JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue

JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)

An International Scholarly Open Access, Peer-reviewed, Refereed Journal

EXTRACTION OF CAFFEINE FROM TEA POWDER: A REVIEW

[1]A. G. Thokal, [2]Ahtisham Tajir, [3]Vivek Mohite. [4]Pranit Patil

[1]Assistant Professor, [2]Student, [3]Student, [4]Student

[1]Department Of Chemical Engineering,

[1]Bharti Vidyapeeth College of Engineering, Navi Mumbai, Maharashtra India

Abstract: Caffeine is a bitter, shiny white alkaloid and stimulant drug. It is found in a wide variety of seeds, leaves, and fruit of some plants, where it acts as a natural pesticide that paralyzes and kills certain plant-eating insects, as well as enhances the memory memory of pollinators. Part of the reason caffeine is classified as Food and Drug Administration as GRAS (Generally Recognized as Safe) is that the toxic amounts (over 10 grams in the average adult) are much higher than commonly used doses (less than 500 milligrams).

Index Terms - **Component, formatting, style, styling, insert.**

1. INTRODUCTION

Caffeine and other purine alkaloids, including theobromine and theophylline, play a major role in the long-term popularity of non-alcoholic beverages and foods such as coffee, tea, cocoa, chocolate and a variety of soft drinks. Caffeine is a naturally occurring chemical stimulant found in the leaves, seeds and fruits of many plant species of a group of compounds called trimethyl xanthine. Its chemical formula is C8 H10 N4 O2.

Properties of Caffeine:

- **Systematic name :**1,3,7-trimethyl-1H-purine- 2,6(3H,7H)-Dione
- **Other name:** 1,3,7-trimethylxanthine & 1,3,7-trimethyl-2,6-dioxopurine
- **Molecular formula:** C8H10N4O2
- **Molecular mass:** 194.19 g/mole
- **Melting point:** 238°C
- **Solubility in water:** slightly soluble

Effects of Caffeine:

- Caffeine increases blood pressure.
- Caffeine stimulates the central nervous system.
- Caffeine promotes urine formation.
- Caffeine stimulates the action of heart and lungs.

Advantages of Caffeine:

- Treats Migraine.
- Increases the potency of analgesics.
- Relieves Asthma Attack.
- Caffeine can reduce the developing risk of Parkinson's disease.

Structure of Caffeine:

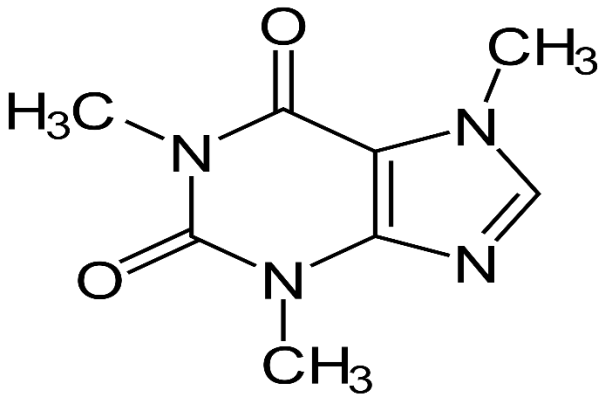

Table No-1: Caffeine Content of Common Food and Drugs

Espresso	120 mg per 2 Oz
Coffee, Regular, Brewed	103 mg per cup
Instant Coffee	57mg per cup
Coffee, Decaffeinated	2 to 4 mg per cup
Tea	30-75 mg per cup
Cocoa	5-40mg per cup
Milk Chocolate	6mg per Oz
Baking Chocolate	35mg per Oz
Coca-Cola Classis	46mg per 12 Oz
Jolt Cola	72mg per 12 Oz
Anacin Bromo Seltzer Midol	32mg per pill
Excedrin Extra Strength	65mg per pill
Dexatrim Dietac Vivarin	200mg per pill
Dristan	16mg per pill
Dristan	100mg per pill

In table 1 the mentioned beverages and drugs are frequently used and it reveals that among them, Espresso contains the maximum amount of caffeine as compared to other beverages and drugs.

