

Research Article

TEA (CAMELLIA SINENSIS) : PHYTOCHEMISTRY AND HEALTH BENEFITS -- TEA CUP THAT CHEERS HAS TEARS

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ABSTRACT

This review of literature paper highlights about tea (*Camellia sinensis*) phytochemistry, health benefits and toxicity. Assam state is the largest tea-growing region in India and is home to India's indigenous, wild-growing tea plant variety, *Camellia sinensis* Assamica. Indian tea is very famous throughout the world and known for famous Assam tea, Darjeeling tea, Niligiri tea, Kodagu or Coorg tea, Chikkamagalore organic tea, Baba Budan hills tea, Kangra tea, Sikkim tea, and Mannar tea. The plant *Camellia sinensis* variety: Assamica or *sinensis* is the source of different teas (black, green, white, yellow, and oolong) consumed worldwide, which are classified by the oxidation degree of their bioactive compounds. Thus, teas are classified according to their processing, where the main variation occurs in the degree of oxidation that modifies chemical and sensory characteristics (aroma, color and flavour). Green tea and black tea are processed differently during manufacturing from *Camellia sinensis*, variety: Assamica or *sinensis*. Teas became more than simply pleasing and cultural hot drinks. Teas have prevailed for their laxative, hypoglycemic, antioxidant, anti-inflammatory, neuroprotective, anticarcinogenic, anti-obesity, cardiovascular and liver protection properties, especially when consumed through functional foods or food supplements in a limited quantity. However, consumption of large amounts of black or green tea may cause nutritional health problems because of the strong binding activities of tea polyphenols and the caffeine content. However, drinking even a very high dietary amount of black tea or green tea would be unlikely to cause these adverse effects in humans. Addition of milk to tea can decrease or completely inhibit tea antioxidant properties. Epigallo-catechin gallate (EGCG) is an important biochemical marker of Assam state, Northeast Indian tea as it contributes 50% of total catechins. Good quality organic tea rich in melatonin content, if consumed in the right quantity can have major positive effects on the body. This review paper updates about the achievements of Indian tea industry in the international market, and growing demand for organic tea.

Keywords: Assam tea, Brahmaputra valley, black tea, catechins, Chikkamagalore tea, Darjeeling tea, green tea, Organi flavoured tea, Kangra tea, Niligiri tea.

INTRODUCTION

Chai or Tea (*Camellia sinensis* (L.) O. Kuntze is the second most popularly consumed beverage worldwide after water (1-8, 9-12). In India, tea is much more than just a drink, it is an emotion. India is the second largest producer and consumer of tea in the world with 80% of tea is consumed in India accounting for 27% of the world tea production (3, 8-12, 35). The tea industry has an important and special place in the Indian economy. Tea is the Indian primary beverage, with almost 80% of total households in the country consuming tea (1-50). **The Indian tea industry is controlled by the Tea Board of India.**

Different varieties of tea, including black, green, oolong, white, and yellow tea are all derived from *Camellia sinensis*, but climatic differences and processing methods account for differences in the composition and degree of antioxidative behaviour (1-50). Tea is the most popular hot beverage in India, consumed both at home and outside. Indian tea culture has very rich history and tea is served in every street of India by Chai Wallah as Cutting (3, 8-12). Indian tea is very famous throughout world and known for famous Assam tea, Darjeeling tea, and Niligiri tea (3, 8-12). The Indian tea industry has grown to own many global tea brands, and has evolved to be one of the most technologically equipped tea industries in the world (3, 8-12). India has always been a major market in tea production (3, 8-12, 26).

In India, 80% people consume black tea with milk and 20% black tea and green tea. Tea is used not only as fresh drink but also as traditional herb which has many health benefits. Indian branded teas have higher demand in the international market (3, 8-12). Generally, these consumable tea products can be classified as green (non-fermented), white (slightly fermented), yellow (mild fermented), oolong (half fermented), black (fully fermented), and dark (post-fermented) tea based on their processing technologies blended or unblended (1-8 to 12, 35-50). Among these, black and green teas are the two most consumed tea products worldwide, which accounting for about 80% and 27% global tea consumption, respectively (1-8-12-35). **Black tea** is typically made from the *Camellia sinensis assamica* variety that originated from the Assam districts of India (1-35). This darker type of tea is made by using leaves that are fully oxidized before they are processed and dried. The flavor profile for black tea can range anywhere from slightly sweet nutty notes to smoky and malty. It's typically stronger and bolder in flavor than green tea varieties (1-35).

Unblended teas are named by their country or region (Assam, Nilgiris, Munnar, Darjeeling, Ceylon, and China) because the hybrids of either the Chinese or Assamese tea subspecies are better suited to and grown in these different geographical locations (3, 26-35). Many reports are available about antioxidant and anticancer properties and health benefits of tea (3, 8-12, 26-35). **Epigallo-catechin gallate (EGCG)** is an important biochemical marker of Northeast Indian tea as it contributes 50% of total catechins (26). The variation in catechin composition is reflected in the variation in theaflavins (TFs) composition of black tea (26-35). Catechins are colorless compounds insoluble in water, which are responsible for the

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bitterness and astringency of teas. India is the largest producer and consumer of black tea (which include CTC and orthodox variety) in the world. China is the largest producer and consumer of green tea in the world. In India, demand for green tea is rapidly increasing whereas in China, demand for black tea is on the rise (22-28, 35-55). The phenolic composition of *Camellia sinensis* is responsible for its antioxidant activity. This property plays an important role to human health, as it inhibits or reduces the effects of aging and chronic-degenerative diseases. In addition, the flavan-3-ols in teas are capable of inhibiting the activity of the main protease (Mpro) of SARS-Cov-2 (56-59). Also, catechins showed a high degree of oxidation during processing (56-59). Food products produced with *Camellia sinensis* showed increased shelf life (meat products) and improved mechanical and sensory properties (bakery and dairy products). Hence, tea extracts are promising ingredients for food industry applications (59).

History of Indian tea

The origin of tea or chai dates back more than 5,000 years, when a king in India ordered a healing spiced beverage be created for use in *Ayurveda*, a traditional medicinal practice in which herbs and spices are used for healing (22-35). A variety of indigenous spices would be used to prepare the healing drink depending on the region of the continent or even the neighbourhood where the beverage was being made (27-35). Original versions of "masala chai," or "spiced tea," contained no actual *Camellia sinensis* tea leaves. The addition of tea, milk, and sugar were popularized thousands of years later (in the mid-1800s) when the British created the now famous tea-growing regions of India and popularized tea as a beverage (27-28). The name "chai" is the Hindi word for "tea," which was derived from "cha," the Chinese word for "tea." The term chai means a mix of spices steeped into a tea-like beverage (27-28). Recipes for chai vary across continents, cultures, towns and families (22-28). But the traditional ingredients of a spiced tea usually include black tea mixed with strong spices like cinnamon, cardamom, cloves, ginger, and black peppercorns. The spiced tea is typically brewed strong with milk and sweetened with sugar or honey (22-35).

The discovery of this native tea plant in 1815 was a boon for English trade in British-colonized India (27-35). The British were quite literally addicted to tea at the time and relied on tea export from China to supply their growing demand (27-28). Conflict between China and British-colonized India as well as shipping and trade competition with the Dutch made it harder and harder for the English to keep up a successful tea trade (27-28). English explorer and botanist **Robert Bruce** is said to have confirmed the discovery of India's native tea plant in 1823 (27-35). Charles Bruce, Robert's brother, took over the research when his brother died (27-28). Bruce explored the wild Assam tea plants growing across the region and learned that local tribes had been using tea for centuries as both food and beverage (27-28). By the 1830s, **Bruce** figured out how these plants could be propagated and cultivated to create what ultimately became a British-dominated tea industry in India (27-35).

The first discovery of the tea plant growing wild in India (upper Assam) was discovered in 1821 (27-28). In 1835, the first tea garden was opened at Lakhimpur district in Assam (27-28). In 1838 the first twelve chests of tea from Assam were received in England. It was found that tea manufactured from Assam plants would be better than the Chinese variety (27-35). In 1833, the East India Company, after losing its legal monopoly of the tea trade between China and Britain, began to look for other sources of supply (27-28). As a result, the cultivation of tea in India began in 1834, with the planting of wild tea found growing in Assam in 1823 (27-35). By the late 1870s, the English had invented machinery to help speed up the tea production process using less labour (22-35). Tea leaves that were originally

hand rolled, slowly fired over coals, and left for hours to dry were now being processed with machinery that replaced by 8,000 machines that could perform the work of half a million people (27-35). In just a short time, the British had the tea plantations and resources to increase the per capita tea consumption in Great Britain from 1 pound per year in 1820 to more than 4 pounds in 1880 (27-28). More importantly, Indian black tea was now on its way to eclipsing Chinese green tea as the most consumed tea in the world. The Assam region is mainly known for its production of black tea (27-28). There are some green and white teas produced here but they are not as well known (22-35). Assam black tea has a hearty, bold flavour that is drinkable on its own but also stands up well to milk and sugar (27-35). Because of its strong and rich flavour, Assam black tea is often used in breakfast tea blends popular with the British, or English tea and other cultures around the world (22-35). **In 1837, the first English tea garden was established at Chabua in Upper Assam;** in 1840, the Assam Tea Company began the commercial production of tea in the region (27-28). Beginning in the 1850s, the tea industry rapidly expanded, consuming vast tracts of land for tea plantations (27-35).

