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Determination of Caffeine in Different tea Samples

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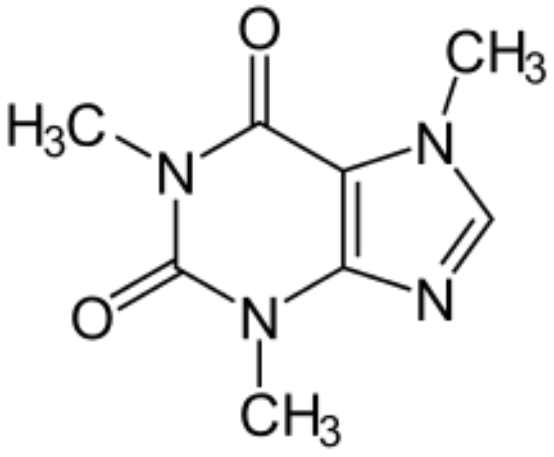
Abstract: *Tea is the most commonly and widely used soft beverage in the household. It acts as a stimulant for central nervous system and skeletal muscles. That is why tea removes fatigue, tiredness and headache. It is also increases the capacity of thinking. It is also used for lowering body temperature. The principal constituent of tea, which is responsible for all these properties, is the alkaloid-caffeine. The objective of this study is to determine caffeine in tea samples and estimate the acid content present in tea leaves are the major objectives of this study.Red Label Tea (Brooke Bond), AVT Tea and Chakara Gold Tea were the three brands from which the samples were taken in this study. It is found that the normality of extract is more in Chakara Gold Tea followed by AVT Tea and Brooke Bond Red Label Tea*

Keywords: *Caffeine, Acid Content, Structure of Caffeine and Properties of Caffeine*

I. Introduction

Caffeine is a very common substance and is found in coffee, tea, soft drinks, chocolate and "stay-awake" pills such as vivarin. It can be synthesized or isolated from natural sources. Caffeine isclosely related to theophylline and theobromine.Pure caffeine takes the form of white, hexagonal crystals, which can be broken into a soft powder. It has a melting point of 235^0C-238^0C and a molecular weight 194.19g/mol. It is easily soluble in chloroform and partially soluble in water. Caffeine is a naturally occurring chemical stimulant called trimethylxanthine. Its chemical formula is $C_8H_{10}N_4O_2$. It is a drug and actually shares a number of traits with more notorious drugs such as amphetamines, cocaine and heroin. In its pure form, caffeine is a white crystalline powder that tastes very bitter. It is medically useful to stimulate the heart and also serves as a mild diuretic, increasing urine production to flush fluid out of the body. Caffeine can increase blood pressure and cause vasoconstriction.Caffeine is an alkaloid occurring naturally in some 60 plant species, of which cocoa beans, kola nuts, tea leaves and coffee beans are the most well-known. Other natural sources of caffeine include yerba mate, guarana berries, guayusa, and the yaupon holly. Caffeine is added to many popular soft drinks, and is also a component of a number of pharmacological preparations and over-the-counter medicines including analgesics, diet-aids, and cold/flu remedies.

Structure And Physical And Chemical Properties
Molar mass: 194.19 g/mol
IUPAC ID: 1,3,7-Trimethylpurine-2,6-dione
Melting point: 238 °C
Boiling point: 178 °C
Density: 1.23 g/cm³
Formula: $C_8H_{10}N_4O_2$



Pure anhydrous caffeine is a bitter-tasting white odorless powder with a melting point of 235–238 °C. Caffeine is moderately soluble in water at room temperature (2 g/100 ml), but very soluble in boiling water (66 g/100 ml). It is also moderately soluble in ethanol (1.5 g/100 ml). It is weakly basic (pK_a = ~0.6) requiring strong acid to protonate it. Caffeine does not contain any stereogenic centers and hence is classified as an achiral molecule.The xanthine core of caffeine contains two fused rings, a pyrimidinedione and imidazole. The pyrimidinedione in turn contains two amide functional groups that exist predominately in a zwitterionicresonance the location from which the nitrogen atoms are double bonded to their adjacent amide carbons atoms. Hence all six of the atoms within the pyrimidinedione ring system are sp^2hybridized and planar. Therefore, the fused 5,6 ring core of caffeine contains a total of ten pi electrons and hence according to Hückel's rule is aromatic.

II. Methods and Methodology

Determination of caffeine in tea samples and estimation of acid content present in tea leaves are the major objectives of this study. Tea samples from three different brands namely,Red Label Tea(Brooke Bond), AVT Tea and Chakara Gold Tea were taken in this study.

Determination of caffeine in tea samples

Chemicals required: Tea sample, Lead acetate, Chloroform and Water

Apparatus:Beakers, Pippetes, Burner, Separating funnel, Filter paper,Weight box,Analytical balance, Spatula and Funnel

Procedure: First of all, 50 grams of tea leaves were taken as sample and 150 ml of water was added to it in a beaker. Then the beaker was heated up to extreme boiling. The solution was filtered and lead acetate was added to the filtrate, leading to the formation of a curdy brown coloured precipitate. We kept on adding lead acetate till no more precipitate has been formed. Again solution was filtered. Now the filtrate so obtained was heated until it had become 50 ml. Then the solution left was allowed to cool. After that, 20 ml of chloroform was added to it.Soon after, two layers appeared in the separating funnel. The residue left behind was caffeine. Then we weighed it and recorded the observations. Similar procedure was performed with different samples of tea leaves and quality of caffeine was observed in them.

