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## RULING THE ROAST

### Up to Speed

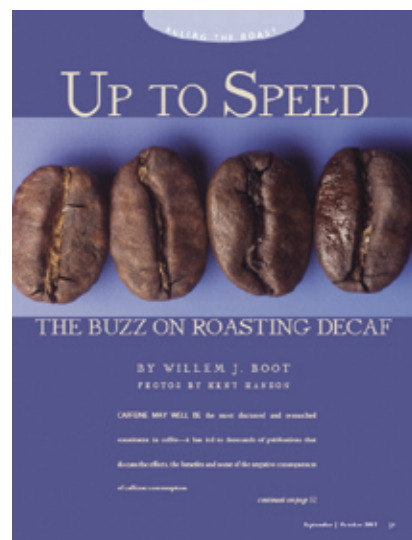
#### The Buzz on Roasting Decaf

by Willem J. Boot  
photos by Kent Hanson

CAFFEINE MAY WELL BE the most discussed and researched constituent in coffee—it has led to thousands of publications that discuss the effects, the benefits and some of the negative consequences of caffeine consumption.

While the process of caffeination—whether geared toward coffee, soda or mints—seems to attract a great deal of attention and study, the process of decaffeination seems to warrant little interest. Perhaps that's because the majority of the market still prefers their coffee—and other edibles—with a full dose of caffeine. Or perhaps it's because caffeine itself is so interesting. A natural substance found in the leaves, seeds and fruits from at least 60 different plant species, caffeine is viewed as something of a wonder drug. And coffee's a great way to get at it: the average cup of brewed coffee (eight-ounce cup) contains up to 120 milligrams of caffeine (about the weight of one small peaberry coffee bean), while a serving of espresso or a cappuccino drink usually contains slightly less. The caffeine content of coffee depends on different factors, like the variety of the coffee, the method of preparation and the serving size of the coffee beverage.

Caffeine—and its effects—were so revered that it wasn't until the beginning of the 20<sup>th</sup> century that a method for decaffeinating coffee was finally developed. Ludwig Roselius



developed the idea to treat coffee beans with steam prior to extracting the caffeine; this process became the model for most processes that are still used today.

#### Decaffeination and Coffee Quality

The daunting mission of researchers to develop the best methods for decaffeination resulted in hundreds of patents to decaffeinate coffee. Today, three main processes are used to create decaf specialty coffee: the traditional chemical process, the water method and the supercritical carbon dioxide method (see *Getting the Lead Out* on page 7 for a detailed description of these processes).

Despite all the improvements made with these technologies, no process completely preserves the natural flavor of the coffee bean. Caffeine has a distinct bitter taste but the major flavor change as a result of decaffeination is not caused by the lack of caffeine, but rather by the impact of the decaffeination method on the bean.

When discussing decaf coffees, there is always the million dollar question about

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quality: which method is best for the beans? Unfortunately, this question is hard to answer because it would require thousands of pounds of coffee beans to perform a comparative test, utilizing the same coffee. Most decaffeination plants require a minimum volume of 7,000 pounds, and we would need three times that amount of the same coffee to test all of the methods.

In general, I have found that the traditional chemical methods, such as methylene chloride, do a good job in maintaining the flavor profile of the beans and that these processes preserve quite well the lower and the higher notes of the coffee. Picture A. (shown right) shows a methylene chloride decaf bean from Costa Rica.

Most methylene chloride processing is done in Germany, which creates a challenge: it is hard to send lots smaller than one container (37,500 pounds) for decaffeination. Many brokers and importers in North America purchase stock lots of decaf beans from the German plants, and the quality of these stock lots tends to be very inconsistent, varying from abysmally bad (decaf coffee with robusta flavor) to very good (decaf coffee with bright, complex flavors).

The best advice when purchasing decaf green beans is to compare at least three alternatives before making a purchase. It is always important to cup your green coffee beans when purchasing decaf beans from any of the other processes as well. When buying water-processed decafs, there is the advantage that North American brokers and importers generally carry a good selection of decaf beans from all around the world.

For the sake of this article, I will make a comparison between some types of Mountain Water- and Swiss Water-processed beans. Picture B. shows a Mountain Water-processed Mexican bean and picture C. displays a Swiss Water-processed Indonesian bean.

## Roasting: Tips & Strategies

I am sure that anyone who has roasted decaf coffees before has struggled with developing a consistent roast profile. The key reason: decaf beans have already been processed once. This leaves the color of the beans ranging from a straw yellow to a light cinnamon brown. As a result, color changes during roasting are difficult to notice, especially towards the end of the process.