Tea Botany

Taxonomically tea is known as *Camellia sinensis* and belongs to the family *Theaceae* (26). Commercial tea cultivars are recognized under three different taxa, namely, *C. sinensis*, *C. assamica*, and *C. assamica ssp. lasiocalyx* (26). However, tea is highly heterogeneous, and all the above taxa freely inter-breed, resulting in a cline extending from extreme China types to those of Assam origin (26). Hybridization has been so extensive that it is often debated if archetypal *C. sinensis*, *C. assamica*, or *C. assamica ssp. lasiocalyx* still exist (26). Based on morphological characteristics, tea is grouped into Assam, China, and Cambod varieties (26). The classification has been generally followed in Indian subcontinent possibly because of more varied and heterogeneous tea populations in the region (26). Tocklai Experimental Station, Jorhat, Assam, has released 153 germplasms to the tea industry of North East India to be grown in plains (26). Over 60% of 0.3 million ha of tea growing area of North Eastern Indian plains is covered with these tea varieties (26). Tea (*Camellia sinensis* L.) leaf contains a large amount of catechins (a group of very active flavonoids) which contribute to major quality attributes of black tea (26). Based on morphological characters, tea plants were classified as Assam, China, and Cambod varieties (26).

Camellia sinensis sinensis: This is a smaller-leaved variety native to China that is typically used to make green and white teas. It evolved as a shrub growing in sunny regions with drier, cooler climates. It has a high tolerance for cold and thrives in mountainous regions (1-28).

Camellia sinensis Assamica: This is a larger-leaved variety first discovered in the Assam district of India and has typically been used to produce strong black teas. Its leaves grow large in warm, moist climates and it is very prolific in sub-tropical forests. There are hundreds of cultivars and hybrid plants that have evolved from these *Camellia sinensis* plant varieties over time. But technically any type of tea can be made from the leaves of any *Camellia sinensis* plant (22-28).

The China bush variety of *Camellia sinensis sinensis* cultivated in Darjeeling produces small, delicate leaves compared to its India bush cousin *Camellia sinensis assamica* from which Assam tea is produced (22-28). It takes about twice as much China bush tea leaf to equal the same weight of India bush tea leaf (22-28). Which is another reason why Darjeeling produces such a small fraction of the annual tea yield in India (22-28). Another reason Darjeeling tea is so prized is that it is completely unique to this region

of India (22-28). While some Darjeeling tea gardens cultivate the native India tea bush variety (assamica), much of the tea cultivated in this region is the China variety (sinensis) that has acclimated to the high elevation and rugged climate that is similar but unique from China (22-28). Because the winter weather is severe across the Darjeeling region, tea bushes are dormant for many months of the year. Depending on the tea garden location, harvest season runs from February to November and yields several seasonal "flushes" along the way. Each "flush" represents the new growth on the tea bush and reflects the seasonal effects on the leaf as the leaves mature (22-28).

- The "first flush" is the picking of the brand new two leaves and a bud in the earliest spring growth of the plant in February and March. These early leaves are usually more delicate and tender and therefore more light, floral, fresh, and astringent in flavour (22-28).
- The "second flush" is picked in May and yields a larger, more mature leaves with a purplish hue and silver tips or leaf buds. These leaves are known for their full-bodied, muscatel, and fruity flavour (22-28).
- The "monsoon flush" from June through October yields large leaves that brew into a stronger color and bolder flavour that is less nuanced than the previous flushes (22-28).
- The "autumnal flush" happens in October and November and yields a rich copper-colored liquor that can be described as full and smooth in flavour (22-28).

Nilgiri tea of Tamil Nadu state, India is typically described as fragrant, bright, and full-bodied. Nilgiri teas tend to have the fruity characteristics of Darjeeling but are strong and bold like Assam tea (22-28). In Tamilnadu, Tea cultivation takes place in the districts of the Nilgiris, Valparai, Kodaikanal, Manjulai of Tirunelveli etc. The Nilgiris plays a major role in tea plantation in Tamil Nadu. Unlike most black teas, Nilgiri does not "cloud" when chilled, which makes it a dependable choice for producers of iced tea (22-28). Because of its strong and consistent flavour, it is also a popular choice as a base for chai masala, in which the black tea needs to stand up to fragrant spices (22-28). Nilgiri tea also contains very little tannins, so it can be brewed for a long time without succumbing to the astringency that other black teas face if over steeped. This is another reason Nilgiri is a great base for both iced tea and a traditional Indian chai, which requires a strong black tea than can withstand being boiled for a good period of time with milk and strong spices (22-28). Thiashola tea Estate was one of the first estates in the Nilgiris to take up the challenge of organic tea cultivation (30). Today, it's probably the only estate in the district that has converted its entire acreage to organic cultivation (30).

Assam state: The Highest producer of tea in India

Assam state with 33 districts is the largest tea-growing region in India and is home to India's indigenous, wild-growing tea plant variety, *Camillia sinensis Assamica* (3, 8-12, 22-28). Assam is the top producer of tea in India. Almost 50 to 70 % of the entire tea produced in India comes from the state of Assam with 685.9 million kilograms (3, 8-12). Assam is the highest tea producing state in India and occupied unique place by producing more than fifty percent of total annual national production (3, 8-12, 22-28, 60). In the year 2015-16, Assam produced 653 Million kg of tea which is fifty three percent of national production in that year. Total tea plantation area in Assam is about 3.22 lakh hectares which is more than half of the country's total area under tea (3, 8-12, 22-28, 60). More than 6.86 lakhs people in the Assam, which is around 50 percent of the total average daily waged employee in the India, are engaged in tea industry of the state (3, 8-12, 22-28, 60). Assam state is called as the land of tea gardens

as it produces the finest popular for taste, texture, aroma and colour (1-50). Lakhimpur, Kamrup, Goalpara, Sivasagar, Cachar, Nagaon and Derang districts of the Assam state, India are the major producers of tea (3, 8-12, 22-28, 35-55). In Assam the famous tea gardens are 1) Monabarie Tea Estate at **Biswanath Chariali District** of Assam is Asia's Largest Tea Estate. The tea estate is owned by the McLeod Russel India Limited, a part of Williamson Magor Group. 2) Mangalam tea estate (Sibsagar, Assam). 3) Halmari tea estate (Moran district, Assam). 4) Corramore tea estate (Udalguri district, Darrang, Assam). 5) Amchong tea estate (Panbari mouza, Kamrup district, Assam). 6) Sapoi tea estate (Sonitpur district, Assam). 7) Manohari tea estate (Dibrugarh, Assam). 8) Nagrijuli tea estate (Baksa district, Assam). 9) Nonoi tea estate (Nagaon district, Assam). 10) Jalinga tea estate (Cachar district, Assam). 11) Mornai tea estate (Kokharjhar district, Assam). 12) Amsoi tea estate (Nagaon district, Assam). 13) Tippuk tea estate (Tinsukia district, Assam). 14) Hattigor tea estate (Udalguri district, Assam). 15) Beesakopie tea estate (Tinsukia district, Assam). 16) Borbam tea estate (Sivasagar and Jorhat district, Assam). 17) Borpatra tea estate (Sivasagar district, Assam). 18) Seleng tea estate (Bhogdoi, Jorhat district, Assam).

The state of Assam, India is comprised of three physical divisions, namely, the Brahmaputra Valley, the Barak Valley (Silchar), Lower Assam (Guwahati), Upper Assam (Jorhat), Central Assam (Nagaon), North Assam (Tezpur), and the Hill range (22-35). The Brahmaputra Valley, which forms northern part, is the largest in size comprising 71.7 percent of total geographical area of the state (22-35). On the other hand the Barak Valley region, which forms the southern part, is comparatively smaller in size. Assam state is known for producing thick and lush plants with large, abundant tea leaves (3, 22-35). The resulting processed leaf produces a characteristically strong, full-bodied and malty tea. Assam is a large, tropical river valley (22-35). In the northern part of Assam, The Brahmaputra River, one of the longest in the world, descends down the center of the region from Tibet and provides the water that sustains the tea gardens of the fertile plains of Assam state (22-28). The southern part of Assam sits in a valley that bumps up against the Himalaya and traps the river water to produce flood plains that feed the valley's tea gardens (22-35).

Assam's tea plucking and producing season runs from March through November. The Assam tea leaves are generally harvested twice during a season; the harvests are known as "first flush" and "second flush." The first flush is picked during the early spring harvest in March and produces the more delicate teas coming out of Assam (3, 22-35). The second flush in mid-summer produces the "tippy" teas considered to be the most distinctive of the Assam teas (22-35). These more mature, tippy leaves (more coppery in color and covered with fine, delicate hair) brew into a creamy, full-bodied, and brisk cup of tea. Because Assam is the largest tea-growing region, which produces from 50 to 75 percent of India's total tea output (22-35).

Other Tea producing region in India

Several Indian states have greatly contributed to the Indian tea production and raising its economy. Indian teas especially from Assam, Darjeeling, **Coorg**, **Chikmagalur**, **Baba Budan hills**, Nilgiris (Trinitea) are valued for their characteristic aroma and taste (3, 8-12-35). Top 16 tea producing Indian states are, 1) Assam (Assam tea; Lakhimpur, Kamrup, Goalpara, Sivasagar, Cachar, Nagaon and Derang), 2) West Bengal (Darjeeling tea), 3) Tamil Nadu (Nilgiris tea; Trinitea, the districts of the Nilgiris, Valparai, Kodaikanal, Manjulai of Tirunelveli), 4) Kerala (Munnar tea), 5) Karnataka (Kodagu or Coorg tea; Chikmagalur tea, Baba Budan hills tea), 6) Tripura, 7) Arunachal Pradesh, 8) Himachal Pradesh (Kangra tea), (9) Sikkim, 10) Nagaland 11) Uttaranchal, 12)

Manipur, 13) Meghalaya, 14) Mizoram, 15) Bihar and 16) Orissa (3, 8-12, 22-35).

