Quantitative Analysis of Caffeine Content in Different Samples of Chocolate

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Abstract : *Chocolate is a typically sweet, most pleasurable food obtained from Theobroma cacao seeds whose major component is cocoa solids. The most important methylated alkaloid that occurs naturally in cocoa solid is caffeine. Caffeine is a bitter, white crystalline purine, methylxanthine alkaloid and is a widely consumed psychoactive drug. In the present study extraction of caffeine from chocolate was done using dichloromethane and was comparatively studied and also its effect on human health. It was found that Kopiko candy contained the maximum amount of caffeine whereas dairy milk had the least amount of caffeine content. Dark chocolate like Amul Dark chocolate had average caffeine content. The calories imparted and carbohydrate content differs extensively among chocolates. The other components like flavinoids which is an antioxidant make dark chocolate healthier when consumed wisely.*

Keywords: *Chocolate, Caffeine, Psychoactive drug.*

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Introduction :

Chocolate is a brown food preparation of *Theobroma cacao s*eeds, roasted and grounded. It is made in the form of a liquid, paste, or in a block, or used as a flavoring ingredient in other foods. After fermentation; the beans are dried, cleaned, and roasted. Chocolate contains cocoa solids and cocoa butter in varying proportions, without any added sugars it is sweet. Much of the chocolate consumed today is in the form of sweet chocolate, a combination of cocoa solids, cocoa butter or added vegetable oils and sugar. Milk chocolate is sweet chocolate that additionally contains milk powder or condensed milk. In the UK and Ireland, milk chocolate must contain a minimum of 20% total dry cocoa solids; in the rest of the European Union, the minimum is 25% whereas according to Indian standards set by FSSAI a minimum of 2.5% by mass of cocoa solids is found in milk chocolate which varies in different chocolates produced by the manufacturer. White chocolate contains cocoa butter, sugar, and milk, but no cocoa solids.

Dark chocolate contains cocoa solids, cocoa butter, sugar and emulsifiers (Emmanuelle et. al., 1996).

Cocoa solids are a source of flavonoids and alkaloids, such as theobromine, phenethylamine and Caffeine. (Gaffan et.al. 2004) The most

important methylated alkaloid that occurs naturally is caffeine. Caffeine is found naturally in cocoa beans, so any chocolate has little bit of the stimulant. Caffeine is a bitter, white crystalline purine, methylxanthine alkaloid (Nehlig et.al., 1992).

Its molecular formula is $C_8H_{10}N_4O_2$ .Its IUPAC name is 1, 3, 7-Trimethylpurine-2,6-dione and with molar mass 194.19g/mol and melting point is 508-511K.
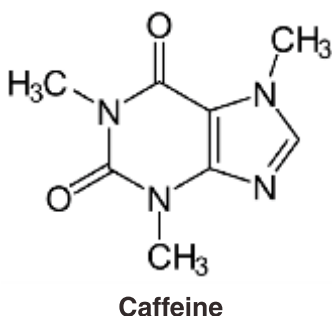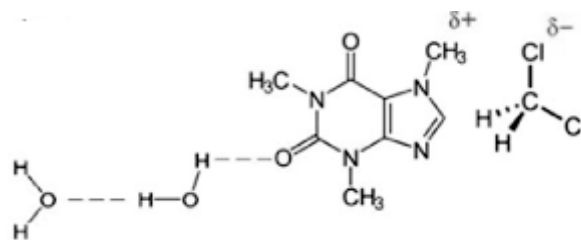

Caffeine

It is the world's most widely consumed psychoactive drug. European Food Safety Authority (EFSA) published their Scientific Opinion on the Safety of Caffeine, advising that caffeine intakes from all sources up to 400 mg per day and single doses of 200mg do not raise safety concerns for adults in the general population. Caffeine often acts as stress busters, enhances our mood and induces pleasure, sense of euphoria and also used as antidepressants. It increases stamina and relieves post work out pain up to 48 % (Snel and Lorist, 2011). When taken in excess, it triggers the symptoms of migraine and can also cause depression (Juliano and Griffithis, 2004).

