of its conversion into fibrous hydroglucan (Houwink & Kreger, 1953).

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The Specificity of Barley Limit Dextrinase

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Extracts of germinated barley contain a mixture of carbohydrases including two α -1,6-glucosidases (MacWilliam & Harris, 1959). One of these, R-enzyme, can hydrolyse the outermost α -1,6-glucosidic interchain linkages in amylopectin, but has no action on α -1,6-glucosidic linkages in glycogen or in branched oligosaccharides. The second enzyme, limit dextrinase, hydrolyses the α -1,6-glucosidic linkages in certain branched oligosaccharides, but has no action on amylopectin. These 'debranching' enzymes can be separated by column chromatography (MacWilliam & Harris, 1959) or by continuous electrophoresis (Manners & Sparra, 1966), although these methods do not entirely separate limit dextrinase from α -amylase. We now report studies on the properties of purified limit dextrinase.

Dehusked barley grain was allowed to germinate at 25° for 36 hr. and then homogenized in citrate buffer, pH 5.9. Protein was precipitated from the extract by the addition of solid ammonium sulphate (70%, w/v), the precipitate was dissolved in water, and, after dialysis, the protein was isolated by freeze-drying in citrate buffer, pH 5.5. This preparation showed maltase, isomaltase, panase, α -amylase, limit dextrinase and laminarinase activity.

The preparation (0.336 g. of protein) was dialysed and fractionated by continuous electrophoresis (Manners & Sparra, 1966). Those protein fractions showing limit dextrinase activity were combined and then subjected to gel filtration at 2° on a column of Sephadex G-200 with 0.02 M-citrate buffer,

pH 5.3, as eluent. Appropriate protein fractions showing limit dextrinase activity were combined and freeze-dried to give 0.135 g. of protein.

This preparation had no effect on the iodine-staining power and β -amylolysis limit of amylopectin, and was therefore free of R-enzyme and α -amylase. It had no action on the following substrates: maltose, isomaltose, maltotetraose, isomaltotetraose, panose, glucosyl-Schardinger dextrin, 6³- α -glucosylmaltotriose, 6³- α -glucosylmaltotetraose, or on 'stuffed' glucan (Stark, 1967). Enzyme action on higher branched oligosaccharides gave a mixture of maltose, maltotriose and other maltosaccharides. Maltosyl-Schardinger dextrin was also hydrolysed. The enzyme is therefore unable to remove single glucose side-chains from substrates and requires at least one α -1,4-linked glucose residue on either side of the susceptible α -1,6-glucosidic linkage. In this respect, the specificity is similar to that of pullulanase from *Aerobacter aerogenes* (Abdullah *et al.* 1966).

The limit dextrinase also differs from barley malt α -glucosidase, which can hydrolyse maltose, isomaltose and panose (Jorgensen & Jorgensen, 1963; Jorgensen, 1963).

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The Determination of Glycosaminoglycans present in Various Mammalian Brains

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Chemical studies from several Laboratories have confirmed the earlier histochemical findings that glycosaminoglycans occur in brain tissue. There is, however, a certain amount of controversy as to the exact nature and relative amounts of the glycosaminoglycans present in brain tissue obtained from different animals. The present study is concerned with the isolation and identification of glycosaminoglycans from brain tissue of ox, dog, horse, monkey, rabbit, rat and sheep.

Brains were removed from animals as soon after death as possible and carefully freed from adhering