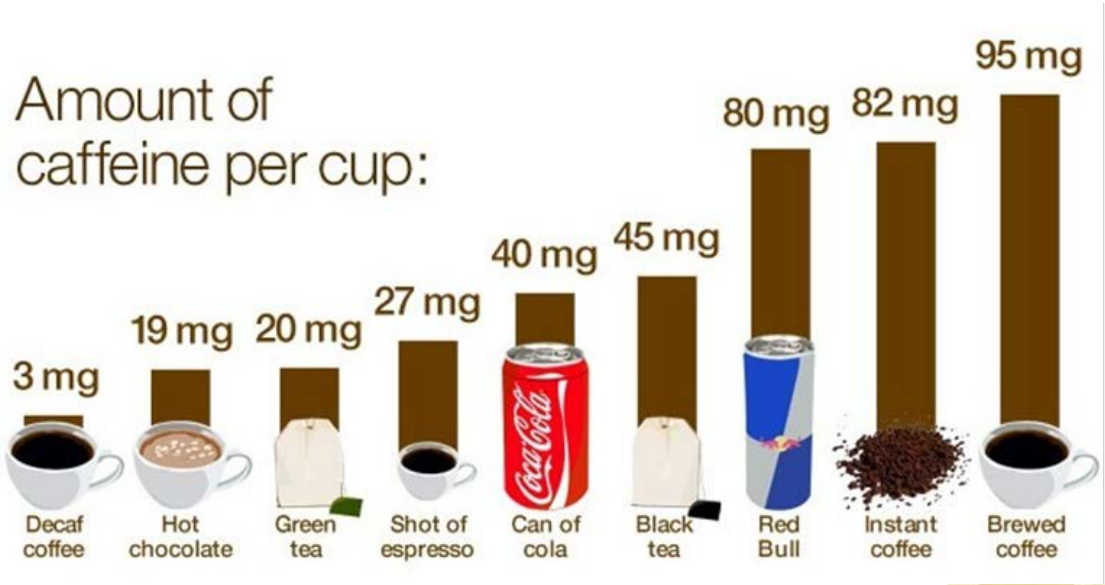
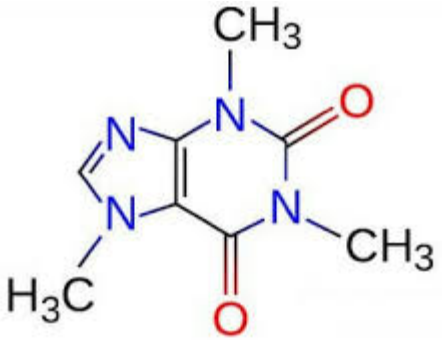
Extraction of Caffeine from Tea Leaves

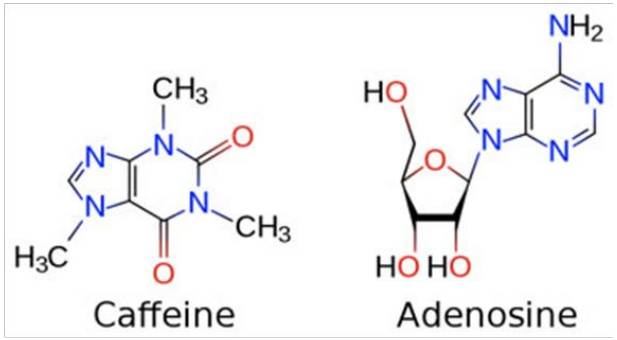
Caffeine is an example of a class of compounds known as alkaloids (alkali like), which usually contain C, H, N and O and are weak bases. Many products such as tea, coffee, chocolate, soft drinks, diuretics, cold and allergy medicines contain caffeine





https://www.billi-uk.com/caffeine-content-favourite-drinks/
https://in.pinterest.com/pin/4531044124844

How does caffeine work?



Caffeine is structurally similar to adenosine, a chemical of the central nervous system that promotes sleep.
It stimulates signals that tell your body it is time to rest and activates the responses necessary to engage in full and sustained sleep.
In your brain, caffeine appears as adenosine to nerve cells and is able to bind to adenosine receptor sites. As a result, your brain does not detect adenosine, and nerve activity does not slow down.
Instead, caffeine increases brain activity, making you feel more energetic and less sensitive to your body's natural rhythms of wakefulness and sleep. With regular consumption, your central nervous system develops a dependency on the substance.

