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"Spectroscopic Study Of Green Tea (Camellia Sinensis) Leaves Extraction"

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Abstract

Coffee beans and tea leaves are important sources of caffeine (3,7-Dihydro-1,3,7-trimethyl-1H-purine-2,6-dione), a prevalent naturally occurring xanthine derivative. Because of its flavor, aroma, and capacity to activate the central nervous system, people have been drinking products containing caffeine for hundreds of years. We calculated the caffeine content of tea and coffee, which are frequently consumed by humans. We used the "liquid-liquid separation" approach to extract caffeine from them. Since caffeine is more soluble in chloroform than in any other solvent, we utilized it as an extracting solvent. After that, the extract's chloroform was evaporated, leaving behind only white crystals that were thought to be pure Caffeine.We found that light absorption increases linearly with green tea content.

Keywords: CNS, tea, caffeine, and chloroform.

Introduction

Tea is one of the most widely used traditional beverages. Different nations view tea differently, which results in distinct tea cultures. This distinctive culture encompasses the aesthetics of tea drinking as well as the production and consumption of tea. Two notable instances of tea preparation and serving are found in Chinese and British tea cultures. In some parts of China, tea is brewed with salt and butter.

Tea is not only a refreshing beverage but also a traditional herb with numerous health benefits, including enhanced brain function, weight loss, and a decreased risk of cancer. Maintaining the tea's quality is crucial, regardless of why it is consumed. A quality criteria that satisfies the taste of the general public must be adopted for a specific quantity of tea drinks. This means that for a given quantity, the density of a chemical compound that characterizes the tea flavor must be roughly consistent.

Laboratory-based analysis is still regarded as one of the most accurate and trustworthy ways to identify the kind and quality of green tea. This extraordinary method is expensive and time-consuming, though. In order to solve this issue, a lot of work has gone into creating a technique and an instrument for properly, conveniently, and affordably analyzing green tea. These include techniques and tools for identifying the different types of green tea [6] and figuring out its content [1–5].

Fiber sensors have drawn more attention in recent decades because of their special physical characteristics, which include their tiny size, flexibility, and immunity to electromagnetic interference. In practically every field where traditional sensors have long been considered the best sensors, fiber sensors are being utilized [7–9]. Over the years, optical fiber liquid and gas sensors have also been studied [10–11], and many of them are currently on the market. This report describes an initial investigation that uses fiber sensors based on evanescence wave absorption to determine the absorption peak characterizing green tea as a function of its concentration.

The plant alkaloid caffeine (1,3,7-trimethylxanthine) has a molecular weight of 194.19. Its chemical structure is C8H10N4O2 and a molecular weight of 194.19. In pure form, it is a bitter white powder. Structurally, caffeine (and the other methylxanthines) resembles the purines. Caffeine has an average half-life of five hours in the plasma of healthy people. However, caffeine's elimination half-life may range between 1.5 and 9.5 hours, while the total plasma clearance rate for caffeine is estimated to be 0.078 L/h/kg (Brachtel and Richter, 1992; Busto et al., 1989). This wide range in the plasma mean half-life of caffeine is due to both innate individual variation, and a variety of physiological and environmental characteristics that influence caffeine metabolism such include smoking, altitude, pregnancy, obesity, and the use of oral contraceptives. Caffeine's pharmacological effects are comparable to those of other methylxanthines, such as those present in different teas and chocolates. These effects include reduced reaction times, the capacity to maintain intellectual engagement, and modest CNS stimulation and alertness.

It is estimated that 10–14 g (150–200 mg/kg body weight [BW]) of caffeine is the lethal acute oral dose in humans (Hodgman, 1998). Caffeine doses up to 10 g have been known to induce convulsions and vomiting, with full recovery occurring within 6 hours (Dreisbach, 1974). Humans who consumed 1 g (15 mg/kg) of caffeine experienced severe adverse effects, such as agitation, anxiety, and restlessness, which progressed to delirium, vomiting, Other symptoms included tachycardia and increased respiration.

