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IMPROVING BREAD AROMA USING SOURDOUGH FERMENTATION

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Abstract

Whole-wheat bread is commonly consumed all over the world, due to its high nutritional content. However, this type of bread have high levels of phytic acid, which can chelate divalent minerals. Phytic acid is a major phosphorous storage compound existing in most cereal grains, oilseeds and legumes and it is necessary to find technological solution for reducing its content in bread. In recent years, consumer appreciation regarding sourdough bread has increased, not only due to higher information of its nutritional properties, but mainly because consumers relish the stronger aroma of sourdough bread compared with yeasted bread. Technological aids such as natural antimicrobial compounds or sourdough utilization can be a particularly useful tool to improve bread shelf life but also bread quality and flavor. Bread aroma is determined by numerous factors, including the sort of cereal flours, the characteristics of sourdough preparation, the baking conditions, and the metabolism of fermenting microorganisms. This paper aim is to review the literature for various state of the art technological solutions for bread flavor and nutritional quality improving.

Key words*: bread, phytic acid, sourdough, whole-wheat bread.*

INTRODUCTION

Known as traditional practice the sourdough fermentation is a used in bread or steamed bread production to ferment cereals for. Compared to the instant active dry yeast commonly used in food industries, the sourdough produced bread/steamed bread has unique flavor, shelf-life, nutrition and texture characteristics (Li et al., 2017; Liu et al., 2016) and in addition lower allergenicity (Fu et al., 2020). In present-day, sourdough has been increasingly used worldwide as the consumer request for natural, tasty, healthy and nutritious foods has increased (Palla et al., 2017). One of the main fabricated products of variety of Romanian food industry is bread. Approximately 55% of the Romanian households are consuming bread with no packaging, obtained particularly from bakeries and small supermarkets. Bread is continuously present in everyday diet. 97 kilograms for each person is the estimation of the annual medium consumption of bread per capita. This fact is overtaking the European medium consumption levels (Tamba-Berehoiu et al., 2014). If we have to compare two categories of bakery products: one made by using highly refined white flour and one containing whole-wheat flour or rye flour, we can observe that the first one contains lower amounts of vitamin B1 and vitamin E. We can obtain B1 and E vitamins enriched food products by adding supplementary ingredients (mixed seeds, garlic, olive oil, onion) to some types of bakery products. These additional vegetable admixtures have been used to improve aroma and diversify the area of bakery products, pursuing to be a motivation and guidance for a healthier consumption of food (Gherghina et al., 2015). A major role in expanding the specific features of sourdough used to process wheat flour foods is played by microorganisms. From different countries there are communications regarding the microbiota of sourdough that having shown that the lactic acid bacteria (LAB) fermentation largely redounds to the specific features of sourdough products (Siepmann et al., 2018). Until now, the *Lactobacillus* genus contain 261 species. These species can be classified into 25 genera (Zheng et al., 2020) and in this category more than 60 species have been identified in sourdoughs worldwide (Gobbetti et al., 2016).

Technologies used in this discipline, Foodomics, like metaproteomics, metagenomics and metabolomics, have been used individually or in combination to obtain a profoundness comprehension of the activity, adaptation and exploitation of LAB microbiota in various complex sourdough ecosystems, particularly with consideration to metabolite production (Vaccalluzzo et al., 2020; Yang et al., 2020; Weckx et al., 2019). The use of bioprocessing techniques like sourdough fermentation constitutes a feasible strategy to meliorate both functional and sensory quality of breads that contains bran flour (Katina et al., 2005). Regarding technology of fermented food, the oldest known example is sourdough that was used to produce leavened baked products for more than 5000 years (Chavan & Chavan, 2011). Lactic acid bacteria (LAB) and yeasts compose the sourdough microbiota, which cause a diversity of organic acids and special flavoring compounds like aldehydes, esters and alcohols during the fermentation proceeding which offers to sourdough bread its unique aroma (Ripari et al., 2016). More studies proved the efficiency of composite sourdough flours insertion in bread producing by improving the texture and sensory profile (Katina et al., 2005), likewise the nutritional attributes, by rising the levels of bioactive composites and slowing starch digestibility of cereal products (Saa et al., 2017). *Humulus lupulus* L. (Cannabinaceae), known as the hop plant, since ancient times has been used for beer brewing. Hop composites reveal anticancer, antibacterial, anti-inflammatory and antioxidant activities in addition to giving beer the particularity aroma and bitterness (Abrama et al., 2015; Wang et al., 2014). Hop polyphenols could be possible functional ingredients like grape and tea polyphenols as we can find in some late studies. The appropriability of hop extracts as potential food preservatives has been studied in bread, meat and cheeses products (Nionelli et al., 2018). It has been studied that we can find only few attempts that were reported for the favorable use of hop sourdough as a natural bio preservative to notably expand the bread shelf life, without affecting its sensory and rheological properties (Nionelli et al., 2018). There are couple of studies regarding the integration of cereal bran into sourdough flour and their effects on bread quality and dough rheology (Farahmand et al., 2015). A couple of factors inclusive of fat oxidation, the cooking procedure and the fermentation process, where fermentation by sourdough associated microbiota perform a significant role in a distinctive or even geographical indication of cereal products (Petel et al., 2017). LAB and yeasts accomplish definite functions that develop flavor formation during wheat flour sourdough fermentation. *Saccharomyces cerevisiae* and yeasts, in generally is part of this category, essentially contribute to the leavening of sourdough goods and in the conversion of substantial fermentable sugars (95%) to carbon dioxide and ethanol (De Vuyst et al., 2016). Furthermore, aroma composites that specifically affect flavor like esters derived hereof generated by the Ehrlich pathway, diacetyl, organic acids and higher alcohols from branched-chain amino acids can be produced by the yeasts (Yang et al., 2020). Considering traditional sourdough goods, LAB perform a substantial role regarding the production of diversified and complex aroma compounds. As an example, LAB can confer such products with attractive flavors, such as caramel, butter, flower, grease, cheese and fruit, by producing diverse sorts of volatile aroma compounds, which includes organic acid, aldehyde, alcohol, ester and ketone (Suo et al., 2020; Petel et al., 2017; Gänzle & Zheng, 2019). In sourdough, the LAB, in combination with yeasts or alone can increase the content of aroma compounds and also can synthesize the precursors, which can as well be converted into flavor ingredient according to the thermic baking process (Aponte et al., 2014).

