Estimation of Caffeine in Tea Samples of Southern Region of India

A. Nithya and P. Parthiban*

Department of Chemistry, CRD, PRIST University, Thanjavur-613403, Tamilnadu, India

Abstract: Caffeine is a bitter, white crystalline purine derivative that closely related to adenine and guanine. Caffeine is used to reduce physical fatigue and to prevent or treat drowsiness. It produces increased wakefulness and focus, improves thought-processing, and better general body coordination. The amount of caffeine needed to produce these effects varies from person to person, depending on body size and degree of tolerance. Hence, it is of importance to estimate the quantity of caffeine present in various types of tea and coffee products. Accordingly, a simple and efficient approach has been done on a variety of tea samples from various places in the southern region of India to understand the quantity of caffeine with respect to the region of cultivation. Among the samples from Nilgiris/ Valparai/ Kodaikanal of Tamilnadu, Munnar of Kerala, and Coorg of Karnataka, the Garden green tea from Coorg (Sample **8**) is the best in terms of caffeine quantity (2.37%).

Keywords: Caffeine, Green tea, Tea dust, Estimation of caffeine.

INTRODUCTION

Originally called "theine", caffeine was first discovered in tea in 1827. It was later shown that the "theine" of tea was identical with the caffeine of coffee; henceforth, the term "caffeine" is used to indicate the active ingredient of both coffee and tea (Figure **1**).

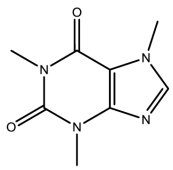

Figure 1: Chemical structure of caffeine.

Many plants that give us caffeine, which is extracted by steeping the plant product in water. Caffeine is a natural constituent in coffee, tea, chocolate, and some cola drinks, and, it is added to consumer products such as soft drinks, diet pills, and analgesics. Caffeine has been used widely around the world over centuries, and today it is estimated by United States Food and Drug Administration (US-FDA) that 80% of the world's adult population consumes caffeine in any one of the forms [1].

One of the prime characteristic effects of caffeine is its ability to stimulate the central nervous system (CNS) of the human body [2]. As a result, there is the common increase of alertness and heart rate accompanied by a change in blood pressure. Most of the effects of caffeine begin about 15 minutes after it has been consumed and can last for several hours in our systems. These effects of caffeine on the body differ from one person to another. While the majority of people can experience excitement, some can experience quite the opposite as any of the following such as restlessness, nervousness, insomnia, flushed face, increased urine excretion, gastrointestinal disturbance and tachycardia, all of which depend on the person and the quantity of caffeine consumed. The most popular effect due to caffeine consumption is the ability to postpone exhaustion. The reason why most people become alert when they consume caffeine is that the molecule fits into the binding sites meant for adenosine, a neurotransmitter that serves to create a calming effect in the body. Whether it is a fresh-brewed coffee, hot tea, or a can of soda, consuming caffeine is the energy boost of choice for millions who want to wake up or stay up [3]. However, the consumption of caffeine should be restricted for pregnant women [4].

The research by Michael Yassa of psychological and brain sciences at Johns Hopkins shows that caffeine enhances certain memories at least up to 24 hours after it is consumed [5]. The reason is, it is chemically attracted to the sites more than adenosine itself. As a result, caffeine blocks the binding sites of adenosine, and at the same time, it raises the levels of other chemicals that stimulate us such as adrenaline, and the adrenal hormone cortisol. Cortisol is known as the "stress hormone", which is released in response to physical or psychological stress [6]. Similarly, Sherman *et al.* reported that caffeine enhances memory performance in young adults during their non-optimal time of day [7].

Caffeine structurally resembles adenosine enough for it to fit into the brain's adenosine receptors (adenosine is a byproduct of many cellular processes, including cellular respiration). In fact, that caffeine can

*Address correspondence to this author at the Department of Chemistry, CRD, PRIST University, Thanjavur-613403, Tamilnadu, India; Tel: +91 4362 265021; Fax: +91 4362 265150; E-mail: parthiban.crd@prist.ac.in

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fit neatly into our brain cells' receptors for adenosine, effectively blocking them off [8]. Normally, the adenosine produced over time locks into these receptors and produces a feeling of tiredness. Caffeine molecules are blocking those receptors, they prevent this from occurring, thereby generating a sense of alertness and energy for a few hours. Additionally, some of the brain's own natural stimulants (such as dopamine) work more effectively when the adenosine receptors are blocked, and all the surplus adenosine floating around in the brain cues the adrenal glands to secrete adrenaline, another stimulant. In addition, various recent studies registered the importance of caffeine as a powerful antioxidant [9].

Hence, we planned to estimate the percentage of caffeine in various tea samples from different locations of southern region of India to understand the better quality of tea in that region in terms of caffeine percentage.

