The four factors involved in the dental caries

The most important factors of caries prevention

Epidemiological observations
- Tristan da Cunha
- During the Last War

Interventional studies
- The Vipeholm-study
- The Hopewood House-study

The most important results of diet-studies: there were no caries
- without contact between substrate and teeth surface
- without substrate
- without microorganisms
- caries increase correlated with the frequency of eating not with the volume of eaten cariogenic food

In both United States and Europe sucrose provides about 90% of the total carbohydrate consumed.

Sucrose is one of the most dangerous sugars, because the bacteria living in the plaque change sucrose to acids.
- Most of us enjoy eating sweet-tasting foods.
- The obesity is the major nutritional problem in developed countries.

Cariogenicity Acidogenicity

The pH changes in plaque following application of different carbohydrate solutions

Novel carbohydrates – glucose polymers
- glucose syrup
- maltodextrin

Use of glucose polymers
- soft drinks
- infant food and drinks
- desserts
- energy supplement
- to increase energy content
- tasteless
- odorless
- Cariogenicity of glucose polymers

Rinse with 10% maltodextrin solution
- 2 min. later pH dropped to 5.6
S. Mutans + amylase

Oligosaccharides
- resistant to digestion, pass to large bowel
- encourage the growth of bifidobacteria

Oligosaccharides
- isomalt-o-oligosaccharides (IMO)
- S. mutans can metabolize but pH never lower than 5.0
  - inhibit the glucan synthesis
- fructo-oligosaccharides (FOS)
  - used in foods mainly in Japan
  - as cariogenic as fructose

Sugar in medicines - ‘medication caries’
- today sorbitol is most widely used

In humans there are four basic taste modalities
- sour - it is H-ion dependent
- salt - caused by salts of the group I metals (both anions and cations)
  - bitter
  - sweet

We know several sweet tasting chemical compounds. For example mono- and disaccharides, alcohols, D-isomers of amino acids, molecules with benzene ring etc.

We need sugar substitutes because it seems difficult to change dietary habits of people.

The noncaloric sweetening agents have not only caries decreasing effect, they are effective against obesity too.

There are the concept of relative sweetness
- The sweetness of sucrose is by definition 1.

The sweetness cannot be measured quantitatively. Sweet taste depends upon concentration of sweeteners, temperature, pH, sensitivity of the taster.
- Relative sweetenings of various sweeteners

Sugar substitutes
- Sugar alcohols are found in many foods labeled as „sugar free”, including hard candies, cookies, chewing gums, soft drinks and throat lozenges.
- They are substituted for other types of sugar
Sugar alcohols
- Sorbitol
- Mannitol
- Maltitol
- Xylitol

Hydrogenated starch hydrolysate
- Lycasin°

Health benefits and concerns of sugar alcohols
- Diarrhea - they are absorbed slowly and only partially, through osmosis hold water into intestines
- not recommended for children under 3 years
- Ear infection – xylitol interferes with the growth of some bacteria
- Dental caries

The chemical features of sugar alcohols
- The absence of reducing carbonyl group
  - less reactivity - less plaque growth
- „Extra hydrogen atom”
  - modification of metabolites – which are less harmful
- Complex formation
  - with Ca – contribute to the remineralisation
- Protein stabilizing effect
  - protect proteins in aqueous solutions against denaturation

Dental aspects of sugar alcohols
- fermentation
- pH change in the plaque
- formation of extracellular polysaccharides
- cariogenicity
- bacterial adaptation
- price

Sugar substitutes Sorbitol E420
- Alcohol form of sucrose, Six carbon sugar alcohol
- Occurs naturally in fruits and vegetables
- Manufactured from corn syrup
- One gram of sorbitol yields 2.4 calories.
- Relative sweetness 0.5
- Only about 70% of orally ingested sorbitol is absorbed. Sorbitol may cause gastric upset in large doses. It acts as a laxative because of osmotic transfer of water into the bowel.
  - 50g/day

Dental aspects of Sorbitol
- fermentation - endproduct: ethanol, formate and lactic acid
- pH change in the plaque
- formation of extracellular polysaccharides
- cariogenicity
- bacterial adaptation

Sugar substitutes Mannitol E 421
- Alcohol form of mannose
- Six carbon polyl
- Occurs naturally in pineapples, olives, sweet potatoes and carrots
- Relative sweetness 0.7

Sugar substitutes Maltitol
- 12 carbon polyl
- Produced by hydrogenation of maltose
- S. Mutans - slow metabolisation

Sugar substitutes Xylitol also called „wood sugar” E 967
- Alcohol form of xylose, five carbon sugar alcohol
- Occurs naturally in fruits and vegetables, cereals
- Extracted from birch wood chips
- Relative sweetness 1
- More than 0.5g/kg body can cause osmotic diarrhea in unadapted subjects
- 50-70 g/day normal amount in adapted persons
- Dentally effective amount is 6-12 g/day

