biology and life sciences forum

MDPI

Proceeding Paper

Enhancing Bread's Benefits: Investigating the Influence of Boosted Native Sourdough on FODMAP Modulation and Antioxidant Potential in Wheat Bread †

Ewa Pejcz [1,*], Sabina Lachowicz-Wiśniewska [2], Paulina Nowicka [3], Agata Wojciechowicz-Budzisz [1] and Joanna Harasym [1]

[1] Department of Biotechnology and Food Analysis, Wroclaw University of Economics and Business, 53-345 Wrocław, Poland; email1@email.com (A.W.-B.); email2@email.com (J.H.)
[2] Department of Health Sciences, Calisia University, 4 Nowy Świat Street, 62-800 Kalisz, Poland; email3@email.com
[3] Department of Fruit, Vegatable and Nutraceutical Technology, Wrocław University of Environmental and Life Sciences, 51-630 Wrocław, Poland; email4@email.com
* Correspondence: ewa.pejcz@ue.wroc.pl
† Presented at the 4th International Electronic Conference on Foods, 15–30 October 2023; Available online: https://foods2023.sciforum.net/.

Abstract: This study aimed to assess the impact of bacterial species and fermentation time on wheat bread quality, FODMAP (fermentable oligosaccharides, disaccharides, monosaccharides, and polyols) content, and antioxidant activity of wheat bread, utilizing boosted native sourdough as a novel approach to enhance bread production. The incorporation of lactic acid bacteria strains, i.e., *Lacticaseibacillus casei* and *Lactiplantibacillus plantarum* in a 72-h fermentation period significantly reduced FODMAP content to less than 0.1 g/100 g of wheat bread. Extending the fermentation time notably increased antioxidant activity, with *L. plantarum*-inoculated sourdough showing the highest enhancement in antioxidant properties among the tested bacterial strains. While the treatment yielded positive effects on FODMAP modulation and antioxidant activity, it is crucial to acknowledge the impact on some organoleptic properties, such as aroma and flavour, which, despite good overal bread quality have changed as a result of prolonged fermentation time. The findings emphasize the effectiveness of bacterial species selection and fermentation duration for FODMAP reduction and antioxidant enhancement. The results contribute to the understanding of sourdough-based interventions in bread production, offering insights for the development of healthier and nutritionally improved wheat bread products.

Keywords: sourdough fermentation; wheat bread; antioxidant activity; FODMAP

Citation: Pejcz, E.; Lachowicz-Wiśniewska, S.; Nowicka, P.; Wojciechowicz-Budzisz, A.; Harasym, J. Enhancing Bread's Benefits: Investigating the Influence of Boosted Native Sourdough on FODMAP Modulation and Antioxidant Potential in Wheat Bread. *Biol. Life Sci. Forum* **2023**, *26*, x. https://doi.org/10.3390/xxxxx

Academic Editor(s): Name

Published: date

1. Introduction

Carbohydrates known as FODMAPs (Fermentable Oligosaccharides, Disaccharides, Monosaccharides, and Polyols) can have positive effects but inadequate digestion leads to gastrointestinal symptoms. Excess FODMAP intake causes abdominal issues like diarrhea, flatulence, and pain [1]. Over 20 g/day of high FODMAP foods can worsen symptoms in those with irritable bowel syndrome (IBS) [4]. IBS affects 5% to 20% of people, especially young individuals, particularly women [2,3]. A low-FODMAP diet, restricting short-chain carbs, helps IBS [3]. Sourdough bread-making reduces FODMAPs [4–6], using bacteria to modify enzyme profiles and create innovative food possibilities. Sourdough, mixing yeast cells and lactic acid bacteria, enhances bread, including carbohydrate changes [7].

This study explores bacterial species and fermentation time effects on bread quality, FODMAPs, and antioxidants. It aims to utilize boosted native sourdough to lower FODMAPs and enhance antioxidant activity in wheat bread, creating healthier products.

