12, total soluble phosphorus 16.01, insoluble phosphorus 9.19, and total phosphorus 25.20. Upon the same basis, the average results for the nine samples of beef ribs cooked by roasting are as follows: Soluble inorganic phosphorus 10.63, soluble organic phosphorus 4.15, total soluble phosphorus 14.78, insoluble phosphorus 5.00, and total phosphorus 19.78 per cent.

By referring to the results given in Table XI, it will be observed that the total soluble phosphorus in the different kinds of flesh expressed in percentage of the total soluble ash gives the following average results: Raw beef round, inorganic phosphorus 12.55 per cent., organic phosphorus 7.32 per cent., and total phosphorus 19.87 per cent.; raw veal, inorganic phosphorus 13.12 per cent., organic phosphorus 4.54 per cent., and total phosphorus 17.66 per cent.; pot-roasted beef round, inorganic phosphorus 15.86 per cent., organic phosphorus 5.42 per cent., and total phosphorus 21.28 per cent.; roast beef round, inorganic phosphorus 14.85 per cent., organic phosphorus 5.67 per cent., and total phosphorus 20.52 per cent.

RELATION OF THE PHOSPHORUS AND OF THE NITROGEN IN FLESH TO EACH OTHER.

In order to show the relationship existing between the quantities of the various forms of total phosphorus and of total nitrogen and the various forms of soluble phosphorus and of total soluble nitrogen in the different kinds of flesh, the data given in Table XII are presented. In this table the amount of

phosphorus existing in the different forms is expressed in per cent. of the total nitrogen of the flesh and the quantity of each of the soluble forms of phosphorus is given in percentage of the total soluble nitrogen.

The forms of the total phosphorus in raw beef round expressed in percentage of the total nitrogen of the same are for the average as follows: Soluble inorganic 3.48, soluble organic 2.05, total soluble 5.53, insoluble 1.81, and total phosphorus 7.34. Upon the same basis the average results for the nine samples of raw veal are as follows: Soluble inorganic phosphorus 3.05, soluble organic phosphorus 1.04, total soluble phosphorus 4.09, insoluble phosphorus 2.41, and total phosphorus 6.46 per cent. It is thus apparent that the ratio of soluble inorganic phosphorus to the total nitrogen in raw veal is somewhat less than it is in raw beef and the ratios of the soluble organic phosphorus and of the total soluble phosphorus to total nitrogen in the case of veal are much less than they are in beef flesh. On the other hand, the ratio of the insoluble phosphorus to the total nitrogen is considerably greater in uncooked veal than it is in uncooked beef.

In the boiled beef round the total soluble phosphorus equals 1.44 per cent. of the total nitrogen, the insoluble phosphorus amounts to 1.52 per cent. of the total nitrogen and the total phosphorus forms 2.96 per cent. of the total nitrogen of the flesh.

The forms of the total phosphorus of pot-roasted beef round expressed in percentage of the total nitrogen of the same are as follows: Soluble inorganic 1.95, soluble organic 0.72, total soluble 2.67, insoluble phosphorus 1.47, and total phosphorus 4.14 per cent. Upon the same basis the average results for the nine samples of roasted beef ribs are as follows: Soluble inorganic phosphorus 2.86, soluble organic phosphorus 1.11, total soluble phosphorus 3.97, insoluble phosphorus 1.34 and total phosphorus 5.31 per cent.

The most striking fact brought out by the above figures is the marked difference of the boiled meats from either the meats cooked by other methods or the raw meats. The ratios of the total soluble phosphorus, the insoluble phosphorus and the total phosphorus to the total nitrogen in the boiled flesh are much less than they are in the other cooked or raw meats.

By studying further the results given in Table XII, it will be

TABLE XII.—FORMS OF PHOSPHORUS IN MEATS EXPRESSED IN PER CENTS. OF THE TOTAL AND TOTAL SOLUBLE NITROGEN, RESPECTIVELY.

