

# DIVERSIFYING TEA: A COMPREHENSIVE REVIEW OF TEA AND ITS DERIVED PRODUCTS

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**Abstract**– Tea, the world’s second most consumed beverage after water, is celebrated for its affordability and numerous health benefits, thanks to antioxidants and essential minerals like potassium, magnesium, calcium, and manganese. Green, Oolong, and black teas are the primary categories, each reflecting distinct processing methods. The high polyphenol content, especially flavonoids, makes tea a powerhouse of antioxidants and free-radical fighters. The global demand for tea is on the rise, making it a vital contributor to tea-producing economies like China, India, Sri Lanka, Bangladesh, and Kenya. However, low market prices and high production costs have led these countries to explore value addition as a strategy to enhance profitability. This review examines the factors driving the development of diverse tea products and their association with health benefits. It also explores the emergence of nutraceutical beverages, confectionery items, toiletries, and cosmeceuticals made from tea, gaining popularity worldwide. Lastly, it addresses the challenges faced by the tea industry in global marketing efforts.

## INTRODUCTION

Tea, derived from the *Camellia sinensis* plant, is a globally cherished beverage known for its diverse flavours and aromas, all while remaining an accessible choice. The cultivation of ideal tea plants requires specific environmental conditions. Tea transcends its role as a cash crop to become a globally traded commodity. Different countries produce diverse tea types to cater to their populations’ varied tastes and cultural preferences. Typically, tea is categorized into three primary types based on processing: green tea (unfermented), Oolong tea (partially fermented), and black tea (fully fermented). As a major plantation crop, tea meets the demand for an affordable and healthful beverage, with global production exceeding 13.4 million tons in 2021-22. The International Tea Committee (ITC) reported that worldwide tea production included 2078 million kg of CTC tea and 1358 million kg of orthodox tea in 2020. The majority of tea production, approximately 85.7%, is concentrated in Asian tea-producing countries, while African producers contribute 12.7%, with other regions making up 1.6%. The global demand for tea has surged, with production reaching 6269

metric tons, retention at 4444 metric tons, imports at 1735 metric tons, and global consumption at 5879 metric tons in 2020, according to the ITC.

The diversification of tea products holds immense potential for the future, with researchers tapping into the diverse chemical constituents of tea to create tailored offerings for various consumer groups. Innovations encompass tea tablets, tea cola, tea toffee, and confectionery products like tea biscuits and tea cakes. Notably, traditional orthodox teas retain their appeal among premium tea connoisseurs due to their distinctive liquor and flavour characteristics. Meanwhile, CTC (crush, tear, curl) tea has gained popularity in regions such as India, Bangladesh, and Sri Lanka for its cost-efficiency in yielding more cups per unit.

Tea possesses a rich composition of soluble substances, including catechins, caffeine, theanine, chlorophyll, organic acids, and vitamins. The exploration of tea-based nutraceuticals, functional beverages, and tea-infused health, beauty, and body-care products initially originated in research laboratories in Japan and China. Today, tea-growing nations worldwide are increasingly embracing the industrial applications of tea. This review offers insights into the foundational aspects of tea and the

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diversified tea products developed across different regions, showcasing the versatile nature of this beloved global beverage.

### Basic Classification of Tea

Tea classification aims to categorize teas with similar traits for educational and evaluative purposes. Methods include colour, infusion hue, oxidation level, and fermentation degree. Globally, there are six primary tea types (Reeves *et al.*, 1987; Karori *et al.*, 2007; Gebely, 2016).

### Green Tea

Green tea is widely consumed globally, supported by research highlighting its safety and health benefits (Hossain *et al.*, 2017). It is rich in catechins, known for their antioxidants and sensory qualities (Kupeli *et al.*, 2007). Unlike fully fermented black tea, green tea undergoes minimal fermentation, preserving its natural polyphenols. Japan excels in producing steamed green teas like sencha, kabusecha, gyokuro, and matcha, with Shizuoka and Kagoshima Prefectures as leading producers (Chen *et al.*, 2012).

### Black Tea

Black tea, often known as fully oxidized tea, undergoes a series of critical processes: withering, rolling, oxidation, and drying. During this transformation, tea polyphenols oxidize, forming theaflavins and thearubigins, lending the tea its distinctive dark red colour, both in dry leaves and the brewed liquor. This hallmark characterizes black tea. After harvest, tea leaves are processed into two main types: Orthodox, composed of whole leaves, and CTC (Crushing Tearing Curling), a favoured choice in Bangladesh, India, Nepal, and Pakistan. Orthodox black tea is popular in Sri Lanka, China, Japan, Vietnam, and various other regions.

