

A critical, updated overview of the role of sugar in our diet

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A healthy diet should meet individual nutritional needs and also incorporate cultural and gastronomic values that make it enjoyable. However, various studies show that nutritional imbalances are the main cause of the premature development of most chronic or degenerative disease that currently affect today's society. Changes that have taken place in the population's lifestyle habits have caused an increase in the prevalence of many chronic illnesses such as obesity, diabetes and metabolic syndrome which have ultimately led to a rise in cardiovascular morbidity. Evolving demographic and lifestyle trends, particularly when it comes to the incorporation of unhealthy diets and the absence of physical activity, are behind all this. Fortunately, despite all this, it is preventable.

Balance, weighting and variety continue to be the cornerstones of a healthy diet. The simplification and categorisation of foods into 'good and bad' is not appropriate, and it would be more accurate to talk about adequate or inadequate diets, according to the variety of foods they contain and the overall calorie intake in relation to physical activity. It's therefore a matter of educating and training people with the aim of encouraging suitable decision making about their diet and nutrition. Moderation should be applied to those foods that may provide excessive calories and/or fat, particularly, if they are poor quality. As far as sugar is concerned, for decades it has been a widely held opinion that it has been responsible for a multitude of ills that humans have to face, and has even been considered a poison. It is a statement which is meaningless from a scientific and critical point of view, and yet, the reality is that this concept has many faithful followers, including in the scientific and health sectors which inevitably creates a great deal of confusion among the general public, who don't know what to believe.

The objective of this paper is to review the most debated aspects of this food. To do this and with the intention of providing greater clarity on various issues, a methodology for studying the literature related to SWOT analysis, detailing the internal issues (Weaknesses, Strengths) and their external issues (Threats and Opportunities) as well as making final recommendations.

Confusing terminology

Carbohydrates are the world's main source of food energy, particularly in developing countries. Carbohydrates should provide between 50 and 55% of total dietary energy and should also be evaluated for their potential energy, their sweetness and their high fibre content¹. The European Food Safety Authority (EFSA) has recently advised that carbohydrate intake should range from 45 to 60% of energy for both adults and healthy children over one year of age².

Carbohydrates present in the diet may be in the form of complex molecules (polymers or polysaccharides) or more simple molecules, commonly referred to as sugars; these can be classified as monomers (monosaccharides) or dimers (disaccharides). Of all the dietary sugars, the most important from a nutritional point of view are: glucose, fructose, galactose, maltose, lactose, sucrose and trehalose.

Sucrose is the sugar par excellence. It consists of one fructose and another of glucose linked via a glycosidic bond. It is extracted industrially from sugar cane and sugar beet. It is also used to sweeten foods, to improve the sour and bitter taste of many of them and to preserve them by increasing osmotic pressure, which inhibits the growth of many microorganisms. In addition to this, there are other less well known functions of sugar such as modifying the melting and freezing points or as a method of naturally colouring food.

There are many terms used to describe sugars and their components: sugar(s), total sugars, total available glucose, free sugars, added sugars, refined sugar(s), simple sugars, intrinsic and extrinsic sugars, non-milk extrinsic sugars and caloric sweeteners.

The existence of numerous terms to define sugars and their indiscriminate use in different countries, substantially hampers the comparison of intake studies that have currently been published. For this very reason, when it comes to quantifying daily sugar consumption, individuals should only take added sugars into consideration, such as sucrose (white and brown sugar), saccharin, aspartame and other substitutes, excluding added sugar as an ingredient in precooked/processed foods.

Sugar and artificial sweetener consumption

In our country the sugar consumption patterns in foods have remained constant during recent years, whilst the consumption of soft drinks has tended to increase. The National Survey of Spanish Dietary Intake (ENIDE, 2010-11) estimates that 20% of calorie intake comes from carbohydrates known as sugars³. This consumption pattern is characterised by the high consumption of processed foods, with changes that affect fat and sugar content marking a notable shift away from the traditional Mediterranean diet⁴.