Laboratory No.	Kind of meat.	Total nitrogen. Per cent.	Total soluble nitrogen. Per cent.	Total phosphorus. Soluble. Inorganic. Per cent.	Soluble. Organic. Per cent.	Soluble. Total. Per cent.	Insoluble. Per cent.	Total. Per cent.	Total soluble phosphorus. Inorganic. Per cent.	Organic. Per cent.	Total. Per cent.
1788	Beef round, raw	3.6530	0.7798	3.42	1.18	4.60	1.42	6.02	16.03	5.51	21.54
1789	Beef round, raw	3.3650	0.7480	3.03	1.31	4.34	1.90	6.24	13.64	5.88	19.52
1823	Beef round, raw	3.3440	0.7885	2.69	2.54	5.23	1.41	6.64	11.41	10.77	22.18
1828	Beef round, raw	3.3620	0.7377	3.03	1.43	4.46	1.78	6.24	13.82	6.50	20.32
1849	Beef round, raw	3 5450	0.8884	4.19	2.86	7.04	1.75	8.80	16.67	11.37	28.04
1850	Beef round, raw	3.4060	0.8998	4.49	3.05	7.54	2.58	10.12	17.00	11.55	28.55
	Average (6)	3.4458	0.8070	3.48	2.05	5.53	1.81	7.34	14.76	8.60	23.36
1853	Veal shank, raw	3.3510	0.5687	2.63	1.04	3.67	1.61	5.28	15.48	6.15	21.63
1854	Veal chuck, raw	3.2270	0.5536	2.70	1.11	3.81	2.17	5.98	15.72	6.50	22.22
1855	Veal ribs, raw	2.9340	0.5904	3.20	1.13	4.33	3.71	8.04	15.92	5.59	21.51
1856	Veal shoulder, raw	3.0670	0.5988	3.32	1.01	4.33	4.43	8.77	17.05	5.17	22.21
1857	Veal breast, raw	2.9530	0 5367	2.54	1.25	3.79	1.90	5.69	13.97	6.90	20.80
1858	Veal loin, raw	3.0390	0.6001	3.03	1.35	4.38	1.74	6.12	15.33	6.83	22.16
1859	Veal flank, raw	3.0500	0.5889	3.13	0.60	3.73	....	5.82	15.96	3.06	19.02
1860	Veal leg, raw	3.2840	0.6790	3.59	1.19	4.78	1.95	6.73	17.38	5.74	23.12
1861	Veal hind shank, raw	3.3200	0.6257	3.28	0.69	3.97	1.78	5.75	17.42	3.68	21.10
	Average (9)	3.1361	0.5935	3.05	1.04	4.09	2.41	6.46	16.02	5.52	21.54
1801	Beef round, boiled	5.6860	0.1769	....	....	1.32	1.53	2.85	....	....	42.40
1807	Beef round, boiled	5.2490	0.1816	....	....	1.28	1.45	2.73	....	....	36.89
1808	Beef round, boiled	5.5550	0.2038	....	....	1.22	1.70	2.92	....	....	33.37

TABLE XII.—FORMS OF PHOSPHORUS IN MEATS EXPRESSED IN PER CENTS. OF THE TOTAL AND TOTAL SOLUBLE NITROGEN, RESPECTIVELY—*Continued.*

Laboratory No.	Kind of meat.	Total nitrogen. Per cent.	Total soluble nitrogen. Per cent.	Total phosphorus. Soluble. Inorganic. Per cent.	Total phosphorus. Soluble. Organic. Per cent.	Total phosphorus. Soluble. Total. Per cent.	Total phosphorus. Insoluble. Per cent.	Total phosphorus. Total. Per cent.	Total soluble phosphorus. Inorganic. Per cent.	Total soluble phosphorus. Organic. Per cent.	Total soluble phosphorus. Total. Per cent.
1802	Beef round, boiled	5.8860	0.1823	....	....	1.24	1.60	2.84	....	....	40.04
1824	Beef round, boiled	5.6110	0.3046	1.51	0.74	2.25	1.55	3.80	27.91	13.46	41.37
1809	Beef round, boiled	5.7420	0.3472	....	....	1.41	1.39	2.80	....	....	23.33
1803	Beef round, boiled	5.9630	0.2534	....	....	1.36	1.44	2.80	....	....	31.97
	Average (7)	5.6703	0.2357	....	....	1.44	1.52	2.96	....	....	35.62
1825	Beef round, pot roast	5.9690	0.4783	2.04	0.99	3.03	1.39	4.42	25.51	12.34	37.84
1829	Beef round, pot roast	6.0180	0.3953	1.86	0.82	2.68	1.09	3.77	28.33	12.40	40.76
1830	Beef round, pot roast	5.3060	0.3365	1.96	0.34	2.30	1.94	4.24	30.91	5.35	36.26
	Average (3)	5.7643	0.4034	1.95	0.72	2.67	1.47	4.14	28.25	10.04	38.29
1831	Beef ribs, roast	2.7790	0.3300	3.42	0.83	4.25	1.08	5.33	28.79	6.97	35.76
1833	Beef ribs, roast	3.0600	0.3678	2.91	1.14	4.05	1.11	5.16	24.20	9.51	33.71
1837	Beef ribs, roast	3.3380	0.3671	2.67	1.16	3.83	1.77	5.60	24.25	10.62	34.87
1838	Beef ribs, roast	3.4960	0.3520	2.97	1.26	4.23	1.20	5.43	29.55	12.50	42.05
1840	Beef ribs, roast	3.1960	0.3086	2.53	1.19	3.72	1.50	5.23	26.25	12.31	38.56
1848	Beef ribs, roast	3.8320	0.3981	2.66	1.23	3.89	1.28	5.17	25.62	11.81	37.43
1842	Beef ribs, roast	2.9510	0.3207	3.05	1.08	4.13	1.26	5.39	28.06	9.98	38.04
1844	Beef ribs, roast	3.6310	0.3271	2.67	1.16	3.83	1.49	5.32	29.65	12.84	42.49
1846	Beef ribs, roast	4.1650	0.3902	2.88	0.90	3.79	1.34	5.13	30.75	9.74	40.49
	Average (9)	3.3853	0.3513	2.86	1.11	3.97	1.34	5.31	27.46	10.70	38.16

