



Mini Review

Can You Have Enough Coffee (The Good, the Bad, and the Ugly of Coffee Intake)?

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Introduction

Coffee is a brewed drink prepared from roasted coffee beans, the seeds of berries from certain coffee species. The genus coffee is native to tropical Africa, specifically having its origin in Ethiopia, Sudan, Madagascar, Comoros, Mauritius, and Reunion in the Indian Ocean [1]. Coffee plants are cultivated primarily in the equatorial regions of the “Americas” (North and South America), Southeast Asia (south of Japan and China, east of India, west of Papua New Guinea, and north of Australia), India subcontinent, and Africa.

The two most grown are *Coffea arabica* and *Coffea robusta*. Once ripe, coffee berries are picked, processed, and dried. Dried coffee seeds (referred to as “beans”) are roasted to varying degrees, depending on the desired flavor. There are basically three methods of coffee preparation that are consumed: boiled unfiltered coffee, filtered coffee, and decaffeinated coffee [2].

Brazil is regarded as the world’s largest producer of coffee, with just over 33.6 million bags (1 bag weighs 132 pounds) produced in 2003 – 2004, followed by Columbia -11.8 million bags and Vietnam -10.75 million bags [3]. Coffee drinking is a common lifestyle in Western society. In the US, for example, 52% of all persons aged 10 years or older drink coffee [4].

Roasted beans are ground depending on the brew, with near-boiling water to produce the beverage known as coffee. “Coffee is darkly colored, bitter, slightly acidic, and has a stimulating effect in humans, primarily due to its caffeine content” [5]. Coffee undergoes a chemical change from the unroasted green bean, and the type of bean (Arabica versus Robusta), degree of roasting, and preparation method all go to determine the biochemical composition of the final output.

Roasted coffee is said to be a complex mixture of several thousand chemicals. The make-up of roasted coffee has been explained to

have antimutagenic and antioxidant activities and the ability to prevent cancer-promoting agents [6-8]. The antioxidant attributes of coffee were assumed to provide a protective role against cancer [9]. Due to the high intake of coffee in Western Society, any small effect can result in a large population impact. More reasons there are many research being carried out on the benefits of coffee intake and the possible effects of it.

Coffee is one of the most widely consumed beverages in the world and it is a major source of caffeine for the population [10]. Coffee and tea remain the leading caffeine-containing beverages in the world. Coffee can be prepared and presented in a variety of ways - Espresso, French press, café latte. It is usually served hot, although iced coffee is a popular alternative. There have been mixed conclusions as to whether coffee consumption is beneficial or harmful to health, and this varies between outcomes [11].

Can you have enough coffee? Clinical studies indicate that moderate coffee consumption is benign or mildly beneficial in healthy adults, with continuing research on whether long-term consumption lowers the risks of some diseases, although those long-term studies are of generally poor quality [12].

It is pertinent to note that most people start their day with a cup of coffee and finish their daily work with a cup of coffee. This makes coffee an important part of modern daily life. It is thought that coffee has an alerting influence on the brains of humans after consumption. However, some people have complained about some side effects of taking coffee, like having an irregular heartbeat, headaches, and sometimes insomnia, which results in them to stop taking coffee altogether. This shows that there are individual variations to coffee intolerance. What has an effect on one human body may not have any effect on another human body, hence the human variation in coffee intake. It is assumed that coffee is the second most valuable commodity after oil in the world, hence it is the most consumed active beverage. It is estimated that more than half

of Americans drink coffee every day. The average consumption for a person in the European community is 5.1 kg/year, which is similar to that in the United States [2].

Coffee is a complex mixture of chemicals, and it is considered to be the main source of caffeine in many populations. It contains carbohydrates, lipids, nitrogenous compounds, vitamins, minerals, alkaloids, and phenolic compounds [13]. Although coffee contains a large proportion of caffeine, the variability of the caffeine content differs according to the type of beans, how it is prepared, and other factors.

There have been numerous studies about the effect of coffee intake and how it might affect human health. Many studies on the health effects of coffee consumption in humans are thought to be observational. Various concerns about potential health risks of coffee and caffeine consumption raised by epidemiological research in the past were likely increased by associations between high intakes of coffee and unhealthy behaviors, such as cigarette smoking and physical inactivity [14]. Despite these numerous studies, conflicting findings and concerns about methodological issues have been an encumbrance for health professionals and the public. This has made the interpretation of the available evidence on coffee intake and any health issue difficult to project.

