Abstract for

Enzymatic Production of Invert Sugar

ensymm company
Düsseldorf, Germany

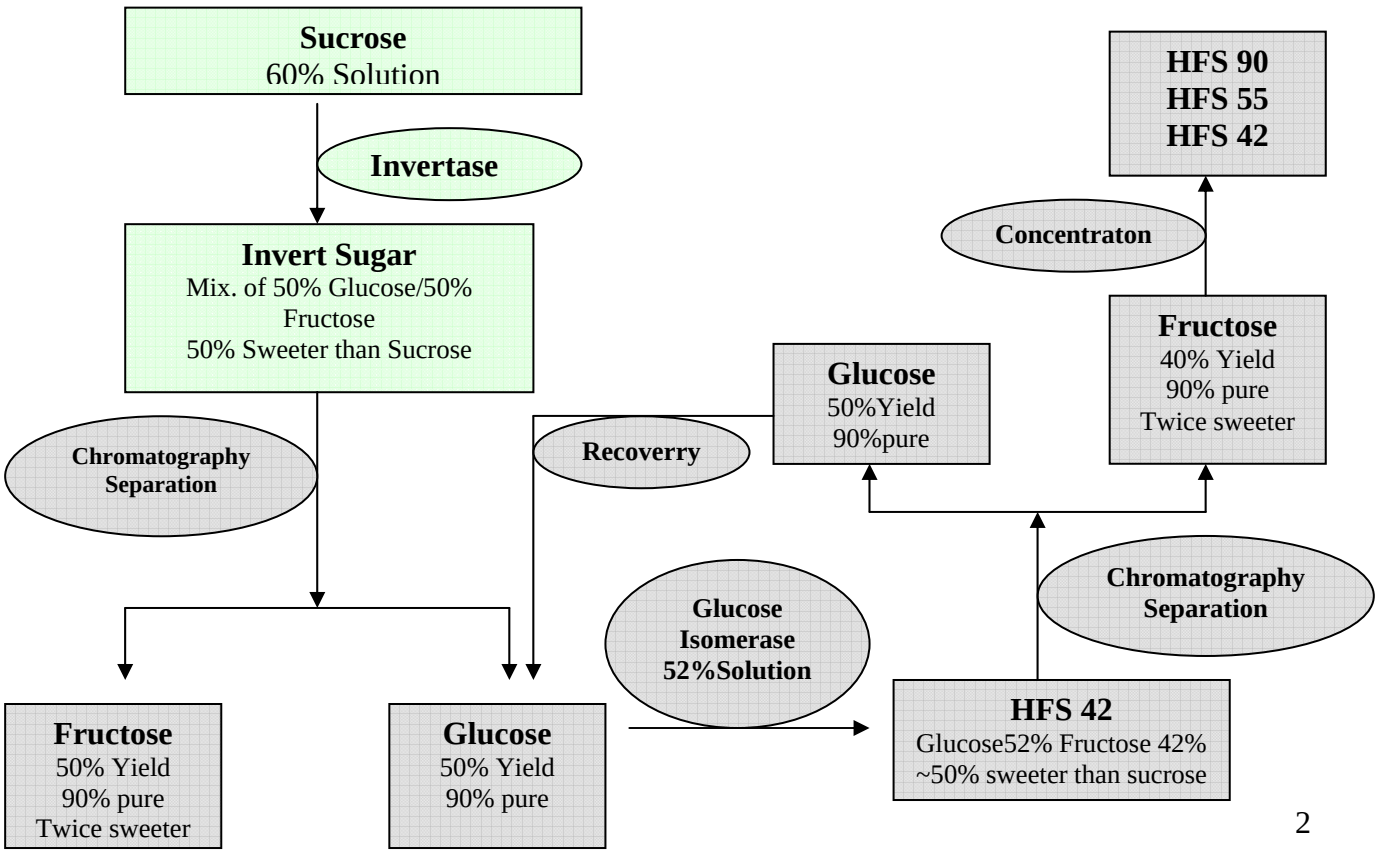
2007

- **Foreword**

The food and drink industry depends heavily on enzymes. Enzymes produced by yeast have been used for thousands of years in brewing and baking.
Inver sugar (IS) contains fructose and glucose in roughly equal proportions. The Invert sugar is greater in demand than pure glucose as food and drink sweeteners, because fructose is sweeter than glucose.

