ISOLATION OF CAFFEINE FROM TEA

EXPERIMENTAL TECHNIQUES REQUIRED

Extraction (T 6), drying agents (T 7), filtration (T 3), rotary evaporation (T 8), recrystallisation (T 2) and/or sublimation (T 9)

OTHER DOCUMENTS

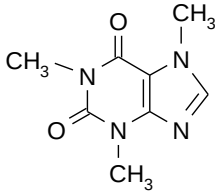
Experimental procedure

INTRODUCTION

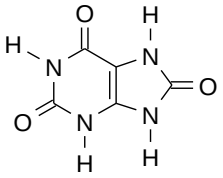
Caffeine is a commonly encountered mild stimulant and a diuretic. It is widely used in proprietary drugs for the stimulant effect in order to prevent drowsiness. Caffeine is naturally present in the fruit and bark of a number of plants, including tea, coffee, and cacao. Tea contains about 30-75 mg and coffee 80-125 mg in a typical 150 mL (cup) serving. The amount of caffeine in tea varies by brand but the average in common brands is typically about 30-40 mg caffeine / tea bag.

The January 2005 edition of National Geographic had the cover title "why we love caffeine" and a 30 page article on the "world's most popular psychoactive drug...". In contrast to popular belief, it includes evidence that in moderate amounts, caffeine is not a diuretic. Did you know you can get fabrics with caffeine woven in and that smokers metabolise caffeine almost twice as fast as non-smokers?

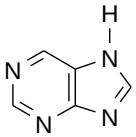
Caffeine belongs to a very important class of compounds called purine alkaloids, a major component of nucleic acids. Other purine systems are found in naturally occurring compounds, including uric acid, which is the form in which nitrogen is excreted in non-mammalian animals. The presence of methyl groups in caffeine is a result of biochemical methylation, a common process in plant metabolism.



Caffeine



Uric acid



Purine

The extraction of caffeine from coffee is commercially important as the effects of caffeine are considered undesirable by some people. Decaffeination used to be carried out by treating the green coffee beans with a small amount of hot water and then exposing to a solvent (trichloroethylene) until 97% of the caffeine was removed. Residual solvent was removed after extraction by steam distillation. The process also removes wax from the beans, which are then roasted in the usual way. In these solvent based methods, the coffee beans are extracted as many as 10 times, maybe for as long as 10 hrs until the required level of decaffination has been reached. A more common today to use super critical carbon dioxide.

The extraction of caffeine from tea leaves requires that the caffeine is separated from other compounds present in the leaves such as cellulose, proteins, amino acids, tannins, saponins and pigments. It is the differing solubilities of these compounds that we take advantage of to extract the

caffeine. Cellulose is insoluble in water so it is not removed in the initial “brew” and the other compounds tend to be more water soluble than caffeine itself so they are not extracted by the dichloromethane. The solubility of caffeine at room temperature is 2.2g/100mL in water at 25 ^{o}C (6.7g/100mL at 100 ^{o}C) and 18g/100mL in chloroform. Caffeine crystallises readily and it can also be purified using sublimation.

In this experiment, the caffeine is first extracted from tea leaves using hot water. This only takes a few minutes (about 10 minutes), and there is no advantage to leaving it to sit for 20 minutes (infact, this may increase the presence of undesired and potentially problematic tannins). This aqueous solution, the tea, also contains tannins and other water soluble materials. The caffeine is then recovered from the aqueous solution by the common and important technique of liquid-liquid extraction using dichloromethane as the extracting solvent. The caffeine in dichloromethane solution is then dried using a chemical drying agent. After filtering to remove the drying agent, the dichloromethane is removed on a rotary evaporator, to obtain the crude caffeine. The caffeine is then further purified by careful recrystallisation. Note that caffeine could in principle be purified by sublimation but this is more difficult and not very good for small amounts.