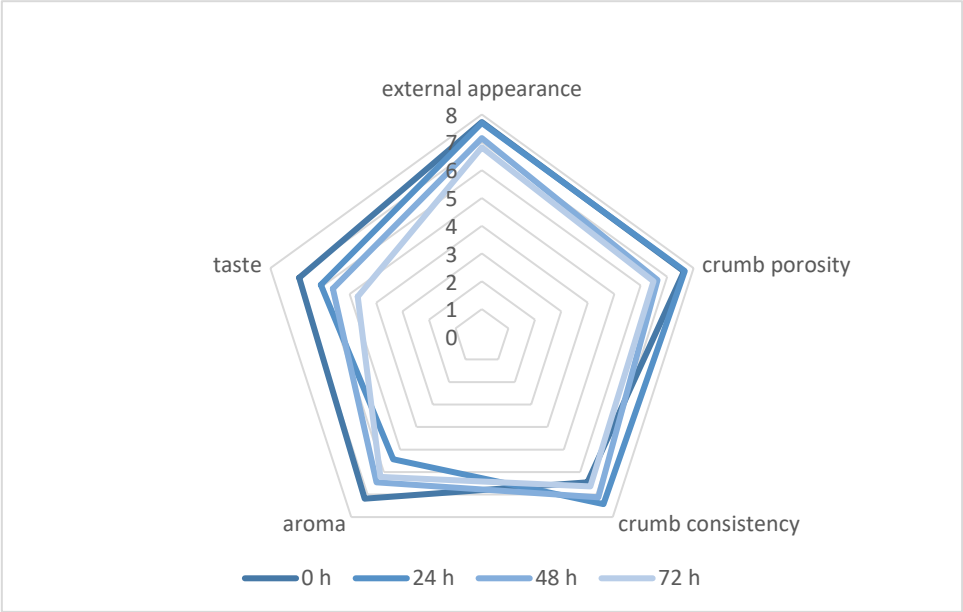
2. Materials and Methods

The research material included type 650 wheat flour and two strains of lactic acid bacteria: *Lacticaseibacillus casei* (DSM 20011) and *Lactiplantibacillus plantarum* subsp. *plantarum* (DSM 20174). Commercial pressed yeast *Saccharomyces cerevisiae*, salt, and tap water were also used for bread baking. The sample preparation process consisted of multiplication of microorganisms, preparation and fermentation of sour soups, production and fermentation of sourdough, and bread baking. The obtained sour soups were used to prepare sourdoughs that were fermented for 24, 48, and 72 h at 30 °C. In the next stage, three doughs were prepared for each variant with the sourdoughs produced. The control samples consisted of wheat bread prepared using the single-phase method (without sourdough). Dough was prepared in a farinograph, then pieces of each dough variant were fermented for 60 min at 30 °C in a fermentation chamber and baked for 30 min at 220 °C in an oven.