Decaffeinated beans are also harder to roast because it is very difficult to gauge the development of the coffee during the roasting process. The last phase of decaffeination generally includes a polishing process which can be necessary to remove oil residues from the outer surface of the beans. This polishing process tends to clean the beans to the extent that little or no chaff is released during roasting. Most roaster operators know that when roasting regular specialty coffee, the outer surface of the

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Picture A. Methylene Chloride process—Costa Rica



Picture B. Mountain Water process—Mexico



Picture C. Swiss Water process—Indonesia



beans tends to change from a corrugated profile (before the first crack) to a smooth profile (after the first crack).

With decaffeinated beans, the exterior part is already smooth before roasting. On top of that, the beans release little or no chaff, so it is understandable that even the more experienced roasters can be confused while roasting decaf.

To make matters worse, decaf coffee has a more brittle cell structure, which allows these beans to release moisture easier, resulting in the likelihood of creating very fast roasting times. I have noticed roaster operators completing their decaf roast batch in less than 10 minutes while they would allow at least 12 minutes of roasting time for regular coffee beans. Decaf coffee beans that have been roasted too fast will easily develop sour or astringent flavor notes. Specifically, it is essential to control the roasting process from the start of the first crack, and at this point you should reduce the level of the gas flames.

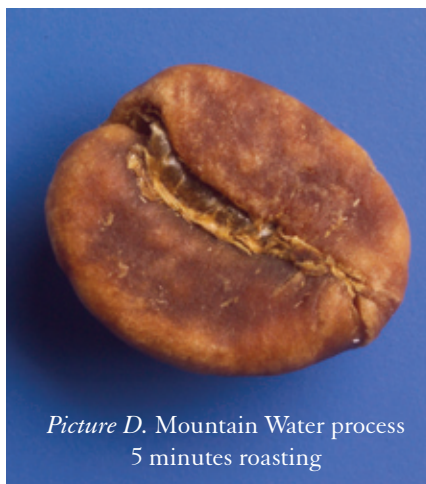
When the first crack is almost completed, the bean temperature should only increase gradually, approximately one degree per five seconds, absolutely no faster. The objective is to be in control of the roasting process. To help you do this, you should create a time frame of at least three minutes between the start of the first crack to the start of the second crack.

If you keep your roasting colors light, which is a challenge with decaf beans, and if the end of the roast is before the second crack, then you must maintain three minutes between the start of the first crack and the end of the roast. As I have previously advocated, it is important to create the best possible light conditions around your roasting machine. I recommend using one or more 75- or 150-watt incandescent full-spectrum flood light bulbs.

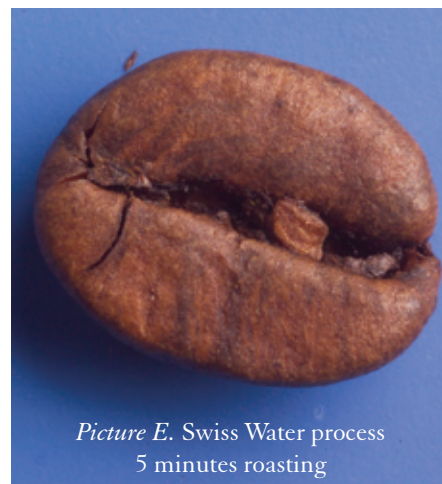
It is interesting to observe how different the roast development is between Mountain Water and Swiss Water beans. Both coffees were roasted on the same sample roaster, using the same time temperature profile.

After five minutes of roasting, it is amazing how different the outside bean color is of both coffees (see pictures D. and E.).

