Bread

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Bread is a staple food consisting in a mixture of flour, water and other ingredients that is kneaded into a dough, often fermented with yeast or another leavening agent, and baked. It is probably the most widely consumed food in the world and an important source of carbohydrate, protein, and fiber.

Bread is a basic healthy element in the Traditional Mediterranean Dietary Pyramid, placed at the base of the foods that should support the diet, including grains, of which a daily intake of one to two servings per meal in the form of bread, pasta, rice, couscous, etc., is highly recommended, https://dietamediterranea.com/en/.

Historical importance of bread

Bread has been part of the human diet for at least 30,000 years since the Upper Paleolithic in Europe. Prehistoric people were already making porridge from water and grains, and the first bread was probably obtained by accident, when some flour was made into *unleavened bread*. At that time, however, the hunter-gatherer diet was based on animal proteins and fats.

Bread became a staple food during the Neolithic period, about 10,000 years ago, when wheat and barley were domesticated in Mesopotamia and near the Nile. Fermented bread was probably discovered in Egypt, when someone baked a grain dough late and it began to swell under the effect of spontaneous fermentation, probably creating the first *leavened bread*.

Other parts of the world domesticated different grains, such as rice in East Asia, maize in the Americas, or sorghum in sub-Saharan Africa, making breads of them and forming the basis for alternative agriculture. Cereal crops allowed alternative agricultural societies to subsist, and thus bread transformed humans from nomadic hunter-gatherers to farmers, leading to the formation of towns.

How do we make it?

Bread is a microbially fermented food made by kneading and baking doughs of various flours mixed with water and often a small amount of sea salt. Fermentation is an anaerobic process carried out by specialized microorganisms in which oxygen is not necessary. The quality and

characteristics of the breads depend on the flours, the microorganisms that ferment and leaven the dough, and the knowledge and technological processes used by each baker.

What are the ingredients?

Flours are powdery substances that are produced when grains are ground in a milling process. The flours contain starch, the main storage carbohydrate of cereals (70-80%), proteins (10-15%), vitamins, and minerals. During the fermentation of the bread dough, enzymes in the flour break down the starch and make sugars available to microorganisms that ferment them.

There are many types of flours made from cereals, such as wheat or rye that contain a mixture of proteins called gliadin and glutenin which, once hydrated, combine to form the gluten; cereals such as rice and maize, and pseudo-cereals (quinoa, teff, buckwheat) do not contain those proteins. Gluten is highly valued in the baking industry for its unique viscoelastic properties, as it imparts elasticity to the dough and, together with fermentation, provides volume, elasticity and a spongy consistency to the baked doughs and the breads.

Refined flours lack the germ and bran of the grain. The germ is the reproductive center of the cereal grain and is a concentrated source of nutrients. The outer layer of the grain, the bran, adds fiber, rough texture, and brown color to flours. Flours that retain the germ and bran during the milling process contain more vitamins, minerals, and fiber than refined flours.

Organic flours are milled from pesticide-free grains, grown in soil fertilized only with natural substances, and retain their bran and germ content intact, making them significantly healthier than refined, white flours. Healthier, organic whole-grain flours are highly recommended for fortifying breads.

Microorganisms are the biological agents that *start* the fermentation of the bakery doughs.
The main *starters* are commercial *baker's yeasts* and *sourdoughs*, used either individually or in combination as leavening agents for bread making. The performance of each starter and the substances produced by microorganisms confer unique characteristics to the doughs and the breads.

Yeasts and bacteria involved in bread fermentation

Baker's yeast is a microorganism whose scientific name is *Saccharomyces cerevisiae*. The general use of yeast in bakery was introduced in the XVII century, originally obtained from breweries. Today, several strains are commercially available worldwide as freshly pressed or dried yeast. *Saccharomyces cerevisiae* produces carbon dioxide gas and ethanol by *alcoholic fermentation of sugars* – maltose, sucrose, glucose, fructose – derived from the starch present in the cereal flours that are kneaded with water. The gas inflates the dough, and the ethanol evaporates during the baking process. In addition to fermentation, *baker's yeast* produces metabolites that give bread its flavor (vitamins, diacetyl, organic acids, esters).

