

Assessing the prebiotic potential of xylooligosaccharides produced by one-step fermentation using agro-residues

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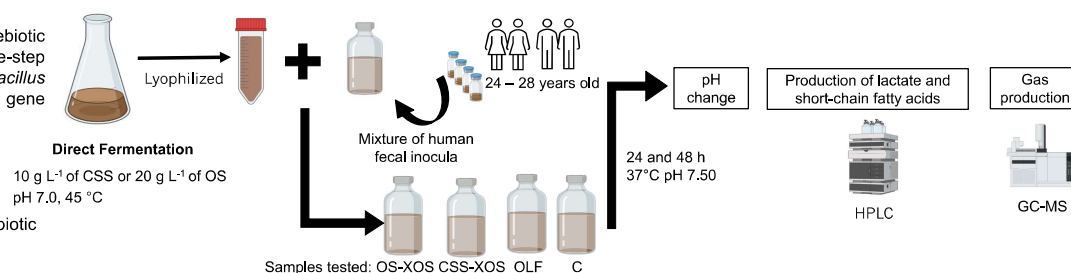
Introduction

A prebiotic is defined as "a substrate that is selectively utilized by host microorganisms, conferring a health benefit" [1]. Xylooligosaccharides (XOS) are an emerging prebiotic composed of xylose units linked through $\beta(1-4)$ linkages [2]. These compounds have attracted significant academic and industrial attention due to their distinct prebiotic and organoleptic properties. XOS can be produced through the hydrolysis of xylan present in various agro-residues (as wheat straw, corn cob, rice straw or cotton stalk) and can give rise to different types of xylo-based oligosaccharides [3]. These compounds have been reported to exhibit prebiotic effects and beneficial health properties, including anti-cancer, anti-inflammatory, and anti-diabetic effects [4]. Furthermore, XOS can enhance the organoleptic properties of foods, demonstrating high stability at acidic pH and high temperatures. This makes their incorporation into functional foods particularly appealing [5]. Recognizing the potential of xylo-based oligosaccharides as functional food ingredients, it is crucial to investigate the prebiotic potential of XOS produced from alternative substrates such as olive stones (OS) and coffee silver skin (CSS).

Methods

In vitro studies to assess the prebiotic potential of XOS produced by one-step fermentation using recombinant *Bacillus subtilis* 3610 carrying the xylanase gene *xyn2* from *Trichoderma reesei* from:

- ➔ Olive stones (OS-XOS)
- ➔ Coffee silver skin (CSS-XOS)
- ➔ Positive control: commercial prebiotic oligofructose (OLF) (Orafti®, BENE, Germany)
- ➔ Negative control: blank with water (C)



Results

The main health-promoting effects of prebiotic oligosaccharides are linked to the production of short-chain fatty acids (SCFAs) and the subsequent pH drop that promotes a beneficial modulation of the gut microbiota [6].

Table 1- pH variation over time of fecal inocula growth. Values followed with different letters have statistically significant differences ($p \leq 0.05$) according to one-way ANOVA. Lowercase letters represent the analysis between different pH values over time, uppercase letters represent the analysis between different prebiotics tested at 48 h.

Time (h)	0	48
C	7.58 ± 0.04 ^{aA}	6.85 ± 0.02 ^{bA}
OLF	7.55 ± 0.1 ^{aA}	3.90 ± 0.1 ^{bB}
OS-XOS	7.50 ± 0 ^{aA}	7.13 ± 0.1 ^{bA}
CSS-XOS	7.53 ± 0.01 ^{aA}	6.97 ± 0.04 ^{bC}

The prebiotic supplementation led to a reduction of the pH value over time, with OLF showing the most significant pH drop at 48 h ($\Delta pH = 3.65$).

pH ↘

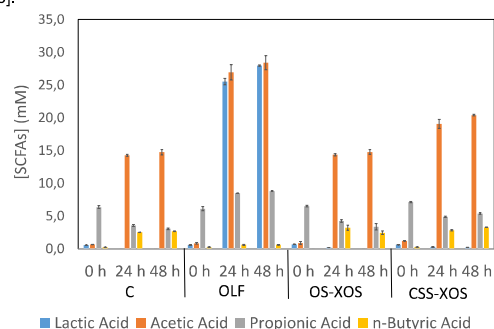


Figure 1 - Quantification of the lactate and short chain fatty acids (SCFAs), namely acetate, propionate, and butyrate, over time of fecal inocula growth from the mix of fecal human inocula in the presence of the prebiotic tested or in the absence of prebiotics (C). Results are the average of two independent fermentations ± standard deviation.

The addition of prebiotics resulted in an increase of the total SCFAs. OLF exhibited a notable increase in the production of lactic and acetic acid production after 48 h (28.0 ± 0.1 and 28 ± 1 mM, respectively), while OS and CSS demonstrated selectivity towards the production of acetic acid (14.8 ± 0.4 and 20.4 ± 0.1 mM, respectively), and butyric acid (2.5 ± 0.3 and 3.29 ± 0.04 mM, respectively) at 48 h.

SCFAs ↗

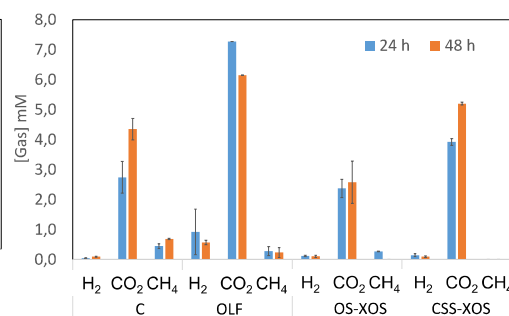


Figure 2 - Production of H₂, CO₂ and CH₄ by human fecal inocula at 24 and 48 h in the prebiotic tested or in the absence of prebiotics. Results are the average of two independent fermentations and duplicate analysis of each sample ± standard deviation.

The gas analysis revealed that the addition of OS/CSS-XOS fully suppressed the production of CH₄ and increased the CO₂ generation after 48 h (2.6 ± 0.7 and 5.20 ± 0.05 mM, respectively).

CO₂ ↗
CH₄ ↘

Conclusions

Comparing the prebiotic produced with the control, it is strongly suggested that these compounds possess potential prebiotic properties for human health.

The addition of prebiotics resulted in an increase of the production of total SCFAs and gases (CO₂), as well as the full suppression of the CH₄ generation and CSS-XOS exhibited a higher prebiotic potential among the tested XOS.

As expected, the commercial oligofructose presented a greater performance most likely due to its superior purity level.

These findings strongly suggest that the XOS produced from OS and CSS holds potential prebiotic properties for human health.

References

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