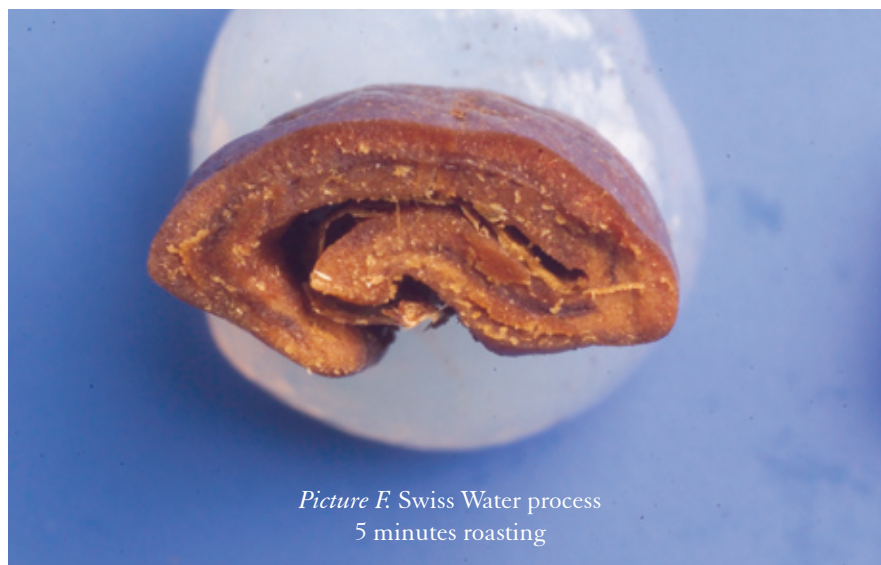
Picture F. shows the lighter interior color of the Swiss Water bean (five minutes), and picture G. and H. display the roast color after



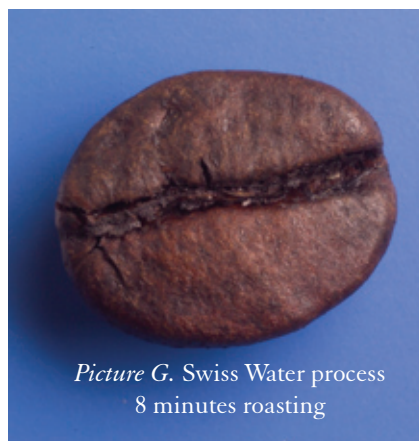
Picture D. Mountain Water process  
5 minutes roasting



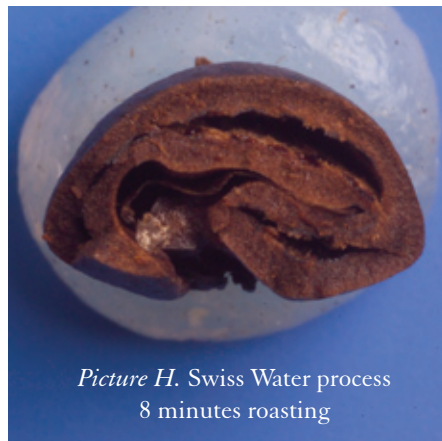
Picture E. Swiss Water process  
5 minutes roasting



Picture F. Swiss Water process  
5 minutes roasting



Picture G. Swiss Water process  
8 minutes roasting



Picture H. Swiss Water process  
8 minutes roasting

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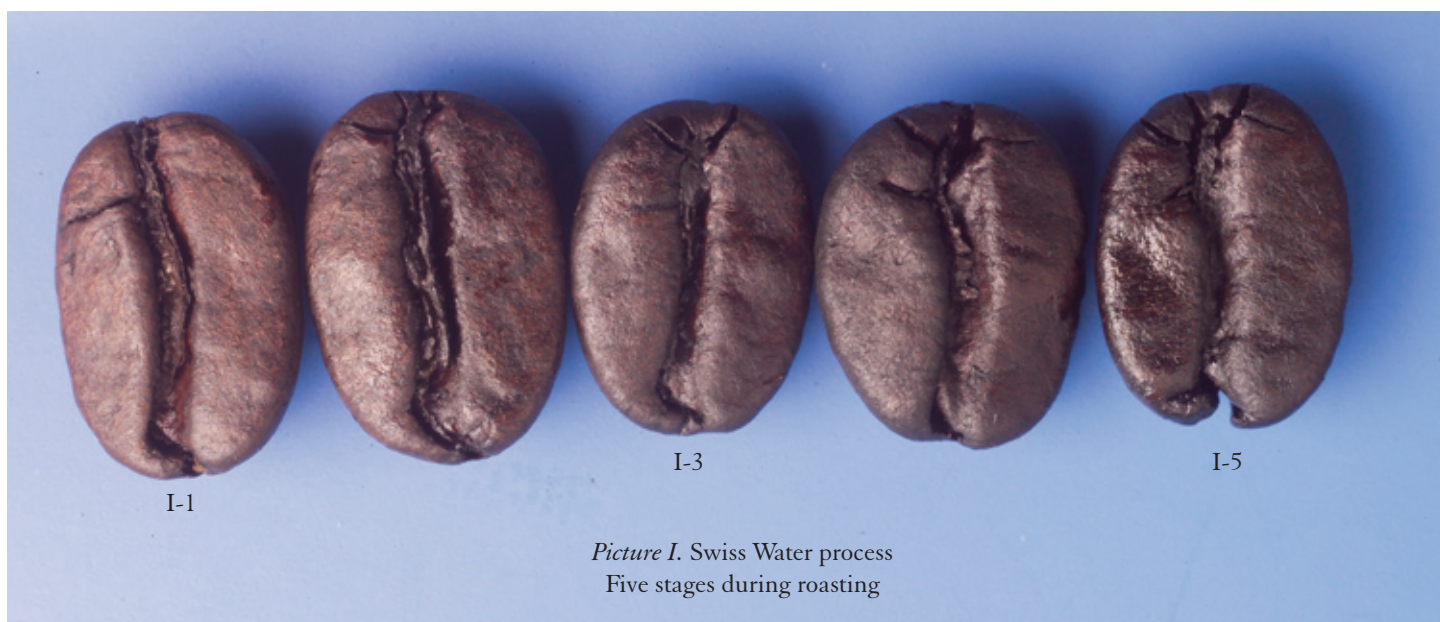
eight minutes of roasting, right after the first crack. The Swiss Water bean has already developed a very dark color, and at this stage, the roaster operator has to reduce the level of the flames to stay in control of the process. It is also quite interesting to notice the progressed expansion of the Swiss Water bean at this point. Picture H. illustrates again the importance of controlling the bean temperature; the roaster operator must prevent the beans from expanding too fast, resulting in a premature second crack.