MATERIALS AND METHODS

This study was conducted exploring Web of Science electronic database for recent articles published between 2011 and 2021. Were studied both research articles and reviews. The main search for articles was based on six main keywords, namely: “flavour”, “aroma”, “bread”, “phytic acid”, “sourdough” and “whole-wheat bread”. The next step was to filter the results by relevance. The idea was to highlight the importance of lactic fermentation

in improving bread aroma. Most of the selected articles contains in the title the words “flour” or “sourdough”.

RESULTS AND DISCUSSIONS

Lactic acid bacteria (LAB) represent a heterogeneous cluster of industrially significant germs that are used to fabricate fermented beverages and foods, using diverse substrates, like cocoa beans, cereals, meat, vegetables or milk. The supreme advantage of LAB which is making them appropriate for the use in food biotechnology is that they are Generally Recognized As Safe (GRAS). Due to the production of a large diversity of composites, acting in a synergistic way to avoid or remove microbial contamination, it has been shown that LAB contribute to the development of the shelf life of fermented foods. LAB leads to formation of organoleptic and nutritional specific features of the final products in fermented foods. For the commercial production of many categories of beverages and foods, LAB are used in traditional manner as starter cultures. The concept “functional foods” was lately suggested and has demonstrated an outstanding development over the last few years. This type of foods should support well-being and health improvements, whereas at the same time should decrease the risk of some high degenerative and chronic diseases, such as gastrointestinal tract disorders, obesity, cancer and cardiovascular diseases (Zamfir et al., 2014). It is extremely difficult to stabilize microbiota of a sourdough with industrial appropriate specific features due to microbiota structure of sourdough which is intricate. After research regarding the varied functional characteristics of LAB isolates could conduct to the election of the most efficient single strains and of the optimum performing strain combinations for application as starters for the fabrication of steamed bread or fermented bread (Palla et al., 2017). Recently, have been spotted and isolated a few LAB strains for their role in sourdough fermentation, with *Pediococcus pentosaceus* and *Fructilactobacillus sanfranciscensis* having earned attention founded on inoculation tests. On a large scale, *P. pentosaceus* has been isolated from different geographical regions sourdoughs and is mainly prevalent in fermented potato dough (Rizzello et al., 2019), the traditional Italian sourdoughs (Reale et al., 2019), various categories of Jiaozi sourdough in China (Liu et al., 2016; Xing et al., 2020; Li et al., 2016) and even in wheat flour (Alfonzo et al., 2017). Taking into acount its capability to decrease the acrylamide content in baking bread (Nachi et al., 2018), also its capability to produce antioxidant exopolysaccharides (Abedfar et al., 2018) and for its antimicrobial and antifungal attributes (Bartkiene et al., 2020), *P. pentosaceus* in fermentation activity has become high interesting for use in sourdoughs. *P. pentosaceus* has the ability to ferment glucose to lactic acid, which benefits the fast production of flavor compounds and bioactive materials (Carafa et al., 2015). It was demonstrated that the inoculated *P. pentosaceus* during faba bean dough fermentation, was increased the dough attributes by decreasing phytic acid production and reducing the oligosaccharide content (Rizzello et al., 2019). If we are making an analogy to commercially purchased starters, bread produced by inoculating *P. pentosaceus* was shown to have more high organic acid - like volatile aroma compounds and greater sensory attributes (Plessas et al., 2020; Montemurro et al., 2020). Notwithstanding *P. pentosaceus* is not the optimum genus for bread aroma constitution, based on analogy between different LABs (Siepmann et al., 2019), therefore when the strain was inoculated in the starter, Chinese steamed bread has the higher sensory attribute (Xing et al., 2019). *P. pentosaceus* was demonstrated to have a beneficial and close connection with the production of volatile aroma compounds, like2-methyl-1-propanol, phenethyl alcohol, isoamyl alcohol, ethyl caprylate and phenylethyl acetate in sourdough fermented steamed bread. (Yan et al., 2019a). When we talk about representative sourdough LAB in the USA, France, United Kindom, Belgium and Italy for making baked bread, we refere to *Fl. sanfranciscensis* (Comasio et al., 2020; De Vuyst et al., 2014). We can find that this genus was evidenced that in the field of steamed bread making is preponderant in type I Chinese traditional sourdough specimens (Wang et al., 2020), even though there is no proof to express that

