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Coffee –Chemical Composition and Potential Impact on Health

Dr. Archana Maurya

Assistant Professor, Department of Chemistry
Shri J. N. P. G. College, Lucknow.

Email: archanamaurya75@gmail.com

Abstract

Today's coffee is most popular beverage amongst people from younger to older. Everyday millions of people around the world begin their day religiously with a morning cup of coffee. But many scientific researchers showed that coffee seemed to found off liver disease, liver cancer, type 2 diabetes, heart disease and stroke. Coffee even appears to protect against depression, Parkinson's and Alzheimer's diseases. These results taken as a whole might explain the most astonishing findings of all. So it is very interesting to know about chemical composition caffeine, polyphenols, trigonelline that how to react and effect human bodies.

Keywords: Coffee, Composition, Health.

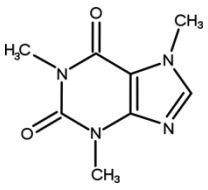
1. Introduction

Throughout history, coffee has taken on several physical transformations, initially serving as an energy source when nomadic tribes combined coffee berries with animal fat as an early form of an energy bar. Later it was consumed as a tea, then wine, and finally to the beverage we've come to identify today. But how much of coffee's chemical composition do we actually know?

Over the past half century scientists have made significant progress which has allowed them to unlock the nearly 1,000 compounds found in roasted coffee. In this issue of Coffee Science we'll briefly discuss a family of compounds called 'alkaloids' which serve an important role in coffee's unique chemical composition.

1.1. Chemical composition

CAFFEEINE



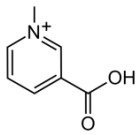
For many, coffee drinking is simply a delivery medium for a potent alkaloid we have come to identify as caffeine or otherwise known as 1,3,7 – trimethylxanthine. Although caffeine is typically associated with coffee, its production within the plant kingdom spans across numerous other plant species. Mate, for example, which is traditionally consumed in parts of Uruguay and Argentina, contains less than one percent by weight. Whereas, teas of Camellia sinesis which originated in China contain almost three times the concentration of caffeine than Arabica.

But for humans caffeine is very unique. Thus far we are the only living forms on Earth that readily seek caffeine for both its stimulatory and psychological effects. For all other life forms, caffeine is a potent toxin capable of sterilization, phytotoxicity and antifungal properties. As

such scientists believe that caffeine, with its intensely bitter taste, has evolved as a primitive defense mechanism in coffee ensuring its survival in the wild for thousands of years.

It's no surprise then, that the caffeine content of the more "robust" Robusta species is almost double that of the more delicate Arabica. The belief is that as insects attack the coffee cherry, they are deterred by the bitter taste of caffeine and simply move on to other crops.

TRIGONELLINE



Trigonelline Molecule Coffee

Another less known alkaloid that shadows in the light of caffeine is that of trigonelline. In Arabica coffee, trigonelline concentrations make up roughly 1% by weight with a slightly less concentration (0.7%) found its Robusta counterpart. Although its concentration is slightly less than that of caffeine, it plays a significant role in the development of important flavor compounds during roasting. But unlike that of caffeine, which survives the roasting process, trigonelline readily decomposes as temperatures approach 160°C (320°F).

Model studies have shown that at 160°C, sixty percent of the initial trigonelline is decomposed, leading for the formation of carbon dioxide, water and the development of a large class of aromatic compounds called pyridines. These heterocyclic compounds play an important role in flavor and are responsible for producing the sweet/caramel/earthy- like aromas commonly found in coffee.

Another important byproduct produced during the decomposition of trigonelline is nicotinic acid, or vitamin B3 - more commonly known as niacin. Depending on roasting conditions niacin can increase up to ten times its initial concentration, providing anywhere between 1 mg of niacin per cup for Americano type coffees and roughly two to three times this concentration in espresso type beverages. When one considers that most Americans consume about 3.2 cups of coffee per day according to the NCA (2008) – makes coffee an ample source of dietary niacin.

