SUGAR CANE,

SORGHUM SACCHARATUM, W.

BY

DR. C. A. GOESSMANN.

FROM TRANSACTIONS N. Y. STATE AGRICULTURAL SOCIETY, 1861.

CONTRIBUTIONS

TO THE

KNOWLEDGE OF THE NATURE

OF THE

CHINESE SUGARCANE,

(Sorghum Saccharatum, W.)

BY CHAS. A. GOESSMANN.

ALBANY:
PRINTED BY CHARLES VAN BENTHUYSEN.
1862.

SUGARCANE—*Sorghum Saccharatum, W.*

There has lately been introduced into the agricultural pursuits of the United States a new plant—Sorghum Saccharatum, W., Holcus Saccharatus, L., commonly called Chinese sugarcane—which, for good reasons, has since excited the interest of the farmers and manufacturers. Although year by year the most gratifying results have been published in numerous reports, coming from various States of the Union, we are still, up to the present time, without a desirable publication of general investigations, as to the nature of this very valuable plant, from a chemical point of view The striking influence in the development of the manufacture of sugar from the beet, of a proper application of chemical principles, prompted the author, two years ago, to call the attention of the agricultural institutes of his native country, Germany, to this matter, by publishing in Dr. Henneberg's "Landwirthschaftlicher Zeitung," Wende, Goettingen, Hanover, his own observations concerning the nature of the juice of Sorghum made during the summer season of 1857, while in Philadelphia. The increased interest which the Chinese sugarcane has assumed, as well as the experience gained during a recent visit to Cuba, have induced me to re-publish my results, having nothing in view but the desire that the following pages may aid in saving time to those who may hereafter be engaged in a more complete elaboration of the subject. Investigations like these under consideration, undoubtedly require repeated testings of the same point in different states of the plant's development, and observations made under various terrestrial, as well as climatical influences. The plants which served for my experiments, were grown on a soil consisting of crumbled syenitic slate, previously manured with a calcareous loam and stable manure.

Henry S. Olcott informs us that a French missionary, Father du Halde found this plant used for the manufacture of sugar in the interior of China. The French Consul General subsequently coming into possession of the seed, sent them, in 1851, to Paris. The first Asiatic specimen of Sorghum we find at the exhibition at Moscow. In 1854 appeared in Paris the first tolerably complete publication concerning the Sorghum Saccharatum, by Mr. Vilmorin—"Recherches de Sorgho sucre." The juice of the plant has since been worked in that country almost exclusively for the manufacturing of Sorghum spirits. Mr. D. E. Brown found a field destined for that purpose, in the south of France, while traveling, by order of the Patent Office at Washington, in search of plants which might prove valuable to the farming interests of the United States. This gentleman induced the Patent Office to order a quantity of the seed of the new sugar plant, which order supplied the parties interested in this country, with seed to start their first experiments. Besides the Asiatic species, which is the subject of my investigations, we learned, in 1851, of another sugar plant, by Mr. Wray, called Imphee plant, since then also recognized as a Sorghum species.

He found the plant on the African coast near Cape Natal. The first sugar, alcohol, etc., manufactured from the Cape Natal plant, was seen at Paris at the grand exhibition in 1856. Further inquiry has shown, however, that Mr. Wray's Imphee is the same plant which Italian merchants had brought from the African coast some sixty or eighty years before, and raised for a short period in Upper Italy. This species seems to ripen too late to secure a good result in regard to its percentage of sugar, and was probably on that account abandoned. I am informed by the director of a very distinguished agricultural institute, in Hungary, that they have cultivated there, for years, several Sorghum species for green food—probably the Italian plant.

In closing this historical introduction, I will mention the following pamphlets, which were published previous to the appearance of my German article, and from which I obtained the material for some of my estimates:

Olcott, H. S., "Sorgho and Imphee," Saxton, N. Y., 1857.
Stanisbury, "Chinese Sugarcane," Boston, 1857.
Hyde, J. C. F., "Chinese Sugarcane," Boston, 1857.

I. Chemical Characters of the Sorghum Plant and its various parts.

The plant I allude to has been so often described, and its strong resemblance to the broom corn, before the ripening of the seed, is so generally acknowledged, that I may trust, wherever I shall have to speak of one of its parts, to recall to the memory of most of my readers a familiar subject. I have, therefore, here omitted the botanical description, which is given in my German publication. My experiments, limited by want of time and assistance, treat principally of those questions which decide the industrial value of the plant, leaving several points, of a mere scientific character, to another investigation. I considered it first of main importance to decide the nature of the sugar, if cane or grape sugar; its quantity or their relative proportions to each other, and the conditions under which it is found, and devoted finally some attention to the most remarkable features of the other parts of the plant, and their relative value for various technical purposes.

I ascertained consequently the concentration, the quantity and the nature of the juice, as well as of the organic and inorganic compounds contained therein, and have closed my article with an appendix, treating of some of the means and ways to secure a good crop, and to turn the various parts of the plants to the best advantage for domestic purposes.

A. The Juice.

1. *General Properties.*—The cane used for the following experi ments was taken from the field in its perfectly ripened state, October 20, 1857. The seed leaves had assumed a dark red color; the lower leaves on the stem had lost their freshness, and the whole plant had ceased to increase in size. For the purpose of obtaining the juice, the stem was cut off about six or eight inches above the roots; was freed from the leaves and the top piece of about two and one-half feet to three feet in length, including the seed ear, and then sent through the roller of a small, powerful sugarcane mill.

The stem of a good sized plant usually weighs in that state one and a half to two pounds, and yields sixty-five to seventy per cent. of juice.

