

# The nature of prebiotics and the impact of prebiotics/probiotics on gut health

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# Agenda

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- ▶ Probiotics and its benefits.
- ▶ Probiotics microorganisms
- ▶ Prebiotics and its benefits.
- ▶ Chemical structure of some prebiotics.
- ▶ Inulin, oligofructos, FOS and GOS.
- ▶ The definition of synbiotics .
- ▶ Microencapsulation.
- ▶ Probiotic market.

# Probiotics

- ▶ Probiotics are viable bacteria which colonize in the large intestine and provide health benefits to the host.
- ▶ Probiotics also colonize in the upper part of the intestine and prevent the adhering of pathogens to the intestinal tract (competitive exclusion).
- ▶ Probiotics also help in food digestion and improve immune response.

# Probiotic Microorganisms

- ▶ There are numerous probiotic microorganisms:
  1. **Fermented foods**: *Lactobacillus rhamnosus*, *Lactobacillus reuteri*, *Lactobacillus casei*, *Lactobacillus acidophilus* and bifidobacteria.
  2. **Investigated**: *Escherichia coli* Nissle 1917, *Enterococcus faecium* SF68, and the probiotic yeast *Saccharomyces boulardii*.

# Benefits

- ▶ Maintaining healthy digestion and friendly bacteria level.
- ▶ Assisting with digestive disturbance (e.g. bloating, flatulence, diarrhea, constipation, poor digestion).
- ▶ Maintaining a healthy-immune system and energy level.
- ▶ Supporting the gut during and after antibiotics treatment.
- ▶ Maintaining healthy liver function.
- ▶ Supporting clear healthy skin.

# Prebiotics

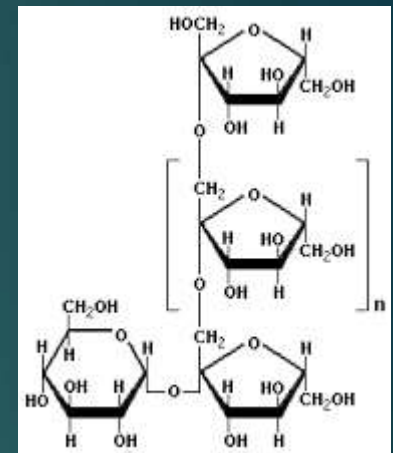
- ▶ Prebiotics is a general term to chemicals that induce the growth and the activity of commensal microorganisms that contribute to the well-being of the host.
- ▶ Its function is in the gastrointestinal tract, where prebiotics can support probiotics growth and alter the distribution of organisms in the gut microbiome.
- ▶ Prebiotics can also function in other areas of the body as well.

# Type of prebiotics

- ▶ Prebiotics are classified as soluble fiber.
- ▶ It is the type of fibers that our gut flora can actually consume and ferment.
- ▶ These type of soluble fibers are:
  1. Inulin and oligofructose. → Polysaccharides
  2. Fructo-oligosaccharides (FOS).
  3. Galacto-oligosaccharides (GOS).
  4. Other oligosaccharides.→ Oligosaccharides

# Polysaccharides (Inulins and Oligofructose)

- ▶ **Inulins** belong to a class of dietary fibers known as **fructans**.
- ▶ Inulins are a group of soluble fibers naturally produced by many types of plants, industrially extracted from chicory.
- ▶ **Oligofructose** belongs to a subgroup of inulin. It's found in various vegetables and plants, including onions, bananas, garlic, chicory and wheat



Inulin  
Fructose polymer B2-1  
DP 60

Oligo fructose  
Fructose polymer B2-1  
DP 10



# Oligosaccharides

- ▶ Oligosaccharides are important group of polymeric carbohydrates that are found in all living organisms.
- ▶ Oligosaccharides composed of 2 to 10 mono-saccharide residues.
- ▶ These mono-saccharide's linked together by glycoside bonds.
- ▶ The discovery of enzymes helps in the production of oligo-saccharides with high yield and cost effective.

# Oligosaccharides Substrates

## Enzymatic process

### Oligosaccharides

### Substrate

- ▶ Fructo-oligosaccharide → Sucrose
- ▶ Galacto-oligosaccharide → Lactose.
- ▶ Malto-oligosaccharide → Starch.
- ▶ Iso-malto-oligosaccharide → Starch.
- ▶ Xylo-oligosaccharide → Xylan.
- ▶ Soy-oligosaccharide → Soy.

