Fermentation Quality of Grain in Fuel Ethanol Production Method

Scope

- Simulate the cooking step in a dry-grind process and identify mashing properties.

Rapid Visco Analyser

The Rapid Visco Analyser (RVA) is a cooking stirring viscometer with ramped temperature and variable shear profiles optimized for testing viscous properties. The instrument includes international standard methods as well as full flexibility for customer tailor-made profiles. Combining speed, precision, flexibility and automation, the RVA is a unique tool for product development, quality and process control and quality assurance.

Description

This procedure is based on the method of Zhao et al. (2008) using sorghum.

In a conventional dry-grind ethanol production process, the cereal grain is ground and mixed with water to form a mash, which is cooked, liquefied, saccharified, and fermented to produce ethanol. The final mash viscosity after liquefaction reflects the degree of starch hydrolysis by α-amylase, and determines the rate and efficiency of sugar production by amyloglucosidase in the subsequent saccharification or simultaneous fermentation step (Zhao et al., 2008).

This test profile mimics the liquefaction process in a laboratory dry-grind procedure. The sample would typically have a rapid increase in viscosity as the starch gelatinizes, followed by a sharp breakdown as the heat-stable α-amylase liquefies the gelatinized starch. The presence of tannins in the grain may inhibit α-amylase hydrolysis of the gelatinized starch, resulting in an increase in peak viscosity, longer peak time, reduce rate of viscosity breakdown, and increase in final viscosity. The test therefore provides a rapid indication of mashing and hence fermentation quality of a grain sample.

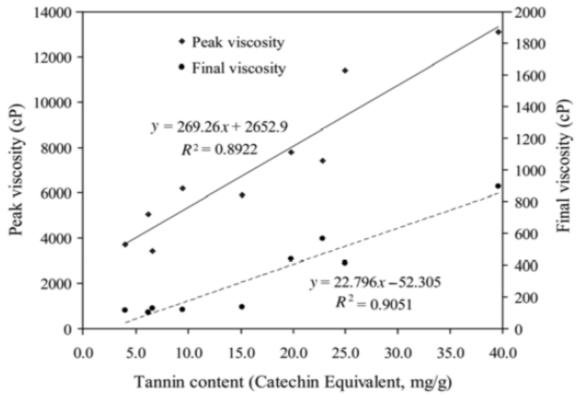

Fig. 1. Relationship between tannin content and peak and final viscosity of sorghum samples. Source: Zhao et al. (2008).

Method

The grain is ground, and tested in distilled water with heat-stable α-amylase. The method simulates the liquefaction process.

Sample Preparation

Enzyme solution: Dilute 2.30 ml of heat-stable α-amylase (Liquozyme SC DC from Novozymes) to 1 liter with distilled water.

RVA Analysis: Test 8.00 ± 0.01 g sample at 14% moisture, 1.0 ml enzyme solution, and 20.0 ml distilled water using the following profile. Keep the total weight of water and required enzyme solution constant at 21.0 ± 0.1 g.

Profile

Time	Type	Value
00:00:00	Temp	95°C
00:00:00	Speed	960 rpm
00:00:10	Speed	160 rpm
00:10:00	End	
Idle Temperature: 95 ± 1°C Time Between Readings: 4 s		

Measure

Peak viscosity (PV)
Peak Time (PkT)
Final viscosity (FV)

High peak and final viscosities, and longer peak times generally indicate the presence of tannins or other α-amylase inhibitors in the grain, which would inhibit hydrolysis of gelatinized starch. This would in turn reduce the efficiency of sugar fermentation and therefore reduce alcohol yield.

See also RVA Method 36: Estimating Fermentable starch in Fuel Ethanol Production Method.

Reference

Zhao, R., Bean, S., Wu, X. and Wang, D. 2008. Assessing fermentation quality of grain sorghum for fuel ethanol production using Rapid Visco-Analyzer. Cereal Chemistry 85(6) 830-836.