

Benefits of Sourdough Bread: A review

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What follows is a glimpse of the scientific literature dealing with to key issues related to sourdough bread. The first deals with aroma, flavor and other important physical features: the second with known health benefits. The curious reader is urged to go to the literature that is provided when further detail is sought.

Aroma, Flavor and Other Important Features

A considerable amount is known about the chemistry behind the aromas and flavors (volatiles) one associates with bread, even to the point that these can be mimicked simply by mixing the known chemical elements in a test tube (3, 12, 28, 48). The bacteria and yeast present work synergistically to produce the specific chemicals responsible (6, 8, 12, 14, 35, 37). These “flavor compounds” include several different and complex organic acids, including acetic acid, but also many others with very complicated names; a whole group of chemicals called aldehydes; and finally a whole group of alcohols. The metabolic pathways that are responsible for generating these compounds also are becoming known in some detail (16, 20, 23, 37).

These compounds, several dozens of which can be found in a particular bread, create flavors that have been characterized as green, grassy, fatty, sweaty, spicy, cucumber-like tea-like, fruity, malty, minty, honey like, metallic, vanilla-like, tallowy, etc (12, 28). Both the lactic acid bacteria and the yeast are contributors (8, 12, 35, 43). The eventual outcome depends on what specific species of each is are present as well as the precise steps and conditions used to create the final product (5, 6, 11, 12, 24, 25, 28, 35, 43, 46, 55). Varying temperature during the process, for example, will change the proportion of yeast to bacteria: higher temperatures favor bacterial growth while lower temperatures favor yeast (53).

The main influence of the microorganisms present appears to be to enhance or decrease the amounts of odorants, rather than generating new ones (12). What changes are the relative amounts and proportions of aroma-flavor producing compounds. Most remain important to the post-baking aroma – bread right out of the oven. Everything depends on the starting ingredients.

Head-to-head comparisons demonstrate that, not surprisingly, aromas are considerably stronger in whole wheat flour-based mixes than in those based on processed white flour (12, 22, 26, 28). As a generality, white flour-based mixes are less sour, while whole

wheat flour mixes have a stronger malty and sweet component. The fermentation step adds additional complexity, with whole wheat fermentation mixes leading the way in intensity, doubtless partly because the whole wheat flour has a more complex and extensive group of aroma precursors to start with.

The fermentation produced by the specific lactic acid bacteria and yeasts highly dependent on the exact species and proportions of each (6, 8, 11, 14, 18, 20, 22, 25, 26, 28, 35). Studies have progressed sufficiently that “designer” combinations can be used that are tailor made to the cereal / pseudocereal and other “substrate” products used (52) and even to create levain-based breads for individuals sensitive to gluten (1, 16, 17, 20, 34, 40, 44; see [Health](#)). The literature also contains comparisons of processed white flour and whole wheat flour both separately and together with various combinations of lactic acid bacteria and yeasts (16). Clearly, the final product depends on precisely what products are used at the start, from flours, to levain, to salt, to even the water. All of these findings illustrating the complexities of aroma, flavor and texture explain why no one’s levain-based bread has the same aroma, taste and texture as anyone else’s.

Numerous studies demonstrate how the fermentation process contributes to other important features that improve its texture, palatability / attractiveness and shelf-life (1, 5, 6, 10, 34, 43, 44). This involves not only the organic compounds present but also simpler things like acidity (pH) that retard the growth of mold and other harmful organisms (see [Health](#)); and even a crumb that slows the desiccation process (1, 6-9, 22). Again, these factors depend on the whole package of ingredients (35, 43).

Health

There are a number of significant health benefits that characterize whole wheat breads in general and fermented breads (levain / sourdough) in particular (5, 6, 44, 47). With NO doubt, the key is using natural, unprocessed ingredients. The refining process to produce white flour results in significant losses of a variety of micronutrients, including a substantial number of both vitamins (e.g. B, E) and trace minerals (e.g. magnesium, selenium), as well as fiber, each critical to human health (33, 51).

The fermentation process itself is a major factor, affecting the levels of several vitamins, among them the vitamin B series (B₁, B₂, B₆,) vitamin E precursors, and additional potentially beneficial phytochemicals, as well as other key micronutrients such as folic acid and minerals (6, 31-33, 38, 44, 51).