# Oligosaccharides properties

- ▶ Low sweetness intensity (*1/3 of sucrose*).
- ▶ Highly soluble than sucrose.
- ▶ Zero calorie (calorie free).
- ▶ Heat stable (*doesn't degrade by heating process*)
- ▶ Resistance to hydrolysis by digestive enzymes.
- ▶ Hydrolyze in high acid environment.
- ▶ Non-cariogenic (*inhibit the growth of Streptococcus mutans*).

# Oligosaccharides general benefits

- Prebiotic (*enhance bifidus bacteria in colon*).
- Increase digestion of lactose metabolism.
- Increase mineral absorption.
- Increase HDL/LDL ratio.
- Decrease serum lipids and blood cholesterol.
- Decrease blood pressure.
- Decrease glycemic response.
- Decrease fecal PH, toxic, and carcinogenic metabolites.

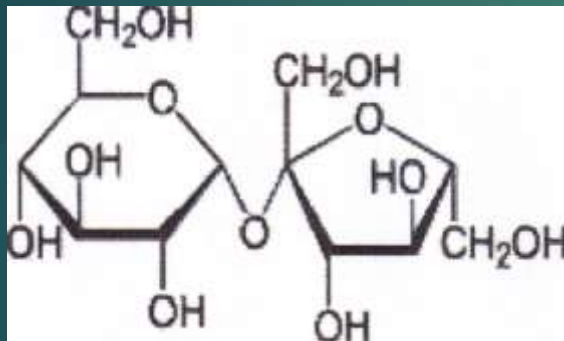
# Oligosaccharides

## Legal status

- ▶ Oligosaccharides cannot be labeled as sugars or carbohydrates.
- ▶ They are food ingredients not food additives.
- ▶ Can be applied without restrictions.

# Fructo-oligosaccharides (FOS)

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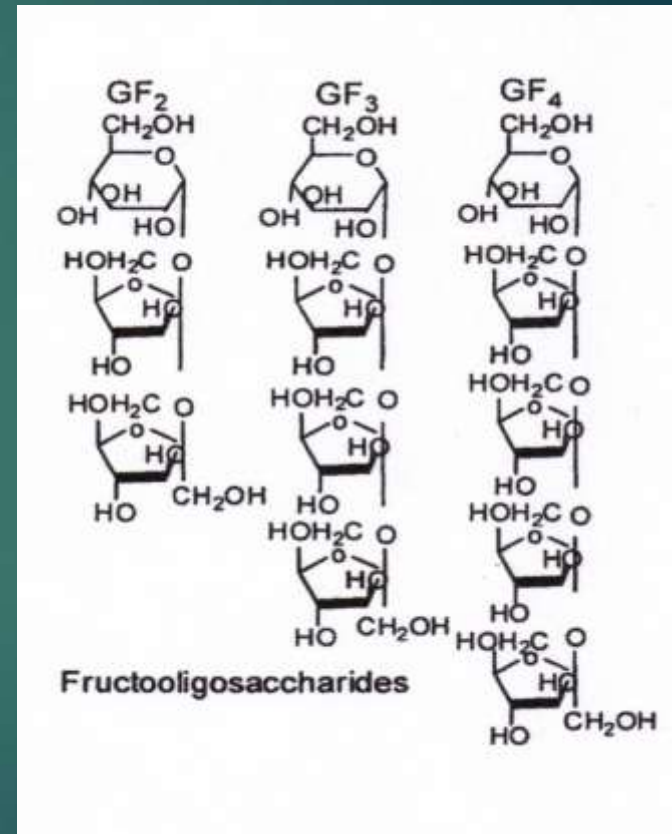


GF

Sucrose

$O\text{-}\alpha\text{-D-glucopyranosyl-(1-2)\beta\text{-D-fructofuranoside}$

Substrate



products

# Fructo-oligosaccharide (FOS)

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- ▶ Naturally occurring (*fruits and vegetable*).
- ▶ Built from sucrose (D-glucose and D-fructose).