In its purest form, caffeine is a shiny white powder with a very bitter taste. It is medically useful to rejuvenate the heart and acts as a booster. It is one of the most widely studied ingredients in the diet. The most popular sources of caffeine are coffee and cocoa beans, guarana, and tea leaves. The amount of caffeine in food and beverage products varies depending on the size of the feed, the type of product and the method of preparation. The tea we drink is usually made from the leaves of an evergreen Asian plant called Camellia sinensis. The presence of caffeine in plants helps to protect themselves from pests and other herbivores with a bitter combination of flavors and stimulant properties. The caffeine content in tea leaves depends on the variety and where they grow; most tea is 3-5% by weight. The optical transition properties of caffeine are measured by different solvents (dichloromethane, water, chloroform and ethyl acetate). Caffeine has a much higher optical conversion to dichloromethane than other solvents. Caffeine can be released more rapidly at boiling temperatures than 30 ° C. Caffeine was widely used in the food industry and pharma. The cost of extracting caffeine from a natural source is higher. Research has been taken to extract it from the natural source with great savings.

Table No-2: Caffeine Content in Tea/Coffee Sample (Extraction with water)

TEA/COFFEE SAMPLES	AMOUNT OF CAFFEINE (gm)
Brook Bond Red Label	0.01
AVT	0.03
Eastern Eastea	0.02
Palat	0.04

3 Roses	0.02
Kannan Devan	0.01
Bru gold Coffee	0.680
AVT Coffee	0.62

These are some of the popular Tea and coffee brands among which Bru Gold Coffee contains the maximum amount of caffeine, whereas Kannan Devan contains the least as mentioned in Table 2

II. METHODOLOGY FOR EXTRACTION OF CAFFEINE:

To extract caffeine from tea, several techniques are used. First, a solid / liquid base must be formed to obtain a solid natural product from the liquid solvent. This can be done by using an extractor, or by simply brewing a cup of tea. To separate the reaction mixture, you want into a natural product, liquid / liquid extractions are used.

Here the Steeping process is used. Specific Solids - Liquids and Liquids - Liquid extract is made to extract Caffeine from tea leaves. The solvent used to extract the liquid sodium carbonate while the solvent used to extract the liquid is Dichloromethane (CH_2Cl_2) (Note - Dichloromethane can irritate your skin so do not handle Dichloromethane by hand).

Note: Sodium carbonate works as a base - you can use sodium hydroxide instead. When you boil tea leaves the tannins dissolve in water and caffeine. If you do not use the foundation the tannins will also be released into the solvent (i.e. methylene chloride) used in the next extraction. The base converts tannins into their sodium salts - as ionic salts do not dissolve in solvents like methylene chloride and therefore remain in the liquid layer during absorption. This allows pure caffeine to be released.

Table No-3: Different Methods Adopted for Extraction of Caffeine

NAME	DIFFERENT METHODS ADOPTED
Gonul Serdar, Ezgi demir, Serhat Bayrak, Munevver Sokmen, 2017	Microwave Assisted extraction
Muthanna J. Mohammed, Firas A. Al-Bayati, 2008	1) Liquid-Liquid Extraction 2)Solid-Liquid Extraction
Gonul Serdar, Ezgi demir, Munevver Sokmen, 2015	1) Citric Acid Water Extraction 2) Ethanol Extraction 3)Two step Water Extraction 4)High Temperature pre-treatment Water extraction 5) Water Extraction 6) Solid-Liquid Extraction
Satarupa Banerjee, Jyotirmoy Chatterjee, 2015	1)Microwave Assisted Extraction 2)High pressure processing 3)Supercritical Fluid Extraction 4)Subcritical Water Extraction
Khalida Khan, M Naeem, M Arshad and M Asif, 2012	Column Extraction

The yield of caffeine release depends on the method adopted and the parameters studied. Table 3 shows the methods used to extract caffeine.

After repeated extraction and use of gravity filters, we get a glossy green caffeine as a product. To find the purest form of crystalline caffeine in crude caffeine, we need to do sublimation. Sublimation is a quick and easy way to cleanse caffeine.

The success rate of extracts involving natural products is often expressed as a percentage of acquisition,

%Recovery= (Grams of caffeine Recovered) / (Grams of tea leaves)

Recovery percentages are called clean percentages or green percentages available. A domain with a high percentage of recovery is considered to be the most successful extraction.

Part 1: Dissolution of Caffeine in Water

1. Take a 500ml beaker.
2. Weigh about 20gm of tea and place them in the beaker. Record actual weight
3. Add 90ml of distilled water to the beaker.
4. Boil the water containing the tea bags on a boiling water bath for 15-20 minutes while stirring occasionally.
5. After the boiling period is over, remove the beaker from the heat and allow to cool 15 minutes or on ice until cooled.
6. After the solution has cooled, squeeze the tea bags to remove all the liquid. Dispose of the bags.
7. Using vacuum filtration, filter the solution through regular filter paper to remove any solid particles.