There are many variables at play in terms of how the starting material, fermentation process and baking conditions affect the outcome (2, 6, 31, 38, 44). As an example for the B-vitamins, in a side-by-side study (2) it was shown that at the start, white flour contains considerably less vitamins B₁, B₃ and B₆ than whole wheat, doubtless due to the

refinement process and representing the most important loss (51): most of these and other vitamins are left behind in the bran and germ. The unleavened baking process causes a significant reduction in vitamins B₁ and B₆ levels in white flour-based bread, much less so when whole wheat flour is used, at least partly because the yeast in the whole wheat actually manufactures the vitamin. There is less loss of B₁ and B₆ vitamins when a levain fermentation mix containing yeast and lactic acid bacteria is used, again probably because the added microorganisms actively synthesize them.

The amounts of vitamin B₂ actually are increased through the baking process, thought due to synthesis of the vitamin by the yeast present and aided by increased fermentation time. Again, whole wheat flour wins out by a substantial margin. Sourdough starter alone with its lactic acid bacteria does not help much. The addition of yeast to the sourdough aids substantially, demonstrating how yeast synthesis of this vitamin is an important contributor. This likely is true of all yeasts, commercial or “wild”, though it can be expected that different yeast strains will produce different amounts of this vitamin and doubtless others as well.

The benefits do not stop with the vitamins. An additional benefit is an activity of lactic acid bacteria and yeast that removes a chemical, known as phytic acid. Phytic acid reduces the ability of the gastrointestinal tract to absorb certain minerals such as magnesium, calcium, zinc and iron, by rendering them insoluble (4, 29, 33, 36, 41, 412, 45). Levain microorganism-produced enzymes that break this acid down. The natural acidity of the fermentation process further enhances this process and, in-and-of itself increases solubility and hence recoverability.

There is still more. Everyone is aware of the obesity epidemic facing the world, leading among other things to cardiovascular disease and diabetes mellitus (sugar diabetes). The type of diabetes mellitus responsible for the epidemic is known as Type-2 diabetes mellitus. An early problem is resistance to one’s own insulin. Later on, the pancreas cannot keep up with the insulin demand.

One of the important issues here is diet, not only how many (excess) calories one is taking in but also dietary sugars that can be rapidly taken up into the body from the gastrointestinal tract. Rapid uptake of sugar puts a load on the pancreas to put out sufficient insulin and is to be avoided in those predisposed to Type-2 diabetes or who already have been diagnosed. Many have heard of classification of sugars according to their “glycemic index” which is a measure of how rapidly a sugar can be taken up from the gut (19, 55).

This gets to the important point about levain-based breads: they lower the “glycemic index” of the sugars present in the bread – they slow down the process by which the body takes up these sugars (30, 33, 44, 49). Part of the reason doubtless lies in the creation through the fermentation process of complex sugars that are difficult to break down in the gut, which slows down their entry into the blood. An additional factor may be the natural acidity of the bread (33, 44).

Anyone who has been around levain-based breads is aware that they last a long time (days) before any hint of spoiling. For sure, there is substantial and quite rapid loss of aroma and flavor (7), but there are additional factors that prevent spoilage due to molds and other organisms (6, 7, 9, 22, 34, 39, 47, 50).

A wide variety of factors protecting from spoilage, ranging from acidity to the alcohols present to gas production (chiefly CO₂) to a variety of other identified organic compounds, many manufactured by lactic acid bacteria (7, 9, 10, 13, 14, 38, 50). Of particular interest is a group of small proteins and enzymes called bacteriocins; while other products, including fatty acids and even naturally-produced antibiotics have important anti-fungal effects.

Of particular recent interest is the use of the fermentation process to create breads for those who must eat a gluten-free diet (44). Two basic strategies have been used. The first is to apply fermentation techniques to gluten-free substrates (40); the second is to select lactic acid bacteria strains that selectively destroy the peptide(s) derived from gluten that are responsible for gluten sensitivity, causing celiac disease (17). Aside from dealing with the causative agent, the use of sourdough-based strategies substantially improves texture and, in blind testing, provides a preferred bread (1).

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