ConCordix®

Sugars & sweeteners

A whitepaper on supplementation

Introduction

Sugar has a remarkable power on humans. It tends to give a feeling of comfort and may reduce pain in infants and children. Milk-sugar present in breastmilk, is one of the first things people are exposed to and embeds a long-lasting memory of security and comfort.[1-3]

Sugar is also known for its preservative effects and improves tastiness (palatability) of many products, which is well recognized by the food industry. For decades sugar has been added to foods and drinks to improve shelf-life and taste. This has led to an enormous increase of unaware sugar consumption (Figure 1). It has been estimated that the global sugar consumption will be more than 35kg per person annually (Figure 2) which is approximately 96g per day.[4-6] This amount is far more than the recommended 25g per day by health institutes [7,8] and has a direct risk potential on health. Today, there is a large body of evidence that confirms that sugar is not that 'sweet' and that overconsumption increases the risk for overweight, diabetes, and dental diseases.[9-11]

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Figure 1: Sugar intake increase since 1700.[12]

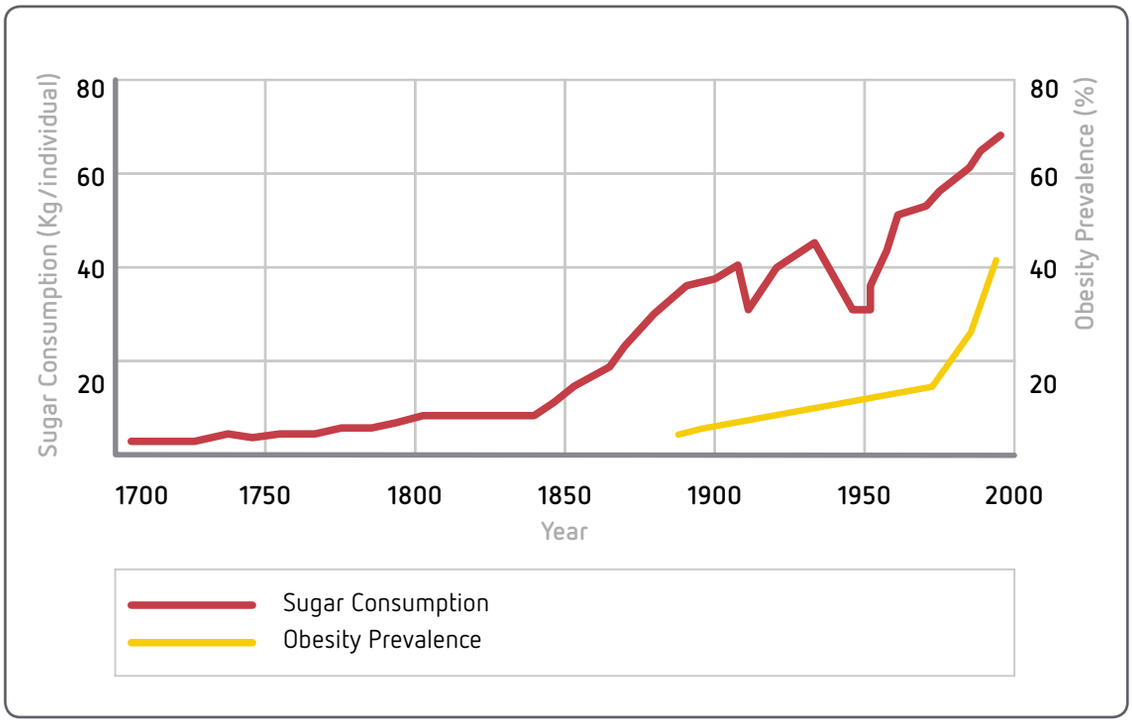
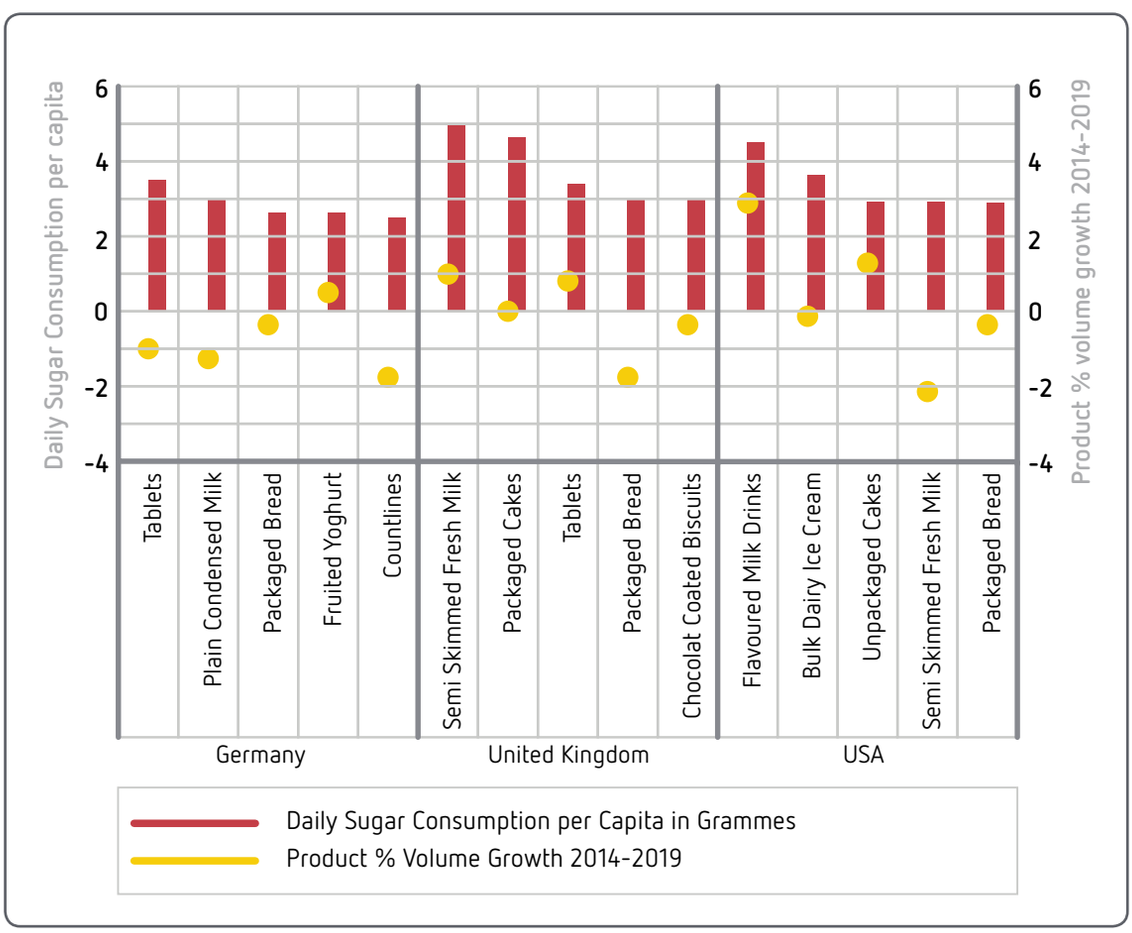


Figure 2: Global sugar consumption per capita per year.[5,6]



2 HEALTH RISKS OF SUGAR OVERCONSUMPTION

Overconsumption of sugar is often due to the unawareness of consumers since most of the added sugar is 'hidden' in foods and drinks. The recommended daily allowance (RDA) of sugar is 130 g/day, which is about 8 teaspoons.13 However, due to the excessive addition of sugar in food products and drinks, the average daily intake increased by 35% the past years.[5,6,14] Researchers demonstrated that overconsumption of sugar significantly increases the risk for various diseases: [7,11,15-18]

- Hypertension
- Cardiomyopathy
- Dyslipidaemia
- Diabetes type II
- Kidney and liver disorders
- Obesity