A filtration of the fresh juice, through paper, is not applicable on account of the slowness of the operation, as it would unquestionably furnish a filtrate worthless for testing as to the nature of the sugar. I operated consequently with the collated juice. The fresh juice *collated*, as soon as possible, through a piece of woolen cloth, was dark and bulky, had a sweet, although herbaceous after-taste, and was of a greenish yellow color; it deposited in a few hours a voluminous, slimy sediment, of which the more solid parts were white, consisting mainly of torn cells, while the lighter and slimy portion was, owing to the presence of chlorophyl, of a green color. In the same degree as the suspended particles settled, the color of the juice changed to a more yellowish opalescent tint. The fresh juice showed a slight acid re-action, had a specific gravity equal to 9 deg. Baumè, (62 deg. F.,) and began to separate at 65 deg.—70 deg. C., (=150 deg.—160 deg. F.;) a coagulated albuminous matter without becoming limpid. It boiled at 101 deg.—101½ deg. C., (=214 deg.—215 deg. F.,) and a continued boiling only produced the desired result. Kept for a short time by itself, at a temperature of 20 deg.—25 deg. C., (=68 deg.—77 deg. F.,) it began to ferment; a white scum rose to the surface, and settled as the fermentation ceased to the bottom of the vessel, forming there a sediment like yeast. The fresh juice filtered much more rapidly through paper when mixed with a sufficient quantity of a solution of caustic potash; it formed, when to this alkaline liquid was added, a sufficient, though small quantity of sulphate of copper, a clear, dark blue solution, which even after twelve hours standing, at the ordinary temperature, did not reduce a trace of oxide of copper. When, instead of a solution of potash, a small quantity of slaked lime was added, and the mixture heated up to 75 deg. C., (=167 deg. F.,) there appeared a bulky coagulum, which increased in quantity till the boiling point was reached; it filtered rapidly, and the filtrate was perfectly limpid. The color of the filtrate depends entirely on the quantity of lime used and the amount of boiling. The larger the excess of lime, and the longer the boiling continues, the darker will be the color, which may vary from a light, greenish yellow to a reddish brown. Likewise did the matter change which remained upon the filter; quickly separated, it was coherent; left for sometime in the alkaline solution, it changed to a slimy matter, rendering the juice unfit for filtration. This circumstance makes the utmost care necessary in working the juice on a large scale for technical purposes. The juice of the cane thus treated, formed, when a moderate quantity of lime had been used, after a proper degree of concentration, small crystals of sugar, lying in a more or less tinged syrup. When the fresh juice, however, was concentrated without the addition of quick lime, the final result was a dark red syrup, which even after months had passed, did not show the slightest tendency to separate crystals of sugar. The juice of the cane contains, if taken from the unripe plant, more or less starch, easily recognized by a solution of iodine in the slightly acid liquid. The facts so far obtained prove, according to the results ascertained by the application of the method of Trommer, that besides cane sugar no other kind of sugar existed in the juice of the ripe and sound Sorghum cane. Yet knowing very well that the whole importance of this fact would mainly depend on a favorable answer concerning the general nature of the juice, I tried to decide next what organic matters and what inorganic saline compounds accompany the cane sugar; of what nature and in what quantities they are present; whether they allow of an advantageous separation, and by what means the whole process of separation may be effected to the best advantage.

Saline Matters.—A quantitive analysis had informed me that the phosphoric acid in the sorghum cane juice was more than the alkaline earths required, I selected on that account a method recommended in such cases by Woehler, and proceeded in the following manner: Two hundred and forty grams of sorghum cane juice were evaporated and the organic matter thoroughly destroyed by a careful heating in a muffled stove. The black spongy residue was then pulverized, and divided into two equal parts, of which one part was extracted by means of hydrochloric acid, and the other by means of nitric acid; finally for the same purpose repeatedly boiled with distilled water; the hereby remaining carbonaceous mass was then heated in a platinum crucible till the combustion of the carbon was accomplished. A white ash was thus produced, which was again heated in the same way as the spongy coal. This process left the silica in its pure state, and brought the rest of the component parts into solution. The average of various analytical results yielded 0.0364 gm. silica, which is equal to 0.0015 per cent.

The question, if that quantity of silica ought to be considered as resulting from a soluble silicate of potash, as Casaseca believes to be the case, by a similar result in the juice of the real sugar cane (Saccharum officinarum,) or as merely originating from the silica of the incrusted cells, as I am disposed to believe, is difficult to decide. The solutions of the salts in hydrochloric and nitric acid, were analyzed with the precaution necessary, and in the first case only the various bases, in the latter, the various acids determined. The results average as follows:

0.219 phosphate of lime and magnesia, besides traces of iron.
0.310 alkaline carbonates, mostly potash.
0.069 sulphuric acid.
0.079 phosphoric acid.
0.065 chlorine.

0.742 grams.

This corresponds with 0.309 per cent of inorganic compounds, of which 0.13 per cent are to be counted as pure alkali; the trace of iron may be ascribed to the iron mill. The quantity of saline matter thus found, must quite naturally be less than the juice really contains, for the organic acids are represented here as carbonic acid. The quantity as well as the quality of the inorganic salts vary, as is known within a certain limit, in plants of the same species. Richly manured soil (stable manure) does not only cause an increase of salts in the plants, but effects even a substitution of elements of the same chemical group, within a certain limit. Such observations have been made, and what renders them particularly of interest here, in a cane sugar containing plant. Hochstetter found that the sugar beet contains in its juice according to the nature of the soil and the manner of manuring, at one time more potash, at another more soda, and that the quantity of those alkalies varies in different soils. The acknowledged fact that the soluble salts in various plants, increase on a richly manured soil, or on soil formed mainly by the crumbling of feldspathic and micaceous rocks, entitles me to suppose that the soil on which the plants for my observations were grown, must have suffered under these disadvantages. It is in regard to practical influence in the manufacture of sugar, of no consequence, whether potash or soda predominates, for both are alike injurious; they accompany the sugar through all the processes of refining; they interfere seriously with the crystalization of the sugar, and give a bad taste to the molasses. For that reason has a cautious farmer, in raising sugar plants, to select a soil, which is known to be poor in alkalies, or to treat the soil in a manner which will reduce them, when present, and to be particularly careful in preventing the accumulation of soluble compounds of ammonia. The phosphates of lime and magnesia, in large quantities, are not obnoxious; they are generally little soluble in the juice, owe their increased solubility in cases like ours to the peculiarity of the juice, and are much more easily removed than the alkalies. In regard to the quantity of organic acids in the sorghum juice, I am unable to judge. The oxalic acid seems to be the predominating one, yet what kind of soil and probably climatical influence may increase its quantity I do not attempt to answer. It may here suffice to remark, that in the real sugarcane the relative quantities of organic acids are known to vary greatly at different periods of the season, and to differ in different localities.

Indifferent organic substances.—The indifferent organic compounds which we here treat of, are divided commonly by chemists into two distinct series, characterized in their members, by presence or absence of nitrogen. The one includes the oxydized and unoxydized carbohydrates and fats, as starch, sugar, pectin, &c.; the other the nitrogenous compounds, as legumin, albumen, &c. Many of the first and most of the second series, have thus far been studied with such unsatisfactory results, that although we are able to identify with facility many members of the first series when isolated, or in some cases even detect them in mixtures, yet it is an undeniable fact that there exist insurmountable obstacles to their exact quantitative separation. The members of the second series are characterized for instance, by indifference to most chemical tests and similarity in general properties, and chemists moreover are totally ignorant in regard to their essential chemical characters. Numerical results, which have been presented to us in connection with similar investigations, represent only the present state of our knowledge in this branch of chemical science, and are only of relative value. They only inform us of results obtained in similar cases by the application of the same imperfect analytical method, and their sole recommendation is often nothing but the acknowledged superior skill and circumspection of the experimenter. Exact calculations, which now and then have been based upon such detailed and specified analytical results, are in many cases more interesting and entertaining than true.

