LVII. Value of different kinds of vegetable food, based upon the amount of nitrogen

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To cite this article: E.N. Horsford M.A. (1846) LVII. Value of different kinds of vegetable food, based upon the amount of nitrogen , Philosophical Magazine Series 3, 29:195, 365-397, DOI: [10.1080/14786444608645526](https://doi.org/10.1080/14786444608645526)

To link to this article: <http://dx.doi.org/10.1080/14786444608645526>

Published online: 30 Apr 2009.

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days they are hardly perceptible, though they never cease altogether. On some days they are violent, if I may be allowed the expression. The needle does not take a sudden start and return as when influenced by lightning, but moves gradually without oscillation to some fixed point, from which it will return sometimes in two minutes and sometimes in ten or fifteen minutes. An extended series of observations will be necessary before any deductions can be safely made. If the wires should be separated by a slight interval during a thunder storm, doubtless electrical sparks would be visible. During heavy storms, a flash of lightning twenty miles distant from the wires of Morse's telegraph will induce electricity in the wire sufficient to operate the magnets and work the telegraph, sometimes recording several signals. A flash of lightning in Baltimore, forty miles distant from this place, will operate the magnet at this end of the line.

Washington, D. C.

LVII. *Value of different kinds of Vegetable Food, based upon the amount of Nitrogen.* By E. N. HORSFORD, M.A.*

SINCE Gay-Lussac's discovery of nitrogen in the seeds of plants, the conception of animal nutrition has been assuming a more and more definite character.

Already have the principal proximate ingredients of meal, by taking advantage of its physical properties, been separated from each other. Gluten, albumen and legumine, starch, gum, sugar, dextrine and woody-fibre, have been made known, and their physical as well as some of their chemical properties† studied. Their more accurate chemical constitution was reserved to a later period, when it was found that they might be arranged in two classes, those containing nitrogen and those containing no nitrogen; and the interesting discovery was made, that the former, as well as the latter, are among themselves identical in composition.

It is well known that labourers supplied only with food containing no nitrogen, become incapable of executing their tasks: and further, that the corporeal system, even without labour, cannot be *sustained* upon such food. The discovery of the near identity in chemical composition between vegetable albumen, fibrine and caseine, and the corresponding bodies

* Communicated by the Author.

† Fr. Marcet found gluten consisting of 55·7 per cent. carbon, 22 per cent. oxygen, 7·8 per cent. hydrogen, and 14·5 per cent. nitrogen.—*Ann. de Ch. et de Phys.* xxxvi. 27.

found in the animal kingdom, gave the above fact its explanation.

The food must contain an ingredient suited to replace the animal matter consumed.

This being known, and the quantitative relation of the several elements of the nitrogenous compounds being also known, an estimate of the value of given kinds of food becomes, in the hands of the chemist, a problem of comparatively easy solution.

The following investigation, undertaken at the suggestion and under the direction of Prof. von Liebig in the Giessen laboratory, had for its object the determination of the relative values of the different kinds of *vegetable food*. These values are *threefold*.

The various forms of food derived from grains, herbage and roots, furnish—1, bodies containing nitrogen; 2, bodies destitute of nitrogen; and 3, inorganic salts, all of which are serviceable in the animal œconomy.

The nitrogenous bodies, from their solution in the blood, form the tissues—the actual organism. The bodies wanting nitrogen contribute, by their more or less perfect combustion, to the warmth of the animal body; and the salts of the alkalies and alkaline earths serve in building up the osseous framework, beside constituting an essential part of every organ of the animal system.

Their values for the latter purpose are in general in proportion to the phosphates their ashes contain.

Their values for the second purpose may be considered in general as in the inverted relation of their values for the first, or inversely proportioned to the per-centage of nitrogen.

Their values for the first purpose, that of ministering to the support and growth of organic tissues, have been the specific object of the hereafter enumerated determinations.

Boussingault, to whom the agriculturist is so largely indebted for investigations bearing upon the interests of husbandry, has not left this field untrodden. It was thought, however, that the worth of his table of nutrition could lose nothing by a series of carefully conducted analyses, having the same object in view. It was moreover conceived, that in substances containing so small a per-centage of nitrogen as grains and roots generally, the method of Messrs. Varrentrapp and Will for determining nitrogen would give more accurate results than that of Dumas employed by Boussingault. The analyses hereafter given of the same substance, rarely varied from each other more than one-tenth of one per cent: and yet in general the determinations which follow, and those of similar

substances made by the distinguished French chemist, differ no further from each other than might be expected from productions of the same vegetable variety grown on different soils.

Buckwheat (*Polygonum Fagopyrum*) constitutes an exception to this remark. In the table of analytical results* this grain has a nitrogen per-centage of 2.40, while two ordinary varieties of wheat (*Triticum vulgare*) have 2.33 and 2.30 per cent. Buckwheat meal from Vienna gave, as shown below, 1.08 per cent. Buckwheat grains (*Polygonum tartaricum*) from the experimental field of Hohenheim Agricultural Institute, gave 1.56 per cent. of nitrogen, while the analysis of three superior varieties of wheat grown in the same field, gave respectively 2.59, 2.68 and 2.69 per cent. This species of buckwheat was further found to contain 22.66 per cent. of woody fibre.

The equivalent value of buckwheat, according to Boussingault, wheat being 100, is 108. The following analyses gave for its equivalent value 170; for that of the Vienna buckwheat meal 245.

For the following investigation, the meals, table-peas and beans and lentils, were procured by Prof. von Liebig from Vienna. The grains, with the exception of rice and *Triticum monococcum*, were furnished from the Agricultural Institute at Hohenheim in the kingdom of Würtemberg, in reply to an order for the most approved varieties of Cerealia cultivated in Europe. The roots were from Giessen.

The several grains, meals and roots, in their market condition, were dried in a water-bath at 100° C. The potatoes, beets, carrots and turnips, were cut into thin shavings with the least delay, weighed between watch-glasses and placed in the water-bath.

The combustions for carbon and hydrogen were made with oxide of copper, a mixture of chlorate of potassa and oxide having been placed at the extreme end of the combustion-tube.

It was found difficult to reduce the woody fibre of the oats, barley and buckwheat, to the requisite fineness for a complete combustion. Where the difficulty could not readily be overcome, in addition to the chlorate of potassa at the end of the tube, it was found well, in filling with mixed substances and oxide of copper, to add, at intervals of an inch and a half, a small quantity of finely pulverized and thoroughly mixed oxide of copper and chlorate of potassa. The successive evolutions of oxygen in this case thoroughly reoxidized any por-

* Boussingault's *Landswirtschaft*, Germ. ed., p. 294.

tions of copper reduced in the progress of combustion, and secured the most satisfactory results.

Difficulty presented itself also in the combustion of the beets and other roots, arising from the extreme compactness of the substance when dried. It was however overcome by the method already mentioned.

The per-centage of woody fibre was determined in the following manner. Grains, such as had been analysed, were digested upon a sand-bath, several weeks, in diluted hydrochloric acid,—one part of acid to a thousand of water. At intervals of from eight to ten days the fluid was poured off, and the digestion resumed with diluted acid, as before. After several weeks, the woody fibre not appearing wholly freed from other substances, an equally dilute solution of caustic potassa was employed, and the digestion therewith continued. At the end of two months, the woody fibre of the oats, barley and buckwheat, were poured upon filters, thoroughly washed with distilled water, and dried at 100° C. The hulls of the peas and beans were treated with diluted caustic potassa alone, and similarly determined.

To express in 100 parts the results of analyses, the carbon, hydrogen, oxygen and sulphur of the nitrogenous ingredients were estimated from the per-centage of nitrogen*. The carbon and hydrogen so estimated, deducted from the whole per-centage of carbon and hydrogen, gave what belonged to the starch, gum, sugar, &c. The oxygen of the latter was estimated from the carbon by the formula $C_{12} H_{10} O_{10}$ †.

* Mulder's analysis of coagulated albumen, Scheerer and Jones's analyses of legumine and gluten (*Ann. de Ch. und Pharm.* xxxix. 360), and Heldt's analysis of the gluten of rye (*Ann. de Ch. und Pharm.* xlv. 198), differ so little from each other, that a single formula has been constructed upon Mulder's analysis of coagulated albumen, and, with a little modification, employed in determining the elements of the nitrogenous ingredients of all the substances analysed. His per-centage of oxygen was reduced by the per-centage of sulphur, which, according to Dr. Rüling (*Ann. de Ch. und Pharm.* lviii. 3 Heft.), for gluten = 1.14 per cent. and for legumine 0.50 per cent. The phosphorus has been neglected, as no accurate determinations of the per-centage of this element has been made. Mucine, discovered by Berzelius, is included in the estimate for the nitrogenous ingredients, since analyses of albumen and of gluten, with and without mucine, correspond with each other.