Metabolism of Xylitol in the Body
- slow passive absorption – then enter in the hepatic metabolic system
- in the distal part of intestinal tract will be broken down by gut bacteria

Physiologic Advantages of Xylitol
- Pleasant taste and sweetness equals that of sucrose
- With correct dosage, carbohydrate tolerance is increased
- Small xylitol doses stabilize the metabolic situation in unstable diabetics
- Xylitol has antiketogenic properties
- Xylitol is non- and anticariogenic

The History of Xylitol
- Around 1890 was discovered
- 1943 Naturally occurring xylitol was found
- 1962 Xylitol is a natural physiological carbohydrate
- 1970 The odontological importance of Xylitol was discovered
- 1975 The clinical conclusions of Turku studies were published
- The first commercial xylitol chewing gum on the market
• 1983 WHO-FAO announced xylitol a safe sweetener for foods

Dental aspects of Xylitol
• fermentation
• pH change in the plaque
• formation of extracellular polysaccharides
• cariogenicity
• bacterial adaptation
• price

Turku- Study (Finland)
• in the xylitol-group was
  - about 90% less Caries
  - less plaque
  - less S. Mutans number

Ylivieska Study
Belize Study
Estland Study

Results of Studies
• Reduction of bacterial adhesion
• Positive effect on saliva and buffer capacity
• Mother-Child effect
• Remineralisation
• Long-term caries prevention

Examples of current uses of Xylitol
• In infusion therapy of post- operative, burn and shock patients
• In the diet of diabetic patients
• Sweetener in products aimed to improve dental health
• chewing gums, dentifrices, mouthwashes, lozenges

Xylitol
• Xylitol is not cariogenic
• Reduce the amount of dental plaque
• Better preventive effect than other sugar-alcohols
• Mother-child effect: reduce the transmission of bacteria – caries-preventive effect

Benefits of the Xylitol
• sweet taste
• sweetness is similar to sugar
• in Diabetics sugar-tolerance will be increased
• small amount of Xylitol can stabilize metabolic status in Diabetics
• Xylitol is anti-cariogenic

Sugar substitutes

Lycasin® Hydrogenated starch hydrolysate
Mixture of mono- di- tri- and tetrasaccharides

High-fructose corn syrup (HFCS)
• Produced from hydrolyzed corn starch
• Cariogenicity with 20-25% lower than that of sucrose

New Oligosaccharides
• Isomalto-Oligosaccharide (IMO)
• Fructo-Oligosaccharide
• not metabolized in the Human body
• S. Mutans

The pH changes in plaque following application of different carbohydrate solutions

Noncaloric sweetening agents
In order to be an acceptable sweetener of commercial utility, a substance must:
1. Have sufficient sweetening power
2. Be nontoxic
3. Be reasonably inexpensive
4. Be thermostable (i.e., resist cooking temperatures)

Noncaloric sweetening agents Saccharin E 954
• pharmacologically inert
• untoward effects are very rare
• photosensitization
• urticaria
• stable

Noncaloric sweetening agents Cyclamate E 952
Remsen and Fahlberg 1879
In animal studies causes urinary bladder cancer

Noncaloric sweetening agents Aspartame (NutraSweet) E 951
• Contains phenylalanine, dangerous in phenylketonuria
• Or during pregnancy
• Various neurological or behavioral symptoms mostly headaches have been reported
• Not backfest

Noncaloric sweetening agents Acesulfam K E 950
Sweeteners in different products
Coca Cola light
• Na-Cyclamate
• Acesulfam K
• Aspartame
Pepsi Cola light
- Acesulfam K
- Aspartame

Wrigley’s Orbit Winter fresh
- Sorbitol
- Mannitol
- Aspartame
- Acesulfam K

Wrigley’s Orbit professional
- Xylitol
- Sorbitol
- Mannitol
- Aspartame
- Acesulfam K

Host factors are:
- saliva
- immunization
- teeth

Host factors: Saliva
Xerostomia may be the consequence of a variety of different human pathological conditions, as listed below.
- Sjögren’s syndrome
- Therapeutic radiation of the head and neck area
- Surgical removal of salivary glands for neoplasms may cause localized xerostomia
- Chronic administration of anticholinergic or parasympatholytic drugs
- In diabetes mellitus, a frequent complaint is dryness of the mouth
- Acute virus infection involving salivary glands results in temporary xerostomia
- Anxiety, mental stress, and depression may temporarily decrease salivary flow

Immunization
Theoretically possible - there were results in animal studies
Problems: cross-reaction is possible with human heart-muscle