The color development of the Swiss Water beans from the end of the first crack to the beginning of the second crack is shown in picture I.

Picture J. shows the same stages of development for Mountain Water processed beans. It appears that the differences in color between the Mountain Water-processed beans are much more significant than with the Swiss Water beans.

The comparative cupping between the different roast profiles of Swiss Water decaf beans revealed that this specific lot did not resist a darker roast profile very well. The darkest roast (I-5) had bitter, carbon-like notes which points to the fact that the roast profile has reached or exceeded the potential of the coffee to sustain such a dark roast.

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*Picture I. Swiss Water process  
Five stages during roasting*



*Picture J. Mountain Water process  
Four stages during roasting*



# BUZZ KILL

## THE FACTS ON DECAF

- In 2005, 10 percent of adult coffee drinkers preferred their coffee sans caffeine, according to The National Coffee Association of the USA.
- Decaf drinkers consume 17.7 percent of annual coffee sales. This means that while there are less decaf drinkers out there, they tend to consume more coffee per person.
- More pounds of decaf are sold worldwide than organic and fair-trade coffee combined.
- Growing decaf markets include the U.S., Australia, New Zealand and the U.K.
- Different coffees contain varying levels of caffeine, mainly depending on their botanical variety. Arabica coffees have approximately half the caffeine content of robustas.
- All decaffeinated coffee actually contains some caffeine.
- Researchers are working on a coffee tree that will actually produce uncaffeinated beans.
- There are varying standards on how much caffeine can be left in the bean and still have it be called decaf. In Canada and Europe, the regulations are set at 99.92 percent caffeine free. In the U.S., the Food & Drug Administration guidelines states that 97 percent of the caffeine should be removed. Despite the smaller number, the U.S. regulations are actually stricter—higher than any other country.
- Many things can alter the level of caffeine in decaffeinated coffee, including blend composition, brewing extraction rates, grind, roast color and water temperature. In addition, a lighter roast typically means a higher caffeine level.
- Most of the caffeine removed from coffee is manufactured for use in other products, such as medicines and soft drinks. In fact, many soft drinks have no inherent caffeine—it is all an addition from coffee.

The comparative cupping between the roasted samples of the Water Process beans had an interesting outcome as well. As in the previous test, it is amazing how the different roast profiles impact the flavor profile of the coffee. Samples J-3 and J-4 contained both a pleasant level of sweetness, which makes both roast levels very suitable for a successful coffee program.