† The following list of the principal organic bodies containing no nitrogen, and present in the substances analysed, and their adjoined constitution, will justify the method of calculation :—

Amylum	} $C_{12} H_{10} O_{10}$
Dextrine	
Gum	
Woody fibre (Payen)	
Cane-sugar.....	$C_{12} H_{11} O_{11}$

No. 1. *Wheat-flour from Vienna.*

I. 1·0883 gramme lost at 100° C. 0·9378 grm.

II. 1·3090 grm. of the flour dried at 100° C. left, after incineration, 0·0091 grm.

III. 0·8620 grm. of the same left 0·0061 grm. ashes.

IV. 0·3805 grm. burned with oxide of copper, gave 0·6370 grm. of carbonic acid and 0·2186 grm. of water.

V. 0·4190 gr. gave 0·7020 gr. CO² and 0·2550 gr. HO.VI. 0·3671 gr. gave 0·6189 gr. CO² and 0·2374 gr. HO.

VII. 0·8078 gr. gave, by Varrentrapp and Will's method for determining nitrogen, 0·3925 gr. ammonio-chloride of platinum.

VIII. 0·8168 gr. gave 0·3893 gr. ammonio-chloride of platinum.

These determinations correspond, expressed in 100 parts, to—

	I.	II.	III.
Carbon ...	45·66	45·69	45·97
Hydrogen	6·38	6·76	6·96
Nitrogen .	3·04	2·99	
Ashes ...	0·69	0·70	
Water ...	13·83		

Estimated in 100 parts, according to the constitution of the ingredients present, the above determinations give the following numbers :—

Nitrogenous ingredients.	{	Nitrogen...	3·00	}	= 19·15
		Carbon ...	10·53		
		Hydrogen	1·31		
		Oxygen ...	4·08		
		Sulphur ...	0·23		
Ingredients containing no nitrogen.	{	Carbon ...	35·23	}	= 79·77
		Hydrogen	5·39		
		Oxygen ...	39·15		
		Ashes.....	0·70		
					<hr/> 99·62

No. 2. *Wheat-flour from Vienna.*

I. 3·6365 grms. lost at 100° C. 0·4964 grm.

II. 1·2599 gr. of substance dried at 100° C. left, after incineration, 0·0084 gr.

Pectic acid, dried at 100° C.—

(Regnault) C₁₂ H₈ O₁₁.(Mulder)..... C₁₂ H₈ O₁₀.

Pectine combined with PbO.

(Fremy) C₁₀ H₉ O₁₁.*Phil. Mag.* S. 3. Vol. 29, No. 195, Nov. 1846.

2 C

- III. 0.3643 gr. gave 0.6015 gr. CO^2 and 0.2175 gr. HO.
 IV. 0.5429 gr. gave 0.9022 gr. CO^2 and 0.1350 gr. HO.
 V. 0.8705 gr. gave, by the method of Varrentrapp and Will, 0.2974 gr. ammonio-chloride of platinum.
 VI. 0.698 gr. gave 0.2331 gr. ammonio-chloride of platinum.

Expressed in 100 parts, the above give—

	I.	II.
Carbon ...	45.03	45.32
Hydrogen .	6.67	6.63
Nitrogen ...	2.14	2.10
Ashes	0.67	
Water.....	13.65	

Estimated in 100 parts, according to the method described at page 368, the above determinations yield the following numbers:—

$$\begin{array}{lcl}
 \text{Nitrogenous} & \left\{ \begin{array}{l} \text{Nitrogen... } 2.12 \\ \text{Carbon ... } 7.44 \\ \text{Hydrogen . } 0.93 \\ \text{Oxygen ... } 2.89 \\ \text{Sulphur ... } 0.15 \end{array} \right\} & = 13.53 \\
 \text{ingredients.} & & \\
 \\
 \text{Non-nitrogenous} & \left\{ \begin{array}{l} \text{Carbon ... } 37.73 \\ \text{Hydrogen } 5.72 \\ \text{Oxygen... } 41.92 \end{array} \right\} & = 85.37 \\
 \text{ingredients.} & & \\
 \text{Ashes & & = \frac{0.66}{99.56}
 \end{array}$$

No. 3. *Wheat-flour from Vienna.*

- I. 3.5345 grms. lost at 100°C . 0.4500 gr.
 II. 4.4785 grs. of substance dried at 100°C . gave 0.0497 gr. ashes.
 III. 0.5545 gr. gave 0.9339 gr. CO^2 and 0.3377 gr. HO.
 IV. 0.3310 gr. gave 0.5655 gr. CO^2 and 0.2031 gr. HO.
 V. 0.6405 gr. gave 0.3514 gr. of ammonio-chloride of platinum.

These determinations, expressed in 100 parts, give—

	I.	II.
Carbon.....	45.93	46.59
Hydrogen	6.76	6.81
Nitrogen ...	3.44	
Ashes	1.11	
Water	12.73	

Estimated in 100 parts, as previously, the above determinations give the following numbers:—

Nitrogenous ingredients.	{	Nitrogen...	3·44	}	= 21·93
		Carbon ...	12·08		
		Hydrogen .	1·50		
		Oxygen ...	4·68		
		Sulphur ...	0·25		
Ingredients containing no nitrogen.	{	Carbon ...	34·78	}	= 78·03
		Hydrogen	5·28		
		Oxygen ...	37·91		
		Ashes.....			
					1·10
					<hr/> 101·06

Talavera Wheat (Triticum vulgare) from Hohenheim.

This variety is of high reputation as a winter grain. Berry yellow, of medium size, and slightly shrunk. 10 grains weigh 0·3606 grm.

I. 2·3010 grs. lost at 100° C. 0·3551 gr.

II. 3·9868 grs. of substance dried at 100° gave 0·1116 ashes.

III. 0·2796 gr. gave 0·3915 gr. CO² and 0·1672 gr. HO.

IV. 0·2387 gr. gave 0·3915 gr. CO² and 0·1427 gr. HO.

V. 0·6429 gr. gave 0·2711 gr. ammonio-chloride of platinum.

These, expressed in parts of 100, give—

	I.	II.
Carbon.....	45·14	44·73
Hydrogen..	6·64	5·97
Nitrogen ...	2·59	
Ashes	2·80	
Water	15·43	

Estimated in 100 parts, as previously, the above determinations give the following numbers:—

Nitrogenous ingredients.	{	Nitrogen...	2·59*	}	= 16·52
		Carbon ...	9·09		
		Hydrogen .	1·13		
		Oxygen ...	3·53		
		Sulphur ...	0·18		
Ingredients containing no nitrogen.	{	Carbon ...	35·84	}	= 80·78
		Hydrogen	5·12		
		Oxygen ...	39·82		
		Ashes.....			
					2·80
					<hr/> 100·10

Whittington Wheat (Triticum vulgare) from Hohenheim.

An English variety of great excellence. Berry yellow, or white, large, and slightly shrunk. 10 grains weigh 0·4239 gr.

I. 2·6221 grs. lost at 100° C. 0·3653 gr.

II. 4·6567 grs. of substance dried at 100° C. gave 0·1460 gr. ashes.

III. 0·2927 gr. gave 0·4747 gr. CO² and 0·1834 gr. HO.

IV. 0·3898 gr. gave 0·6377 gr. CO² and 0·2343 gr. HO.

V. 0·5494 gr. gave 0·2343 gr. ammonio-chloride of platinum.

Expressed in 100 parts—

	I.	II.
Carbon.....	44·23	44·61
Hydrogen..	6·96	6·67
Nitrogen ...	2·68	
Ashes	3·13	
Water	13·93	

Estimated in 100 parts, as previously, the above determinations give the following numbers:—

$$\begin{array}{lcl}
 \text{Nitrogenous} & \left\{ \begin{array}{l} \text{Nitrogen...} \quad 2\cdot68 \\ \text{Carbon ...} \quad 9\cdot40 \\ \text{Hydrogen} \quad 1\cdot17 \\ \text{Oxygen ...} \quad 3\cdot65 \\ \text{Sulphur ...} \quad 0\cdot19 \end{array} \right\} & = 17\cdot09 \\
 \text{ingredients.} & & \\
 \\
 \text{Ingredients} & \left\{ \begin{array}{l} \text{Carbon ...} \quad 35\cdot02 \\ \text{Hydrogen} \quad 5\cdot65 \\ \text{Oxygen ...} \quad 38\cdot91 \end{array} \right\} & = 79\cdot58 \\
 \text{containing no} & & \\
 \text{nitrogen.} & & \\
 \text{Ashes.....} & & = 3\cdot13 \\
 & & \hline
 & & 99\cdot80
 \end{array}$$

Sandomierz Wheat (*Triticum vulgare*) from *Hohenheim*.

Berry scarcely of medium size, plump and sound. This variety is known as one of the best in Germany. 10 grains weigh 0·3199 grm.