Black tea and green tea are the two more prominent types of tea of Himachal Pradesh, India. Major tea production takes place in the Kangra Valley of Himachal Pradesh state, India (3, 8-12). The valley is also recognized as the 'Valley of Gods' for its unique flavours of tea. The state of Karnataka, India is one of the leading contributor of tea production in India (3, 8-12). Tea is another major plantation of Karnataka, India. Kodagu or Coorg, Chikmagalur, Baba budan hills of Karnataka is known for tea plantation in Karnataka, India (3, 8-12). The organic Chikmagalur tea is packed in containers and is exported to different corners of the world. The authentic tea of Chikmagalur district, Karnataka state, India has a very pungent aroma and taste (3, 8-12). Coorg and Chikmagalur district of Karnataka is the largest organic tea producing region of Karnataka state, India. Further, the Baba Budan Hills of Western Ghat region of Karnataka is a major tea producing region in Karnataka state, India. These teas are much sought after and used by consumers throughout the world (3, 8-12). Unlike North India which halts production from mid-December to mid-February and this is the quality season for South Indian tea.

Indian Green teas are grown mostly in **tea estates in Darjeeling (West Bengal)**, Kangra valley of Himachal Pradesh state and Nilgiri green teas grown in Tamil Nadu state (22-28). High-altitude Darjeeling grown green teas have a special astringent flavour, whereas Nilgiri green teas grown in Tamil Nadu state, India have distinct vegetal notes with a stronger taste. The **Makaibari Tea Estate** consists of 7 villages, of which Makaibari village is the biggest. The tea estate is situated in Darjeeling district, in the state of West Bengal, North-East of India, approximately 30 km south of Darjeeling. Each tea-producing region of India provides a different yet perfect climate for tea growing, leaving us so many ways to explore the subcontinent through its culture of tea (1-40). India and China are known for the title of world's largest producer of tea. There are more than 100,000 tea estates employing millions of tea workers across the geographically and ethnically diverse subcontinent of India (1-50). Tea is so important in traditional Indian culture that 75 percent of the million or so metric tons of tea produced is consumed by its own Indian people (1-35). India's terrain defines its tea-growing regions by the subcontinent's significant differences in climate and geography. The three main Indian tea regions are Assam, Darjeeling, and Nilgiri (3, 22-35). Northeastern India is home to both the Assam region, located in the lush, dense jungles at the foot of the eastern Himalaya, and the Darjeeling region, which bumps up against Tibetan Himalaya and stretches between high mountain ridges and deep mountain valleys. Nilgiri, by contrast, is situated in the mountains of the southernmost tea-growing region, Tamil Nadu state in India. The Nilgiri (Blue Hill) mountains feature high altitude ridges that boast lush forests and jungles where tea plants thrive (22-26, 35-50).

Tea Research in India

The main players in research and extension in Indian tea sector include: 1) Tocklai Tea Research Institute, Jorhat, Assam state. 2) **United Planters' Association of Southern India (UPASI)** - Tea Research Foundation (TRF), Nirar Dam, Valparai, Coimbatore, Tamil Nadu. 3) Darjeeling Tea Research and Development Centre (DTRDC) at Kurseong, Darjeeling, West Bengal state. 4) Institute of Himalayan Bioresource Technology (IHBT), Palampur, Himachal Pradesh state are four major research institutes carrying out tea research in India (60-62). Despite, National Tea Research Foundation (NTRF) jointly set up by Tea Board, tea industry and National Bank for Agriculture & Rural Development (NABARD) provides funds for universities/Institutes involved in innovative tea research (60-62). Their mission is to promote, develop and encourage research

connected with cultivation, production, processing, machinery, marketing, package of tea and allied products of tea, socio-economic aspects and health benefits of tea through tea research organizations/bodies/institutions/universities by providing financial grants to them (60-62). In North East India, Tea Research Association popularly known as TRA Tocklai (60-62). **Tocklai Tea research institute (TRI), Jorhat, Assam state, India is the oldest and the largest tea research institute in the world** (60-62). It looks after the research and development needs of the Assam and North Bengal tea industry. **United Planters' Association of southern India (UPASI)** has established Tea Experimental Station at Davershola in 1927 (60-62). At present UPASI - Tea Research Foundation (TRF), comprises the Tea Research Institute at Valparai, Coimbatore, Tamil Nadu state (60-62). In Kangra Valley, the State Govt. of Himachal Pradesh started tea research station in 1936 but the efforts at practical research have been augmented only in 1986 when Institute of Himalayan Bioresource Technology (IHBT), Palampur under CSIR started functioning. Darjeeling Tea Research and Development Centre (DTRDC) were established in 1977 at Kurseong to provide R & D support to the Darjeeling tea Industry (60-62). The increase in productivity from 424 kg/ha in 1900 to about 2153 kg/ha (2017) is a reflection of the impact that Tocklai, UPASI and other research institutes have had on the Indian tea industry (60-62).

Tea germplasm resources are the most basic materials for tea breeding and biotechnology (60-62). Over the past decades collection, preservation, exploitation, utilization and cataloguing of germplasm have accelerated expanding genetic pool and breeding of new cultivars of the tea producing countries despite improvement of our understanding of the genetic diversity of the tea plant and its related species (60-62). The narrow genetic base of tea cultivars is a hindrance to improving productivity due to rapid vulnerability of genetically uniform cultivars (60-62).

Development of new climate resilient cultivars having high tolerance to heat, cold and drought stress, high resistance to pests and diseases, high nitrogen nutrient use efficiency and high net photosynthesis, especially in response to higher CO₂ concentrations is the priority research area in the face of climate change. For example, tea cultivars with characteristics of deep-growing roots and high metabolite content (e.g. amino acids and sugars) have proved highly resistant to drought (60-62).

Tocklai Tea Research Institute (TRI), Jorhat, Assam state, India has shortlisted planting materials suitable for unfavorable conditions like marginal land, drought and poor drainage for Assam and Darjeeling (60-62). Recently, TRA released two high yielding and drought tolerant clones viz. TV 34 and TV 35 (60-62). The TV 34 is very good cup quality for CTC and TV 35 is good for both CTC and orthodox tea manufacture (60-62). These two clones are more tolerant to drought over the popular TRA clones used by the tea industry (60-62). For the drought prone areas in Southern India, clones like UPASI-2, UPASI-9, ATK-1, TRI-2025, UPASI-20, UPASI-26, biclonal seed stocks viz. BSS-1 to BSS-5 are recommended by UPASI- Tea Research Institute, Nirar Dam, Valparai, Coimbatore, Tamil Nadu. In Kurseong, Darjeeling, B157, P312, T78 and AV2 are comparatively performing well during drought (Ghosh Hajra, 2001). These stress tolerant tea cultivars may be selected for new planting and replanting in drought prone area (60-62).

Effect of climate change on Indian tea production.

Currently global warming is one of the major environmental problems due to climate change. Tea is an ideal model perennial plant for studying the effects of climate change due to its wide distribution, stable ecosystem, quality parameters, and long economic life (60-62). Tea is a rain-fed mono-cropping system and has been found that tea would be one of the crops most adversely affected by

climate change (60-62). In India, the main tea-growing areas of Northeast India, Assam and West Bengal, showed a steady increase in mean temperature with the average minimum temperature having increased by about 1.3°C over the last 100 years (60-62). Increasing temperatures, enrichment of ambient CO₂, changes to annual rainfall and its distribution pattern, coupled with major shifts in other meteorological parameters have a profound impact on growth and yield of tea (60-62). It has been observed that climate change influences tea yields by altering precipitation levels, increasing temperatures, shifting the timing of seasons and encouraging insect pests. In a study on the suitability of the tea growing regions in 2050 and 2070, it has been reported that tea growing areas in Assam could drastically reduce drastically by 2050 (60-62). Hence, facing an unpredictable fate and with the knowledge that climatic conditions are likely to worsen (60-62).

Tea Cup that Cheers has Tears

The most encouraging development of the tea sector of the Assam state is the participation of unemployed youths as small tea grower and thereby helping to increase the tea production in the Assam state (27-35). The total number of tea gardens (large and small) in Assam at present is around 51000 covering an area of 26 million acres (27-28). The tea industry is also playing a vital role in the economic development of the Assam state (22-35). It has become one of the most important foreign exchange earning industries in the country. However the tea industry of Assam, which is considered as main stay of the Assam state's economy, is now facing crisis (27-28). As the tea gardens in Assam are becoming age old, the productivity of these old gardens is declining. The conditions of tea estates in the state are not as productive as in the past (27-35). A considerable number of tea gardens of the Assam state have gone sick over the period due to lack of infrastructure, modernisation and efficient management (27-35). Another serious problem faced by the tea industry in Assam state is the general fall in the price of medium and plain tea (27-35). For some time there were no buyers of such tea from Assam, Darjeeling, and Nilgiris (Trinitea). In the prevailing general climate of globalisation and dismantling of tariff barriers, All the Indian tea including Assam tea has been facing open competition (27-35). The sustainability of Assam tea thus depends on different factors like improvement in quality, cost effectiveness, control of diseases and pest attacks, increase in domestic demand, identification of newer export market (27-35). The growth rate of production of tea in Assam in recent past is not up to the expectation. Assam Tea which has name and fame in the foreign market is also going down by quality. This tea Industry in Assam state also helps in providing indirect employment in different sectors like road construction, transportation, warehouses, manufacture of plywood, tea chest, paper, card board, aluminum foil, tinsplate, metal fittings, fertilizers, insecticides, pesticides, iron, steel, coal.

During the season of 2021, Barak Valley region of Assam state of India produced a total 43.23 million kg of Tea compared to 44.84 million kg in 2019 and 41.04 million kg in 2020 (72). Production in 2020 and 2021 declined due to COVID protocol and severe climatic changes. Tea industry officials explained that if exports are impacted then more tea will be available in the domestic market and that will lead to an oversupply situation, causing prices to crash, a situation that will pile the pressure on a troubled industry. Tea prices for most years have been depressed. Stagnation in tea prices and increase in costs led to a decline in operating profitability of bulk tea players (72).