Main consumers of Invert Sugar are the baking, beverages, canning,, confectionery and dairy industries. In addition, high fructose syrup is used in many other processed foods like jams and jellies. However, it is being used only in biscuits and soft drinks. A manufacturer of IS expecting to supply it in next couple of years to the confectionery, fruit canning, processed foods and dairy products industries also.
Fructose, also known as fruit sugar, is the sweetest natural sugar and is found in fruits, vegetables, and honey.
The body responds to fructose in a different way than to glucose and sucrose. Fructose is more satiating, and it is up to 1.8 times sweeter than sucrose, making it useful in foods and beverages for the health conscious. Fructose is also ideal for use in diabetic foods as it has very little effect on blood glucose and only a negligible effect on the secretion of insulin.
Enzymatic treatments are a now a major way of producing sweeteners, including syrups derived from sucrose derived from sucrose or starch that contain mixtures of glucose, maltose, fructose, and other sugars.
Glucose has 70-75% the sweetening strength of beet sugar (sucrose), but fructose is twice as sweet as sucrose. Thus, processes for the manufacture of fructose are of considerable value.
Invertase enzyme is used traditionally in the production of inverted sugars for industry, especially in the manufacture of candies and preserves, production of lactic acid and ethanol production from fermentation of cane sugar molasses. The present study deals with the substrate-induced changes in invertase formation by *Saccharomyces cerevisiae*

- **Process Pathway:**

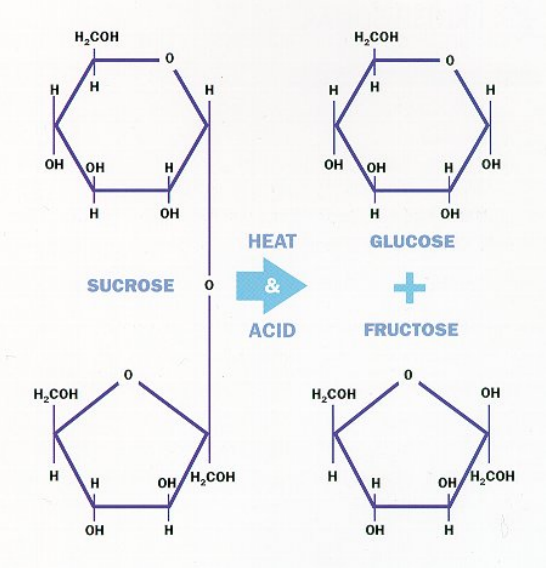


Invert sugar

Invert sugar is prepared by the hydrolysis of sucrose to glucose (dextrose) and fructose. This is achieved by subjecting a sucrose solution to acid and heat:

Invert sugar syrups can be fully inverted as above, or partially inverted to leave part of the original sugar unchanged. These syrups are known as medium or partial invert sugar syrups. The term "invert" originates from the effect on the polarimeter instrument traditionally used to analyse sucrose solutions. Compared to pure sucrose, a mixture of glucose and fructose "inverts" the plane of polarised light, and so this is known as invert sugar.

Inverting sugar in your own factory is a time consuming process that needs critical process control, and can be difficult to manage in the busy production environment.



Properties of Invert Sugar

Invert sugar has the following properties that provide benefits in many food applications:

Sweetness

Medium Invert (50% sugar, 50% invert) has an increased sweetness of 20%, when compared to pure sugar or pure invert. This extra sweetness can be of benefit in fruit flavoured drinks where around 20% less carbohydrate sweetener can be used if ordinary sugar is replaced with medium invert.

