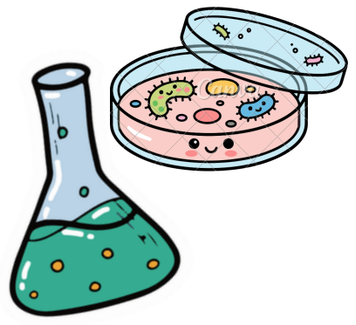
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CONTROLLED FERMENTATION OF BUCKWHEAT HULLS: ACIDIFICATION KINETICS AND MICROBIAL GROWTH

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ABSTRACT

Buckwheat hulls represent an underutilized by-product with potential applications in functional foods. This study evaluated the controlled fermentation of a hull-rich sourdough matrix (60% buckwheat hulls) using three lactic acid bacteria (*Levilactobacillus brevis, Weissella confusa, Leuconostoc citreum*) and *Saccharomyces cerevisiae*. All microorganisms exhibited active fermentation, with *Weissella confusa* showing the fastest acidification and highest microbial growth. *Leuconostoc citreum* achieved the lowest final pH (3.78), while *Levilactobacillus brevis* produced the highest titratable acidity (10.0 mL NaOH/10 g). These preliminary findings highlight the potential of controlled fermentation for buckwheat hull valorization, although further biochemical and functional analyses are required (Giménez-Bastida et al., 2015; Sofi et al., 2023).

INTRODUCTION

Buckwheat (*Fagopyrum esculentum Moench*) is a naturally gluten-free pseudocereal rich in bioactive compounds, dietary fiber, and essential minerals. Buckwheat hulls, a by-product of grain processing, represent a valuable but underutilized source of insoluble fiber and phenolic compounds. Lactic acid bacteria fermentation offers a promising strategy to enhance the release and bioavailability of these compounds. This study investigates the controlled fermentation of buckwheat hulls using *Levilactobacillus brevis, Weissella confusa, Leuconostoc citreum*, and *Saccharomyces cerevisiae*, focusing on acidification kinetics and microbial growth (Huda et al., 2021; Sonawane et al., 2024; Zamaratskaia et al., 2024).

METHODOLOGY



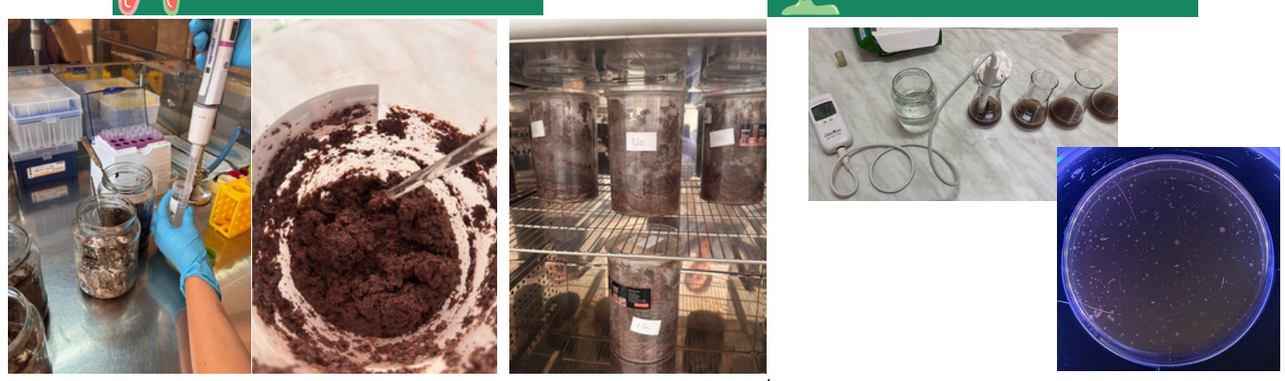
SUBSTRATE PREPARATION
250 g hull powder + 234 g wheat flour + 571 ml water + 129 g inoculum



CONTROLLED FERMENTATION
Lb/ Wc/ Lc/ Sc
30 °C / 48 h

pH & TTA
0,4,8,12,24,30 and 48 h

Microbial viability
0,12,24 h



Further analyses will include phenolic profiling (HPLC-DAD/MS), antioxidant activity (DPPH, ABTS, CUPRAC), organic acids and carbohydrates (HPLC-RID), volatile compounds (ITEX/GC-MS), amino acids (LC-MS/MS), minerals (AAS), and rheological properties (G', G'', tan δ).