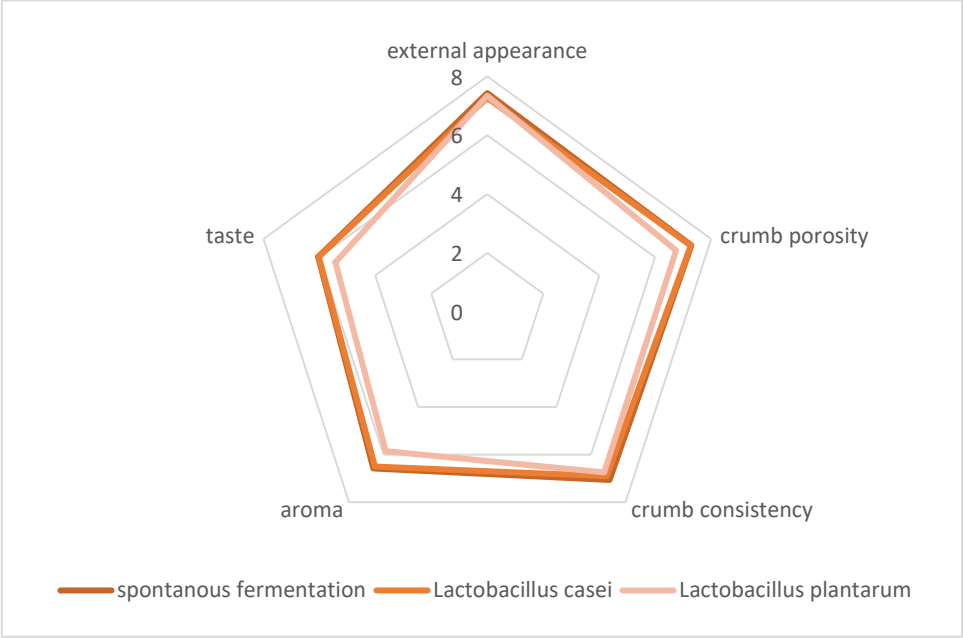
Fresh bread was and subjected to consumer acceptance assessment carried out on a 9-point hedonic scale. The content of FODMAP compounds and total polyphenol content (TPC) as well as antioxidant activity were determined in the samples of flour and bread. The content of fructans was determined acc. to the AACC 32-32.01 spectrophotometric-enzymatic method [8]. The content of fermentable sugars was determined by high performance liquid chromatography (HPLC) as described in previous study [9]. The content of FODMAPs is presented as the sum of fructans and identified sugars and polyols, and expressed in grams/100 g of the product. For the antioxidant activity determination, the total polyphenol content of the samples was determined by the Folin-Ciocalteu spectrophotometric method and expressed as mg gallic acid equivalents (GAE) per 100 g dry sourdough. The $ABTS^{\bullet+}$ and FRAP assays were performed and the results are expressed as Trolox equivalents in mmol/L per 100 g dry sample [10].

3. Results and Discussion

The lowest loaf volume per 100 g of flour was found for the breads with the addition of spontaneously fermenting sourdough and for the bread made without sourdough and the highest for breads made with sourdough inoculated with both *L. casei* and *L. plantarum.* However, their loaf volume decreased along with the extension of the fermentation time. For consumer acceptance measurement the panelists assessed such quality attributes of the bread as: external appearance, crumb porosity, texture, aroma and taste. With the longer fermentation time of the sourdough, only crumb texture was rated higher, while flavor ratings deteriorated. The quality parameters of bread with spontaneously fermented sourdough and inoculated with *L. casei* were assessed similarly, while the use of *L. plantarum* inoculum resulted in lower scores for poosity, aroma and flavor of the bread.



(**a**)



(**b**)

Figure 1. The organoleptic properties of breads depending on (**a**) the fermentation time; (**b**) the fermentation type.