I. 4·2256 grs. lost at 100° C. 0·6545 gr.

II. 3·6555 grs. of substance dried at 100° gave 0·0886 gr. ashes.

III. 0·5754 gr. gave 0·9327 gr. CO² and 0·3465 gr. HO.

IV. 0·7303 gr. gave 0·3131 gr. ammonio-chloride of platinum.

Expressed in 100 parts—

	I.
Carbon ...	44·20
Hydrogen	6·68
Nitrogen	2·69
Ashes ...	2·40
Water ...	15·48

Estimated in 100 parts, as previously, the above determinations give the following numbers:—

Nitrogenous ingredients.	{	Nitrogen...	2·69	}	= 17·15
		Carbon ...	9·44		
		Hydrogen .	1·17		
		Oxygen ...	3·66		
		Sulphur ...	0·19		
Ingredients containing no nitrogen.	{	Carbon ...	34·76	}	= 78·89
		Hydrogen .	5·51		
		Oxygen ...	38·62		
		Ashes.....			
					<u>2·40</u>
					<u>98·44</u>

No. 1. *Rye-flour from Vienna.*

- I. 3·253 grs. at 100° lost 0·4482 gr.
- II. 2·889 grs. of the substance dried at 100° gave 0·0387 gr. ashes.
- III. 3·2285 grs. gave 0·0427 ashes.
- IV. 0·3383 gr. gave 0·5576 gr. CO² and 0·1983 gr. HO.
- V. 0·3109 gr. gave 0·5055 gr. CO² and 0·1901 gr. HO.
- VI. 0·6519 gr. gave 0·1941 gr. ammonio-chloride of platinum.

These correspond in 100 parts to—

	I.	II.
Carbon.....	44·41	44·34
Hydrogen..	6·51	6·79
Nitrogen ...	1·87	
Ashes	1·34	1·32
Water.....	13·78	

Estimated in 100 parts, as previously, the above determinations give the following numbers:—

Nitrogenous ingredients.	{	Nitrogen...	1·87	}	= 11·92	
		Carbon ...	6·56			
		Hydrogen .	0·82			
		Oxygen ...	2·54			
		Sulphur ...	0·13			
Non-nitrogenous ingredients.	{	Carbon ...	37·81	}	= 85·65	
		Hydrogen .	5·83			
		Oxygen ...	42·01			
		Ashes				
					<u>1·33</u>	
					98·90	

No. 2. *Rye-flour from Vienna.*

- I. 7·4625 grs. lost at 100° C. 1·0956 gr.
- II. 2·8000 grs. of substance dried at 100° C. gave 0·0300 gr. ashes.
- III. 0·5312 gr. gave 0·8752 gr. CO² and 0·3116 gr. HO.

IV. 0·4577 gr. gave 0·7626 gr. CO² and 0·2720 gr. HO.

V. 0·7558 gr. gave 0·3537 gr. ammonio-chloride of platinum.

VI. 0·7378 gr. gave 0·3433 gr. ammonio-chloride of platinum.

These correspond in 100 parts to—

	I.	II.
Carbon.....	44·94	45·44
Hydrogen..	6·52	6·60
Nitrogen ...	2·94	2·92
Ashes	1·07	
Water	14·68	

Estimated in 100 parts, as previously, the above determinations give the following numbers:—

Nitrogenous ingredients.	{ Nitrogen... 2·93	} = 18·69
	{ Carbon ... 10·28	
	{ Hydrogen. 1·28	
	{ Oxygen ... 3·99	
	{ Sulphur ... 0·21	
Non-nitrogenous ingredients.	{ Carbon ... 34·91	} = 78·97
	{ Hydrogen. 5·28	
	{ Oxygen ... 38·78	
	Ashes.....	
		1·07
		<hr/> 98·73

Bush-rye (*Secale cereale*) from *Hohenheim*.

Winter crop. In the Hohenheim catalogue is the following remark:—"Besides its other qualities, it yields such excellent straw that it deserves being mentioned." The berry is small and generally shrunken. 10 grains weigh 0·1220 grm.

I. 4·2303 grms. lost at 100° C. 0·5896 gr.

II. 4·3792 grs. of substance dried at 100° C. gave 0·1078 gr. ashes.

III. 0·4742 gr. gave 0·7879 gr. CO² and 0·2767 gr. HO.

IV. 0·6281 gr. gave 1·0555 gr. CO² and 0·3777 gr. HO.

V. 0·6807 gr. gave 0·3016 gr. ammonio-chloride of platinum.

These correspond in 100 parts to—

	I.	II.
Carbon.....	45·31	45·83
Hydrogen..	6·48	6·68
Nitrogen ...	2·78	
Ashes	2·43	
Water	13·94	

Estimated in 100 parts, as previously, the above determinations give the following numbers:—

Nitrogenous ingredients.	{ Nitrogen... 2.78	} = 17.73
	{ Carbon ... 9.76	
	{ Hydrogen. 1.21	
	{ Oxygen ... 3.78	
Non-nitrogenous ingredients.	{ Sulphur ... 0.20	} = 80.86
	{ Carbon ... 35.76	
	{ Hydrogen. 5.37	
	{ Oxygen ... 39.73	
	Ashes.....	= 2.43
		<hr/> 101.02

Rush-rye (*Secale cereale arundinaceum*) from *Hohenheim*.

Berry of medium size and slightly shrunken. 10 grains weigh 0.1838 grm.

I. 3.3139 grms. lost at 100° C. 0.4579 gr.

II. 1.4596 gr. of substance dried at 100° gave 0.0346 gr. ashes.

III. 0.2795 gr. gave 0.4620 gr. CO² and 0.1742 gr. HO.

IV. 0.2632 gr. gave 0.4381 gr. CO² and 0.1638 gr. HO.

V. 0.6435 gr. gave 0.2530 gr. ammonio-chloride of platinum.

These, expressed in 100 parts, give—

	I.	II.
Carbon.....	45.08	45.39
Hydrogen..	6.92	6.22
Nitrogen ...	2.47	
Ashes	2.37	
Water	13.82	

Estimated in 100 parts, the above determinations give the following numbers:—

Nitrogenous ingredients.	{ Nitrogen... 2.47	} = 15.76
	{ Carbon ... 8.67	
	{ Hydrogen. 1.08	
	{ Oxygen ... 3.36	
Non-nitrogenous ingredients.	{ Sulphur ... 0.18	} = 82.67
	{ Carbon ... 36.56	
	{ Hydrogen. 5.49	
	{ Oxygen ... 40.62	
	Ashes.....	= 2.37
		<hr/> 100.80

Polenta Meal (Indian corn-meal) from *Vienna*.

Yellow and coarse.

I. 5.5810 grs. lost at 100° 0.7456 gr.

II. 4.3933 grs. of substance dried at 100° C. gave 0.0386 gr. ashes.

III. 3.9323 gr. gave 0.331 gr. ashes.

IV. 0.5444 gr. gave 0.9010 gr. CO^2 and 0.3330 gr. HO.

V. 0.5095 gr. gave 0.8399 gr. CO^2 and 0.2943 gr. HO.

VI. 0.9055 gr. gave 0.3093 gr. ammonio-chloride of platinum.

These correspond in 100 parts to—

	I.	II.
Carbon.....	45.14	44.96
Hydrogen..	6.89	6.49
Nitrogen ...	2.14	
Ashes	0.87	0.84
Water	13.36	

Estimated in 100 parts, the above determinations give the following numbers:—

$$\begin{array}{lcl}
 \text{Nitrogenous} & \left\{ \begin{array}{l} \text{Nitrogen...} \quad 2.14 \\ \text{Carbon} \quad \dots \quad 7.51 \\ \text{Hydrogen.} \quad 0.93 \\ \text{Oxygen} \quad \dots \quad 2.92 \\ \text{Sulphur} \quad \dots \quad 0.15 \end{array} \right\} & = 13.65 \\
 \text{ingredients.} & & \\
 \text{Non-nitrogenous} & \left\{ \begin{array}{l} \text{Carbon} \quad \dots \quad 37.53 \\ \text{Hydrogen.} \quad 5.67 \\ \text{Oxygen} \quad \dots \quad 41.70 \end{array} \right\} & = 84.90 \\
 \text{ingredients.} & & \\
 \text{Ashes} & \dots\dots\dots & = 0.86 \\
 & & \hline
 & & 99.41
 \end{array}$$

Common Yellow Maize, Indian corn (Zea mays), from Hohenheim.

Yellow oval berry, bright and sound. 10 grains weigh 3.5934 grms.

