

**FACTSHEET ON GLUCOSE FRUCTOSE SYRUPS, ISOGLUCOSE AND
HIGH FRUCTOSE CORN SYRUP**

1. Understanding the terms

Terms like glucose fructose syrups, isoglucose and High Fructose Corn Syrups (HFCS) are often confused and used interchangeably. This section aims to clarify the differences (read more)

Glucose is a simple sugar found naturally in many foods. Glucose performs a unique and vital role as an energy source for the brain which cannot use other types of energy¹.

Fructose is also a simple sugar found in many foods. It is the sweetest of all naturally occurring sugars. High levels of fructose are, for example, typically found in fruits notably tree fruits (oranges, apples etc.), berries, melons and some root vegetables such as sweet potatoes, parsnips and onions

Sucrose, or table sugar, is made up of glucose and fructose linked together in a 1:1 ratio (i.e., 50% glucose, 50% fructose).

Glucose Fructose Syrup (GFS) is a liquid sweetener used in the manufacturing of foods and beverages. It is composed of different sugars, mainly glucose and fructose, with varying compositions, with a fructose content ranging from 5 to 50%. If the fructose content exceeds 50%, the product becomes a **Fructose-Glucose Syrup**.

Isoglucose is glucose fructose syrups with more than 10% of fructose, as defined in EU legislation¹.

In the United States, this type of product is produced from maize starch most commonly either with a 42% or a 55% fructose content and is called **High Fructose Corn Syrup (HFCS)**.

¹ For a definition of isoglucose please see COUNCIL REGULATION (EC) No 1234/2007 of 22 October 2007 establishing a common organisation of agricultural markets and on specific provisions for certain agricultural products (Single CMO Regulation) – definition on page 89

2. How Glucose Fructose Syrups are produced

In the EU, Glucose Fructose Syrups² are made typically from wheat or maize starch. The starch molecule is a long chain of glucose cells. By first liberating free glucose molecules through a process called 'hydrolisation' and then changing some of these glucose molecules into fructose in a process called 'isomerisation' ([link to infographic](#)).

3. The uses of Glucose Fructose syrups (GFS)

Glucose Fructose Syrups are found in many food and drinks, not only for their sweetening characteristics, but also for their other specific properties ([read more](#))

In the EU, GFS is mainly found in confectionery, beverages, jams and preserves, baked goods, cereal products, yogurts and other dairy products, condiments and canned and packed goods. It is not only used for its sweetening properties but also for its other properties, for example as a texturiser and preservative. GFS also, for example, prevents crystallisation in confectionery and prevents sweets from sticking to their wrappers.

Outside of the EU, and notably in the US, GFS (notably HFCS as it is termed there), because, unlike sucrose, is a liquid, it is particularly well suited to and also used widely in soft drinks.

4. Differences between the EU and the US situation

The extent and type of GFS use varies significantly from one region to the next. This is partly because of different legislative approaches and partly due to different consumer preferences, for example between the US and the EU ([read more](#))

The use of GFS in soft drinks in the EU has been limited because soft drinks need a fructose content of at least 42% to achieve their desired level of sweetness and GFS with such a high level of fructose is not available in the EU in sufficient quantities. This is because in the EU, the production of isoglucose (glucose fructose syrups with more than 10% of fructose) was limited until October 2017 by the EU sugar regime to 5% of total EU sugar production. In the EU, soft drinks are therefore sweetened primarily using sucrose, which has a fructose content of 50%.

In the US, no production limits exist on GFS, and HFCS today constitutes up to 40% of US sugars consumption. Its main application is in soft drinks¹¹.

The EU sugar regime ended in October 2017, meaning that, from that date, there no longer exist EU production quotas on either sucrose or isoglucose.

This is expected to result in a possible change in isoglucose production in the EU. The extent of this change is extremely difficult to predict and subject to as yet unknown outside factors but industry estimates suggest an increase in EU isoglucose production

² For a legal definition of glucose fructose syrup please see Council Directive 2001/111/EC, of 20 December 2001, relating to certain sugars intended for human consumption, OJ L10, 12 January 2002, p. 53

from its current level of approx. 720,000 tonnes a year to at least 2 million tonnes a year over time (representing approximately 15% of total EU sugar consumption).

