## Food Science and Nutrition: Food Analogs

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## Food Analogs Overview

- What are food analogs?
- Why are food analogs used?
- What must be considered when selecting a food analog?
- Real world examples
  - products
  - process…
    - factors that influence selection process

## Food Analog

Natural or manufactured substances that are used in place of a traditional food or a food ingredient

**Food substitute**

## Food substitutes--examples


## Food substitutes--examples


## Formulating with food analogs

- Ingredients have specific roles in foods
- Selection among analog alternatives depends on desired end quality
- Complexity of predicting ingredient functionality increases as number of ingredients increases in the food system
- Formulation must take into account the impact of ingredients on key product quality attributes
  - appearance, flavor, texture, nutrition, safety
  - ?? Price, ?? Marketing claims

## A real world example– cakes and hydrogenated shortening

| Traditional cake formula | High-ratio cake formula |
|---|---|
| *Ingredient weight* | *Ingredient weight* |
| sugar = flour | sugar ≥ flour (1.1-1.7x) |
| egg = fat | egg > shortening |
| egg + milk = sugar or flour | egg + milk > sugar (+25-35%) |

## A real world example– cakes and hydrogenated shortening

**Traditional cake formula**

**High-ratio cake formula**

## Today's ***gold standard*** for cake

***Functions of shortening***

1. aeration → volume
2. coats protein and starch → tenderizes
3. increases system stability → softness sweetness

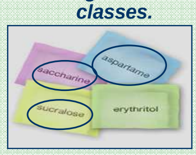
**Possible through the functional effects of hydrogenated shortening w/ added emulsifiers**

## A real world example— Sugar substitutes


## Classification of Sweeteners

- Nutritive (Provides energy to body)
  - Sugar (sucrose, dextrose, fructose, lactose)
  - Corn syrup
  - High fructose corn syrup
  - Sugar alcohols (polyols)
- Non-Nutritive
  - High-intensity sweeteners

*One of the most widely used ingredient classes.*



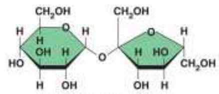

## A real world example-- Sweeteners

- Reason for use…
  - Sweetness
- Depending on product also for…
  - bulk
  - texture/structure
  - browning
  - flavor enhancement
  - moisture retention
  - control water activity




## Sugar


- Most common sweetener
- Sucrose is a disaccharide

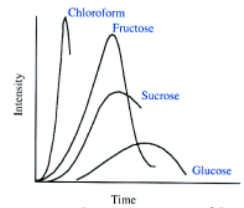



Sucrose ($C_{12}H_{22}O_{11}$)

- Primary sources: sugar cane and sugar beets
- Standard for all sweeteners

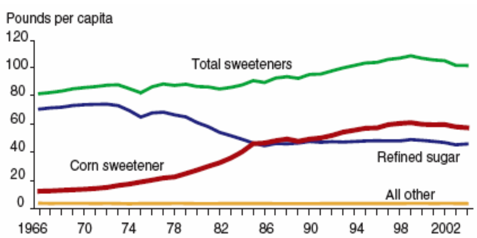
## It's more than just sweetness! Sucrose flavor profile

- Magnitude at a given concentration
- The impact or onset time
- Temporal persistence
- Other tastes?
- Tactile attributes?




**Partial sweetness profile**
(Shallenberger, 1997)

## Sugar alternative– a success story high fructose corn syrup

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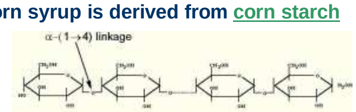
## What is high fructose corn syrup?

- Corn syrup is derived from corn starch

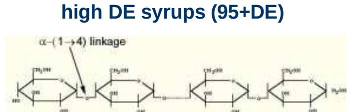



- Corn starch + acid + heat = 42 DE Corn Syrup

DE = dextrose equivalent
a measurement of the extent of starch hydrolysis
DE scale = 0 - 100.
•All dextrose then DE = 100; 100% hydrolysis
•All starch then DE = 0; no breakdown

## What is high fructose corn syrup?

- 42 DE Corn Syrup + amylase & glucoamylase = high DE syrups (95+DE)




Amylase and glucoamylase are enzymes that break the bonds between the glucose units that make up starch– frees glucose.

