

bed ; but these symptoms soon went off and left the person remarkably well afterwards. I generally begin, when using the acid of the strength I first had it, with about six drops, to be given in a little water, and the dose to be repeated every six hours, augmenting the number of drops each time, until head ach is produced. The energy of the Hydrocyanic Acid when duly prepared, is such, as to afford a hope that, it may not only prove a most valuable auxiliary in the cure of many other chronic diseases, but also afford the means of curing those herculean maladies Hydrophobia and Tetanus. Professor Silliman has suggested its use in the latter disease.*

I have found it to be a very important part of the treatment of phthisis pulmonalis, to bleed in the incipient stages of the disease. But, no process is beneficial unless aided by warm clothing particularly of the chest, and for this purpose, an eider down waistcoat is very convenient. If to this be added, the administration of the prussic acid given in as large doses as is compatible with the comfort of the sick, much hope may be entertained of the result. We are, however, always to bear in our minds, that the medical art is a conjectural and uncertain one ; and that the action of every medicine is modified by that of the system, and that according to this state or condition of the system, a medicine is active or inert. Hence the propriety of trying different active medicines, in the hope that some one of them may meet that condition of the system which may render it efficient.

I am Sir, with much respect, and esteem,

Your friend and obedient servant,

B. LYNDE OLIVER.

Salem, July, 1820.

Chemical Analysis of Indian Corn. By JOHN GORHAM, M.D.
Professor of Chemistry, in Harvard University.

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INDIAN CORN, either alone, or mixed with the flour of wheat or of rye, constitutes a considerable article in the food of the

* Professor Silliman, in his excellent Journal, has a very interesting paper on the subject of the Prussic Acid, in which, not having heard of the experiments that had been made here ; remarks, " As far as I am informed, these researches have not been so extensively prosecuted in the United States as could be desired,—partly from the difficulty of obtaining the acid, which is no where sold in the shops, and which can be prepared only by a practical chemist ; and partly, in all probability, from negligence and incredulity." Silliman's Journal, vol. 11. p. 62.

inhabitants of the United States. By many it has been preferred to wheat, and it has been said to yield in equal weight a greater quantity of nutritive matter than either of the other farinaceous grains. It is a subject of some interest to determine this point. I do not recollect to have seen any analysis of this grain by the European chemists ; and the following experiments were made as an attempt to supply the deficiency.

Several varieties of maize are cultivated ; but for the present my attention will be confined to the small yellow grain, and the large, flat and white kind, which is commonly known by the name of Virginian corn. The results obtained in examining these two varieties were so similar, with the exception of the colouring matter of the first, that I shall confine myself to the detail of experiments on the yellow species.

The corn employed grew in the neighbourhood of Boston. It was reduced to powder, but not sifted.

Expt. 1. One hundred grains of this powder, after exposure to a moderate heat, until perfectly dried, weighed 91 grains.

Expt. 2. The dry mass was then macerated in water for 48 hours ; it was afterwards triturated in a mortar, with a portion of the liquid in which it had been immersed ; the opaque and milky fluid obtained was poured off, new portions of water were added and triturated as before, and these processes were repeated until no more of the solid remained in the mortar. The emulsive liquid after having been passed through a filtre, was very nearly as transparent as water.

It was not affected by alcohol, acids, nor alkalies. With solution of neutral acetate of lead, it gave a white precipitate. A crystal of iodine put into a portion of it and allowed to remain for 24 hours became surrounded with a light blue cloud, but from the shade of colour, the farina present appeared to be in very minute proportion.

Expt. 3. The liquid was evaporated to dryness in a basin of Wedgewood's ware, and during the process its vapour gave out a very perceptible odour of bread, made of or containing Indian corn. The residue was a grayish semi-transparent substance disposed in laminae. It weighed 4 grains.