I have, in consequence of those facts, confined myself to the use of methods sanctioned hitherto in practical investigations of a similar character, and claim no other value for my statement, than I have endeavored to explain.

Besides the purely mechanical methods for separating various organic matters, settling, decanting or washing, as is recommended for the separation of starch, for instance, or fermentation, a much more exact method under suitable circumstances, as in the case of starch and sugar, the acetate of lead, alcohol and slaked lime, are applied generally in precipitating many of those indifferent organic compounds, with or without nitrogen. The precipitates thus produced in the juice of plants are generally mixtures of various compounds: they have been weighed either in their dried state as such, or have been subjected to further analytical treatment. Acetate of lead, and slaked lime particularly, answer here very well, in regard to the main question; they at least enable us to bring the sugar, which they leave in solution, under such conditions, that we can ascertain its kind and its quantity, with much certainty.

a. Precipitation with Alcohol.—Equal volumes of the sorghum cane juice and *absolute* alcohol were mixed, and after a thorough shaking, kept well covered and without further motion till the sediment did not further increase, and the liquid appeared limpid, which effect was produced generally in twenty-four hours. The solution filtered rapidly, and was of a clear light wine color; the residue on the filter was of a greenish color. Washed with a mixture of absolute alcohol and distilled water in equal parts, this residue retained its greenish hue, but when washed with pure absolute alcohol the chlorophyl was dissolved, its green solution passed through the filter and the residue became yellowish white.

One hundred and twenty grams of juice, treated in the described manner, left as an average in several experiments, a precipitate equal to 1.4980 grams, dried at 100° C., (=212° F.,) which consisted mainly of the slimy nitrogenous matter, with small quantities of phosphates and oxalates of magnesia and lime.

Being compelled to make all my observations at one period of the development of the plant, late in the season, I was not enabled to pay particular attention to the physiological character of the starch; it is not unlikely that the starch decreases in the same degree as the sugar increases, and that at an earlier period in the life of the sorghum, larger quantities of starch are to be found; this being the fact sorghum cane would fully resemble the real sugar cane, in which Payen found that the sugar originates from the starch.

The solution of this scientific problem would prove to be one of the most valuable discoveries of our day. Kirchhof enriched at the beginning of the present century the chemical industry by his great discovery of changing starch and cellulose of almost every description by artificial means into grape sugar.

Science has since pointed out several ways of accomplishing the same result. Scientific investigations have thus drawn the lines of relationship between starch and grape sugar, as well as between cane sugar and grape sugar, closer year by year, and it needs no prophetic eye to favor the idea, that in sight of the rapid progress of organic chemistry, the day might not be very far distant when we may have to register in our annals the manufacture of cane sugar by artificial means.

b. Precipitate with Acetate of Lead.—I added a solution of acetate of lead to one hundred and twenty grams of sorghum cane juice, till the precipitate did not further increase; an excess of the solution of acetate of lead caused a partial solution of the precipitate.

The precipitate thus produced weighed after being dried at 100 C. (=212° F.,) 3.5060 grams, which carefully burned, left 1.6960 grm. of oxyd of lead combined with the larger quantities of sulphuric acid, phosphoric acid and chlorine.

The organic matter, represented by the loss in burning equaled 1.81 gram, or 1.51 per cent.

In order to gain some idea of the nature of this organic matter I precipitated again two thousand grams of fresh juice, collected the precipitate upon a filter, and washed it once with cold distilled water; suspended it afterwards in cold distilled water, and treated it with washed hydrosulphuric acid gas, till an excess of gas was still perceptible after twenty-four hours rest. The solution obtained by the filtration and separation from the sulphuret of lead was colorless, and settled by boiling a small quantity of coagulated albuminous matter, it contained all the sulphuric acid, phosphoric and oxalic acid of the juice, besides a small quantity of another organic acid, which I according to the properties of its compound with lime believe to be tartaric acid. The quantity of this still questionable compound of lime was too small to ascertain its true chemical character by an elementary analysis. The sulphuret of lead gave when boiled with distilled water, an opalescent solution, which tested with iodine, proved to contain a small quantity of (starch?) cellulose, originally suspended in the juice. The sulphuret of lead thus extracted and heated with hydrate of lime evolved large quantities of ammonia, resulting from the insoluble albuminous matter retained by it. The collective name of albuminous matter is applied for various nitrogenous compounds, which are found generally in plants. They are usually in a large proportion soluble in the fresh juice, predominate more in the juices than in the stalks and leaves; they undergo, when removed from the vital action of the plant, a rapid change, and one of their best general characteristic properties is, that they coagulate at 65°-70° C. (=150°-160° F.) They present on account of their rapid change, great difficulty in ascertaining their true original character, and leave it thus in most cases, undecided whether we had originally only one member of the series, meeting in the course of the investigation the products of its decomposition and its changes, or several distinct members from the beginning. In sight of these disadvantages, it is not to be wondered at that the classification and nomenclature of these, although as a group, well characterized compounds, are still left more or less to the caprice of the chemist. It seems to be the best practice for the present to consider them as modifications of but one compound. Some chemists have exerted themselves in establishing in similar cases a formula, for the albuminous matter in plants. I have omitted following them here, believing that in cases where not only the analytical methods are defective, particularly in regard to a complete separation, but at the same time many facts prove that the product, we isolated, differs widely in its properties from the original compound we met with; that a formula will be of no advantage in enlarging our information. Confining myself exclusively to the practical side of the question, I ascertained the fact that the albuminous matter was less in the sorghum juice than in beet juice; that it does not interfere with the practicable separation of the sugar, and although its quantity may be small, it fully suffices to change under suitable circumstances all the sugar present into grape sugar, and finally into alcohol and carbonic acid. Mulder's observations have proved that one part of vegetable albuminous matter is sufficient for one hundred and twenty-five parts of sugar.

