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Strategies to reduce sugars in food

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The most notable function of sugar in food is its sweet taste, but it also contributes to the flavor and texture profiles; it is involved in Maillard reaction, it affects also several food quality properties, from the other hand, the sugar should not represent more than 10% of the daily caloric intake.This review aims to critically illustrate the strategies which could be applied to reduce sugars and their application in specific food categories.Product reformulation by partially or totally sugar replacement is the most studied strategy in the most part of investigated food categories, such as bakery, chocolate, ice-cream and dessert, jams and jellies.However, a gradually reduction of sugar content could be an interesting approach to use in some specific cases. An innovative strategy to reduce sugar content in food is also illustrated and it involves the use of multisensory integration principles.

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Introduction

The WHO directives state that sugar should not represent more than 10% of the daily caloric intake [1•] and by 2020, EFSA will establish a science-based cut-off value for daily exposure to added sugars from all sources [2]. Replacing sugars seem to reduce both short-term and long-term energy intake, determining loss or reduced gain of body weight [3].

According to Childhood Obesity Plan [4] sugar-sweetened beverages are the biggest calorie contributors. Others are yogurt, breakfast cereals, sweet bakery, dessert, ice-cream, chocolate and sweet confectionery. For each of these, different aspects should be considered such as product reformulation, portion size reduction and shifting purchasing toward lower sugar alternatives [5].

Sugar plays several roles in food, as widely described [6,7,8•,9]. The most notable function of sugar is its sweet taste, but it also contributes to the flavor profile and affects mouthfeel and texture properties as well. It is involved in Maillard reaction, affects freezing point, acts as bulking and preserving agent and promotes lightness among others. Food manufacturers, restaurants, take-aways and cafes are being challenged to reduce overall sugar content across a range of product categories by at least 20% by 2020 [5].

This review aims to critically illustrate the strategies that have been applied to reduce sugars, as well as to present recent advances in sugar reduction approaches and application in specific food categories (Table 1).

Strategies for sugar reduction

In Figure 1, all the strategies already used to reduce sugar in foods are illustrated.

Product reformulation may be an acceptable way of reducing sugar intake by some consumers, even though significant improvements in the sensory quality of sugar reduced products are required [10].

Reformulation could be achieved in two ways: partially or totally sugar replacement or just reducing the sugar amount. Generally, sugar replacement requires using both alternative sweeteners and bulking agents. The latter usually provide energy and their use depends on the food recipe, on the legislative restrictions and on consumer preference.

High-intensity sweeteners (HIS) are typically used in low calorie dairy products, confectionery and chewing gums. Non-digestible carbohydrates including non-starch polysaccharides, resistant starches [11], oligosaccharides (such as fructo-oligosaccharides and inulin) or polyols (such as sorbitol and xylitol) are used as bulking agents [5]. As detailed in Article 7 of EU Regulation 1333/2008, HIS and polyols can be used only in products with no added sugars or where calories have been cut by at least 30%. The combined use of alternative sweeteners and bulking agents is still one of the most used approach to reduce

Table 1

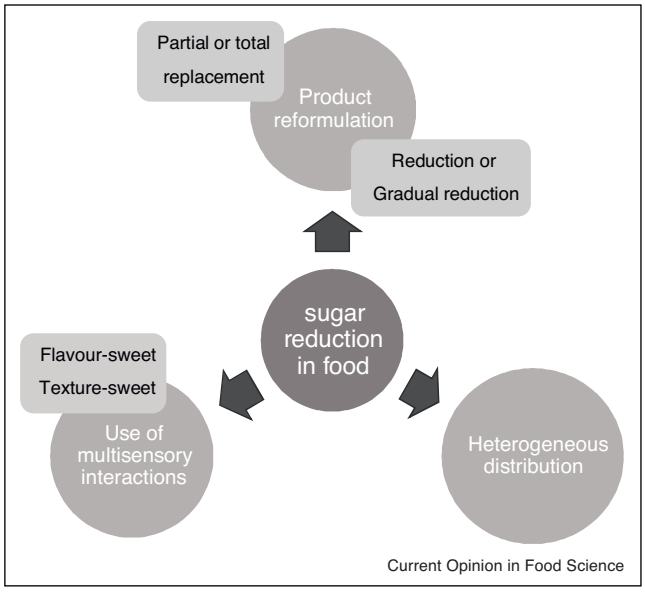
Sugar replacement in specific food categories.