Enzymatic reaction:



By-product:

- Free glucose (*process enzyme inhibitor*)

# Fracto-oligosaccharides products of enzymes

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## ▶ Enzymes:

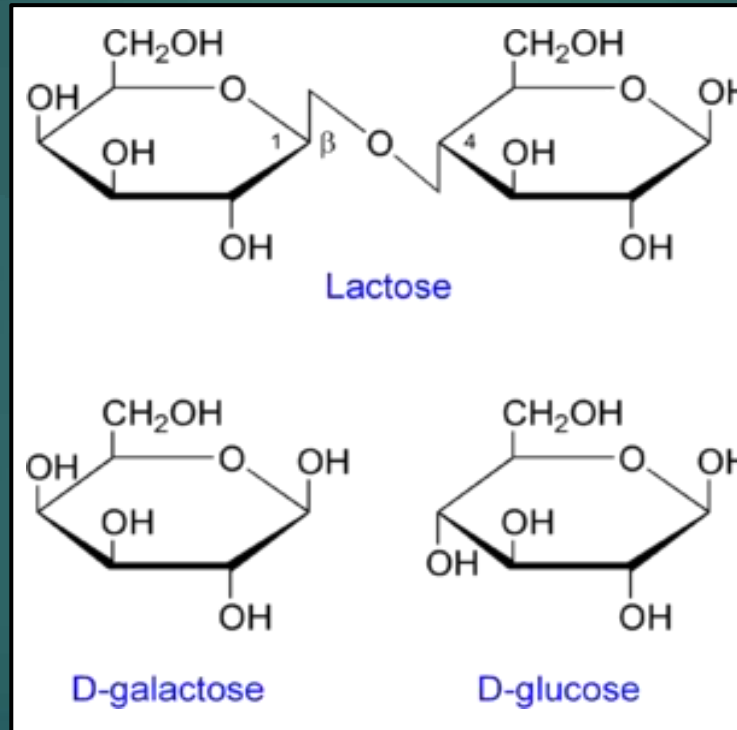
- Fructosyltransferase (**EC 2.4.1.9**).
- *B*-fructofuranosidase (**EC.3.2.1.26**).

## ▶ Microbial source:

- *Aureobacidium pullulans*.
- *Aspergillus niger*.
- *Fusarium Sp.*
- *Arthrobacter sp.*
- *Lactobacillus vulgalicus*



# Galacto-Oligosaccharides 17 (Substrate)



# Galcto-oligosaccharides (GalOS)

- ▶ Naturally occurring in milk products.
- ▶ It is one of the major oligosaccharide in Japan.
- ▶ It is built from lactose (**D-glucose** and **D-galactose**).

## G-(Gal)<sub>n</sub>-Gal

### % of mixture

G-Gal	→	di-saccharide	33 %
G-(Gal) <sub>2</sub>	→	tri-saccharide	39 %
G-(Gal) <sub>3</sub>	→	tetra-saccharide	18 %
G-(Gal) <sub>4</sub>	→	penta-saccharide	7 %

# Galacto-oligosaccharides (GalOS)

Enzyme



## Process by-product:

- Glucose (*enzyme inhibitor in the process*).
- Galactose (*galactocymia in the blood*)

# GalOS Production Enzyme

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## ▶ Enzyme name:

- *B*-galactosidase (**EC 3.2.1.22**).
- (Also known by the name lactase)
- *B*-galactosyl transferase (**EC 2.4.1.134**)

## ▶ Microbial source:

- *Aspergillus niger*.
- *Aspergillus oryzae*.
- *Kluyveromyces fragilis*.
- *Kluyveromyces fragilis*.
- *Bacillus circulans*.
- *Streptococcus thermophilus*.