Fig.3 BOILING

Part 2: Transfer of Caffeine from Water by using Chloroform/Dichloromethane

Caution: Use Dichloromethane under hood with proper ventilation Do Not Breath Fumes.

1. Transfer the solution obtained from step 7 above to a 500ml separatory funnel. Add 20ml of Dichloromethane Instructor will demonstrate proper use of the separatory funnel.
2. Allow the Dichloromethane to settle to the bottom. Carefully drain the Dichloromethane layer into a flask or beaker. Dispose of the aqueous top layer.
3. Filter the Dichloromethane/caffeine solution through reverse-phase filter paper using vacuum filtration. This will allow the Dichloromethane to filter through but will trap any water and residue. Transfer the solution to a 125ml flask

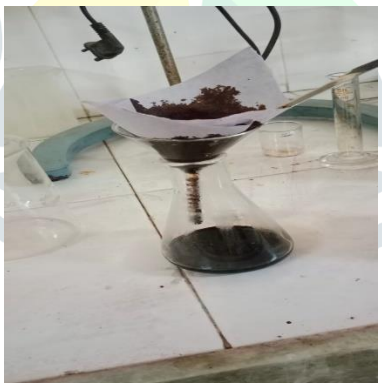

Fig.4. Vacuum filtration

Fig. 5. Liq-liq extraction

Part: 3 Crystallization of Caffeine

1. Using a hot water bath in the fume hood, place the Dichloromethane solution over the boiling water.
2. Evaporate the solution down to about 20ml and then remove from the heat.
3. Weigh a clean watch glass.
4. Record its weight.
5. Place the watch glass over the boiling water bath, fill it with a portion of the concentrated caffeine solution, and evaporate it. Repeat this process until all the concentrated solution is gone.
6. Remove the watch glass from the water bath and let it cool. Wipe the moisture from the bottom of the watch glass. 0
7. Reweigh the watch glass.

Fig.6. Crude Caffeine

Analysis Techniques for Caffeine:

- **Murexide Test: -**

Murexide testing is a diagnostic method for detecting the presence of caffeine and other purine extracts in the sample. These compounds do not respond to common tests for alkaloid detection as a Dragendorff reagent. In this experiment alkaloids were mixed with a small amount of potassium chlorate and a drop of hydrochloric acid. The sample then evaporates dry and the resulting residue is exposed to the ammonia concentration. Purine alkaloids produce a pink color in this experiment. The pink color indicates the presence of caffeine in the sample

- **Iodometric Back Titration: -**

Iodometric Back Titration Caffeine reacts with an excess of well-known iodine in an acidic environment, forming insoluble rain. The insoluble precipitate is then filtered. By using titration with a standard sodium thio-sulphate solution containing starch solution as an indicator, we can determine the amount of iodine left over, and thus the amount of caffeine can be obtained. Here are the chemical statistics:

$C_8H_{10}N_4O_2 + 2\ I_2 + KI + H_2SO_4 \rightarrow C_8H_{10}N_4O_2.\ HI.\ I_4 + KHSO_4$

$I_2 + 2\ Na_2S_2O_3 \rightarrow 2NaI + Na_2S_4O_6$

- **Thin Layer Chromatography (TLC): -**

There are different types of chromatographic methods such as paper chromatography, thin layer chromatography, column chromatography, gas chromatography, etc. They have the same goal:

1. Different solvents have different solubility in soluble / different solvents have different degree of solubility in the same solvent.
2. As the solution (consisting of a solvent containing soluble solids) travels on a solid surface (solid surface), different solvents are marketed on a solid surface at a different level as they have different levels of advertiser markers (due to different levels. Melting tendency).
3. The "less soluble" solute will be stored first, and the "more soluble" solvent will be stored later. (Note: No two items have the same solubility as adsorption features.
4. Different solvents will then be separated into different solids.
5. The Retention Factor (RF) for each component is calculated as follows

Rf = (the distance travelled partially forms the foundation) / (the distance travelled by the solvent from the base). Pure caffeine and extracts are analysed on the same TLC plate and compared with any variant of their Rf.

- **Spike Test: -**

By adding a known amount of regular caffeine to pure water and a solution of green coffee, then remove the solvent. By comparing the effects of extraction, we can analyse the percentage of spiked caffeine intake and the efficiency of solvent extraction.

III. RESULT AND DISCUSSION

The various weights of the flasks and solutions were obtained in order to calculate the final amount of caffeine product in grams. The final amount of caffeine extracted could then be used to calculate percent error and percent recovery.

