The potential use of synbiotic combinations in bread- A review

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Introduction

PRObiotic

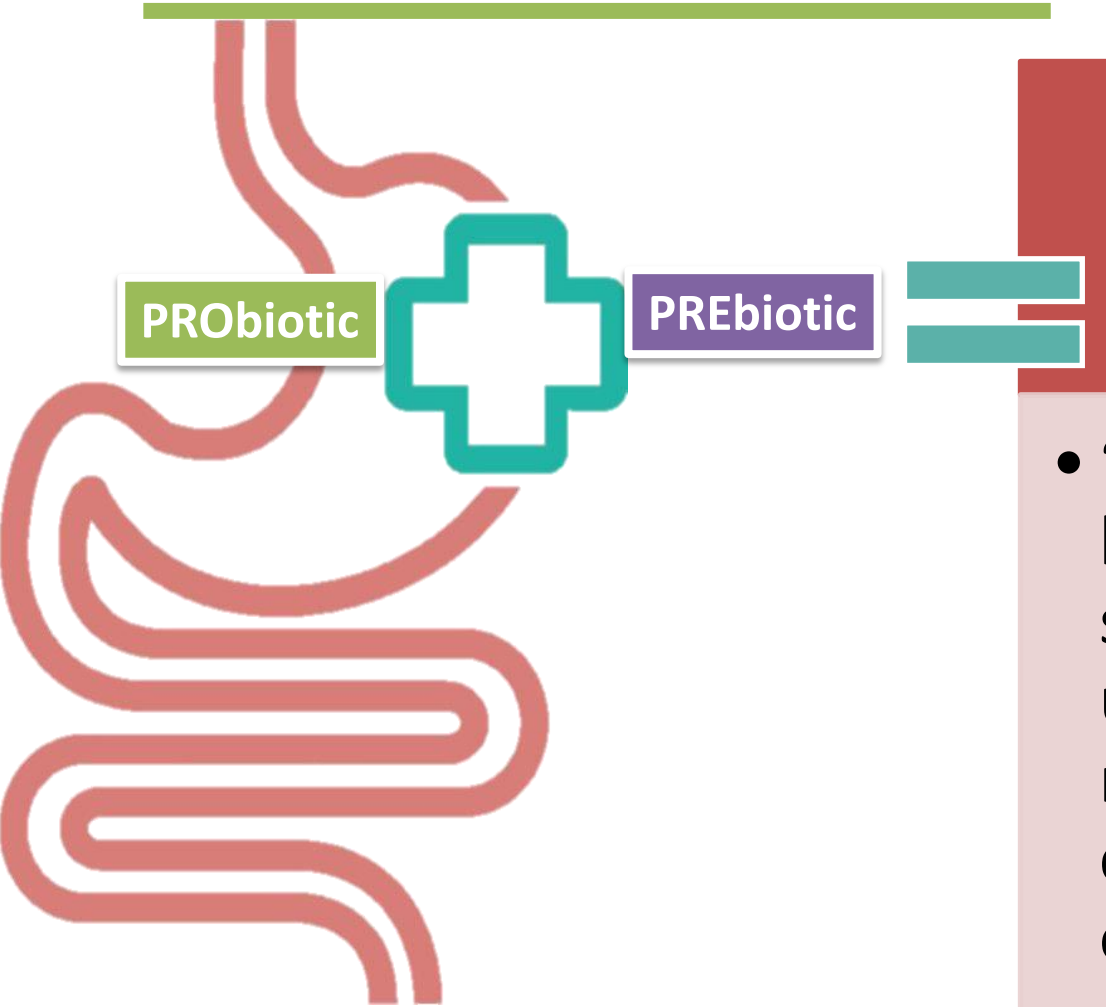
- "Live microorganisms that, when administered in adequate amounts, confer a health benefit on the host." (ISAPP, 2013).

PREbiotic

- "A substrate that is selectively utilized by host microorganisms conferring a health benefit." (ISAPP, 2015).

