

# The blessings of fungi

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If you have ever joined a Jewish family for a meal on the Sabbath, or seen one depicted in movies, you will know it is quite a ceremonial occasion. Before everyone begins to eat, your host will recite two blessings. The first, over a cup of wine, blesses God 'for creating the fruit of the vine'. The second is over plaited loaves, for 'bringing forth bread from the ground'. The ritual is ancient and is echoed in Christian holy communion, when a priest blesses a cup of wine and a wafer—which are then considered by some devout believers to turn into the blood and body of Jesus. The origin of these Christian blessings—and the connection with the Jewish ones—is in the New Testament account of Jesus's supper with his disciples, which took place on the Sabbath that marked the eve of his crucifixion.

The blessings have often intrigued me. Why, for example, are these specific food-stuffs the subject of these central rituals of faith rather than other staples such as vegetables and fruit? Do wine and bread seem holy because both are the products of fermentation, which must have seemed a very magical process to ancient peoples? Could anyone two or three millennia ago have realised somehow that both are the consequence of the same biological process? (The answer to this last question is obviously no, since it was only in 1827 that Jean Baptiste Desmazières described finding germs in beer and wine, and in 1857 that Louis Pasteur (see [figure 1](#)) showed that these were the cause of fermentation.) Or did a major group of religious believers regard it as important to bless God for the two chief by-products of a fungus because these shared some particular cultural importance in early civilisations?

I think I have now discovered an explanation. It appears in a recent book by a botanist from Ohio called Nicholas P Money.<sup>1</sup> The book has the delightful title of 'The rise of yeast: How the sugar fungus shaped civilisation'. Money's case is quite simply that brewing alcohol and making bread played a crucial role in transforming our ancestors from nomadic hunter-gatherers into urban dwellers around 10 000 years ago, and hence in determining the



Figure 1 Louis Pasteur.

structure and direction of all the major civilisations.

## A MARRIAGE MADE IN EDEN

Money takes his readers on an impressively learned tour of history, sociology, biology and chemistry. He describes yeasts that are pathogens, as well as those used to make biofuel and medicines. Here, I shall summarise what he has to say about bread and wine specifically, along with excursions down other byways the book prompted me to explore.

The kingdom of fungi probably has over 2 million species, of which around 1500 are yeasts with the power of fermentation. The sugar fungus *Saccharomyces cerevisiae*, which we mainly use nowadays for brewing and baking, goes back around 100 million years to the sudden doubling in size of the genome in one of its ancestors (see [figure 2](#)). This happened to coincide with a similar duplication in some plants, leading to the emergence of fleshy fruits that the yeast was able to devour: a marriage made in Eden.

Like every other organism (including ourselves), the sugar yeast has only one ultimate biological purpose, namely to make descendants. It does this by budding every hour or two, although at times when sugars are scarce it can also mate sexually and form into spores to wait for better days. When there is a lot of oxygen around, it gobbles up

sugars to derive energy for reproduction by turning them into water and carbon dioxide, just as we do. When oxygen runs out, it metabolises the sugar into acetaldehyde and then alcohol instead. This happens to be especially convenient because alcohol kills off other fungi and bacteria that might compete for the same fruit, although when the level arises above 10% or 15%, the sugar fungus itself will die—which is why unfortified wine commonly has a concentration around that level.

Sugar fungi sometimes make alcohol in the wild, for example in palm trees, and other mammals including shrews, elephants and chimpanzees consume it, although they do not appear to get drunk. Human production of alcohol may have been prompted by our ancestors discovering that palm sap left out in the sun was intoxicating. We probably inherited the enzymes for digesting alcohol from earlier apes who ate over-ripe fruit, but unlike them we later mastered the skill of making it in enough quantities to get drunk. Archaeological discoveries show evidence of making wine from rice in China from 8600 years ago, and beer from grain in Iraq and wine from grapes Egypt around 5000 years ago.

