

# Non-nutritive sweeteners

*A brief overview of their use in foods, potential health effects, recommendations and policies*



EU Platform on Diet,  
Physical Activity and Health

**02 June 2016**

**DG Joint Research Centre**

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## **Scope**

- ❑ Brief overview: use of sweeteners in foods and beverages, implications for public health & existing policy recommendations

## **Structure**

- ❑ *Terminology*
- ❑ *Types of sweeteners*
- ❑ *Application in food*
- ❑ *Health implications*
- ❑ *Policies*

# Terminology

- ❑ Dir. 94/35/EC<sup>1</sup> on sweeteners for use in foodstuffs
  - *"refers to sweeteners as food additives which are used to impart a sweet taste to foodstuffs and as table top sweeteners*
- ❑ WHO Nutrient Profile model<sup>19</sup>:
  - *Non-sugar sweeteners: "food additives (other than a mono- or disaccharide sugar) which impart a sweet taste to food."*
- ❑ Reg. (EC) No 1333/2008<sup>2</sup> on food additives specifies conditions for an additive to be classified as a sweetener:
  - *"replacing sugars for the production of energy-reduced food, non-cariogenic food or food with no added sugars" or*
  - *"replacing sugars where this permits an increase in the shelf life of the food" or*
  - *"producing food intended for particular nutritional uses"*

- ❑ Nutritive sweeteners (NS)

- *"caloric sweeteners"*, provide energy in the form of carbohydrates (e.g. sugar)

- ❑ Non-nutritive sweeteners (NNS)

- Zero or low-calorie alternatives. Terminology variable: low caloric sweeteners, hypo caloric sweeteners, low energy sweeteners, high intensity sweeteners, intense sweeteners etc.

### ***"Sugar replacers"***

- ❑ Replacing the sweet taste of sugar: Intense sweeteners

- substances with an intense sweet taste and with no energy value that are used to replace sugars in foods (e.g. acesulfame K; aspartame)<sup>3</sup>

- ❑ Replacing mainly other technological properties of sugar: Polyols

- Also "sugar alcohols" (e.g. xylitol, sorbitol), often used as bulking agents

# Labelling

## ❑ Table top sweeteners:

- Exempted from mandatory nutrition declaration (Reg. 1169/2011)

## ❑ Sweeteners authorised as additives in Reg. (EC) 1333/2008

- Name of food should be accompanied by *"with sweetener"* statement or *"with sugar and sweetener"*.
- Aspartame containing foods should state *"contains aspartame (a source of phenylalanine)"*.  
If designated only by E-number or not present fully written in ingredient list (in that case: *"contains a source of phenylalanine"*)
- More than 10% polyols: *"excessive consumption may produce laxative effects"*

# Types & applications

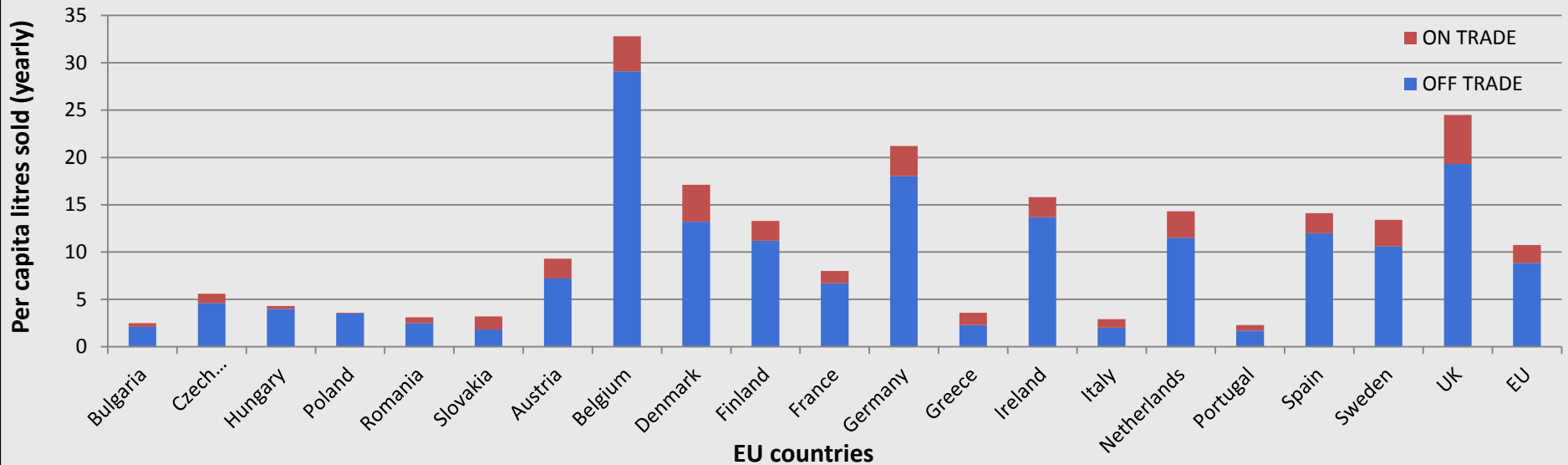
Sweetener	Energy (Kcal/g)	Sweetness Index
<b>Sucrose</b>	<b>4,0</b>	<b>1</b>
Acesulfame K (E950)	0	130-200
Aspartame (E951)	4,0	200
Advantame (E969)	0	20000
Cyclamates (E952)	0	30-50
Neohesperidine DC (E959)	0	1500-1800
Neotame (E961)	0	7000-13000
Saccharin (E954)	0	300-500
Salt of Aspartame-Acesulfame (E962)	3,0	350
Steviol glycosides (E960)	0	480
Sucralose (E955)	0	600
Thaumatococin (E957)	4,1	2000-3000
Polyols (Sorbitol, Mannitol, Isomalt, Maltitol, Lactitol, Xylitol, Erythritol (E420, 421, 422, 953, 965 966, 967, 968))	2,4 (0 Erythritol)	0,4-2