Importantly to note is that sugar has an effect on the brain similar to tobacco and alcohol addiction.[19,20] Sugar tends to give feelings of comfort because it stimulates the release of dopamine which is also known as a feel-good neurotransmitter produced in the brain. Frequent sugar consumption may change the dopamine receptors causing a need for more sugar. Research demonstrated that the increased need for sugar is one of the main factors of overweight and obesity in every age category. [7,18,19,21]

Because of the growing evidence that sugar overconsumption is negatively associated with health, the World Health Organization (WHO), European Food Safety Association (EFSA) the Food and Drug Administration of the United States of America (USFDA) provided guidelines and recommendations how to reduce sugar intake with 5% to 10% per person per day.[4,13,22] These recommendations urged the food industry to reduce the amount of added sugar to their products and to replace it with healthier alternatives.

The unawareness of consumers that most of the added sugar is 'hidden' in foods and drinks.

3 SUGAR VS SWEETNERS

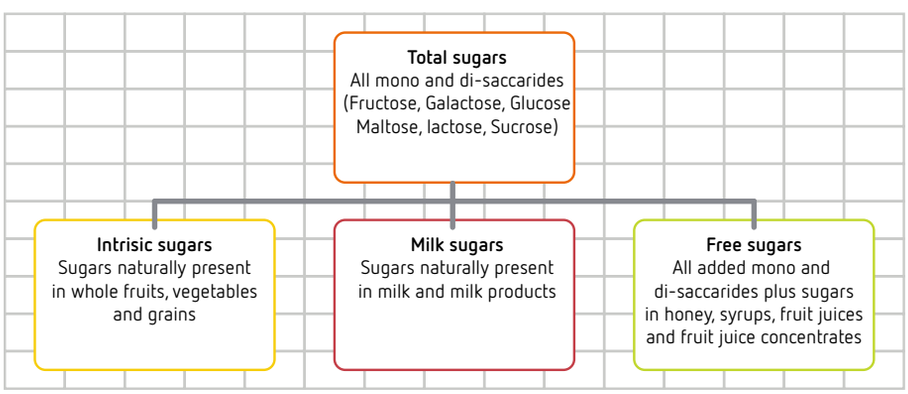
3.1 What is sugar?

White table sugar or sucrose is a carbohydrate found in plant sources. It is a disaccharide formed by glucose and fructose. Sucrose has a glycaemic index (GI) of 65 which means that it rapidly increases blood sugar and insulin levels. [23-25] Frequent fluctuations of insulin levels increase the risk for various diseases including type 2 diabetes mellitus and cardiovascular diseases. [26,27] Sucrose is considered a non-essential nutrient that provides 3.9 kilocalories per gram of energy and added to foods and drinks, it easily increases the calorie amount. [7,15,16]
Besides sucrose there are 2 other main sugar forms commonly added to foods and drinks: [28]

- Fructose (from fruits)
- Glucose (original form of carbohydrates)

Fructose is present in fruits and replaced sucrose for a large part because of its sweetening power, low production costs and lower GI of 19. [28]
Glucose is a simple sugar and the breakdown-product of sucrose and fructose. It is the essence of sugar forms and provides energy particularly for the brain.[25]

Figure 3: Different sugar forms [25]



3.2 What are sweeteners

Sweeteners can replace sucrose as a healthier alternative. There are two types of sweeteners: natural and artificial sweeteners.
1) Natural sweeteners are sugars forms that occur mainly in fruits and vegetables. The chemical structure of natural sweeteners is different compared with sucrose and fructose. Xylitol and sorbitol for instance, are classified as sugar-alcohols, also known as polyols.[29]
These sweeteners are frequently combined to mimic the sweetness of sucrose.[28]
Besides polyols, stevia can also be used as natural sweetener. The sweetness of stevia comes from steviol glycosides which has more than 100 times the sweetness of table sugar.[30]
The most common natural sweeteners are: [29]

