



Protection of Packed Bread Against Fungal Contaminants



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Abstract

The fungal and yeast contaminants cause the spoilage and devaluation of packed bread. The precautions to fungal contaminants include physical treatment, chemical preservative, and packaging system. Nowadays, the active antifungal microorganisms and its metabolites are implemented in the technology of the packing bread to substitute chemical preservatives and approach clean label.

Keywords: Packed bread; Antifungal; Fungal contaminants; Ferments; Lactic acid bacteria

Abbreviations: LAB: Lactic Acid Bacteria; PE-LD: Low Density Polyethylene; MAP: Modified Atmosphere Packing; APT: Active Packing Techniques

Introduction

The bread is the staple food represented by many national bread types differing according to production methods and countries of origin. In general, the bread is available for consumers in unpacked and packed form as the loaf or sliced one. In consideration of the fact that the consumption of packed bread increases yearly over Europe and North America, the safety and effective preservation of packed bread against spoilers and contaminants is highly demanded. The right packaging preserves the bread against contamination, prolong the freshness, and consequently limits the bread waste [1]. In spite of sophisticated systems of packaging and application of food preservatives, the fungal spoilage is the main problem of packed bread. This review is focused on possibilities of the protection of the packed bread against fungal spoilage emphasis on alternative methods to approach "clean label."

The fungal spoilers

The fungi and yeast are widespread eucaryotic organisms present in the environment of bakeries in the form of persistent spores in spite of HAACP concept. The spores are transmitted by air, humans, equipment and input material as the flours, grains, sourdoughs and other raw materials. Although the fungal contaminants are inactivated during the baking process, the new contamination appears during cooling, slicing, wrapping, and storage of the bread. The environmental factors limiting the germination of the spores and development of fungus are moisture, temperature, rate of O₂/CO₂, the content of permitted preservatives, packaging system including

packaging material. All these factors consequently influence the shelf-life of the packed bread. The fungal contaminants of packed bread are represented mainly by *Penicillium commune*, *P. freii*, *P. olsoni*, *P. roquefortii*, *Aspergillus glaucus*, *A. niger*, *Fusarium culmorum*, *F. graminearum*, *Mucor mucedo*, *Cladosporium sp.*, *Alternaria sp.*, *Neurospora crassa*, *Eurotium repens* and many others [2-4].

Packaging system

The bread is exposed to contaminants from the environment during the cooling phase. The physical treatment, such as UV light, is the traditional treatment of the bread surface in most of the bakeries. The characters of UV radiation don't allow to treat all part of the bread but is an effective support to keep the contaminant-free environment, including packaging process. The use of packaging material concerning the food contact phase, permeability, vapor, and other desired properties is controlled by regulation (2002/72/72/EC) [5]. The modified PE-LD bags are the most frequently used [6]. Modified atmosphere packaging (MAP) with carbon dioxide and nitrogen gas can suppress the mold spoilage depend on packaging technology material used. The MAP, in combination with an antimicrobial agent such as calcium propionate (0.4%), was tested effectively on soy bread by [7]. Similarly, the active packing techniques (APT) based on trapping of oxygen migrating (oxygen absorbers) from bread eliminate the growth of fungi and prolong the shelf-life of the packed bread [8].

Chemical preservatives

The chemical preservatives represented mainly by short chain organic acids such as propionic acid, sorbic acid lactic and phenylacetic acid were tested in many studies as the effective antifungal agents in bread [9,10]. The weak organic acids can be applied as protective agents in several ways. The weak acids can be sprayed on the surface of bakery products or incorporated as the layer in packaging material [9,11]. The practical use of a chemical preservative in the bakery is limited by regulation [12]. According to law, the propionate can be added at a maximum of 0.3% and sorbate 0.2% w/w only to packed sliced and rye bread. In the case of unsliced bread is allowed up only 0.1% w/w of propionate. The high concentrations of the preservatives can protect the bread against fungal spoilage, but also influence the sensory properties. The unsuitable application of chemical preservatives can develop fungal resistance, fungal growth, and mycotoxin production.

Alternative preservation of packed bread

The limited application of chemical preservatives, emerging fungal resistance, and the effort to “clean label” encourage the researchers to test alternative and safety preservatives in packed bread [13]. The natural products such as ferments with the effective content of organic acids performing antifungal effect remain an alternative to approach clean label. The whole process of fermentation includes essential steps such as the substrate selection, selection of microorganisms, and the balance of the technological parameters to obtain optimal chemical composition of the ferment. Then the ferments need to be tested against target fungal spoilers in vitro. The utilization of naturally produced whey ferment with natural propionate produced by *Propionibacterium freudenreichii* was successfully tested in vitro and under semi-pilot conditions [14, 15]. The practical use of whey ferment with propionate in the bread dough needs the adjustment of the bread recipe concerning sensory properties. The antifungal effect lies in temporary inhibition of spore germination not in the total elimination of the molds. Thus, the shelf life of packed bread can be prolonged about two weeks [14,15].

Lactic acid bacteria

The utilization of lactic acid bacteria (LAB) as the protective microorganisms in the bakery is based on its production of active microbial compounds with antifungal activity during the fermentation process in sourdoughs. LAB release during fermentation lactate, acetate, and other active microbial compounds contributed to the production of phenyl and substituted phenyl derivatives of short chain organic acid [16,17]. The antifungal inhibitory effect is the result of the synergic action of substrate acidification and low molecular compounds. The production of active microbial compounds

by LAB is intraspecific characteristics regulated by genes and environment [3]. The protective LAB cultures are utilized as the starter culture or/and adjunct in sourdough [16,18,19]. The antifungal activity *Lbc. fermentum* C14 was successfully tested against bread molds via spraying LAB suspension on bread surface by [20]. The strains of LAB belonging to genera *Lactobacillus*, *Lactococcus*, *Pediococcus*, *Weisella*, *Leuconostoc* are included in Qualified Presumption of Safety (QPS) for authorized use in the food and feed chain within European Union [21]. Similarly, in the US, these LAB have the status as Generally Regarded as Safe (GRAS) under to U. S. Food and Drug Administration [22].

The yeast such as *Wickerhamomyces anomallus*, *Pichia fermentans*, *Meyerozyma quilliermondii* themselves or in combination with LAB are tested as promising agents with antifungal properties suitable for sourdough fermentation with antifungal effect [16,23].

Conclusion

The packed bread is the most widespread commodity of the bakery industry. The demands of consumers on the quality and shelf life of bread reflect current nutrition trends and healthy benefits. The “clean” or “friendly label” designates the packed sliced bread without E-numbered additives, enzymes, and preservatives. The alternative preservatives with antifungal effects include the ferments with a sufficient content of short chain organic acid as the product of the fermentation process. The implementation of the ferment into bread dough or the application on the bread surface after the baking process are two main applications needed technological adjustments. The representatives of LAB remain an effective alternative of chemical preservatives. Although the principles of antifungal activity of LAB, yeast, and ferments are known, the fungal contaminants remain still a severe problem regarding resistant and adaptive mechanisms fungal organisms to sanitation chemicals, fungicide, and antibiotics. The antifungal activity is intraspecific characteristic, so the research is aimed at the selection and testing new strains of LAB and yeast suitable for packed bread technology. All the alternative antifungal treatments postpone the germination of spore or fungus development but don't eliminate the fungal contaminants. The chemical and sensory properties of packed bread are changing during storage as well as a microbial composition including yeast and fungi. The healthy packed bread with “clean label” needs the balance among the nutritious composition, the effect of natural protective agents, and reasonable shelf life period.

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