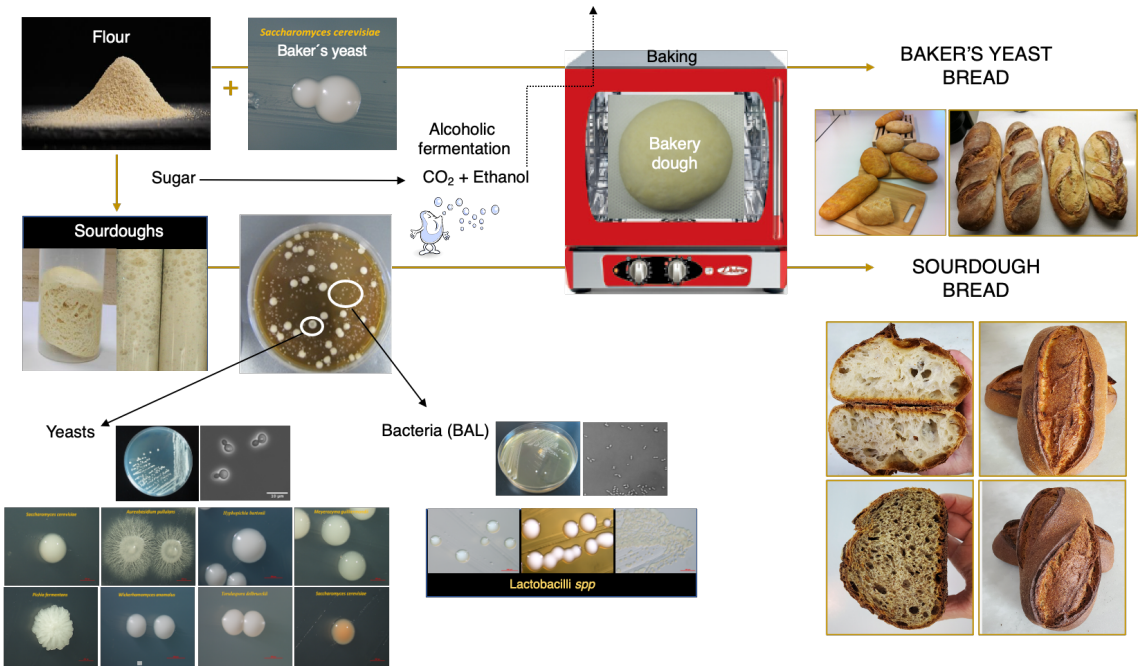
Spontaneously fermented sourdoughs were historically the *first ferment* used in bread making. These *natural* sourdoughs are rich sources of microorganisms, mainly *species of yeast and lactic acid bacteria (LAB)* that come from the grains, the flours, or the environment. Sourdoughs are obtained from mixtures of flour and tap water that are incubated at a warm temperature and fed almost daily with more flour and water to keep the indigenous microbiota alive (back-slopping process).

Sourdoughs are microbiologically active products used as leavening and souring agents in the doughs. The part of a sourdough used to ferment the bread dough is called the *mother-dough*.

Sourdoughs have a high species biodiversity and metabolic diversity, allowing a wide range of interactions and symbiotic associations that greatly influence the performance of the doughs and the quality of the *sourdough breads*. These two types of microorganisms provide fermentative power, metabolites, vitamins, organic acids, flavors, nutritional properties, and extend shelf life.

