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# NATURAL FERMENTATION PROCESSES IN BREADMAKING

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**Abstract:** Natural fermentation is an important biotechnological process in breadmaking, influencing the physicochemical, nutritional, microbiological, and sensory characteristics of bakery products. This review examines the principal natural fermentation processes employed in breadmaking, emphasizing their microbiological and biochemical mechanisms, technological characteristics, and effects on bread quality. Particular attention is given to spontaneous fermentation, controlled fermentation using selected starter cultures, and the technological characteristics of Type I, Type II, and Type III sourdoughs. Interactions between lactic acid bacteria and yeasts are discussed in relation to the production of organic acids, carbon dioxide, and volatile aroma compounds, which influence dough development and the properties of final bread products. Furthermore, the effects of fermentation temperature, duration, dough hydration, and substrate composition on microbial activity and enzymatic transformations are examined. Available scientific evidence indicates that natural fermentation can enhance flavor complexity, modify crumb texture, improve the bioaccessibility of certain nutrients, and extend product shelf life under appropriate processing conditions. However, these effects depend on microbial community composition, raw material characteristics, and fermentation parameters. The review also highlights the potential of selected starter cultures to improve process reproducibility and facilitate the industrial implementation of sourdough technologies. Challenges associated with maintaining microbial community stability, controlling acidification, and ensuring consistent product quality are also addressed. Overall, optimizing natural fermentation processes provides opportunities to diversify bakery products and improve their technological and nutritional characteristics. Integrating microbiological knowledge with appropriate technological control may support the development of high-quality bakery products that meet contemporary consumer demands while preserving the distinctive characteristics of traditional fermentation.

**Keywords:** *natural fermentation; breadmaking; sourdough; yeasts; bread quality.*

## • Introduction

Natural fermentation plays an essential role in breadmaking, influencing the technological, nutritional, and sensory properties of bakery products. Sourdough fermentation relies on the metabolic activity of lactic acid bacteria (LAB) and yeasts, which contribute to dough acidification, leavening, and flavor development. Depending on fermentation management and processing conditions, sourdough technologies are classified into three main types (I, II, and III), each characterized by distinct microbiological properties, technological functions, and industrial applications.

## • Material and method

Narrative review and qualitative comparison of peer-reviewed literature addressing microbial ecology, fermentation management, bread quality and industrial applications.

## • Results and discussions

**LACTIC ACID BACTERIA**
Organic acid production
Acidification and flavor development

**MICROBIOLOGICAL FOUNDATIONS**

**YEASTS**
$CO_2$ production and dough leavening
Formation of volatile aroma compounds

| | | |
|---|---|---|
| **Type I Sourdough Fermentation** | **Flour + water → Fermentation → Repeated refreshments** | Active LAB and yeasts; contributes to acidification, aroma and leavening.<br>Application: Traditional and artisanal breads. |
| **Type II Sourdough Fermentation** | **Flour + water + selected cultures → Controlled fermentation** | Predominantly acidifying LAB; often 30–37 °C; usually needs separate baker's yeast.<br>Application: Industrial bakery processes. |
| **Type III Sourdough Fermentation** | **Fermented sourdough → Drying → Stable dried ingredient** | Viability depends on drying conditions; supplies fermentation-derived acidity and flavor.<br>Application: Industrial premixes and bakery formulations. |

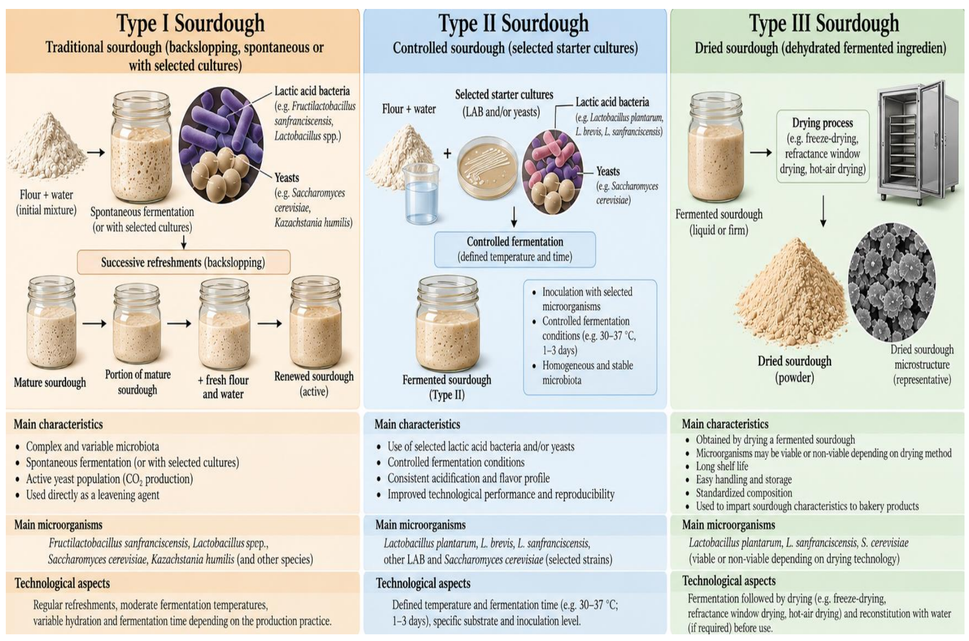



**Table 1. Comparative technological and functional characteristics of Type I, Type II, and Type III**

| Parameter | Type I sourdough | Type II sourdough | Type III sourdough |
|---|---|---|---|
| **Production principle** | Repeated refreshments (backslopping) | Prolonged, controlled fermentation | Fermentation followed by drying |
| **Fermentation temperature** | Generally moderate, often 20–30 °C | Frequently 30–37 °C | Depends on the fermentation process preceding drying |
| **Fermentation management** | Successive propagation cycles | Usually single-stage fermentation | Fermentation and subsequent stabilization |
| **Microbial characteristics** | Metabolically active LAB and yeasts | Predominantly acidifying LAB; yeast activity may be limited | Microbial viability depends on drying conditions |
| **Main technological function** | Acidification, flavor development, and leavening | Primarily acidification and flavor development | Delivery of fermentation-derived acidity and flavor |
| **Leavening capacity** | Can contribute directly to dough leavening | Usually requires additional baker's yeast | Usually requires additional baker's yeast |
| **Storage and handling** | Requires regular maintenance | Requires suitable storage and process control | Generally easier to store, transport, and dose |
| **Principal limitation** | Variability associated with propagation conditions | Control of acidity and fermentation parameters | Possible loss of microbial viability and volatile compounds during drying |
| **Main application** | Traditional and artisanal breadmaking; selected industrial processes | Industrial breadmaking | Industrial bakery formulations |

**Figure 1.** Schematic representation of the technological characteristics of Type I, Type II, and Type III sourdough production systems.

## Conclusions

Type I favors active fermentation and traditional breadmaking; Type II enables controlled acidification; Type III offers storage and handling advantages. Performance depends on microbial cultures, flour composition and processing conditions; no single technology is universally superior.

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