I. 4.5765 grs. lost at 100°C . 0.6849 gr.

II. 5.0654 grs. of substance dried at 100°C . gave 0.0974 gr. ashes.

III. 0.4164 gr. gave 0.6984 gr. CO^2 and 0.2468 gr. HO.

IV. 0.4103 gr. gave 0.6800 gr. CO^2 and 0.2454 gr. HO.

V. 0.7319 gr. gave 0.2684 gr. ammonio-chloride of platinum.

These correspond in 100 parts to—

	I.	II.
Carbon.....	45.74	45.20
Hydrogen..	6.58	6.64
Nitrogen ...	2.30	
Ashes	1.92	
Water	14.96	

Estimated in 100 parts, the above determinations give the following numbers:—

Nitrogenous ingredients.	{	Nitrogen...	2·30	}	= 14·66
		Carbon ...	8·07		
		Hydrogen.	1·00		
		Oxygen ...	3·13		
		Sulphur ...	0·16		
Non-nitrogenous ingredients.	{	Carbon ...	37·38	}	= 84·52
		Hydrogen.	5·61		
		Oxygen ...	41·53		
		Ashes.....	1·92		
					<hr/> 101·10

Triticum monococcum from Hohenheim.

- I. 4·4914 grs. lost at 100° C. 0·6472 gr.
 II. 7·1327 grs. of substance dried at 100° C. gave 0·1438 gr. ashes.
 III. 0·6303 gr. gave 1·0288 gr. CO² and 0·3811 gr. HO.
 IV. 0·6757 gr. gave 1·1041 gr. CO² and 0·4098 gr. HO.
 V. 0·7105 gr. gave 0·2340 gr. ammonio-chloride of platinum.

These correspond in 100 parts to—

	I.	II.
Carbon.....	44·51	44·56
Hydrogen..	6·71	6·74
Nitrogen ...	2·07	
Ashes	2·01	
Water	14·40	

Estimated in 100 parts, the above determinations give the following numbers :—

Nitrogenous ingredients.	{	Nitrogen...	2·07	}	= 13·20
		Carbon ...	7·26		
		Hydrogen.	0·90		
		Oxygen ...	2·82		
		Sulphur ...	0·15		
Non-nitrogenous ingredients.	{	Carbon ...	37·28	}	= 84·52
		Hydrogen.	5·82		
		Oxygen ...	41·42		
		Ashes	2·01		
					<hr/> 99·73

Jerusalem Barley (Hordeum distichon) from Hohenheim.

10 grains weigh 0·5312 grm.

- I. 1·9328 grm. lost at 100° C. 0·3247 grm.

II. 2·3553 grs. of substance dried at 100° C. gave 0·0670 gr. ashes.

III. 0·4457 gr. gave 0·7392 gr. CO² and 0·2787 gr. HO.

IV. 0·4603 gr. gave 0·7728 gr. CO² and 0·2913 gr. HO.

V. 0·6910 gr. gave 0·2560 gr. ammonio-chloride of platinum.

These determinations correspond in 100 parts to—

	I.	II.
Carbon.....	45·23	45·78
Hydrogen...	6·94	6·79
Nitrogen ...	2·31	
Ashes	2·84	
Water	16·79	

Estimated in 100 parts, the above determinations give the following numbers:—

Nitrogenous ingredients.	{	Nitrogen...	2·34	}	= 14·72
		Carbon ...	8·11		
		Hydrogen.	1·00		
		Oxygen ...	3·14		
		Sulphur ...	0·16		
Non-nitrogenous ingredients.	{	Carbon ...	37·39	}	= 84·80
		Hydrogen	5·89		
		Oxygen ...	41·54		
		Ashes.....	2·84		
					102·36

Common Winter Barley (*Hordeum vulgare*) from *Hohenheim*.

10 grains weigh 0·3955 grm.

I. 1·5268 gr. lost at 100° C. 0·2107 gr.

II. 2·5708 grs. of substance dried at 100° C. gave 0·1409 gr. ashes.

III. 0·3244 gr. gave 0·5380 gr. CO² and 0·1928 gr. HO.

IV. 0·2505 gr. gave 0·4152 gr. CO² and 0·1611 gr. HO.

V. 0·5266 gr. gave 0·2342 gr. ammonio-chloride of platinum.

VI. 4·3619 grs. of grains (calculated upon substance dried at 100° C.) gave, by the method already described, page 368, 0·2356 gr. woody fibre and combined inorganic matter.

VII. 0·1793 gr. of the same woody fibre gave 0·0035 gr. ashes.

These, expressed in 100 parts, correspond to—

	I.	II.
Carbon.....	45·23	45·20
Hydrogen...	6·60	7·14
Nitrogen ...	2·79	

of different kinds of Vegetable Food.

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Ashes	5.52
Water	13.80
Hulls	5.40
Ashes of hulls	1.90

Estimated in 100 parts, the above determinations give the following numbers :—

Nitrogenous ingredients.	Nitrogen ..	2.79	} = 17.70
	Carbon ...	9.79	
	Hydrogen	1.12	
	Oxygen ...	3.80	
	Sulphur ...	0.20	
Non-nitrogenous ingredients.	Carbon ...	35.43	} = 80.64
	Hydrogen.	5.85	
	Oxygen ...	39.36	
	Ashes.....	5.52	
			103.86

	Dried at 100° C.	Fresh.
Nitrogenous ingredients	17.70	15.26
Inorganic ingredients ...	5.52	4.76
Woody fibre	5.30	4.57
Starch, sugar, &c.	71.48	61.61
Water		13.80
	100.00	100.00

Kamskatka Oats (Avena sativa) from Hohenheim.

10 grains weigh 0.3446 gr.

I. 2.3657 grs. lost at 100° C. 0.3446 gr.

II. 3.1728 gr. of substance dried at 100° C. gave 0.1032 gr. ashes.

III. 0.4310 gr. gave 0.7341 gr. CO² and 0.2552 gr. HO.

IV. 0.4001 gr. gave 0.6830 gr. CO² and 0.2427 gr. HO.

V. 0.4102 gr. gave 0.1581 gr. ammonio-chloride of platinum.

VI. 0.6207 gr. of the same gave 0.2324 gr. ammonio-chloride of platinum.

These, expressed in 100 parts, correspond to—

	I.	II.
Carbon ...	46.45	46.55
Hydrogen	6.55	6.73
Nitrogen...	2.42	2.35
Ashes.....	3.26	
Water ...	12.71	

Estimated in 100 parts, the above determinations give the following numbers :—

Nitrogenous ingredients.	{	Nitrogen...	2·89	}	= 15·24
		Carbon ...	8·39		
		Hydrogen.	1·04		
		Oxygen ...	3·25		
		Sulphur ...	0·17		
Non-nitrogenous ingredients.	{	Carbon ...	38·11	}	= 86·05
		Hydrogen.	5·60		
		Oxygen ...	42·34		
		Ashes.....	3·26		
				104·55	

Early White-panicked Oats (Avena sativa) from Hohenheim.

Berry bright, plump and sound. 10 grains weigh 0·3689 gr.

I. 1·7548 gr. lost at 100° C. 0·2271 gr.

II. 1·8486 gr. of substance dried at 100° C. gave 0·0765 gr. ashes.

III. 0·3539 gr. gave 0·6057 gr. CO² and 0·2144 gr. HO.

IV. 0·2410 gr. gave 0·4123 gr. CO² and 0·1451 gr. HO.

V. 0·4977 gr. gave 0·2236 gr. ammonio-chloride of platinum.

VI. 3·5498 grs. gave, by the method already described, 0·5916 gr. woody fibre and combined inorganic matter.

VII. 0·4197 gr. of the same woody fibre gave 0·0140 gr. ashes.

Expressed in 100 parts, these correspond with—

	I.	II.
Carbon	46·68	46·66
Hydrogen ...	6·73	6·69
Nitrogen	2·82	
Ashes	4·14	
Water.....	12·94	
Hulls	16·66	
Ashes of hulls	3·35	

Estimated in 100 parts, the above determinations give the following numbers:—

Nitrogenous ingredients.	{	Nitrogen...	2·82	}	= 17·99
		Carbon ...	9·90		
		Hydrogen.	1·23		
		Oxygen ...	3·84		
		Sulphur ...	0·20		
Non-nitrogenous ingredients.	{	Carbon ...	36·76	}	= 83·08
		Hydrogen	5·48		
		Oxygen ...	40·84		
		Ashes.....	= 4·14		
					<u>105·21</u>

	Dried at 100° C.	Fresh.
Nitrogenous ingredients	= 17·99	15·67
Inorganic ingredients...	= 4·14	3·60
Woody fibre	= 16·11	14·01
Starch, sugar, &c.	= 61·76	53·78
Water		12·94
	<hr/> 100·00	<hr/> 100·00

As the woody fibre, = 16·66 per cent. of the whole, belongs mostly to the chaff, this grain ranks among the richest in nitrogenous compounds. 2·82 per cent. of nitrogen *with* the chaff equals 3·38 per cent. *without*.

Common Rice (Oryza sativa).

- I. 7·4606 grs. lost at 100° C. 1·1301 gr.
- II. 8·3670 grs. of substance dried at 100° C. gave 0·0306 gr. ashes.
- III. 0·7158 gr. gave 1·1701 gr. CO² and 0·4244 gr. HO.
- IV. 0·6095 gr. gave 0·9982 gr. CO² and 0·3559 gr. HO.
- V. 1·5609 gr. gave 0·2892 gr. ammonio-chloride of platinum.