Yeasts are the main contributors to the *flavor* of sourdough breads. Over 30 species have been identified in sourdoughs worldwide, most commonly from the *Kazachstania, Torulaspora, Pichia, Meyerozyma, Saccharomyces* and *Wicherhamomyces* genera. Some yeasts have good fermentative power (*Saccharomyces, Kazachstania*), and others provide nutritional or safety benefits to sourdough breads (e.g., inhibition of fungi and the mycotoxins they produce). *LAB* dominate the sourdough microbiota and coexist with yeasts, generally in a 100:1 ratio. More than 90 LAB species have been identified that determine the main functional benefits of using sourdoughs, including species of the *Leuconostoc, Pediococcus* and *Weisella* genera, and lactobacilli (*Lactiplantibacillus, Levilactobacillus, Fructolactibacillus Limosilactobacillus*, etc.).

The preservative effect of the sourdoughs is due to the production of lactic acid and acetic acid. LAB also produce bioactive compounds and enzymes that contribute to the nutritional and sensory quality of the bread (vitamins, enzymes, exopolysaccharides). Bacteriocins secreted by some lactobacilli inhibit the growth of undesirable bacteria.



Breads around the world

As mentioned above, bread has been part of the human diet for thousands of years. It is estimated that about 60% of the current world population eats some bread daily. In most countries, bread accompanies almost every meal, and in others it is the basic food.

Even in the same country, bread baking is constantly being improved and different flours, baking methods and different kind of typical breads are available in the different regions. There are many varieties that are part of the cultural heritage of each country. Some examples of popular breads or *bakery goods* made of wheat are the American and the Polish bagels; the Croatian flatbread; the English crumpets; the French baguette; the Indian paratha; the Italian focaccia; or the Middle Eastern pita bread. The Mexican tortilla and the Croatian *kukuruzni kruh* are made of corn; the Ethiopian *injera* is made of teff; the Austrian *semmel*, Danish *rugbrød* and German *schwarzbrot* are all made of rye; In Spain, Galicia, and the provinces of Castilla y León (Zamora and León) produce a variety of high-quality breads made of wheat and with other organic flours.

Current tendencies and perspectives in making breads with improved properties

Current efforts are focused on creating more diverse, innovative bakery products with beneficial health effects. Thus, there is a tendency in the sector to elaborate the old style "*slow breads*", using *sourdoughs* as the only starter and fermenting the doughs for a sufficiently long time. These products are of better nutritional and sensory quality than "*fast breads*", which are leavened with commercial yeasts in rapid fermentations. Sourdough fermentation is also an effective strategy for producing gluten-free breads with fewer external additives. Sourdough breads have been shown to reduce the metabolic response compared to breads made with commercial yeast, as organic acids improve the postprandial glucose and insulin responses in healthy individuals.

However, the use of *spontaneously fermented sourdoughs* is not risk-free since they can contain, together with useful species, spoilage microorganisms or pathogens that produce unwanted substances. *Inoculated sourdoughs* made with selected strains of lactic acid bacteria and yeasts of beneficial species, originally isolated from sourdoughs, are microbiologically stable, safe, and easy to use. Selected microorganisms can provide functional metabolites, such as vitamins (B_1-B_6, B_{12}, folates), enzymes that pre-digest the starches, proteins, and sugars present in the flours; and minerals (iron, manganese, calcium, zinc, potassium, selenium, iron, manganese, magnesium, phosphorus), making breads more nutritive, digestible, and healthier.

Other efforts to improve the nutritional quality of breads are based on the partial or total replacement of refined wheat flours with other raw materials, which are valued for their content of ingredients not found in traditional breads. It is, therefore, advisable to include "*ancient grain*" flours in the production of innovative breads, since they have not been modified for thousands of years and tend to be richer in fiber, omega-3 fatty acids, B-vitamins, zinc, etc. Ancient grains include varieties of wheat such as spelt, kamut, einkorn, and emmer; the grains millet, barley, teff, oats, and sorghum; and the pseudo-cereals quinoa, amaranth, buckwheat, and chia.

An important agricultural commodity group are *legumes,* which are a valuable source of protein with a balanced amino acid profile, carbohydrates, fiber, vitamins, minerals, and phytochemicals with beneficial health effects. Many legumes, such as chickpeas, peas, beans, and lentils naturally contain high levels of resistant starch, which is digested slowly and prevents potentially harmful blood sugar spikes.