There have been both epidemiological and experimental studies showing the positive effects of consistent coffee intake on various aspects of health. This includes psychoactive response (alertness, mode change), neurological (infant hyperactivity, Alzheimer's, and Parkinson's diseases), and metabolic disorders (diabetes, gallstones, liver cirrhosis), and gonad and liver function [15].

Despite the concerns about the side effects of coffee intake, there are possible health benefits associated with coffee intake. These positive effects have been observed in the prevention of several chronic diseases. Research has found that long-term coffee consumption is a main contributor to significant dose-dependent reductions in the development of type-2 diabetes [16]. Also, it has been observed that coffee intake reduces the risk of liver damage in people with a high risk of liver disease, including hepatic injury, hepatocellular carcinoma, and cirrhosis [17].

Another observation made by some researchers linked an inverse relationship between coffee and Parkinson's disease in males and females who have never used postmenopausal estrogen [18]. It is also assumed that the risk of Alzheimer's disease is lower in those who usually take or ingest caffeine-containing coffee than in those who do not drink it [19].

Another highlight of the benefits of coffee intake has been observed in aiding physical activities. Various research has shown that coffee tends to improve performance in long-duration physical activities. This is a factor in determining the rate of suicide. It is assumed that the relative risk of suicide has decreased by a factor

of 13% for daily consumption of a cup of coffee [20]. Though, there have been observational studies into the consumption of caffeine and its limiting risk of cancer at various sites, including liver and colorectum, there is still no evidence to support this observation on how coffee consumption can protect against cancer [11].

Despite the above positives/benefits of coffee intake, it is noteworthy to consider the effects of high intake of caffeine. The effects of coffee have been observed to be the cause of some cardiovascular effects, such as tachycardia, high blood pressure, and sometimes arrhythmia [2]. This effect varies from one individual to another, as the severe effect may arise from the time of consumption or be dependent on individual physiological makeup.

There were observed studies linking the relationship between the intake of coffee to the risk of stroke. Though this needs further clarification [11]. Another study also observed the development of hypertension with the ingestion of coffee. Though it is attributed to taking coffee in small quantities but not frequently [16]. A different study of the effect of large consumption of caffeine led to a slight drop in the level of calcium absorption in the gastrointestinal tract. Thereby, it was recommended that an adequate intake of calcium and vitamin D, with a decrease of coffee intake to 2-3 cups/day, help limit the risk of osteoporosis and its related fractures, especially in seniors [21].

The effects of caffeine intake were also observed in pregnant women. It was noticed that caffeine is absorbed in the human placenta, which quickly gets into the fetus. It was studied that most sudden abortions or impaired fetal growth were due to the excessive intake of caffeine by pregnant women [21]. The recommended caffeine intake for women who plan to become pregnant and for women during pregnancy should not exceed 300 mg/day [21]. It was stated that an ingestion of 2.5 mg/kg body weight/day is the greatest amount of caffeine consumption in children [22].

The intake of coffee can be separated from a meal or taken when eating. It is regarded as a compliment to your meal and not necessarily as nourishment. However, the purpose of ingestion, depending on the quantity consumed, it was observed can affect the intake of K, Mg, and Mn [23]. Coffee-brewing has been observed to help take out dangerous metals such as Pb from influent water [24]. The intake of coffee was researched to be loved around the world, mostly because of its pleasant taste and aroma, and because of its physiological and psychoactive properties, credited to the presence of compounds such as methylxanthines [25].

Coffee is rich in biologically active substances such as nicotine acid, tuigonelline, quinolinic acid, tannic acid, pyrogalllic acid, and, of course, caffeine [26]. Caffeine isn't the only component found in coffee; it is widely used in the food and pharmaceutical industries. The effect of caffeine found in coffee that is needed for mental alertness, restlessness, wakefulness, and faster information

processing in those who consume it was later attributed to be in tablet form and used broadly in medication and beverages [27]. Present in coffee, especially roasted and brewed coffee beans, are volatile substances that cause it to be highly aromatic and reactive in the human body [28].