Another class of compounds containing nitrogen and worthy to be mentioned here, embraces the salts of ammonia. They have no influence whatever upon the nature of the juice, its changes, etc.; they interfere mainly with the separation of sugar in the form of crystals, surpassing almost in that bad effect, the salts of the fixed alkalies, and on account of their strong saline taste they render the molasses entirely unfit for domestic use, when present in large quantity. The large amount of the salts of ammonia found in the molasses of beet sugar, cause mainly the unfitness of that kind of molasses for domestic use. The determination of the ammonia salts in the juice of plants requires some precautions. Albuminous matters produce by their decomposition ammonia; and strong alkalies, particularly when aided by an elevated temperature, greatly facilitate this decomposition. It is therefore necessary to employ the fresh juice and to liberate the ammonia at the ordinary atmospheric temperature by a suitable alkali. I proceeded in the following manner: I filled a common glass flask with a quantity of fresh juice, attached on one side a hydrogen gas generator, on the other a Liebig's glass apparatus, commonly used for the absorption of carbonic acid; filling it up to a suitable height with dilute hydrochloric acid, and then sending during twenty-four hours, slowly but constantly, washed hydrogen gas through the main flask, with the intent to carry the freed ammonia into the hydrochloric acid. The hydrochloric acid tested afterwards by chloride of platinum, proved to be free from ammonia. The fresh sorghum cane juice, is therefore free from compounds of ammonia. Should they be observed during the process of making sugar, we may know that they are either brought into the solutions as such by carelessness, or originated from the decomposition of albuminous matter, left in the juice by imperfect clarification.

c. Precipitate with Lime.—Caustic lime has a decided effect upon a number of organic and inorganic compounds, which have generally been found in the juice of plants. Added in a small excess it precipitates at the boiling point, starch and pectin entirely, and arabin, bassorin, and the albuminous matter, in large proportion; it forms almost insoluble basic compounds with phosphoric acid and some of the common organic acids: removing consequently numerous compounds, which the sugar bearing juice usually contains. Slaked lime, or when operating on a small scale, lime-water, has been frequently used in precipitating those compounds alluded to.

The juice of the beet root, and of the real sugar cane, have also been subjected to this method for the purpose of obtaining quantitive results, and getting thus insight in regard to their condition. That this method, as a quantitive one, suffers more by inaccuracy than any other spoken of before, will be seen by the following statement. The fact that slaked lime is soluble in large proportions, in a solution of cane sugar, producing thus a strong alkaline liquid, which will more or less intensively affect, destroy and finally dissolve various organic compounds, renders its proper use very difficult, leaving it almost entirely to the practice of the analyst to obtain corresponding results; not speaking of the increased solubility of the phosphate of lime and magnesia by the presence of sugar, etc., still the great and well deserved importance attached to the effect of caustic lime in the manufacture of cane sugar in general, requires here undoubtedly a few remarks on the method itself, and the results obtained by its application.

We have very few instances in technical chemistry in which a simple process, aided by skill and experience, has produced as valuable results as the application of caustic lime to the clarification of saccharine juices. Well may it be said that when Payen pointed out the effect of caustic lime, an important branch of industry, the manufacture of beet sugar, received its most powerful impulse, and that thereby was opened a new channel for agricultural and manufacturing industry.

I shall take the opportunity hereafter to call the attention of my readers again to a more detailed explanation of the subject here under consideration, and for the present confine myself to a brief statement of my results. I heated in a suitable vessel fifteen hundred grams of Sorghum juice, to 60 deg.—70 deg. C., (=140 deg.—158 deg. F.,) added in small quantities dilute milk of lime, till a slight alkaline reaction remained; increased then the temperature gradually but rapidly to the boiling point of the mixture, which proceeding, if properly executed, resulted in the throwing of a thick bulky coagulum to the surface of the liquid, changing the latter into a limpid solution of a light, yellow color, similar to old Rhine wine. The scum soon sinks to the bottom; separated by a filter, once washed and dried at 110 deg. C., (=230 deg. F.,) it weighed 28,810 grams.

The organic matter, carefully destroyed by heating, left 7,699 grams carbonate of lime, including small quantities of phosphate and sulphate of lime; the loss was 21.111 grams, which corresponds to 1.40 per cent., mainly organic matter, and 0.52 inorganic residuum, composed principally of the lime added, and the carbonic acid resulting from the combustion of the organic matter.

The color of the filtrate (from the precipitate with lime) has been considered the best criterion for a successful operation; if it is greenish yellow or a little opalescent, we may expect soon a new separation of a slimy, bulky matter, and the quantity of lime used or the given time for its effect, or the temperature applied has not sufficed to produce the desired result. Is the filtered solution, on the contrary, dark yellow, or has it a reddish brown tint, we are taught that either the excess of lime has been too great, or that the temperature has been either too high or too long continued. In both cases a portion of the organic matter which should be precipitated will be left in solution.

A little practice, with some attention, soon teaches one how to obtain corresponding results.

I did not pay further attention to the ascertaining of exact corresponding results, they varied within small limits. I felt satisfied that lime would have its beneficial influence, so far as to precipitate the injurious matters present as completely here as in other similar cases, and would therefore render the separation of sugar practicable.

The quality of these organic substances is undoubtedly of far more practical importance than the quantity. For large quantities of matter, which we can easily separate by lime, are less objectionable than small quantities of those which we are not able to remove; taking for granted both have a like injurious effect upon the juice.

Determination of the Quality and the Quantity of Sugar.

Sugar is a generic term, which was formerly applied to all sweet substances, as, for instance, "sugar of lead."

Its use is at present limited almost exclusively to three well characterized organic compounds, which resemble each other not only in their remarkable sweet taste, but also in their ability to form alcohol and carbonic acid, under the influence of a ferment.

Milk sugar occurs in milk, and being peculiar to animal life does not require discussion here. Grape sugar occurs in large quantity in the grape and most of our ripe fruits, it is some times called fruit sugar. This is the kind of sugar into which starch and cane sugar are transformed before they are capable of undergoing alcoholic fermentation. It is moreover the only kind of sugar we are able to produce artificially, for technical purposes, from starch and all the varieties of cellulose or vegetable fiber. Its applications are numerous, and its importance in the arts very great. Its intimate relation to cane sugar makes it of considerable importance in connection with the subject of this article.

The third kind of sugar was originally found in large quantities in various gramineous plants, particularly in the juice of the cane of Saccharum Officinarum, Linnaeus, and is called cane sugar. The occurrence of the cane sugar in any considerable quantity, seems to be limited to a few plants—some graminean palms, the maple and beet, most of which, on account of the sugar, have been more or less extensively introduced into the agricultural industry of the various sections of the earth. In describing the general properties of the Sorghum cane juice, I have already mentioned that the results which I obtained by the application of the method of Trommer, entitled me to believe that cane sugar is the only kind of sugar that exists in that juice. Trommer's method of distinguishing cane sugar from grape sugar. in the juice of plants, has been approved by Pelouze in his valuable investigation of the juice of the beet root. Its reliability is now generally acknowledged, and the conclusions drawn from its results are only modified by the progress of experience so far as to prove that the method is more precise and reliable in deciding the absence of the grape sugar than in affirming its presence.