RESULTS AND DISCUSSIONS

Table 1. Proximate composition of buckwheat hull powder

Proximate composition of buckwheat hull powder

Parameter	Analytical method	Result (%)
Dry matter	SR EN ISO 712/2010	92.05
Moisture	SR EN ISO 712/2010	7.95
Fat	SR 91/2007	0.22
Protein	SR EN ISO 20483:2014	3.87
Ash	SR EN ISO 2171	1.65
Carbohydrates (calculated by difference)	Calculation	86.31

Table 2. Evolution of pH and TTA during fermentation

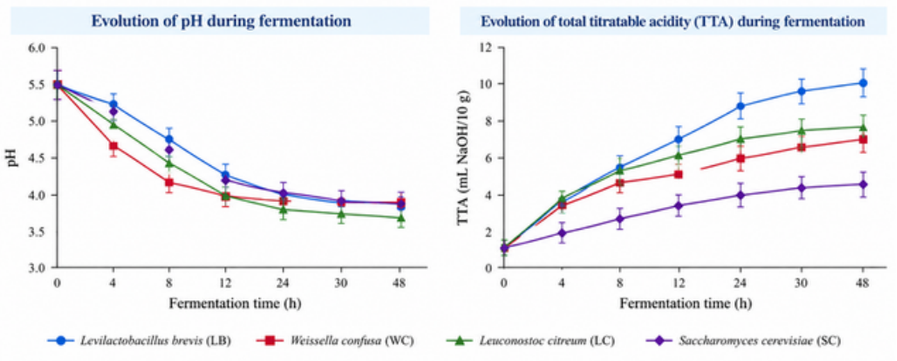


Table 3. Cell growth dynamics during fermentation

Cell growth dynamics during fermentation
(log CFU/g)

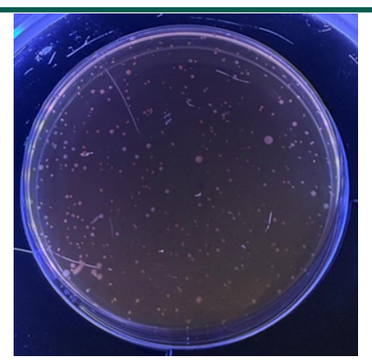
Microorganism	Fermentation time (h)		
	0	12	24
Levilactobacillus brevis (LB)	6.12 ± 0.10^{a}	8.37 ± 0.15^{b}	8.62 ± 0.12^{c}
Weissella confusa (WC)	6.20 ± 0.08^{a}	8.65 ± 0.11^{b}	8.81 ± 0.09^{c}
Leuconostoc citreum (LC)	5.98 ± 0.12^{a}	8.21 ± 0.14^{b}	8.49 ± 0.16^{c}
Saccharomyces cerevisiae (SC)	6.45 ± 0.09^{a}	7.78 ± 0.13^{b}	8.04 ± 0.11^{c}











KEY FERMENTATION OUTCOMES

FASTEST INITIAL ACIDIFICATION
***W. confusa*: pH 5.46 → 3.98±0.43 at 12 h**

LOWEST FINAL pH
***Lc. citreum:* 3.78±0.50 at 48 h**

HIGHEST FINAL TTA
L. brevis: 10±0.33 ml NaOH/ 10 g at 48 h

HIGHEST CELL COUNT AT 24 H
***W. confusa*: 2.98 × 10^{11} CFU/g**

CONCLUSION

- Fermentation feasibility: Buckwheat hulls, representing approximately 60% of the flour mixture, proved to be a suitable substrate for controlled fermentation with all four microorganisms.
- Rapid acidification: *Weissella confusa* exhibited the fastest early acidification (pH 3.98 at 12 h) and the highest microbial population (2.98 × 10^{11} CFU/g at 24 h).
- Distinct fermentation profiles: *Leuconostoc citreum* achieved the lowest final pH (3.78), while *Levilactobacillus brevis* produced the highest total titratable acidity (10.0 mL NaOH/10 g).
- Technological potential: The substantial acidification and microbial growth observed within 24 h highlight the potential of buckwheat hull fermentation for developing value-added food ingredients.
- Future research: Further biochemical, antioxidant, and rheological analyses are required to assess the functional properties of the fermented matrices.