

THE PROTEINS OF THE PEANUT, *ARACHIS HYPOGÆA*.

II. THE DISTRIBUTION OF THE BASIC NITROGEN IN THE GLOBULINS ARACHIN AND CONARACHIN.*

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The culture of peanuts in the United States has increased rapidly during the last ten years. During the year 1916 a large number of mills which were formerly engaged in pressing cottonseed to obtain oil and press cake were unable to secure a sufficient supply of cottonseed and are now pressing peanuts. Thus, there has been produced a large supply of peanut oil and peanut press cake. The oil, which compares favorably with olive oil for culinary purposes and is also used for making oleomargarine, has found a ready market and was quoted February, 1917, at \$1.05 per gallon. The press cake is ground to a meal and is readily finding favor as a stock food. It is quoted at \$35 per ton. When this meal is made from whole peanuts it contains about 28 per cent of protein, while meal made from shelled peanuts contains about 45 per cent of protein (N x 6.25).

In a recent paper (1) from this laboratory it was shown that the globulins of the peanut yield a relatively high percentage of basic nitrogen. Arachin, which is the chief protein of the peanut, contains 4.96, and conarachin 6.55 per cent. These values were obtained by the Hausmann method in which no correction is made for the solubility of the phosphotungstates of the bases and are therefore somewhat lower than the figures obtained by the Van Slyke method in which such a correction is applied. These proteins have now been analyzed by the Van Slyke method to ascertain the percentage of the basic amino-acids. The dis-

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tribution of nitrogen previously reported from analyses by the Hausmann method are given in the following table (2).

N	Arachin.	Conarachin.
Amide.....	2.03	2.07
Humin.....	0.22	0.22
Basic.....	4.96	6.55
Non-basic.....	11.07	9.40
Total.....	18.28	18.24

The results of the analyses by Van Slyke's method show that both arachin and conarachin contain arginine, histidine, lysine, and cystine. Both proteins also give a strong qualitative test for tryptophane.

Percentage of Basic Amino-Acids in the Globulins of the Peanut.

	Arachin.	Conarachin.
Arginine.....	13.51	14.60
Histidine.....	1.88	1.83
Lysine.....	4.98	6.04
Cystine.....	0.85	1.07

The figures for cystine are undoubtedly too low, as they represent only the cystine which escaped destruction during the hydrolysis of the proteins with hydrochloric acid.

The most important fact brought out by these analyses is the high content of lysine in arachin and conarachin. For the sake of comparison the percentages of lysine in the proteins of some common seeds and in muscle from some animals are also given in the following tables.

The figures marked by (§) were obtained by the Van Slyke method and, therefore, probably represent the maximum percentage of lysine obtainable. Those not so marked were obtained by Kossel's absolute method and may be somewhat too low. It is seen, however, that the percentages of lysine in arachin and conarachin of the peanut are relatively high, and, indeed, approach the lysine content of muscle substance of different animals. It will also be noted that no lysine has been found in zein

and that the maximum percentage of lysine obtained from gliadin is only 1.21 per cent.

Osborne and Mendel (3) and other workers have shown that lysine is essential to the growth of animals. Nutrition experiments indicate (4) that the animal organism cannot synthesize lysine which must, therefore, be provided in suitable quantity in the food to insure normal growth. Since the muscle substance of animals contains about 7 per cent of lysine, foods deficient in this essential amino-acid should be supplemented by the

Lysine Content of Some Vegetable Proteins.

Protein.	Source.	Percentage.
Zein.	Maize.	0.00*
Gliadin.	Wheat.	§1.21**
Legumin.	Pea.	4.29†
Phaseolin.	Kidney bean.	4.58‡
Arachin.	Peanut.	§4.98
Conarachin.	“	§6.04

* Osborne, T. B., and Jones, D. B., *Am. J. Physiol.*, 1910, xxvi, 227.

** Osborne, T. B., Van Slyke, D. D., Leavenworth, C. S., and Vinograd, M., *J. Biol. Chem.*, 1915, xxii, 259.

† Osborne, T. B., and Clapp, S. H., *J. Biol. Chem.*, 1907, iii, 219.

‡ Osborne, T. B., *Ergebn. Physiol.*, 1910, x, 116.