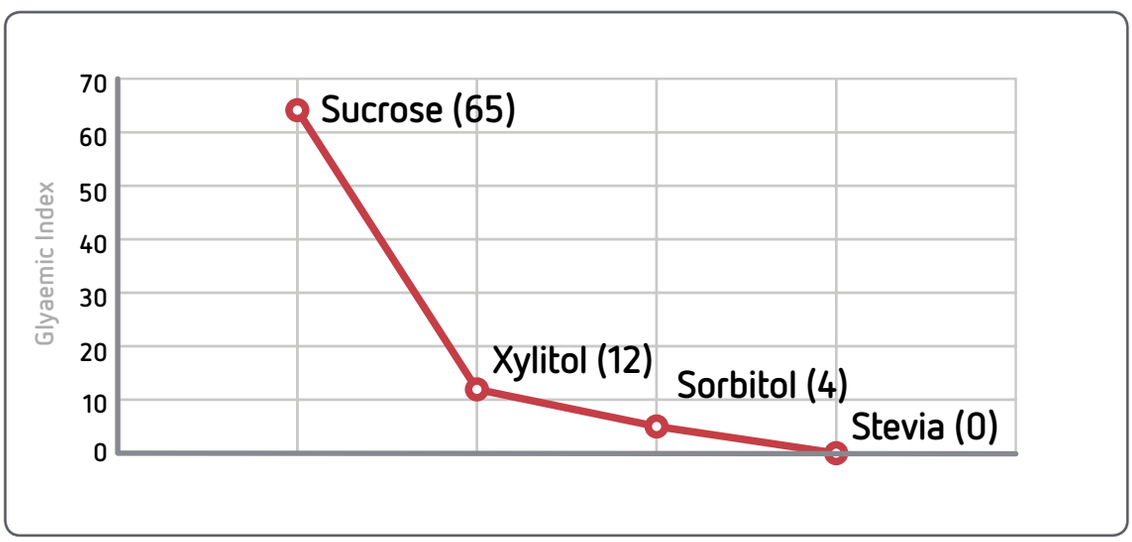
- Xylitol
- Sorbitol
- Stevia
- Mannitol
- Erythritol
- Maltitol

2) Artificial sweeteners are manufactured sweeteners that provide a sweet taste to mimic the taste of sucrose. The most common artificial sweetener is sucralose.

3.3 Differences between sugar and sweeteners

Sweeteners have many health benefits compared with sucrose and the main advantage is the low GI resulting in less insulin fluctuations and thus a reduced risk for type 2 diabetes.[27]

Figure 4: Glycaemic index versus different sweeteners



Natural sweeteners also contribute to:

- Dental health
- Satiety
- Healthy microflora
- Shelf-life of products (antimicrobial)

In contrast, sucrose consumption may:

- Cause tooth decay
- Increase craving for (sweet) foods
- Disrupt the microflora resulting in overgrowth of yeasts and bacteria

3.4 Safety of sweeteners

The safety of sweeteners (natural and artificial) is strictly regulated. Sweeteners permitted for food additives are subjected to a comprehensive examination to determine their safety before being accepted for human use.[31]

National authorities, the EU's Scientific Committee on Food and the Joint Food and Agriculture Organization (FAO)/WHO Expert Committee on Food Additives, provide information about the safety and the maximum permitted doses of approved sweeteners.[31-33]

Some sweeteners may have a laxative effect when consumed in extreme high doses. However, research suggested daily doses below 50g are unlikely to cause undesirable effects.[34,35]

3.5 E-Number

Though E-numbers are sometimes judged as unhealthy or unsafe, these are actually identification codes given by the EU Commission to permit additives used in foods and drinks after a thorough safety investigation.[36]

4 COMMON NATURAL SWEETENERS

4.1 Xylitol

Xylitol naturally occurs in almost all plants and acts as an antioxidant. It is roughly as sweet as sucrose and has a cooling effect in the mouth. Xylitol may prevent the incidence of dental diseases by: [29,37-39]

- Reducing plaque and dental cavities by 80%
- Promoting remineralization of tooth enamel
- Increasing saliva production
- Reducing infections in the mouth

Xylitol has a low GI of 12 and it has no effect on blood glucose and insulin levels which makes it advantageous in products for diabetic patients and in diet products. It also increases satiety that may reduce bingeing.[39]

