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THE PURITY OF REFINED SUGAR.

BY HENRY A. MOTT, JR., PH.D., E.M.

Having had occasion during the past five years to constantly examine the refined sugars of the market, I can say that in the whole course of my experience I have never examined a sample of sugar to which any intentional foreign substance had been added It is true that in some refined sugars a trace of tin has been detected by acute chemical tests, but the amount present was so infinitesimal that no harm could accrue from the use of such sugars. Professor Chandler, speaking on this point, says, "The quantities of tin employed are too small to give any cause for alarm." The fact that some sugars when used in tea produce a dark color has led some people to believe that the change in the color of the tea was due to some substance used to adulterate the sugar, which, however, is not the case. In preparing the raw sugars from the cane juice it sometimes happens that the juice being acid (not being thoroughly neutralized) takes up a small percentage of iron from the evaporating pans, and strange as it may seem, this small per cent or trace of iron follows the sugar all through the refining process; and it is this small trace of iron which, when brought in contact with the tannin in tea, produces a dark color, which is objectionable for green teas, but in no way injurious; this, however, is only present by the merest chance, not once in a thousand times.

With respect to the addition of glucose to refined sugar—as considerable has been written on this subject—I think it well to say a few words. With the exception of cut-loaf, granulated, and extra powdered sugar all refined sugar contains a small percentage of a sugar known as inverted sugar. This inverted sugar has been falsely represented to be glucose. The truth of the matter is that very few persons appreciate what the word glucose is understood to represent in commerce, hence arises the misstatements regarding it. The word glucose applies to the sugar in commerce known as common starch sugar. In chemistry it still has another name, dextrose. The cause of the importation and increased home production of glucose arises from the fact that most of the lager beer brewers in the country and the manufacturers of other malt liquors are using a large percentage of glucose as a substitute for malt. Glucose also has a large use in the manufacture of candy and honey.

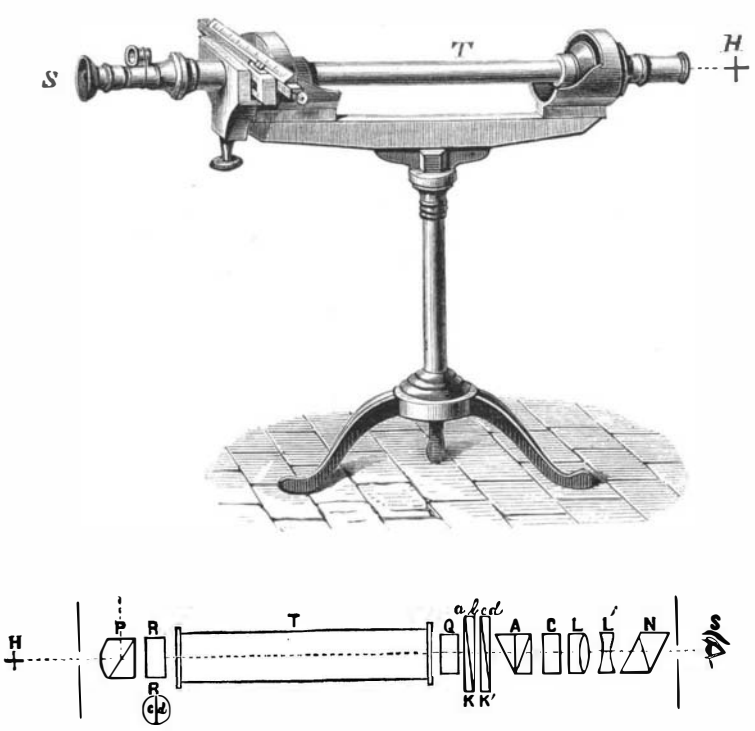
I think the following explanation will clearly demonstrate the impractibility of adding glucose (starch sugar) to cane sugar and still have the latter sugar test less than 100 per cent. Several instruments known as saccharometers are used for determining the per cent of sugar in a given sample. The annexed engraving represents the one known as the Duboscq Saccharometer.

For this instrument it is necessary to weigh 16·035 grammes of the sugar to be tested, to dissolve the same in 100 cubic centimeters of water, decolorizing if necessary, and examine a portion of the solution in the instrument.

With pure granulated cane sugar, taking 16·035 grammes, 100 per cent will be indicated. With pure dry powdered glucose, 194 per cent will be indicated—for convenience, we will say 200 per cent. Therefore one grain of glucose affects light as powerfully as two grains of cane sugar. Now let us apply this fact to an analysis. Given a sugar which has the following composition Cane sugar, 90 per cent; water, 3 per cent; gums, inverted sugar, and mineral matter, 7 per cent; total, 100 per cent.

