A BASIC METHOD FOR THE ANALYSIS OF STARCH IN CLEAR JUICE

M A RONALDSON and B M SCHOONEES

Sugar Milling Research Institute, University of KwaZulu-Natal, Durban, 4041, South Africa
E-mail: bschoonees@smri.org

Abstract

The analysis of starch in factory streams and products is tedious and time consuming. It is not surprising, therefore, that only one South African sugar mill laboratory currently analyses the factory streams for seasonal starch levels and trends. This essentially means that high starch levels are picked up only in the final raw sugar, causing an uncomfortable delay between detection and application of starch hydrolysing enzymes to rectify the situation.

Various attempts have been made world-wide to simplify the analysis. It appears that most of these attempts have been based on the 'SASTA method' or the 'SASTA Simplified method'. The latter was further simplified by the Sugar Processing Research Institute (SPRI) in the United States of America, who developed the 'Rapid Starch Test'. Further modifications made at the Sugar Milling Research Institute, as well as the application of this method to clear juice to eliminate the centrifugation step, resulted in the 'Basic Starch Test', which is the subject of this poster. To render this method even more straightforward, a predetermined calibration graph was set up and distributed for use in a ring test between several South African sugar laboratories. Feedback on the method was positive, and results indicated that the method could be used with confidence, albeit using a much higher tolerance.

Introduction

The starch content of raw sugars is one of the most important parameters when evaluating sugar for export purposes. It is also an important quality factor in raw sugar production and sugar refining. Starch arises in the actively growing part of the sugarcane plant and from immature cane – hence it is delivered to the factory together with the cane itself (Meade and Chen, 1977). Cane varieties differ widely in the amount of starch in juice, ranging from 200 ppm on Brix to around 1200 ppm (Godshall *et al.*, 1996). Growing conditions and the immediate environment also influence starch content (Meade and Chen, 1977). However, high or low levels of starch in certain regions are still unexplained (Boyes, 1958).

Starch in the process streams at the mill increases viscosity, hampers crystallisation, causes molasses sucrose content to increase and is partially passed into the raw sugar (Meade and Chen, 1977). Starch levels of around 400 ppm on Brix in cane juice will generally result in starch levels of above 150 ppm on Brix in raw sugar (Schoonees, 2003). Values of about 150 ppm and above in raw sugar adversely affect refining, especially in the carbonatation process (Meade and Chen, 1977). Starch may also cause a haze in sugar solutions and has been associated with the appearance of acid beverage floc (Edye, 2001).

Clearly, high starch levels result in a lower quality product with a lower market value that may attract severe penalties (SASMAL Sugar Quality Committee, 2003).

This situation led to an investigation into the development of an efficient yet simple method to determine starch levels early on in the mill process where preventative measures can be taken to limit the transfer of starch to the raw sugar.

The basic starch test

Four methods that are generally used for the determination of starch in raw sugar were evaluated.

The methods were:

- SMRI method (TM 054)
- SASTA Simplified method (Anon, 1985)
- CSR method (Anon, 2001)
- SPRI Rapid Starch Test (Anon, 2002).

Each method was assessed in terms of time, repeatability and reproducibility. The analysis of starch in cane juice and raw sugar is tedious and time consuming, a factor that may have discouraged South African mill laboratories from conducting routine starch analyses. On the basis of these factors the SPRI Rapid Starch Test, which is based on the SASTA Simplified method, was selected for further investigation into the analysis of starch in juice.

Several modifications were made to the method, rendering it more practical for use in mill laboratories. As most South African mills do not have the centrifuge required by the SPRI method, this step was removed, which is possible only if clear juice is used.

The principle of the test is simple. The starch in the clear juice is solubilised by boiling for five minutes. The starch is then reacted with iodine to form a blue/purple starch-iodine complex. The absorbance of the dissolved complex is read in a spectrophotometer at 600 nm and the amount of starch determined from the calibration curve shown in Figure 1. To encourage the use of this method and to simplify it further, this curve is to be provided by the SMRI.