Fig. 1. The definitions of 'probiotic' and 'prebiotic'

Introduction



SYNbiotic

- "A mixture comprising live microorganisms and substrate(s) selectively utilized by host microorganisms that confers a health benefit on the host" (Swanson, 2020).

Fig. 2. The definition of 'synbiotic'

Introduction

Fig. 3. The majority of studies based on 'synbiotic' foods

González-Herrera et al., 2021, Kumar et al., 2015; Chaturvedi and Chakraborty, 2021

Introduction

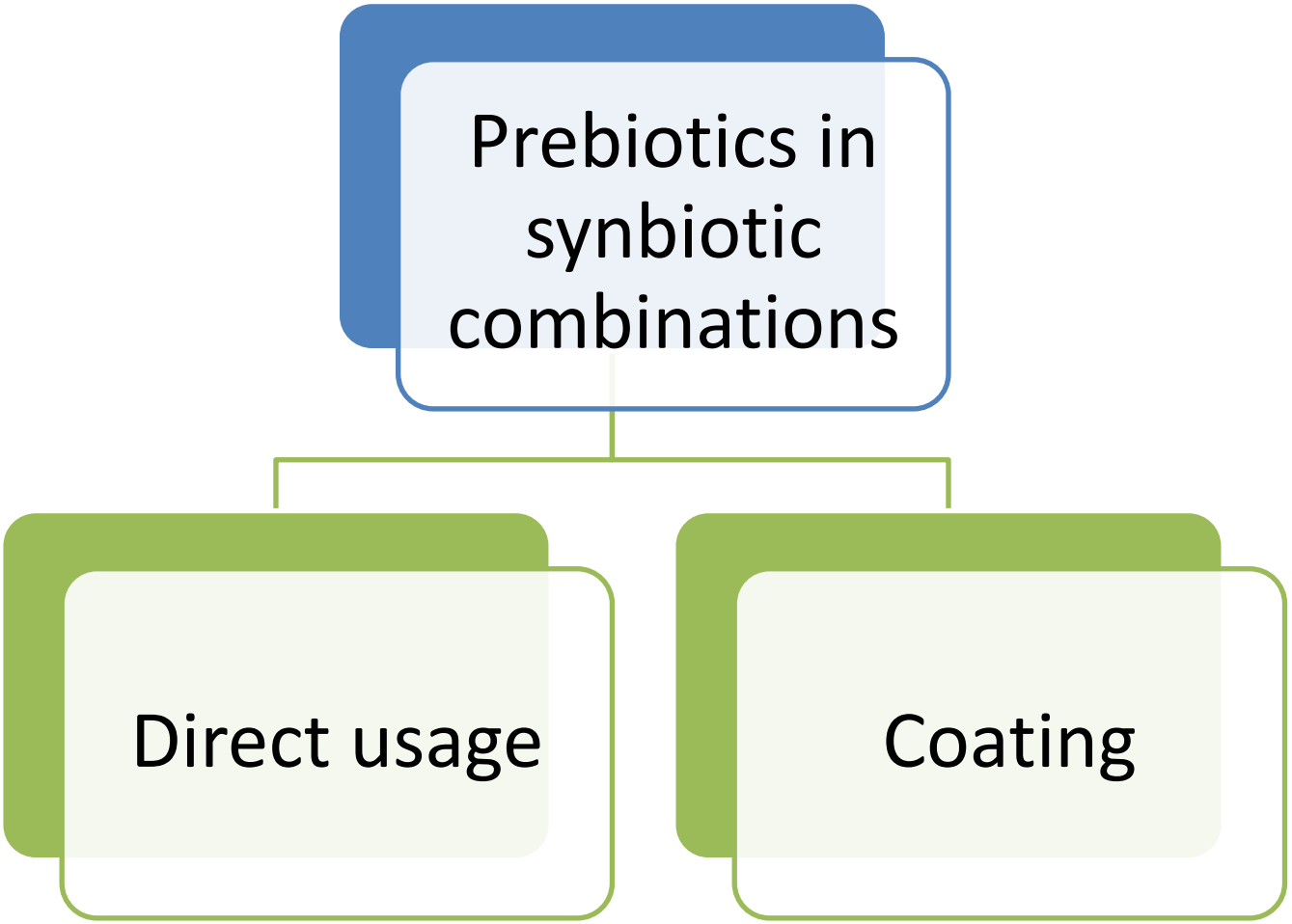


Fig. 4. The potential usage of prebiotics in 'synbiotic' combinations in breads

Introduction

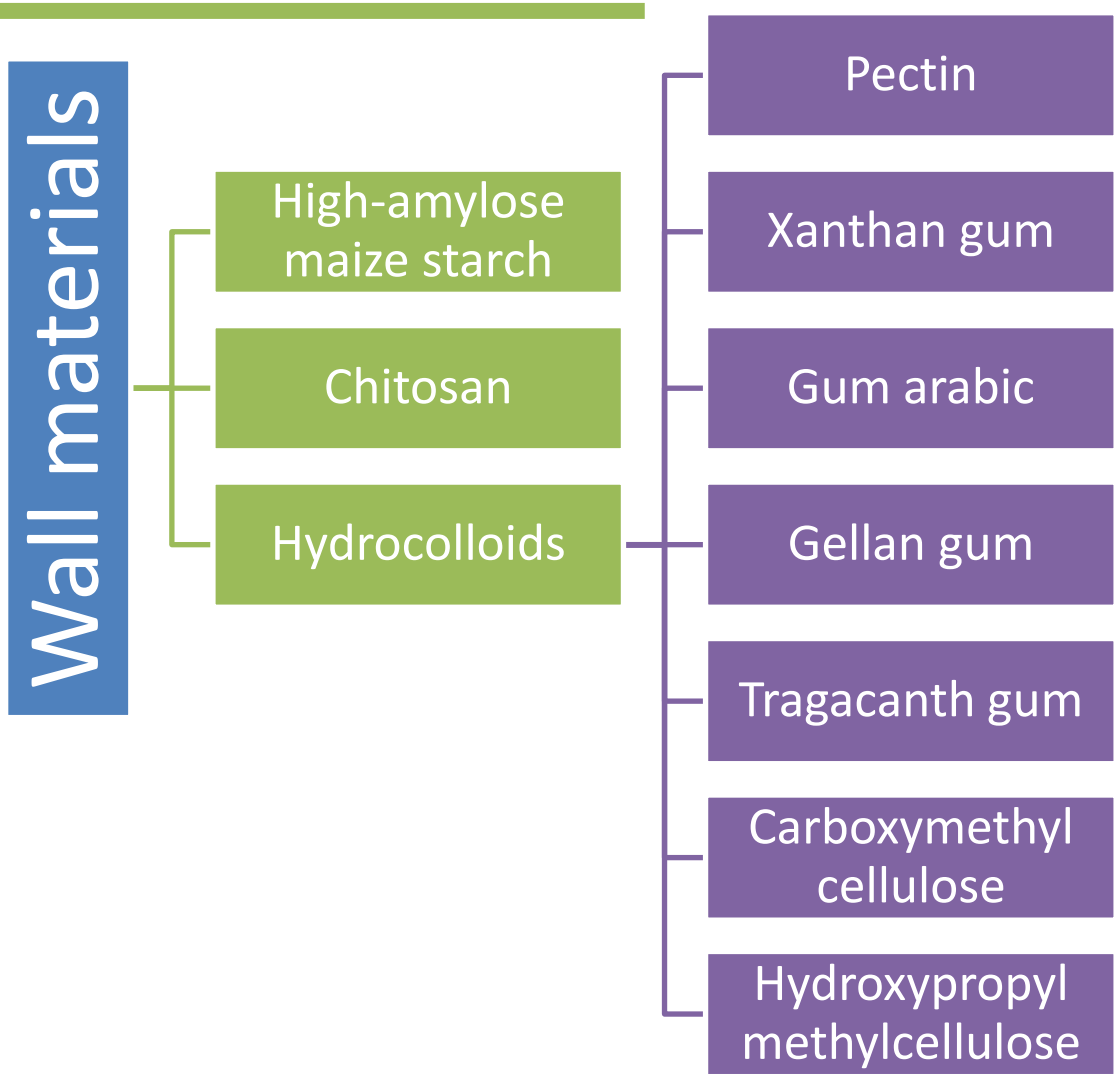


Fig. 6. The major potential prebiotics used of 'synbiotic' combinations in breads