In this respect, there has been an exponential growth both in energy-rich foods and those that are supposedly low-calorie. Industry pressure plays a pivotal role in these food consumption patterns. The term 'sweetener' refers to those food additives which are able to mimic the sweetness of sugar and which usually provide less energy. Some are natural extracts whilst others are synthetic; in the case of the latter they are also known as artificial sweeteners. The use of non-caloric sweeteners, as a substitute for all or part of the sugar content in food and drink, has experienced its biggest growth over the past 35 years. However, the substitution of sugar with artificial sweeteners represents an insignificant calorie saving with regards to total daily calories, and can general a 'false sense of security' that encourages counterproductive behaviour, such as the excessive consumption of 'low calorie' products and other foods with a high fat content. Following their appearance and in response to the interest in clarifying their beneficial effects (faced with different conditions such as obesity, diabetes, tooth decay, etc.) a multitude of studies have been carried out that, instead of supporting this hypothesis, seem to prove that their use is ineffective.

Therefore, today further research is needed to provide convincing evidence of their long-term effectiveness, as well as the absence of potential negative effects from their continued use. The general population, including many health professionals, often lacks correct knowledge on the particular characteristics of the different sweeteners available in the market, such as advising on and/or choosing a particular sweetener based on its properties⁵.

Not all calories are equal

In addition to the sweet flavour, sugars add a wide variety of favourable qualities to foods, such as their antimicrobial action, taste, smell and textures, as well as viscosity and consistency, which generate satiety. Although the sensation of fullness is greater for proteins, it is higher for sugar and carbohydrates than fats which are also the diet's greatest source of calories. By using the glycaemic index (GI) we can categorise foods based on the postprandial plasma glucose response to sucrose compared with a reference food

(glycaemic index = 100). Sucrose has a medium glycaemic index (≈ 65)⁶.

Studies on food induced thermogenesis showed that energy dissipated in the form of heat is lower following the digestion of fats ($\approx 7\%$), than after digesting carbohydrates ($\approx 12\%$) and proteins ($\approx 22\%$).

Furthermore, isotopic studies have confirmed the absence of significant 'de novo' lipogenesis in high carbohydrate diets. Glucose is stored in the liver and muscles in the form of glycogen. Excess glucose that is not used as immediate source of energy or for the synthesis of glycogen can be converted, via de novo lipogenesis, into fat which is stored in the adipocytes. However, this conversion is energetically costly. Astrup and Raben calculate that 68% more energy is needed to increase body fat by 1kg with carbohydrates than with fats, which confirms that 'it is difficult to increase body fat in subjects of normal body weight, especially through the overconsumption of carbohydrates'.

In contrast to what happens with fat consumption, where a strong correlation has been shown between excessive consumption and the increased risk of becoming overweight and/or obese; the relationship between the consumption of sugars included in foods or added to them and an increase in weight gain is less clear. Various cross-sectional studies have concluded that there is no association, or even that there is a negative association, between sugar consumption and weight gain.

However, there is widespread debate over whether increased sugar consumption via sugary drinks may have a more significant impact on body mass index (BMI). The CARMEN study (Carbohydrate Ratio Management in European National diets) compared the effects on body weight, and the lipid profile of isocaloric diets with high sugar and polysaccharide contents, in relation to diets with a high fat content over a period of 6 months. The results showed that both high sugar and high polysaccharide diets led to a significant reduction in body weight of 1.6 kg and 2.4 kg respectively, when compared with isocaloric diets with a higher fat content⁷.

Studies carried out in different countries, such as Australia and the UK, have observed how in spite of an increase in non-caloric drinks at the expense of sugary drinks, whether they contain sucrose, fructose or high fructose syrup, there has not been an associated reduction in the incidence of obesity. This phenomenon is called the 'Australian paradox' and suggests that there is no association between sugar consumption and the appearance of obesity in the general population⁸.