DE scale = 0 - 100.
•All dextrose (glucose) then DE = 100; 100% hydrolysis
•All starch then DE = 0; no breakdown

## What is high fructose corn syrup?

- HFCS derived from high DE corn syrup
  - High DE corn syrup + glucose isomerase = 42% fructose and 58% glucose
    - 42% HFCS
  - Equals sucrose in…
    - Sweetness intensity
    - Sweetness profile

Glucose isomerase– an enzyme that converts glucose to fructose

## Why use HFCS?

- *Beverages*–
  - Extremely soluble
  - Greater stability in acidic carbonated sodas
    - Flavors remain consistent over shelflife
- *Baked goods*—
  - Fermentable sugars
  - Reduces crystallization
  - Enhances flavors

## Why use HFCS?

- Yogurt
  - Controls moisture
  - Regulates tartness
  - Enhances fruit and spice flavors

- Sauces and condiments
  - Enhances flavor
  - Balances tartness of tomatoes

## Another alternative…
## High intensity sweeteners

- Relative sweetness compared to sucrose varies but high
  - Very low concentrations
- Synthetic and Natural possibilities
- Each w/ unique characteristics

*But…*

- No bulking
- No fermentation
- No browning
- No moisture retention
- No textural effects
- No effect on water activity
  - Additional ingredients necessary for these functions

## Synthetic High Intensity Sweeteners

| Sweetener | Relative Sweetness | Time to max intensity | Sweetness duration | Date of Commer-cialization | Comments |
|---|---|---|---|---|---|
| Sucrose | 1 | 4.1 sec | 66.1 sec | Natural | |
| Saccharin | 300 | 3.1 sec | 77.2 sec | 1880s | Cook temp stable |
| AceK | 200 | 4.9 sec | 77.4 sec | 1980's | Hi temp & low acid stable |
| Sucralose | 600 | 5.0 sec | 75.4 | 1990's | Cook temp, pH 3-7 stable |

## Synthetic High Intensity Sweeteners

| Sweetener | Relative Sweetness | Time to max intensity | Sweetness duration | Date of Commer-cialization | Comments |
|---|---|---|---|---|---|
| Sucrose | 1 | 4.1 sec | 66.1 sec | Natural | |
| Aspartame | 180 | 6.2 sec | 76.7 sec | 1970's | Not heat stable; stable at pH 3-5 |
| Neotame | 8,000 | 6.2 sec | 76.7 sec | 2000's | Flavor enhancer; Heat stable; pH 3 to 5.5 stable |

## High Intensity Sweeteners…
## Multiple Ingredient Approach & Sweetness

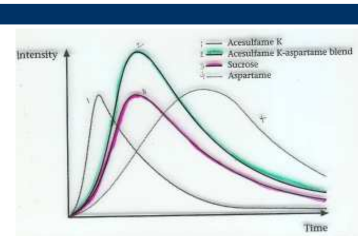



Fig. 6-1. Time-intensity profiles. (Adapted from Nutrinova, 1996, Beverages—In Duet with Sunett, Tech. Bull., Nutrinova, Somerset, NJ)

## Another possibility
## Polyols

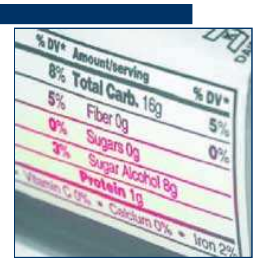

- Also known as...
  - Low-calorie sweeteners
  - bulk sweeteners
  - sugar replacers
    - 1:1 substitution for sucrose
- Examples
  - Sorbitol
  - Mannitol
  - Isomalt


## Another possibility
## Polyols (sugar alcohols)

- Nutrition Facts Panel
  - Referred to as "sugar alcohols"

  ***But…***

  **Neither sugar, nor alcohols!**




Nutrition Facts Panel

## Another possibility
## Polyols

- Nutritive sweeteners
  - 0.5 to 3 kcal/g
- Non-cariogenic
- Less effect on blood glucose levels than sucrose
- Heat and pH stable
- Provide bulk
- Control water activity

***But…***

- No browning
- No fermentation
- "Cooling" effect on tongue sometimes
- Usually less sweet than sucrose

*HIS + polyols*

## Polyol Warning….

- In large amounts…

## Sugar analogs must provide…

- Sweetness

  ***And maybe…***
- Flavor enhancement
- Bulk
- Texture/structure
- Browning
- Moisture retention
- Control water activity

***Remember…***

- A single ingredient may serve multiple functions
- All functions must be considered
- Desired final quality determines selection

## Summary
## Food analogs…

- Save money
- Solve availability problems
- Alter nutritive value
- Meet special dietary needs
- Improve food quality (functionality)

Offer more consumer choices