MATERIALS AND METHODS

1. Caffeine Isolation Procedure [10]

- In a one litre round bottom flask 40 gm of sample **1** was taken.
- To this, about 250 ml of distilled water added and the content refluxed for about an hour.
- The brown color extract separated by decantation followed by filtration at hot.
- Lead acetate dissolved into water in 250 ml beaker.
- The lead oxide added slowly to the boiling solution with constant stirring.
- It was filtered and again boiled.
- The filtrate thus obtained was added drop wise to this extract until no precipitation occurs.
- The filtrate was treated with activated charcoal.
- The clear solution extracted with 100 ml of chloroform after separating by filtration.
- Solvent removed by rotovapor.
- The residue left in the flask was dissolved in minimum amount of hot water and the dissolved contents transferred to the boiling tube.
- The solution was kept for slow crystallization. Gradual evaporation offered good crystalline caffeine.
- The above procedure repeated for all tea samples **2-10**.

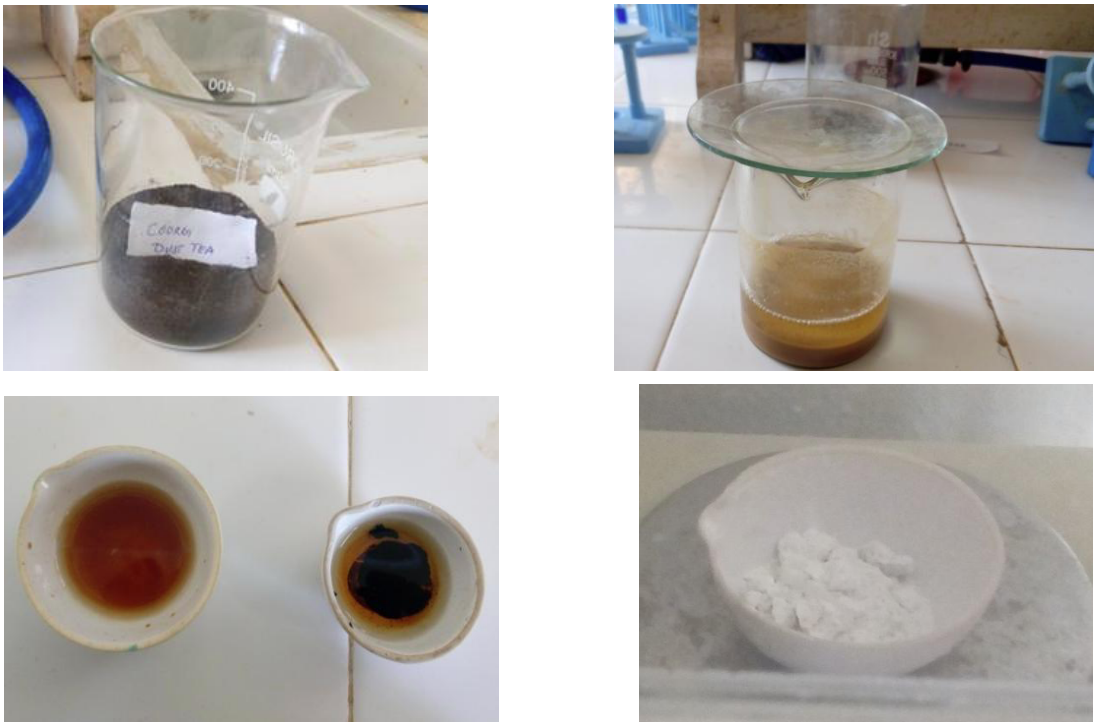


Figure 2: Photographs during the isolation of caffeine.

2. Schematic Representation of Isolation Protocol

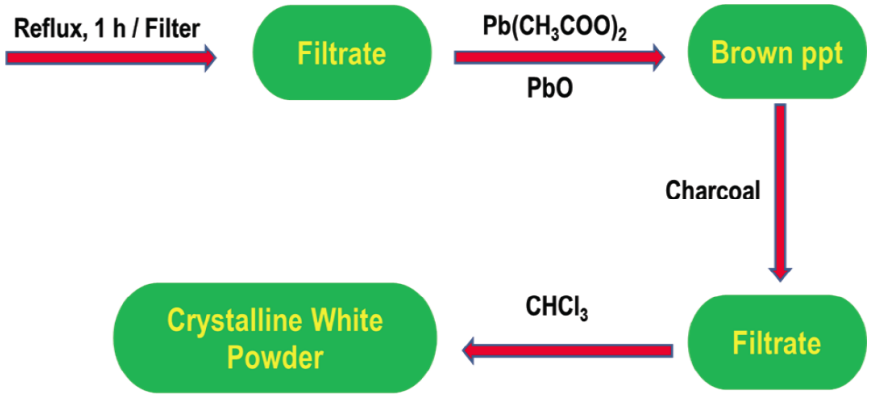


Figure 3: Flow chart of the experimental protocal.

