How can controlled fermentation processing methods enhance coffee flavour and quality?

In the specialty coffee industry, it's no understatement that experimentally processed coffees have become increasingly popular in recent years. More and more producers are using new and innovative processing methods, with fermentation playing a significant role in many of them.

However, as with any newly emerging coffee processing technique, farmers need to take great care when manipulating fermentation to process coffee. By tightly controlling a range of variables, producers can create some truly wonderful flavours in their coffees and increase final cup scores.

But how can farmers do this in a way which balances success and profitability? To find out, I spoke with four industry experts to understand more about the process. Read on for more of their insight on fermentation and coffee flavour and quality.

You may also like our article on how to ensure consistency in coffee fermentation & processing.

What is fermentation?

Despite its recent growth in popularity in the specialty coffee sector, fermentation has long been a part of coffee production.

All coffee undergoes some level of fermentation. As soon as cherries are harvested, the sugars and acids contained within the mucilage of the coffee fruit (a sticky, translucent substance which surrounds the seeds) begin to break down. This is largely where the sweetness in coffee derives from.

With washed coffee processing, farmers soak depulped cherries in water for several hours to remove any remaining flesh and mucilage. This usually results in a cleaner-tasting and brighter flavour profile, and can highlight more of the coffee's acidity.

However, over the past few years, there has been an increasing focus on controlling fermentation during processing, as well as using selected microbes to facilitate fermentation. These methods can have a number of benefits, which include enhancing flavours and preserving them for longer.

When we talk about fermentation, however, we must differentiate between the two main ways by which it takes place. These are anaerobic and aerobic fermentation – which are different due to the presence or absence of oxygen.

When including selected yeasts in coffee processing, the presence or absence of oxygen triggers various reactions, namely the growth or breakdown of a number of substrates. These substrates produce various chemical and volatile compounds, such as acids and alcohol.

In general, anaerobic fermentation is most common, whether the cherries are in sealed or open tanks. With open tanks, generally speaking only the surface is exposed to oxygen,

which means anaerobic fermentation occurs further down the tank. This allows the sugars to break down over a longer period of time, creating sweeter and more complex flavours.

Generally speaking, the longer the duration of fermentation is, the more intense the flavours in the coffee will be. This is because more flavour compounds are created and transferred into the coffee beans over longer periods. However, it's important that this process is controlled to facilitate the transfer of desirable flavours.

In order to carry out fermentation successfully, farmers can add selected microorganisms (which include yeasts and bacteria) to better facilitate fermentation. One of the most commonly used yeasts in the coffee industry is *Saccharomyces cerevisiae*, which is also widely used to make bread, wine, and beer.

However, in recent years, many coffee farmers have started to branch out and use different microorganisms, which can result in a number of different sensory profiles.

Camille Duez is the Coffee and Cocoa Fermentation Global Technical Support specialist at Lalcafé, a company which specialises in the development, production, and marketing of yeasts and bacteria.

"We develop and produce yeasts which are known to result in desirable flavour profiles in coffee," she says. "Many of the flavours you perceive in fermented coffee are a result of the strain of yeast used in the process," she explains.

How can yeast inoculation affect coffee flavour and quality?

Although it's often said that fermentation can help to enhance coffee quality and flavour, producers need to understand more about how the process works in order to carry it out successfully.

Dr. Renaud Boulanger is the coordinator of the Sensory Quality of Fresh and Processed Products department at the Mixt Research Unit at CIRAD, a French agronomic research institute.

"During fermentation, the breakdown of sugars and acids by the yeast produces aromatic and volatile compounds," he says. "These compounds are then secreted into the water (also known as the fermentative medium) and are absorbed by the green coffee beans."

Renaud explains that there are two ways this can happen.

"One way is through passive transfer," he says. "Because of the difference in compound concentration between the water and the green coffee, the aromatic compounds move from the most concentrated area to the least concentrated.

"Active transfer, meanwhile, is when specific proteins allow the green coffee to absorb the aromatic compounds," he adds.

But understanding which aromatic compounds are transferred from the yeast to green coffee beans is also equally important.

In a 2020 study entitled *Transfer kinetics of labelled aroma compounds from liquid media into coffee beans during simulated wet processing conditions*, the transfer of three compounds from yeast to green coffee was measured.

The study analysed four different coffee samples, all of which had various amounts of pulp attached, including depulped cherries with no mucilage and parchment, as well as depulped cherries with only parchment.

The three compounds measured in the study were butanal, 2-phenylethanol, and isoamyl acetate.

"We chose these compounds because they often result in more herbaceous, floral, and fruity flavours in coffee," Renaud tells me.

Specifically, butanal is responsible for apple, chocolate, and bread-like flavours in coffee, while the presence of 2-phenylethanol creates more floral notes. Isoamyl acetate, meanwhile, can produce more tropical flavour notes, such as banana.

The study found that out of all three compounds, the transfer of 2-phenylethanol was by far the highest at all levels of pulp attachment. However, all compounds produced by yeasts can transfer to green coffee, albeit at different rates and concentrations.

How can producers control the transfer of flavour?

In essence, the 2020 study indicates that using different yeasts during fermentation can exacerbate and heighten different flavours in coffee. This means producers can select different yeasts dependent on the sensory profile they want to create for a specific coffee.

Lalcafé produces six different yeast strains, which have different fermentative properties that in turn enhance a variety of flavour compounds in coffee. Ultimately, this means farmers can create a more diverse range of flavour profiles.

