Application Note P2

SCHMIDT HAENSCH
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Starch Determination

RAW STARCH DETERMINATION by use of Hydrochloric acid principle acc. to Ewers

Q Question

How can I measure the starch content of goods like potatoes, corn or other organic substances?

A Answer

Using the optical rotation

Polarimetric Method

Polarimeters utilise the so called polarized light. Starch solutions turn the plane of polarization and are therefore called optical active. Starch is a white, granular, organic chemical that is produced by all green plants. Most commercial starch is made from corn but wheat, tapioca, rice and potato are also being used.

Why is starch so important?

Starch is so important because it's an essential ingredient in human nutrition for the provision of energy. The human digestive process breaks down the starches into glucose units with the aid of enzymes. Those glucose molecules circulate in the blood stream as an energy source. Starch products, for example glucose and fructose syrups, are often used to give the sweetness in food products like soft drinks, fruit drinks, brewing and alcoholic beverages. But there are a lot of further applications within the food and other industries.

It's also essential for a lot of other applications. Some examples are:

Pet food: The high protein content of starch co-products makes them a very good meat substitute for pet food, while native and modified starches are used as binders and thickeners.

Paper industry: Starch products are used in paper bags, tissues and packaging paper, corrugating board, and stationery – for, for example, wet end addition, size-press and surface coating.

Pharmaceuticals: Starches are a source for use in pharmaceuticals and make a variety of contributions – from binder to sugarless sweetener – to products as disparate as toothpaste, tablets, emulsions, lotions, liquid medicines and creams.

Quality control in those products often requires determination of the starch content. The most accurate method is the determination of the optical rotation.

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Solution

Schmidt + Haensch Circle Polarimeter or Saccharimeter / Saccharomat

Method

This method consists of a double polarimetric determination. In the first determination, the sample is treated with warm diluted hydrochloric acid, clarified and filtered. The optical rotation of the resulting solution is determined. In the second determination, the sample is extracted with 40% ethanol and filtered. The filtrate is acidified with hydrochloric acid, clarified and filtered again. The optical rotation of the resulting solution is determined. From the difference of both rotation angles the content of starch is calculated.

Procedure

1. Determination of total optical rotation

Weigh to the nearest 2.5g of the prepared sample and transfer to a 100ml graduated flask. Add 25 ml hydrochloric acid, stopper and shake until the sample is uniformly suspended. Then add further 25ml of hydrochloric acid. Immerse the flask in a boiling water bath and shake vigorously for the first 3 minutes to avoid agglomeration of the sample. Keep the flask in the bath for exactly 15 minutes, then remove, add 30 ml cold water and cool immediately to a temperature of 20°C. Add 5ml Carrez solution I and shake for one minute then add 5ml Carrez solution II and shake again for one minute. Dilute to volume 100ml with water, mix and filter. If the filtrate is not perfectly clear, the determination should be abandoned and the analysis repeated using a larger quantity of Carrez solution I and II (e.g. 10ml). Transfer the solution in a 200mm polarimeter tube and measure the optical rotation with a polarimeter or saccharimeter.

2. Determination of the optical rotation of substances soluble in 40% ethanol ((V/V)

Weigh to the nearest 5g of the prepared sample and transfer to a 100ml flask. Add about 80ml ethanol and allow standing for 1 hour. Shake the flask vigorously 6 times during this period in order to disperse the sample.

Dilute to 100ml volume with ethanol, mix and filter. Transfer by pipette 50ml of the sample filtrate to a 250ml Erlenmeyer flask, add 2.1ml hydrochloric acid and shake. Fit a reflux condenser to the flask and place the latter on a boiling water bath. Remove the flask after exactly 15 minutes and transfer the contents to a 100ml graduated flask. Cool to a temperature of 20°C. Clarify the solution using Carrez solution I and II as previously, dilute to 100ml volume with water, mix and filter. Measure the optical rotation as in the previous determination.

Calculation

Calculate the percentage of starch in the sample using the following formula, according to the method of measurement used:

1. Measurement by circle polarimeter

$$\text{Starch (\%)} = \frac{2.000\ (\alpha - \alpha^{1})}{[\alpha]^{20^{\circ}}_{D}}$$

Where:

α	=	total optical rotation in degrees
α^{1}	=	optical rotation in degrees of substances soluble in 40% ethanol
$[\alpha]^{20^{\circ}}_{D}$	=	specific rotation of pure starch

Specific rotation of starches are given as follows:

- Barley starch +181.5°
- Maize starch +184.6°
- Oat starch +181.3°
- Potato starch +185.7°
- Rice starch +185.9°
- Wheat starch +182.7°
- Tapioca starch +183.6°
- Other starches +184.0° (starch mixtures in compound feeding stuffs)

2. Measurement by saccharimeter

$$\text{Starch (\%)} = \frac{2{,}000}{[\alpha]^{20^\circ}_{D}} \times \frac{(2N \times 0.665)(Z - Z^1)}{100} = \frac{26.6N\,(Z - Z^1)}{[\alpha]^{20^\circ}_{D}}$$

Where:

Z	=	total optical rotation in degree Z
Z^1	=	optical rotation in degree Z of substances soluble in 40% ethanol
N	=	weight of sucrose in g per 100ml water which gives a rotation of 100 °Z
$[\alpha]^{20^\circ}_{D}$	=	specific rotation of pure starch

Polarimeter requirements:

- Circle polarimeter or Saccharimeter
- Precision: At least 0.01°
- Polarimeter tube: 200 mm long

Product	Unipol / Polartronic / Saccharomat
Productpackage	e..g Polartroninc M100 incl. 200 mm polarimeter tube

Schmitd + Haensch Products used
- Unipol L / Unipol L1000
- Polartronic N100 / M100 /N100 T / M100 T

Recommended Accessories
- Polarimeter tube with funnel, riser and integrated temperature sensor 200 mm (Code: 03830)

Benefits
- Cost and Time savings
- Accurate, Fast and Precise Measurement
- Product Quality securing

Typical Industries
- Food Industry
- Sugar Industry
- Paper Industry
- Pharmaceutical

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