Because of the high intake of coffee, it has also led to the development of various coffee-making machines. Specialized coffee establishments have grown over the years, and this has also aided employment opportunities in most industrialized and affluent countries. The flourishing nature of the industry specialized in coffee-making machines has led to an increase in varied methods of coffee preparation, suitable for homes and offices. There is virtually no “established office” you visit in Canada without a coffee-making machine that helps to keep their guests or staff welcomed, relaxed, and entertained while they wait or work. This can also be seen in most hotel and motel rooms and their lobbies.

Due to the presence of coffee machines in most offices, it was observed to be the cause of an increase in coffee intake at work [29] (Steptoe & Wardle, 1999), possibly because it was thought to increase work performance [30]. The high intake of coffee was also observed in truck drivers who drive long distances. To help them keep their mental alertness and eyes from sleeping while driving long distances, most of these drivers take coffee for that purpose. It has also been observed from research that caffeine intake in coffee reduces early morning driving drowsiness for about 30 minutes following no sleep and for close to 2 hours after you have been deprived of sleep [31].

Most road accidents, as observed, were attributed to the driver’s sleepiness, therefore a need to take coffee to avoid falling asleep while on the wheels, though this is a poorly evaluated role of coffee-drinking [32]. It was also observed among airline pilots to avoid fatigue and enable safety [33].

Because of the high pharmacological effect of caffeine, most consumers have asked for caffeine-free coffee beverages. This has led to the introduction of decaffeinated coffee brands. These brands vary according to the methods of preparation. At inception, organic solvents were employed to remove the caffeine in coffee, but this was abandoned

and stopped due to the side effects noticed. The method being practiced for removing caffeine in coffee is the use of supercritical CO₂ to extract caffeine from coffee beans. It is still not certain whether the caffeine extraction is 100%. [34], analyzed coffee brands sold as decaffeinated and found them to have caffeine concentrations less than 17.7 mg/dose. Another study tested to see the levels of caffeine in a naturally decaffeinated Coffee arabica plant (genetic selection) from Ethiopia, and it showed a 93.7% reduction in the level of caffeine [35].

Though there have been conflicting outcomes in the studies of coffee intake due to cultural or individual preferences, these

differences have sometimes inhibited getting accurate data for possible health outcomes in these studies.

The way the coffee beans are roasted, the brewing techniques, and the level of coffee consumption differ around the world. In France, for instance, the roasting process appears to be more intense than that in the USA [36]. Another study observed that coffee is consumed unfiltered in Italy [37] and Sweden [38]. This is attributed to the varied influences of lifestyle trends, which might be a factor in the type of coffee consumed.

More research is being done to see the effects of coffee intake in the morning, especially with breakfast. [39] Smith et al (1999) were able to distinguish profiles (working memory, attention, mood, cardiovascular function) based on coffee and cereals consumed during breakfast. They found out that those who consumed cereal for their breakfast had a better positive mood at the start of the test sessions, performed a lot better on a spatial memory task, and were at ease at the end of the test session than those who didn’t consume cereals for their breakfast. It was also noticed that the intake of caffeine from the coffee consumed had no contribution to prior mood or working memory, but it helped to improve the encoding of new information and helped to prevent any form of tiredness that may have developed during the test session [39].

There are studies that have been made to see how coffee affects children. It is considered an inappropriate beverage for kids in the US [40]. [4] Barone & Roberts (1996) assessed caffeine intake from coffee consumption between 1 and 5 years of age. While this might be inappropriate for kids in the US, in some societies, coffee-drinking is introduced early in life [41] [39]. Dorea and Furumoto (1992) reported that coffee is introduced into infants’ diets as early as 2 months of age.

In coffee-growing countries in South America, coffee consumption is part of the meals, especially during breakfast. In places like this, there are no restrictions on the amount of coffee intake during pregnancy and lactation [43]. Another study found that coffee is part of the liquid first given to infants in Guatemala [40].

A clinical article on the effect of coffee intake on blood flow and maternal stress during the third trimester of pregnancy was found not to affect maternal or fetal blood flow. This test was performed by a “Doppler blood flow analysis” for women in their third trimester of pregnancy before and after they drank a cup of coffee. Salivary samples were collected from these ten pregnant women. While coffee did not affect the fetal blood flow, it was found that the salivary cortisol levels were significantly reduced after coffee intake, but “salivary chromogranin” A concentration was not significantly different before and after coffee intake [44].

