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Extraction of Caffeine from Tea Leaves

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A B S T R A C T

Caffeine is a centra nervous system (CNS) stimulant of the methylxanthine class. Caffiene is found in seeds, leaves and often in some fruits in minor amounts where it plays the role of natural pesticide and kills certain insects by paralyzing them. There are some known mechanisms of action that explain the effects of caffeine. The most important is that it blocks the action of adenosine on its receptors and also consequently, prevents the onset of drowsiness induced by intake of adenosine. Caffeine also stimulates certain parts of the (ANS) autonomic nervous system. Caffeine is a chemical found majorly in coffee, tea, cola, guarana, mate, and other products.

Keywords: Methylxanthine class, coffee, tea

INTRODUCTION

Caffeine is a naturally occurring chemical stimulant found in the leaves, seeds and fruits of numerous plant species of a group of compounds called trimethyl xanthine. Chemical formula is $C_8H_{10}N_4O_2$. Caffeine is most used to improve mental alertness, but it also has many other uses. It is used by combination with painkillers (such as aspirin or acetaminophen) and a chemical called ergotamine for treating migraine headaches [1]. It is also used with painkillers for simple headaches and preventing and treating headaches after epidural anesthesia. Is caffeine a drug? -Yes, Caffeine is a drug as it stimulates the (CNS) central nervous system, causing an increase in alertness. Caffeine gives most people a temporary energy boost and improves alertness. Caffeine is found in tea, coffee, chocolate, many soft drinks, pain relievers and other over-the-counter medicines and supplements. Caffeine is naturally found in the fruit, leaves, and beans of coffee, cacao, and in guarana plants [1]. Heart rate and blood pressure is affected by caffine

EXTRACTION

(LLE) Liquid liquid Extraction is a method used for the separation of liquid solutes from solvents using an another solvent having higher affinity towards the liquid solute or organic compounds from a mixture of compounds. This method dissolves one or more (components) compounds into an appropriate solvent. The solution of these dissolved compounds is referred to as the desired extract. In the case of Caffeine extraction from tea powder or leaves, the solubility of caffeine in water is approximately 20g/l at 25°C, 600g/l at 80°C, and 670g/l at 100°C. Here the organic solvent Dichloromethane (CH_2Cl_2), we can also use chloroform ($CHCl_3$), is used to extract caffeine from aqueous extract of tea powder as caffeine is more soluble in this solvent (140mg/ml) than it is in water (22mg/ml). Then the dichloromethane - caffeine mixture can be separated based on the differences in densities and boiling point of dichloromethane and water, as dichloromethane is denser than water and also boiling point of dichloromethane is less than that of water. , Residual water is separated from dichloromethane by draining out the dichloromethane through separating funnel, thus dichloromethane passed through the funnel while polar solvents such as water still remain in the funnel. As water and dichloromethane are slightly soluble in each other. So, after separating the solvents, remaining water will remain in the organic layer. Mainly anhydrous sodium sulfite is used for the removal of water from organic layer. Anhydrous sodium sulfite is an insoluble inorganic solid which will absorb water, thus drying the dichloromethane we will get caffiene crystals.

PROCEDURE

1) Take 40 grams of dried black tea leaves (tea powder) in a beaker, add 6 -7 grams of anhydrous sodium carbonate, add 300 ml of distilled water in it and mix it completely.

2) Keep the beaker containing liquid mixture on heating mantle or burner or else hot plate will also work.

3) Heat the mixture by frequently stirring it until it boils. After boiling remove the burner and let it cool down for some time in cold water bath.

4) As the solution cools down filter the contents using strainer and get the filtrate and residue separated

5) Add 300 ml of water again to the residue and repeat steps 2,3,4 again to get more filtrate.

6) Collect the filtrate in the beaker or in a conical flask and cool it down using cold water

7) After cooling the filtrate, filter it by using vacuum filter, if not available filter it by using filter paper setup. You can use multiple filter paper setups as it takes too much time. Before this step you can filter it additionally by cotton cloth as it increases efficiency and decreases filtration time

8) Adjust the separating flask setup completely and add the entire filtrate in the separating flask. Measure 10 ml dichloromethane or chloroform and gently pour it into the separating flask (don't pour vigorously)

9) After adding both liquids remove the separating flask and agitate it for about 15 seconds gently (don't agitate vigorously). As it makes pressure During agitation in between release the pressure 2-3 times by gently opening the lid to air.

10) Again, adjust the separating flask in the stand and wait so that both the liquids get separated after 10-15 minutes.

