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Chemical Analysis of Caffeine Content in Tea and Coffee Samples

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Abstract **– Tea refers to the agricultural products of the leaves, leaf buds and internodes of the Camellia Sinensis plant. The principal constituent of tea, which is responsible for all the properties, is the alkaloid caffeine. Caffeine is a bitter, white crystalline xanthine alkaloid and a stimulant drug. It is found in varying quantities in the seeds, leaves, and fruit of some plants, where it acts as a natural pesticide that paralyzes and kills certain insects feeding on the plants, as well as enhancing the reward memory of pollinators. Theanine is an amino acid found only in tea leaves, which imparts a pleasantly sweet taste to tea. It is degraded to glutamic acid and has relaxation effects in humans. Tea and coffee have no nutritional value, but have been drunk for their stimulating effects.**

Keywords: **Caffeine, Tea leaves, Coffee powder**

I. Introduction

Tea is an aromatic beverage commonly prepared by pouring hot or boiling water over cured leaves of the tea plant, *Camellia sinensis* [1]. After water, tea is the most widely consumed beverage in the world. It has a cooling, slightly bitter, and astringent flavour that many people enjoy. Tea likely originated in China as a medicinal drink [2]. It was first introduced to Portuguese priests and merchants in China during the 16th century. Drinking tea became popular in Britain during the 17th century. The British introduced it to India, in order to compete with the Chinese monopoly on the product [3].

Tea has long been promoted for having a variety of positive health benefits. Recent studies suggest that green tea may help reduce the risk of cardiovascular disease and some forms of cancer, promote oral health, reduce blood pressure, help with weight control, improve antibacterial and antivirasic activity, provide protection from solar ultraviolet light, and increase bone mineral density[4]. Green tea is also said to have "anti-fibrotic properties, and neuroprotective power.

In humans, caffeine acts as a central nervous system stimulant, temporarily warding off drowsiness and restoring alertness [5]. It is the world's most widely consumed psychoactive drug, but unlike many other psychoactive substances, it is legal and unregulated in nearly all parts of the world. Beverages containing caffeine, such as coffee, tea, soft drinks, and energy drinks, enjoy great popularity. In North America, 90% of adults consume caffeine daily.

Fig. 1 Tea leaves

II. Caffeine

Caffeine is one of the world's most widely used drugs. Some anthropologists believe its use may date back to the Stone Age. Pharmacologically, caffeine is one group

of stimulants called methylxanthine, or xanthine, which occur naturally in some plants. The most commonly known sources of caffeine are coffee, cocoa beans, cola, nuts and leaves. In its pure state, it is an intensely bitter white powder. Its systematic name is 1, 3, 5-trimethlxanthine (Fig. 1).

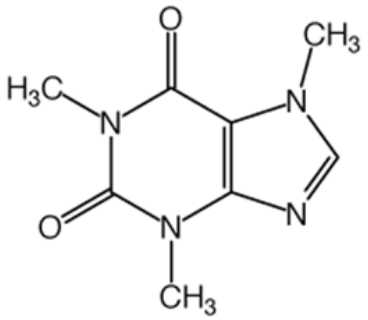

Fig. 2 Structure of Caffeine

The most important methylated alkaloid that occurs naturally is caffeine. Its molecular formula is $C_8H_{10}N_4O_2$. Its IUPAC name is 1, 3, 7-trimethylxanthene and common name is 1-methylated thiobromine [6]. Purely it is white, crystalline solid in the form of needles. Its melting point is 238 ^{o}C. It is the main active principle component of tea leaves. It is present in tea leaves up to 3% and can be extracted by first boiling the tea leaves with water which dissolves many glycoside compounds in addition to caffeine. The clear solution is then treated with lead acetate to precipitate the glycoside compounds in the form of lead complex. The clear filtrate is then extracted with extracts caffeine because it is more soluble in it then water.

III. Caffeine and Health

Caffeine is also used as a food additive regulated by the Federal Food and Drug Administration (FDA). The FDA regulates caffeine's use as a stimulant in some over-the-counter and prescription medications. Consumers commonly see caffeine listed as an active ingredient in some stimulants, cold remedies, and various pain killers. Caffeine is a pharmacologically active substance and depending on the dose, can be a mild central nervous system stimulant. Caffeine does not accumulate in the body over the course of time and is normally excreted within several hours of consumption [7].

Originally it was thought that caffeine is responsible for the taste and flavor of tea. But pure caffeine has been found to be tasteless while substance. Therefore, the taste and flavor of tea is due to some other substance present in it. There is a little doubt that the popularity of the xanthenes beverages depends on their stimulant action, although most people are unaware. The degree to which an individual is stimulated by given amount of caffeine varies from individual to individual.

Caffeine administered acutely increases diuresis (urination), but this effect is not seen for habitual users who consume the equivalent of a few cups of coffee per day. Nor do such users typically suffer much sleep disturbance especially when most caffeine is consumed in the morning. Tolerance to these effects is believed to be due mainly to the adaptive increase (up regulation) in number of adenosine receptors. Although tolerance is usually seen for elevation of blood glucose by caffeine, there may be little tolerance of this effect for people who are obese or who are suffering from maturity-onset diabetes. Caffeine can significantly increase the secretion of gastric acid & pepsin. But coffee even decaf has an even stronger effect. Apparently there is a non-caffeine component to coffee which has a significant effect on gastric secretion [8].