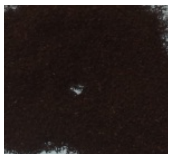
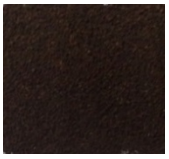
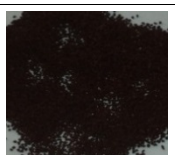
RESULTS AND DISCUSSION

1. Estimation of Caffeine

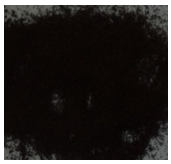
By adopting the foresaid isolation protocol, the following ten samples were used for caffeine estimation. The tea samples used in this study were collected from different locations in southern region. Eight samples from Tamilnadu (Ooty, Coonoor and Gudalur of the Nilgiris district, Valparai and Kodaikanal], and one sample each from Kerala (Munnar) and Karnataka (Coorg).

All the ten samples were analyzed by adopting the same protocol and the results are reproduced in Table **1** along with image of appropriate sample. The comparison of caffeine percentage of various tea samples can better be understand from this table.

Table 1: Estimation of Caffeine from Samples 1-10

Sample No.	Name of the sample/ Location	Image of the sample	% of Caffeine
1	Grade A Tea/ Valparai (Nedumalai Tea Factory)		1.87
2	Grade B Tea/ Valparai (Nedumalai Tea Factory		1.50
3	Grade A Tea/ Coonoor (Highfeild Tea Factory)		1.42
4	Grade A Tea/ Kodaikanal (Flower Tea Factory)		1.77
5	Grade A Tea/ Ooty (Tiger Hill Tea Factory)		1.75

(Table 1). Continued.

6	Grade A Tea/ Ooty (Ithalat Indco Tea Factory)		1.37
7	Grade A Tea/ Munnar (Tea Museum Factory)		2.15
8	Green Tea/ Coorg (Gallibedu Tea Projet)		2.37
9	Grade A Tea/ Cuduloor (Yaseen Tea Factory)		1.12
10	Grade A Masala Tea/ Ooty (Ripple Tea Factory)		1.65

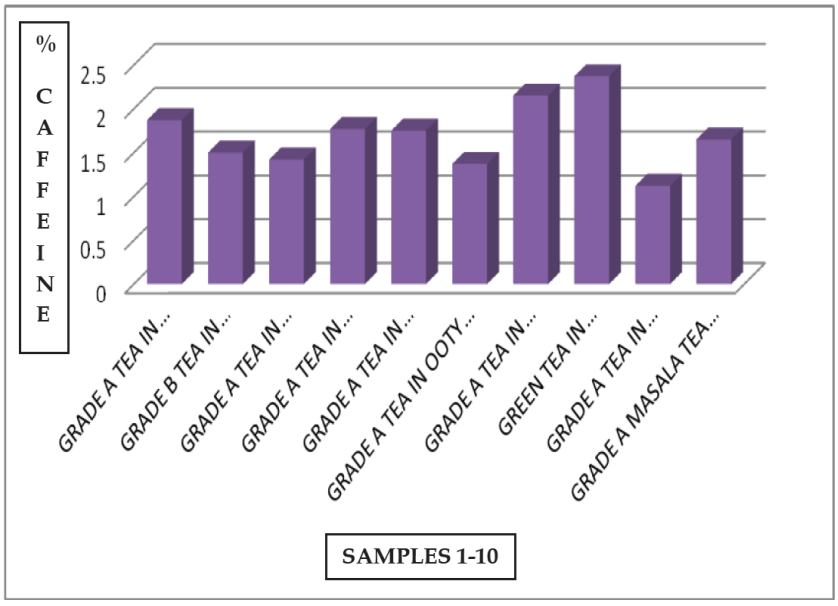


Figure 4: Bar graph between percentage of caffeine and samples.

2. Graphical Representation of Caffeine Percentage

For easy comparison and better understanding the percentage of caffeine present in appropriate samples are provided as bar graph in Figure **4**.

Among the samples, the Green tea from Coorg Gallibedu tea project (Sample **8**) possess the highest percentage of caffeine, i.e., 2.37%. Grade A tea from Munnar tea museum possess second highest quantity in this region (Sample **7**, 2.15% caffeine) whereas, the

grade A tea from Cuduloor Yaseen tea factory samples contain the lowest quantity of caffeine (Sample **9**, 1.12% caffeine).

CONCLUSION

Ten samples collected from Tamilnadu (Ooty, Coonoor and Gudalur of the Nilgiris district, Valparai and Kodaikanal), Kerala (Munnar) and Karnataka (Coorg) of south Indian regions were studied for the assessment of their quality. All the ten samples were subjected to a non-laborious chemical method using lead acetate and lead oxide to estimate the quantity of caffeine. As a result, it is observed that "Coorg Gallibeedu tea project (Sample **8**)" is the best one among the ten samples, which contains 2.37% of caffeine.

Of the ten samples from the south region, the Green tea from Goorg Gallibeedu tea project (Sample **8**, 2.37%) and Grade A tea from Munnar tea museum (Sample **7**, 2.15%) possess more than two percentage of caffeine. Hence, it is postulated that, in addition to weather, the geochemical conditions and harvesting parameters play vital role in the composition of tea leaves.

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