Introduction

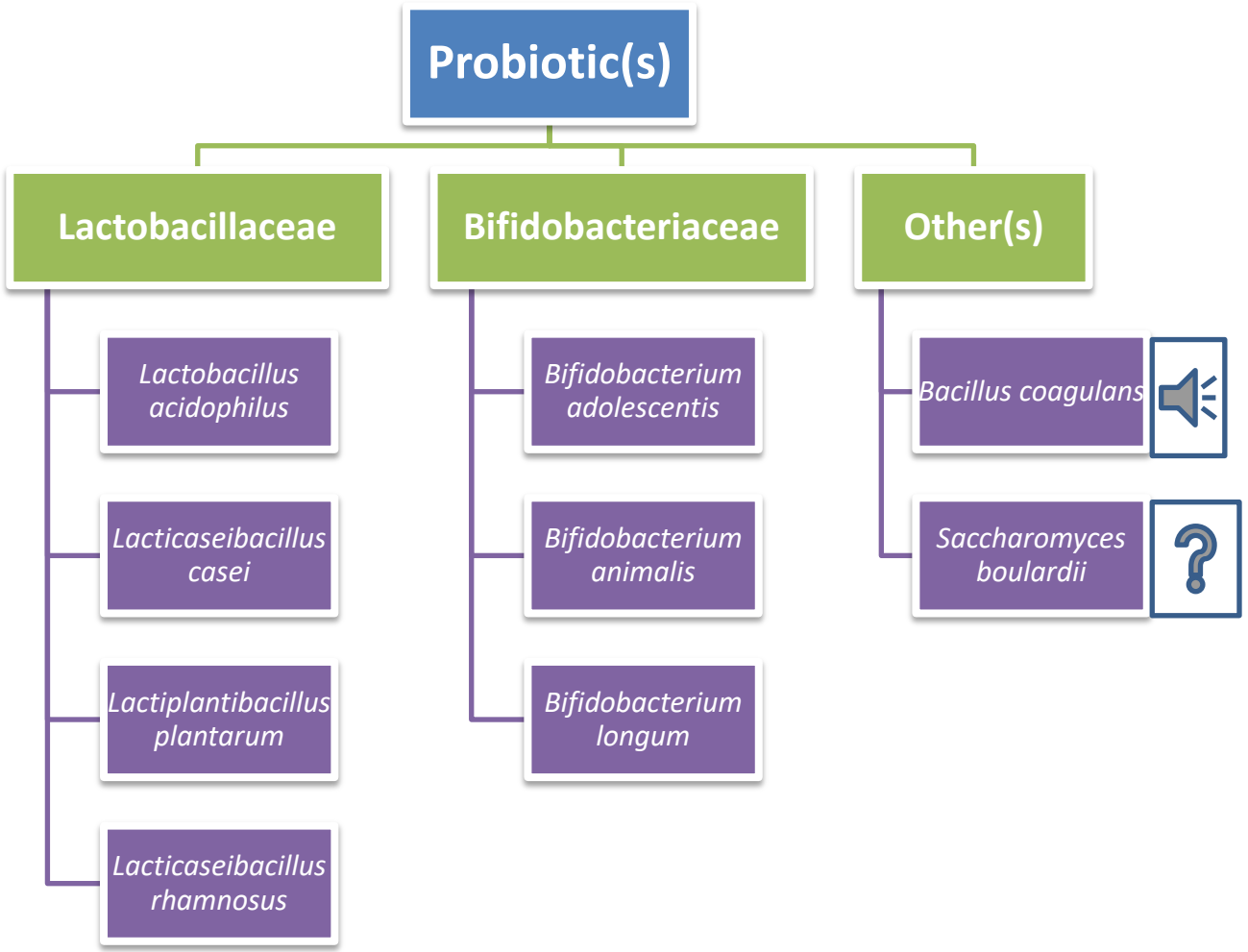


Fig. 5. The major probiotics used of 'synbiotic' combinations in bread

Synbiotic combinations in bread

Table 1. The potential use of synbiotic combinations in bread

Bread type	Probiotic source(s)	Prebiotic or potential prebiotic source(s)	References
Bread	*Lactobacillus acidophilus*	Inulin[a, b], carboxymethylcellulose[b], pectin[a, b], fresh agave sap[a, b]	Altamirano-Fortoul et al., 2012
Bread	*Lactobacillus acidophilus*	Xanthan gum[b], gellan gum[b], chitosan[b]	Mirzamani et al., 2021
Cream bread	*Lactobacillus acidophilus*	Xanthan gum[b], maltodextrin[b]	Duc Thang et al., 2019
Gluten-free "Barbari" bread	*Lactobacillus acidophilus, Lactiplantibacillus plantarum*	Tragacanth gum[b], sago starch[b]	Ghasemi et al., 2022
Bread	*Lactiplantibacillus plantarum*	Inulin[b], gum arabic[a,b], maltodextrin[a, b]	Zhang et al., 2018
Pan bread	*Lacticaseibacillus rhamnosus*	Baobab pulp[a], high- amylose maize starch[b], chitosan[b]	Adedeji et al., 2022
Pan bread	*Lacticaseibacillus rhamnosus*	High-amylose maize starch[b], cassava starch[b], chitosan[b]	Ezekiel et al., 2020
Pan bread, hamburger bread	*Lactobacillus acidophilus, Lacticaseibacillus casei*	Inulin[a], high-amylose maize starch[b], chitosan[b]	Seyedain-Ardabili et al., 2016