Moreover, xylitol has prebiotic properties that may help to promote the growth of beneficial bacteria (microflora) in the colon. In particular, it promotes the growth of *bifidobacteri*a and *lactobacilli* that both are significantly related to an improved immunity.[40] It may also act as a preservative against unwanted bacteria and certain yeasts.[41,42]

With respect to safety, a single dose of 50g is well tolerated and does not cause side effects such as bloating or diarrhoea.[34,38,43] The Scientific Committee for food of the EU approved xylitol as a safe additive in food and beverages and gave it the E-number E967.[44]

4.2 Sorbitol

Sorbitol or D-glucitol, naturally occurs in fruits. It is often combined with other sweeteners because it is approximately 40% less sweet than sucrose. It has a GI of 4 which makes it ideal for diabetic food products.[29]

Sorbitol has similar health benefits as xylitol; it has a positive effect on teeth, does not affect blood glucose and insulin levels, and promotes the microflora in the colon.[29,32] A single dose of 50g is well tolerated and does not cause laxative effects.[34] Sorbitol is approved as a sweetener by the Scientific Committee for food of the EU since 1984 and carries the E-number E420.[32]

4.3 Stevia

Stevia or stevioside, is found in the leaves of the stevia plant (Stevia revaudiana Bertoni). It has an intense sweet taste which is almost 200 to 300 times sweeter than sucrose. Stevia has no effect on blood glucose and insulin levels because it has a GI of 0. Stevia may also have antimicrobial properties and might reduce hypertension.[30,45]

The WHO's Joint Experts Committee on Food Additives approved stevia as a sweetener for foods. The EFSA established a recommended daily intake of 4mg/kg body weight.[21,33] Stevia has been approved as a sweetener in food and beverages by the Scientific Committee for food of the EU since 2011 and received the E-number E960.[33,46]

5 ADDED SUGAR IN DIETARY SUPPEMENTS

Dietary supplements are intended to complement the normal diet with functional ingredients that benefit health. Sugar (sucrose or fructose) and flavours are generally added to improve the tastiness (palatability) of the final product, because some of the active nutrients in dietary supplements have a bitter or distinct taste. Some supplements, such as gummies, contain more than 15 grams of sugar. The addition of sugar (sucrose) to dietary supplements seems a contradiction in the health-benefit purpose of dietary supplements.

Children are the most difficult group to pursue to voluntarily consume dietary supplements. Supplements for children are generally designed to mimic all sorts of candy, e.g. gummy forms, and contain often a low amount of active ingredients and added sugars to improve palatability and acceptance.[7,17,18]
Natural sweeteners are a much healthier alternative for table sugar. Sweeteners do not excessively affect blood glucose and insulin levels and do not cause food cravings. They have a similar sweetness as sugar without the negative effects on (dental) health.

The addition of sugar (sucrose) to dietary supplements seems a contradiction in the health-benefit purpose of dietary supplements.

Stevia is one of the natural substitutes for sugar

6 PATENTED CONCORDIX® TECHNOLOGY

Vitux AS uses the innovative ConCordix® technology for the development of dietary supplements.

This patented technology provides customized dietary supplements that combines both water- and oil-based ingredients are combined in one soft chewable tablet. The supplements are sugar-free and sweetened with a combination of xylitol, sorbitol and stevia, and have exceptional taste masking properties.
The uniqueness of the technology lies within the design of the supplements: a gelatin matrix with an emulsion of water and oil. This allows both water-and oil- soluble active ingredients to be embedded in the delivery unit, which is an exceptional feature and offers a wide array of possibilities.
The compliance and acceptance of ConCordix formulated dietary supplements is high across all age groups. The gelatin creates a chewable supplement that is soft and easy to ingest without the necessity of water and enhances bioavailability of active ingredients.

