Biologia (2023) 78:1789–1806
https://doi.org/10.1007/s11756-023-01440-4

REVIEW

Exploring the potential of xylooligosaccharides as prebiotics: insights from CAZymes families and their emerging health benefits

Cilia Bouiche[1] · Aicha Asma Houfani[2] · Zahra Azzouz[3] · Lamia Taouzinet[1] · Lamia Medouni-Haroune[1] · Meriem Amrane-Abider[1] · Khodir Madani[1]

Received: 29 December 2022 / Accepted: 17 May 2023 / Published online: 31 May 2023

Abstract
Converting xylan from the hemicellulosic fraction of lignocellulose into xylooligosaccharides (XOS) has attracted intense research focus in the recent years for obtaining high added-value products. These XOS are emerging prebiotic compounds that present significant functional properties. This paper reviewed the current status of lignocellulosic pretreatments and the CAZymes hydrolysis of xylan, investigating the previously reported alternatives and enzymes. The evaluation criteria and parameters for XOS production processes, which can differ significantly between studies, are also reported. For example, one study may focus on the cost of production, while another may focus on the environmental impact. Most generally, however, XOS are produced in two stages through acid pretreatment and enzymatic hydrolysis. This process is known to be highly effective, and it yields a product that is rich in nutrients and beneficial for many purposes. This two-stage production process is also easy to regulate and control, which makes it an ideal method of production when looking to create a high-quality XOS product. Throughout this work, we discuss relevant topics that should be considered when exploring the enzymatic production of XOS, including strategies for producing XOS by CAZymes and the evaluation of the prebiotic effects of XOS on the gut microbiota.

Keywords CAZymes · Gut microbiota. LCB · Prebiotics · XOS

Introduction

Current heterotrophs are more aware of the benefits of natural products, such as functional foods, which strengthen their immune systems, improve the structure of intestinal flora, and have anti-inflammatory and antioxidant effects (Liu et al. 2023). These supplements, which are naturally present in foods or added during industrial processes, may change the gut microbiota and promote good health (Kaprelyants et al. 2017; Mhetras et al. 2019). In ancient times, Hippocrates envisaged such a concept and proclaimed: "Let food be thy medicine and medicine be thy food" (King 2019). As the demand for such dietary supplements increases, researchers face the dilemma of where to source raw materials (Mhetras et al. 2019). Collectively, science has enabled the recovery of valuable and usable by-products that were previously considered wastes (Panesar et al. 2015), for example, corn cobs (Samanta et al. 2012).

In order to produce these supplements effectively, raw materials that are underutilized must be converted into value-added products (Hutkins et al. 2016). These various wastes contain a significant amount of lignocellulosic biomass (LCB), which is made up of three main biopolymers: cellulose (35–50 wt%), hemicelluloses (20–35 wt%), and lignin (5–30 wt%) (Menezes et al. 2010). The hemicellulose molecules are present in various polymers composed of pentoses (D-xylose and D-arabinose) and/or hexoses (D-mannose, D-glucose, and D-galactose), with xylose

✉ Aicha Asma Houfani
aicha.asma.houfani@ubc.ca

1 Centre de Recherche en Technologies Agroalimentaires. Route de Targa Ouzemmour, Campus Universitaire, Bejaia 06000, Algeria

2 Food, Nutrition and Health, Faculty of Land and Food Systems, University of British Columbia, 2205 East Mall, Vancouver, BC V6T 1Z4, Canada

3 Laboratoire de Microbiologie Appliquée (LMA), Faculté des Sciences de la Nature et de la Vie, Université de Bejaia, 06000 Bejaia, Algeria