We know that cane sugar does not reduce the oxyde of copper in alkaline solutions at the ordinary temperature, while grape sugar, under the same circumstances, invariably reduces it more or less to a red suboxide. Various other substances have been shown, however, to produce a like effect.

The quantity of cane sugar is ascertained by various methods, which may be divided into two classes: The first class including the direct methods in which the cane sugar is separated in crystals; the second class including the indirect methods in which the sugar is not separated, its quantity being estimated either from the weight of the products of its decomposition, or from optical effects produced by the solution containing it.

The various direct methods are more or less wanting in exactness, yet properly modified and carefully executed, they are of particular practical importance; their results show at least to the manufacturer that the quantity obtained by the test is really in a suitable state for separation.

In the examination of real sugarcane, Payne, Pelouze, Casaseca, and others have successfully applied these methods. They usually either extracted the carefully dried cane with alcohol, or evaporated the clarified juice. The latter method is undoubtedly preferable. Extracting the dried plant with alcohol is certainly a less objectionable method when applied to the pure cane than when applied to the beet root, particularly when in the latter case the residue obtained on evaporating the alcohol is weighed as cane sugar. Such a method is an outrage on science, though supported by high authority. The alcoholic extract of beet roots, weighed as pure cane sugar, is inferior to common raw sugar; the results varying, according to the observations of Peligot and of myself, to the extent of six or eight per cent. Exact science cannot employ such a method, and the manufacturer who depended upon it would be ruined.

Several indirect methods have been recommended for the determination of cane sugar.

Biot noticed that cane sugar and grape sugar could be distinguished from each other by polarized light, and employed a polariscope for this purpose. Biot's observations were confirmed and enlarged by Mitscherlich, Ventzke, Dubrunfaut and others, who adapted the method to practical operations. They arranged scales for different degrees of concentration, and recommended the polariscope to the sugar manufacturers. Many are the advantages which organic chemistry has since derived from the use of the polariscope, but its value in estimating the different varieties of sugar has diminished year by year. Experience has shown that certain bases and acids, and even changes of temperature, seriously affect the optical properties of organic compounds. Numerous other compounds are found to exert the same influence on polarized light as sugar, and what is of most importance, such bodies sometimes accompany the sugar in the fresh juice or are the products of changes which the syrup is liable to undergo.

These circumstances have greatly diminished confidence in the polariscope, and render great caution necessary in its use. That such would be the result of experience, was predicted by Berzelius when it was first introduced.

Other indirect methods for determining cane sugar are based upon the action of certain chemical agents. The method of Barreswil and Fehling is entitled to much credit, being based upon Trommer's observation that grape sugar reduces protoxide of copper, to suboxide, in an alkaline solution. Barreswil proposed to change the cane sugar to grape sugar by means of an acid, to neutralize the acid, to treat with an alkaline solution of sulphate of copper and tartrate of potassa, and to calculate the weight of the cane sugar from the weight of the reduced suboxide of copper. Fehling improved the method by using a copper solution of known strength, and calculating the amount of sugar from the amount of copper solution employed. Experience soon enables the analyst to obtain corresponding results. There are different opinions with regard to the exact proportion between sugar and suboxide of copper, but they do not materially affect the results. When cane sugar and grape sugar occur together, two tests are necessary to determine the proportions of both—the grape sugar actually present is first determined as above; then, in another portion of the solution, the cane sugar is changed by an acid to grape sugar, the whole amount of which is determined. The difference in the results of the two determinations represents the grape sugar derived from the cane sugar, and its equivalent in cane sugar is ascertained by calculation.

Equal, if not superior, is a method in which the amount of sugar is calculated from the results of its fermentation, either alcohol or carbonic acid. It is merely necessary, first, to change the cane sugar to grape sugar, and then to attend carefully to the conditions which insure a good fermentation. The probable alkaline reaction of the liquid must be corrected, and carbonate of lime, if present, must be decomposed, as it is liable to cause slimy fermentation, producing lactic acid, instead of alcohol. Both these points are attained by the addition of a little bitartrate of potassa or tartaric acid, which, according to H. Rose, insure exact results. A proper temperature, 25° to 30° C. (=77° to 86° F.,) and the proper degree of concentration are also essential.

Pelouze determined the quantity of sugar in the beet root by fermenting the juice and ascertaining the quantity of alcohol in the same manner that Gay Lussac determined the alcohol in various wines. The amount of alcohol was reduced to grape sugar and then to cane sugar.

Zennek, in his investigations, determined the sugar from the amount of carbonic acid liberated during the fermentation.

There is another method, which is in fact the only one in which cane sugar is weighed as such, in combination, by which a compound of sugar and caustic lime is separated. The use of this method is recommended by many chemists and sugar refiners, and I shall have occasion by and by to refer to it again. In my examination of the juice of the sorghum, I have employed both the direct separation of sugar in its most characteristic form of crystals, and have also resorted to the fermentation test, thereby obtaining practical results upon which the manufacturer can depend, as well as the exact percentage of sugar present in the juice.

I placed 1440 grammes of fresh juice in a glass flask, heated it carefully to 70°–75° C. (158°–167° F.) added carefully dilute slaked lime, till a slight alkaline reaction prevailed, then increased the temperature rapidly to the boiling point and filtered immediately. The precipitate left upon the filter formed a comparatively consistent bulky green coagulum, which, on being twice washed, lost all its sweetness. The entire filtrate, of an alkaline reaction, was rapidly concentrated to 12°–15° Baume, decolorized by animal charcoal, and finally evaporated over steam to a syrup of 34°–35° Baume. On suffering the syrup to stand for forty-eight hours, a crop of crystals was obtained; these were separated, and washed with eighty per cent alcohol—the washings being added to the syrup, which was then again concentrated to 38°–40° Baume, and mixed with alcohol, the sugar crystals obtained were washed as above, and added to those of the first crop. The washings and syrup were mixed and evaporated, and yielded 66.22 grammes light yellow molasses, which was found, by the fermentation test, to be equivalent to 16.78 grammes cane sugar. The crystals of cane sugar separated, weighed 120 grammes. The sugar of the molasses, and in the form of crystals, amount to 9.95 per cent of the juice employed. The fermentation was conducted in a little flask, such as is employed in carbonic acid determinations generally. 6.27 grammes molasses were placed in the flask, diluted with fifteen to twenty parts of water, a small quantity of good yeast added. The mouth of the flask was then closed with a cork bearing two different tubes; one of these was slender and extended to the bottom of the flask, the outer end being closed by a plug of beeswax; the other tube was larger, merely entered the flask, and was filled with chloride of calcium to absorb and retain the moisture of the escaping carbonic acid. The flask and its contents were then exposed to a temperature of 25°–30° C., (77°–86° F.) as long as fermentation continued. The beeswax plug was then removed and the carbonic acid still remaining in the tube sucked out through the tube containing the chloride of calcium. The decrease of the whole in weight represented the carbonic acid which escaped and was 0.819 grammes: Cane sugar, $C_{12} H_{11} O_{11}$, under the influence of yeast, first unites with the elements of one equivalent of water and becomes grape sugar, $C_{12} H_{12} O_{12}$. By the act of fermentation the grape sugar is transformed into four equivalents of carbonic acid, 4 CO_2, and two equivalents of alcohol, 2 $C_4 H_6 O_2$. Expressed in weights, 180 parts of grape sugar form 88 parts of carbonic acid and 92 of alcohol. Accordingly 0.819 grammes of carbonic acid require for their formation 1.675 grammes of dry grape sugar or 1.59 grammes of crystallized cane sugar. The 66.22 grammes of molasses contained therefore 16.78 grammes of cane sugar. Of course a small proportion of the cane sugar in the molasses is unavoidably converted into grape sugar during the process of extracting the crystals. The molasses obtained from sorghum juice after removing the crystallized sugar is fully equal to the best sugar-house molasses. It tastes agreeably sweet without any unpleasant after taste, which is far from true of beet-root molasses. The good quality of the sorghum molasses is of great importance here, for the United States far surpass every other country in the consumption of molasses.