Jean Faleiros is the owner of Fazenda El Dorado in Alta Mogiana, Brazil. He tells me how he selects certain strains of yeast to create specific flavours in his coffee.

“If I want to create a more fruity flavour profile, with notes of red fruits, I use the Lalcafé Intenso yeast strain,” he says. “If I want to produce a more exotic sensory profile, I use the Lalcafé Oro strain.

“For a more clean and bright coffee, I use the Lalcafé BSC yeast strain,” he adds, explaining that this Lalcafé strain helps to break down the mucilage on coffee cherries more quickly.

With regards to improving coffee quality, lactic acid bacteria are becoming more commonly used by producers to result in cleaner and brighter coffees, sometimes used alongside yeasts.

"When using yeast, the body, flavours, sweetness, and complexity of a coffee can increase," Camille explains. "When you also add lactic acid bacteria, such as Lalcafé's Bactifresh product, you can also enhance the brightness and clarity of a coffee."

Jean tells me: "In my experience, controlled fermentation using yeasts helped to improve the quality of my coffee, as well as creating flavour profiles that were previously impossible to produce without using inoculation."

Ultimately, controlling the transfer of flavour during fermentation comes down to which types of flavours the farmer is looking to produce in a coffee.

This is especially beneficial for producers as they can create more unique sensory experiences for a range of different markets – helping to differentiate their product and potentially meaning they can receive a higher price per pound for each lot.

"I know which flavour profile each of my customers prefers," Jean says. "Each market has its own preferences, and using yeast helps me to create more specific and repeatable flavour profiles."

However, it is important to note that many other variables will also influence coffee flavour and quality – such as coffee variety, altitude, and the nutrient content of the soil, for example. This means producers need to also keep these factors in mind when carrying out fermentation.

Moreover, as yeasts are living microorganisms, producers need to be mindful when using them.

"Yeasts are living single-celled microorganisms," Camille says. "Essentially, this means it's not easy to control everything during the fermentation process.

"There are also a number of other factors which affect the final cup profile, including terroir, climatic conditions (such as temperature), cherry ripeness, and the quality of water used to grow and process coffee," she adds.

Other considerations

Alongside influencing coffee quality and flavour, producers also need to take into account a number of other factors when using yeasts during fermentation.

“When carrying out anaerobic fermentation, for example, we need to control temperature, pressure, pH, and several other variables,” Jean says.

Furthermore, many producers also focus on the total fermentation time.

In theory, the longer the fermentation time, the more aromatic and volatile compounds will be absorbed by the green coffee.

In the *Transfer kinetics of labelled aroma compounds from liquid media into coffee beans during simulated wet processing conditions* study, the concentration of the 2-phenylethanol compound increased throughout fermentation when using Lalcafé’s Oro, Cima, and Intenso yeast strains.

However, the concentration of other compounds, namely isoamyl acetate, peaked at 24 hours and then began to steadily decline past this point during fermentation – meaning controlling total fermentation time has a significant effect on flavour.

Other processes also take place during fermentation, such as germination. This results in the degradation of certain flavour compounds, or even a reverse transfer of them. There has to be a balance – which is why fermentation duration is so key.

As well as fermentation time, the amount of pulp retained on the coffee cherries is also important to consider.

The results of the study also found that green coffee containing parchment (a paper-like skin covering the beans) absorbed less aromatic compounds created by the yeast. This is because parchment can act as a molecular filter, meaning producers may need to take this into account when fermenting their coffee.

With the exception of wet hull processing, parchment is kept on the coffee beans as they are processed. Removing the parchment could prove to unveil a range of new flavour profiles – but producers should be mindful that this could impact the roasting process, too.

Roasting fermented coffees

While producers certainly need to understand how fermentation affects coffee quality and flavour, roasters also have to know so they can optimise their roast profiles.

Pedro and João Foster are the co-owners of Fuzz Cafés in Rio de Janeiro. They have purchased coffee from Jean for some time.

“We have been roasting the Abacaxi ‘pineapple’ coffee for around three years now,” says Pedro.

João tells me how the coffee’s flavour profile has developed over the years.

“In the first harvest year, we tasted pineapple and flavours similar to black pepper,” he explains. “In the second year, there were more lemon notes, as well as pineapple, and the coffee scored 90 points.

“It can be difficult to maintain such a consistent flavour profile, but it shows how useful it can be to predict flavour profiles,” he adds.

However, certain factors need to be taken into account when roasting fermented coffees.

“Traditional Brazilian fermented green coffees will stay fresh for up to four months, and the more delicate flavours will deteriorate more quickly,” João says. “But we recently roasted robusta, which had been fermented with Lalcafé’s Cima yeast strain, 18 months after harvest and it was still bright and clean-tasting.”

Pedro offers some advice when roasting yeast inoculated coffees.

“We often roast with a higher air flow, so it’s more similar to convection roasting,” he explains. “This can help to highlight the more subtle fruity and floral flavours.”

There’s no denying the growing popularity of experimentally processed coffee among roasters and baristas in the specialty coffee sector, and it’s likely that demand will continue to increase.

For farmers looking to produce these coffees, investing in the right equipment and resources beforehand is essential – as is being prepared to experiment slowly and work your way up towards processing like this on a larger scale.

And while experimental processing may not be viable for some producers, it's certainly clear that controlled fermentation can have a number of benefits when it is leveraged effectively.

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