The tea industry in Barak Valley of Assam state, India is in dire need of a coal depot in the region to meet its energy need, any disruptions throughout the year to boost production by the tea estates in the region (72). The erratic power supply and frequent tripping of electric supply made the tea industry more and more dependent on

captive power generation for running tea factories of the Barak Valley area, resulting in an uneconomical increase in cost of production. Since the last tea season, Barak Valley tea industry has been facing shortage of coal for stoppage of supply by the local vendors. "The survival of the Tea Industry of Barak Valley with its huge workforce depends on availability of Coal locally at a reasonable price. Tea Industry being the backbone of the economy of Barak Valley, urged upon the Govt of India to set up a Coal Depot at Barak Valley, so that in all-weather tea industry can procure Coal at a reasonable price." (72).

Yield per hectare is the lowest in Barak Valley compared to other parts of North India. Along with other factors, reasons of low land productivity are ageing tea bushes, high vacancies and poor bush frame, which can be overcome to the large extent by replanting, rejuvenation and infilling. The TAI has urged upon the Tea Board to provide funds for replanting, rejuvenation and infilling. The Tea Research Association (TRA) has been exhorted for development of suitable clone variety for this region.

India was occupied first position till 2005 in terms of world tea production, but China occupied first position in terms of production in the year 2006 forced India in second position (22-35). Since then India could recover its position in the world tea market. Growth of production of tea in India is less comparatively other tea producing country which is an alarming factor for Indian economy (22-35). The Asia Pacific region turns out to be a potential market as countries like India, Pakistan, and Bangladesh have a major population of people who prefer tea over other beverages. Tea has been traditionally and culturally linked with India, China and Japan since ages and with the upcoming developments in the organic sector, the tea market has a great potential to expand even further in the region. Matcha tea, kombucha, lemon tea, and green tea are gaining popularity among the fitness freaks as they are both refreshing and have multiple associated benefits.

Iran is the top importer of Indian tea at nearly \$11 billion in the fiscal year 2019. India exported tea worth 13.98 billion Indian rupees to Iran in the financial year 2020. Even though Iran imported the highest worth of Indian tea, Russia imported the highest volume of Indian tea that same year. **Russia is among the top buyers of Indian tea, accounting for about 18 per cent of the industry's total exports**, and the entire Commonwealth of Independent States (CIS) at close to a quarter.

India produces an average of 120 million kg of **orthodox tea** per annum and Sri Lanka an average 300 million kg per annum, predominantly orthodox. There has been a drop of above 15% tea production in Sri Lanka and it has to be seen whether Indian quantum is capable of filling in the gap of orthodox tea supplies in the global market. Tea exports from India to Iran jumped twofold in January this year to 2.7 million kg from 0.59 million kg during the corresponding month last year. Price realisation this year was also higher at ₹282.63 a kg against 271.34 a kg realised in January last year, according to tea board data. The fall in quality of tea may be detrimental for Sri Lanka in the Iranian market and that's where there is an opportunity for India to focus on increasing its market share in Iran, which down the line would increase India's total global market share. **"But other's loss is not our gain. Gains should come in competitive manner.** The Sri Lanka economic crisis may prove to be a boon for Indian tea exporters. Sri Lanka, which is a leading tea exporter, has been facing immense financial hardships since the inception of the Covid-19 pandemic. Sri Lanka produces around 300 million kg of tea annually and is predominantly an orthodox tea producer. The country exports around 97-98 per cent of its annual output. Both Indian and Sri Lankan orthodox teas are popular in Russia, and India's dependence on the CIS country for the export of the beverage is significant. "The demand for Indian orthodox tea could go up with the shortage of Sri Lankan variety. However, international buyers have allegiance to Sri

Lankan tea and their logo, despite the shortage of the crop,” Sri Lanka has seen a major dip in tea production and lost a chunk of Iranian market for orthodox tea. Around 20% of India’s total tea exports go to Iran and the present decline in Sri Lankan orthodox production may enable India to increase its market share of orthodox tea in Iran (72).

Difference between Black and Green tea

Both black and green tea are made from the leaves of the *Camellia sinensis* plant. The key difference between the two is that **black tea is oxidized and green tea is not** (1-25). To make black tea, the leaves are first rolled and then exposed to air to trigger the oxidation process (1-24). Tea manufacturers produce black tea using the leaves of the *Camellia sinensis* plant—the same tea plant they used to produce green tea (1-35). A majority of green tea is made from the *Camellia sinensis* variety from China and is grown in sunny and dry climates (1-25). Most green tea is made by picking the leaves and quickly processing them before oxidation occurs. Oxidation is the process where tea leaves are exposed to the air, which causes them to dry out and brown—this process changes the flavour of tea and makes it bolder and sometimes richer (1-27). Popular varieties of black tea include Darjeeling and Assam, which are both products of India, as well as Ceylon, which is a product of Sri Lanka (1-30). Several varieties of black tea leaves also grow in China. Some types of black tea, such as English breakfast tea or Irish breakfast tea, contain a mixture of different black tea leaves, while Earl Grey is typically an Assam or Darjeeling tea infused with bergamot oil (1-29). A cup of green tea contains less caffeine—twenty-five to thirty-three milligrams—than a cup of black tea as a result of the shorter processing time (1-27). Black tea contains about forty-seven to fifty milligrams of caffeine per cup (still less than the amount of caffeine you will find in a cup of coffee) (1-22). The longer the tea bag brews, the higher the caffeine content (1-30). Once tea manufacturers harvest the green tea leaves, they gently heat them—usually with steam—which helps to prevent higher levels of oxidation (1-24). This process maintains green tea’s green color. In black tea production, the leaves undergo a longer oxidation process, also called the tea’s fermentation process. This gives black tea leaves their dark brown or black color (1-26).

Since all teas derive from plants, they contain polyphenols—organic compounds that include flavonoids (such as catechins), tannins, and theaflavins (1-20). However, black tea and green tea contain different types and amounts of polyphenols. For example, green tea contains a high amount of Epigallo-catechin gallate (also called EGCG), the most abundant catechin found in tea, while black tea contains more theaflavins, which contribute a reddish color (1-30). Tea also contains L-theanine, an amino acid that gives green tea its brothy flavor (1-23). A shorter steaming process—in other words, a shorter oxidation process—preserves and even enhances green tea’s natural flavour profile and prevents the bitterness that is typical of black tea (1-25). In contrast, black tea undergoes a longer oxidation process, resulting in a much stronger taste than green tea (1-25). Other types of tea that tea drinkers could confuse for black tea or green tea include white tea, herbal tea, chai tea, and oolong tea, all of which are actually different categories of tea altogether (1-24).

There are also what is known as blends of black tea that may have heard of previously: earl grey tea, English breakfast tea, and masala chai (1-30). These types of teas are made with black tea but are mixed with other ingredients like bergamot oil, Ceylon, cardamom, and other ingredients to make blends (1-25). Green tea and black tea have an abundance of different varieties between them and each type of tea has different flavour profiles (1-27). Green tea can taste any between light and sweet (like jasmine) or earthy and

herby (like matcha or sencha) (1-25). Depending on the type of tea, black tea can taste strong and bold (like Ceylon) or malty and rich (like Assam) (1-25).

Both green tea and black tea have different health benefits based on various studies: various antioxidants, and anti-inflammatory characteristics (1-25). For instance, both types of tea are filled with anti-inflammatory and antihypertensive chemicals called flavonoids, but green tea has more flavonoids because the tea leaves are less oxidized before processing like black tea (2-30).

Caffeine content: When comparing caffeine content, green tea has 25-40 milligrams of caffeine and black tea has 40-60 milligrams of caffeine depending on the tea variety used (1-25).

Green tea processing

For green tea, the tea leaves are harvested from the *Camellia sinensis* plant and are then quickly heated—by pan firing or steaming—and dried to prevent too much oxidation from occurring that would turn the green leaves brown and alter their fresh-picked flavour (1-25). A brewed green tea is typically green, yellow or light brown in color, and its flavour profile can range from grass-like and toasted (pan fired) to vegetal, sweet and seaweed-like (steamed) (1-20). If brewed correctly, most green tea should be quite light in color and only mildly astringent. Green tea is passed through a steaming treatment before rolling (1-25). Steaming applies light heat to the leaves to help halt the oxidation process before the leaves are rolled into shape (1-25). Steaming also helps to expose the fresh, grassy flavour of the leaf. Green tea leaves are not allowed to oxidize after rolling, which is why they remain light color and flavour (1-25). All green tea originates from the same plant species, there are different types of green tea grown and produced all over the world today, including China, Japan, India, Sri Lanka, Taiwan, Bangladesh, New Zealand, Hawaii and even South Carolina (1-25). Green tea is generally known to have lower caffeine content per cup than black tea and much lower caffeine content than coffee (1-22). Green tea, however, is considered to have originated in China (1-22). It is said that even today the word “tea” in China refers only to green tea, not to the general category of tea as it does in the West (1-22). China’s **Yunnan province** is considered to be the original home of the *Camellia sinensis* plant species. In fact, 260 of the world’s 380+ varieties of tea can be found in Yunnan (1-25).

Phytochemistry and health benefits of Black tea

Black tea is not only a non-sweetened or less-calorie drink but also provides several health benefits as it contains powerful groups of polyphenols including Epigallo-catechin gallate (EGCG), theaflavins, thearubigins, an amino acid L-theanine, and several other catechins or flavonoids which provide protection against the onset of several chronic disorders (1-22, 23-25).

