Operation "antivinegar"

Arbois, Jura, a few hundred and fifty years ago, during September 1858.

Jules Vercel is troubled. Recently, the demand for good wine has increased enormously and Jules, like all the other wine growers, must produce more and more wine. But there is a threat hanging over them. Often, the wine they produce and which is so good at the time of bottling takes on a very unpleasant taste after some time and cannot be sold. What can be done?
After dinner, Jules reads the last issue of *Moniteur Viticole*, the wine growers magazine, when all of a sudden, a familiar name makes him smile: Louis Pasteur, an old classmate.
Jules reads the article out loud:
"Mr. Louis Pasteur, young chemist from Arbois, has just discovered that there are living organisms so small that we can only see them through a microscope; he called them "microbes".
"These microbes, explains the scientist, are like all living beings: in order to develop, grow and reproduce themselves, they need to feed on organic matter or living substances. To nourish themselves, these very little microbes only take an infinitely small amount of the living substance. But this is enough to modify the chemical composition of this substance. We call this modification fermentation. Having grown up on a vineyard, the first fermentation Mr. Pasteur took an interest in was obviously the fermentation of grape juice into wine. ".

Jules stood up:

"And it is in fermenting grape juice that Mr. Pasteur, using his microscope, quickly discovered the microbe that modifies grape juice and turns it into wine, what has been called since time immemorial the fermentation of grape juice."
"This particular microbe, explains the scientist, can transform the sugar contained in any juice into alcohol; this is why Mr. Pasteur called it "alcoholic yeast" and called the fermentation of sugar into alcohol "alcoholic fermentation".
"Of course, there are an infinite number of different microbes, each causing a particular fermentation, in very specific conditions. For example, this "alcoholic yeast" can only develop inside the living substance, where it is no longer in contact with air, as in grape juice."
" Good, it's great to have discovered this wonderful little living being that turns grape juice into wine but I would still like to know why my wine doesn't stay wine and often turns to vinegar or some other totally undrinkable substance."
And, hoping to learn more, Jules continues reading the article:
"There's more, continued the journalist from the *Moniteur Viticole*, Mr. Pasteur has then noticed that after the "alcoholic yeast" fermented the grape juice into wine, that wine can in turn be transformed, fermented by another microbe, the mycoderma aceti, which can only develop in air, on the surface of the wine. Thanks to the oxygen in air, this other microbe transforms the wine alcohol into acetic acid, which means wine turns to vinegar. Vinegar makers can now use this microbe to make their product from wine."
It so happens Louis Pasteur spends his vacation every year in his family home, right next door. In five minutes, Jules is at his friend's house, brings him home and take him down to his cellar. He then opens a bottle of wine that was put away with other bottles in a separate part of the cellar; he pours a little in a glass and gives it to Louis. As soon as he took up to his mouth, he said:
"Ugh! It's vinegar!
-I know! recognized Jules, discouraged, and this happens often! But you, who has discovered this microbe so useful for making vinegar, couldn't you help us wine growers to stop our wine from turning into vinegar?"

Louis thought about the problem:

"We should first check that all your bad wine does contain this particular vinegar microbe and also try to understand why wine goes bad only in certain bottles. To do this, I need a big laboratory and some help".

But his vacation at Arbois is ending and he must go back to Paris where he is a professor. For five years, busy with other research on microbes, he asked Jules to conduct certain experiments on wine, such as comparing two different fermentation processes, one on wine left open to the air and the other on wine kept in a container hidden from air. Jules was very proud to collaborate with the great scientist in his experiments and scrupulously

noted the appearance and the taste of each wine tested. But Louis needs more information and in January of 1863, he announced to Jules that he will come in person to study bad wines in Arbois during the summer vacation.

As soon as they arrived, Pasteur and his collaborators unpacked their equipment - vases, ovens, various devices and products - on tables mounted on trestles in an old café. In this improvised laboratory, there was no gas, water or electricity, it was heated with coal, water had to be collected at the public fountain and the entire team had to wash the utensils in the river. Certain chemical devices were even specially made by the tinsmith and the blacksmith of Arbois.

For nearly two months, Jules guided his friend from cellar to cellar at old classmates' houses. Louis took samples of wine in test tubes then took them back to the laboratory to taste them and to examine them under a microscope. In his notebook, he described each bad taste and each observed microbe, drawn next to his notes. He also noted what the weather was like when the wine went bad and took on a terrible taste.

After two months, Louis asked Jules to get all the wine growers together, whose bad wine he analyzed. They all sat around a little table and the scientist spoke:

"Using my microscope, I discovered four different microbes in your bad wine, which result in four different bad tastes and four possible types of wine "disease".
- But where do these microbes come from? Jules asked.
- The different manipulations of the grapes, answered Pasteur, from the picking to the bottling of the juice bring hundreds of microbes. They only develop, causing fermentation, once the wine is made and in certain conditions. This depends on the weather, the place where the wine is stored, the air around the bottle and all sorts of complex criteria or those unknown to us. Fortunately, all these conditions are not always present, which explains why only part of your wine is transformed by microbes and goes bad.
- "The best solution for you, confirmed Louis, is to intervene when all the grape juice has just been turned into wine in order to destroy all the microbes brought in, before they have time to develop. But you must not add anything to the wine, or else you will change the taste.
- How do we do it? Jules asked.
- Use magic, suggested ironically a grower.
- No, logic, answered Louis to a captive audience. According to your remarks, these bad microbes produce bad tastes only when certain unusual temperatures are observed, which I was able to verify at the laboratory. It was at this moment that I discovered that very high and sudden heat could also kill them.
- But if we boil the wine, said another grower, all the alcohol will evaporate and we will be left with cooked grape juice!
- That's right, answered Louis, you must then heat your wine, without boiling it, for only a few minutes, during which the heat will destroy all microbes present in the wine. Then quickly cool it and bottle it. There will not a single microbe left in the wine that will ferment it, thus give it a bad taste during its storage".

On April 11, 1865, Pasteur filed for a patent for a "process relative to the preservation of wine" in the following terms: "I have recognized that wine diseases are produced by microbes that are present in the wine before it turns bad. Wine will not go bad if the microbes are killed beforehand. A simple and practical way is to heat the wine to a temperature between 60 and 100 C. This process stops all bad fermentation without ruining the wine".

From that moment on, all the growers heated their wine according to the method invented by Pasteur and all recognized that the wine thus rid of its microbes through heating no longer turned bad; they could then sell much more wine. Some growers even decided to call this wine heating process "pasteurization".

Thanks to this invention, Pasteur became the most famous young scientist of the time; he was the guest of honor of all the scientific evening events, including those of his most prestigious admirer, Napoleon 3rd. But the happiest is Jules, who is now considered a grower-chemist and who is asked to test each new pasteurization machine. There was a particularly high number of inventors in the 19th century and they all tried to develop a machine that could pasteurize large quantities of wine.

Pasteurization become common at the beginning of the 20th century to stop fermentation of fluids and to destroy dangerous microbes; it has been mandatory since 1920 for many beverages, in particular milk.

Elisabeth Liber