The main objective of this research work was to extract caffeine from the chocolate samples taken and compare it with each other and also its effect on human health.

Materials and Methods :

Liquid–liquid extraction (LLE), also known as solvent extraction and partitioning, is a method to separate compounds based on their relative solubilities in two different immiscible liquids, usually water and an organic solvent. (Rezaee et. al., 2006) In the case of Caffeine extraction from chocolate (Peker et. al., 1992), the organic solvent Dichloromethane is used to extract caffeine from aqueous extract of chocolate because caffeine is more soluble in dichloromethane (140mg/mL) compare to water (22mg/mL).

Forces acting between caffeine, dichloromethane and water : H-atom of water molecule form H- bond with the oxygen atom of caffeine. Dipole dipole forces act between Chlorine atom of dichloromethane and hydrogen atom of caffeine.

Anhydrous sodium sulphate which is a hygroscopic inorganic solid is used to absorb water from the organic layer.

$$Na_2SO_4 + 10H_2O ® Na_2SO_4.10H_2O$$

About 20g of chocolate sample was weighed and was taken in a 400mL beaker. 250 mL of distilled water was added to it. The solution was heated to boiling. On cooling 70mL of supernatant was taken in the seperatory funnel.10mL of dichloromethane was measured using measuring cylinder and was added to the above solution. The mixture separated into two layers - the top layer was the water-chocolate solution layer and bottom layer was the dichloromethane-chocolate solution layer since it is denser than water. The bottom layer was drained into the conical flask. The solution was extracted three times with 10-mL portions of dichloromethane and transferred in the same conical flask. About 2 g of anhydrous sodium sulphate was added to the solution in the conical flask. This solution was filtered and was allowed to evaporate on the water bath. Crude caffeine was

collected. The caffeine thus obtained was weighed; calculations and results were analyzed thereafter.

Results and Discussion :

When the extracted caffeine content in 20 g of chocolate sample was analyzed for the different samples following results were obtained which is shown in Table 1.

Table 1. Amount of caffeine and percentage of caffeine content in 20 g of chocolate sample studied

Chocolate sample	Amount of caffeine obtained (g)	Percentage of caffeine
Dairy milk	0.37	1.85%
Bournville rich cocoa	1.32	6.6%
Kopiko candy	1.92	9.6%
Amul dark chocolate	1.66	8.3%
Hershey's Special Dark	0.95	4.7%
Bournville Cranberry	1.76	8.8%

A glance at the Table 1 indicates the presence of wide variation in caffeine content and percentage of caffeine in different sets of chocolate samples studied. The candy Kopiko which is made up of coffee beans as it tastes so contains the largest amount of caffeine. For Dairy milk which is a milk chocolate, the caffeine content in it is the least. The samples Bournville Rich cocoa, Bournville Cranberry, Hershey's Special Dark and Amul Dark chocolate which are 50%, 45% and 55% dark respectively their caffeine content is moderate.

Conclusion :

The amount of caffeine in chocolate is enough to affect most people unless enormous amounts of chocolate are consumed. From our study we found that Kopiko candy contained the maximum amount of caffeine whereas dairy milk had the least amount of caffeine content. The calorie intake of candies and dark chocolate are almost equal but the other components in chocolate like flavinoids which are potent antioxidants and glucose content is also low so dark chocolate must be preferred over candies. In Dairy milk the caffeine content is minimum but calories imparted and carbohydrate content is more so it must not be used as a psychoactive substance. They are useful when sudden hike in carbohydrate

is required as in case of hypoglycemic conditions. Caffeine can increase blood pressure, anxiety and heart rate in people who are sensitive to its effects and it is not recommended for pregnant women because it is linked to miscarriages. If we are sensitive to caffeine, it's best to avoid eating whole bar of chocolate once.

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