Tea plants biosynthesize various specialized metabolites related to the remarkable flavour and health functions (1-19, 21). The popularity of tea consumption can be attributed to its unique color, flavour, and health properties, which is a result of the presence of thousands of metabolites (1-18, 21). Among these metabolites, tea flavonoids are particularly specialized, exhibit hyper-accumulation, and account for 20-30% tea dry matter (1-21). Tea flavonoids with multiple roles in improving resistance to multiple stresses in fresh tea leaves, forming characteristic flavour and color, and most importantly, possessing many health benefits (1-21). Notably, considering the huge amount of tea consumed, it is an optimal source of dietary flavonoids that cannot be synthesized by the human body (1-21). Flavan-3-ols (mainly tea catechins) are the most abundant subclass of flavonoids in teas (21). The major constituents of catechins present in gallogated forms unique to tea plants include (-)-gallocatechin-3-

gallate (GCG), (-)-epicatechin-3-gallate (ECG), and (-)-epigallocatechin gallate (EGCG); while non-gallogated forms include (-)-epigallocatechin (EGC), (-)-epicatechin (EC), (-)-gallocatechin (GC), (-)-catechin (C) (1-21).

Many novel tea flavonoids have been identified, including novel A- and B-ring substituted flavan-3-ol derivatives, condensed and oxidized flavan-3-ol derivatives, and glycosylated and methylated flavonoids, and are found to be closely associated with the characteristic color, flavour, and health benefits of tea (1-21, 26). Flavoal-alkaloids exist widely in various teas, particularly 8-C N-ethyl-2-pyrrolidinone-substituted flavan-3-ols (21-26).

The important chemical constituents which influence the taste and flavour in tea are polyphenols, caffeine, sugars, organic acids, volatile flavour compounds and amino acids (1-3, 21, 26). Phenolic compounds of tea such as theaflavins and thearubigins, are very important from an intrinsic quality and are responsible for the colour, flavour and brightness of tea (1-3, 21). Caffeine is responsible for the briskness. Assam leaf black tea has higher polyphenolic content followed by silver cloud leaf black tea of Southern India (3, 21-36). Higher the polyphenol content higher the quality of tea (1-21). Higher the concentration of total polyphenols, stronger the 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity and reducing power assay (3-36). Of the chemical quality parameters, Assam leaf black tea has higher theaflavin content used for assessing the quality of black tea, irrespective of geographical area of production (3, 26-36). These results suggested that the tea growing environment largely influences the phenolic compound distribution in black tea. The contribution of caffeine to the infusion is the briskness in tea (3-36).

Black tea leaves are reported to contain thousands of bioactive constituents such as polyphenols, amino acids, volatile compounds, and alkaloids that exhibit a range of promising pharmacological properties (22, 26-36). Due to strong antioxidant property, black tea inhibits the development of various cancers by regulating oxidative damage of biomolecules, endogenous antioxidants, and pathways of mutagen and transcription of antioxidant gene pool (22, 26-36). Regular drinking of phytochemicals-rich black tea is linked to regulate several molecular targets, including COX-2, 5-LOX, AP-1, JNK, STAT, EGFR, AKT, Bcl2, NF- κ B, Bcl-xL, Caspases, p53, FOXO1, TNF α , PARP, and MAPK, which may be the basis of how dose of black tea prevents and cures cancer (22). In vitro and preclinical studies supported the anti-cancer activity of black tea; however, its effect in human trails is uncertain, although more clinical experiments are needed at molecular levels to understand its anti-cancer property (22).

The consumption of black tea has a range of health benefits as it contains lots of powerful antioxidants and other compounds which have potential to decrease inflammation and to reduce the risk for the onset of chronic conditions (1-23). Consumption of Black tea on a regular basis helps to reduce the chances of onset of cardiovascular disorders and onset of heart disorders (1-23). The inclusion of black tea in the diet reduced low-density lipoprotein cholesterol in hypercholesterolemic humans (1-23). Another study also showed that drinking black tea improves the cholesterol levels not only in adults with risk of heart disorders but also in obese. Besides these benefits, drinking black tea also plays a key role in reducing body weight (1-23). Further, polyphenols present in black tea inhibit obesity by suppressing the digestion and absorption of lipid and complex sugar (1-23). Study also noticed that the black tea polyphenols also increase lipolysis and decrease lipid accumulation by reducing the proliferation of fat cells (1-23). Long-term drinking of black tea results in the improvement of blood pressure either from lower or higher sides. Black tea health benefits are 1) Prevention of cancer disease. 2) Cardiovascular disease. 3) Anti-inflammatory. 4) Antiarthritic. 5) Antibacterial 6) Antiangiogenic

7) Antioxidative 8) Antiviral 9) Neuroprotective 10) Cholesterol-lowering effects (1-13-20 to 36).

Black tea is not significantly different from water in the maintenance of normal hydration in human subjects (1-23). One of the study concluded that black tea, in the amounts studied, offered similar hydrating properties to water (23). Tea and water offered similar hydrating properties at intakes of four to six servings/d, equating to 168 or 252 mg caffeine (1-23). Given that average intakes of tea in the UK are considerably lower than the levels tested in the present study, the risk of dehydration in response to regular tea consumption is minimal (23). Indeed, the present trial indicated that the hydrating properties of water and tea are similar (23). Beneficial health effects of black tea have been demonstrated in animal experiments and some human studies (36). The two most extensively investigated diseases are cancer and heart disease. **The potential health benefits of black tea consumption warrant further investigation (36).**

Warning: Caution is required, however, in the use of high concentrations of black tea for disease prevention. Ingestion of large amounts of black tea may cause nutritional and other problems because of the strong binding activities of black tea polyphenols and the caffeine content, although no solid data exist concerning harmful effects of black tea consumption (36).

Phytochemistry and health benefits of green tea

The first green tea was exported from India to Japan during the 17th century (13-20). Tea is one of the most popular beverages consumed worldwide (1-20). Tea from the plant *Camellia sinensis*, is consumed in different parts of the world as green, black, or Oolong tea (13-20). The health-promoting effects of green tea are mainly attributed to its polyphenol content particularly flavanols and flavonols, which represent 30% of fresh leaf dry weight (13-20). The beneficial effects of green tea were attributed to its most abundant catechin, (-)-epigallocatechin-3-gallate (EGCG) (1-13). The health benefits of green tea are 1) Prevention of cancer disease. 2) Cardiovascular disease. 3) Anti-inflammatory. 4) Antiarthritic. 5) Antibacterial 6) Antiangiogenic 7) Antioxidative 8) Antiviral 9) Neuroprotective 10) Cholesterol-lowering effects (13-20, 36).

Green tea extracts are more stable than pure epigallocatechin gallate, one of the major constituents of green tea, because of the presence of other antioxidant constituents in the extract (13-20, 36). Recent data from human studies indicate that the consumption of green tea and green tea extracts may help to reduce the body weight, mainly body fat, by increasing postprandial thermogenesis and fat oxidation (13-20). Tea catechins, especially EGCG, appear to have antiobesity and antidiabetic effects (13-20). Long-term consumption of tea catechins could be beneficial against high-fat diet-induced obesity and type II diabetes and could reduce the risk of coronary disease (13-20, 36). The health benefits of green tea for a wide variety of ailments, including different types of cancer, heart disease, and liver disease, were reported (1-20, 36). Many of these beneficial effects of green tea are related to its catechin, particularly (-)-epigallocatechin-3-gallate, content (13-20-36).

Green tea and black tea are processed differently during manufacturing (13-20, 26). To produce green tea, freshly harvested leaves are immediately steamed to prevent fermentation, yielding a dry, stable product (13-20, 26-36). This steaming process destroys the enzymes responsible for breaking down the color pigments in the leaves and allows the tea to maintain its green color during the subsequent rolling and drying processes (13-20). These processes preserve natural polyphenols with respect to the health-promoting properties (13-20, 36). As green tea is fermented to Oolong and then to black tea, polyphenol compounds (catechins) in green tea are

dimerized to form a variety of theaflavins, such that these teas may have different biological activities (13-20, 36).

Green tea contains polyphenols, which include flavanols, flavandiol, flavonoids, and phenolic acids; these compounds may account for up to 30% of the dry weight (13-20, 36). Most of the green tea polyphenols (GTPs) are flavonols, commonly known as catechins (1-20). Fresh leaves contain, on average, 3-4% of alkaloids known as methylxanthines, such as caffeine, theobromine, and theophylline (13-20, 26). In addition, there are phenolic acids such as gallic acids and characteristic amino acid such as theanine (13-20). Green tea contains polyphenols, which include flavanols, flavandiol, flavonoids, and phenolic acids; these compounds may account for up to 30% of the dry weight (13-20). The major flavonoids of green tea are various catechins, which are found in greater amounts in green tea than in black or Oolong tea (13-20, 36). There are four kinds of catechins mainly found in green tea: epicatechin, epigallocatechin, epicatechin-3-gallate, and catechin, (-)-epigallocatechin-3-gallate (EGCG) (13-20, 36).

The chemical composition of green tea is complex: proteins (15-20% dry weight), whose enzymes constitute an important fraction (13-20); amino acids (1-4% dry weight) such as theanine or 5-N-ethylglutamine, glutamic acid, tryptophan, glycine, serine, aspartic acid, tyrosine, valine, leucine, threonine, arginine, and lysine (13-20, 36); carbohydrates (5-7% dry weight) such as cellulose, pectins, glucose, fructose, and sucrose (13-20); minerals and trace elements (5% dry weight) such as calcium, magnesium, chromium, manganese, iron, copper, zinc, molybdenum, selenium, sodium, phosphorus, cobalt, strontium, nickel, potassium, fluorine, and aluminum (13-20, 36), and trace amounts of lipids (linoleic and α -linolenic acids), sterols (stigmasterol), vitamins (B, C, E), xanthic bases (caffeine, theophylline), pigments (chlorophyll, carotenoids), and volatile compounds (aldehydes, alcohols, esters, lactones, hydrocarbons) (1-10, 13-20, 36).