These determinations correspond in 100 parts to—

	I.	II.
Carbon ...	44·57	44·66
Hydrogen ...	6·58	6·48
Nitrogen...	1·16	
Ashes	0·36	
Water ...	15·14	

Estimated in 100 parts, these determinations give the following numbers:—

$$\begin{array}{lcl}
 \text{Nitrogenous} & \left\{ \begin{array}{l} \text{Nitrogen... } 1\cdot16 \\ \text{Carbon ... } 4\cdot07 \\ \text{Hydrogen } 0\cdot51 \\ \text{Oxygen ... } 1\cdot58 \\ \text{Sulphur ... } 0\cdot08 \end{array} \right\} & = 7\cdot40 \\
 \text{ingredients.} & & \\
 \\
 \text{Non-nitrogenous} & \left\{ \begin{array}{l} \text{Carbon ... } 40\cdot54 \\ \text{Hydrogen } 6\cdot02 \\ \text{Oxygen ... } 45\cdot04 \end{array} \right\} & = 91\cdot60 \\
 \text{ingredients.} & & \\
 \text{Ashes & & = 0\cdot36 \\
 & & \hline
 & & 99\cdot36
 \end{array}$$

Buckwheat-meal from Vienna.

- I. 7·3962 grs. lost at 100° C. 1·1187 gr.
- II. 5·1500 grs. of substance dried at 100° C. gave 0·0564 gr. ashes.
- III. 0·5041 gr. gave 0·8194 gr. CO² and 0·2911 gr. HO.

- IV. 0·3441 gr. gave 0·5577 gr. CO² and 0·2061 gr. HO.
 V. 1·1295 gr. gave 0·2062 gr. ammonio-chloride of platinum.
 VI. 0·9536 gr. gave 0·1561 gr. ammonio-chloride of platinum.

These, expressed in 100 parts, correspond to—

	I.	II.
Carbon ...	44·36	44·20
Hydrogen	6·42	6·68
Nitrogen..	1·14	1·03
Ashes....	1·09	
Water....	15·12	

Estimated in 100 parts, the above determinations give the following numbers:—

$$\begin{array}{lcl}
 \text{Nitrogenous} & \left\{ \begin{array}{l} \text{Nitrogen ... } 1\cdot08 \\ \text{Carbon ... } 3\cdot79 \\ \text{Hydrogen } 0\cdot47 \\ \text{Oxygen ... } 1\cdot47 \\ \text{Sulphur ... } 0\cdot07 \end{array} \right\} & = 6\cdot88 \\
 \text{ingredients.} & & \\
 \\
 \text{Non-nitrogenous} & \left\{ \begin{array}{l} \text{Carbon ... } 40\cdot48 \\ \text{Hydrogen } 6\cdot07 \\ \text{Oxygen ... } 44\cdot97 \end{array} \right\} & = 91\cdot52 \\
 \text{ingredients.} & & \\
 \text{Ashes.....} & & = 1\cdot09 \\
 & & \hline
 & & 99\cdot49
 \end{array}$$

Tartarian Buckwheat (*Polygonum tartaricum*) from *Hohenheim*.

This variety differs from the common species, *Polygonum Fagopyrum*, in that while the hulls of the latter are smooth, those of the former are covered with folds and excrescences. The whole grain, hull included, was pulverized and analysed. 10 grains weigh 0·2566 grm.

- I. 2·7598 grs. lost at 100° C. 0·3916 gr.
 II. 2·5924 grs. of substance dried at 100° C, gave 0·0597 gr. ashes.
 III. 0·4245 gr. gave 0·7013 gr. CO² and 0·2503 gr. HO.
 IV. 0·3401 gr. gave 0·5710 gr. CO² and 0·1943 gr. HO.
 V. 0·5677 gr. gave 0·1407 gr. ammonio-chloride of platinum.
 VI. 5·0444 grs. of the same, by the method already described, gave 1·1438 gr. woody fibre and combined inorganic matter.
 VII. 0·7100 gr. of the woody-fibre gave 0·0006 gr. ashes.
 These, expressed in 100 parts, correspond to—

of different kinds of Vegetable Food.

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	I.	II.
Carbon ...	45·06	45·79
Hydrogen ...	6·55	6·35
Nitrogen ...	1·56	
Ashes	2·30	
Water	14·19	
Hulls	22·67	
Ashes of hulls	0·08	

Estimated in 100 parts, the above determinations give the following numbers :—

Nitrogenous ingredients.	{ Nitrogen ...	1·56	} = 9·94
	{ Carbon ...	5·47	
	{ Hydrogen ...	0·68	
	{ Oxygen ...	2·12	
	{ Sulphur ...	0·11	
Non-nitrogenous ingredients.	{ Carbon ...	40·29	} = 90·38
	{ Hydrogen ...	5·77	
	{ Oxygen ...	44·32	
	Ashes	2·30	
			<hr/> 102·62

Table Peas (Pisum sativum) from Vienna.

Bright, plump, sound and of medium size. 10 peas weigh 2·6080 grms.

I. 4·4804 grs. lost at 100° C. 0·6018 gr.

II. 2·1600 grs. substance dried at 100° C. gave 0·0687 gr. ashes.

III. 0·4527 gr. gave 0·7476 gr. CO² and 0·2789 gr. HO.

IV. 0·3810 gr. gave 0·6314 gr. CO² and 0·2272 gr. HO.

V. 0·8603 gr. gave 0·6047 gr. ammonio-chloride of platinum.

VI. 5·2332 grs. of the same, according to the method described, gave 0·4005 gr. hulls.

VII. 0·3962 gr. of hulls dried at 100° C. gave 0·0098 gr. ashes.

These correspond in 100 parts to—

	I.	II.
Carbon ...	45·04	45·20
Hydrogen	6·84	6·62
Nitrogen	4·42	
Ashes	3·18	
Water	13·43	
Hulls	7·65	
Ashes of hulls	2·47	

Estimated in 100 parts, the above determinations give the following numbers :—

Nitrogenous ingredients.	{	Nitrogen ...	4.42	}	= 28.02
		Carbon ...	15.51		
		Hydrogen ...	1.93		
		Oxygen ...	6.02		
		Sulphur ...	0.14		
Non-nitrogenous ingredients.	{	Carbon ...	29.61	}	= 67.31
		Hydrogen ...	4.80		
		Oxygen ...	32.90		
		Ashes	3.18		
					<hr/> 98.51

Legumine, according to the analysis of Dumas and Cahours, gave for the above determinations 102.00*.

	Dried at 100° C.	Fresh.
Nitrogenous ingredients	= 28.02	24.41
Inorganic ingredients	= 3.18	2.75
Woody fibre	= 7.47	6.46
Starch, sugar, &c. ...	= 61.35	52.95
Water		13.43
<hr/>		
100.02		100.00

Field Peas (Pisum sativum) from Giessen.

Less in size than the preceding variety. 10 grains weigh 1.9829 grm.

I. 3.5904 grs. lost at 100° 0.7002 gr.

II. 2.2455 grms. of substance dried at 100° C. gave 0.0628 gr. ashes.

III. 0.6178 gr. gave 1.0267 gr. CO₂ and 0.3572 gr. HO.

IV. 0.6467 gr. gave 0.4708 gr. ammonio-chloride of platinum.

V. 31.925 grs. gave, by the method already described, 1.9510 gr. hulls.

VI. 0.7232 gr. of the hulls dried at 100° C. gave 0.0135 gr. ashes.

These correspond in 100 parts to—

* Their analysis gave—

Carbon	50.5
Hydrogen	6.8
Nitrogen	18.5
Oxygen	24.2
<hr/>	
100.0	

I.	
Carbon	45.32
Hydrogen . . .	6.42
Nitrogen	4.57
Ashes	2.79
Water	19.50
Hulls	6.11
Ashes of hulls	1.86

Estimated in 100 parts, the above determinations give the following numbers :—

Nitrogenous ingredients.	{ Nitrogen . . .	4.57	} = 29.18
	{ Carbon . . .	16.04	
	{ Hydrogen . . .	2.00	
	{ Oxygen . . .	6.43	
Non-nitrogenous ingredients.	{ Sulphur . . .	0.14	}
	{ Carbon . . .	29.28	
	{ Hydrogen . . .	4.42	
	{ Oxygen . . .	32.53	
		Ashes	= 2.79
			<hr/> 98.10

Legumine, according to Dumas' and Cahours' analysis, gave for the above determinations 101.06.

	Dried at 100° C.	Fresh.
Nitrogenous ingredients	29.18	23.49
Inorganic ingredients . .	2.79	2.24
Woody fibre	6.00	4.83
Starch, sugar, &c.	62.03	51.14
Water		19.50
	<hr/> 100.00	<hr/> 101.20

Table Beans (Phaseolus vulgaris) from Vienna.

Berry bright, plump, and of less than medium size. 10 beans weighed 3.1431 grms.