## Applications

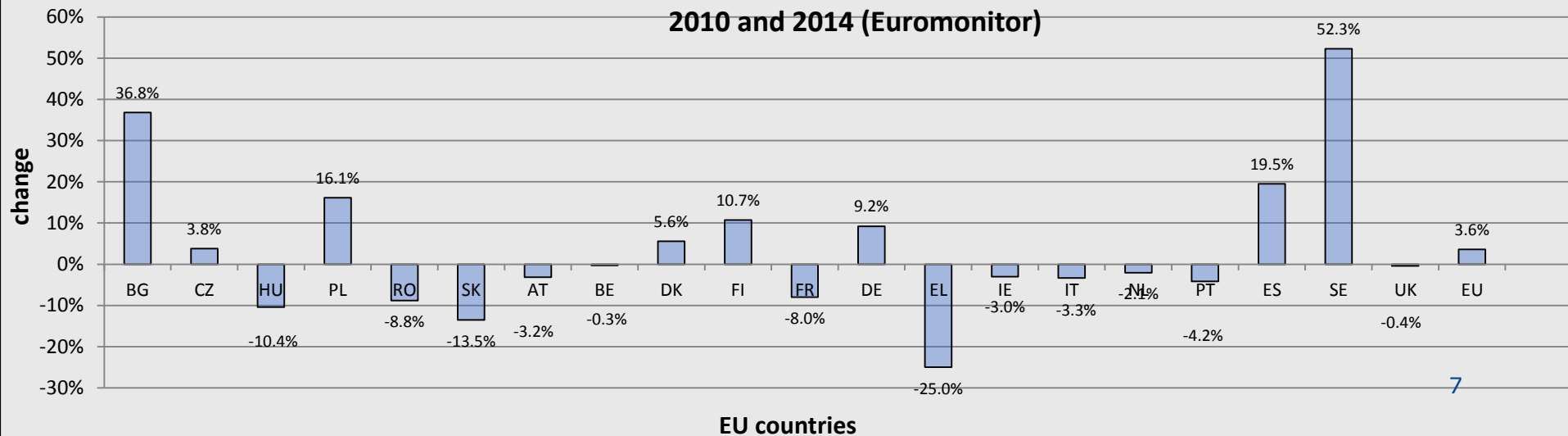
- Soft drinks, carbonated or non-carbonated, teas, flavoured waters
- Dairy drinks (milk & yoghurt based)
- Fruit juices and drinks
- Bakeries, candies
- Jams, jellies, gums
- Table-top
- Others: chocolate drinks, energy drinks



## Per Capita (on- trade & off-trade) sales of low-calorie cola carbonates in 2014 (Euromonitor)



## Change of per capita sales (on-trade & off-trade volumes) of low calorie cola carbonates between 2010 and 2014 (Euromonitor)



# *Approach of this overview*

- ❑ Focus: NNS and diet related NCDs
- ❑ Authoritative sources:
  - Organisations, authorities, e.g. WHO, EFSA, FDA, AHA
- ❑ Peer-reviewed literature included where needed information could not be obtained from the above sources, e.g. very recent developments, scarcity of data.
  - We did not perform a systematic analysis of the literature
  - Included systematic reviews (2010 onwards)
- ❑ Safety of NNS extensively reviewed – not within scope of presentation