So far that's great news for people with an unbalanced diet but there is another therapeutic benefit to coffee that is even more surprising. Recently Italian scientists discovered that drinking coffee may lower our incidence of dental caries. According to researchers trigonelline works by preventing the adhesion of mucus-like acid byproducts onto teeth which would otherwise lead to dental caries.

2. Effect on Health

Drinking coffee has been associated with a variety of harmful and beneficial health effects Coffee contains huge numbers of compounds, including antioxidant chlorogenic acids Recent evidence suggests coffee could help prevent type 2 diabetes and neurodegenerative diseases like Alzheimer's The absorption and profile of both helpful and harmful compounds in coffee is complex and depends on many factors. It is hard to avoid stories about the latest must-eat food to join the anticancer brigade. First it was select vegetables and berries, then red wine, dark chocolate and coffee.

Newspapers frequently tell us those antioxidants 'fight (nasty) free radicals', and the words 'polyphenol antioxidants' have entered the mainstream. Swiss food giant Nestlé even sells a coffee called Nescafe Green, advertised as containing 'high levels of naturally occurring polyphenol

antioxidants which can help protect the body's cells from day to day damage'. The coffee contains unroasted (green) coffee beans in a bid to boost antioxidant levels.

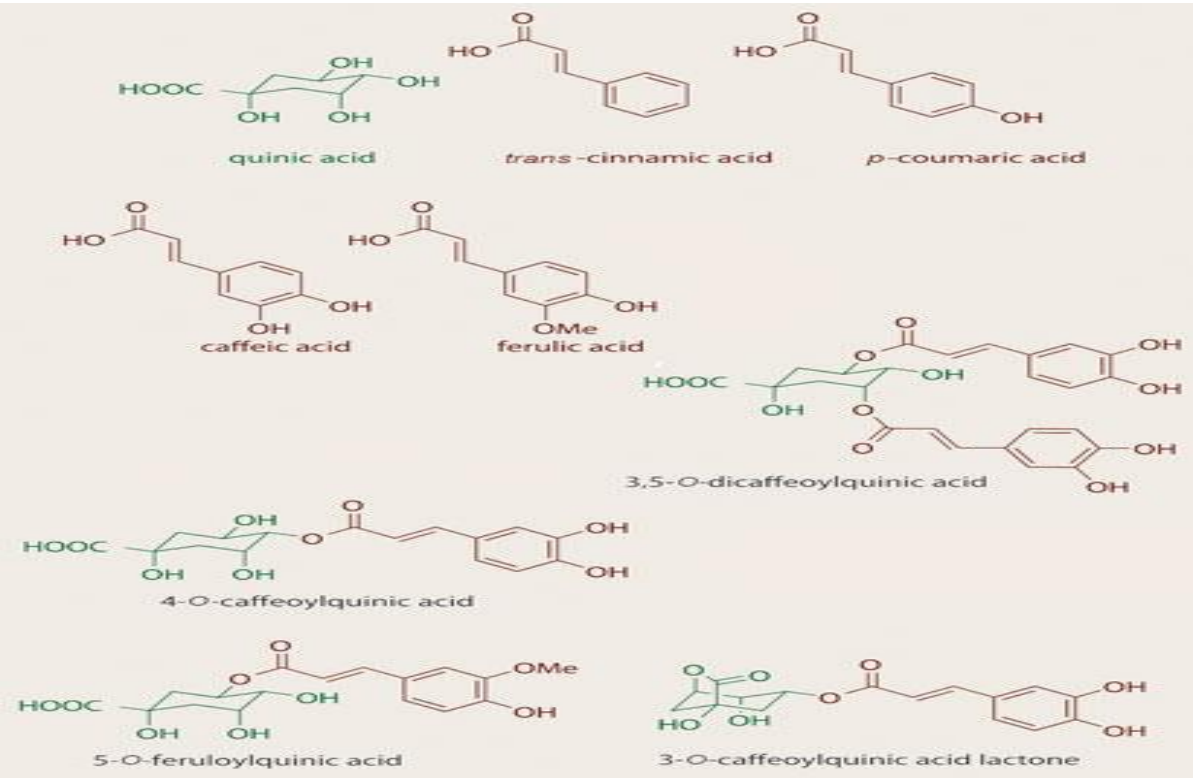
Coffee is indeed one of the richest sources of phenolics in the western diet and can potentially pack a strong antioxidant punch, in theory protecting cells if the body's natural mechanisms fail to keep levels of reactive oxygen species under control. Yet the story is far more complex than a simple battle between antioxidants and free radicals. All of the antioxidant-rich products, from red wine to coffee, have far subtler modes of action than previously thought, says Alan Crozier, a plant biochemist at the University of Glasgow, UK.