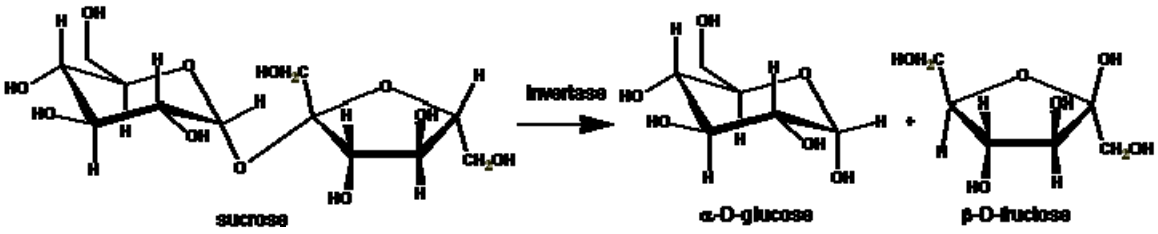
Enzymatic invert sugar is an absolutely health-friendly sweetener. Herein, the enzyme invertase is employed for hydrolysis of sucrose into glucose and fructose. Now, fructose is a sugar, which can be consumed even by diabetic patients. This is because its metabolism is insulin independent. Also, invert sugar is 28-30% sweeter than table sugar so the amount of sugar required for a particular degree of sweetness is also reduced. Finally, enzymatic invert sugar does not involve the use of any chemicals or acids unlike the conventional acid-hydrolyzed invert syrup. Hence, it is a completely healthy sweetener.

Sucrose inversion using Invertase

The conventional method of manufacturing **Invert Sugar** involves acid hydrolysis of sucrose, the popular and cheap sweetener. However, such acid hydrolysis has a low conversion efficiency, high-energy consumption and thus cost of production is high. The acid-hydrolysed product also contains impurities introduced by uncontrollable parameters during inversion. The said conversion can also be achieved by enzymatic action of *invertase* on sucrose with a conversion efficiency of almost 100% without the inherent disadvantages of acid hydrolysis. The key to the process developed is a specific enzyme for the continuous production of concentrated **Invert Sugar** using immobilised yeast cells in an inorganic insoluble matrix. Now because of the feasible production of invertase enzyme can be used as free enzyme. The advantage against the hot acid process is

- Near 100% yield
- Low Temperature (low energy cost)
- No impurity
- 1:1000 Dosage
- Better taste of product
- Easy handling
- Small stock

Invertase enzyme:
The official name for invertase is beta-fructofuranosidase, which implies that the reaction catalyzed by this enzyme is the hydrolysis of the terminal nonreducing beta-fructofuranoside residues in beta-fructofuranosides. Note that alpha-D-glucosidase, which splits off a terminal glucose unit, can also catalyze this reaction. Note that sucrose can be hydrolyzed relatively easily; the reaction proceeds in an acidic environment without the aid of invertase.but with very low yield! The key to the process developed is a specific enzyme for the continuous production of concentrated Invert Sugar using immobilised yeast cells in an inorganic insoluble matrix.



Invert sugar as liquid product:

A considerable change in the market of sweetening of foods has been observed and the