If the 7 per cent of the above sugar were glucose (which it is not) then, the per cent of cane sugar is too high. For 7 per cent of glucose is equal to about 14 per cent of cane sugar in its effect on light, as shown above. Therefore from 90 per cent we must subtract 14 per cent, leaving only (90 — 14) 76 per cent as the amount of cane sugar present in the sample. This is known to be false, as 90 per cent of sugar can be obtained from a sugar testing 90 per cent. Therefore 7 per cent of glucose cannot be present in the sugar. If, in another case, 7 per cent of glucose were added to the above sample of cane sugar, it would test over 100; but no such reports have been made even from the Custom House chemist; therefore to say that any profitable amount of glucose has been added to any of the samples, the analysis of which has been published as testing under 100 per cent, is simply nonsense. The question may be asked, What is inverted sugar? The answer is simple. If cane sugar be heated in any part of the operation of its production or refining process for a considerable length of time, or in a slightly acid solution, some of the sugar will be converted into inverted sugar; this sugar is present in the unripe cane, which in the ripe cane is transformed into cane sugar, and then in the decay of the sugar cane appears again, as also in the renewed growth of the cane. Inverted sugar is largely present in molasses; not crystallizing itself, it prevents the cane sugar from crystallizing also. Inverted sugar is a compound made up of dextro-glucose and lævulose. Dextro-glucose is the same sugar chemically as dextrose, and effects the light to the right the same as cane sugar. Lævulose is a left handed sugar and effects the light in the opposite direction. The mixture of these two sugars, known as inverted sugar, is also left handed from the fact that the per cent of lævulose which enters its composition is more than sufficient to neutralize the effect of the dextro-glucose on light.

If the 7 per cent in the above analysis were all inverted sugar, then the 90 per cent of cane sugar would be too small, for the 7 per cent would prevent some of the cane sugar manifesting itself to the right, or, in other words, some of the cane sugar would be neutralized; the test of the instrument would in such a case fluctuate with the quantity of inverted sugar present. It may be well to state that inverted sugar does not act as powerfully to the left by two thirds as cane sugar does to the right, therefore the effect would be considerably less. The 7 per cent in the above analysis, as stated, is composed of gums, inverted sugar, and mineral constituents (present in most all foods). The gums act on light, some to the right and some to the left, but sufficiently to the right to neutralize those to the left, as also to neutralize the inverted sugar. Therefore the test of the instrument for cane sugar is correct. From the above it will be clearly seen that if glucose (starch sugar), which acts to the right, were added to cane sugar alone, the sample would in every case test over 100 per cent, but as no such sample has as yet been reported, we must deny that glucose is used to adulterate sugar. Inverted sugar (which, I have stated, contains dextrose), cannot be added as the crystallization of the cane sugar would be prevented. Let us look for a minute at raw sugars, analyses of which I have made by the thousands, and of which I can state (with the exception of sand) I have never met with any adulterated samples. The impurities present in raw sugar, which it is the duty of the refiner to remove, are treacle, caramel, fragments of sugar cane, sporules of a fungus, live animalcula or acari, and albuminous matter, which decomposes and promotes fermentation. It is for these impurities that raw sugars are unfit to use before being refined. The acarus sacchari can be seen by the eye, being itself of sufficient dimensions, and when taken into the system produces a series of disturbances. From the following analysis of raw sugar it will be seen that it contains inverted sugar, which some ignorant writers have tried to pass off as glucose (starch sugar). If raw sugar contains inverted sugar, we certainly would expect in the low grade refined sugars to find it present also, which is the case; thus demonstrating that inverted sugar is naturally present in refined (soft) sugars, and not that it is added.



DUBOSCQ'S SACCHAROMETER.

ANALYSIS OF A RAW SUGAR.

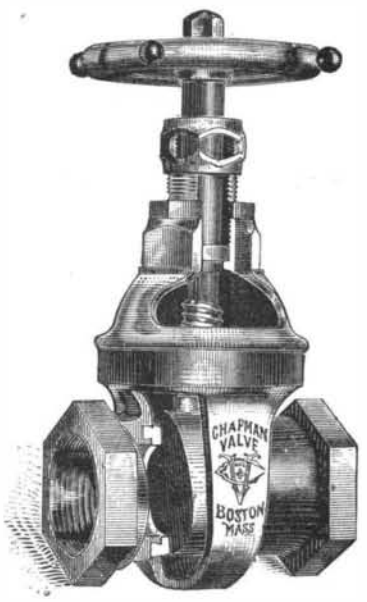
Cane sugar	82·50	per cent.
Water	6·20	" "
Inverted sugar	6·30	" "
Extractive matter, gums, etc.	3.52	" "
Mineral matter	1·48	" "
	100·00	per cent.