# *Weight Management*

- ❑ Effects of NNS when replacing sugar
  - Energy intake, weight management
  - EFSA, American Heart Association (AHA) & American Diabetes Association (ADA), Scientific Advisory committee on Nutrition UK (SACN), ANSES (FR)
  - Few recent systematic reviews

# Weight Management

Source	Statement/Opinion/Finding
EFSA health-claim related opinion (2011) <sup>4</sup>	<ul style="list-style-type: none"> <li>- no cause and effect relationship between total sugar intake &amp; body weight gain</li> <li>- <b><u>no cause and effect relationships</u></b> between consumption of foods/beverages with sugars replaced by sweeteners <b><u>for maintenance/achievement of normal body weight</u></b></li> </ul>
AHA & ADA (2012) <sup>5</sup>	<ul style="list-style-type: none"> <li>- <b><u>Insufficient data</u></b> to conclude if replacing NS with NNS reduces added sugars, or carbohydrate intakes, <b><u>benefits appetite, energy balance, or body weight.</u></b></li> <li>- some data suggests that <b><u>NNS can be used in a structured diet to replace added sugars</u></b>; that this may result <b><u>in modest reduction of energy intake &amp; subsequently weight loss.</u></b></li> <li>- <b><u>when used judiciously,</u></b> (and with no energy compensation), <b><u>NNS could help reduce added sugar intake,</u></b> resulting in decreased energy intake and weight control or loss.</li> </ul>
ANSES (2015) <sup>21</sup>	<ul style="list-style-type: none"> <li>- Use of intense sweetener as sugar substitutes results in a decrease in <b><u>short term energy intake due to their low calorie content and the lack of compensation.</u></b></li> <li>- However, the <b><u>available data cover insufficient time periods to guarantee the maintenance of this effect over the medium or long term.</u></b></li> <li>- <b><u>no conclusions</u></b> can be drawn as to the <b><u>long term effect</u></b> of replacing caloric sweeteners with ISs on the <b><u>weight of regular adult consumers</u></b> of sweet products. <b><u>Similar</u></b> for <b><u>children and adolescents.</u></b></li> </ul>
SACN UK, Public Health England (2015) <sup>6</sup>	<ul style="list-style-type: none"> <li>- RCTs in adults indicate that increasing or decreasing the percentage of total dietary energy as sugars when consuming an ad libitum diet leads to a corresponding increase or decrease in energy intake.</li> <li>- RCTs in children &amp; adolescents indicate <b><u>consumption of SSBs, as compared with non-calorically sweetened beverages, results in greater weight gain &amp; BMI increase.</u></b></li> <li>- <b><u>replacing foods and drinks sweetened with sugars with those sweetened with no/low calorie sweeteners can be useful in the management of energy intake and weight</u></b></li> </ul>

# Weight Management

Source	Statement/Opinion/Finding
Am J Clin Nutr (2014) <sup>7</sup>	<ul style="list-style-type: none"> <li>- observational studies show a small positive association of NNS intake with BMI and no association with body weight or fat mass</li> <li>- RCTs indicate that replacing <b><u>caloric dense alternatives with NNS</u></b> results in a <b><u>modest reduction of body weight, BMI, fat mass and waist circumference &amp; may be a useful dietary tool</u></b></li> </ul>
Int J Obes (2016) <sup>8</sup>	<ul style="list-style-type: none"> <li>- Majority of evidence from human RCTs indicate that <b><u>NNS do not increase energy intake or body weight</u></b>, compared with caloric or non-caloric controls</li> <li>- Balance of evidence indicates that <b><u>using NNS as a sugar replacer</u></b>, in both children and adults, <b><u>leads to reduced energy intake and body weight</u></b></li> </ul>

# *Metabolic parameters*

## □ Effects of NNS when replacing sugar:

- Post prandial glucose levels, normal blood glucose concentration maintenance, Type 2 Diabetes
- EFSA, ANSES, American Heart Association (AHA) & American Diabetes Association (ADA)
- Some recent systematic reviews