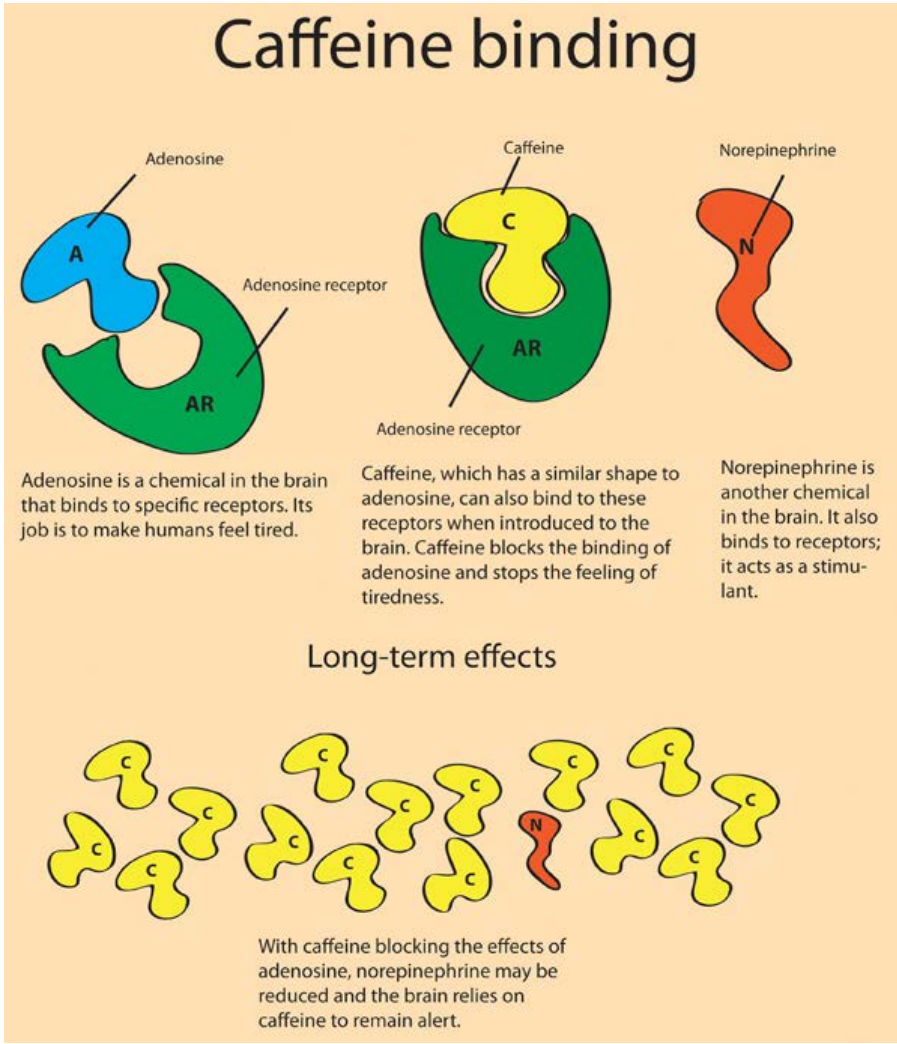


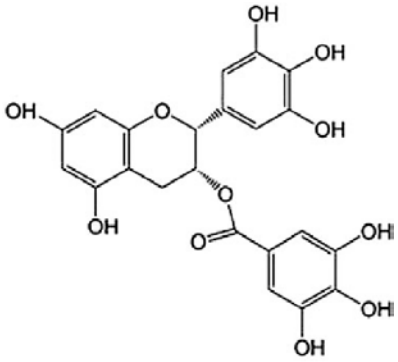
Image adapted from The Tartan, Carnegie Mellon

Principles

In this experiment, caffeine is extracted from tea leaves.

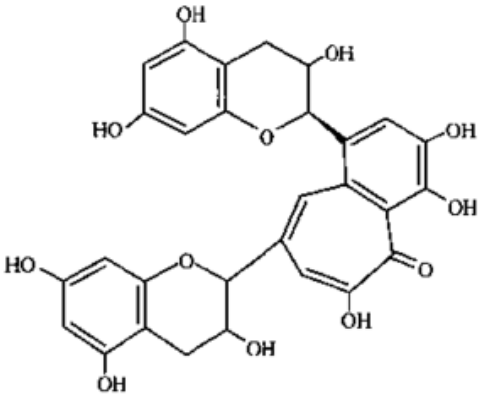
- We initially extract the caffeine in water by boiling the tea leaves in water.
- Additional products such as tannins are also extracted from tea leaves in the process.
- Tea also contains other organic and inorganic molecules other than the polyphenols.
- The difference in solubility of caffeine (less polar) as compared to other molecules is used to extract the caffeine in an organic solvent.