6.1 Unique palatability and sugar-free

The unique palatability and exceptional taste masking properties are possible due to a combination of tasty aromas and sweeteners as xylitol, sorbitol and stevia. Several clinical studies have shown the tastiness of ConCordix formulated supplements in products for nutritional and pharmaceutical purposes.[47,48]
Ibuprofen is known for its bitter taste when a hard tablet is chewed or when a powder formulation is not well dissolved. A group of adults received ibuprofen embedded in ConCordix and were instructed to chew the supplement 3 to 6 times before swallowing. Repeated chewing did not release the bitter taste of ibuprofen and clearly confirmed the unique taste masking.[47,50]

Fish-oil has many health benefits but has a distinct taste and smell. Children who received either a ConCordix formulated fish-oil or placebo supplement for 3 months, reported that the supplements had a comparable taste with that of candy and the acceptance-rate was high.[49]

6.2 Exceptional stability

A well-known challenge during the development of dietary supplements is that active ingredients may have a poor stability. This potentially affects the functional properties and taste of the final product. Supplements formulated with ConCordix have a low water activity, optimized pH and a unique air-tight packaging that provides long-term stability for up to 24 months.[47]
Exceptional stability results in:

- Reduced risk for degradation of ingredients
- Reduced risk for ingredient interactions
- Reduced risk of formation of oxidation products
- Improved shelf life
- Improved taste

7 CONCLUSION

Overconsumption of sugar has considerably increased the past decades, with associated health risks including type 2 diabetes and obesity. This has led to the development of guidelines and recommendations from authorities on a global scale to reduce the amount of sugar in foods and drinks.

A healthy alternative to replace sugars is to use (natural) sweeteners. Sweeteners have a similar taste as sugar without imposing the health benefits of functional ingredients in dietary supplements. They do not affect blood glucose and insulin levels or induce food cravings that can lead to overweight. Sweeteners as xylitol and sorbitol may even protect teeth and support the gut microflora.

In contrast to most other dietary supplements, ConCordix Soft Chews are completely sugar free and only contain natural ingredients.

8 COMPANY PROFILE

Vitux AS is a Norwegian based company that provides dietary supplements for private label manufacturers. Vitux AS offers custom-made and sugar-free products made with the patented, innovative ConCordix technology.
At Vitux AS we try to make health easy. Vitux AS uses state-of-the-art BRC certified manufacturing methods. Only natural ingredients with high quality standards are used to produce turnkey products and customized dietary supplements. We provide a tailor-made solution that fits your needs. A team of experts will assist you to produce a tailor-made product based on your needs. Feel free to get more information about our unique ConCordix chewable soft chews and visit our website: www.concordix.com or contact one of our experts.

Vitux AS would like to thank Dr. Andrew Myers, Sire Fors Grønmo, Magnus Hattrem and Dr. Merel Hazewindus for their contribution to the preparation of this white paper.