Caffeine, a central nervous system (CNS) stimulant of the methylxanthine class, is the most commonly used psychoactive substance worldwide. It is mostly used for its ergogenic (improving physical performance), nootropic (improving cognition), or eugeroic (improving wakefulness) properties. [11] [12] By preventing adenosine from attaching to various adenosine receptor types, caffeine reduces the centrally depressive effects of adenosine and increases acetylcholine release. Caffeine can bind and inhibit its receptors because of its comparable three-dimensional structure to that of adenosine. Although these processes usually take place at quantities above what is normally consumed by humans, caffeine also raises cyclic AMP levels via nonselectively inhibiting phosphodiesterase, increasing calcium release from intracellular reserves, and antagonizing GABA receptors.

The adenine and guanine bases of ribonucleic acid (RNA) and deoxyribonucleic acid (DNA) are molecularly comparable to caffeine, a methylxanthine alkaloid and a bitter, white crystalline purine. It is present in the seeds, fruits, nuts, or leaves of several

plants that are indigenous to Africa, East Asia, and South America. It helps shield these plants from herbivores and competition by stopping neighboring seeds from germinating [17] and promoting consumption by specific animals like honey bees. [18]The two most common sources of caffeine are the tea leaves of the Camellia sinensis plant and the coffee bean, which is the seed of the Camellia plant. The coffee bean, which is the seed of the Caffeine-containing beverages may be consumed by people to enhance cognitive function and alleviate or avoid sleepiness. Caffeine is extracted for these beverages by a method known as infusion, which involves steeping the plant product in water. Drinks with caffeine, like tea, coffee, and cola, are widely consumed throughout the world. Nearly 10 million tonnes of coffee beans were eaten worldwide in 2020. The most often taken psychoactive substance in the world is caffeine. Caffeine is still mostly uncontrolled and lawful in almost every country in the globe, in contrast to the majority of other psychoactive chemicals. Since most cultures view caffeine as socially acceptable and even encourage its use, it is also an anomaly.

There are advantages and disadvantages to caffeine's health impacts. Bronchopulmonary dysplasia of preterm and apnea of prematurity are two premature newborn respiratory problems that it can treat and prevent. Caffeine citrate is listed in the WHO Model List of Essential Medicines. It might have a slight preventive effect against Parkinson's disease and other illnesses. Caffeine consumption causes anxiety or disturbed sleep in some persons, but no disruption in others.There is conflicting information regarding the risk during pregnancy; some organizations recommend that pregnant women limit their coffee intake to no more than two cups per day. When someone quits using caffeine after using it everyday, it can cause a minor kind of drug dependence that is accompanied by withdrawal symptoms like headaches, irritability, and tiredness. Long-term use causes tolerance to the autonomic effects of raised blood pressure and pulse rate, as well as increased urine output (i.e., these symptoms lessen or do not occur following continuous use).

The Food and Drug Administration (FDA) considers caffeine to be harmless. Compared to the usual dosage of less than 500 milligrams per day, toxic doses—more than 10 grams per day for an adult—are significantly greater.

According to The European Food Safety Authority states that non-pregnant persons who use up to 400 mg of caffeine per day (or roughly 5.7 mg/kg of body mass per day) do not have any safety concerns, and pregnant and lactating women who consume up to 200 mg daily do not have any safety concerns for either the fetus or the breastfed infants. Coffee can contain anywhere between 80 and 175 mg of caffeine, depending on the type of "bean" (seed), roasting technique, and preparation method (e.g., drip, percolation, or espresso). Therefore, 50 to 100 regular cups of coffee are needed to obtain the hazardous amount. However, a tablespoon of pure powdered caffeine, which is sold as a nutritional supplement, can be fatal.