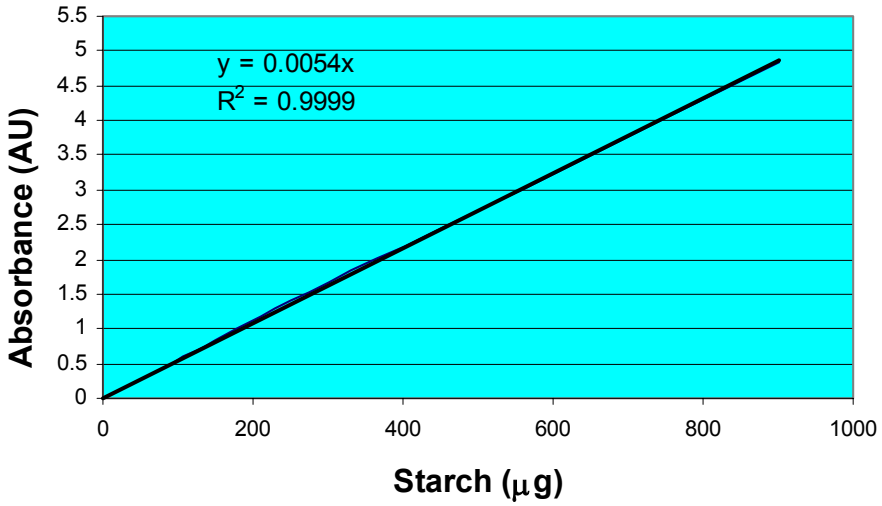

Figure 1. The Basic Starch Test calibration curve.

The Basic Starch Test is exactly as its name implies. Starch levels in clear juice are determined rapidly. However, it must be remembered that this is not a precise method. Its purpose is to give a good indication of starch levels in clear juice, so that an appropriate amount of enzyme may be added to the process to hydrolyse the starch.

Validation of the method

To validate this new method, four clear juice samples were analysed by three analysts at the SMRI using the Basic Starch Test. Results were compared with those obtained when using the SASTA starch method and are tabulated in Table 1. An inter-laboratory ring test was also done, where the same four juice samples were sent to several mill laboratories.

Table 1. Inter-laboratory comparison of starch detection methods.

Clear juice sample	SASTA method (starch ppm)	Basic Starch Test (starch ppm)	
		Analyst 1	Analyst 2
A	525	720	730
B	440	608	600
C	720	953	938
D	576	825	819

From these results it is clear that the method is reproducible and gives an acceptable estimate of the true value as determined by the SASTA method. Figure 2 indicates the direct correlation between results obtained using the Basic Starch Test and the SASTA method, and can be used to relate results back to the corresponding SASTA method values. The inclusion of this simple test in mill laboratory routine testing is therefore warranted.

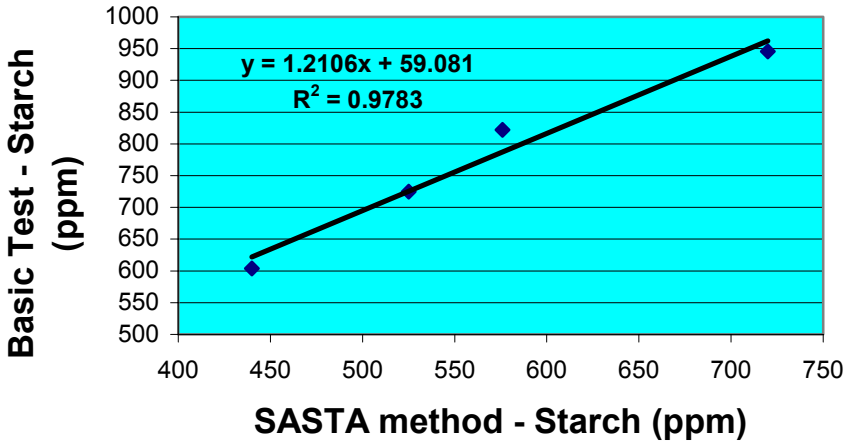

Figure 2. Correlation between the Basic Starch Test and the SASTA method.

Advantages of the basic starch test

- The test will eliminate the time delay between the determination of starch levels and enzyme dosage, which is the most important advantage.
- The test will aid in lowering starch levels in raw sugar produced, thereby preventing processing problems and the risk of penalties.
- The method is simple.
- The method is not time consuming; one sample takes less than 15 minutes.
- Testers require minimum training and should already be familiar with the equipment and glassware used.

- The method is inexpensive.
- The method does not use any toxic chemicals.
- The calibration curve is provided by the SMRI, where it will be maintained.

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