NO	WEIGHT OF TEA TAKEN (IN GRAMS)	EMPTY BEAKER WEIGHT (IN GRAMS)	BEAKER WEIGHT WITH CAFFEINE (IN GRAMS)	WEIGHT OF CAFFEINE (IN GRAMS)
1	20	50.287	50.449	0.162
2	25	50.287	50.476	0.189
3	30	50.287	50.492	0.205

The percent yield and percent recovery were calculated by using the final amount of caffeine obtained and by using the known value of caffeine in two tea bags. The percent recovery makes it possible to understand how much pure product was recovered from the crude product. The percent error accounts for the mistakes that led to a loss of product.

When dichloromethane is added to extract caffeine from the aqueous solution, two interlocking layers form: the living and the water layers. In this example, caffeine is usually a cool thing, but it is much less in a cool place when it is a basic solution. Therefore, it dissolves in dichloromethane and forms an organic layer. Dichloromethane is an alkyl halide and is thicker than water, so it is found under a separating panel. It has a density of 1.325 g / m. It had active chloro groups that made it easy for both reaction and removal. The concentration of solutes in the organic layer also contributes to the fact that it is found under the aqueous layer. There are high concentrations of caffeine, reactants (because the reaction does not go to 100% dissolution), and low amounts of water. Caffeine was extracted from dichloromethane to be "washed" three times in order to obtain a more pure sample. Emulsions of small droplets of organic matter suspended in water are the result of the strong vibration of the separating funnel There are many ways to remove emulsions, although the best form is prevention. However, emulsions can break down after a sufficient period of time. The aqueous layer can also be made more ionic, and centrifugation works very well especially at the microscale level. The amount of caffein obtained for different weigh tea samples like 20gm, 25gms and 30gms are 0.162gms, 0.189gms, and 0.205gms dry caffein respectively.

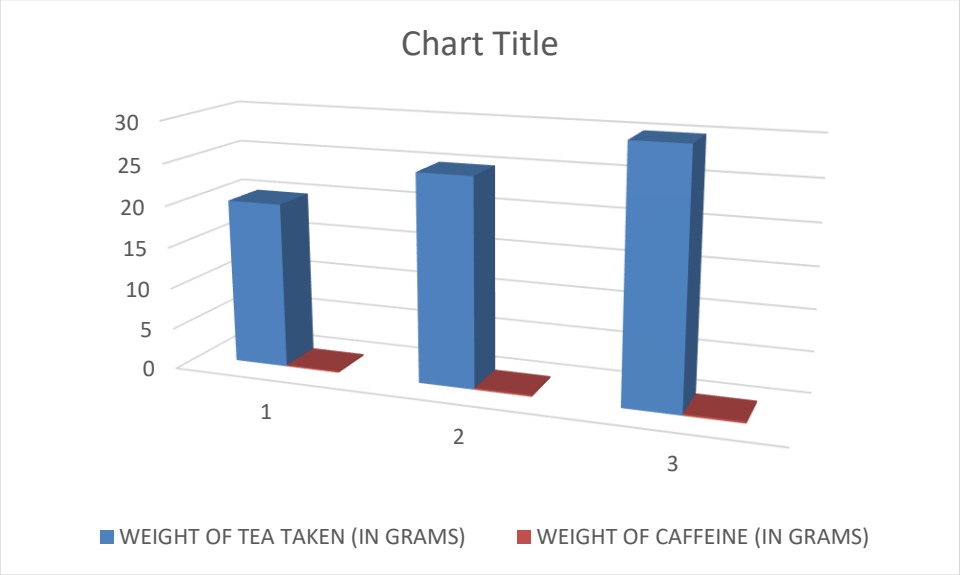

Fig. Weight of tea taken vs Weight of Caffeine Obtained

IV. CONCLUSIONS

Tea is very rich in antioxidants. It is the most widely used beverage in the world. It also has medical facilities. In this study tea would be extracted caffeine using dichloromethane as a solvent. This study will be performed to assess the amount of caffeine in the tea powder used. It is acceptable that the amount of caffeine decreases with all consumption. The caffeine that comes out of the tea is extracted by releasing a liquid that is followed by recycling. Caffeine is the most widely used psychotropic drug in the world. It is an active pharmacological agent and depending on the dose, it can be a central nervous system stimulant. About 80% of the world's population consume caffeine daily. Pure caffeine is then analysed using effective liquid chromatography or the Iodometric back titration method. Serious concerns about caffeine use that may have pathogenic effects have made it one of the most widely studied drugs. In the present study the caffeine content of different tea weight samples was studied and it was found that the caffeine content varied from 0-1%. Prices are generally in line with quoted books at 0-5%. The amount of caffein obtained for different weigh tea samples like 20gm, 25gms and 30gms are 0.162gms, 0.189gms, and 0.205gms dry caffein respectively.