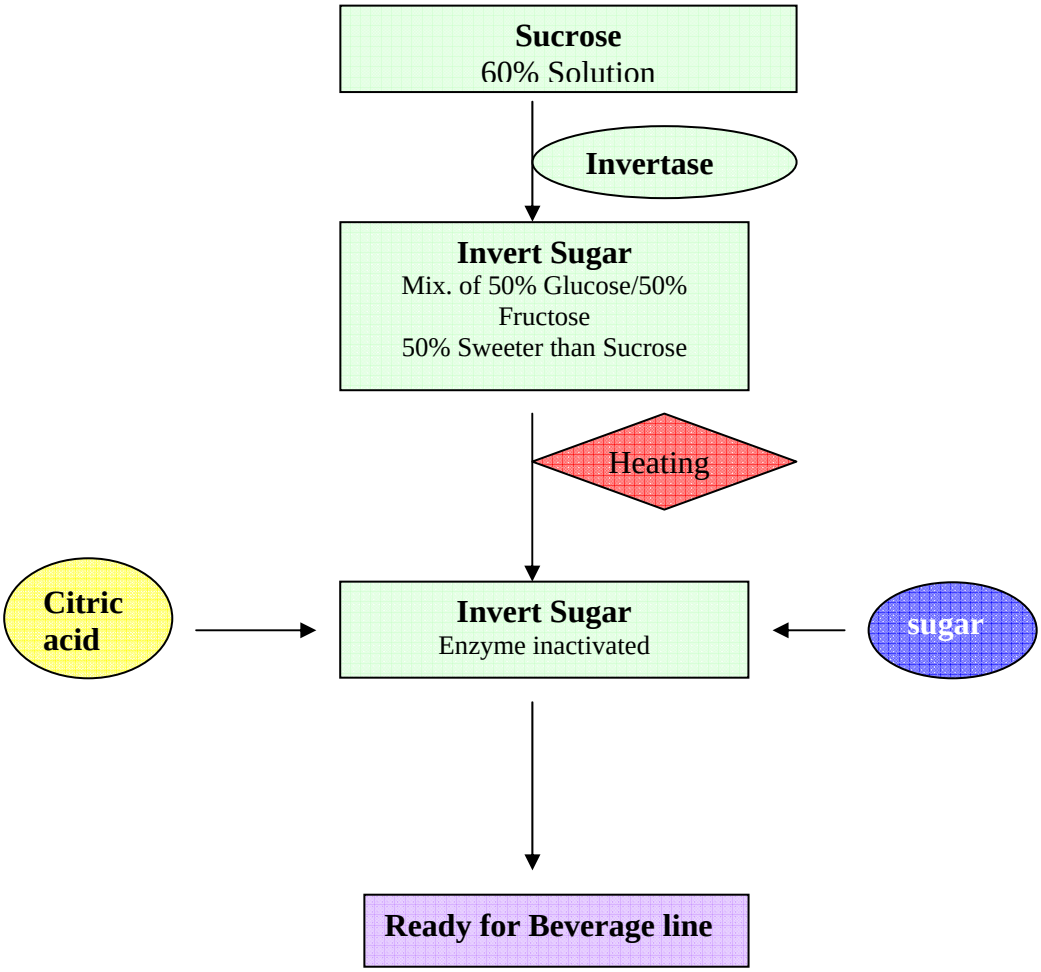
dominance of sucrose as a major carbohydrate sweetener has been challenged. A wide range of new and more desirable carbohydrate-based sweeteners has emerged on the scene to keep pace with the advances in food technology. These sweeteners have wide applications in the food and pharmaceutical industries. The most important among them is Invert Sugar, an equimolecular mixture of glucose and fructose. Invert sugar is a valuable sweetener in food and pharmaceutical application because of its functionally more desirable properties i.e. high osmotic pressure, high solubility and humid nature.

Some of the important applications of Invert Sugar are :

- Sweet-meat, bread, biscuits, chocolates, condensed milk, jams, jelly etc.
- Syrups in the pharmaceutical industry.
- Beverages including aerated beverages.
- As a substitute for honey.
- Infant foods.

- Intravenous injectables for treatment of certain pathological conditions such as diabetes.
- In paper and tobacco industries. because of its humectancy.

Process Line:



Summary

The invert Sugar can be used in :

- Biscuits:
  For caramelisation and enhanced flavour. Better texture.
- Bread, Cakes & Pastries
  For better crust colour and softer crumb and faster yeast activation.
- Fruit Processing
  For better shelf life due to good humectant properties. Provides better taste profile and enhances flavour.
- Honey
  For bee feeding and blending with honey. Restricted bacterial activity. Good and chemically purer replacement of Honey.
- Squashes, Lemonades and Instant Energy Drinks:
  Glucose and fructose provide instant energy and better taste.
- Pharmaceuticals
  Ready to use for cough syrups and glucose and fructose based intravenous fluids.

Enzymatic invert sugar is an absolutely health-friendly sweetener. Herein, the enzyme invertase is employed for hydrolysis of sucrose into glucose and fructose. Now, fructose is a sugar, which can be consumed even by diabetic patients. This is because its metabolism is insulin independent. Also, invert sugar is 28-30% sweeter than table sugar so the amount of sugar required for a particular degree of sweetness is also reduced. Finally, enzymatic invert sugar does not involve the use of any chemicals or acids unlike the conventional acid-hydrolyzed invert syrup. Hence, it is a completely healthy sweetener.

Sucrose can be inverted to an equimolar mixture of glucose and fructose called invert sugar. There are different methods of inversion among which acid inversion and bio-inversion are more popular. Bio-inversion though expensive, is a better alternative as it does not produce any polymerized byproducts as seen in case of acid inversion

The conventional method of manufacturing **Invert Sugar** involves acid hydrolysis of sucrose, the popular and cheap sweetener. However, such acid hydrolysis has a low conversion efficiency, high-energy consumption and thus cost of production is high. The acid-hydrolysed product also contains impurities introduced by uncontrollable parameters during inversion. The said conversion can also be achieved by enzymatic action of *invertase* on sucrose with a conversion efficiency of almost 100% without the inherent disadvantages of acid hydrolysis