

A Study on Caffeine Effect of Tea on Health

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ABSTRACT:

Caffeine is a xanthine alkaloid which occurs in various plant sources such as tea leaves, coffee bean, cocoa seeds, etc. It is bitter in taste and is usually seen in the form of white crystals. Caffeine is consumed in the form of tea, coffee, chocolates, cold beverages, etc. Tea contains a considerably small amount of caffeine. Caffeine when consumed can either have advantages or disadvantages on health depending on the amount consumed. When consumed in small quantities, it causes positive effects such as increased alertness, decrease in fatigue. Individuals who consume less amount of caffeine also have a lesser risk of diabetes and have an increased metabolic rate. Individuals who consume excess caffeine experience negative effects such as addiction to caffeine, anxiety, increased blood pressure due to increased vasoconstriction. Caffeine can be extracted from beverages by a process called decaffeination which is done in the presence of organic solvents like benzene, dichloromethane. This review focuses on effect of caffeine on health.

Keywords: Caffeine, Tea, Metabolism, Catabolism, health, properties

[I] INTRODUCTION

Tea is the most commonly consumed beverage which is prepared from the leaves of a shrub named *Camellia sinensis* [2].



Figure: 1. Tea plant(*Camellia sinensis*) [2]

It was first prepared by the Chinese who used it as a medicine. According to Chinese legends, tea was invented by Shennong in 2737 BC. Tea is grown in well drained sandy loam soil rich in organic matter. Acidic soil with pH 4.5-5 is used for cultivation. In the tropical belt, it is usually grown on the slopes of hills, flat plateaus, at altitudes varying between 700 m and 2400 m above sea level. Being a rainfed crop, tea grows well in the areas having annual precipitation of 1000 mm to 3000 mm. Persistent rainless condition is lethal for the tea bush. Irrigation during dry months gives better crops [2].

Tea is of different types which include black tea, green tea, oolong tea, yellow tea, white tea and post fermented tea[2]. The basis of classification is as follows:

White Tea: Wilted and unoxidised.

Yellow Tea: Unwilted and unoxidised, but allowed to yellow.

Green Tea: Unwilted and unoxidised.

Oolong: Wilted, bruised, and partially oxidized.

Black tea: Wilted, sometimes crushed, and fully oxidised.

Post-fermented tea: Green tea that has been allowed to ferment[3].

Herbal teas are also made by the addition of herbal ingredients such as ginger, mint, etc. Flavoured teas are also prepared using various flavouring agents like vanilla, jasmine, etc. Tea is produced by enzymatic oxidation of tea leaves. Initially the tea leaves are agitated and broken into smaller pieces. This is followed by enzymatic oxidation which occurs due to the action of enzymes released due to the disruption of cell walls. A firing process is done to prevent excess oxidation [4].

The various organic components present in tea include theobromine, theophylline, caffeine, L-theanine which is an amino acid, etc. Tea also contains other chemical components such as antioxidants; minerals like fluoride, magnesium, potassium, zinc; vitamins A, B1, B2, B6, B12, C, E, K; carbohydrates like raffinose, glucose, fructose, fiber; lipids; carotenoids and organic acids like citric acid, tartaric acid, oxalic acid [7].

[2] STRUCTURE AND PROPERTIES OF CAFFEINE

Caffeine is a xanthine alkaloid having the chemical formula $C_8H_{10}N_4O_2$. It is also known as 1,3,7- trimethylxanthine and constitutes about 3% of the dry weight.[1] The structure of caffeine is shown in Fig: 2.

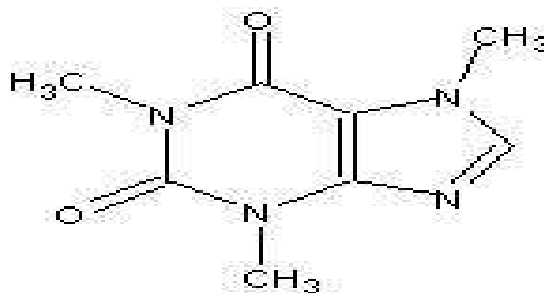


Figure: 2. Structure of Caffeine [1]

According to Changquan et al [15], it occurs in the form of white crystals having an orthorhombic structure. Caffeine molecules are held together by intermolecular hydrogen bonds as shown in Fig:3. It is an achiral molecule with slight basic nature.