5. The nutritional properties of GFS and HFCS

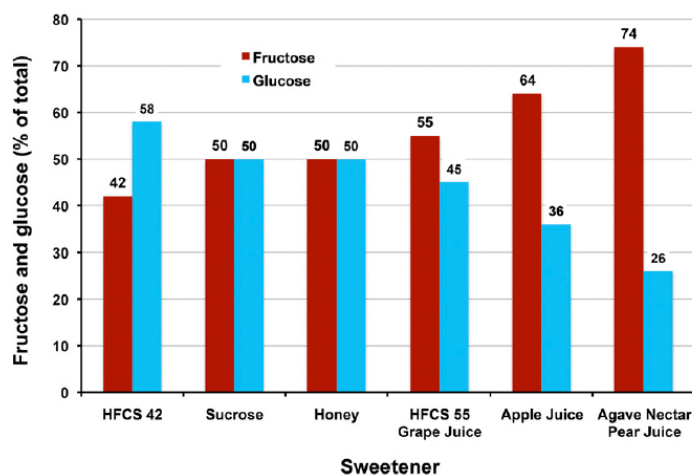
GFS, other starches and sucrose are nutritionally equivalent and contain the same number of calories, 4kcal/g (read more).

Human beings derive their energy from carbohydrates, proteins and fats. EFSA (European Food Safety Authority) published guidelines suggesting that carbohydrates should constitute 45-60% of total energy intake for both adults and childrenⁱⁱⁱ.

GFS is a sugar and one source of carbohydrates. Other carbohydrate sources include starch, found predominantly in starchy foods like bread, potatoes and pasta and sucrose, an important ingredient in many food products that are commonly found in the diet.

GFS, other starches, and sucrose all contain the same number of calories, 4Kcal /g ^{iv}.

HFCS is typically produced in the US with a fructose level of either 42% or 55%. The fructose level in sucrose or honey is 50%, i.e. equivalent to HFCS as illustrated in the chart below:



The US Academy of Nutrition and Dietetics in 2012 noted that 'High Fructose Corn Syrup is nutritionally equivalent to sucrose. Both sweeteners contain the same number of calories (4 per gram) and consist of about equal parts of fructose and glucose. Once absorbed into the blood stream, the two sweeteners are indistinguishable' ^v.

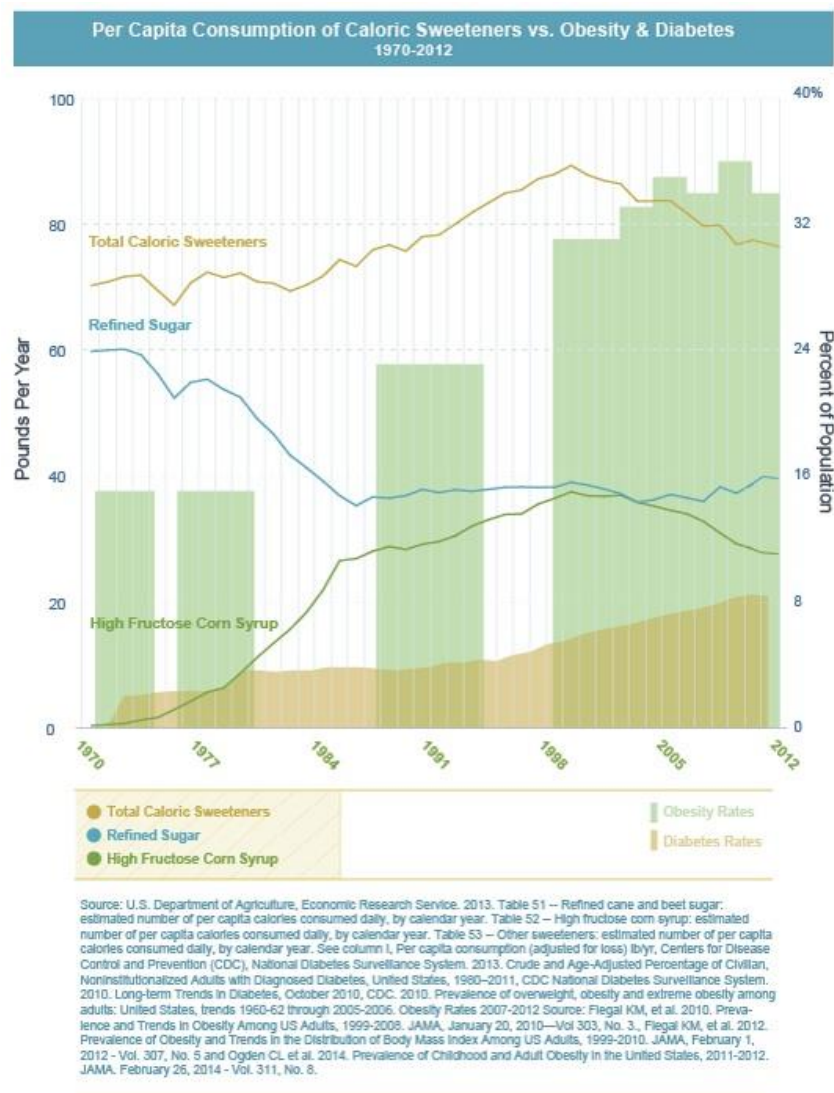
6. HFCS consumption and obesity

No causal relationship between increased HFCS consumption and increased obesity rates has been demonstrated. The reality is that HFCS consumption in the US has been decreasing since 1999 but obesity rates have continued to increase (read more)

As a result of the popularity of GFS in the US, at levels with a similar fructose level to sucrose (i.e. HFCS), there has been extensive research in that country comparing the

health and nutritional characteristics of HFCS with sucrose. Though causality was never established, the evidence initially suggested a correlation between increasing HFCS consumption and rising US obesity and diabetes rates^{vi}.