Expt. 4. This matter after having been softened by water was digested in warm alcohol for some hours, the whole was filtered, and there remained on the filtre a solid substance, which when dried weighed 1.75 grains. It was opaque, of a gray colour, ductile, tenacious and adherent to the fingers. It dissolved in water, and was precipitated from it by alcohol. Exposed to heat, it burned like gum, at the same time exhaling the odour of burning bread. Rubbed with quicklime, it did not exhale the odour of

ammonia, nor produce white fumes when a paper moistened with muriatic acid was brought near it. I considered it as analogous to gum.

Expt. 5. The clear alcoholic solution, which exhibited a bright yellowish red colour, and had a taste at first sweetish followed by a perceptible bitterness, was evaporated in a glass capsule. When highly concentrated it had the appearance and consistency of honey, and on cooling, concreted into a solid of a dark amber colour, the taste of which was both sweet and bitter. It weighed 2.25 grains. It was deliquescent, and on standing for a few hours became liquid. It was redissolved in alcohol, forming with it a dark red solution. Water added to this liquid produced no other apparent change than that of diluting its colour.

Expt. 6. To this diluted solution, Goulard's Extract of Lead, (*neutral acetate*,) being cautiously added, a brown coloured substance was separated, the whole was thrown on a filtre, and the fluid which passed through was transparent and colourless, while there remained on the paper, a matter, which was collected, diffused in water, and exposed to a stream of sulphuretted hydrogen. After standing for a little while, the liquid was poured off from the sediment and evaporated to dryness in a glass capsule. The mass weighed about 0.80 of a grain. Its colour was reddish brown, its taste bitter and it was soluble in water. It exhibited the properties of extractive matter.

The saccharine substance which amounted in weight to 1.45 grains, remained dissolved in the liquid.

Expt. 7. In consequence of the rapidity with which the entire mass in the preceding experiment deliquesced, I was led to suspect the presence of some deliquescent salt. I had ascertained, that when the powder of indian corn was rubbed with quicklime, it gave out the odour of ammonia and produced white fumes with muriatic acid. But, in my experiments upon this substance, I was not able to detect any ammonia in either of the solid products of its analysis. Hence it appeared probable, that it might exist in it in a saline form, and be removed by the liquid in which the corn was immersed or boiled.

Accordingly, about 4 grains of gummy and saccharine matter were obtained by the process stated above, it was acted upon by alcohol, which was then evaporated. The mass was deliquescent. To one portion of this, a drop of sulphuric acid was added, an acid odour was immediately developed, and it had the characteristic smell of acetic acid. The other portion was mixed with quicklime, and produced, with a paper moistened with liquid muriatic acid, a white vapour, though very small in quantity. These experiments would seem to show the existence of acetate

of ammonia, but it was in minute quantity, and it is impossible to say whether it originally constituted in that form a part of the corn, or was a product of analysis.

When the gummy portion was boiled in water, it left a white substance in minute quantity, which I found to be soluble in muriatic acid, and precipitable from it in white flocks by pure ammonia. This substance, when heated before the blow-pipe, turned black, then became white, and finally melted into a perfectly white and transparent bead. It probably consisted of, or at least, contained, phosphate of lime.

Expt. 8. The mass which remained when the emulsive liquid in expt. 2. was filtered, exhibited when dried, two distinct strata, the one was of a beautiful white, and formed into angular masses, the other of a fibrous appearance, with a mixture of gray and yellow. The whole mass was digested for 24 hours in warm alcohol; at the end of that time the liquid had assumed a fine straw yellow colour; it was filtered and evaporated in a glass capsule. When highly concentrated, or so soon as the odour of alcohol ceased and it was allowed to cool, a substance possessing the following properties, was deposited.