I. 2.9467 grs. lost at 100° C. 0.3953 gr.

II. 2.8422 grs. of substance dried at 100° C. gave 0.1244 gr. ashes.

III. 0.4648 gr. gave 0.7721 gr. CO² and 0.2747 gr. HO.

IV. 0.4334 gr. gave 0.7126 gr. CO² and 0.2617 gr. HO.

V. 0.9082 gr. gave 0.6457 gr. ammonio-chloride of platinum.

VI. 13.6091 grs., by the method already described, gave 0.5461 gr. hulls.

VII. 0.5510 gr. hulls dried at 100° C. gave 0.0212 gr. ashes.

These correspond in 100 parts to—

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	I.	II.
Carbon.....	45.30	45.84
Hydrogen ...	6.56	6.76
Nitrogen ...	4.47	
Ashes	4.38	
Water	13.41	
Hulls	4.11	
Ashes of same	3.84	
Woody fibre	3.86	

Estimated in 100 parts, the above determinations give the following numbers:—

Nitrogenous ingredients.	{ Nitrogen ...	4.47	} = 28.64
	{ Carbon ...	15.69	
	{ Hydrogen ...	1.95	
	{ Oxygen ...	6.39	
	{ Sulphur ...	0.14	
Non-nitrogenous ingredients.	{ Carbon ...	29.38	} = 66.70
	{ Hydrogen ...	4.68	
	{ Oxygen ...	32.64	
	{ Ashes		
			4.38
			<hr/> 99.72

According to the analysis of legumine by Dumas and Cahours, the estimate gives 102.99.

	Dried at 100° C.	Fresh.
Nitrogenous ingredients	= 28.54	24.71
Inorganic ingredients ..	= 4.38	3.79
Woody fibre	= 3.86	3.34
Starch, sugar, &c.	= 63.22	54.75
Water		13.41
	<hr/> 100.00	<hr/> 100.00

Large Field-beans (Vicia faba) from Giessen.

White, plump and sound. 10 weigh 5.289 grms.

I. 7.4054 grs. lost at 100° C. 1.1705 gr.

II. 2.7950 grs. of substance dried at 100° C. gave 0.1150 gr. ashes.

III. 0.4987 gr. gave 0.8255 gr. CO² and 0.3053 gr. HO.

IV. 0.7238 gr. gave 0.5291 gr. ammonio-chloride of platinum.

V. 44.5335 grs. gave, by the method already described, 1.9680 gr. hulls.

VI. 0.8335 gr. of the hulls dried at 100° C. gave 0.0624 gr. ashes.

These, expressed in 100 parts, correspond to—

I.	
Carbon	45.18
Hydrogen	6.80
Nitrogen	4.59
Ashes	4.01
Water	15.80
Hulls	4.44
Hull-ashes	7.48
Woody fibre	4.09

Estimated in 100 parts, the above determinations give the following numbers:—

Nitrogenous ingredients.	{ Nitrogen	4.59	} = 29.31
	{ Carbon	16.11	
	{ Hydrogen	2.00	
	{ Oxygen	6.47	
	{ Sulphur	0.14	
Non-nitrogenous ingredients.	{ Carbon	29.07	} = 66.17
	{ Hydrogen	4.80	
	{ Oxygen	32.30	
	Ashes	4.01	
			<hr/> 99.49

According to Dumas' and Cahours' analysis of legumine, the estimate from the above determinations gave 102.73.

	Dried at 100° C.	Fresh.
Nitrogenous ingredients	= 29.31	24.67
Inorganic ingredients	= 4.01	3.37
Woody fibre	= 4.09	3.44
Starch, sugar, &c.	= 62.59	52.72
Water		15.80
	<hr/> 100.00	<hr/> 100.00

Lentils (Ervum lens) from Vienna.

Grains bright and sound.

- I. 9.3074 grs. lost at 100° C. 1.2108 gr.
- II. 2.1669 grs. pulverized lost at 100° C. 0.2820 gr.
- III. 1.4724 gr. of the substance dried at 100° C. gave 0.0402 gr.
- IV. 0.3511 gr. gave 0.5813 gr. CO² and 0.2122 gr. HO.
- V. 0.3863 gr. gave 0.6452 gr. CO² and 0.2362 gr. HO.
- VI. 0.6797 gr. gave 0.5198 gr. ammonio-chloride of platinum.

The above, expressed in 100 parts, correspond with—

2 D 2

	I.	II.
Carbon ...	45.15	45.55
Hydrogen	6.71	6.79
Nitrogen	4.77	
Ashes ...	2.60	
Water ...	13.01	13.01

Estimated in 100 parts, the above determinations give the following numbers:—

Nitrogenous ingredients.	{ Nitrogen ...	4.77	} = 30.46
	{ Carbon ...	16.74	
	{ Hydrogen	2.08	
	{ Oxygen ...	6.72	
	{ Sulphur ...	0.15	
Non-nitrogenous ingredients.	{ Carbon ...	28.61	} = 65.06
	{ Hydrogen	4.67	
	{ Oxygen ...	31.78	
	Ashes.....		
			= 2.60
			<u>98.12</u>

According to Dumas' and Cahours' analysis of legumine, the estimate gave 101.34.

White Potatoes (*Solanum tuberosum*) from Giessen.

I. 1.1455 gr. lost at 100° C. 0.8586 gr.

II. 3.2201 grs. substance dried at 100° C. gave 0.1163 gr. ashes.

III. 0.5814 gr. gave 0.9351 gr. CO² and 0.3139 gr. HO.

IV. 1.1530 gr. gave 0.2843 gr. ammonio-chloride of platinum.

These, expressed in 100 parts, give—

Carbon ...	43.86
Hydrogen	6.06
Nitrogen	1.56
Ashes ...	3.61
Water ...	74.95

Estimated in 100 parts, the above determinations give the following numbers:—

Nitrogenous ingredients.	{	Nitrogen ...	1.56	}	= 9.96
		Carbon ...	5.47		
		Hydrogen	0.68		
		Oxygen ...	2.14		
		Sulphur ...	0.11		
Non-nitrogenous ingredients.	{	Carbon ...	38.39	}	= 86.36
		Hydrogen	5.32		
		Oxygen ...	42.65		
		Ashes			
					= 3.61
					<u>99.93</u>

Blue Potatoes (Solanum tuberosum) from Giessen.

- I. 2·8369 grs. lost at 100° C. 1·9558 gr.
 II. 3·6446 grs. of substance dried at 100° C. gave 0·1226 gr. ashes.
 III. 0·8315 gr. gave 1·3260 gr. CO² and 0·4711 gr. HO.
 IV. 0·7625 gr. gave 1·2030 gr. CO² and 0·4345 gr. HO.
 V. 1·3485 gr. gave 0·2587 gr. ammonio-chloride of platinum.

Corresponding in 100 parts to—

	I.	II.
Carbon ...	43·49	43·02
Hydrogen ...	6·29	6·33
Nitrogen ...	1·20	
Ashes ...	3·36	
Water ...	68·94	

Estimated in 100 parts, the above determinations lead to the following numbers:—

Nitrogenous ingredients.	{	Nitrogen ...	1·20	}	= 7·66
		Carbon ...	4·21		
		Hydrogen ...	0·52		
		Oxygen ...	1·65		
		Sulphur ...	0·08		
Non-nitrogenous ingredients.	{	Carbon ...	39·04	}	= 88·20
		Hydrogen ...	5·79		
		Oxygen ...	43·37		
		Ashes			
					3·36
					<u>99·22</u>

Carrots (Daucus carota) from Giessen.

- I. 2·6735 grs. lost at 100° C. 2·3021 gr.
 II. 1·6379 gr. of substance dried at 100° C. gave 0·0946 gr. ashes.
 III. 0·6668 gr. gave 1·0597 gr. CO² and 0·3736 gr. HO.
 IV. 0·6797 gr. gave 0·1885 gr. ammonio-chloride of platinum.
 V. 0·7043 gr. of the same gave 0·1790 gr. ammonio-chloride of platinum.

Expressed in 100 parts, these correspond to—

	I.	II.
Carbon ...	43·34	
Hydrogen ...	6·22	
Nitrogen ...	1·74	1·59
Ashes ...	5·77	
Water ...	86·10	

Estimated in 100 parts, the above determinations give the following numbers:—

Nitrogenous ingredients.	Nitrogen ...	1·67	} = 10·66
	Carbon ...	5·87	
	Hydrogen ...	0·73	
	Oxygen ...	2·27	
	Sulphur ...	0·12	
Non-nitrogenous ingredients.	Carbon ...	37·47	} = 84·59
	Hydrogen ...	5·49	
	Oxygen ...	41·63	
	Ashes	5·77	
		101·02	

Red Beets (*Beta vulgaris rapacea*) from *Giessen*.

