Starch

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Considering the advanced state of our knowledge of starch enzymology it might be expected that a suitable enzymatic method for the determination of starch would be readily available. However, this is not the case. Such a method must consist of the enzymatic hydrolysis of the polysaccharide to defined products which can be determined chemically or enzymatically. If starch could be rapidly and specifically degraded to glucose, then the problem would be solved. An α-glucosidase that degrades starch in this way has recently been crystallized[2]. A similar, amorphous enzyme has been purified from commercially available concentrates[3].

α-Amylase attacks α-1 → 4 bonds within the starch molecule, but does not split the α-1 → 6 bonds of amylopectin. The later stages of this hydrolysis can be very slow and the end-point of the reaction is governed by the source of the enzyme[4]. The hydrolysis products are simple sugars (glucose, maltose, maltotriose) and oligosaccharides which contain the α-1 → 4 together with the α-1 → 6 bonds of the amylopectin[4]. Starch is a mixture of amylose and amylopectin, the relative amounts of which can vary widely according to the source of the starch[5,6]. Therefore there is no fixed end-point of amylolysis applicable to all types of starch.

β-Amylase hydrolyses starch to a single sugar, maltose, but since the degrees of β-amylolysis of amylose and amylopectin are very different[5], it is also not possible to define an end-point in this case.

The current methods for the hydrolysis of starch use impure amylase preparations. For example, *Steiner* and *Guthrie*[7] used the official A. O. A. C. malt diastase method[8] for the determination of starch in Jerusalem artichokes. Although this plant contains no starch the analysis indicated an apparent starch content of 27.4% (refer also to[9,10]). Amylases or other enzyme systems cannot quantitatively distinguish between starch and glycogen, as may be necessary in the analysis, for example, of sweet corn[11].

An attempt has been made to avoid the difficulty of the inconstant end-point of amylolysis by acid hydrolysis of liberated products to glucose[8]. Assuming that the sample is free from glycogen and the amylase is pure (a crystalline enzyme from pig pancreas is commercially available[12]), this method should allow the specific and accurate estimation of starch, although the procedure has not yet been fully developed. (Enzymatic determination of glucose see p. 59, 117, 123).

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1) Cf. *W. J. Whelan:* Modern Methods of Plant Analysis. Springer, Berlin 1953, Vol. II, p. 145.
2) *T. Sawasaki*, Rep. Inst. Phys. and Chem. Res. [Japan] *36*, 590 [1960].
3) *J. H. Pazur*, *K. Kleppe* and *J. S. Anderson*, Biochim. Biophys. Acta *65*, 369 [1962]; *J. H. Pazur* and *T. Ando*, J. biol. Chemistry *234*, 1966 [1959].
4) *W. J. Whelan*, Die Stärke *12*, 358 [1960].
5) *W. J. Whelan:* Encyclopedia of Plant Physiology, Springer, Berlin 1958, Vol. VI, p. 154.
6) *G. Harris* and *I. C. MacWilliam*, J. Inst. Brewing *63*, 210 [1957].
7) *E. T. Steiner* and *J. D. Guthrie*, Ind. Engng. Chem., analyt. Edit. *16*, 736 [1944].
8) Official Methods of Analysis. 7th ed., Association of Official Agricultural Chemists, Washington 1950, p. 348.
9) *R. D. Powell*, Iowa State Coll. J. Sci. *26*, 264 [1952].
10) *E. F. Steagall*, J. Assoc. off. agric. Chemists *35*, 691 [1952].
11) *S. Peat*, *W. J. Whelan* and *J. R. Turvey*, J. chem. Soc. [London] *1956*, 2317.
12) Worthington Biochemical Corporation, Freehold, New Jersey, USA.