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Review

Lactobacilli in sourdough fermentation

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Abstract

Sourdough technology is widely used; it is employed in bread making and for the production of cakes. Sourdough is characterized by a complex microbial ecosystem, mainly represented by lactic acid bacteria and yeasts, whose fermentation confers to the resulting bread its characteristic features such as palatability and high sensory quality. Investigation of the microbial composition of sourdough is relevant in order to determine the potential activities of sourdough microorganisms. This review focuses on the role of the most important group of sourdough fermenting bacteria that consists of lactobacilli; species that belong to the *Lactobacillus* genus are the main responsible of flavor development, improvement of nutritional quality as well as stability over consecutive refreshments of sourdough. Lactobacilli also establish some durable microbial associations. An overview of the tools for monitoring predominant species is also reported.

Keywords: Antimicrobial substances; Healthy aspects; *Lactobacillus*; Microbial monitoring; Nutritional quality; Sourdough

Contents

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1. Introduction

Dry cereals can only be eaten after grinding and mixing with water (Salovaara, 1998). Such a mixture, resulting in the formation of a dough characterized by sour aroma when left on its own for a while, may have been the first example of fermented food employed by mankind (Hammes & Gänzle, 1998). The first evidence of baking of leavened dough are dated at around 1500 BC by mural Egyptian paintings (von Stokar, 1956), although sourdough bread was already part of the European diet 5000 years ago (Währen, 1985). Sourdough was used as a leavening agent in bread production until it was replaced by baker's yeast in the 19th century; from then on its use was reduced to artisan and rye bread. Nowadays, sourdough is employed in the manufacture of a variety of products such as breads, cakes and crackers, with its application still being on the increase (De Vuyst & Gänzle, 2005; Foschino, Terraneo, Mora, & Galli, 1999; Ottogalli, Galli, & Foschino, 1996; Vogel et al., 1999) while being applied to a large variety of cereal flours throughout the world. Wheat sourdough is used in more than 30% of Italian bakery products (Ottogalli et al., 1996), including more than 200 different types of sourdough breads (INSOR, 2000). Some regions of southern Italy, such as Apulia, produces sourdough breads mostly from wheat flour species *Triticum durum* instead of the common species *Triticum aestivum* used in several other Italian regions (Corsetti et al., 2001). Rye as cereal for bread making is widely used in Germany, Poland, Russia and Scandinavian countries (Bushuk, 2001).

Study of sourdough from a microbiological point of view barely started a hundred years ago (Salovaara, 1998). Sourdough is reported to be a dough whose typical characteristics are mainly due to its microflora, basically represented by lactic acid bacteria (LAB) and yeasts. Thanks to its microbial community such a dough is metabolically active and can be reactivated. Sourdough microorganisms ensure acid production and leavening upon addition of flour and water (Anon., 1994). Since flour cannot be subjected to heat-sterilization, the occurrence and number of certain types of microorganisms will strictly depend on a combination of available substrates and specific technological parameters (Salovaara, 1998). Sourdoughs, on the basis of the technology applied, have been grouped into three types (Böcker, Stolz, & Hammes, 1995): type I, type II and type III (Fig. 1). Type I sourdoughs are produced with traditional techniques and are characterized by continuous, daily refreshments to keep the microorganisms in an active state. Type II sourdoughs, often used as dough-souring supplements during bread preparation, are semi-fluid silo preparations characterized by long fermentation periods (from 2 up to 5 days) and fermentation temperature sometimes >30 °C to speed up the process (Böcker et al., 1995; Hammes & Gänzle, 1998). Type III sourdoughs are dried preparations containing LAB resistant to the drying process (Hammes & Gänzle, 1998). Unlike type I sourdoughs, doughs of types II and III require the addition of baker's yeast (*Saccharomyces cerevisiae*) as leavening agent.

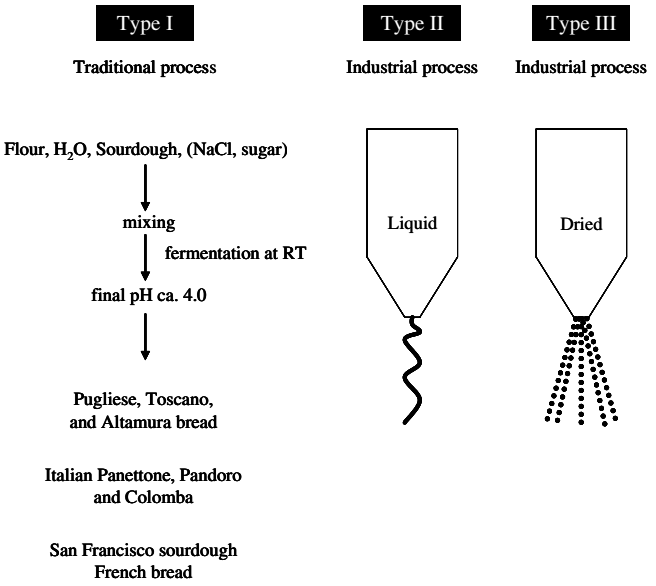

Fig. 1. Scheme of sourdough production processes.

The modern biotechnology of baked goods largely uses sourdough as a natural leavening agent because of the many advantages it offers over baker's yeast, e.g. in the development of the characteristic flavour of bread, resulting in a final product with high sensory quality (Hansen & Hansen, 1996). Many inherent properties of sourdough rely on the metabolic activities of its resident LAB: lactic fermentation, proteolysis, synthesis of volatile compounds, anti-mould and antiropiness are among the most important activities during sourdough fermentation (Gobbetti, 1998; Hammes & Gänzle, 1998). Moreover, endogenous factors in cereal products (carbohydrates, nitrogen sources, minerals, lipids and free fatty acids, and enzyme activities) and process parameters (temperature, dough yield, oxygen, fermentation time and number of sourdough propagation steps) markedly influence the microflora of sourdough and the features of leavened baked goods (Hammes & Gänzle, 1998).

2. Sourdough fermenting microorganisms

In contrast to the use of mostly homofermentative species of LAB in the majority of (fermented) food applications, heterofermentative species play a major role in sourdough fermentation (Salovaara, 1998), especially when sourdoughs are prepared in a traditional manner (Corsetti et al., 2003; Corsetti et al., 2001). So far, a few less than 50 different species of LAB isolated from sourdough have been reported (Hammes et al., 2005), some of which, e.g. *Lactobacillus reuteri* and *Lactobacillus acidophilus*, may be of intestinal origin and, due to cross-contamination, are found in sourdoughs (Gänzle, oral communication).