In another study focused on examining whether coffee intake was related to the intensity of aggressive feelings in reaction to various provoking or frustrating situations, along with consideration of sex

and culture [45]. Participants from Greece (n = 299) and Poland (n=300) declared whether they were coffee drinkers (at least one mug of coffee per day) and completed the Situation “Triggers of Aggressive Refuses Questionnaire”. The result showed that in females, coffee drinkers had higher scores in sensitivity to privation (SP) and frustration (SF) than non-drinkers, while there were no differences between drinkers and non-drinkers. Females had higher scores in SP and SF than males, while no sex differences were found in non-drinkers.

There have been many types of research suggesting the positive effects of coffee consumption on various aspects of health. Though there are good outcomes of coffee intake, it should be emphasized that an individual’s sensitivity to coffee and the biological effects of coffee among humans may vary because of personal single-nucleotide polymorphic variants, as seen in the investigation of genetic polymorphisms in apolipoprotein E (APOE) [46].

Another study looked at the effect of coffee intake on breast milk and lactation. It was observed that caffeine doesn’t change the breast milk composition but helps the production of milk [6].

Phenolic compounds and antioxidant compounds are major components of coffee beans and tea. However, during the bean-roasting process, the phenolic compounds are observed to be lost while the antioxidant compounds are developed. They studied that during the bean-roasting process, while keeping or following roasting conditions, there was a maximum antioxidant activity. They observed that any decrease in antioxidant properties must be related to high-molecular-weight Maillard Reaction Product (MRP). Del Castillo et al. (2002) also observed that the degree of roasting is directly proportional to the amount of antioxidant activity. They presented their observation that a medium- roasted coffee gave a high antioxidant activity.

The main amount of polyphenol in coffee is due to the presence of chlorogenic acid. Chlorogenic acid is one of the main sources of antioxidant compounds in coffee [47]. The chemical composition determines the antioxidant activity. It was also observed that the antioxidant activity of coffee varies according to the degree of roasting. Maximum antioxidant activity was measured for the medium-roasted coffee [15].

[48] Nicole et al. (1997) also observed that applying heat during coffee-roasting largely affects the overall antioxidant properties of the coffee beans, and it further enhances the development of MRP. Other factors, like brewing, also play a role in determining the degree of antioxidant activity. Lots of speculations still surround the consumption of coffee and the induction of cancer [49]. They found out that coffee acts as a modifier that may enable or disable tumor formation. [50] Vattern et al (1990) suggested that the intake of coffee plays a major role in reducing the formation of breast cancer in women who aren’t obese, whereas it might enable

the formation of cancer in relatively obese women. Lung cancer patients usually have their prognosis linked to cigarette smoking. There haven’t been many studies linking cancer patients to taking of coffee and smoking at the same time. It is observed as a usual occurrence that those who smoke cigarette, they are usually heavy coffee drinkers. There is no significant effect on lung cancer risk of smoking and drinking coffee [51].

[52] Diokno et al (1990) observed that taking at least one cup of coffee per day was significantly associated with a high libido in elderly women and a much higher libido in elderly men. Studies in Sweden showed that intake of coffee was related to an improved insulin sensitivity in elderly, non-diabetic men [53] (Arnlov et al., 2004), and a reduced risk of type-2 diabetes and impaired glucose tolerance in men and women drinking five or more cups of coffee per day [54].

The mood and performance of people due to the intake of caffeine were studied. They found out that a regular caffeine intake is likely to benefit drinkers amply, but an effect called “withdrawal relief” was a factor that contributed to caffeine consumption [55]. It was also noticed that other factors, other than caffeine level accumulation, were responsible for the delay in intervals between the number of cups consumed during the day [56].

Taking coffee on a regular basis can have both positive and negative effects, as studies have shown both ways. Habitual coffee-drinkers deprived of caffeinated beverages in the morning, even for short periods, can have noticeably unpleasant “caffeine withdrawal” symptoms by midday [57]. These “caffeine withdrawal” symptoms can range from restlessness to headache, etc. These symptoms can be transient but continuous [58]. They observed that these symptoms disappeared after a few days of not taking coffee or any caffeine-induced beverages, and it gets weakened over time.