observed that the different forms of soluble phosphorus expressed in percentage of the total soluble nitrogen give the following average results: Raw beef round, inorganic phosphorus 14.76 per cent., organic phosphorus 8.60 per cent., and total soluble phosphorus 23.36 per cent.; raw veal, inorganic phosphorus 16.02 per cent., organic phosphorus 5.52 per cent., and total soluble phosphorus 21.54 per cent.; pot-roasted beef round, inorganic phosphorus 28.25 per cent., organic phosphorus 10.04 per cent., and total soluble phosphorus 38.29 per cent.; roasted beef ribs, inorganic phosphorus 27.41 per cent., organic phosphorus 10.70 per cent., and total soluble phosphorus 38.16 per cent.

The ratio of the total soluble phosphorus to the total soluble nitrogen is much greater than is the ratio of the total phosphorus to the total nitrogen. This shows very clearly that the total phosphorus existing in flesh is more completely soluble in cold water than is the total nitrogen. Further the ratios of the soluble inorganic phosphorus, the soluble organic phosphorus and the total soluble phosphorus to the total soluble nitrogen are much greater in the three cooked meats than they are in the two raw meats.

NATURE OF THE ORGANIC PHOSPHORUS COMPOUNDS IN FLESH.

Experiments which have been made in this laboratory (see above, page 30) have proved that the soluble proteids of flesh which are coagulated by heat in neutral solutions are practically free from phosphorus. That being the case, the proteid matter precipitated as albumoses from aqueous extracts of flesh by saturation with zinc sulphate was tested for phosphorus. Such tests gave no trace of phosphorus, which shows that the zinc sulphate precipitate contained no phosphorus compounds. In order to test further whether the proteids of cold water extracts contained any phosphorus, portions of such extracts were treated with tannin and salt, which precipitates practically all of the proteids, including albumin, albumoses and peptones. The resulting precipitates were found to be free from phosphorus.

These results prove conclusively that the proteids of aqueous extracts of flesh thus separated do not contain phosphorus but that the organic phosphorus of such solutions is due to non-proteid bodies.

A preliminary study of these non-proteid bodies of flesh which contain phosphorus together with the insoluble phosphorus compounds of flesh has been made but the publication of the results is withheld until they may be further confirmed by additional work.

CONCLUSIONS.

(1) The Hart-Andrews method of separating and determining the inorganic and organic phosphorus gives satisfactory results in aqueous extracts of flesh after the coaguable proteids have been removed.

(2) There is a difference in the phosphorus content of the flesh of beef and veal.

(*a*) Of the total phosphorus in beef 75 per cent. and in veal 64 per cent. is soluble in cold water.

(*b*) Of the total phosphorus, one-fourth is soluble organic phosphorus in the beef and one-sixth in the veal.

(*c*) The soluble organic phosphorus in beef constitutes one-third of the total soluble phosphorus and in the veal one-fourth.

(*d*) The ratio of the soluble organic to the soluble inorganic phosphorus is in the beef, 3 : 5, and in the veal, 3 : 9.

(*e*) The phosphorus forms 23.4 per cent. of the ash of beef and 20.2 per cent. of the ash of veal.

(*f*) The soluble forms of phosphorus in beef constitute 17.8 per cent. and in veal 12.8 per cent. of the ash.

(3) The percentage of fat in the different cuts of veal has little influence upon the total phosphorus content.

(4) The cuts of veal which are nearest the bony structure apparently contain more insoluble phosphorus than the other cuts.

(5) The different methods of cooking flesh give products which differ decidedly as to the quantities and the nature of the phosphorus contents.

(6) The water-soluble organic phosphorus of the aqueous extracts of flesh is not in combination with the coagulated proteid, with the albumoses or with the peptones.

(7) The soluble organic phosphorus compounds in flesh are quite stable even in the presence of considerable excess of nitric acid.