References

1. Blass EM, Watt LB. Suckling- and sucrose-induced analgesia in human newborns. Pain. 1999;83(3):611-623.
2. Pepino MY, Mennella JA. Sucrose-induced analgesia is related to sweet preferences in children but not adults. Pain. 2005;119(1-3):210-218.
3. Harrison D, Beggs S, Stevens B. Sucrose for procedural pain management in infants. Pediatrics. 2012;130(5):918-925.
4. World Health Orgainization. Sugar intake for adults and children. WHO guideline, WHO/NMH/NHD/152 2015:49.
5. Euromonitor. 2015; https://blog.euromonitor.com/a-bittersweet-future-for-sugar-consumption-in-packaged-food/. Accessed: 05 September, 2018.
6. Euromonitor. 2017; http://www.euromonitor.com/search?txtSearch=sugar+consumption+europe. Accessed: 05 September, 2018.
7. Fidler Mis N, Braegger C, Bronsky J, et al. Sugar in Infants, Children and Adolescents: A Position Paper of the European Society for Paediatric Gastroenterology, Hepatology and Nutrition Committee on Nutrition. J Pediatr Gastroenterol Nutr. 2017;65(6):681-696.
8. National Health Service. How much sugar is good for me? https://www.nhs.uk/chq/pages/1139.aspx?categoryid=51. Accessed: 05 September, 2018.
9. Avena NM, Rada P, Hoebel BG. Evidence for sugar addiction: behavioral and neurochemical effects of intermittent, excessive sugar intake. Neurosci Biobehav Rev. 2008;32(1):20-39.
10. Westwater ML, Fletcher PC, Ziauddeen H. Sugar addiction: the state of the science. Eur J Nutr. 2016;55 (Suppl 2):55-69.
11. Gordon EL, Ariel-Donges AH, Bauman V, Merlo LJ. What Is the Evidence for "Food Addiction?" A Systematic Review. Nutrients. 2018;10(4).
12. Johnson RJ, Segal MS, Sautin Y, et al. Potential role of sugar (fructose) in the epidemic of hypertension, obesity and the metabolic syndrome, diabetes, kidney disease, and cardiovascular disease. Am J Clin Nutr. 2007;86(4):899-906.
13. USDA. Dietary Reference Intakes (RDI). https://www.nal.usda.gov/fnic/dietary-reference-intakes. Accessed: 05 September, 2018.
14. USDA. Dietary Guidlines for Americans (DGA). https://www.cnpp.usda.gov/2015-2020-dietary-guidelines-americans. Accessed: 05 September, 2018.
15. Bes-Rastrollo M, Sayon-Orea C, Ruiz-Canela M, Martinez-Gonzalez MA. Impact of sugars and sugar taxation on body weight control: A comprehensive literature review. Obesity (Silver Spring). 2016;24(7):1410-1426.
16. Azais-Braesco V, Sluik D, Maillot M, Kok F, Moreno LA. A review of total & added sugar intakes and dietary sources in Europe. Nutr J. 2017;16(1):6.
17. Paglia L. WHO: healthy diet to prevent chronic diseases and caries. Eur J Paediatr Dent. 2018;19(1):5.
18. Moynihan P, Makino Y, Petersen PE, Ogawa H. Implications of WHO Guideline on Sugars for dental health professionals. Community Dent Oral Epidemiol. 2018;46(1):1-7.
19. Garber AK, Lustig RH. Is fast food addictive? Curr Drug Abuse Rev. 2011;4(3):146-162.
20. Beauchamp GK. Why do we like sweet taste: A bitter tale? Physiol Behav. 2016;164(Pt B):432-437.
21. Lohner S, Toews I, Meerpohl JJ. Health outcomes of non-nutritive sweeteners: analysis of the research landscape. Nutr J. 2017;16(1):55.
22. European Food Safety Authority. EFSA to give advise on the intake of sugar added to food. 2017; https://www.efsa.europa.eu/en/press/news/170323-0. Accessed: 05 September, 2018.
23. Grant SM, Wolever TM. Perceived barriers to application of glycaemic index: valid concerns or lost in translation? Nutrients. 2011;3(3):330-340.
24. Wolever TM. Is glycaemic index (GI) a valid measure of carbohydrate quality? Eur J Clin Nutr. 2013;67(5):522-531.
25. Whitney & Rolfes. Understanding Nutrition. 13th ed: Cengage Learning; 2013.
26. Rosset R, Surowska A, Tappy L. Pathogenesis of Cardiovascular and Metabolic Diseases: Are Fructose-Containing Sugars More Involved Than Other Dietary Calories? Curr Hypertens Rep. 2016;18(6):44.
27. Evans CE, Greenwood DC, Threapleton DE, Gale CP, Cleghorn CL, Burley VJ. Glycemic index, glycemic load, and blood pressure: a systematic review and meta-analysis of randomized controlled trials. Am J Clin Nutr. 2017;105(5):1176-1190.
28. Grembecka M. Natural sweeteners in a human diet. Rocz Panstw Zakl Hig. 2015;66(3):195-202.