It was soft, ductile, tenacious and highly elastic, but destitute of taste and nearly so of odour. Its colour was yellow, and it resembled beeswax which had been melted in a capsule and allowed to cool in it. Its specific gravity was greater than that of water. When exposed on a spatula to the heat of a lamp, it increased in bulk, became brown, exhaled the odour of burning bread, then melted, giving out the smell of burning animal matter, and was decomposed without inflaming, leaving a black and voluminous coal. Put into the flame of a lamp, it took fire, but did not burn with much rapidity. When distilled in a glass tube, it produced inflammable gases, an empyreumatic oil, similar in appearance to thin tar and of a sharp somewhat acid taste, and left a quantity of charcoal. During this distillation, there was no perceptible odour of ammonia, nor were white fumes produced by muriatic acid.

It was insoluble in water at any temperature, but it readily dissolved and in large proportion in alcohol, producing a transparent and light yellow solution, which was immediately rendered white and turbid by the addition of water. The insoluble matter separated very slowly from the mixed liquid, requiring in fact, several days for its completion. It was likewise soluble in oil of turpentine, and sulphuric ether, and sparingly so in the mineral acids. From its solution in nitric acid it was precipitated both by water and solution of potash, but when the latter was added in excess, the precipitate was redissolved, producing a yel-

lowish solution. The caustic alkalies dissolved this matter, but it was insoluble in solutions of their carbonates. When rubbed in a mortar with liquid ammonia, it produced a sort of soapy compound, decomposable by acids. While dissolving in solution of potash, it did not give out the odour of ammonia, nor when rubbed with quicklime. Heated with sulphuric acid it was decomposed, and an uniform black liquid produced. It was insoluble in the fixed oils, even when aided by heat, but at the boiling temperature of olive oil it melted, and began to decompose, gradually changing its colour to brown and black.

When put into melted resins it apparently incorporated with them, and formed a homogeneous mass.

The amount of this matter procured in the way I have mentioned, was 3 grains.

This substance may be obtained with great ease, and in sufficient quantity for experiment, by putting a few ounces of meal formed from the yellow corn, into a flask, pouring into it alcohol, heating the mixture gently, allowing it to remain at rest for some hours, then filtering, and evaporating.

From the results of its examination it appears, that this matter differs from all the known proximate principles of vegetables. In its physical properties, independently of its colour, it resembles vegetable gluten, and like that substance it is soluble in caustic alkalies, but it differs from it apparently in containing no azote, in its great solubility in alcohol, and in its permanency. It is not apparently liable to spontaneous decomposition, at least a small portion which has been exposed to the air for six weeks, has not undergone any obvious change. On the other hand, it seems to exhibit a considerable analogy to the resins. Like them it is soluble in alcohol, essential oils, alkalies, and partially in acids, but is perfectly insoluble in water. It is inflammable, and probably composed of oxygen, hydrogen, and carbon.

This substance I shall call *zeïne*, not from any wish to multiply vegetable principles, nor because I think it of any importance, but merely that it may be definitely described and designated without circumlocution.

It should have been remarked before, that the powder of yellow corn, after having been digested in alcohol, loses its colour and becomes white.

Expt. 9. The mass which had been exposed to the action of alcohol was washed with water, it was then macerated in water for several hours, and afterwards boiled in successive portions of that liquid. The last portion being decanted, the whole was thrown on a piece of linen, the residue washed with warm water, and then dried.

The liquid was opal coloured, and on cooling deposited a thick white and flocculent substance. This solution when triturated with iodine produced a pure blue colour, and exhibited with other reagents the properties of a solution of farina or starch.

The residue when dried weighed 14.25 grains. It was not homogeneous, but evidently consisted of two distinct substances, one of them having a gray colour and being tough, somewhat elastic, and adhesive, the other exhibiting a fibrous texture and consisting apparently of cuticle.

Expt. 10. The 14.25 grains of residual matter were boiled for some time in water acidulated with sulphuric acid, it was passed through a filtre, and the substance which remained, when collected and dried, was found to weigh 3.75 grains.

The acid solution being boiled for some time and then concentrated, deposited on cooling a grayish substance, which on being dried weighed 2.25 grains. It was adhesive and somewhat elastic. Exposed to heat it enlarged in bulk, became brown, appeared to undergo imperfect fusion, and exhaled the odour of burning bread. Hence I considered it as identical with albumen.

