

Determination of Sucrose in Sugar Beets

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Accurate, reproducible methods are recognized as essential tools of the chemist, and if we add the adjective "rapid" to these qualifications we satisfy the needs of the sugar chemist both for factory control and for accounting of beets purchased from the grower.

In the accounting for yields and losses in the factory our present methods are fairly reliable and satisfactory. But in those sections of the country where beets are paid for on individual sampling and analysis of the grower's delivery there is always room for questioning the laboratory results.

In the first place, we have the difficulty in obtaining a representative sample. Present practice in most California plants is to sample every truck load delivered. These samples usually weigh about 25 pounds from an average of five to six tons per load. Both tare and percent sugar are determined.

The California factories use 179.1 ml. of a seven Brix lead solution. This volume was determined and recommended by the late Dr. Bachler of American Crystal. Recently this volume has been questioned. The basis for questioning the volume was work done on determination of dry marc. The use of the dry marc determination carries all the classical objections raised in discussion of all volumetric methods where the pulp is a portion of the volume.

A few years ago Lewon and Hartmann tried a method using an extraction with 50 ml. of 5° Brix lead acetate solution.

A normal weight of finely chopped beets is digested for 15 minutes with 50 ml. of 5° Bx lead acetate, 1 ml. of concentrated NH_4OH is added and marc precipitate and solution are then transferred to a paper extraction thimble, which is lowered into a Soxhlett extraction tube, beneath which is connected a 200-ml. volumetric flask.

The apparatus used is the regular Soxhlett extraction apparatus. The washings from the digestion beaker serve as extraction liquid. The tube is connected to a reflux condenser with vacuum connection, and the flask immersed in boiling H_2O . The pressure within the apparatus is then reduced to 25 cm. Hg. absolute, so that the extraction is carried on at a temperature of about 72° C. At this temperature, 10 to 12 extractions (requiring about 1 hour in all) are sufficient to free the contents of the thimble from sugar as determined by the alphanaphthol test. The resulting extract is cooled, made up to 200 ml. and polarized.

Except for a slight haziness which must be filtered off before polarizing, no lead precipitate is included in the extract. The small amount of ammonia added maintains the beet pulp at a pH of about 9 during extraction, thereby insuring against inversion. The extract itself is at a pH of less than 8 when extraction is completed so that the polarization is not affected. A single small drop of a suitable oil prevents foaming in the volumetric flask. This is proven by blank tests to have no effect on the polarization. Two samples of the same pulp were extracted simultaneously.

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At the same time weigh out a group of samples of the same pulp, and add to these a series of different lead additions, e.g. 175, 177, 178, 179, 181 ml. of Bx, lead acetate solution. Digest these for 0.5 hour @ 80° C, filter and polarize. By plotting a smooth curve for each set, the polarization by the digestion method equal to that by the extraction method, and hence the correct Sachs-le Docte volume, is determined.

This method is open to several objections; however, the idea expressed here of making a separate determination for plotting against varying volume of lead solution has much merit.

In later tests by the Hartmann and Lewon method it was demonstrated that the density of the lead used in digestion had a great influence on the polariscopic reading.

These tests indicate the difficulty in relying on a purely polariscopic method for determining the sucrose content of the sugar beet.

What is needed is a chemical method for determination of sucrose which eliminates the errors caused by polarizable substances other than sucrose. Such a method could be used to calibrate the present tare laboratory practice.

One of the subjects on the agenda of the U. S. Committee of the International Commission for Uniform Methods of Sugar Analysis is Subject No. 26, "Sucrose in Sugar Beets." The objective of the referees on this sub-committee will be the development of a method for determination of sucrose in the sugar beet.

The active cooperation of all interested in this subject is requested.