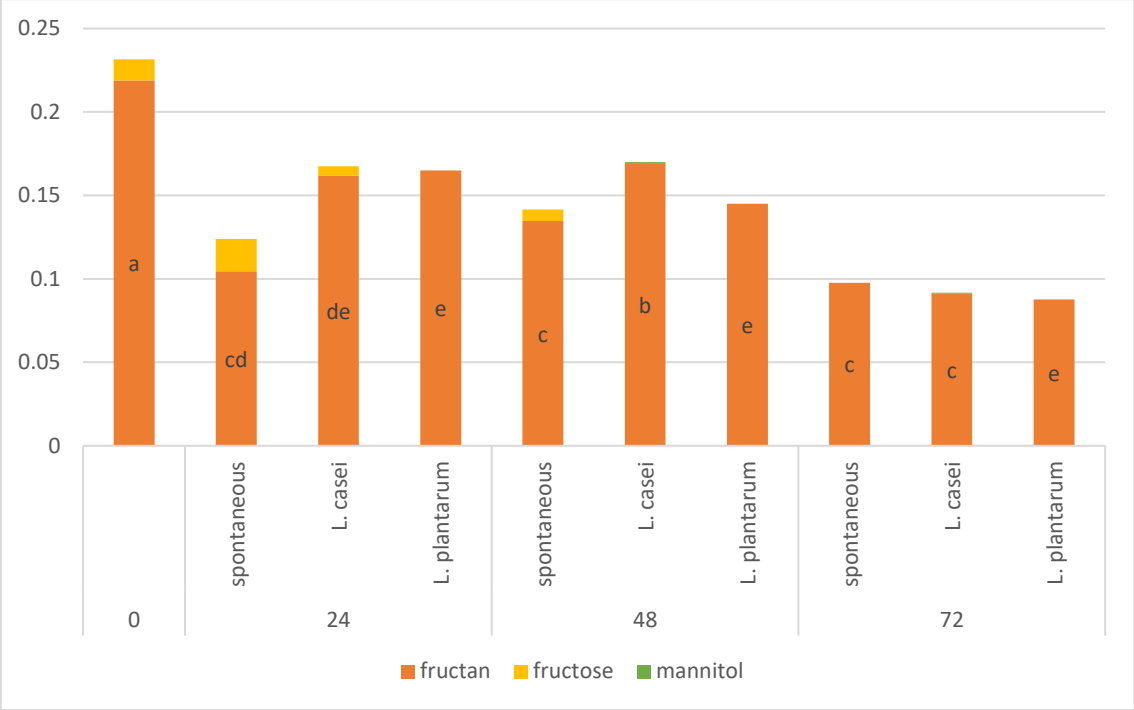


Figure 2. The FODMAPs content in wheat bread [g/100 g dry matter]; Small letters denote significant differences according to Duncan's test ($p \leq 0.05$).

Fructans constituted the dominant FODMAP fraction in each type of bread, and no glucose was identified in any of the bread samples and fructose turned out to be the major sugar found in the produced breads. Trace amounts of mannitol were identified only in the bread with the addition of *L. casei*-fermented sourdough for 48 h and 72 h. Regardless of the sourdough fermentation method, the lowest FODMAPs content was found in the breads made of the sourdough fermented for 72 h. According to Struyf et al. (2017) [3] the content of fructans in wheat flour is at 1.4–1.7 g/100 g flour. In the present study, it was influenced by both the time and method of sourdough fermentation and breads made without the sourdough had the highest content of fructans. Also in the study by Menezes et al. (2018) [1], the content of fructans in wheat bread decreased along with extending sourdough fermentation time.

The total polyphenol content (TPC) was higher in the bread produced after each type of sourdough fermentation than in the bread produced without sourdough and was the higher the longer the fermentation time. The proteolytic activity of LAB influences the profile of polyphenols, which contributes to the improvement of their solubility [11]. The FRAP activity increased with the extension of sourdough fermentation time, however, this increase is significant within the first 24 h of fermentation also with the increase being greater upon the use of inoculated than spontaneously fermentating sourdoughs.

Producing wheat bread with a reduced content of FODMAP compounds is feasible by making the dough with the use of sourdough fermented by lactic acid bacteria of the *L. casei* and *L. plantarum* species for 72 h. Extension of the sourdough fermentation time contributes to FODMAPs content reduction, especially fructans. In addition, extension of the lactic acid fermentation contributed to the improvement of the antioxidant properties of wheat bread, which were the highest upon the use of the *L. plantarum*-inoculated sourdough.

Table 1. The total polyphenol content (TPC) and the antioxidant activity of the wheat sourdough breads Values represent the means of 3 replicates. Small letters in the same column denote significant differences according to Duncan's test ($p \leq 0.05$); dm- dry matter.

Factors		TPC [mgGA/100 g dm]	ABTS [mmol Trolox/100 g dm]	FRAP [mmol Trolox/100 g dm]
Fermentation time	0 h	62.32 c	0.44 a	0.39 b
	24 h	131.76 b	0.38 b	0.51 a
	48 h	130.51 b	0.44 a	0.53 a
	72 h	157.28 a	0.40 b	0.50 a
Sourdough type	spontanous	122.31 ab	0.38 b	0.45 b
	L. casei	114.35 b	0.44 a	0.51 a
	L. plantarum	124.74 a	0.43 a	0.50 ab