# Synbiotics

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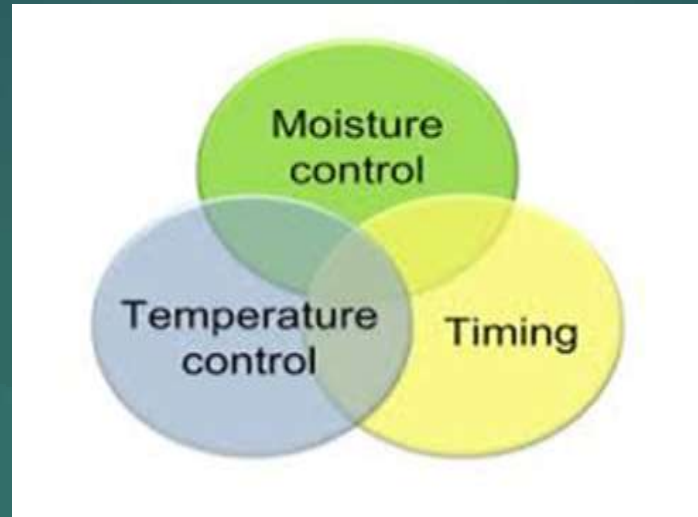
- ▶ the United Nations Food & Agriculture Organization (FAO) recommends that the term "synbiotic" be used only if the net health benefit is synergistic
- ▶ Synbiotic concept was first introduced as "mixtures of probiotics and prebiotics that are beneficially to the host."

# Protecting Probiotic Bacteria

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- ▶ Probiotic bacteria play an important role in promoting and maintaining human health.
- ▶ In order, to produce health benefits probiotic strains should be in a viable form during: **(1)** its shelf life until consumption and **(2)** maintain its high viability throughout the gastrointestinal tract.
- ▶ Experimental data indicated free probiotic cells have a poor survival rate.
- ▶ Maintaining probiotics in a viable form (living cells) is the must approach.
- ▶ Develop a physical barrier for probiotics to be protected from adverse environmental conditions.

# Protecting Probiotic Bacteria



# Microencapsulation

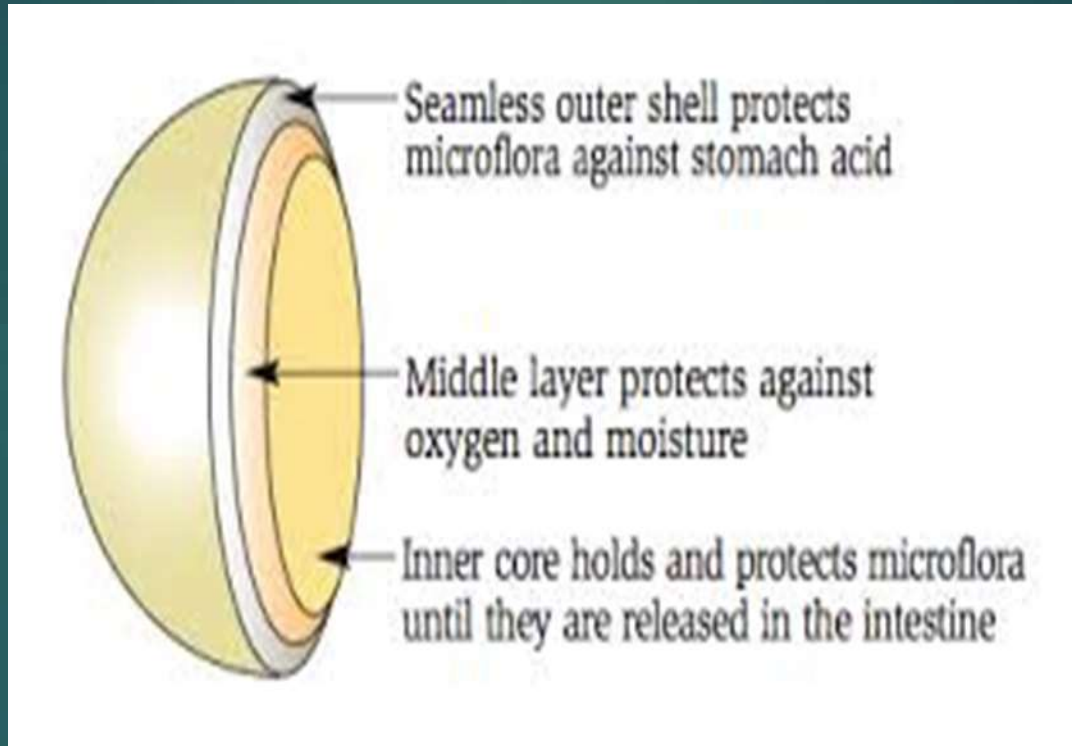
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- ▶ The microencapsulation techniques enhanced viability of Probiotics in food products as well as in the gastrointestinal tract.
- ▶ microencapsulation is a process to entrap active agents (probiotic/prebiotic) within a carrier material and convert them into a powder form for convenient use.
- ▶ microencapsulation prevent these microorganisms from multiplying in food that would otherwise change their sensory characteristics
- ▶ In addition, microencapsulation can promote controlled release and optimize delivery to the site of action.