a: direct usage, b: coating

Synbiotic combinations in bread

Table 1. The potential use of synbiotic combinations in bread (*continued*)

Bread type	Probiotic source(s)	Prebiotic or potential prebiotic source(s)	References
Bread bun	*Lacticaseibacillus casei*	Inulin[b], konjac glucomannan[b]	Pruksarojanakul et al., 2020
Bread	*Streptococcus salivarius* subsp. *thermophilus, Lactobacillus delbrueckii* subsp. *bulgaricus, Lactobacillus acidophilus, Acetobacter aceti, Bifidobacterium bifidum, Bifidobacterium adolescentis, Bifidobacterium longum, Bifidobacterium animalis, Lactobacillus acidophilus, Lactococcus lactis* subsp. *cremoris, Propionibacterium freudenreichii, Enterococcus faecium, Streptococcus salivarius* subsp. *thermophilus*	Whey, glycerol[b]; high amylose maize starch[b]	Gregirchak et al., 2020
Bread	*Bacteroides ovatus, Bifidobacterium adolescentis*	Arabinoxylan[a]	Zhang et al., 2023
Bread	*Lactobacillus acidophilus, Bifidobacterium animalis*	Apple pomace[a]	Jagelaviciute et al., 2023
Bread	*Bifidobacterium animalis* spp. *lactis*	Hydroxypropyl cellulose[b]	Penhasi et al., 2021
Steamed bread	*Bifidobacterium longum*	Gellan gum[b]	Yang et al., 2023
Bread	*Bacillus coagulans*	Inulin[a]	Majzoobi et al., 2019