# Metabolic parameters

Source	Statement/Opinion/Finding
EFSA health-claim related opinion (2011) <sup>4</sup>	- <b><u>no cause and effect relationship</u></b> between the consumption of foods and beverages in which sugars have been replaced by intense sweeteners and <b><u>maintenance of normal blood glucose concentrations</u></b> .
EFSA health-claim related opinion (2011) <sup>9</sup>	- <b><u>“cause and effect relationship has been established</u></b> between the consumption of foods/drinks containing xylitol, sorbitol, mannitol, maltitol, lactitol, isomalt, erythritol, D-tagatose, isomaltulose, sucralose or polydextrose instead of sugar and <b><u>reduction in post-prandial blood glucose responses</u></b> (without disproportionally increasing post-prandial insulinaemic responses) as compared to sugar-containing foods/drinks” - <b><u>the above claim also applies to intense sweeteners</u></b>
AHA & ADA (2012) <sup>5</sup>	- <b><u>Insufficient data</u></b> to conclude if <i>“displacing caloric sweeteners with NNS in beverages and foods [...] benefit [...] <u>cardiometabolic risk factors</u>”</i> - <b><u>when used judiciously</u></b> , (and with no energy compensation), <b><u>NNS could help reduce added sugar intake</u></b> , resulting in <b><u>decreased energy intake and weight control or loss</u></b> , and promoting <b><u>beneficial effects on related metabolic parameters</u></b>
ANSES Opinion (2015) <sup>21</sup>	- consumption has <b><u>no effect on short and medium term blood glucose parameters in healthy subjects or in diabetics</u></b> . - Long term epidemiological studies on the <b><u>risk of developing T2D show heterogeneous results, but the most robust studies do not report any effects</u></b> .
In J Pediatr Obes (2010) <sup>10</sup>	- <b><u>Lack of strong clinical evidence</u></b> to support <b><u>causality regarding artificial sweetener use and metabolic health effects in youth</u></b> (<18 yrs.), both adverse and harmful.

# Metabolic parameters

Source	Statement/Opinion/Finding
BMC Medicine (2011) <sup>11</sup>	<ul style="list-style-type: none"> <li>- <u>little high quality research</u> has been done to identify potential harms and benefits of NNS</li> <li>- Since even small weight reductions can prevent chronic disease, <b><u>NNS could play an important role</u></b> in public health strategies to <b><u>reduce and manage obesity-related comorbidities</u></b></li> <li>- <b><u>need for long-term, adequately powered RCTS</u></b> to confirm this hypothesis</li> </ul>
Br J Nutr (2014) <sup>12</sup>	<ul style="list-style-type: none"> <li>- comparing the positive <b><u>association between SSBs and T2D</u></b>, there is a <i>“<b><u>less consistent trend for artificially sweetened soft drinks</u></b> and together with the effect of adjusting for BMI, this may indicate an alternative explanation for the observed association, such as lifestyle factors or reverse causality”</i></li> <li>- <i>“Recommendations to limit the consumption of sugar-sweetened soft drinks by promoting the supply of sugar-free alternatives depend, in part, on the nature of the association with obesity and whether alternatives to artificially sweetened soft drinks also have negative consequences”</i></li> </ul>
Eur J Prev Cardiol (2015) <sup>13</sup>	<ul style="list-style-type: none"> <li>- RCTs suggest that <b><u>steviol glycosides may generate reductions in blood pressure and fasting blood glucose</u></b>. <i>The sizes of the effects are small, and the substantial heterogeneity limits the robustness of any conclusions”</i></li> <li>- RCTs vary in reporting quality and design, inadequate sample sizes, while participants have high CVD risk. Further RCTs are required.</li> </ul>
Br Med J (2015) <sup>14</sup>	<ul style="list-style-type: none"> <li>- Habitual consumption of sugar sweetened beverages associated with a greater incidence of Type 2 diabetes</li> <li>- <b><u>Artificially sweetened beverages</u></b> also showed a <b><u>positive association with incidence of Type 2 diabetes</u></b>. However quality of evidence is limited by potential bias and heterogeneity by study design.</li> <li>- Findings support that <b><u>artificial sweetened beverages are unlikely to be health alternatives to SSBs for T2D prevention</u></b>.</li> </ul>
Pediatrics (2016) <sup>20</sup>	<ul style="list-style-type: none"> <li>- <b><u>Limited and inconsistent evidence of the long-term metabolic effects of NNS exposure during gestation, infancy and childhood</u></b>.</li> <li>- Further research is need to inform recommendations</li> </ul>