## LEAVENED LOAVES

Bread using fermentation arrived on the scene much later than alcohol. *Homo sapiens* was using flour to make flatbread, without yeast, from the Stone Age, but leavened loaves only originated with the ancient Egyptians. Initially, these were almost certainly the result of accidental contamination of dough with foam from beer, but at some point people must have realised they could bring about this form of apparent magic intentionally. They also discovered that a batch of unbaked dough could be set aside from 1 day's breadmaking to prime the following day's batch.

Although yeast cannot metabolise dry flour, it can do so once the flour has been wetted, releasing enzymes that break down its complex sugars into simple ones. The yeast starts its work aerobically as usual, but quickly changes over to fermentation instead, producing carbon dioxide and alcohol just as it does in beer. The main difference from beer, apart from the smaller amount of water added, is what happens at the next stage: as soon as the loaf goes into the oven for baking, the alcohol evaporates, while the carbon dioxide leaves its mark in the form of bubbles that are trapped between

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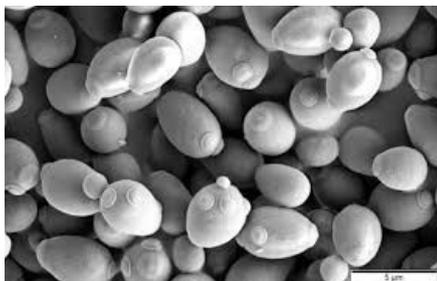


Figure 2 *Saccharomyces cerevisiae*.

strands of gluten and that give the loaf its fluffy texture. Nowadays, virtually all the yeast used for baking is not from beer but produced industrially—two million tons of it a year, in businesses valued at \$3 billion—using sophisticated and computerised production methods that are carefully protected secrets.

Bread is, in effect, solid non-alcoholic beer, where the fungal creatures in it have nearly all been baked to death, rather than being swallowed alive as they are in beers (unless these have been pasteurised, or supplemented with sulfites where wine is concerned). Ultimately, both alcohol and bread are quite literally rotten products, no different in strictly biological terms from decomposing fish we might turn away from disgust. It just so happens that they confer benefits to humans as a side effect of their rottenness—one by inducing conviviality, and the other by making grain digestible in large quantities—and hence our ancestors found ways of making them palatable.

### CODEPENDENCY WITH YEAST AND CATS

Money describes our relationship with the sugar fungus as one of codependency. To cultivate grain or vines, groups of people needed to become sedentary, which happened in China, the Middle East and elsewhere around the same time as evidence of brewing appears. Genetic analysis suggests that domestic yeasts—different from wild ones—originated in China around the time rice wine was first manufactured, which would fit with this hypothesis. Domesticated cats may have been part of this codependency, through their role in keeping rodents away from grain stores. Although the development of breweries and vineries led to drunkenness, this may have conferred an evolutionary advantage to individuals who increased their reproductive success through disinhibition. Money quotes anthropologist Claude Lévi-Strauss, who regarded the invention of brewing as a symbol of the transition of humans from nature to culture.

I am largely persuaded by Money's argument, although there are some gaps that remain for me. One concerns societies that have eschewed alcoholic drinks and leavened bread but have been successful in spite of this. Money does not refer specifically to religious blessings over bread and wine—although he does briefly refer to the festival of Passover, when Jews avoid all leavened products for 8 days of the year, commemorating their escape from Egypt as told in the

Bible. In spite of this, Money's account suggests why these substances have become so important in the Jewish and later the Christian faith: at some level, people must have recognised that civilisation rested on the products of fermentation, and on the uncanny power this gives us to transform rotten produce into food and drink that contribute to our merriment and fertility. Money implies in the book that he is an agnostic, but he offers something close to religious respect to yeast in the final sentence, where he writes: 'This inspiring microbe, *Saccharomyces cerevisiae* is a secular deity, something to be revered as much as the warmth of the sun'.

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- 1 Money NP. *The rise of yeast: how the sugar fungus shaped civilisation*. Oxford University Press: Oxford, 2018.