The above results have been repeatedly confirmed by other tests on a smaller scale. While I was occupied with my examination of the sorghum cane, Mr. J. S. Lovering of Philadelphia, a sugar refiner of high reputation, was engaged on experiments with a view to test the practicability of manufacturing sugar from sorghum. The results of his experiments have since been embodied in a pamphlet. Operating on a large scale and under very favorable circumstances, he was according to his report very successful. His results calculated upon one acre, with 18,-277 stalks, equal 1221.85 lbs. sugar, and 74.39 gallons of molasses. His best results were obtained during the first week of November, 1857. Besides determining the cane sugar in the sorghum juice I endeavored to determine it in the dried cane itself. One pound of the fresh cane was cut into thin slices, carefully dried, and extracted with 70 per cent alcohol. I pursued exactly the same method which Peligot and Casaseca successfully employed in their examination of the real sugar cane. The alcoholic extract on careful evaporation yielded a yellowish red and agreeably sweet syrup, which deposited no crystals of sugar after weeks of standing. Raspail and Fabroni observed that in all plants which contain cane or grape sugar in any quantity there are peculiar cells which contain the sugar. These cells protect the sugar from the action of the juice during a certain period of the vegetation, and also after careful drying of the plant. As soon however as these cells begin to decay or are mechanically destroyed the sugar begins to be transformed into carbonic acid and alcohol, the latter afterwards changing to acetic acid. Moisture, access of air, and the juices of the plant, aided by a favorable temperature cause the decomposition of the sugar. The juices of plants contain more or less nitrogenous matter which acts upon the sugar, particularly in the presence of several common vegetable acids, as tartaric, etc., hastening as Rose, Rousseau and Thenard observed their fermentation. It is a well known fact that an unhurt and carefully dried grape will retain its sugar unchanged till the skin and cells are destroyed either by some mechanical influence or after lapse of time by decay. The contents of the various cells coming in contact with each other, and moisture gaining access to them, decomposition of the sugar ensues, giving rise to carbonic acid and alcohol, then to acetic acid and finally resulting in the putrefaction of the whole fruit. The same is the case with real sugar cane and to a certain extent with sorghum cane and the beet root. Sudden change of temperature is the most efficient destroyer of the system of cells, and the effects of an unexpected frost in countries where sugar cane is raised, as Louisiana, or the penetrating of the winter frost into the ill-covered beet-root deposits, silos, confirm this theory most seriously. Speedy consumption of the sugar plants so affected, before the approach of warmer days, will alone prevent their rapid destruction. I had an opportunity to observe that the temperature which destroys Dahlia pinnata, Cav. (Georgiana variabilis, Wild,) also destroys the sorghum plant. Sugar bearing plants, as the sugar cane, beet, and sorghum, are after having been frozen fit only for the manufacture of molasses and alcohol.

Dried sorghum cane is as my experience proves unfit for the manufacture of cane sugar; dried beet root gave the same discouraging results, and their employment has been maintained for several years only at great sacrifices. Even the project of carrying the dried colonial sugar cane to Europe and working it there under more favorable climatical influences, by the aid of greater skill, has been abandoned. Though Peligot and Cassaseca, contrary to practice, found that dried sugar cane contained only cane sugar, it may be urged that results obtained on a small scale by experienced and skillful hands are not always confirmed by practical operations on a large scale.

B. The Cane.

The cane used was cut off four or five inches above the root and freed from the leaves, and the top piece three or four feet in length including the seed ear. 2,108 grammes of the rind separated from the spongy interior lost at a temperature of 100°—110° C. (212°–230° F.,) 1.178 grammes of moisture, equivalent to 55.88 per cent. 5,143 grammes of the soft interior lost under the same circumstances 4,375 grammes, equal to 85.06 per cent., and 33,012 grammes of the fresh cane lost 26.06 grammes, equal to 78.94 per cent, The moisture of the interior soft substance is to that of the rind as 17 to 11. 180 grammes of fresh cane were exhausted by repeated boiling, and the solution obtained evaporated to dryness and exposed to a temperature of 100°–110° C. (212°–230° F.,) the residue weighed 18,407 grammes, equal to 10.22 per cent. 9,733 fresh cane left by its combustion 0.0722 grammes of ashes, equal to 0.71 per cent. The ash thus obtained had an alkaline reaction, evolved considerable carbonic acid on the addition of an acid, and contained phosphates of lime and magnesia, with an excess of magnesia, soda and potash in combination with chlorine and carbonic acid. By treatment with a mineral acid a small quantity of silica was separated. As usual the alkaline earths predominate; they were probably originally combined to a large extent with organic acids. The phosphoric acid was probably mainly combined with the alkalies, the potassa exceeding the soda in quantity. It is very probable that the larger part of the alkaline and earthy compounds are mainly due to the peculiar nature of the soil. A feldspathic soil, enriched by carbonate of lime and stable manure presents all the conditions necessary to render soluble a large quantity of alkalies; and the formation of ammonia compounds is favored by the decomposition and decay of animal and vegetable matter in the presence of carbonate of lime. It would seem as though the circumstances usually favorable to a crop would prove injurious to the sorghum cane; though this supposition has not yet been confirmed by observation. I base this opinion on the analogous case mentioned by Hochstetter, who found the saline matter of the beet root to vary greatly, both in quality and quantity, the variations being due mainly to the soil and the manures. As soluble compounds of potash, soda and ammonia interfere seriously with the separation of crystallized sugar further observations on this point would be very desirable.

