# A Review on Influence of Elevation on the Caffeine content in Tea and Coffee

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#### Abstract

A review work has been done on the influence of altitude on caffeine content in two most popular beverages tea and coffee. Tea is an aromatic beverage prepared by using the leaves of *Camellia sinensis*. Another widely consumed drink is coffee which is prepared by using roasted coffee beans. Coffee beans are the seeds of berries from *Coffea* Species. Caffeine is a trimethylxanthin purine alkaloid which occurs naturally in tea and coffee. Caffeine is used widely as psychoactive drug. This article seeks to address the ways that altitude change impact in tea and coffee in India and other countries. It directly focuses on how altitude change affects the caffeine quantity. After reviewing several previous research papers this article concluded that the caffeine level in tea from different country increase with increase in elevation. The caffeine content is changing with altitude even in a single region. On the other hand in coffee the caffeine level decreases with increase in elevation.

Caffeine is a trimethylxanthin purine alkaloid which is naturally occurs in tea and coffee. The taste of caffeine is bitter, and it is a white crystalline substance. The chemical structure of caffeine is related to the adenine and guanine bases of DNA and RNA. People drink beverages that containing caffeine to prevent drowsiness and to improve cognitive performance. Caffeine is the most frequently consumed pharmacologically active substance. Because of its medicinal properties, The scientists have expressed interest and focused

more on the potential of caffeine on human health. After reviewed the research paper, it is concluded that regular uptake of 400 mg caffeine do not affect a healthy human population. Caffeine reduces risk of cancer, reduces risk of parkinson's disease. As caffeine has both advantages and disadvantages we should concentrate on production of caffeine as it occurs naturally in tea and coffee. Thus we select tea and coffee for our review work. The caffeine level varies with the geographic location, climate change, seasonal

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variation. The ultimate purpose of this project is to determine the impact of elevation change on the caffeine content in tea and coffee.

### Brief Concept on Caffeine :

In tea and coffee caffeine is a trimethylxanthine in which the three methyl groups are located at positions 1, 3, and 7. Thus it is a purine alkaloid that occurs naturally in tea and coffee. Caffeines are not true alkaloids. True alkaloids are derived from amino acid. As caffeine is a purine alkaloid and have a nitrogen containing ring structure it is called pseudoalkaloid.





Benefits of Caffeine :

The structure of caffeine related to adenosine and it acts as an adenosine receptor antagonist with psychotropic and antiinflammatory activities. After ingestion, caffeine binds to adenosine receptors in the central nervous system (CNS), which inhibits the adenosine-mediated downregulation of CNS activity, thus, stimulating the activity of the medullary, vasomotor, and respiratory centers in the brain. It boosts production of neurotransmitters such as serotonin, dopamine, and noradrenaline. This neurotransmitter elevate our mood. 50% of suicidal risk can be reduced by Two cups of coffee a day. Noradrenaline neurons are activates by caffeine and seems to affect the local release of dopamine. The effects of caffeine on learning, memory, performance and coordination are related to the methylexanthine action on arousal, vigilance and fatigue.

## Commercial uses of Caffeine :

Caffeine is also an important ingredient of soft drinks, such as cola. Per 12 ounce of Soft drinks typically contain 0- 55 mg of caffeine.

Chocolate is derived from cocoa beans. A small amount of caffeine is present in it. Due to a combination of theobromine and theophylline, as well as caffeine, the chocolate have the weak stimulant effect.

Climate change differently affects tea and coffee yield at various altitudes.

In this respect in 1990, Philip O. Owuor, *et al.* showed by their research that the theaflavins, thearubigins and caffeine in tea are increased with increase in altitude. In 2011, Akiko Ohno, *et al.*,<sup>1</sup> researched with Sri Lankan tea,the result showed that the highest elevation showed characteristic trends in the levels of caffeine were higher. In 1988 Pradip K Mahanta *et al.* researched on black teas manufactured from different altitudes in Darjeeling concluded that major differences between the caffeine contents of teas from the different altitudes appear to be not so

Country	Region	Altitude (m)	Caffeine content (%)
China	Taiwan	2590	0.07
	Fujian provinces	1500	0.05
	Zhejiang	300-800	0.05
India	Darjeeling	2623	2.67
	Nilgiri	1000-2500	2.32
	Assam	60-95	2.55
Sri Lanka	Nuwara Eliya	1868	3.2
	Kandy	650-1300	2.9
	Uda Pusselawa	<650	2.6
China	Taiwan	2590	0.07
	Fujian provinces	1500	0.05
	Zhejiang	300-800	0.05

Table-1. Caffeine content in tea from different altitudes

(Mjesus et al. 2000), (Komes et al. 2009), (PL Sriram, 2016)

Table-2. Caffeine content in Ethiopian coffee sample from different altitude

Types of coffee sample	Altitude(m)	Caffeine Content%w/w±SD
Gedeo Y wetie	2220	0.79±0.02
Mike Gedeo	2210	0.86±0.04
Bolo Wolega Nekemt	2088	0.78±0.02
Gedeo Y. Wegide	2037	1.07±0.02
Gedeo Tulusa	1909	1.00±0.05
Gedeo Dumersa	1867	1.03±0.06
Yachi Jimma	1780	1.79±0.03
Illubabure Dildilaba	1665	1.36±0.02
Jimma G. Chochie	1515	1.69±0.06

(Gebrekidan et al. 2019)

significant. Another research by Chuang Zhang *et al.* in New Zealand in 2018, by their research showed that black tea contained less caffeine at low elevation than from high elevation. In 2020 Wen-Yan Han *et al.*,<sup>13</sup> showed by their research that an increase in cultivation altitude increase the caffeine level.