I. 1·6173 gr. lost at 100° C. 1·3200 gr.

II. 2·3399 grs. of substance dried at 100° C. gave 0·1505 gr. ashes.

III. 0·4875 gr. gave 0·7525 gr. CO² and 0·2512 gr. HO.

IV. 0·5505 gr. gave 0·2152 gr. ammonio-chloride of platinum.

Corresponding in 100 parts to—

Carbon ...	40·99
Hydrogen ...	5·72
Nitrogen ...	2·43
Ashes ...	6·43
Water ...	81·61

Estimated in 100 parts, the above determinations give the following numbers:—

Nitrogenous ingredients.	Nitrogen ...	2·43	} = 15·50
	Carbon ...	8·53	
	Hydrogen ...	1·06	
	Oxygen ...	3·31	
	Sulphur ...	0·17	
Non-nitrogenous ingredients.	Carbon ...	32·46	} = 73·18
	Hydrogen ...	4·66	
	Oxygen ...	36·06	
	Ashes	6·43	
		95·11	

Peligot found in this beet—

10·6	per cent.	sugar ; add to this
2·8	...	nitrogenous ingredients,
1·1	...	inorganic matter,
81·6	...	water, and there remain,
3·9	...	woody fibre, &c. in
100·0	parts.	

of different kinds of Vegetable Food.

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Yellow French Beet (Beta cicla) from Giessen.

- I. 1·8545 gr. lost at 100° C. 1·5255 gr.
 II. 2·2840 grs. of substance dried at 100° C. gave 0·1148 gr. ashes.
 III. 0·4530 gr. gave 0·6853 gr. CO² and 0·2587 gr. HO.
 IV. 0·4057 gr. gave 0·6165 gr. CO² and 0·2202 gr. HO.
 V. 0·5660 gr. gave 0·1635 gr. ammonio-chloride of platinum.

Corresponding in 100 parts to—

	I.	II.
Carbon ...	41·25	41·45
Hydrogen ...	6·34	6·03
Nitrogen ...	1·81	
Ashes ...	5·02	
Water ...	82·25	

Estimated in 100 parts, the above determinations give the following numbers:—

Nitrogenous ingredients.	{ Nitrogen ...	1·81	} = 11·54
	{ Carbon ...	6·35	
	{ Hydrogen ...	0·79	
	{ Oxygen ...	2·46	
	{ Sulphur ...	0·13	
Non-nitrogenous ingredients.	{ Carbon ...	34·74	} = 78·49
	{ Hydrogen ...	5·15	
	{ Oxygen ...	38·60	
	Ashes	5·02	
			99·05

Ruta Baga (Brassica napo-brassica) from Giessen.

- I. 2·2981 grs. lost at 100° C. 1·9139 gr.
 II. 2·5171 grs. of substance dried at 100° C. gave 0·1010 gr. ashes.
 III. 0·6762 gr. gave 1·1226 gr. CO² and 0·3665 gr. HO.
 IV. 0·6122 gr. gave 1·0180 gr. CO² and 0·3306 gr. HO.
 V. 0·7625 gr. gave 0·1765 gr. ammonio-chloride of platinum.

Corresponding in 100 parts to—

	I.	II.
Carbon ...	45·27	45·35
Hydrogen ...	6·02	6·00
Nitrogen ...	1·45	
Ashes ...	4·10	
Water ...	83·28	

Estimated in 100 parts, the above determinations give the following numbers:—

Nitrogenous ingredients.	{	Nitrogen...	1.45	}	= 9.24
		Carbon ...	5.09		
		Hydrogen	0.63		
		Oxygen ...	1.97		
		Sulphur ...	0.10		
Non-nitrogenous ingredients.	{	Carbon ...	40.23	}	= 90.32
		Hydrogen	5.38		
		Oxygen ...	44.71		
		Ashes	4.01		
					<hr/> 103.57

White Turnips (Brassica rapa) from Giessen.

- I. 0.8742 gr. lost at 100° C. 0.7674 gr.
 II. 1.7487 gr. of substance dried at 100° C. gave 0.1229 gr. ashes.
 III. 0.4376 gr. gave 0.6953 gr. CO² and 0.2225 gr. HO.
 IV. 0.2831 gr. gave 0.4472 gr. CO².
 V. 0.5976 gr. gave 43.42 per cent. C. and 5.91 per cent. H.
 VI. 0.7969 gr. gave 0.2523 gr. ammonio-chloride of platinum.

Corresponding in 100 parts to—

	I.	II.	III.
Carbon ...	43.33	43.08	43.42
Hydrogen	5.64	6.04	5.91
Nitrogen	1.98		
Ashes ...	7.03		
Water ...	87.78		

Estimated in 100 parts, the above determinations give the following numbers:—

Nitrogenous ingredients.	{	Nitrogen...	1.98	}	= 12.62
		Carbon ...	6.95		
		Hydrogen	0.86		
		Oxygen ...	2.69		
		Sulphur ...	0.14		
Non-nitrogenous ingredients.	{	Carbon ...	36.24	}	= 81.33
		Hydrogen	4.82		
		Oxygen ...	40.27		
		Ashes	= 7.02		
					<hr/> 100.97

White Onions from Giessen.

- I. 4.3169 grms. lost at 100° C. 4.0478 grms.
 II. 0.6775 gr. of substance dried at 100° C. gave 0.0578 gr. ashes.

III. 0·6726 gr. gave 0·1272 gr. ammonio-chloride of platinum.

These determinations correspond in 100 parts to—

Nitrogen... 1·18
Ashes 8·53
Water ... 93·78

Hulls.

Name.	Undissolved residue in 100 parts (hulls ?) dried at 100° C.	Ashes of the hulls.	Woody fibre.
Common Winter Barley	5·40	1·90	5·30
Tartarian Buckwheat	22·67	0·08	22·66
Panicled Oats.....	16·66	3·35	16·10
Table Peas	7·65	2·47	7·47
Field Peas	6·11	1·86	6·00
Table Beans	4·01	3·84	3·86
Large Field-beans	4·41	7·48	4·09

Relative worth of the individual grains according to weight and per-centage of nitrogen.

Name.	10 grains weighed in undried condition.	Relative weight of the individual grains, Bush-rye = 1.	Per cent. of nitrogen in undried condition.	Relative quantity of nitrogen in the individual grains, Bush-rye = 1.
	grs.			
Bush-rye	0·1220	1	2·39	1
Rush-rye	0·1838	1·5	2·13	1·3
Talavera Wheat	0·3606	3	2·19	2·7
Whitington Wheat	0·4239	3·5	2·30	2·9
Sandomierz Wheat	0·3199	2·8	2·13	2·4
Indian Corn	3·5934	29·4	1·95	24·0
Jerusalem Barley	0·5312	4·3	1·92	3·6
Common Barley.....	0·3955	3·2	2·40	2·4
Kamtskatka Oats	0·3446	2·8	2·08	2·4
Early-panicled Oats	0·3689	3	2·45	3·1
Tartarian Buckwheat	0·2566	2·1	1·33	1·2
Table Peas	2·6080	21·4	3·83	34·3
Field Peas	1·9828	16·3	3·68	25·1
Table Beans	3·1431	25·5	3·87	41·2
Large White Beans	5·2890	43·3	3·86	69·9

Tabular Results of Analysis.

Name.	Nitro- gen.	Carbon.	Hydro- gen.	Oxygen.	Sulphur.	Ashes.
Wheat-flour from Vienna, No. 1...	3.00	45.74	6.70	43.23	0.23	0.70
Wheat-flour from Vienna, No. 2...	2.12	45.18	6.65	44.81	0.15	0.66
Wheat-flour from Vienna, No. 3...	3.44	46.86	6.78	42.65	0.25	1.10
Talavera Wheat from Hohenheim.	2.59	44.93	6.25	43.35	0.18	2.80
Whittington Wheat	2.68	44.42	6.82	42.56	0.19	3.13
Sandomierz Wheat	2.69	44.20	6.68	42.28	0.19	2.40
Rye-flour from Vienna, No. 1	1.87	44.37	6.65	44.55	0.13	1.33
Rye-flour from Vienna, No. 2	2.93	45.19	6.56	42.77	0.21	1.07
Bush-rye from Hohenheim	2.78	45.52	6.58	43.51	0.15	0.86
Rush-rye from Hohenheim	2.47	45.23	6.57	43.98	0.18	2.37
Polenta Meal from Vienna	2.14	45.04	6.60	44.62	0.15	0.86
Indian Corn from Hohenheim ...	2.30	45.45	6.61	44.66	0.16	1.92
<i>Triticum monococcum</i> from Giessen	2.07	44.54	6.72	44.24	0.15	2.01
Jerusalem Barley from Hohenheim	2.31	45.50	6.87	44.68	0.16	2.84
Common Winter Barley from } Hohenheim	2.79	45.22	6.99	42.16	0.20	5.52
Kamskatka Oats from Hohenheim	2.39	46.50	6.64	45.59	0.17	3.26
Early-panicked Oats from Ho- } henheim	2.82	46.66	6.74	44.68	0.20	4.14
Common Rice	1.16	44.61	6.53	46.62	0.08	0.36
Buckwheat Meal from Vienna ...	1.08	44.27	6.54	46.50	0.07	1.09
Tartarian Buckwheat from Ho- } henheim	1.56	45.42	6.45	46.50	0.11	2.30
Table Peas from Vienna	4.42	45.12	6.73	37.92	0.14	3.18
Field Peas from Giessen	4.57	45.33	6.42	38.75	0.14	2.79
Table Beans from Vienna	4.47	45.07	6.63	38.73	0.14	4.38
Large White Beans from Giessen	4.59	45.18	6.80	38.55	0.14	4.01
Lentils from Vienna	4.77	45.35	6.75	38.28	0.15	2.60
White Potatoes from Giessen.....	1.56	43.86	6.00	44.77	0.14	3.61
Blue Potatoes from Giessen	1.20	43.25	6.31	45.00	0.08	3.36
Carrots from Giessen	1.67	43.34	6.22	43.90	0.12	5.77
Red Beets from Giessen	2.43	40.99	5.72	39.37	0.17	6.43
Ruta Baga from Giessen	1.81	41.09	5.94	41.06	0.13	5.02
Yellow French Beet from Giessen.	1.45	45.31	6.61	42.59	0.10	4.01
White Turnips from Giessen	1.98	43.19	5.68	42.96	0.14	7.02
White Onions from Giessen	1.18					8.53