The importance of sucrose consumption at different times of day, during physical exercise and at different stages of life

Carbohydrates are important for our bodies to function properly and particularly for the brain, as brain

cells need a constant supply of glucose from the blood stream in order to maintain their integrity and functionality (140 g/day). When sucrose is included in the diet, in a balanced manner, it has important properties because it facilitates the rapid supply of glucose to the brain and muscles; it is an essential carbohydrate for cognitive function and physical activity. The consumption of a food or drink containing sucrose is associated with an improvement in mental agility, memory, reaction time, attention and the ability to solve mathematical problems, as well as a reduction in the feeling of tiredness, in young and elderly healthy people, and also in Alzheimer patients.

Sports drinks that contain sugar, minerals and water prevent dehydration, the depletion of glycogen reserves and delay the onset of tiredness and fatigue, as sugar, primarily, provides a direct supply of glucose to muscles and this prolongs exercise time. There is evidence that a high carbohydrate diet and the consumption of carbohydrates before and during exercise is beneficial, due to the increase in concentrations of hepatic glycogen and the maintenance of blood sugar concentrations.

The idea that sucrose may cause addiction in a similar way to 'abused drugs' and should therefore be included among addictive substances, is an opinion of little scientific basis. Available experimental evidence does not support the hypothesis that sugar and other highly palatable foods cause addiction. It is important to note that sugars are part of pleasurable foods and do not cause dependence⁹.

Stereotypes used in relation to sucrose consumption

The natural sugar content of foods cannot be distinguished from added sugar, although it is true that this added sugar mainly provides energy and no other essential nutrients. Furthermore, in the context of diet, sugar is not consumed in isolation and helps to make the diet more varied and appetising, enabling foods to be included that would perhaps otherwise not be consumed, thus contributing indirectly to the intake of other nutrients.

Interested in finding out about the possible relationship between high sugar intake and the decrease in micronutrient intake, we noted that the diet's nutrient density might be influenced by factors such as the high levels of sugar added to food. It seems that this nutritional dilution, which is produced by adding sugar to food, is in general, not very significant and is often offset by the fortification in micronutrients that we usually can find in many sugary products. Following a detailed analysis of the studies published on this subject, it has been found that there is no clear evidence of the hypothetical micronutrient dilution that could occur by adding sugar to the diet.

On the other hand, given that the addition of sugar to the diet doesn't seem to highlight any remarkable advantages from the point of view of micronutrient intake; it seems reasonable to promote the moderate consumption of sugary foods and drinks, to avoid them becoming an extra important energy source.

Sucrose consumption and illnesses

In developed countries tooth decay has ceased to be a problem due to the widespread use of adequate oral hygiene, exposure to fluoride and regular visits to the dentist. Sweet foods should be consumed with main meals (meals, snacks..) and after that the teeth should be brushed.

In relation to the nutritional recommendations, based on the evidence for treating and preventing diabetes, the total amount of carbohydrates consumed is more important than the type. Nowadays diabetics can consume sucrose (sugar) and foods that contain sugar as long as they are eaten as part of a healthy diet and there is appropriate medical supervision. Sugar consumption does not cause the onset of diabetes, however, becoming obese, an unbalanced diet and a lack of exercise have a lot to do with this condition¹⁰.

Although there is a clear relationship between fat intake and weight gain, the role of carbohydrates and, more specifically, the role of sucrose in developing obesity is more controversial. A huge part of this controversy is attributed to the growing demand for sugary drinks and the possible dietary calorie intake associated with their consumption. In spite of the publication of numerous studies and communications on this subject in recent years, there are still many uncertainties about the role that high sugar diets play in the rising incidence and prevalence of obesity. In the dietary treatment of obesity the key objective is to reduce energy intake, whereas macronutrient distribution is less important. Once the desired weight has been reached, diets that limit fats and that are high in carbohydrates are the preferred method to maintain the weight lost. Although low carbohydrate diets may exercise a pathophysiological mechanism in short term weight loss, it is important to point out that the long term effects of continuing to follow these diets are not known.

There is insufficient evidence available on the association between monosaccharide intake (glucose and fructose), as well as disaccharides intake (sucrose) and different types of cancer. In certain cases there is clear evidence of no association.