This suggested correlation has been thoroughly reviewed and subsequently strongly questioned primarily because whilst US HFCS consumption has been falling since 1999, obesity and diabetes rates in that country have continued to increase.



⁴⁾ The Effects of Sucrose, Fructose, and High-Fructose Corn Syrup Meals on Plasma Glucose and Insulin in Non-insulin-dependent Diabetic Subjects

The American Medical Association clearly stated in June 2008 that 'high fructose syrup does not appear to contribute to obesity more than other caloric sweeteners^{vii}'. These findings have also been confirmed by more recent research, including in June 2018 by the German Federal Institute for Risk Assessment (BfR) which concluded that '*it can be expected that there are no significant differences between isoglucose and sucrose*

from a nutritional perspective and that their health assessments are thus also similar³. Furthermore, data from other countries showed no correlation between HFCS and obesity prevalence rates^{viii}.

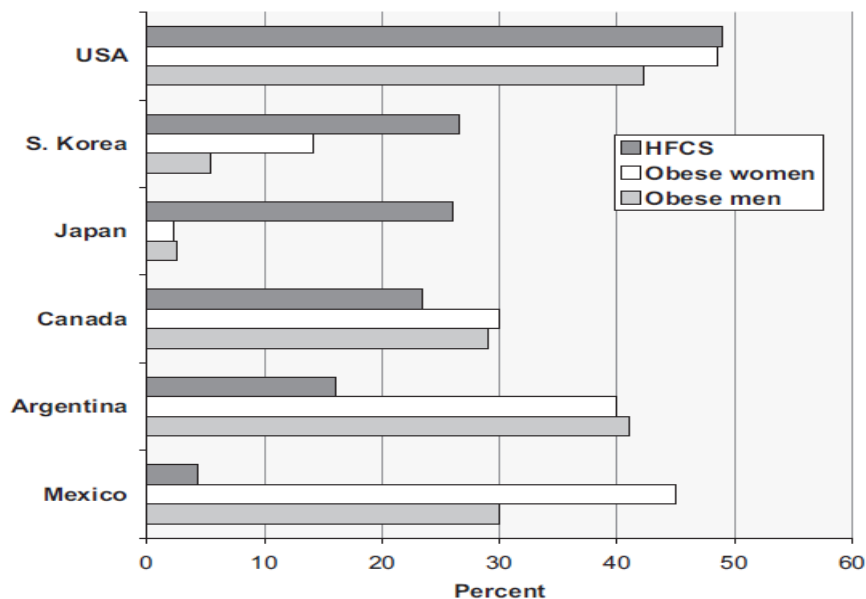


FIGURE 4. World Health Organization obesity rates (BMI ≥ 30 kg/m², age ≥ 30 y) versus high-fructose corn syrup [(HFCS); share of (sucrose + HFCS)] in selected countries for 2005 (32, 33).

7. Fructose compared to other sugars

Studies comparing beverages with different levels of fructose have not demonstrated any differential effects on feelings of fullness between fructose and other sugars^{ix} (read more).

Evidence demonstrates that fructose and glucose, the main constituents of both HFCS and sucrose are indeed metabolised in different ways in the body ^x.

However, studies comparing beverages with different levels of fructose have not demonstrated any differential effects on feelings of fullness between fructose and other sugars^{xi}. More generally, when fructose or fructose-containing sweeteners are used as an alternative to other carbohydrates in diets providing similar calories, no adverse effect on body weight is observed^{xii}. To cite *Sievenpiper J L, de Souza R J, Mirrahimi A, Me Y, Carleton A J, et al.*, 'Fructose, if consumed in high doses can contribute to increasing bodyweight but such effect would be due to excessive caloric intake rather than to the consumption of fructose itself'^{xiii}.

Recent research published in Europe supports these conclusions, to cite Tappy et al :

"Through multiple misconceptions about fructose and fructose-containing sugars, a causal role of their intake has been proposed in the aetiology of the global obesity epidemic. However, current evidence on the metabolic effects of fructose, as consumed by the majority of populations, is insufficient to demonstrate such a role in metabolic diseases and the global obesity epidemic."^{xiv}

³ (Bundesinstitut für Risikobewertung –BfR – Communication No 019/2018 of 8 June 2018).