Tannins are polyphenols which account for up to 30% of the dry weight of green tea



Epigallocatechin gallate (EGCG)

Enzyme catalyzed oxidative polymerization



Theaflavin

Green tea component

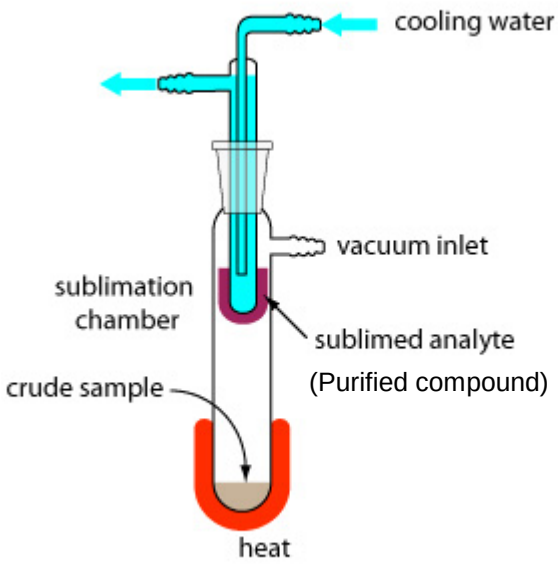
Black tea component

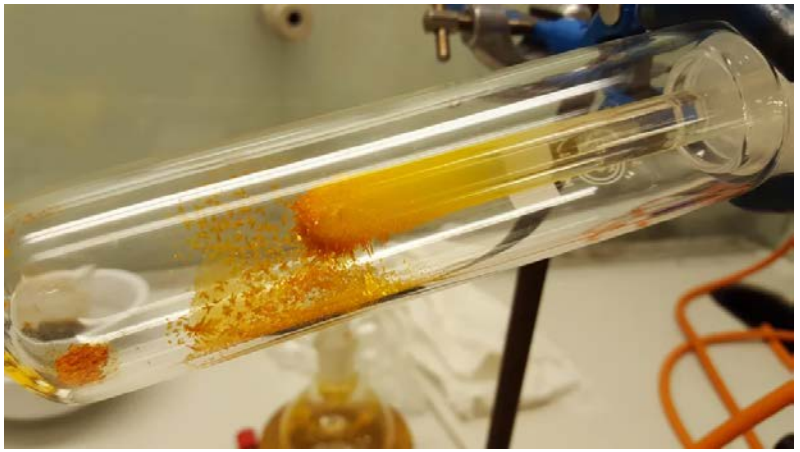
Principles

Purification Using Sublimation

Sublimation is used to separate volatile substance from non-volatile impurities. An apparatus used for this purpose is called the *cold finger* apparatus.

Cold Finger

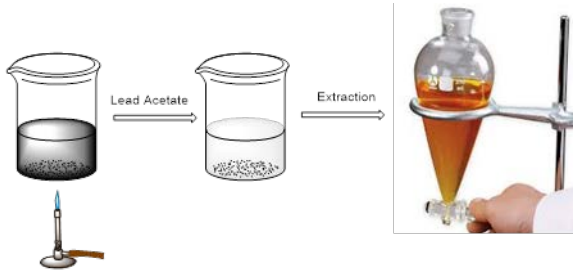




Sublimation of Ferrocene

https://community.asdlib.org/imageandvideoexchangeforum/2013/07/24/separation-by-sublimation/
https://www.gulfscientificglass.com/item/cold-finger-condenser/
https://www.reddit.com/r/chemistry/comments/5rg3v7/an_old_one_but_still_a_favourite_the_sublimation/

Experimental Protocol



1.Take 100 mL of distilled water in a 250 mL conical flask/ beaker.
2. Add 10 g of tea leaves and boil it roughly for 10 minutes.
3. Filter the mixture carefully in hot condition to get tea extract (by removing tea leaves).
4. To this extract, add 10 mL of 10% lead acetate and mix it thoroughly. You will see a quick precipitation.
5. Filter the mixture to obtain the aqueous extract.
6. Transfer the extract to a 125 mL separating funnel and add 20 mL of chloroform or dichloromethane. Shake it well and separate the organic layer. The organic solvent creates pressure during shaking. To release the pressure, open the lid before you shake the mixture again. Collect the organic layer in a 250 mL beaker.
7. Repeat the extraction with additional 15 mL portions of the organic solvent.
8. Combine all the organic extracts and dry with magnesium sulphate. Filter and remove the solvent by evaporation.
9. Report yield of the caffeine obtained.

The crude caffeine obtained is then purified by sublimation using a cold finger apparatus. Weigh the purified caffeine and report percentage purity.

Observations and Calculations

To calculate percentage purity

Percentage Purity = (Weight of purified compound / Weight of crude compound) x 100

Amount of crude caffeine obtained = 1.23 grams
Amount of purified compound obtained = 0.77 grams

Percentage purity = (0.77 / 1.23) x 100 = 62.60 %

Results

- Caffeine was extracted from tea leaves
- Obtained compound was purified using sublimation
- Percentage purity = 62.60 %