Harmful effects of green tea consumption

Harmful effects of tea overconsumption (black or green) are due to three main factors: (1) its caffeine content, (2) the presence of aluminum, and (3) the effects of tea polyphenols on iron bioavailability (13-20, 36). Green tea should not be taken by patients suffering from heart conditions or major cardiovascular problems (1-20, 36-55). Pregnant and breastfeeding women should drink no more than one or two cups per day, because caffeine can cause an increase in heart rhythm (13-20, 26-36, 55). It is also important to control the concomitant consumption of green tea and some drugs, due to caffeine's diuretic effects (13-20, 36-55). Some studies revealed the capacity of tea plants to accumulate high levels of aluminum (1-20, 36-55). This aspect is important for patients with renal failure because aluminum can be accumulated by the body, resulting in neurological diseases (1-20, 36-55). Therefore, it is necessary to control the intake of food with high amounts of this metal (13-20, 36-55). Likewise, green tea catechins may have an affinity for iron, and green tea infusions can cause a significant decrease of the iron bioavailability from the diet (13-20, 26, 36-55).

Although green tea has several beneficial effects on health, the effects of green tea and its constituents may be **beneficial up to a certain dose yet higher doses may cause some unknown adverse effects** (13-20, 26-36, 55). Moreover, the effects of green tea catechins may not be similar in all individuals (13-20, 36-55). Catechin, (-)-epigallocatechin-3-gallate (EGCG) of green tea extract is cytotoxic, and higher consumption of green tea can exert acute cytotoxicity in liver cells, a major metabolic organ in the body (13-20, 36). Another study found that higher intake of green tea might cause oxidative DNA damage of hamster pancreas and liver (1-13-20, 36-55). However, drinking even a very high dietary amount of green tea

would be unlikely to cause these adverse effects in humans (1-13-20, 26-55).

Effect of addition of milk to black and green tea

Tea consumption is practiced as a tradition and has shown potential to improve human health (1, 37-55). Although tea is consumed without any additional ingredients in many Asian countries, addition of milk to tea is a ubiquitous practice (1, 37-55). In India tea with milk is very common and very few percentage of people drink black tea without milk. Therefore, India is known for drinking milk with tea and also called as the English tea. The effect of addition of milk on tea polyphenolic activity depends upon the ratio of milk to tea, milk composition, tea type, temperature of brewing, and infusion method (1, 37-55). Maximal uptake of tea antioxidants and milk proteins without a negative impact on tea flavour is highly desired by consumers (1, 37-55). **There is a conflicting evidence for the effect of milk addition to tea on antioxidant activity** (1, 37-55). Differences in the type of tea, the composition, type and amount of milk, preparation method of tea-milk infusions, the assays used to measure antioxidant activity, and sampling size likely account for the different findings (1, 37-50). The addition of milk to tea can decrease or completely inhibit tea antioxidant properties (1, 37-55). 1) Milk caseins interact with polyphenolic catechins from tea. 2) **Skimmed milk has a more negative effect on tea health benefits than whole milk** (1, 37-50). 3) Proteins from soy and milk similarly affect the bioavailability of tea antioxidants (1, 37-55).

The addition of cow's milk increased the antioxidant activity of green and black tea preparations (1, 37-55). Generally, antioxidant activities of tea with milk infusion approximately 2.1 fold greater than black and green tea (1, 37-55). Both green and black tea infusions released high level of total phenols and antioxidants into the boiling water within 30 min compare to boiling water in duration of 10 min (1, 37-55). For acquires of the highest antioxidant activity and therefore, greatest health value, infusion with water at boiling point for up to 30 min in a flask was recommended (1, 37-55). Interactions between tea polyphenols and milk proteins, especially between catechins and caseins, could account for a decrease in antioxidant activity (1, 37-55). Based on the results of previously published studies with consideration of the variations among individuals, tea type, milk type, and methods of assessing antioxidant properties, the evidence appears to point toward a negative (masking) effect for adding milk, especially skimmed milk, to tea beverages because of the putative association between tea polyphenols (such as catechins) and milk proteins (specifically caseins) (1, 37-55). This effect may vary depending upon the concentration of milk proteins and tea phenolics (1, 37-55). Another important aspect is the purpose of consuming tea by different people. Some may drink tea for pleasure whereas others may do so for the health benefits of either caffeine or antioxidants (1, 37-55). Although the negative effects of the addition of milk on the activity of tea antioxidant have been broadly reported. However, there is lack of information about the effect of milk addition on the activity or bioavailability of caffeine in tea infusions (1, 37-55).

Growing demand for Indian Organic Flavored Tea

Organic tea products are becoming common among consumers due to their changing lifestyles and the growing notion is that organic products are healthier than conventional tea (60-69). Tea is a very popular beverage prepared by boiling leaves and buds obtained from the plant of *Camellia sinensis* (60-70). Cultivation of organic tea is done without the use of harmful fertilizers and pesticides which contain harmful chemicals. The harmful chemicals may enter food chain and can lead to severe health problems (60-70). Good quality **organic tea rich in melatonin** content, if consumed in

the right quantity can have major positive effects on the body. It helps with digestion, improves skin, helps in weight loss, and reduces risk of heart disease. In the developing countries, consumption of organic tea is on the rise owing to the increase in lifestyle related diseases (60-70). Today consumers are careful about the effects of their food and beverage tea consumption due to health consciousness and body detoxification. Tea contains phenols and polyphenols with antioxidant properties which detoxifies the body, protects the heart, reduces infections, and increases the immunity (60-70). Tea also helps to restore the balance of bacteria in the gut and improve gut function. The demand of organic tea is growing rapidly as the people are becoming more health conscious. Organic tea is helpful in slimming and also keeps the body hydrated (60-70). Due to these advantages, it is closely linked to the fitness, health and wellness industry and is among the foremost choices of people who want to tone their body, or lose weight. Theanine, found in tea, helps to soothe the mind and keep the person relaxed and calm (60-70). Therefore, the working population consumes a lot of flavoured tea, driving the growth of the organic tea market. This evidently leads to an increased consumption of organic tea to meet the needs. Along with its medical applications, the rich taste of organic tea has been favoured globally, creating a positive impact on the organic tea market (60-69). Tea is considered to be a refreshing drink which helps in reducing stress and is consumed worldwide. Organic tea is rich in antioxidants and flavonoids (60-70). Flavonoids are beneficial in reducing the risks of cardiovascular diseases and also help in lowering cholesterol. They are considered to have anti-cancer and anti-ageing properties which make them a healthier choice (60-69). However, lack of awareness amongst the population and higher prices in comparison to non-organic tea is expected to affect the organic tea market growth. However, due to advancements in the organic coffee market, the organic tea market is expected to witness some retardation in the regions where coffee is the most consumed beverage (60-70).

There are several types of organic tea available in the market. Some of these include white tea, oolong tea, green tea, and black tea. Based on the type, organic tea market is segmented into five major segments which include white organic tea, green organic tea, black organic tea, oolong organic tea, and others (60-70). Out of these, black organic tea segment is estimated to occupy a dominant market position. Also, due to the increasing awareness amongst people about the health advantages obtained from green tea, the organic green tea market is expected to grow in the given forecast period (60-70).

On the basis of form, organic tea market can be segmented into dried leaf, powder, liquid (organic iced tea) and others. The organic tea available in the dried leaf form is being increasingly consumed and the market is expected to grow at a higher rate. Due to easy storage and greater shelf life, carton packages of organic tea are more preferred over others (60-69).

The traditional organic teas are gaining popularity among the global population as they possess the benefits of natural ingredients with the least amount of preservatives, and promote the exchange of cultural ethics across the globe (60-69). Traditional organic tea brands increasingly look to diversify their functional offerings, promoting a holistic lifestyle that supports general wellbeing as well as more specific health benefits (60-69). Supercharged teas, fusing naturally functional ingredients with added nutrients take functional organic tea to an upgraded level. Lipton introduced a similar product in Germany, which is a flavoured green tea with added vitamin C and super foods like yellow turmeric, aromatic lemon verbena, and a touch of spicy ginger (60-70). Some of the common organic tea with additional herbal medicinal plants as flavouring agents available in the market are; Chamomile Herbal Tea, Triphala herbal tea Peppermint Herbal Tea, Ginger Herbal Tea, Lemongrass

Herbal Tea, Gymnema herbal tea, Costus herbal tea, Turmeric herbal tea, Tulsi herbal tea, *Glycyrrhiza glabra* (Licorice)- Mulathi herbal tea, Lemon tea, Cardamom herbal tea, Ashwagandha tea, Areca nut tea and Bitter melon herbal tea.

The global organic tea market size was USD 820.8 million in 2019 and it is projected to reach USD 1,918.7 million by 2027, exhibiting a CAGR of 11.2% during the forecast period. Based on product type, herbal organic tea is anticipated to account for over 50% of the market share over the forecast period (60-70). The organic tea market is segmented based on type, packaging, distribution channel, and region. Based on type, it is divided into black tea, oolong tea, green tea, and white tea. Based on the form, organic tea is differentiated into dried leaf, powder, and liquid organic tea. Based on packaging, it is categorized into pouches, cans, cartons, tea bags and others. Based on distribution channel, it is classified into online retail, supermarket/hypermarket, specialty stores, and convenience stores. The market is also diversified based on geography into North America, Europe, Asia Pacific, South America, and Middle East and Africa regions (60-70).

The organic tea market is fragmented but competition among the leading players is high because tea, as a beverage, already owns a significant global market share. The basic processing add-on and marketing techniques can make a brand the market leader. The introduction of an organic tag along with multiple flavours is the innovation platform for the players (60-70). The manufacturers are expanding their product portfolio by launching organic functional tea varieties to capture the market. Organic India, Hindustan Unilever, Tata Global Beverage, Shangri-la tea, and Celestial Seasonings, Inc. are among the market giants (60-70). Tata Tea and Hindustan Unilever are the key market players in the Indian Tea Industry with around 60% market share based on sales, consumption and popularity.

