High Fructose Corn Syrup

The development of the various types of corn syrups, maltodextrins, and high-fructose corn syrup from corn starch sources could be called one of the greatest achievements in the sugar industry. Corn starch can be hydrolyzed into glucose relatively easily, but it was not until the 1970s that it became a commercially major product bringing about changes in the food industry.

Introduction

The starch is processed and refined from the kernels of corn by using a series of steeping (swelling the kernel), separation, and grinding processes to separate the starch from the other parts of the kernel which is used for animal feed.
The starch is hydrolyzed using acid, acid-enzyme, or enzyme-enzyme catalyzed processes. The first enzyme is generally a thermally stable alpha amylase which produces about 10-20 % glucose. Further treatment with the enzyme glucoamylase yields 93-96% glucose. The final Corn Syrup (glucose syrup) products include: dried corn syrup, maltodextrin, and dextrose (glucose).

**Glucose Isomerase**

With the development of glucoamylase in the 1940s and 1950s it became a straightforward matter to produce high percent glucose syrups. However, these have shortcomings as used in the sweetener industry. D-glucose has only about 70% of the sweetness of sucrose, on a weight basis, and is comparatively insoluble. Fructose is 30% sweeter than sucrose, on a weight basis, and twice as soluble as glucose at low temperatures so a 50% conversion of glucose to fructose overcomes both problems giving a stable syrup that is as sweet as a sucrose solution of the same concentration.

One of the triumphs of enzyme technology so far has been the development of 'glucose isomerase', which in turn led to the commercialization of high fructose corn syrups. Now it is known that several types of bacteria, can produce such glucose isomerases. They are resistant to thermal denaturation and will act at very high substrate concentrations, which have the additional benefit of substantially stabilizing the enzymes at higher operational temperatures. The vast majority of glucose isomerases are retained within the cells that produce them but need not be separated and purified before use.
All glucose isomerases are used in immobilised forms. Although different immobilisation methods have been used for enzymes from different organisms, the principles of use are very similar. The corn syrup is then converted to fructose in a batch process to make 42% fructose syrup.

For many purposes a 42% fructose syrup is perfectly satisfactory for use but it does not match the exacting criteria of the quality soft drink manufacturers as a replacement for sucrose in acidic soft drinks. For use in the better colas, 55% fructose is required. This is produced by using vast chromatographic columns of zeolites or the calcium salts of cation exchange resins to adsorb and separate the fructose from the other components. High fructose corn syrups are classified according to the fructose content (i.e., 42%, 55%, 90%).

**Glucose vs. Fructose**

The six member ring and the position of the -OH group on the **carbon (#4) identifies glucose** from the -OH on C # 4 in a down projection in the Haworth structure. **Fructose** is recognized by having a five member ring and having six carbons, a hexose.

Both glucose and fructose may be either alpha or beta on the anomeric carbon, so this is not distinctive between them.