Description	Swiss Water Process Indonesian Decaf (Komodo Blend)		
	Roast I-1	Roast I-3	Roast I-5
Fragrance & Aroma	Malt	Toast Caramel	Dried fruit Carbon-like
Body	Somewhat raw	Smooth	Full Pungent
Acidity	Mild sour	Slightly refreshing	Bland
Flavor	Somewhat underdeveloped	Balance between lower and higher notes	Carbon and paper notes Neutral
Aftertaste	Slightly citric	Lingering	Short and bitter

Description	Mountain Water Process Colombia Decaf		
	Roast J-2	Roast J-3	Roast J-4
Fragrance & Aroma	Malt	Neutral	Dried fruit Floral
Body	Somewhat raw	Low Silky	Round
Acidity	Sharp	Refreshing	Mildly refreshing
Flavor	Underdeveloped Malty	Balance between sweetness and refreshing notes	Sweetness of dried fruits
Aftertaste	Slightly sweet	Lingering and sweet	Lingering and sweet

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## Some Final Remarks

Maintaining consistent flavor profiles with decaf coffee beans is a difficult task. Decaf coffee beans tend to age much faster than regular green coffee beans. With certain decaf coffees, I have noticed paper or even wood-like flavor notes within four months after decaffeination.

The challenge starts at the point of procuring the right decaf beans. For roasters who are not able to purchase at least 7,000 pounds of decaf coffee at a time, the decision of which beans to decaffeinate is usually made by the decaffeination plant. As a result, choices are often limited when buying decaf beans, which will increase the risk of flavor changes in the end product. For this reason, it is important to compare before you buy.

If you can commit to larger order quantities, I definitely recommend having your own green beans decaffeinated. To avoid any possible flavor contamination, you should always discuss the process protocol with your supplier beforehand.



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## WHAT'S THE BUZZ?

Product (all 5 oz. unless otherwise stated)	Caffeine Content
Regular coffee (drip method)	60–180 mg.
Regular coffee (percolated)	40–170 mg.
Regular coffee (instant)	30–120 mg.
Decaffeinated coffee (drip method)	2–5 mg.
Decaffeinated coffee (instant)	1–2 mg.
Espresso (1 oz.)	30–50 mg.
Tea (loose or bags)	20–90 mg.
Red Bull (8.2 oz)	80 mg.
Pepsi and Coke (12 oz.)	45–55 mg.

Source: US Food & Drug Administration

## BEAN THERE, DONE THAT

### A BRIEF HISTORY OF DECAF

CAFFEINE WAS DISCOVERED in coffee by the chemist F.F. Runge in the 1820s as a pharmaceutical byproduct of coffee. Although the effects of coffee were widely known for centuries, prior to Runge's discovery, no one knew that the bitter white alkaloid (proper name:  $C_8H_{10}N_4O_2$ ) was the culprit. Once caffeine was found out, many caffeine-removal processes were developed, although the majority of them removed both the caffeine and the flavor.

According to legend, it was around 1900 when Ludwig Roselius, a coffee merchant from Bremen, Germany, developed the first commercially available decaf process. In 1903, Roselius and his researchers began to experiment with coffee beans that had been soaked in brine during a storm at sea. Through these experiments, Roselius discovered that he could use benzene as a solvent to bond with caffeine and then boil the benzene-caffeine combo away.

In 1906, he patented his process.

Shortly after, he started a decaffeinated coffee company called Kaffee Hag. He then introduced his product in Europe under various names including Café Sanka in France and Life Belt in England. Not surprisingly, Roselius had a difficult time marketing his new products—not only was benzene an ineffective caffeine removal tool, the green beans were boiled prior to the process, meaning they lost almost all of their flavor.

Determined to take advantage of the opportunities in the U.S., Roselius moved his company to the states in 1923, founding the Sanka Coffee Corporation in New York. But the company was seized during World War I under the U.S. Alien Property Custodian Act. In 1932, General Foods acquired both the Sanka



Corporation and the process and went on to build the Sanka empire. In 1979, General Foods also purchased Kaffee Hag, Roselius's original company, from Roselius' son.

Today, there are more than 30 decaffeination plants around the world, and almost every one uses a slightly different process. In the U.S., 10 percent of the adult population drinks their coffee unleaded, according to the National Coffee Association.

see Getting the Lead Out sidebar on next page

# GETTING THE LEAD OUT

## HOW BEANS BECOME DECAF

THERE ARE DOZENS of processes for decaffeinating coffee, but only three of those are commonly used in the specialty industry: the traditional chemical process, the water method and the supercritical carbon dioxide method. About 80 percent of decaf coffee is decaffeinated via a traditional chemical decaffeination method.

Decaffeination processes can also be broken down into the two main contact methods of the bean: direct and indirect. In the **direct method**, the beans are first softened by steam and then put in contact with a decaffeinating agent that strips the caffeine from the bean. In the **indirect method**, a water and coffee solution is used to remove the caffeine. Once the caffeine is removed from the beans and becomes part of the solution, the solution is then treated with a decaffeinating agent before being returned to the bean.