# Microencapsulation

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**A technology to Protect Probiotic Bacteria**

# Materials used for Microencapsulation

- ▶ Various types of encapsulating materials are used for the process.
- ▶ Namely, **alginate**, **chitosan**, **carrageenan**, **gums** (locust bean, gellan gum, xanthan gum, etc.), **gelatin**,  **whey protein**, and **starch**.
- ▶ The selection of any material depends on **(1)** its capsule forming capability, **(2)** its strength, **(3)** its enhancing viability of probiotics, **(4)** its cheapness, **(5)** its availability, and **(6)** biocompatibility.



# Microencapsulation Techniques

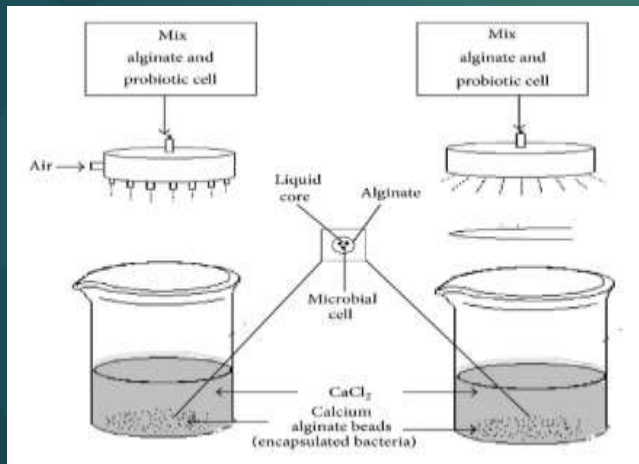
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The techniques are divided into two parts:

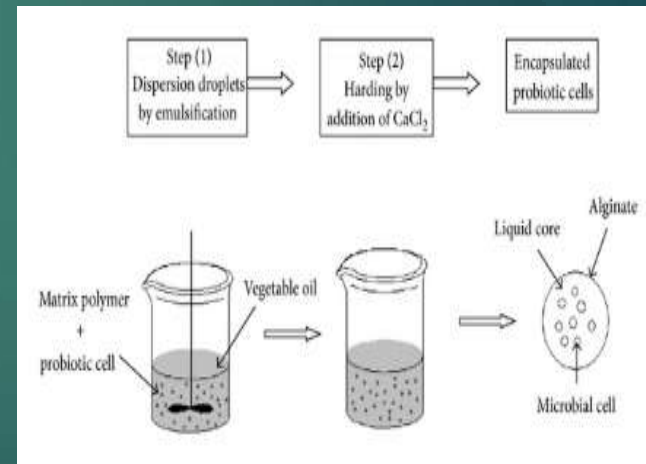
(1) Encapsulation process.

(2) Drying process (freeze drying , spray drying , fluidized bed drying ).

## Encapsulation Process



**Extrusion Technique**



**Emulsion Technique**

# Probiotics market



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- ▶ Food & beverages dominated the application market and accounted for over 80% of the total probiotics market.
- ▶ Asia Pacific emerged as the most dominant regional market, accounting for over 50% of the total market share. This owing to the fact that the concept started in Japan.
- ▶ The global market for probiotics is expected to reach \$ 52.34 billion by 2020.
- ▶ Asia Pacific is also expected to be the fastest growing market.

# Probiotics market



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- ▶ In the United States, probiotics are available as dietary supplements (capsules, tablets, and powders) and in dairy foods (such as yogurts with live active cultures).
- ▶ Probiotics for human consumption accounted for over 90% of the total market,
- ▶ probiotics have made significant growth in the animal feed industry and are expected to grow.

# Conclusion

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- ▶ Growing consumer awareness regarding gut health has pushed the demand for supplements and dietary products.
- ▶ This awareness has tremendous reflect on probiotics consumption.
- ▶ Probiotics expected to play a critical role in market development over the next years.
- ▶ Labeling and regulations, especially in the U.S. and European Union, are also expected to have significant impact on market growth.

**Thank You for your  
attention**