In 2020, SJuan Gaibor *et al.*, showed by their reseach that when *Coffea arabica* (Arabica coffee) and *Coffea canephora* (Robusta coffee) cultivated at 1300-1600m higher altitude then it shows lower caffeine content. Research with coffee beans in Ethiopia showed that caffeine decreased with increasing altitude (Worku *et al.* 2017). Another research on coffee the coffee sample collected from four different varieties, are cultivated in high, mid and low altitudes ,the result of showed that the contents of caffeine in both raw and roasted coffee beans decreases as the growing altitudes increases and, thus for all varieties, their highest concentrations of caffeine were recorded in lowland coffee beans (Girma et al., 2020). In 2017 Kassaye Tolessa et al. researched on Ethiopian coffee, showed that coffee from high altitude with open or less shade and early harvest periods gave superior bean quality. These growing conditions also favoured production of beans with lower caffeine. Increasing altitude from mid to high about 400m decreased caffeine content by 10%.

By reviewing the above research papers we can say that elevation can mark the difference between good quality and lower quality. Generally tea plants cultivated at high elevations. The altitude at which a tea or coffee plant is growing influences almost every aspects of its development, from aroma and flavor to nutritional value. Change in elevation can drastically affect the environmental condition, thus affecting the quality of tea and coffee. These variations are applicable even within a single growing region. In different altitude the temperature is also different. Variations in temperature and precipitation are also affect the tea vield as well as alter the complex balance of chemicals that gives tea its flavor.

When the altitude increases, the air becomes colder, the soil becomes rockier, and due to the land gradient rainwater is less available there. This long and slow growing process is very suitable and helps in producing high quality of tea. Fertilized plants that grow fast cannot develop a mighty root system. Thus they cannot survive in low winter temperature and regular soil erosion. In such adverse conditions, in order to growth power, the plant must send more carbohydrates to the leaves.

Besides the height of the region, the climate change such as temperature and rainfall both affect land management and soil fertility physically, chemically and biologically. By studying previous papers it can be concluded that the caffeine content in all the coffee bean samples was observed in the range between 0.6-1.2% (w/w). There was a significant differences in caffeine contents among all the coffee beans samples. This indicated that the caffeine content of coffee beans obtained from the plants growing at different altitudes of geographical location is significantly different. The elevation plays a major role in determining the quality of green coffee bean, because there is less oxygen, coffee plants that grown at higher elevation sometimes take longer time to mature than the plants of lower elevation. This allows the flavors to fully develop and produces delicate and flavorful beans. Coffee beans from high altitude usually have a high density than low altitude coffee beans. In support of this study different value of caffeine contents in coffee beans have been reported by the various reseachers. An average value of 1.10% (w/w) by HPLC methods for Ethiopian coffee samples and in the range of 0.96-1.23% (w/w) for Arabica coffee. The variation in caffeine level may be due to the different geographical location which might have different altitude, soil type, rain fall and other agricultural as well as environmental condition. Temperature above 28-30p C may affect the flower bud formation. When temperature rises,

coffee ripens more quickly and leading to a fall in inherent quality. In this research a significant variation in the concentration of caffeine in the coffee bean samples were observed depending upon the level of elevation at which the coffee plants grew.

Tea and coffee are a widespread drink with stimulating and functional properties. For the bibliometric analyses of the overall elevation change related publications, we developed a search query to find the relevant literature as much as possible. After reviewing previous paper the finding shows that at above 2000 m altitude the caffeine content in tea in China and India is 0.07% and 2.67% respectively. And at lower altitude that is 300-800 m in China, 60-95 m in India and <650 in Sri Lanka the concentration of caffeine in tea is 0.05%, 2.55% and 2.6% respectively. The climatic conditions are different in this three country. The requirement of temperature and rainfall are also different for tea cultivation. But increase in caffeine concentration with increase in altitude are common in this country. The concentration of caffeine in Sri Lankan tea is greater than China and India. In the case of coffee at low altitude the concentration of caffeine is higher and it decreasing with the increae of altitude. The present research deals with how the change of elevation affect the caffeine concentration in tea and coffee. Currently, scientists have started a lot of research. In this regard an experimental tea garden yielding good quality tea leaves is maintained at the Bidhan Chandra Krishi Viswa Vidyalaya, Nadia, West Bengal, India.

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