In 2015, the UK SACN report on “Carbohydrates and health” stated that “It is unlikely that fructose, as consumed as a component of HFCS, causes metabolic abnormalities... more than other sugars consumed in an isocaloric diet...On balance it is considered that there is insufficient evidence to demonstrate that fructose intake, as consumed in the diet, leads to adverse health outcomes independent of any effects related to its presence as part of total and free sugars (...)”⁴”

8. The causes of obesity

The increasing rates of obesity, both in the US and Europe, and indeed elsewhere in the world are, as nutritionists, health experts and researchers generally agree, primarily the result of an imbalance between calories consumed and calories burned. The solution to reducing obesity is promoting a balanced diet and sufficient physical activity^{xv}.

⁴ Scientific Advisory Committee on Nutrition (2015), [Carbohydrates and Health Report](#).

List of references

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- i European Food Information Council (EUFIC) (2012) Carbohydrates. Available at <http://www.eufic.org/article/en/expid/basics-carbohydrates/>
- ii Corn Refiners Association, 2010 Annual Report. <http://www.corn.org/wp-content/uploads/2009/12/CRAR2010.pdf>
- iii EFSA (2010). "Scientific opinion on dietary reference values for CHO and dietary fibres." EFSA Journal 8(3): 1462 [77 pp].
- iv Textbook knowledge, supported by Food insight which says "HFCS and table sugar contain the same number of calories – 4 calories per gram or 16 calories per teaspoon." http://www.foodinsight.org/Content/6/HFCS_v7.pdf
- v Acad Nutr Diet 2012; 112: 739-758.
- vi Bray, G.A., S.J. Nielsen, and B.M. Popkin, Consumption of high-fructose syrup in beverages may play a role in the epidemic of obesity. American Journal of Clinical Nutrition, 2004. 79: p. 537-543;
Moeller et al. 2009 the effects of high fructose syrup. J Am Coll Nutr 28(6) 619-26.
- vii The Health Effects of High Fructose Syrup, Report 3 of The Council on Science and Public Health (A-08), The American Medical Association.
- viii <http://www.theaustralianparadox.com.au/Fructose.php>; <http://www.mdpi.com/2072-6643/3/4/491/htm> –
- ix Soenen E, Westerp-Plantenga WS (2007) No differences in satiety or energy intake after high-fructose corn syrup, sucrose, or milk preloads. Am J Clin Nutr 86:1586-94.
Monsivais P, Perrigue MM, Drewnowski A (2007) Sugars and satiety: does the type of sweetener make a difference. Am J Clin Nutr 86: 116-23.
- x L. Tappy and K-A Lé (2010) Metabolic effects of fructose and the worldwide increase in obesity. Physiol Rev 90: 23-46.
- xi Akhavan T and Anderson GH. (2007). Effects of glucose-to-fructose ratios in solutions on subjective satiety, food intake, and satiety hormones in young men. Am J Clin Nutr 86(5):1354-1363.
Soenen S, Westerp-Plantenga WS (2007) No differences in satiety or energy intake after high-fructose corn syrup, sucrose, or milk preloads. Am J Clin Nutr 86: 1586-94.
Monsivais P, Perrigue MM, Drewnowski A (2007) Sugars and satiety: does the type of sweetener make a difference. Am J Clin Nutr 86: 116-23.
- xii EFSA (2011). "Scientific opinion on the substitution of health claims related to fructose and reduction of postprandial glycaemic responses pursuant to article 13(1) of regulation (EC) No 1924/2006." EFSA Journal 9(6): 2223 [15 pp].
Cozma, A. I., J. L. Sievenpiper, et al. (2012). "Effects of fructose on glycaemic control in diabetes: a systematic review and meta-analysis of controlled feeding trials." Diabetes Care 35(7): 1611-1620.
Ha, V., J. L. Sievenpiper, et al. (2012). "Effects of fructose on blood pressure: a systematic review and meta-analysis of controlled feeding trials." Hypertension 59(4): 787-795.
- xiii Sievenpiper J L, de Souza R J, Mirrahimi A, Me Y, Carleton A J, et al. (2012) Effect of fructose on body weight in controlled feeding trials. Ann. Intern. Med. 1856: 291 – 304.
- xiv V.J. van Buul, L. Tappy and F.J.P.H. Brouns, Nutrition Research Reviews, 2014, Misconceptions about fructose-containing sugars and their role in the obesity epidemic.
- xv WHO (2003). Diet, Nutrition and the prevention of chronic diseases: Technical report 916.