Although caffeine is water soluble at temperatures above 175° F, water alone is not usually enough to decaffeinate coffee because it erodes many of the flavor and aroma elements. Instead, decaffeination usually involves a solution of water and coffee flavor elements as well as a decaffeinating agent such as methylene chloride.

The **traditional process** utilizes a chemical like methylene chloride or ethyl acetate. This method can be considered both direct and indirect, depending on the process.

In the direct contact method, the beans are placed in a drum and softened by steam for approximately 30 minutes. After, they are rinsed repeatedly with the agent to remove the caffeine. The caffeine-filled solvent is removed and the beans are re-steamed to allow the remaining solvent to evaporate. To finish, the beans are air or vacuum dried to remove excess moisture.

In the indirect method, coffee beans are soaked in very hot water to extract the flavor oils as well as the caffeine. The caffeine/flavor oil solution is then collected in a separate tank and treated with the chemical decaffeinating agent. This agent bonds to the caffeine molecules, creating a new caffeine-chemical compound. Heating the water to a specific temperature (104 degrees for ethyl acetate and 114 degrees for methylene chloride) causes the compound to boil and vaporize, leaving only the flavor oils. The process is completed by reintroducing the flavor oils to the beans, followed by a drying process.

Here are some important remarks about the chemicals used in this traditional process. Ethyl acetate is a compound found in fruits, coffee cherries and sugar cane and, as a result, processors sometimes refer to this method as a “natural process,” which is quite misleading because in all cases the ethyl acetate for decaffeination is produced synthetically.

Now, how about methylene chloride? While many companies prefer the flavor profile of “MC-processed” decaf coffee, it is remarkable how discreet roasters are about this environmentally dangerous chemical in their promotional materials. Despite the fact that nearly no traces (less than one part per million) remain in the decaffeinated green beans, and that the Food & Drug Administration does not consider this chemical a health hazard, more and more consumers have become aware of the negative impact of methylene chloride on the environment (apparently it affects the Ozone

layer) as well as on the workers at the decaffeination plants. As a result, some of the other methods are growing in popularity.

In the **water method**, no chemicals are used to decaffeinate the coffee. The caffeine is removed in two steps. The first step, which is only done once, creates a flavor-charged solution that is then reused in all future processes. The solution is made by soaking coffee beans in hot water to remove the flavor oils and caffeine. The beans are then discarded. The solution, however, is treated by utilizing activated charcoal filters, which remove the caffeine but leave a solution with only flavor oils.

This flavor-charged solution is then utilized for the actual decaffeination process of all future batches. To do this, each new batch of green beans is soaked in the solution. According to the laws of chemical solubility, molecules move from an area of higher concentration to an area of lower concentration. This means that the caffeine moves from the caffeinated beans to the decaffeinated solution, while the flavor—which is equal in both the beans and the solution—stays the same.

The best known water process is the Swiss Water method. Initially, water-processed decaf coffees lacked the flavor that made the traditional methods (using synthetic chemicals) so popular. The growing consumer awareness about their own health and environmental concerns has led to an increased demand for water-processed decaf coffees. In recent years, water processes have improved and, as a result, market shares have increased significantly.

The third, less popular, decaffeination method is the **supercritical carbon dioxide method**. In this method, green beans are soaked in liquid, highly pressurized carbon dioxide (compressed to 200–300 times normal atmospheric pressure). At this high pressure, carbon dioxide looks like a liquid in terms of its density, but it has the viscosity of a gas and becomes a very effective solvent. Since CO<sub>2</sub> is a naturally occurring gas (humans breathe it out; plants and trees consume it), the beans are stripped of their caffeine in an environmentally safe method. In general, this process is technically somewhat more challenging and as a result the operating costs are relatively high.

A variety of other methods are also being explored. One relatively new method involves the use of triglycerides. Triglycerides are a naturally occurring combination of fatty acids and glycerol that draw the caffeine to the surface of the beans. After several hours, the triglycerides in the oils remove the caffeine from the beans while leaving the flavor intact.

Another interesting approach is the cultivation of naturally caffeine-free coffee varieties, which were first discovered growing in semi-wild conditions in Ethiopia. To date, at least two projects have been deployed to test the cultivation of caffeine free coffee on a larger scale. Within a few years we will know the commercial and technical viability of this method.

As technology advances and science gains a better understanding of both chemicals and caffeine, there are sure to be even more options when it comes to creating unleaded coffee beans with all the flavor of regular.