There is another point connected with the analyses of refined sugar which have been published, which is very apt to mislead the public, and that is to use the word impurities for all that is neither water nor cane sugar. To a scientific man this word explains itself, but to the public it means everything impure and injurious, such as arsenic, antimony, tin, etc., while it really means inverted sugar, gums, and mineral matter. Until, then, a refined sugar is found that tests over 100 per cent and contains a large amount of tin, the public may indulge in this important article of food with perfect safety.

POUGHKEEPSIE, N. Y., according to the Chicago *Railway Review*, is to have no more locomotive whistling. A bell, worked by electricity, is set up at the depot, and when the trains come within a mile of the station, it will ring until they arrive. The danger signal is thus given, and the waste of steam is avoided, to say nothing of the racket. Any engineer who whistles hereafter when in Poughkeepsie loses his situation on the Hudson River Railroad.

CHAPMAN'S VALVES AND HYDRANTS.

At the recent Massachusetts Mechanics' Exposition in Boston, the Chapman Valve Manufacturing Company had a fine exhibit of their valves and hydrants, to which allusion was made in our notices of the exhibition. The highest award given in their class (a silver medal and diploma) has been awarded this exhibit, coupled with a report from the Board of Managers indorsing the claims made by this company for superiority of their manufactures.



The company construct fire hydrants and direct passage valves of all sizes from one half inch to thirty inches in diameter, for all the various uses to which valves are applied. They are constructed on principles that differ from other valves and hydrants.

The accompanying cut is a sectional representation of one of their steam valves. To all who have been troubled with leaky valves a brief description showing the advantages claimed for the Chapman valves may be interesting. The introduction of a ring or packing of Babbitt metal, or other similar alloy, around the inlet and outlet openings of the valve, forms a seat for the gate when the valve is closed that insures tightness between them. This material will outwear any other known substance used for seats of valves, and will resist the cutting action of steam. Hot or cold water has no injurious action upon it; for gas and ammonia it possesses qualities not found in any metal; while for acids, various alloys may be used adapted to the different kinds of acids that are to pass through the valves. Thus each class of valve has for its seat an alloy which has been found by experience best fitted for the service the valve is to perform. It is stated that all of the seats are non-corrosive, and that as the alloy forming the seats is dissimilar from the metal forming the gate, no cohesion can take place. The alloy is cast into dovetailed recesses in the body of the valve when the gate is in position, and forms a perfect joint with the face of the gate. The body of the valve and seats are made tapering to conform to the taper of the gate. In case of wear or accident to the seats, they may be refaced, a recess being left in the bottom of the valve for the tapering gate to conform to its new seat. In case of destruction of the seats, they may be recast into the valve with slight trouble and expense. The use of alloys of metal for valve seats is secured to this company by letters patent. The gate is made in one piece in the form of a hollow tapering plug, guided upon its sides to prevent it from coming in contact with its seats until the passage is closed, thus avoiding wear of both seats and plug. It is probably well known that the form of gate in direct passage valves in general use is two disks, hanging loosely upon the spindle, variously joined at their backs, and having some expanding form to force the disks in closing to their bearings, when opposite their seats. These valves are called adjustable disk valves, and are fitted with seats of hard metal. The early make of gate valves were constructed with a plug gate, but owing to the cohesion which took place between the gate and its seats of hard metal, it was found impossible to operate them with satisfaction, hence the invention and introduction of adjustable disk valves. The advantages of a plug gate over disks is, that there are no parts, joints, or wedges to get out of order, and that the action of the plug gate in closing is positive in a vertical line, and not by expanding to the seats. It has been reserved for this company to combine the advantages of a plug gate with seats to which the gate would not cohere under any circumstances, irrespective of the length of time they may remain in contact. All valves are tested by hydraulic pressure far above what they will be required to withstand. Special valves of large size are made for oil pipe lines that are tested to a pressure of 2,000 lbs. per square inch. The largest valves open and close easily, the seats and all the working parts being fitted to insure ease of operation.

The fire hydrants manufactured by this company are known as gate hydrants, having a gate valve at their base which opens and closes vertically, gradually cutting off the flow of water and preventing any water hammer or strain upon the pipes and joints in closing. The gate valve is constructed on the same principle as the water gates, and possesses all the merits claimed for them.

Further information may be obtained from the Chapman Valve Manufacturing Co., 77 Kilby street, Boston, Mass.