Moreover, the growing trend of consuming naturally derived and pesticide-free products will help organic tea sales soar across the world. Food safety has become a critical consideration for consumer's thus organic food which are cultivated naturally without the use of chemical fertilizers, such as organic tea leaf, are regarded safer than conventional tea leaf (60-70). This is also helping the organic tea market gaining attraction. Furthermore, the organic tea industry is predicted to expand as a result of the rising trend of organic and clean label nutritious beverages. The supply chain for the organic tea market was severely affected by COVID-19, resulting in a slowdown in sales. However, with the recovery of the economy and rising demand for functional beverages, the organic tea market is anticipated to grow significantly. Organic tea with additional flavoring agents sold in tea bags is expected to hold a market share of over 50% in the forecast period.

Detection of Melatonin in tea leaf

Melatonin is a light sensitive tryptophan-derived substituted indoleamine (N-acetyl-5-methoxytryptamine) detected in many plant species including tea leaves of *Camellia sinensis*. Melatonin, synthesized from L-tryptophan by enzymes, protects plants against difficult conditions (71). Melatonin is an indole-amine neurohormone (biogenic indoleamine) structurally related with tryptophan, serotonin, indole-3-acetic acid (IAA) (71).

A cup of **coffee** is estimated to contain even as much as 40 mg of melatonin and a cup of tea contains 26 mg of melatonin (71). Caffeine has both the stimulatory and inhibitory mechanisms affecting the levels of melatonin (71). The consumption of food sources and beverages of melatonin is associated with health benefits, significantly increasing serum concentrations and raising the antioxidant capacity in humans, being therefore considered a nutraceutical (71). The most popular drinks, which are tea, coffee,

beer and wine contain melatonin. Not only melatonin but also its isomers (tryptophan-ethylester) were determined in tea, coffee, wine and bread (71). A study reported that regular tea consumption remarkably decreases the prevalence of human prostate cancer (71). Scientists introduced that melatonin in wine besides the other secondary metabolites, had protective effect against heart injury (71). It is thought that melatonin can have positive effects on health via synergic effects with other compounds (71). For instance, eating strawberries, apples, cherry/juice, rice, pistachios, almonds, spinach, cabbage, onions, tomatoes, cucumber, linseed and sunflower seeds, thistle, fenugreek and mustard; drinking teas such as fennel and anise tea (71).

People have consumed these plants particularly consumption of tea for their antioxidant, immunomodulator, anti-inflammatory and anticancer effects (71). As an endogenous indoleamine, melatonin has huge physiological functions, including regulation of the sleep promotion, circadian rhythms, mood, immunomodulatory actions, neuroprotective effects, bone growth, hormonal regulation, tumor suppression, defense against oxidative stress, and anti-inflammatory activity (71). It may also be considered a therapeutic alternative to fighting bacterial, viral, and parasitic infections (71). Melatonin supplements have proven significant results for treating insomnia and other circadian rhythms caused sleep disorders, moreover, jet lag and shift work, headache, various cancers, gallbladder stones, tinnitus, rheumatoid arthritis, Alzheimer's disease, and psychiatric disorders have also tried to be eased with melatonin (71). Besides, it is known that melatonin is a powerful antioxidant and it improves the immune system. According to recent research, melatonin has also a great anti-aging effect (71). The use of melatonin beverages particularly tea may be extremely beneficial in helping to maximize the health-promoting effects of medicinal plants and healthy foods in humans, possibly acting in synergy with other bioactive phytochemicals (i.e., polyphenols) that are ingested daily (71).

Melatonin is a hormone that naturally produced by pineal gland in human brain especially at night-time. However, smoking, using alcohol, excessive coffee consumption, some medications and disorders can suppress the production of the melatonin (71). Therefore, melatonin should be taken externally such as synthetic melatonin supplements, or from natural resources which produce or contain melatonin (71). Furthermore, taking nutrients, which contain tryptophan, can increase the secretion of melatonin in the body. Therefore, consumption of tea at limited quantity per day is found to be beneficial for maintaining good health.

WORLD CLASS- INDIAN BRANDED TEA COMPANIES

Following list is the important Indian tea branded companies with popular commercial variants in the national and International market.

Tata tea: Popular variants in the market are 1) Tata Tea Gold. 2) Tata Tea Gold Leaf Tea. 3) Tata Tea Gold Black Tea. 4) Tata Tea Premium. 5) Tata Agni Leaf Tea. 6) Tetley Green Tea. 7) Tata Tea Teaveda (Natural Ingredients). 8) Tetley Green Tea. 9) Tata Tea Agni.

Brooke Bond Red Label Tea: A product of Hindustan Unilever Private limited, the Brooke Bond brand aims to make the world a more welcoming place with people getting together for a cup of hot tea. Since 1966, the **Brooke Bond Red Label** brand tea has been trendy among tea lovers across India and abroad. It is known for the perfect quality, taste and aroma. Some of the Brooke Bond Red Label tea variants available in the market are, 1) Taj Mahal Classic Tea. 2) Taj Mahal Gold. 3) Taj Mahal Masala. 4) Taj Mahal Ginger. 5) Taaza

Leaf Tea. 6) Taaza Gold. 7) Taaza Dust. 8) Brooke Bond 3 Roses Tea.

Organic India Tea: Organic India tea is one of the best tea brands, which has become popular among the health-conscious generation. The wellness brand was founded in 1997 in Lucknow (Uttar Pradesh state) and has introduced the world to Tulsi (holy basil), herbal tea and infusions. The herbal tea gives the perfect taste and aroma; it relieves stress and improves the immune system. Organic India herbal tea is available in both forms' tea bags and loose leaves. The popular variants of Organic India tea in the market are 1) Organic India Tulsi Ginger Turmeric Tea. 2) Organic India Tulsi Sleep. 3) Organic India Tulsi Green Tea Classic. 4) Organic India Tulsi Masala Chai. 5) Organic India Tulsi Sweet Lemon Tea. 6) Organic India Green Tea Classic. 7) Organic India Green Tea Jasmine.

Lipton Tea: The list of the best tea brands in India will not be complete without mentioning Lipton Tea. However, it is a British brand primarily famous for green and black tea. Lipton is undoubtedly a household name associated with Tea in India. The calorie-free ready-to-drink tea is the perfect choice for health-conscious tea lovers. The tea brand also produces various types of fruit teas. The popular tea variants of Lipton tea in the market are 1) Lipton Yellow Label Tea. 2) Lipton Darjeeling Long Leaf Tea. 3) Lipton Green Tea. 4) Lipton Green Tea Tulsi Natura. 5) Lipton Green Tea Classic. 6) Lipton Indian Chai.

Wagh Bakri Tea: Wagh Bakri is the third-largest producer of tea in India and was created in 1915 inspired by Mahatma Gandhi. This branded tea wanted to create equality in society and they did this through their logo. A Wagh (tiger) and Bakri (lamb) symbolised the higher and lower class and are shown drinking from the same cup. This unity is exemplified in the different varieties, including 'Organic Darjeeling Tea', 'Masala Tea', 'Ginger Tea' and 'Lemon Tea'. They also have leaf and dust teas and even lemon ice tea is available. Among the best tea brands in India, Wagh Bakri is a product by Gujarat Tea Processors and Packers Limited (GTPPL). The company headquarters is in Ahmedabad, Gujarat state, India and is also known as the National Tea brand of India. It is one of the oldest tea brands, with production since 1892. Wagh Bakri Tea processes the best quality of tea from Assam's tea gardens and is known for its strong taste and aroma. Its products are also sold in US, Canada, Middle East, Europe, Australia, New Zealand, Fiji, Malaysia, and Singapore. Exports contributed 5% of total sales by the company as in March 2021. The popular Wagh Bakri tea variants in the market are 1) Wagh Bakri Premium Leaf Tea. 2) Wagh Bakri CTC Tea. 3) Wagh Bakri Green Tea. 4) Wagh Bakri Tea Bags Pure Darjeeling Tea. 5) Wagh Bakri Flavoured Tea Bags. 6) Wagh Bakri Instant Mix Tea. 7) Wagh Bakri Organic Tea. 8) Wagh Bakri Ice Tea.

The Hillcart Tales Tea: This is a gourmet range of teas created by a family with over five generations in the tea-making industry. Originating in Hillcart Road, Darjeeling, they pride themselves on their rare blends. Their exotic variations include 'Apple Strudel', 'Blood Orange' and 'Caramel Dream'. Koffie-Cha Lush provides a coffee-tea infusion of green coffee beans and blackberry leaves. Chado Tea India is translated as 'the way of tea' and their range has more than 300 varieties of loose leaf tea.

Tea Trunk: This tea brand was founded by tea sommelier Snigdha Manchanda in 2013. All teas are crafted with natural ingredients and the most popular varieties include 'Marigold Green Tea' and 'Lavender White Tea'. With no artificial colours or additives, Tea Trunk is heavily invested in celebrating just pure tea. Some iconic flavours within their teas range from marigold flower petals to saffron to lemongrass. In addition, each tea flavour comes with different health benefits and beautiful elephant-decorated packaging.

Anandini Himalaya Tea: This branded tea was created in 2013 by Anamika Singh, who comes from a second-generation tea-making family. Blends are sourced from the family's Manjhee Valley Tea Estate, India. They branded herbal teas and muslin tea bags, there is a range of 'Feel Better' teas available. Their 'Emerald Spiced' tea blends cloves, cardamoms, ginger and cinnamon to enhance immunity and soothes the mind. It also has a splash of orange marigold flowers. Their range includes white and black teas, herbal, oolong and green teas. Their 'Green Lemonade Tea' has lots of zesty, lemon flavour and is a good source of vitamins and antioxidants. They also boast a herbal section that focuses on zero caffeine, offering a beverage to boost overall wellness.