11) After separating the liquids, we will get to see two different layers of liquids. Where the upper one is the solution while the lower transparent liquid is chloroform or dichloromethane containing caffeine crystals.

12) Carefully by opening the knob remove only the chloroform layer and collect it in a beaker. Repeat step 8,9,10,11 for 3-4 times to get more chloroform liquid. Collect the liquid in a small beaker or Petri dish. Cover it with aluminum foil with pores so that chloroform may evaporate. And leave it overnight. Or to get results quickly we can also heat it on hot plate.

13) We can clearly observe the caffeine crystals in the beaker or Petridish. In white needle like structures. In amounts of milligram

INTAKE

How much is too much? Up to 400 (mg) of caffeine in a day is safe for most healthy adults. That's roughly the amount of caffeine present in four cups of brewed coffee, 8-10 cans of cola or two "energy shot" drinks. Remember that the actual caffeine content in beverages may vary widely, especially in energy drinks. Caffeine in powder or in liquid form can provide toxic levels of caffeine, the U.S- Food and Drug Administration has cautioned. Just a single teaspoon of powdered caffeine is equivalent to around 28 cups of coffee. Such high levels of caffeine can cause serious major health problems

and possibly death also. High caffeine consumption in energy drinks (At least 1 liter or 320 mg of caffeine) is associated with short-term cardiovascular side effects like hypertension, prolonged QT interval and heart palpitations. Such cardiovascular side effects are not seen with smaller amounts of caffeine consumption in energy drinks (less than 200 mg) Smoking tobacco increases caffeine clearance by 56%. Cigarette smoking induces the cytochrome P450 1A2 enzyme that breaks down caffeine, which may lead to increased caffeine tolerance and coffee consumption for regular smokers.

FOOD	***CONTENT (Average)***
Coffee, Regular, Brewed	100-120mg per cup
Coffee, Decaffeinated	2 to 4 mg per cup
Tea	30-75 mg per cup
Milk Chocolate	6-10mg per Oz
Baking Chocolate	30-35mg per Oz
Coca-Cola Classis	40-50mg per 12 Oz

RESULT

From 40 gram of black tea leaves (powder) amount of caffeine extracted = around 30 mg.

PROPERTIES OF CAFFEINE

➢ Systematic name:1,3,7-trimethyl-1H-purine- 2,6(3H,7H)-Dione.

➢ Another name: 1,3,7-trimethylxanthine & 1,3,7-trimethyl-2,6-dioxopurine.

➢ Molecular formula: $C_8H_{10}N_4O_2$.

➢ Molecular mass: 194.19 g/mole.

➢ Melting point: 238°C.

➢ Solubility in water: slightly soluble.[2]

HEALTH BENEFITS OF CAFFEINE

➢ Research indicates that caffeine may help protect human brain cells, which lowers the risk of developing some diseases, such as Parkinson's.

➢ Regular cups of coffee may stimulate the gallbladder and reduce the risk of gallstones.

➢ Caffeine causes the blood vessels to constrict, which may help relieve some headache pain.

➢ Coffee reduces inflammation and may help prevent certain heart related illnesses.

➢ Treats Migraine.

➢ Relieves Asthma Attack

➢ Increases the potency of analgesics.

➢ Caffeine is also used for weight loss and type 2 diabetes.

➢ Very high doses are used, often in combination with ephedrine, as an alternative to illegal stimulants.

➢ reduced risk of mortality and chronic diseases[3]

ADVERSE EFFECTS OF CAFFEINE

➢ There is a significant association between drinking caffeinated coffee and the decrease of bone mineral density, which leads to osteoporosis.

➢ The daily consumption of caffeinated drinks can increase blood sugar levels and cause problems for people with diabetes.

➢ Caffeine is a diuretic and can cause dehydration.

➢ Caffeine can prevent some from falling asleep and interferes with deep sleep, which can lead to fatigue during the day

CONCLUSION

Here the organic solvent dichloromethane or chloroform is used to extract caffeine from an aqueous extract of tea leaves because caffeine is more soluble in dichloromethane (140 mg/ml) than it is in water (22 mg/ml). However, the tannins that are slightly soluble in dichloromethane can be eliminated by converting it to their salts (phenolic anions by adding sodium carbonate) (tannins are phenolic compounds of high molecular weight and being acidic in nature can be converted to salts by deprotonation of the -OH group) which remain in the water. Because of the presence of Caffeine, tea and coffee are gaining popularity as an addictive stimulant. An average 30g of tea can contain 20-ll0 mg of caffeine thereby making tea a significant source of caffeine compared to other beverages.

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