Figure: 3. Caffeine Crystals in pure form [1]

Caffeine has very poor tabletability, which means that there is a lack of plastic deformation of caffeine during compaction. During this process, caffeine forms a tablet which is weak and porous. Caffeine has a very low tensile strength.

Sl. No.	Properties	Values/Appearance
1	Molecular weight	194.19 g/mol
2	Density	1.2 g/cm ³
3	Melting point	237 ⁰ C
4	pK _a	10.4
5	Solubility in water	Slightly soluble
6	Boiling point	178 ⁰ C
7	Appearance	white needles or powder

Table: 1. Properties of Caffeine [1]

[3] METABOLISM OF CAFFEINE

Biosynthesis of caffeine is as shown in Fig:4 according to Hiroshi and Alan [12], Xanthosine is the precursor for caffeine biosynthesis, in the presence of 7-methylxanthosine synthase and S-adenosyl-L-methionine it is methylated to produce 7methylxanthosine. This in the presence of methylxanthosine nucleotidase gives 7-methylxanthine. 7-methyl xanthine in the presence of caffeine synthase and S-adenosyl-L-methionine gives first gives Theobromine and then caffeine. Paraxanthine is an intermediate synthesised during caffeine biosynthesis which also leads to the synthesis of caffeine.

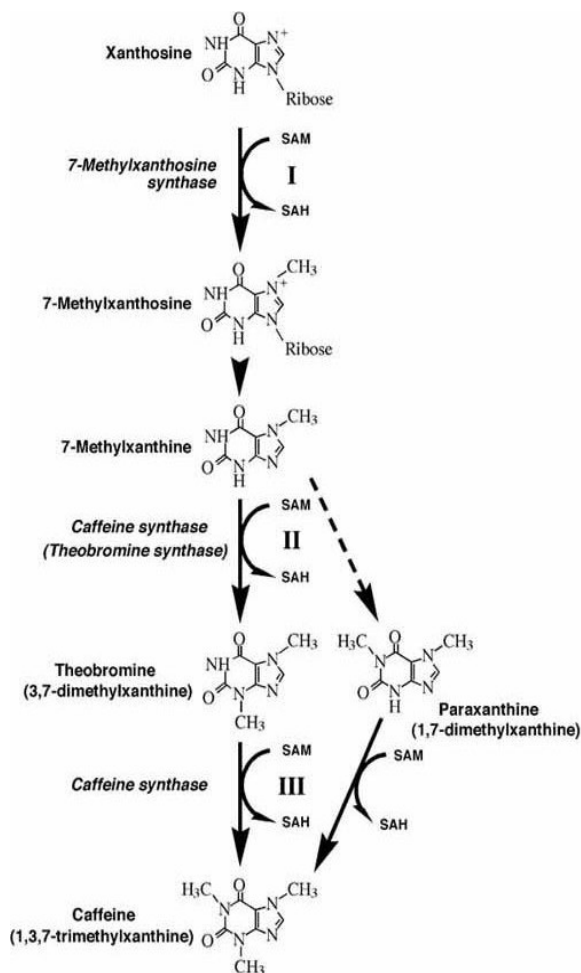


Figure: 4. Biosynthesis of Caffeine [12]

It is consumed through various food sources such as tea, coffee and chocolates. The catabolism is initiated by the degradation of caffeine to xanthine as shown in Fig:5. Intermediates such as 3-methyl xanthine, theophylline, are formed. before the formation of xanthine, then it is degraded into uric acid, allantoin, allantoate and finally to ammonia and carbondioxide.