Principle of experiment

1. Caffeine Quantification

• The amount of caffeine in tea extracts is measured using UV spectroscopy.

• The technique is based on the idea that a substance's absorbance at a certain wavelength is directly correlated with its concentration.

• By measuring the absorbance of the caffeine solution, researchers can accurately determine how much caffeine is in the tea leaves.

•By revealing the caffeine concentration, UV spectroscopy aids in evaluating the quality of tea leaves.

• A significant component of tea is caffeine, which varies in concentration among brands and kinds

3. Method Validation:

•To guarantee their accuracy, precision, and specificity, UV spectroscopy techniques are frequently evaluated.

• In order to verify that the results acquired by UV spectroscopy are correct and dependable, validation include evaluating the method's linearity, reproducibility, and capacity to discriminate between various substances, such as caffeine and its breakdown products.

4. Simplifying Analysis:

•UV spectroscopy is a useful instrument for the tea business since it provides a quick and reasonably easy way to analyze tea samples.

•It can also be automated and utilized in regular quality control processes.

Process

Preparation of Sample

Five grams of sodium carbonate were added to 150 milliliters of distilled water along with seven grams of tea (or coffee). After that, the solution was heated and maintained at 100C for 15 minutes. After cooling, Whatman filter paper was used to filter the mixture.

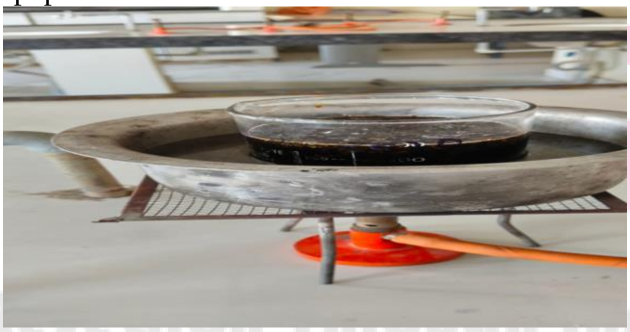


Fig. Sample is heated

Caffeine Extraction Procedure

A separating funnel was filled with this material, and six milliliters of dichloromethane (DCM) were added. In order to extract the caffeine, the funnel was inverted at least three times, with each inversion followed by a funnel vent. Excessive shaking will result in an unmanageable emulsion, and very mild mixing will not be able to extract the caffeine. The water layer was left behind after the bottom layer containing dichloromethane (DCM) was removed to a clean flask. The extraction process was then done twice more, combining the solvent layers.

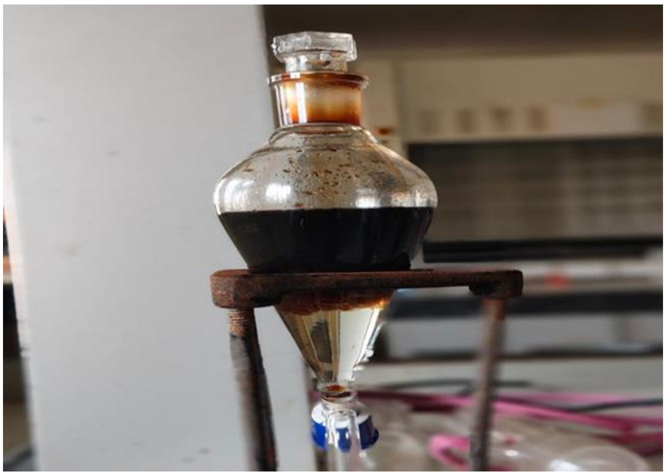


Fig. Bottom layer containing dichloromethane

Separation of Caffeine

By heating the flask on a mantle or covering it with perforated aluminum foil and letting it evaporate for a while, the dichloromethane was removed from the extract. It was then recovered in the other beaker using the Heat Reflux Extraction technique. A white powder that was believed to be pure caffeine was the residue that resulted. Using an electronic scale, the mass of the flask containing residue was determined.