[59] Lawson et al (2004) observed that signs of early pregnancy induced a distaste for coffee consumption. They found that a woman who took coffee and suddenly stopped taking it, or no longer had the desire to drink coffee, was a sign of pregnancy, in addition to nausea and vomiting. Moderate coffee drinking is defined as taking 2 – 4 cups of coffee per day, and it may not have any of the side effects being studied by researchers. However, there are many studies that support the idea of taking coffee or caffeine-related beverages because of their many health benefits.

Massey John’s book on coffee: Production, Consumption and Health Benefits supports the fact that coffee is among the most widely consumed beverages worldwide. He opines that high consumption of coffee has been considered to have negative health consequences due to the “stimulant effects of caffeine”. On the contrary, there is also substantial evidence that coffee contains a range of “bioactive compounds and antioxidants” with potentially beneficial effects on human health [60]. Is there an oxidant in

coffee? It is believed that coffee is the number one dietary source of antioxidants in many countries, including the United States, Italy, Norway, and Spain.

The excellent aspect of coffee intake is attributed to the fact that it contains bioactive compounds and antioxidants that help keep the body cells and system balanced, as mentioned above. However, the wrong aspect of coffee is connected to too much consumption, thereby accumulating a large dose of caffeine, which has a stimulating effect. The ugly part of coffee is its stimulating effect. This ugly part of coffee intake is in the nature and style of it being taken. In Canada, especially in Edmonton, coffee drinkers are apparent. They may be in the office, on the road, or even while driving. Sometimes, when moving around the city, there is littering of coffee cups around.

“Coffee also shows protective or adverse effects on various systems like the skeletal (bone) system, the reproductive system, the nervous system, the “cardiovascular” system, the homocysteine levels, and the cholesterol level [61]. This study admits to the harmful effects of coffee when it is associated with people who are sensitive to stimulants. Overall, with the available information, it can be concluded that moderate consumption, corresponding to 3 to 4 cups a day with average strength, is safer to human health.

How do you quantify your coffee intake to measure the required amount needed by the body and not become addicted to it? Moderate amounts of coffee are right for you; drinking way too much of it can still be harmful. If you want to ensure the potential health benefits of coffee, avoid adding sugar. If drinking coffee tends to affect your sleep, don't drink it after two in the afternoon. The coffee content in a cup of coffee is of a higher variable, ranging from 50 to 400 mg per cup.

A small home-brewed cup of coffee could contain 50mg, while a prominent 16oz Starbucks grande can contain over 300mg. As a rule, we can assume that an 8-ounce cup of coffee contains around 100mg of caffeine. Several sources suggest that 400mg of caffeine, or 4 cups of coffee, is safe for most healthy adults [21]. Keep in mind that there are many other sources of caffeine besides coffee, including tea, soft drinks, energy drinks, chocolate, and certain medications.

Conclusion

In summary, when it comes to the health effects of coffee, there are both short-term and long-term symptoms. The short-term is related to the caffeine content, which works primarily in the brain, where it affects the function of “neurotransmitters” and exerts a stimulant effect. Drinking too much coffee in a short amount of time leads to an experience of symptoms mostly related to the brain and digestive system. The health effects of chronic coffee are still debated, although most recent findings indicate that moderate coffee consumption is unlikely to adversely affect cardiovascular

outcomes. The potential benefits of chronic coffee intake also include protection against neurodegenerative diseases and cancer. However, most data are from very few randomized, controlled studies. Besides, considerable interindividual variability in cardiovascular and psychoactive responses to coffee drinking has been observed: this is partly due to tolerance, but there is evidence that variability may have a genetic basis [62].

According to the Specialty Coffee Association of America (2005) [63], there are over 100 million Americans who consume an average of 3.1 cups of coffee per day. Where is coffee placed in the class of food? Is coffee a functional food (FF)? Functional food is defined based on its beneficial effects on health promotion and/or disease prevention [15]. With the above definition, coffee may be classified as a functional food (FF) due to its beneficial effects on health and disease prevention [64-65].

The amount of caffeine in a cup of coffee can range from 50 to over 400mg. Many sources recommend 400mg of caffeine per day as the safe upper limit for healthy adults. Your genetic makeup also determines how much coffee is considered too much.

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