a: direct usage, b: coating

Human health

Table 2. Influence of potential synbiotic combinations in bread on human health

Major findings	References
Consumption of synbiotic bread including *Lactobacillus sporogenes* and inulin for 8 weeks by T2DM patients (*n*=26): Triacylglycerol(s)↓; Very low-density lipoprotein cholesterol ↓; High-density lipoprotein-cholesterol ↑; Total cholesterol ↔; Low-density lipoprotein-cholesterol ↔	Shakeri et al., 2014
Consumption of synbiotic bread consisting of *L. sporogenes* and inulin through 3 times/day in a 40 g per serve for 8 weeks by T2DM patients (*n*=27): Serum insulin ↓	Tajadadi-Ebrahimi et al., 2014
Consumption of a total of 120 g per day of the same content of synbiotic bread consisting of *Lactobacillus sporogenes* and inulin for 8 weeks by T2DM patients : Nitric oxide ↑, Malondialdehyde ↓, Blood pressure ↔ , Liver enzymes ↔ , Plasma glutathione ↔ , Plasma total antioxidant capacity, ↔, the levels of iron, calcium, and magnesium ↔	Bahmani et al., 2016
Consumption of synbiotic bread composed of *B. coagulans*, β-glucan, and inulin, for 3 times in a day for 8 weeks by T2DM patients: Total cholesterol ↓, Apo A1 ↓	Ghafouri et al., 2022

T2DM: Type 2 diabetes mellitus

CONCLUSION

- The following studies should focus on the survival of more probiotic microorganisms, especially ***Bacillus coagulans*** and ***Saccharomyces boulardii,***
- The **optimization of different encapsulation** techniques, **wall materials, film/coatings together with different types and concentrations of prebiotic** sources used in other cereal-based food products, and also in **gluten-free bread,**
- The **viability of probiotics** with prebiotics which isused directly, or as a wall material for encapsulation or edible film/coating should be assessed from a holistic perspective **regarding the nutritional, technological, and sensorial properties of bread.**

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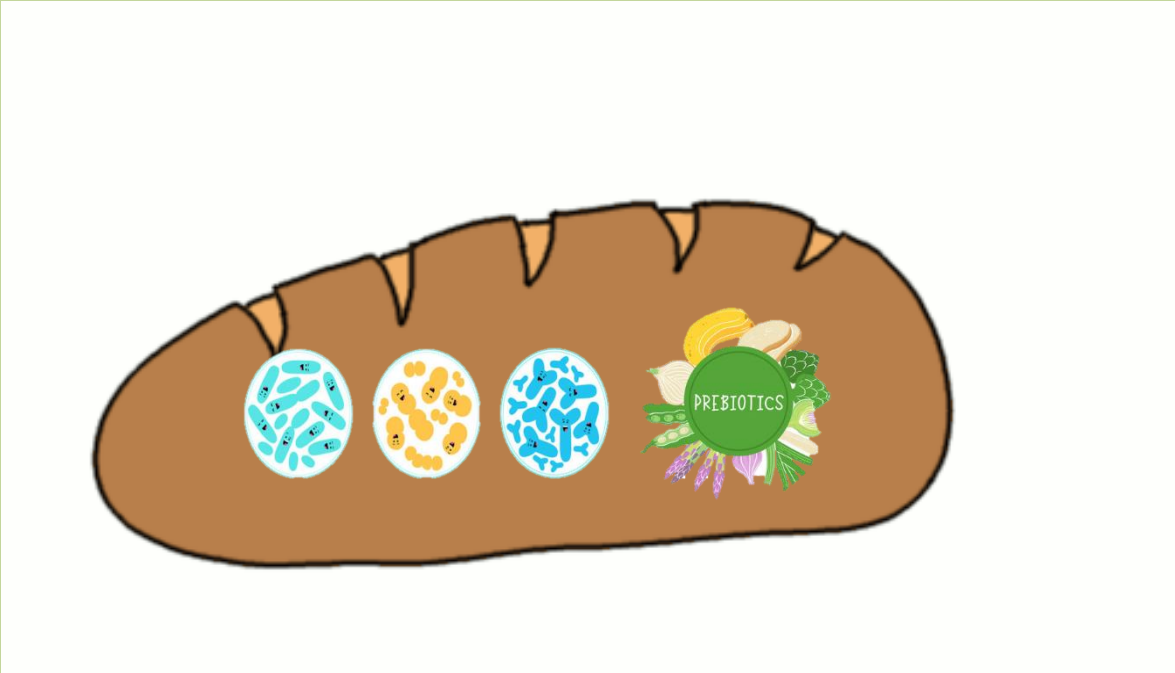

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