Consumption recommendations: numerous recommendations and a lack of consensus

Some mathematical models, which are decidedly pessimistic, point to the possibility that we are at a time

when the life expectancy curve, which has always been rising in industrialised countries in recent years, has for the first time reversed its upward trend and is levelling out. If we want our strategy to succeed we should move away from any repressive, prohibitive temptation, that undermines our creativity, lifestyles and the recreational role that food plays in our society. On the other hand, what is clear is that we can't move forward without considering that there are no 'guilty' foods, and as Paracelsus said before me (a long time before me) even poison depends on the amount consumed.

Recommendations by international organisations such as the FAO/WHO recommend that simple carbohydrate consumption (sugars) should be lower than 10% of the diet's energy value, acknowledging that this figure is 'controversial'. Although public health strategies should be developed in order to reduce the excessive consumption of sugary drinks, as part of a healthy lifestyle and the best nutritional advice for the general population could be to eat a balanced and varied diet with foods and nutrients that come from different sources, combining this diet with exercise and physical activity.

The Mediterranean diet is currently the eating pattern that should be promoted or revived amongst the Spanish people. This diet is characterised by its low calorie density, as it is rich in fruit, vegetable, pulses, fish and olive oil, which allows sugar to play a role in energy levels and the palatability of this diet¹¹.

References

1. FAO/WHO (Food and Agriculture Organization / World Health Organization), 1998 Carbohydrates in human nutrition. (FAO Food and Nutrition Paper - 66) Rome: FAO.
2. EFSA Panel on Dietetic Products, Nutrition, and Allergies (NDA); Scientific Opinion on Dietary Reference Values for carbohydrates and dietary fibre. *EFSA Journal* 2010; 8 (3): 1462 [77 pp.]. doi:10.2903/j.efsa.2010.1462. Available online: www.efsa.europa.eu
3. Valoración de la Dieta Española de acuerdo al Panel de Consumo Alimentario. Ministerio de Agricultura Pesca y Alimentación (MAPA)/Fundación Española de la Nutrición (FEN). Madrid: Ministerio de Medio Ambiente y Medio Rural y Marino, 2008. Visitado en: http://www.magrama.gob.es/es/alimentacion/temas/consumo-y-comercializacion-y-distribucion-alimentaria/valoracion_panel_tcm7-7983.pdf
4. Agencia Española de Seguridad Alimentaria y Nutrición (AESAN), 2011. Encuesta Nacional de Ingesta Dietética Española 2011. http://www.aesan.msc.es/AESAN/docs/docs/notas_prensa/Presentacion_ENIDE.pdf
5. Wiebe N, Padwal R, Field C, Marks S, Jacobs R, Tonelli M. A systematic review on the effect of sweeteners on glycemic response and clinically relevant outcomes. *BMC Med* 2011; 9: 123.
6. Atkinson FS, Foster-Powell K, Brand-Miller JC. International Tables of Glycemic Index and Glycemic Load Values: 2008. *Diabetes Care* 2008; 31: 2281-3.
7. Saris WH, Astrup A, Prentice AM, Zunft HJ, Formiguera X, Verboeket-van de Venne WP et al. Randomized controlled trial of changes in dietary carbohydrate/fat ratio and simple vs. complex carbohydrates on body weight and blood lipids: the CARMEN study. The Carbohydrate Ratio Management in European National diets. *J Obes Relat Metab Disord* 2000; 24: 1310-8.
8. Barclay A, Brand-Miller J. The Australian Paradox: A Substantial Decline in Sugars Intake over the Same Timeframe that Overweight and Obesity Have Increased. *Nutrients* 2011; 3: 491-504.
9. Gearhardt Ashley N, Grilo CM, DiLeone RJ, Brownell KD, Potenza MN. Can food be addictive? Public health and policy implications. *Addiction* 2011; 106 (7): 1208-11.
10. American Diabetes Association. Standards of medical care in diabetes—2013. *Diabetes Care* 2013; 36 (Suppl. 1): S11-66.
11. Sociedad Española de Nutrición Comunitaria (SENC). Objetivos nutricionales para la población española. *Rev Esp Nutr Comunitaria* 2011; 17 (4): 178-199.