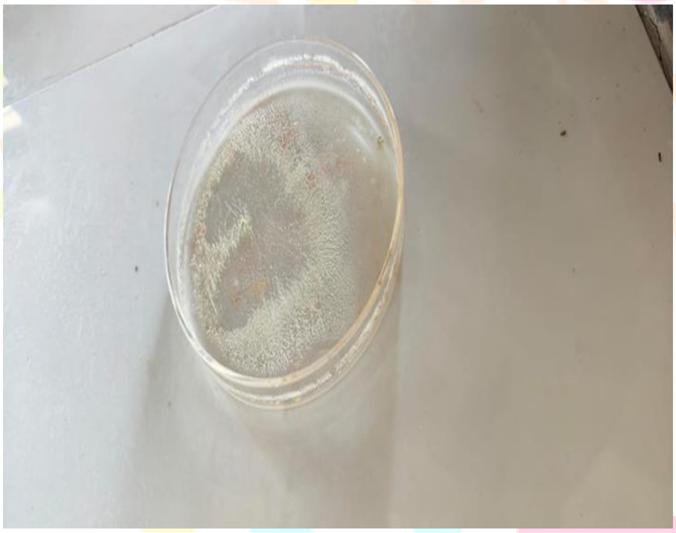
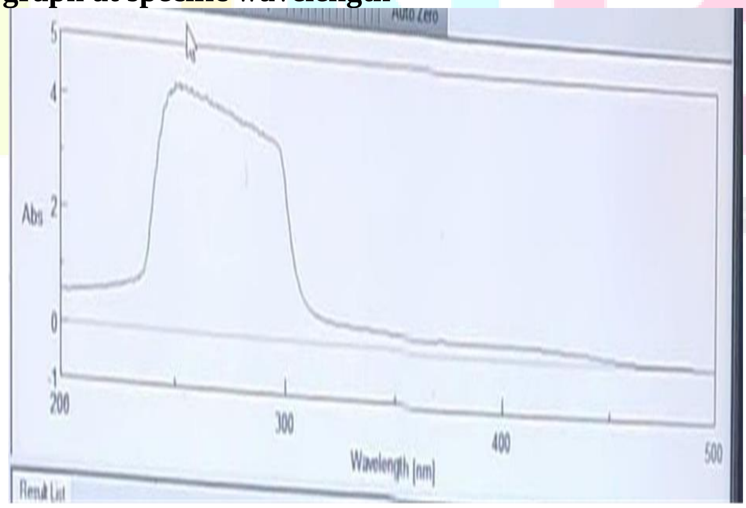


Fig. Caffeine

Caffeine absorption graph at specific wavelength



The range of the spectrum is roughly 200 nm to 500 nm. A notable absorption peak, characteristic of caffeine, emerges at approximately 270 nm. A sharp ascent begins at about 240 nm, reaches its peak, and then starts to decline after 300 nm. At the time of capture, the maximum absorbance (Abs) recorded was roughly 0.0153, though this could vary based on the sample and path chosen important for a full spectrum scan are the D2 (Deuterium) and WI (Tungsten) lamps, which cover the UV and visible regions, respectively. A dependable indicator for either quantitative or qualitative examination of caffeine is the obvious absorption at about 270 nm.

Conclusion

Green tea's spectroscopic characteristics have been investigated in both ethyl acetate and chloroform extractions. Using a UV-VIS-NIR spectrophotometer, their absorption spectra in the 200–500 nm wavelength range have been measured as a function of green tea content. We discovered that as the content of green tea rises, so does the absorption. We have utilized this outcome to investigate an evanescence fiber sensor intended for measuring a green tea single component solution. We have demonstrated that the amount of light absorbed by the evanescence process increases linearly as the concentration of green tea increases. This finding raises the possibility that the evanescent fiber sensor created in this study could be applied to the quality control of green tea beverages.

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