Estimation of acid content present in tea leaves:

Chemicals required: Tea samples, Water, NaoH and Phenolphthalein indicator

***Apparatus*:**Beaker, Pipette, Burette stand, Conical flask, Burner, Measuring flask, Separating funnel, Filter paper, Weight box and Analytical balance

***Procedure*:**10 gm of each of tea leaves are mixed in the beakers each containing of 200 ml of water.The contents of the beaker are then heated constantly for about 30 minutes and the extract is filtered out. 5 ml of tea extract is taken in a conical flask and added to 20 ml of distilled water.It is now shaken to prepare a homogenous mixture and titrated against N/50 NaoH solution.The same procedure is carried for other types of tea leaves.

Table 1: Observation Table

	Red Label Tea	AVT Tea	Chakara Gold Tea
Weight of china dish	50.61gms	51.62gms	50.61gms
Weight of china dish with precipitate	50.81gms	51.72gms	50gms
Amount of caffeine	20gms	10gms	20gms

III. Result & Discussion

Table 2: Standarzation of NaoH

S.NO	TEA LEAVES	INITIAL VOLUME	FINAL VOLUME	VOLUME OF NAOH
1	Red label	0ml	3.1ml	3.1ml
2	AVT	0ml	4.2ml	4.2ml
3	Chakara gold	0ml	4.7ml	4.7ml

Calculation

Finding out the Normality

$V_1N_1 = V_2N_2$

$N_1 = 0.02$,

V_1=Volume of NaOH

V_2 = Volume of tea extract used 5ml

Red Label Tea(Brooke Bond)

$N_1V_1 = N_2V_2$

Volume of NaOH (V_1) =3.1 ml
Volume of NaOH(N_1) =0.02N
Volume of tea extract(V_2)=5ml
Volume of tea extract(N_2)=?
$N_1V_1=N_2V_2$

$$N_{2=}\frac{V_1N_1}{V_2}$$

$$N_2 = \frac{3.1X\ 0.02}{5}$$

=0.0124N
∵ Normality of tea extract= 0.0124N

AVT Tea

$V_1\ N_1 = V_2N_2$
Volume of NaOH (V_1) =4.2 ml
Volume of NaOH(N_1) =0.02N
Volume of tea extract(V_2)=5ml
Volume of tea extract(N_2)=?
$N_1V_1 =N_2V_2$

$$N_{2 =}\frac{V_1N_1}{V_2}$$

$$N_{2 =}\frac{4.2X\ 0.02}{5}$$

=0.0168N
∵ Normality of tea extract= 0.0168N

ChakaraGold Tea

$V_1\ N_1 = V_2N_2$
Volume of NaOH (V_1) =4.7 ml
Volume of NaOH(N_1) =0.02N
Volume of tea extract(V_2) =5ml
Volume of tea extract(N_2) =?
$N_1V_1 =N_2V_2$

$$N_{2 =}\frac{V_1N_1}{V_2}$$

$$N_{2 =}\frac{4.7X\ 0.02}{5}$$

=0.0188N
∵ Normality of tea extract= 0.0188N

Table 3: Strength of Acid

S.NO	Tea leaves	Normality of Tea extract	Strength of acid
1	Red label	3.1/250	0.0124wgm/lt
2	AVT	4.2/250	0.0168wgm/lt
3	Chakara gold	4.7/250	0.0188wgm/lt

Table 4: Amount of Caffeine

S.NO	Tea leaves	Normality of Tea extract	Amount of Caffeine
1	Red label	3.1	20 mg
2	AVT	4.2	10mg
3	Chakara gold	4.7	20mg

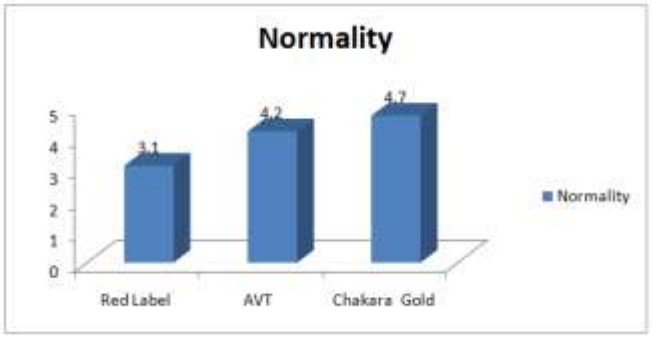


Figure 1: Normality of tea extract vs. Amount of caffeine

IV. Conclusion

When a graph between acidity strength in tea and weight of caffeine is plotted, we obtained a straight line which shows the amount of caffeine present in the tea leaves is inversely proportional to the strength of the acids in the tea extract.Different tastes of different teas are due to the variation of amount of caffeine present.Maximum amount of caffeine present in this two sample Red Label and Chakara Gold tea.Minimum amount of caffeine present in the sample AVT.

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