ON THE NATURE OF THE SUGARS FOUND IN THE TUBERS OF SWEET POTATOES.*

K. MIYAKE.
(From the Chemical Laboratory, College of Agriculture, Tohoku Imperial University, Sapporo, Japan.)

(Received for publication, April 19, 1915.)

This is a second paper on the results of investigations, now being conducted in our laboratory, concerning the sugars in the underground reserve organs of plants.[1]

Stone[2] studied the carbohydrate constituents of the sweet potato and proved the presence of saccharose among the sugars. Other previous investigations have been concerned only with the general composition. Consequently we selected the sweet potato as the object of our second study on this subject, and investigated the nature of the sugars.

PREPARATION OF THE SYRUP.

One hundred gm. of the finely pulverized material were extracted in a Soxhlet apparatus with ether. After evaporating the ether, the oil-free residue was placed in a 750 cc. Erlenmeyer flask, and extracted daily with 300 cc. of 95 percent alcohol by heating in a boiling water bath, with a reflux condenser. About two weeks were required to remove the last traces of sugars. The combined extracts were filtered to remove the sediment which was formed on standing, and the filtrate was evaporated to a syrupy condition in a partial vacuum. The syrup was purified by shaking with absolute alcohol. The clear solution was decanted and evaporated down to about 10 cc.

The above method of preparing the syrup was once more repeated to get a sufficient quantity of the material for the investigation.

QUALITATIVE TESTS OF THE SYRUP.

The syrup gave the following qualitative reactions:

1. It had a very sweet taste.
2. It reduced Fehling's solution strongly; after inversion with hydrochloric acid the reducing power is much enhanced, showing the presence of both reducing and non-reducing sugars.
3. It gave Molisch-Udransky reaction with a-naphthol and sulphuric acid.
4. It gave the characteristic blood-red color on heating with picric acid and caustic soda (reaction of Braun for glucose).
5. It gave the characteristic fiery red color of ketose with resorcin and hydrochloric acid (Selivanoff's reaction).
6. It gave Pinoff's reaction with ammonium molybdate and acetic acid.
7. It did not show any pentose reaction by the phloroglucin method.
8. No mucic acid was produced upon oxidation with nitric acid.

* Journal Biological Chemistry, June, 1915, 503.

[1] The first paper entitled On the Nature of the Sugars Found in the Tubers of Arrowhead, is published in the Journ. Biological Chemistry, xv, p. 221, 1913.

[2] W. E. Stone: Ber. d. deutsch. chem. Gesellsch, xxiii, p. 1406, 1890.

9. Saccharic acid was detected as acid potassium salt in the oxidized solution of the syrup.

10. It rotated the plane of polarization toward the right; after inversion it was slightly levorotatory.

11. It produced no characteristic mannose phenylhydrazone with phenylhydrazine, either in the original or in the inverted syrup. When the mixture in both cases was warmed in a boiling water bath with acetic acid, the yellowish, well crystallized osazone was produced.

12. Two drop portions of the syrup were placed on object glasses, and inoculated respectively with crystals of glucose, fructose, maltose and sucrose. After twenty-four hours the solution which had been inoculated with sucrose showed the formation of new crystals, while the others remained unchanged.

From the above tests it is evident that the syrup contains both reducing and non-reducing sugars. Moreover, it is safe to conclude that the presence of pentose and mannose molecules is excluded, since no characteristic reactions could be found, as above mentioned.

ISOLATION OF SUCROSE.

When the syrup was left untouched for about twenty-four hours, fine crystals were abundantly formed in it. A small amount of 95 percent alcohol was then added to the syrup, the mixture was filtered and the precipitate washed with absolute alcohol and ether. The sugar thus obtained was recrystallized from alcohol. After drying in a vacuum over sulphuric acid the purified sugar was about 2 gm. in weight.

0.6439 gm. of the sugar was dissolved in water, made up to 25 cc. and polarized in a 200 mm. tube, in a Schmidt and Haensch half-shadow polariscope. A dextrorotation of 9.9 on the scale was observed. The specific rotary power is

$$(a)d = \frac{9.9 \times 0.346 \times 25}{0.6439 \times 2} = 66.5 \text{ (at } 20°)$$

The specific rotary power indicates that the sugar under examination is sucrose.

PHENYLOSAZONE TESTS.

The mother liquor filtered from the sucrose crystals was concentrated again into a syrup, but it did not show any sign of forming new crystals, even after one week's standing. An attempt was then made to separate and detect the sugars as phenylosazones.

1 gm. of the syrup, 2 gm. of phenylhydrazine hydrochloride, 3 gm. of sodium acetate, and 20 cc. of water were mixed and heated in a boiling water bath. After fifteen minutes yellowish crystals had been produced. At the end of one hour and a half the heat was removed and the crystals were examined under the microscope. None of the other forms, besides the stellate form of yellow needle-shaped crystals which coincides with that of phenylglucosazone was observed. When cooled it was filtered and washed with a little water. Upon recrystallization from 60 percent alcohol and drying over sulphuric acid in a vacuum, the amount was 0.85 gm. The melting point was determined and found to be 204°, which coincides with that of phenylglucosazone. Consequently, the osazone under examination is phenylglucosazone.

1 gm. of the syrup was dissolved in 20 cc. of water and inverted with hydrochloric acid in a boiling water bath for about thirty minutes. After it was neutralized with sodium carbonate, 2 gm. of phenylhydrazine hydrochloride and 3 gm. of sodium acetate were added and the mixture was heated in a boiling water bath, exactly in the same manner as above described. After heating for one hour and a half, the crystals were examined under the microscope, but they were all uniform and quite identical with those of phenylglucosazone which was obtained in the previous experiment. When cooled, it was filtered and washed with a little water. The yellow crystals thus obtained were recrystallized from dilute alcohol and dried over sulphuric acid in a vacuum. The product weighed 1.06 gm., and the melting point was found to be 204°. The crystalline form and melting point indicate that the osazone obtained was phenylglucosazone without admixture of other osazones.

The osazone test which was made to separate and detect the sugars in the syrup thus did not yield results differing from those obtained by the qualitative tests, as already described. But, as a result of this experiment, the presence of maltose is excluded, since maltose, if present, would have formed an osazone of a melting point very similar to that of glucosazone, but easily distinguishable from the latter by its crystalline form.

SUMMARY.

1. Sugar of the sweet potato tubers is made up of both reducing and non-reducing sugar.

2. The reducing sugar consists of both glucose and fructose, while the non-reducing sugar is sucrose.

3. The presence of pentose, galactose, and mannose molecules is excluded. The presence of maltose is also excluded.

IPECACUANHA: BOTANICAL SOURCE—MEDICINAL VALUE.

MRS. HAMPTON RAY KENASTON.*

IPECACUANHA.—Portuguese form of the native Brazilian word, ipe-kaa-guene, which is said to mean "road-side sick-making plant," or a creeping plant that causes vomiting. The plants are perennial herbs 10 to 20 cm. high, with creeping, woody hypogeous stems. It is somewhat shrubby with leaves eliptical, entire, short-petiolate, and with divided stipules. The flowers are white and form a bunch of small flowers upon a long-stalked, terminal head. The fruit is a soft, dark, purplish-blue berry, with characteristic spiral arrangement of the carpels.

The part of ipecacuanha used in medicine is the root obtained from *Psychotria*, or *Uragoga (Cephælis) Ipecacuanha*, a small shrubby plant of the natural order Rubiaceæ. It is a native of Brazil, growing in clumps or patches in moist shady

* Chairman Committee on Botany and New Medicinal Plants, South Dakota State Pharmaceutical Association.