# Dental health

## □ Effects of NNS when replacing sugar for dental health

### ➤ EFSA, SACN

Source	Statement/Opinion/Finding on DENTAL HEALTH
EFSA health-claim related opinion (2011) <sup>9</sup>	<ul style="list-style-type: none"> <li>- established cause and effect relationship <i>“between consumption of sugar-containing foods/drinks at an exposure frequency of four times daily or more and an increased tooth demineralisation”</i></li> <li>- <i>“the <u>consumption of foods/drinks containing xylitol, sorbitol, mannitol, maltitol, lactitol, isomalt, erythritol, D-tagatose, isomaltulose, sucralose or polydextrose</u>, instead of sugar in sugar-containing foods/drinks, <u>may maintain tooth mineralisation compared with sugar-containing foods</u>, provided that such foods/drinks do not lead to dental erosion.”</i></li> <li>- the above claim <u>also applies to intense sweeteners</u></li> </ul>
SACN UK (2015) <sup>6</sup>	<ul style="list-style-type: none"> <li>- <u>moderate evidence of an effect of polyols on dental caries</u></li> <li>- <u>use of chewing gum containing polyols</u>, compared to not using a chewing gum, is <u>beneficial to oral health</u> (mixed and permanent dentition)</li> <li>- <u>insufficient/inconsistent evidence</u> on effects of polyols on <u>deciduous dentition, confectionary containing polyols in mixed and permanent dentition</u></li> </ul>

# Intestinal health

## □ Effects of NNS in intestinal health

Source	Statement/Opinion/Finding on INTESTINAL HEALTH
SACN UK (2015) <sup>6</sup>	<ul style="list-style-type: none"> <li>- <b>Limited evidence of effect of polyols on faecal weight.</b> Effect could be biologically relevant, and higher consumption of polyols can be potentially beneficial to health; however effects likely to be limited by low levels of polyols in the diet.</li> <li>- Limited evidence of effects on <u>faecal mass</u></li> <li>- Limited evidence of no effects <u>on faecal pH, faecal SCFA or faecal bacterial content</u></li> <li>- <u>insufficient/inconsistent evidence</u> on effects of polyols on: <u>intestinal transit time, constipation</u></li> </ul>
J Neurogastroenterol Motil (2016) <sup>15</sup>	<ul style="list-style-type: none"> <li>- <u>general lack of evidence</u>, especially human studies; some data suggest that artificial sweeteners can affect <u>GI tract motility and gut microbiome composition</u>.</li> <li>- further research required to assess the potential effects of artificial sweeteners on gastrointestinal health.</li> </ul>



# Policies – School foods

Source	School food policies examples
IoM (2007) <sup>16</sup>	No recommendations made for NNS for US school food policies, due to limited and inconsistent evidence
EC/JRC (2014) <sup>17</sup>	<ul style="list-style-type: none"> <li>- Austria: No artificial sweeteners in soft drinks or other drinks</li> <li>- Greece: Artificial sweeteners are not allowed in junior high school and high school canteens for some beverages (chamomile, tea, sage)</li> <li>- Hungary: no artificial sweetened soft drinks for school children &lt;6 yrs.</li> <li>- Latvia: Soft drinks with food additives (incl. sweeteners) not allowed, except for lunch</li> <li>- Spain: Foods should be free from artificial sweeteners.</li> <li>- UK: <ul style="list-style-type: none"> <li>- Scotland: sugar-free soft drinks, including low or no added sugar versions not allowed</li> <li>- Wales: fizzy soft drinks including diet or sugar free versions in primary and secondary schools are not allowed</li> <li>- Northern Ireland: artificial sweeteners permitted for combination drinks (water, milk, unsweetened fruit or veggie juice, yoghurt or milk drinks)</li> </ul> </li> </ul>
Lancet Diabet Endocrinol (2016) <sup>3</sup>	Australia, Brasil: include NNS beverages in school food policy restrictions (due to minimal nutritional value)

## *Other policies*

### ☐ France

- Sugar tax on SSBs includes NNS alternatives (apparently due to no specific category in custom codifications<sup>18</sup>)

### ☐ Finland

- Sugar tax on SSBs includes sweetener-based soft drinks and waters<sup>18</sup>

### ☐ UK

- Change4Life campaign, Smart-Swaps: recommends swapping SSBs with water, drinks with no added sugars or drinks containing low-calorie sweeteners<sup>3</sup>

### ☐ WHO Nutrient Profile model (2015)<sup>19</sup>

- Certain beverage categories not to be marketed to children if they contain non-sugar sweeteners (0% w/w)
- Other beverages (cola, lemonade, other soft drinks, flavoured waters)
- Milk drinks

## *Conclusions*

- ❑ No readily available and comprehensive data on NNS intakes in EU
- ❑ Lack of conclusive evidence from literature on benefits or drawbacks of replacing sugars with NNS
- ❑ Some recommendations or policies that deal specifically with NNS

***Thank you for your attention***



## References

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