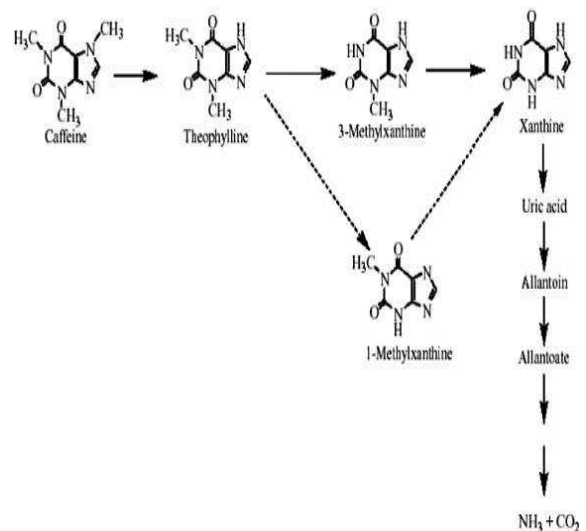


Figure: 5. Catabolism of Caffeine [12]

[4] EFFECT OF CAFFEINE ON HEALTH

It can either have either a positive or a negative effect on human health.

4.1 ADVANTAGES ON HEALTH

When caffeine is consumed in lower doses (20-200) mg it has the following advantages on the body:

People feel energetic and are able to concentrate very well. This keeps them alert and enables them to work efficiently. A recent study has also shown that patients suffering from common cold could concentrate well and could perform the task given to them efficiently on consuming caffeine by Fredholm et al[8].

Caffeine inhibits adenosine which has an inhibitory effect on neurotransmitters. This increases the activity of neurotransmitters like

dopamine It causes relief from tension and headache. The chances of suffering from depression also reduce was stated by Fredholm.

According to Janet Bryan[16], there is also a positive effect on cognitive behaviour by increasing speed of perception. People are able to make proper decisions and are able to respond well. The risk of hepatocellular and endometrial cancer also reduces.

It acts as a thermogenic agent by inhibiting the degradation of intracellular cAMP caused by phosphodiesterase. This helps in weight control according to Kristel Diepvens et al[14].

According to Hamilton et.al [11] caffeine has an anticariogenic effect that helps in preventing dental caries which is caused by the production of acid by various types of bacteria such as *Streptococcus mutans*, *Actinomyces*.

This also shows the antimicrobial effect of tea, suggested Hamilton et al [5].

Christiane et al[10] surveyed ,caffeine helps in reducing blood cholesterol levels and fat absorption by the body and hence reduces obesity. This helps in reducing the risk of arteriosclerosis .It acts as an antioxidant due to the presence of various polyphenols. This helps in preventing oxidative stress in vivo. It also increases the activity of leucocytes

4.2 HARMFUL EFFECTS OF CAFFEINE ON HEALTH

When caffeine is consumed in excess, it brings health hazards.

Excess caffeine reduces the time a person is able to sleep. It is because of this phenomenon that people suffering from insomnia consume very less amount of caffeine according to by Fredholm .

According to earlier studies in 1995 by Morten et al [6], adenosine causes vasodilation. Presence of caffeine stimulates the release of norepinephrine from the adrenal glands which

causes vasoconstriction in turn causes an increase in heart rate and blood pressure .

Studies by Azra et al in 2001[9], have shown that caffeine increases the stiffness of arteries causing a decrease in elasticity of arteries .

A high dose of caffeine (>1000 mg) causes caffeine addiction. Anxiety is the main symptom of caffeine addiction, there is an increase in the risk of bladder, the condition of patients suffering from glaucoma is worsened by the increase in pressure within the eye ,there is an increase in the risk of osteoporosis due to decreased calcium absorption by bones and increased calcium secretion in urine. The overdose of caffeine also causes premenstrual symptoms in women and there is an increase in the secretion of insulin by the β cells of the pancreas, thus increasing the risk of diabetes according to a research by James Greenberg et al in 2001[13].

[5] CONCLUSION

Thus the concentration of caffeine that we consume through every cup of tea we drink can either benefit us or deteriorate our health. All this depends on the amount of tea we consume per day. More the number of tea cups, greater is the dose of caffeine consumed per day, and more are people susceptible to caffeine addiction and psychological ailments like anxiety. But in certain doses caffeine can also be used as a drug to treat diseases like cancer

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