Food category	Sub-category	Alternative sweeteners	Bulking agents
Bakery	Cookies	Sucralose [41], maltitol [43], erythritol [43], stevioside [44]	Inulin [43], maltodextrine [44]
	Muffins and cakes	Rebaudioside A [46–48], sorbitol [49,50], maltitol [49–51], isomalt [49], erythritol [49,51], xylitol [50,51], mannitol [50]	Inulin [46,47], polydextrose [46,47], dietary cocoa fiber [48]
Confectionery	Chocolate	Neotame [24], rebaudioside [24], sap-based sugar [25], stevia [21,22,26–28], sucralose [24], thaumatin [21,26,27]	Inulin [21,22,26–28], polydextrose [21,26,27]
	Dessert	Aspartame [33], neotame [33,37] sucralose [33,37], stevia [33,37]	
	Ice-cream	Erythritol [31,32], fructose [31], honey [32], trehalose [32], xylitol [31]	Inulin [31]
Gel	Jelly	Erythritol [52], sucralose [52]	Oligofructose [52], polydextrose syrup [52]
	Jam/Marmalade	Isomaltulose [55], stevioside [53], sucralose [53], tagatose [54]	Oligofructose [54]

sugar content in food, however for some food, as cereal products and confectionery, energy reduction achieved through sugar replacement is minimal [5].

In some cases, it is possible to reduce sugar content until a critical amount without affecting the final product quality. The impact of reducing both fat and sugar on consumer acceptability in real tasting conditions was evaluated for several commercial foods [12]. The muffins with the 25% reduction of both sugar and fat content were liked as well as the full calorie version. In other foods, product reformulation did not maintain consumer appreciation. In the US, the reformulation has been largely voluntary and initiated by food industry [13]. For instance, both Nestlé and Kellogg reported their plan to reduce sugar in breakfast cereals by a further 10% by the end of 2018. (URL: http://www.nestle.com/csv/individuals-families/sugar-salt-fat; http://www.openforbreakfast.com/en_US/content/nutrition/Kelloggs-progress-on-2020-goals.html). A gradual reduction of sugar content could be an interesting approach to use which is widely used for salt reduction but not yet for sugar [14]. The UK Department of Health recommended to reduce added sugar by 30–40% with no substitution. To date, this approach was documented just for chocolate flavored milk [15]. They found that was possible to cut added sugar of about 13% in one-year by implementing two sequential reductions. The same approach could be easily implemented for beverages. It would be harder for foods in which sugars are not merely sweeteners.

Figure 1



Strategies for sugar reduction in food.

An innovative strategy to reduce sugar content in food is the use of multisensory integration principles. The addition of appropriate aromas enhances the sweet intensity due to cross-modal interactions [16••]. However, that approach was used more for salt reduction than for sugar. A significant enhancement of saltiness and fattiness intensity was found in cheese-like food by adding an appropriate aroma [17]. Taste enhancement could be performed also through texture modification, modifying serum release and breakdown properties and/or non-homogeneous distribution of taste stimuli in the matrix [18]. To date, this approach, apart some researches [19•,20], have been adopted only in simple gel matrices and mainly for salt reduction.

Sugar reduction in chocolate

In addition to sweetness, sugar confers bulk and texture properties to chocolate [21]. Replacing it with a high-intensity sweetener will cause changes in chocolate manufacturing [22] and unwanted modifications in texture properties [23]. When sugar was replaced by