In the present study caffeine content in some selected tea leaves and coffee samples were determined and compared with standard values. These values are important in determining the quality of tea and can account for the caffeine intake by taking tea and coffee.

IV. Experimental

Materials

Tea samples, Coffee samples, Lead acetate, Chloroform, Dil. HCl

Procedure

50gm of tea leaves/coffee powder were mixed with 150ml water and heated up to extreme boiling. The solution was filtered and lead acetate was added to the filtrate and a curdy brown precipitate was obtained. Lead acetate was added till the precipitation was complete. It was filtered again and the filtrate was boiled until it was reduced to 50ml. The solution was allowed to cool and caffeine was extracted from it using chloroform. Chloroform was evaporated from the extract and the residue left behind was caffeine. It is dried and weighed. The procedure was repeated with all the tea and coffee samples.

V. Results and Discussion

Table I Caffeine Content in Tea/ Coffee Samples (Extraction With Water)

Sl.No.	Tea/ Coffee Samples	Amount of Caffeine (gm)
1	Brook Bond Red Label	0.01
2	AVT	0.03
3	Eastern Eastea	0.02
4	Palat	0.04
5	3 Roses	0.02
6	Kannan Devan	0.01
7	Bru gold coffee	0.68
8	AVT coffee	0.62

Table II Caffeine Content In Tea/ Coffee Samples (Extraction With Acidified Water)

Sl.No.	Tea Samples	Amount of Caffeine (gm)
1	3 roses tea	0.54
2	Green tea	0.63
3	Kannan Devan strong tea	0.71
4	AVT	0.76

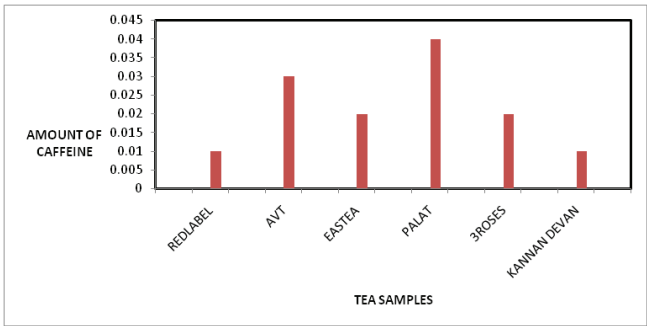

Fig 1 Graphical representation of Caffeine content of Tea samples (water extraction)

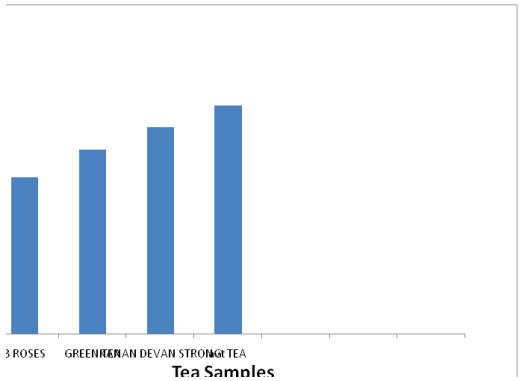

Fig 2 Graphical representation of Caffeine content of Tea samples (acidified water extraction)

This shows that acidified water is a more efficient extractor of caffeine. This proposition makes a sense theoretically since caffeine been basic because of the lone pair of electrons on one of the nitrogen forms the conjugate acid salt under acidic conditions. This gives it increased water solubility as a cation [9].

VI. Conclusion

Caffeine is the most commonly used psychoactive drug in the world. It is a pharmacological active substance and depending on the dose, can be a mild central nervous system stimulant. Approximately 80% of the world's population consumes caffeine on a daily basis. The most common dietary sources of caffeine are Tea, Coffee, Cola and Chocolate. It is noted that caffeine is not a food but a drug working through nervous system. Excessive amount should be avoided since caffeine consumed in large amounts has adverse health effects. In particular, people suffering from high blood pressure should be advised to avoid use of caffeine containing beverages since caffeine is known to increase the blood pressure. In addition to those who with coronary heart disease should avoid such beverages as caffeine disrupts normal heart rhythm.

In the present study caffeine content of different tea and coffee samples were studied and it is found that the caffeine content varies from 1-5%. The values generally agree well with literature quoted values of 2-5%. The caffeine content of the tea brands analyzed was not found to be alarming since it correlated well with reported UV/Vis spectrophotometric methods [10]. The levels of caffeine obtained would be higher if acidified water is used for extraction. This is because caffeine been basic due to the lone pair of electrons on one of the nitrogen forms the conjugate acid salt under acidic conditions. This gives increased water solubility as a cation. However, in the present study the amount of caffeine that enters the human system through drinking tea is determined. Thus only normal water is used.

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