2.1. Kill or cure?

Bacterial digestion in the colon makes coffee's antioxidants more readily absorbed. We are used to thinking that coffee must be bad for us - a guilty pleasure - and many try their utmost to kick the habit. Yet some epidemiological studies, which involve questioning people about daily coffee intake and following their health over a period of years, suggest that regular coffee drinkers are less likely to get various cancers, including liver, colon, oral and oesophageal. In 2008, a team of researchers from Harvard Medical School in Cambridge, US, and the University of Madrid, Spain, led by Esther Lopez Garcia, assessed data from two major US epidemiological studies following more than 125 000 people over two decades. They concluded that regular coffee consumption was 'not associated with an increased mortality rate'. In fact, taking into account risk factors such as body size, smoking and specific diseases, the team suggested that people who drank more coffee were actually less likely to die within the decades of the study because of a lower risk of cardiovascular disease.

Coffee has been suggested to help protect against gout (by lowering uric acid levels), tooth decay and gallstones. And so the list goes on. In particular, there is mounting and strong evidence for coffee providing some protection against type 2 diabetes.

3. Acid House



Coffee contains a tremendous number of chemicals, with over 1000 aroma compounds. If you are looking for antioxidants, the most abundant phenolic compounds in coffee are chlorogenic acids (CGAs), which account for up to 12 per cent of the dry weight of green unroasted coffee beans. Much of coffee's bitter taste comes from CGAs, which also cause the acid reflux that is sometimes experienced by coffee drinkers.

CGAs form in the coffee plant by esterification of trans-cinnamic acids (mainly caffeic, ferulic and p-coumaric acids) with hydroxyl groups on quinic acid. The resulting conjugated CGA structures are known as caffeoylquinic acids, feruloylquinic acids and p-coumaroylquinic acids respectively.

Antioxidant chlorogenic acids combine phenolic acids with quinic acid in various combinations. Up to half of the CGAs in green coffee beans degrade during high-temperature roasting, which causes a host of chemical reactions. Some of the CGAs hydrolyse to form free phenolic acids or dehydrate to bitter-tasting chlorogenic acid lactones. Others are involved in Maillard browning reactions to give a wide range of compounds including brown colored and very bitter-tasting antioxidant polymers called melanoidins.

The concentration of CGAs in a cup of brewed coffee varies hugely, from about 20-675mg per cup compared with 20-60mg in an average cup of tea. CGA levels not only depend on roasting time and temperature, but also on the coffee beans Arabica beans have lower levels of CGAs than Robusta and the brewing method. Decaffeinated coffee contains similar levels of phenolics to caffeinated coffee, and can contain higher levels, thanks to a concentration effect that occurs during decaffeination, says Yi-Fang Chu, who leads the coffee and wellness research group in the US at Kraft Foods Global.

4. Digestive Juices

CGAs in coffee are absorbed in the small intestine to appear in the circulatory system mainly as glucuronidated (coupled with glucuronic acid, a common way the liver solubilises compounds to prepare them for excretion via the kidneys), sulfated and methylated metabolites. It is also becoming clear that the large intestine (colon) plays a crucial role in getting GCAs and their metabolites into the bloodstream. Crozier's team has collected evidence for this by analysingileal (small intestine) fluid samples from people who have had their colons removed (ileostomists). In such people, only 30 per cent of CGAs were absorbed in the small intestine, suggesting that 70 per cent would have passed to the colon in healthy people.