29. Makinen KK. Sugar alcohol sweeteners as alternatives to sugar with special consideration of xylitol. Med Princ Pract. 2011;20(4):303-320.
30. Chatsudthipong V, Muanprasat C. Stevioside and related compounds: therapeutic benefits beyond sweetness. Pharmacol Ther. 2009;121(1):41-54.
31. Mortensen A. Sweeteners permitted in the European Union: safety aspects. Scandinavian Journal of Food and Nutrition. 2006;50(3):104-116.
32. Food SCo. Opinion on a maltitol syrup not covered by the current specifications. 1999; https://ec.europa.eu/food/sites/food/files/safety/docs/sci-com_scf_out48_en.pdf. Accessed: 05 September, 2018.
33. Authority EFS. Scientific Opinion on the safety of steviol glycosides for the proposed uses as a food additive. EFSA Journal. 2010;4(4):1537.
34. SCF. Sweeteners (opinion expressed on 14 September 1984). Reports of the Scientific Committee on Food (16th series). SCF; 1985. EUR 10210 EN. Luxembourg: Commission of the European Communities. http://ec.europa.eu/comm/food/fs/sc/scf/reports/scf_reports_16.pdf. Accessed: 05 September, 2018.
35. Scientific Committee on Food. Sweeteners (opinion expressed on 11 December 1987 and 10 November 1988). Reports of the Scientific Committee on Food (21st series). SCF; 1989. EUR 11617 EN. Luxembourg: Commission of the European Communities.
36. European Commission. Food Improvment Agents. https://ec.europa.eu/food/safety/food_improvement_agents/additives_en. Accessed: 05 September, 2018.
37. Ur-Rehman S, Mushtaq Z, Zahoor T, Jamil A, Murtaza MA. Xylitol: a review on bioproduction, application, health benefits, and related safety issues. Crit Rev Food Sci Nutr. 2015;55(11):1514-1528.
38. Makinen KK. Gastrointestinal Disturbances Associated with the Consumption of Sugar Alcohols with Special Consideration of Xylitol: Scientific Review and Instructions for Dentists and Other Health-Care Professionals. Int J Dent. 2016;2016:5967907.
39. Vasilescu RI, AM. Mihai, A. Carniciu, S. Sweeteners and metabolic diseases: xylitol as a new player. ProcRomAcad. 2011(B2):125-128.
40. Lugani YS, B. XYLITOL, AN EMERGING PREBIOTIC: A REVIEW. International Journal of Applied Pharmaceutical and Biological Research. 2017;2(2):67-73.
41. Amaral LF, Camilo NS, Pereda MD, Levy CE, Moriel P, Mazzola PG. Evaluation of antimicrobial effectiveness of C-8 xylitol monoester as an alternative preservative for cosmetic products. Int J Cosmet Sci. 2011;33(5):391-397.
42. Ferreira AS, Silva-Paes-Leme AF, Raposo NR, da Silva SS. By passing microbial resistance: xylitol controls microorganisms growth by means of its anti-adherence property. Curr Pharm Biotechnol. 2015;16(1):35-42.
43. Payne AN, Chassard C, Lacroix C. Gut microbial adaptation to dietary consumption of fructose, artificial sweeteners and sugar alcohols: implications for host-microbe interactions contributing to obesity. Obes Rev. 2012;13(9):799-809.
44. Regulation European Commission. No 1131/2011 of 11 November 2011 amending Annex II to Regulation (EC) No 1333/2008 of the European Parliament and of the Council with regard to steviol glycosides. Off J Eur Union L. 2011;295/205.
45. Chattopadhyay S, Raychaudhuri U, Chakraborty R. Artificial sweeteners - a review. J Food Sci Technol. 2014;51(4):611-621.
46. Regulation European Commission. No 1131/2011 of 11 November 2011 amending Annex II to Regulation (EC) No 1333/2008 of the European Parliament and of the Council with regard to steviol glycosides Official Journal of the European Union. 2011;54.
47. Dille MJ, Hattrem MN, Draget KI. Soft, chewable gelatin-based pharmaceutical oral formulations: a technical approach. Pharm Dev Technol. 2017:1-8.
48. Consultancy AMR. Qualitative research Turkey Concordix Concept Research. 2014.
49. Danielsson P MC. Study STOP 8 OM3: evaluation of compliance of omega-3 oil intake or placebo in gel-tablets. Karolinska Institu;2015.
50. Hattrem MN, Dille MJ, Seternes T, Ege T, Draget KI. The Relative Bioavailability of Ibuprofen After Administration With a Novel Soft Chewable Drug Formulation. Clin Pharmacol Drug Dev. 2017.