Table for the Nitrogenous Ingredients.

Name.	Nitrogenous Ingredients.		Water.
	Dried at 100° C.	In fresh con- dition.	
Wheat-flour from Vienna, No. 1	19.16	16.51	13.85
Wheat-flour from Vienna, No. 2	13.54	11.69	13.65
Wheat-flour from Vienna, No. 3	21.97	19.17	12.73
Talavera Wheat from Hohenheim	16.54	13.98	15.43
Whittington Wheat from Hohenheim	17.11	14.72	13.93
Sandomierz Wheat from Hohenheim	17.18	14.51	15.48
Rye-flour from Vienna, No. 1	11.94	10.34	13.78
Rye-flour from Vienna, No. 2	18.71	15.96	14.68
Bush-rye from Hohenheim	17.75	15.27	13.94
Rush-rye from Hohenheim	15.77	13.59	13.82
Polenta Meal from Vienna	13.66	11.53	13.36
Indian Corn from Hohenheim	14.68	12.48	14.96

Table for the Nitrogenous Ingredients (continued).

Name,	Nitrogenous ingredients.		Water.
	Dried at 100° C.	In fresh condition.	
<i>Triticum monococcum</i> from Giessen	13.22	11.30	14.40
Jerusalem Barley from Hohenheim	14.74	12.26	16.79
Common Barley from Hohenheim	17.81	15.35	13.80
Kamskatka Oats from Hohenheim	15.26	13.32	12.71
Early-panicked Oats from Hohenheim	18.00	15.67	12.94
The same without hulls	21.57	18.78	12.94
Common Rice	7.40	6.27	15.14
Buckwheat Meal from Vienna	6.89	5.84	15.12
Tartarian Buckwheat from Hohenheim ...	9.96	7.94	14.19
Table Peas from Vienna	28.02	24.41	13.43
Field Peas from Giessen	29.18	23.49	19.50
Table Beans from Vienna	28.54	24.74	13.41
Large White Beans from Giessen.....	29.31	24.67	15.80
Lentils from Vienna	30.46	26.59	13.01
White Potatoes from Giessen	9.96	2.49	74.95
Blue Potatoes from Giessen.....	7.66	2.37	68.94
Carrots from Giessen	10.66	1.48	86.10
Red Beets from Giessen	15.50	2.83	81.61
Ruta Baga from Giessen	11.56	2.04	82.25
Yellow French Beet from Giessen	9.25	1.54	83.28
White Turnips from Giessen	12.64	1.54	87.78
White Onions from Giessen	7.53	0.46	93.78

Tabular Arrangement of Nutrition Values in Equivalents.
Wheat at 100.

Name.	Theory.		Experiment.
	Dried at 100° C.	In fresh condition.	In fresh condition.
Wheat	100	100	94
Rye	98.8	97.6	97.6
Indian Corn	115	113	108
<i>Triticum monococcum</i>	128	124.6	
Barley.....	104	102	101.5
Panicked Oats	92	90	112.7
The same without hulls	78	76.3	
Kamskatka Oats	110	106	
Common Rice	220	225	
Tartarian Buckwheat	170	166	122.7
Table Peas from Vienna	59.9	57.6	90.7
Field Peas from Giessen	57.7	60	90.7
Table Beans from Vienna	59.2	57	94.7
Large White Beans from Giessen	58.8	57	94.7
Lentils	55.5	53	
White Potatoes	169.8	565.6	429
Blue Potatoes	220.8	596.3	429
Carrots	158.6	959.4	545.4
Red Beets	109	501.5	
Ruta Baga	146	689.5	643
Yellow French Beet	182.7	919.4	589.7
White Turnips	133.8	919.4	1000
White Onions	224.6	2106.0	

The last column in the preceding table contains the average results of experiments made to ascertain the practical equivalents, as they are given in Boussingault (*Landwirthschaft*, Germ. ed. p. 292-295). One of the results with wheat was neglected, its variation from the others being so great

By comparing the results of the above investigation with each other, and with those previously known, the following conclusions have been arrived at:—

That the same species of cereal grain grown on different soils may yield unequal per-centages of nitrogen.

That one-seventh of fresh ripe cereal grains is moisture, which may be expelled at a temperature of 100° C. (212° F.).

That wheat- and rye-flours, which to the eye and sense of feeling are undistinguishable from each other, may differ by from one to three-tenths of their whole quantity of nitrogen.

That root-crops grown on different soils may yield unequal per-centages of nitrogen.

That the per-centage of moisture in edible roots of the same species is, in the fresh condition, a constant quantity.

That beets, carrots and turnips, have a larger per-centage of moisture than potatoes.

That the nutritive values of peas, beans and lentils, correspond with each other.

That more aliment is contained in a given weight of peas, beans or lentils, than in an equal weight of any other kind of vegetable food analysed.

That in several of the grains and roots analysed there are organic bodies beside those identical in composition with gluten and starch.

That the ashes of carrots, beets, turnips and potatoes, as Prof. von Liebig has already remarked, contain carbonates.

That iron is present in the ashes of all the grains and roots analysed.

That the differences between the theoretical equivalents, as estimated from the per-centages of nitrogen and those ascertained by the experiments of stock-growers, and particularly the differences between the results of the different stock-growers, may be attributed to the following reasons:—

Because the per-centages of nitrogen and carbon in fodder grown on different soils are unequal.

Because the prominent test has been the increase or diminution in weight of the animal fed. *Increase* in weight may arise from secretion of fat, derived from the sugar and starch of the plants. *Diminution* in weight may follow unusual activity, increasing the consumption of fat already present.

Because the experiments, in but few instances, were under-

taken with substances whose per-centages of water and nitrogen had been ascertained.

Because theoretical equivalents have been employed in conditions unequally suited to digestion. The same food, coarse or fine, fresh or prepared for easy digestion, yields unequal measures of nutrition.

Because the conditions, whether exposed to the open air or protected in stalls, whether subjected to labour of uniform severity, or allowed the free range of pastures, have not been made alike.

Finally, because, as above intimated, some animals by nature differ greatly from others, in the facility with which fat and muscle are developed, even when the circumstances are precisely the same.

LVIII. *Microscopic Observations on the Perforation of the Capillaries by the Corpuscles of the Blood, and on the Origin of Mucus and Pus-globules.* By AUGUSTUS WALLER, M.D.*

[Continued from p. 287.]

IN the preceding Number of this Journal I have already given a brief outline of some observations respecting the manner in which the white corpuscles of the blood are seen to leave the interior of the capillary vessels. As this subject is intimately connected with the formation or origin of the globules found in mucus and purulent matter, it deserves a close and strict investigation.

In the first place, we must bear in mind that the blood consists of transparent fluid parts containing two kinds of particles in suspension; the one of a red colour and a flattened disc-like shape, and the other nearly transparent and spherical. The examination of the tongue of the frog, or of any other transparent part of a living animal, shows these globules and corpuscles generally circulating together through the capillaries.

The examination of mucus and purulent matter shows that they contain great quantities of globules, which are exactly similar to the spherical corpuscles found in the blood. In all these instances these particles are of a spherical form, transparent or whitish, granulated, and about the size of $\frac{1}{100}$ th of a millimetre. In acetic acid they contract, in the alkalies they are quickly broken up, in water they swell and are disaggregated into separate minute granules.

The corpuscles of blood in the mammiferæ and in the frog are found to be of about the same size as in man.

In proof of what I have stated respecting the similarity of

* Communicated by the Author.