12,406 grammes of fresh sorghum cane were successively extracted with boiling water, carbonate of soda solution, dilute hydrochloric acid, and finally with a mixture of 90 per cent alcohol and ether. 1.06 grammes of dried residue, cellulose, remained, equal to 8.54 per cent. 5,056 grammes of dried cane lost 0.107 per cent, when extracted with absolute ether. Considering 5,056 grammes dry cane equal to 26.19 grammes of fresh cane, the loss would be equivalent to 0.408 per cent in the fresh cane, and consists of wax. This wax, probably cerosine, penetrates particularly the rind or exterior layer of the cane, and is more or less distinctly visible as an exudation which covers the cane near the joints, as well as the inside basis of the leaves, and increasing in quantity as the season advances it causes the smoke-like bluish tint of the whole field. It is evidently very unequally distributed on the plant; the cane selected for my analysis showed no visible exudation of the wax; one-half per cent might therefore represent its average quantity.

I have already mentioned that a single cane freed from leaves, roots, and top piece, weighs from 1½ to 2½ lbs., though heavier plants frequently occur. Three plants weighed together, including roots, leaves, and seed ears, 17 lbs., the same plants without the seed ears 13 lbs, without seed ears and roots 9 lbs., and on finally removing the leaves 8 lbs.

According to my examination the fresh sorghum cane consists of

Water	78.94	
Soluble matter	10.22	of which 9.–9.5 are cane sugar.
Cellulose	8.20	
Cerosine and insoluble earthy compounds	1.24	
Albuminous matter, etc.	1.40	
	100.00	

The following analyses are interesting for comparison:

Beet-root Juice—Payen.

Water	83.5
Cane sugar	10.5
Cellulose	0.8
Albumen, &c.	1.5
Fat acids, saline matter and ash	3.7
	100.00

Sugarcane Juice—Peligot and Dugeny.

Water	77.2
Cane sugar	20.9
Inorganic compounds	1.7
Organic compounds	0.2
	100.00

C. The Leaves.

The leaves are of a bright green color during the period of growth, and assume in autumn a bluish green tint. One hundred pounds of fresh leaves taken from the mature plants, lost when perfectly dried 27 per cent. of moisture, and in this state constitute good food for cattle, equivalent to 80 or 85 pounds of ordinary hay.

One hundred grammes of fresh leaves left 2.07 grammes of a white ash, consisting mainly of lime, magnesia and silica. Thirty-four and a half pounds of fresh cane, freed from the roots and seed ears, averaged five pounds of fresh leaves; taking the average weight of a single cane at two pounds, a pound of leaves would be furnished by seven canes. The taste of the leaves is herbaceous, they contain no sugar, and are readily eaten by cattle and horses.

D. The Seed-ears.

The seed-ear of the sorghum is in the form of a panicle, which during the blooming period is yellowish green, changing afterwards to yellow; while the glumes or seed-leaves change during the ripening from yellow to red, and finally to reddish violet. The red coloring matter of the seed-leaves appears to be constant and durable, and has been repeatedly recommended as a dye. It is soluble in alcohol and ether, and almost insoluble in water and dilute acids. Dilute carbonate of soda dissolves it to a dark violet blue solution, from which acids precipitate a bright red dye.

The seed itself is yellow, of the size of shelled barley, and produces a yellowish white flower. It contains considerable starch and fat, and forms, when boiled with ten or fifteen parts of water, a starch-like pap. The fat is readily extracted by ether. From fifty or sixty grammes of ground seed I obtained several grammes of fatty acid, by extracting with ether, evaporating the etherial solution to dryness, saponifying the fat with an alkali, and decomposing the soap with a mineral acid.

Six seed leaves gave nine ounces of seed. One seed ear weighs usually, when ripe, from ninety to ninety-five grammes, or about three ounces. The sorghum will undoubtedly rank among our most valuable cereals for feeding cattle.

II. Valuation of the Chinese Sugar Cane for Agricultural and Industrial Purposes.

In the former publication of these investigations my estimates were based upon the supposition that 24,000 stalks would be the average of an acre. This was the result of experience on the part of persons entitled to my confidence, but others have considered an average crop as only 18,000 stalks per acre. Below are given estimates on both suppositions; the single stalk freed from roots, leaves and top piece weighing two pounds.

At 24,000 stalks per acre, the yield would be:

Dry seed	190 lbs.	
Dry leaves	5,900 "	
Fresh cane	48,000 "	which would produce
Juice	33,600 "	and
Moist bagasse	14,400 "	

At 18,000 stalks per acre:

Dry seed	142 lbs.	
Dry leaves	4,425 "	
Fresh cane	36,000 "	which would produce
Juice	25,200 "	and
Moist bagasse	10,800 "	

The cane sugar in 33,600 lbs. juice at 9–9½ per cent, would amount to from 3,000 to 3,190 lbs., and in 25,200 lbs. juice to 2,268 to 2,384 lbs. J. S. Lovering actually obtained per acre from 1,221.85 lbs. of sugar and 74.39 gallons of molasses, to 1,466.22 lbs. sugar and 74.39 gallons of molasses at 18,000 stalks per acre.

These results are very encouraging as they show that more than half the sugar, or 5 per cent out of 9 to 9½ per cent in the juice, can be separated. When Archard established the first beet-sugar manufactory in Silesia, he was able to separate only from 3 to 4 per cent of sugar, although 10½ per cent were present; and the French manufacturers were quite contented when they succeeded in extracting from 4 to 5 per cent of sugar, till Pelouze, Payen and others proved to them that they were still leaving more than half the sugar in an unpalatable molasses. The history of the development of the manufacture of beet sugar may be studied with great advantage by those interested in the sorghum. The rapid development of a rational system of agriculture in Europe, is undoubtedly due in great part to the exertions of the chemists and the observing farmers to make the beet root the staple sugar plant for the country. It may be remarked that the practical success of the sorghum cultivation does not depend upon the quantity of crystallized sugar that may be manufactured from it; even the manufacturer of palatable molasses, or the fermentation of an inferior molasses will make it a profitable crop.

The Manufacture of Alcohol.