*Lysine in Muscle Substance of Different Animals.**

Scallop (<i>Pecten irradians</i>).....	5.77
Halibut (<i>Hippoglossus vulgaris</i>).....	7.45
Chicken.....	7.24
Ox.....	7.59

* Osborne and Jones, *Am. J. Physiol.*, 1909, xxiv, 438.

addition of other foods which contain a high percentage of lysine. Wheat and corn, both of which contain but little lysine, should therefore prove more efficient diets if supplemented by some food of high lysine content. Peanut meal appears to be well adapted to this purpose. From a nutritive standpoint, it is one of our cheapest foods and seems to possess no objectionable properties. Animals fed on it thrive and increase rapidly in weight (5). It therefore seems probable that corn and wheat could be much better utilized and a considerable saving in the cost of feeding effected by supplementing these cereals with peanut meal.

Peanuts may be used in many ways for human consumption. The Laboratory of Plant Chemistry of the Bureau of Chemistry has found that a mixture of 75 per cent of wheat flour and 25 per cent of peanut flour makes excellent bread. Such a bread is higher in protein content and contains much more lysine than bread made from wheat alone.

Investigations on the proteins of the peanut will be continued.

EXPERIMENTAL.

Analysis of Arachin.—Duplicate samples of 3 gm. of arachin, each equivalent to 2.7210 gm. of ash and moisture-free protein, were hydrolyzed by boiling with 100 cc. of 20 per cent hydrochloric acid for 24 hours. The protein contained 18.28 per cent of nitrogen, equivalent to 0.4974 gm. in each of the samples analyzed. The phosphotungstates of the bases were decomposed by the amyl alcohol-ether method. The following results are corrected for the solubilities of the phosphotungstates of the bases.

Analysis of Arachin. Van Slyke Method.
Total Nitrogen Corrected for Solubility of Bases.

	I.	II.	I.	II.	Average.
	gm.	gm.	per cent	per cent	per cent
Amide N.....	0.0581	0.0594	11.68	11.94	11.81
Humin N adsorbed by lime.....	0.0028	0.0029	0.56	0.59	0.57
Humin N in amyl alcohol extract....	0.0035	0.0007	0.71	0.15	0.43
Cystine N.....	0.0037	0.0036	0.75	0.73	0.74
Arginine N.....	0.1182	0.1183	23.76	23.78	23.77
Histidine N.....	0.0112	0.0166	2.24	3.33	2.78
Lysine N.....	0.0257	0.0262	5.17	5.28	5.22
Amino N of filtrate.....	0.2640	0.2662	53.08	53.52	53.30
Non-amino N of filtrate.....	0.0076	0.0089	1.52	1.79	1.65
Total N regained.....	0.4948	0.5028	99.47	101.11	100.27

Basic Amino-Acids in Arachin.

	I.	II.	Average.
	per cent	per cent	per cent
Arginine.....	13.50	13.51	13.51
Histidine.....	1.51	2.25	1.88
Lysine.....	4.93	5.03	4.98

Analysis of Conarachin.—Duplicate samples of 3 gm. of conarachin, each equivalent to 2.6967 gm. of ash and moisture-free protein, were hydrolyzed by boiling with 100 cc. of 20 per cent hydrochloric acid for 24 hours. The protein contained 18.23 per cent of nitrogen, equivalent to 0.4916 gm. in each of the samples analyzed. Ether and amyl alcohol were used to decompose the phosphotungstates of the bases. The following results are corrected for the solubilities of the bases:

*Analysis of Conarachin. Van Slyke Method.
Total Nitrogen Corrected for Solubility of Bases.*

	I.	II.	I.	II.	Average.
	<i>gm.</i>	<i>gm.</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
Amide N.....	0.0548	0.0542	11.14	11.02	11.08
Humin N adsorbed by lime.....	0.0031	0.0033	0.64	0.67	0.65
Humin N in amyl alcohol extract..	0.0007	0.0006	0.13	0.12	0.13
Cystine N.....	0.0046	0.0028	0.93	0.58	0.75
Arginine N.....	0.1247	0.1288	25.37	26.19	25.78
Histidine N.....	0.0131	0.0136	2.67	2.78	2.72
Lysine N.....	0.0320	0.0305	6.51	6.20	6.35
Amino N of filtrate.....	0.2486	0.2452	50.57	49.88	50.23
Non-amino N of filtrate.....	0.0089	0.0102	1.81	2.08	1.94
Total N regained.....	0.4905	0.4892	99.77	99.52	99.63

Basic Amino-Acids in Conarachin.

	I.	II.	Average.
	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
Arginine.....	14.37	14.84	14.60
Histidine.....	1.79	1.87	1.83
Lysine.....	6.20	5.89	6.04

SUMMARY.

1. The globulins of the peanut have been analyzed by the Van Slyke method and the results show that they contain the basic amino-acids, arginine, histidine, lysine, and cystine.

2. The relatively high percentage of lysine in the proteins of the peanut indicates that this seed might be used to advantage in supplementing diets deficient in lysine.

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