Author Contributions: Conceptualization, E.P. and J.H.; methodology, E.P., S.L.-W. and P.N.; software, E.P. and P.N.; validation, E.P., S.L.-W. and P.N.; formal analysis, A.W.-B.; investigation, E.P. and S.L.-W.; resources, E.P. and J.H.; data curation, E.P. and A.W.-B.; writing—original draft preparation, E.P.; writing—review and editing, A.W.-B.; visualization, E.P.; supervision, E.P. and J.H.; project administration, E.P.; funding acquisition, E.P. and J.H. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement:

Informed Consent Statement:

Data Availability Statement: The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

Acknowledgments: The authors thank the laboratory assistants of the Department of Fermentation and Cereal Technology, Beata Włodarska and Krystyna Siekańska, for their help in carrying out the research.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Menezes, L.A.A.; Minervini, F.; Filannino, P.; Sardaro, M.L.S.; Gatti, M.; De Dea Lindner, J. Effects of Sourdough on FODMAPs in Bread and Potential Outcomes on Irritable Bowel Syndrome Patients and Healthy Subjects. *Front. Microbiol.* **2018**, *9*, 1972.
2. Loponen, J.; Gänzle, M.G. Use of Sourdough in Low FODMAP Baking. *Foods* **2018**, *7*, 96.
3. Pirkola, L.; Laatikainen, R.; Loponen, J.; Hongisto, S.; Hillilä, M.; Nuora, A.; Yang, B.; Linderborg, K.M.; Freese, R. Low-FODMAP vs. regular rye bread in irritable bowel syndrome: Randomized SmartPill® study. *World J. Gastroenterol.* **2018**, *24*, 1259–1268.
4. Nyyssölä, A.; Ellilä, S.; Nordlund, E.; Poutanen, K. Reduction of FODMAP content by bioprocessing. *Trends Food Sci. Technol.* **2020**, *99*, 257–272.
5. Schmidt, M.; Sciurba, E. Determination of FODMAP contents of common wheat and rye breads and the effects of processing on the final contents. *Eur. Food Res. Technol.* **2020**, *247*, 395–410.
6. Fraberger, V.; Call, L.-M.; Domig, K.J.; D'Amico, S. Applicability of Yeast Fermentation to Reduce Fructans and Other FODMAPs. *Nutrients* **2018**, *10*, 1247.
7. Colosimo, R.; Gabriele, M.; Cifelli, M.; Longo, V.; Domenici, V.; Pucci, L. The effect of sourdough fermentation on Triticum dicoccum from Garfagnana: ^{1}H NMR characterization and analysis of the antioxidant activity. *Food Chem.* **2020**, *305*, 125510.
8. *Approved Methods of Analysis AACC International 92010*; AACC Method 56-81.03 Determination of falling number, AACC Intl. 46-12.01 Crude protein—Kjeldahl method, boric acid modification, AACC 32-32.01 Measurement of total fructan in foods by an enzymatic/spectrophotometric method, AACC Method 54-60.01 Determination of rheological behavior as a function of mixing and temperature increase in wheat flour and whole wheat meal by Mixolab. AACC international: St. Paul, MN, USA.
9. Pejcz, E.; Lachowicz-Wiśniewska, S.; Nowicka, P.; Wojciechowicz-Budzisz, A.; Spychaj, R.; Gil, Z. Effect of Inoculated Lactic Acid Fermentation on the Fermentable Saccharides and Polyols, Polyphenols and Antioxidant Activity Changes in Wheat Sourdough. *Molecules* **2021**, *26*, 4193. https://doi.org/10.3390/molecules26144193.
10. Lachowicz, S.; Świeca, M.; Pejcz, E. Biological activity, phytochemical parameters, and potential bioaccessibility of wheat bread enriched with powder and microcapsules made from Saskatoon berry. *Food Chem.* **2021**, *338*, 128026.

11. Struyf, N.; Laurent, J.; Lefevere, B.; Verspreet, J.; Verstrepen, K.J.; Courtin, C.M. Establishing the relative importance of damaged starch and fructan as sources of fermentable sugars in wheat flour and whole meal bread dough fermentations. *Food Chem.* **2017**, *218*, 89–98.