The remaining liquid when boiled for a long time, gave evidences of the presence of saccharine matter, and it appeared therefore, that about 8 grains more of farina had been dissolved.

Expt. 11. The three and a half grains of solid matter were put into a solution of caustic potash, heated nearly to the boiling point of the liquid and then kept for 24 hours. On examining the fluid it was found to be turbid; it was passed through a filtre, the residue washed with water, which was added to the alkaline solution, and dried. It weighed rather more than 3 grains, and appeared to consist of cuticle and ligneous matter.

When this matter was exposed to heat, it burned into a coal; it was digested in muriatic acid, which was afterwards filtered and saturated with ammonia, a light flocculent precipitate took place, which I concluded to be phosphate of lime.

The alkaline solution when saturated with nitric acid, let fall a precipitate of a yellowish gray colour, which, when collected on a filtre and dried, was so small in quantity and adhered with so much pertinacity to the paper, that it could not be separated for examination. Its weight might have been from $\frac{1}{15}$ to $\frac{1}{10}$ of a grain. When the paper was burned, this matter, as the flame reached it, became black, appeared to melt and exhaled an odour similar to that produced by albumen.

Indian corn when submitted to destructive distillation gives out a considerable proportion of water, an empyreumatic liquid,

with slight traces of ammonia, and abundance of inflammable gases, of which carbon is the basis. I succeeded but imperfectly in incinerating its coal. It was partly soluble with slight effervescence in muriatic acid, from which a white precipitate was thrown down by pure ammonia; when this was removed, oxalate of ammonia occasioned a further turbidness and precipitation. There were traces of the presence of a sulphate in the portion on which muriatic acid did not act. Hence I concluded that the ashes of corn contain phosphate and carbonate of lime, and a sulphate, probably sulphate of lime.

According to this analysis, the constituents of the yellow Indian Corn, will be as follows:

| | Common State. | Dry. |
|---|---------------|--------|
| Water, | 9.00 | 0.000 |
| Farina, or Starch, | 77.00 | 84.599 |
| Zeine, | 3.00 | 3.296 |
| Albumen, | 2.50 | 2.747 |
| Gummy matter, | 1.75 | 1.922 |
| Saccharine matter, | 1.45 | 1.593 |
| Extractive matter, | 0.80 | 0.879 |
| Cuticle and Ligneous fibre, | 3.00 | 3.296 |
| | 98.50 | |
| Phosphate, Carbonate, and probably Sulphate of Lime, and Loss. | 1.50 | 1.648 |
| | 100.00 | 99.970 |

The powder of corn is a hygrometric substance, and the quantity of water in it after exposure varies with the state of the atmosphere. In some instances, when the atmosphere was moist, it would lose on drying 12 per cent. In other cases, the loss did not amount to more than half the quantity. I therefore took the mean.

The constituents of the *Virginia Corn* are the same as those above stated. But the proportion of zeine is much less, the quantity from 100 grains, being so small as not to be weighed; and it is not a little remarkable, that it has a greenish hue.

It is known, that varieties of indian corn sometimes exhibit colours other than yellow. In some the colour is blue verging on violet, while in others it is red. The colouring matter of the former penetrates the whole substance of the grain, excepting the cuticle, which is transparent, and that part which is commonly called the eye; that of the latter resides altogether in the epidermis, the mass of the grain being white. These facts may be easily ascertained by immersing the grain in water and allowing

it to steep until it begins to swell ; the cuticle may then be separated without difficulty. I have made some experiments to determine the nature of these colouring matters. I have found that they are soluble both in water and alcohol when aided by heat, and the colours of the solutions are similar to those of the grains themselves. The violet or blue is rendered green by alkalies, and red by acids ; the red is much diminished by alkaline substances, while it is augmented by acids. With sulphuric acid it produces a superb crimson. Hence it appears, that the substances which colour blue and red corn are analogous to the colouring matters of red cabbage, litmus, violet, &c. By digesting a quantity of the coloured cuticle of red corn in alcohol, filtering and evaporating the solution, I obtained a minute portion of zeïne which had an olive colour ; that from blue corn was yellowish. In both instances the colouring matter remained in solution, in the small quantity of water which remained after the alcohol was evaporated.