Goodwyn Tea: is one of the largest producers of tea in India and features more than 50 unique blends. The tea is sourced from their 6000+ acre tea estate in Assam, India, which is over a century old. Their '**Ayurvedic Kadha Tea**' contains seven herbs that will help to prevent coughs and colds and curb diseases. Meanwhile, their '**Kashmiri Kahwa Green Tea**' will help to relieve stress and provide headache relief. Packaged in hygienic conditions, Goodwyn Tea produces an abundance of teas that preserve the high level of natural antioxidants found in each flavour.

Satori Tea is a luxury tea brand that aims to promote Indian produce, sourcing from family-run tea estates across the country. The company focuses on comfort within the cup of tea, paying homage to the traditional Indian ritual of having tea with guests and family. One example is the '**Lavender Dream Tea**,' which exploits the silky texture of white tea buds that produces an intense, delicate and luxurious beverage.

Sancha Tea brand was created in 1981 by **Sanjay Kapur** who opened India's first gourmet tea store in Old Delhi. They have over 75 varieties of teas, with very famous flavours of two different mint leaves, the drink rejuvenates the body, helping with fatigue and stress. Black and white teas, they also offer caffeine-free herbal teas. Their 'Sleeping Beauty Herbal Tea' blends vanilla with calming flowers and is perfect as a bedtime beverage. It contains lavender to reduce stress, whilst the vanilla relaxes the muscles.

Tea Treasure: is a relatively new organic brand tea that is trying to change the supply of tea. Varieties include the 'CTC Assam Indian Chai,' which is the perfect brew for early mornings. Also, the 'Slim Life' tea contains vital minerals and vitamins for the body. A joy for those with an active lifestyle, this blend will increase metabolism, whilst maintaining energy levels for a productive day with exclusive flavours successfully tie the elements of taste, nutrition and quality.

The Dharmsala Tea: Company was founded in 1882, originated in the Himalayas. They have a wide range of Ayurvedic teas, with different benefits. Dharmsala Tea Company also has caffeine-free teas and many varieties of blends including floral and fruit. They even have a range of dessert teas with a 'Cinnamon Chocolate Blend' and a 'Himalayan Hot Chocolate Blend'.

JugMug Thela: is a new brand tea from New Delhi, India and is all about healthy drinks with no artificial flavours or chemicals. **JugMug Thela tea brand** carry a range of masala chais as well as a selection of fine teas. Their distinct 'Kinnow & Rose Earl Grey' tea is prepared out of Kinnow oranges and rose petals for a refreshing and citrusy taste.

Marvel Yellow tea and Marvel Red tea: Marvel Tea was created in 1994 with well functional infrastructural unit that is situated at **Gurgaon (Haryana, India)**. This branded tea comes in many varieties including 'Marvel Yellow Tea' which is good for providing energy. In addition, their 'Marvel Red Tea' contains antioxidants that prevent illness and also reduces inflammation. Marvel tea company is

engaged in **manufacturing and exporting** a wide assortment of **Gold Pattian Tea, Green Tea, Elaichi Tea**, etc.

Tulsi Tea has been around since 1981 and is available in nine different varieties. These include 'Tulvita Green' and 'Tulvita Lemon', which are both full of antioxidants and provide a healthy start to the day. Tulsi Tea is especially famous in Gujarat, and Rajasthan, India.

Amaara Herbs Tea was created in 2018 and they focus on herbal teas by infusing natural herbs in tea with a range of interesting varieties such as the 'She-B Well Tea'. This wellness tea is created specifically for women to promote a healthy menstrual cycle and boost immunity. They also have a range of herb lattes including one with a chamomile flower herb mixture containing ashwagandha, coconut milk and nutmeg which fortifies physical and mental health.

N0-3 Clive Road-Jaipur blend tea: **Radhika Chopra** founded No. 3 Clive Road-Jaipur blend tea in early 2015 in her family home (No. 3 Clive Road) in New Delhi. Besides black tea, it contains dark chocolate, dried orange and rose petals for antioxidants and hydration. The quintessential comfort tea, Madurai Masala Blend is a twist on the classic masala chai and an all-time bestseller. Infused with a variety of spices and adorned with marigolds, find comfort in a staple this winter season. The brand specialises in hand blended teas and bespoke locally produced accessories, and celebrates the elegance of an old-world, bygone era.

The Good Life Tea company: The Good Life Tea Company was started in 2016 and prides itself on exotic, artisanal tea. By sourcing the best teas in the world and mixing them with a range of flavours, they have created what they call a high-quality brew.

Pataka tea: Pataka Tea was launched as part of the Pataka Group in 2000. The Pataka tea brand started with simple leaf and dust varieties and in 2006 brought out 'Pataka Mukta'.

Areca Tea: **Nivedan Nempu**, is the founder and owner of Areca Tea, Mandagadde, Shivamogga district, **Karnataka**, India. Considered as the best remedy for diabetes, the product has also played a large role in the lives of areca nut farmers of Karnataka.

Limtex is an Indian multinational tea branded company, headquartered in Kolkata, West Bengal, India. Limtex is the leading producer, manufacturer and exporter of Indian Tea both in the domestic and international market.

Teabox is an Indian tea brand that sells tea and tea-based products sourced from Darjeeling, Assam, Nilgiris, and Nepal. Teabox founded in 2012 has its offices in Siliguri, West Bengal, and Bangalore.

Madhu Jayanti International Limited manufactures and exports Tea. It operates seven brands across the world and is also a manufacturer for multiple private label tea brands. Its private labels, as well their own brands, are distributed in Africa, Russia, Europe and in the UK. It has unique tea brands, TE-A-ME Teas, Lalpan, Saraswati, Gold Bond, Indus, Old England, Golden Victoria (Flavour tea, Herbal tea, Tea bags, Bulk tea, Specialty tea, Packet Tea).

Society Tea: is an Indian tea brand, headquartered in Mumbai, Maharashtra, India, founded in 1933. Society Tea is a retail tea brand of Hashmukh Rai & Co tea blenders which is the parent company, also based in Mumbai.

Damodar-Shivram Tea Company: is a leading tea manufacturer with a glorious heritage of over 75 years in Devrukh, Ratnagiri, Maharashtra. Under the brand name of **Damodar Shivram**, they introduced their brands **Lal Chatri** and **HP** in the market. The other variants in the market are HP Masala chai, HP Elaichi chai, HP Green tea, Tea Pot CTC Leaf tea, HP family mixture tea, The Pot

Kadak Dust tea, The Pot popular, The Pot CTC Leaf Tea, The Pot Gold CTC Leaf Tea, HP CTC Dust Tea and HP Gold.

CONCLUSION

India is a key player in the production of best quality tea. Tea (*Camellia sinensis*) is a plantation crop has been considered as a strong nutraceuticals, non-alcoholic and widely consumed beverage after water. Tea production from *Camellia sinensis* is a multibillion-dollar industry. The consumption of teas goes beyond a pleasant and cultural activity. Teas are major sources of bioactive compounds that may bring health benefits, mainly because of their Laxative, hypoglycemic, antioxidant, anti-inflammatory, neuroprotective, anticarcinogenic, anti-obesity, cardiovascular and liver protection properties. Processing and gastrointestinal digestion of *Camellia sinensis* teas influences their chemical composition and upcoming biological properties. Flavan-3-ols, such as catechins and epicatechins, the main phenolic compounds in teas, are highly unstable to processing conditions and gastrointestinal digestion. Tea is an aromatic beverage prepared by infusing dried and crushed leaves of the *Camellia sinensis* plant in boiling water. Some of the commonly available variants include white, black, herbal, green and oolong tea, which are primarily cultivated in the hilly regions of Assam, West Bengal, Tamil Nadu, Karnataka, Kerala, Tripura, Arunachal Pradesh and other states. Tea is a rich source of polyphenols, caffeine, antioxidants and minerals, such as potassium, manganese, magnesium and calcium. Regular consumption of tea can aid in minimizing the damage caused by free radicals in the body, reduce cholesterol levels in the blood and facilitate healthy weight management. It is also important to control the concomitant consumption of green tea, black tea and some drugs, due to caffeine's diuretic effects. Although green tea and black tea has several beneficial effects on health, the effects of green and black tea and its constituents may be beneficial up to a certain dose yet **higher doses may cause some unknown adverse effects.**

Indian tea industry produces about 1.2 million tons from about 5.64 million hectares of land accounted for 22.7 per cent of global tea production. On an average 18% of the total production is exported and balance 82% is consumed within the country. Indian tea industry provides direct employment to 4.5 million people of which 50% are women. Additionally, more than six million people derive their livelihood from ancillary activities associated with the tea industry. As tea is predominantly an Asian crop, India is a leading global tea producer/exporter has the responsibility to deal with different tea-research issues and further showed the way to the researchers. Unfortunately, the following bottlenecks are sometimes hindering the pace of scientific progress in Indian tea. Indian tea research institutes are facing unprecedented financial crises due to curtail of funds and further exorbitant delay in releasing approved fund. The tea sector despite the numerous challenges that it faces, the resources expended on R&D is only around one third of that at the national level. This reflects the need to increase R&D investment which would in turn help in realising the research outcomes. It is obvious, absence of a steady and assured funding for research would have undermined the ability of the tea.

Cultivation of **organic tea** is done without the use of harmful fertilizers and pesticides which contain harmful chemicals is a new ray of hope for the Indian tea industry. The organic tea market is fragmented but competition among the leading players is high because tea, as a beverage, already owns a significant global market share. The introduction of an organic tag along with multiple flavours is the innovation platform for the Indian tea industry players. In the developing countries, consumption of organic tea rich in **melatonin** is on the rise owing to the increase in lifestyle related diseases.

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