Three thousand pounds of cane sugar are equivalent to 3,158 lbs. of grape sugar, and as 180 lbs. grape sugar produce 92 lbs. of absolute alcohol, will yield 1,614 lbs. of absolute alcohol or 1,782 lbs. or 260 gallons of 90 per cent alcohol of 0.8228 specific gravity. Supposing the yield to be only 18,000 stalks per acre, the 2,300 lbs. of cane sugar would be equivalent to 1,030 lbs. of 90 per cent alcohol or 150 gallons. How near it will be possible to approach these figures in actual practice will depend mainly on the skill of the manufacturer. Waste is unavoidable, but it is an acknowledged fact in most technical operations that better results as to quantity can be obtained on a large than on a small scale.

Other valuable products of the Sorghum.

The value of the leaves for feeding cattle has been already alluded to. It remains for me to call attention to the bagasse. The fibre of the sorghum is strong and very flexible, differing in the latter peculiarity from the fibre of our common grains, even from that of Indian corn. Hypochlorites readily remove its color without injuring its flexibility. Its fitness for the manufacture of paper has been repeatedly tested with encouraging results.

My own experiments, in which after extracting the bagasse with various chemicals and decolorizing with hypochlorite of soda, I obtained a colorless pulp suitable for making a superior quality of paper, without injuring the fibre, confirm the numerous statements of others.

In my analysis I obtained 8.2 per cent of very pure cellulose or fibre, the manufacturer would probably obtain more, as he could not afford to purify it as completely as was done in my analysis. A pound of this prepared fibre is worth for the manufacture of paper from three to four cents. The increased consumption of paper has for years obliged the manufacturer to resort to new sources for the supply of vegetable fibre, and no plant promises so abundant a supply of a superior material as the sorghum. The United States surpasses all other countries in its consumption of printing paper, and has quite recently imported several million dollars worth of material for its manufacture. If this money could be put into the hands of enterprising farmers here, much could be done to encourage improvements in our system of general agriculture.

National economy teaches us that the independence, welfare, and prosperity of a nation are mainly secured by producing within its own limits the requisites for supplying its indispensible daily wants. Sugar has become a necessary article of daily consumption, and a larger quantity per head is consumed in the United States than in any other country. It is estimated that on an average thirty pounds are annually consumed by every individual in this country, or nine hundred millions of pounds by the thirty millions of inhabitants. A low estimate of six cents per pound for raw sugar shows that fifty-four million dollars are annually invested in the raw article.* Placing the production of maple sugar in the Northern states at sixty-five or seventy million pounds, and of cane sugar in the Southern states at from two hundred to two hundred and fifty million pounds, there remains five hundred and eighty million pounds to be imported from abroad; which at six cents per pound costs the country annually thirty-four or five million dollars. Estimating the quantity of molasses imported at fifteen or sixteen million of gallons we have probably five million of dollars more to send

* This estimate was made for the year 1857; since then an import duty of from two to three cents per pound has been levied on foreign raw sugar, which is an important inducement to home production.

abroad annually; making the total cost of our foreign supply of this article for sweetening life at least forty million of dollars. As the production of sugar in our Southern states has for several years been on the decline, and as the production of maple sugar must decrease as the country becomes more thickly peopled, we cannot too strongly urge upon our farmers the importance of entering at once this new channel of agricultural wealth and national prosperity.

The farmer whose husbandry is carried on in a small scale cannot expect to reap the full advantage offered by the cultivation of the sorghum. Wherever professional skill is required in working an article and in arranging and superintending the necessary machinery a large establishment aided by considerable capital is always most successful. The farmer may manufacture good molasses in a small way, but the manufacture of sugar will be most prosperous when conducted on the large scale, or the principle of the beet sugar manufacture or plantation system. The United States contain an abundance of area favored by indispensable climatic advantages and means of transportation, and in no country is the skill required in such a branch of industry more generally diffused. Many of the inhabitants are familiar with the raising of the sugar cane, and the good lessons taught by beet-sugar cultivation of Europe, accessible through our immigrants, would undoubtedly aid in securing after a short time, the successful management of the sorghum. The Middle, Western, and undoubtedly some of those Southern states now struggling to keep up their plantations of sugar cane, against disadvantages of climate, would gain in a few years a very reliable and valuable branch of agricultural industry. The real sugar cane prospers only where a moderately tropical sun and a mild winter favor its growth throughout the entire year. The islands and moderately elevated sea shores within the tropics are the congenial districts where upon a calcareous clayey soil its luxuriant stalks reach their highest development. Experience has shown that its successful cultivation is confined to very narrow geographical limits. The beet root flourishes in more northern climates, and when transplanted to southern districts failed entirely. The sorghum seems to occupy the middle ground between these two plants.

As I before mentioned J. S. Lovering obtained in practice 7 to 8 per cent of sugar without estimating the amount left in the molasses, I found from 9 to 9½ per cent in the juice, and Mr. Wray, an Englishman, who examined several species of sorghum at Cape Natal, on the southeasatern coast of Africa, found the percentage almost equal to that of the real sugar cane, 18 per cent. I mention these facts to show what may be expected when the sorghum shall have received the attention of our farmers, and have become acclimatized on a suitable soil. The transplantation of a plant to a new and perhaps less congenial climate and soil invariably exerts at first an injurious influence on the vital principle and its products. When the beet root was first cultivated for the manufacture of sugar, it contained only 7 to 8 per cent of sugar, but by the application of proper care to the cultivation and to selecting the best specimens for seed the percentage was increased to from 11 to 12 in some species. Should it be possible to increase the percentage of sugar in the sorghum in the same ratio, its successful cultivation would become an accomplished fact; and our farmers, aided by their superior skill, more perfect machinery, and many other advantages afforded by this country, would be able to compete successfully with the planters of the West Indies.

SYRACUSE, N. Y., Feb. 1862.

molasses; I found from 9 to 9½ per cent in the juice, and Mr. Wray, an Englishman, who examined several species of sorghum at Cape Natal, on the southeastern coast of Africa, found the percentage almost equal to that of the real sugar cane, 18 per cent. I mention these facts to show what may be expected when the sorghum shall have received the attention of our farmers, and have become acclimatized on a suitable soil. The transplantation of a plant to a new and perhaps less congenial climate and soil invariably exerts at first an injurious influence on the vital principle and its products. When the beet root was first cultivated for the manufacture of sugar, it contained only 7 to 8 per cent of sugar, but by the application of proper care to the cultivation and to selecting the best specimens for seed the percentage was increased to from 11 to 12 in some species. Should it be possible to increase the percentage of sugar in the sorghum in the same ratio, its successful cultivation would become an accomplished fact; and our farmers, aided by their superior skill, more perfect machinery, and many other advantages afforded by this country, would be able to compete successfully with the planters of the West Indies.

SYRACUSE, N. Y., Feb. 1862.