V. ACKNOWLEDGEMENT

The authors acknowledge the great help that scholars receive in their articles quoted and included in the manuscripts. The authors also thank the authors, editors, and publishers of all those articles, journals and books in which the articles for this article were reviewed and discussed.

VI. REFERENCES

1) S. Venkatesh, M.M Swamy, Y.S. R Reddy, B. Suresh and M. Sethuraman (1994). A simple method for determination of caffeine content in tea samples. Journal Ancient Science of Life,14(1-2),35-38.
2) G. Serdar, E. DEMIR and M. Sokmen (2016). Recycling of tea waste: Simple and effective separation of caffeine and catechins by Microwave Assisted Extraction (MAE). International Journal of Secondary Metabolite. INT. J. Sec. Metabolite,4(2),78-89.
3) A. Chaudhary, S. Sarkar, A. Chaudhary, S. Bardhan, P. Mandal and M. Chaudhary (2016). Tea waste management: A case study from West Bengal, India. Indian Journal of Science and Technology, 9(42), 89790.
4) CHEM 333L (2010). Organic chemistry laboratory. Revision1.3. Isolation of caffeine from tea.
5) A. Postu and S. Wilson (2013). Isolation of caffeine from tea leaves via Acid-Base liquid-liquid extraction. Asian Journal of Science and Technology,12(2), 2157
6) M. Debartolo, Fall (2002). Org Chem 1 Extraction of caffeine from tea Part 1.
7) A. Amoozegaran and M. Javaherian (2014). Comparative Evaluation of caffeine extraction in waste tea as a potential low-cost source relative to dry tea in different solvents. Natural products-An Indian journal, 10(1), 27-29.
8)L. jeyanthi Rebecca, C. Seshiah and T. Tissopi (2014). Extraction of caffeine from tea leaves. Journal The annals of "Valahia University" of Targovishte.
9)C. Biological supply Company. Caffeine Extraction from tea. University of pittsburg at Bradford. Science in motion. Chemistry lab 023.
10) I. Ahmed, T. Parveen, A. Yusuf Belel and H. Sikder. (2013). Extraction of caffeine from tea and development of caffeinated fruit juice. Journal of Food Chemistry and Nutritio, 2308-7943.
11) R. Patel and M. Salvitti (2016) Chemistry 213 W 001, Synthetic experiment 21: Isolation and purification of caffeine from tea.
12) D Scott, Murray, Hansen, J Peter and J.J Lagowski (1995). Extraction of caffeine from tea: an old undergraduate experiment revisited. Journal Of Chemical Education, 851-852.
13) M. J. Mohammad and F. Al- Bayati (2014). Isolation, Identification and Purification of Caffeine from Coffea Arabica L. and Camellia Sinensis L.: A combination antibacterial study. Journal of Green pharmacy.
14) S. Banerjee and J. Chatterjee (2015). Efficient Extraction strategies of tea (Camellia Sinensis) Biomolecules.
15) D. Komes, D. Horzic, A. Belscak, K. Kovacevic Ganicc and A. Baljak. Determination of caffeine content in tea and mate tea by using different methods (2009). Journal Czech J. food sci, 27.

16) P. Setyopratomo (2014). Extraction of phenolic compounds from green tea using Ethanol. Journal ARPN Journal of science and engineering and applied sciences, 9(09).
17) G. Serdar, E. Demir, M. Sokmen (2016). New approaches for effective microwave assisted extraction of caffeine and catechins from green tea. Journal International Journal of Secondary Metabolite, 3,3-13.
18) S. Anbuselvi, S. Sarvanthi and M. A. Nikhil Kumar (2017). Extraction of caffeine from different variety of tea samples. Journal International Journal of pharmacy and Technology. Coden-IJPTFI.
19) G. Serdar, E. DEMIR and M. Sokmen (2015). Comparison of some extraction methods for isolation of catechins and caffeine from Turkish green tea. Journal international journal of secondary metabolite, 2, 16-25.
20) A. Nawab, Q. Waseem, J. Asif, F. Ahmed and A. khan (2016). Analysis of caffeine in different available brands of black tea. Journal of chemical, biological and physical science,6(4), 1188-1192.