The ferulic and caffeic acids form phenolic acids such as dihydroferulic acid or dihydrocaffeic acid. 'People are starting to get interested in the impact of these things on colonic health,' says Crozier. There are some suggestions that the compounds could act as prebiotics, stimulating the gut bacteria.

There is growing evidence that compounds broken down in the colon form a key part of the 'bioavailability equation' of flavonoids and related compounds that not only occur in coffee, but also in vegetables and other beverages. The colon-derived phenolic acids appear to have in vitro anti-inflammatory activity, and to protect human nerve cells against oxidative damage. Some of the phenolic acids are also thought to be involved in helping to prevent regular coffee drinkers from developing type-2 diabetes.

5. Blood Sugar

Experiments on human fat cells showed coffee doubled the levels of glucose uptake. In the body, such an increase in uptake would lower glucose levels in the blood. But it is not yet clear which coffee compounds induce cells to take up more glucose.

6. Caffeine in the Bloodstream

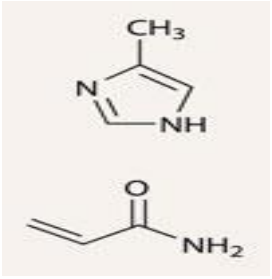
Caffeine is known to improve memory and the speed with which our brains process information. It binds to some of the same receptors as adenosine, a compound that promotes sleep, amongst other things. Caffeine is a non-selective antagonist at A1 and A2A adenosine receptors in the heart and the brain, having an opposite effect to adenosine and producing a stimulant effect.

There is also a suggestion that caffeine can perhaps benefit those suffering from Alzheimer's disease. The theory is that blocking the A2A receptors weakens the damage caused by beta-amyloid, the peptide that accumulates in the brain with Alzheimer's. Giving caffeine to mice engineered to have the disease limited their levels of beta-amyloid and increased adenosine levels. Human studies have not brought out strong links between caffeine and Alzheimer's although analysis of Finnish data on 1409 people over 21 years led by Marjo Eskelinen at the University of Kuopio, Finland, suggested that people who drank 3-5 cups of coffee per day had a greatly reduced risk of developing Alzheimer's or dementia.5

Moderate coffee intake could have significant health benefits, but excess is best avoided

7. Carcinogens in Coffee

Of course, there are negatives. For example, coffee contains 4-methylimidazole, which the US National Toxicology Program (NTP) has identified as a carcinogen. The compound is used to manufacture many products, from dyes to agricultural chemicals and rubber. But it can also form through the Maillard reaction in foods and drinks, particularly those with a caramel flavor such as Cola. The levels of 4-methylimidazole in cola drinks are similar to those in coffees, says Takayuki Shibamoto, at the Department of Environmental Toxicology at the University of California, Davis, US.



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Carcinogens including 4-methylimidazole and acrylamide are found in small amounts in coffee Carcinogens including 4-methylimidazole and acrylamide are found in small amounts in coffee.

8. Conclusion

Coffee drinking and caffeine intake stimulate the cascade of hormones and the body's stress hormones. Being beneficial and harmful for body, scientists have yet to fully ascertain just how coffee works. So it is necessary to work on the process on substituting or replacing a non-caffeinated, alkaline herbal coffee that brews and tastes just like coffee.

References

1. Arendash, G. W. et al., (2006); *Neuroscience*, 142, 941.
2. Chu, Y. F. et al., (2011); *Food Chem*., 124, 914.
3. Del Rio, D. et al., (2010); *Nutrients*, 2, 820.
4. Eskelinen, M. H. et al., (2009); *J. Alzheimer's Dis*., 16, 85.
5. Ernestoilly, Andreyilly, (2015); June 1, 2015.
6. Lopez-Garcia, E. et al., (2008); *Ann. Intern. Med*., 148, 904.
7. Ritchie, K. et al., (2007); *Neurology*, 69, 536.
8. Seppa, Nothan, (2005); *Science News*, Sep. 18, 2015.
9. Zhang, Sarah, (2012); *Discover*, May 18, 2012.