From the products of this analysis it would appear, that the bitterish taste perceptible in bread which contains indian corn is owing to the extractive matter. The peculiar flavour depends in part upon this matter and partly upon the gummy substance and zeïne, though the latter is very faint. A spirituous liquor may be obtained from indian corn, and this is owing to the changes which take place in its saccharine matter. It contains no gluten, and is, therefore, incapable of going through the fermentative processes necessary to the formation of good bread. Hence it is, that, in making *brown bread*, as it is here called, it is necessary to mix it with rye-flour, and sometimes with the flour of wheat, both of which contain gluten, and are capable of fermenting on the addition of yeast.

Indian corn contains a large proportion of farinaceous matter, and this substance experience has shown to be very nutritive. What may be the effect of zeïne it is impossible to say, but in judging from its chemical properties, we should be disposed à priori, to say, that it is not easily digestible, as it has many of the properties of resins. It is probable that if indian corn were submitted to the same processes as wheat before it should be used as food, it would be equally nutritious, because the proportion of soluble and nutritive matter would be increased by the removal of its cuticle and fibrous substance.

In order that the reader may compare the composition of indian corn with that of the other grains, I shall subjoin the analyses of some of the latter made by European chemists.

1. *Farina of Wheat. (a)*

| <i>Triticum Hybernum.</i> | | <i>Triticum Spella.</i> |
|---------------------------|-----------------|-------------------------|
| Fecula, or Starch, | 68.0 | 74.00 |
| Gluten, | 24.0 not dried, | 22.00 |
| Gummy Sugar, | 8.0 | 8.50 |
| Vegetable Albumen, | 1.5 | 0.50 |
| <hr/> | | <hr/> |
| 98.5 | | 105.00 |

2. *Farina of the Oat. (b)*

| | |
|-----------------------------|-------|
| Fecula, | 59.00 |
| Albumen, | 4.30 |
| Gum, | 3.50 |
| Sugar and bitter principle, | 8.25 |
| Fat Oil, | 2.00 |
| Fibrous matter, | <hr/> |

3. *Rice, Carolina.*

| | |
|-------------------------|-------|
| Water, | 5.00 |
| Starch, | 85.07 |
| Parenchyma, | 4.80 |
| Vegeto-animal matter, | 3.60 |
| Uncrystallizable Sugar, | 0.29 |
| Gummy matter, | 0.71 |
| Oil, | 0.13 |
| Phosphate of Lime, | 0.40 |

100.00 (c)4. *Rye Meal. (d)*

| | |
|--------------------|-------|
| Albumen, | 3.27 |
| Gluten, not dried, | 9.48 |
| Mucilage, | 11.09 |
| Starch, | 61.09 |
| Saccharine matter, | 3.27 |
| Husk, | 1.38 |
| Loss, | 5.42 |
| <hr/> | |
| 100.00 | |

5. *Barley Meal. (e)*

| | |
|-------------------------|--------|
| Volatile matter, | 360 |
| Albumen, | 44 |
| Sacch. matter, | 200 |
| Mucilage, | 176 |
| Phosph. Lime & Albumen, | 9 |
| Gluten, | 135 |
| Husk, with Gluten and | } 280 |
| Starch, | |
| Starch, not quite free | } 2580 |
| from Gluten, | |
| Loss, | 76 |

3840(a) Vogel. *Annals of Philosophy*, II. 314.(b) *Ib.* *Ib.* *Ib.*

(c) Braconnot.

(d) Einhof. (e) Einhof. *Thomson's Chemistry*, IV. 263, 5th ed.