Fl. sanfranciscensis is corresponding with geographical source, as no region specific strains could be recognized in a study using Multilocus Sequence Typing (MLST) and multiplex-RAPD techniques (Yang et al., 2017). The widespread allocation of *Fl. sanfranciscensis* in sourdough ecosystems may be due to the fact that it comes originary from insects, as stated in the examinations in which the predominant genus was most often discovered in both sourdough and insect powder food. (Boiocchi et al., 2017). *Fl. sanfranciscensis* is a ambitious genus in the microbiota over sourdough fermentation, in conformity with a differential analysis research utilising the Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) - Locus Length Polymorphism PCR (CLLP-PCR), where *Fl. sanfranciscensis* TMW 1.392 get prevailing after 2 days of sourdough fermentation and remained the only recognized strain in the subsequent sampling session (Rogalski et al., 2020). The competitiveness of *Fl. sanfranciscensis* could be attenuated by small perturbations of the ecosystem, like the existence of ferulic acid and fluctuations in the sucrose levels of the fermented sourdough (Dinardo et al., 2019). In sourdough, *Fl. sanfranciscensis* has a high impact at the level of rheological characteristics of dough and bread (steamed) sensory quality, aroma, texture and specific features (Xu et al., 2019a), shelf-life through the medium of the inhibition of fungal growth (Zhang et al., 2019a), the fabrication of exopolysaccharides with characterized antioxidant actions (Zhang et al., 2019b) and gluten attributes (Xu et al., 2018). When inoculating bread with yeast and *Fl. sanfranciscensis* the intricate structure volatile compounds is higher than intricate structure of bread made with baker's yeast (Xu et al., 2019b). It was demonstrated that the prevailing of *Fl. sanfranciscensis* in type I sourdough-based Jiaozi Chinese steamed bread is performing a substantial role in the creation of volatile aroma compounds, like aldehydes, furan and organic acids (Yan et al., 2019b). Recent studies have shown in an analysis of the microbial community dynamics that *Fl. sanfranciscensis* with a metabolic preference for maltose and a *Kazachstania humilis* strain unable to use maltose were predominantly stable microorganisms anywhere in the fabrication of type I sourdough steamed bread made using the process of retarded sponge-dough, which agreed with the formation of ethyl esters of volatile compounds because the accumulation of ethanol and organic acids as the sponge delay time was extended. (Wang et al., 2020). It was shown in an investigation of a gene deletion mutant that *Fl. sanfranciscensis* collected γ-glutamyl-cysteine and decreased glutathione through the medium of glutathione reductase (GshR) process over proofing, which is salutary to meliorate the texture and taste of type I sourdough bread (Tang et al., 2017). Omics boardings have been on a large scale utilised to realize the sourdough fermentation activity, as transcriptomics has high potential in clarifying the expression of functional genes based on RNA specimens (Weckx et al., 2019). *Fl. sanfranciscensis* demonstrated improved self-protective actions and carbohydrate metabolism and reduced cell proliferation in sourdough at 12 hours, resulting in an exclusive volatile profile, with no defined compounds in the sourdough, according to a transcriptomic analysis using the process of RNA sequencing process compared to fermented sourdough for 6 hours (Liu et al., 2020).

CONCLUSIONS

Using LAB in food biotechnology has the main advantage of being recognized as GRAS. Also, when using LAB in fermented food products, especially bread, the organoleptic and nutritional characteristics, as well as rheological characteristics, sensory quality, aroma and texture are improved. Fermentation and baking process influenced also the functional properties of bread by leading to a reformulation of some bioactive compounds. LAB combined with yeast fermentation may increase or retain the content of bioactive compounds present in flour. In combination with yeasts or alone, in sourdough, the LAB can increase the content of aroma compounds. The LAB can synthesize the precursors, which can as well be converted into flavor ingredient according to the baking process. In fermented foods, LAB is important not only because it acidifies and therefore preserves food from

deterioration, but also because of their contribution to the organoleptic properties of the fermented food. This is partly due to the production of exopolysaccharides (EPS), which are long-chain polysaccharides composed of a single type (homopolysaccharides - HoPS) or several different monosaccharides (heteropolysaccharides - HePS), released by bacteria in their surroundings.

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