### Oolong Tea

Oolong tea, with its unique partial fermentation process, sits between fully-fermented black tea and unfermented green tea. It is highly popular in China and Japan, not only for consumption but also for the creation of various tea products. Oolong tea production involves distinctive steps, including withering and gentle rolling, leading to partial oxidation, giving it a distinct flavour profile. Taiwan, located just off the eastern coast of Fujian province, is renowned for its Oolong tea, representing about 90% of its tea production (Luo, 2012).

Among the three tea types, black tea enjoys the highest popularity, commanding a substantial 78% share of the global market, favoured in the United States, England, and Western nations. Green tea follows closely behind, constituting 20% of consumption, primarily preferred in Asian and Northern African countries. Oolong tea makes up the remaining 2% of tea consumption, primarily found in regions such as Taiwan, southern China, and various Eastern countries (Bode and Dong, 2003; Yang *et al.*, 2000).

### White Tea

White tea, derived from the young shoots of the *Camellia sinensis* plant, is highly regarded for its non-oxidized or non-fermented nature. To preserve its quality, white tea is shielded from direct sunlight to protect its polyphenols. It is crafted exclusively from youthful leaves and buds, harvested before they fully unfurl, and subjected primarily to air drying (Venditti *et al.*, 2010). This minimal processing imparts unique and highly sought-after aroma and flavour characteristics (Müller *et al.*, 2010; Rusak *et al.*, 2008). Originating from China's Fujian province, notably Fuding and Zhenghe counties, popular white teas include Bai Mu Dan, Gong Mei, Shou Mei, and Yue Guang Bai. Darjeeling, India, and Sri Lanka also produce noteworthy white teas (Gebely, 2016). In Bangladesh, a blend of 80% BT2 and 20% BT4 has been identified for the highest quality white tea (Hossain *et al.*, 2018).

### Yellow Tea

Yellow tea, known as huángchá in Chinese, hails from China and is a lightly fermented tea variety. Gaining popularity for its delightful mellow flavour and well-documented health benefits, including antioxidative, anti-inflammatory, and potential anti-cancer properties (Jingyi *et al.*, 2018), yellow tea's production involves light fermentation with steps like fixing, rolling, yellowing, and drying, akin to green tea (Yuming *et al.*, 2021). It's distinguished by its high theanine, glutamic acid, aspartic acid, and flavonoid levels, with studies showing it has the highest flavonoid content among green, yellow, and white teas (Zhang *et al.*, 2019). Rich in phenolic and amino acids, soluble sugars, vitamins, and nutrients (Jiao *et al.*, 2016; Hor•iæ *et al.*, 2012).

### Dark Tea

Dark tea distinguishes itself with solid-state fermentation by microorganisms, altering tea leaf

phytochemical composition through reactions like degradation, oxidation, condensation, methylation, and glycosylation (Li *et al.*, 2018; Zhu *et al.*, 2020). Traditionally, dark tea has been used for its therapeutic properties, especially for gastrointestinal dysmotility issues like dyspepsia, bloating, and constipation (Zheng *et al.*, 2015; Zhang *et al.*, 2013).

### Other Different types of Tea

#### Loose Tea

Loose tea, unlike tea bags, is not pre-packaged. It preserves flavour, aroma, and health benefits better. Typically stored openly in containers like canisters, it's globally accessible and offers superior flavour and quality. Loose leaf tea is also environmentally friendly, as it's easily compostable, eliminating the need for tea bags (Gebely, 2016).

#### Tea Bag

A tea bag, often called a teabag, is a small, sealed pouch containing tea or herb leaves used for steeping in water to flavour it. Made of filter paper or food-grade plastic, they function like tea infusers and can be reused until they lose flavour. Some have attached strings and labels. Tea bags originated in the early 1900s when Thomas Sullivan, a New York tea and coffee importer, distributed silk tea bags, popularizing this convenient brewing method (Dubrin, 2012).

#### Handmade Tea

Handmade tea, as described by Baruah (2015), is meticulously crafted in smaller quantities at the garden level, intended for exclusive marketing, in contrast to mass-produced tea processed in large factories using automated machinery.

### Tea Diversification

Tea consumption is increasing due to health benefits. A rising demand for premium teas with specific advantages and flavours exists globally, reflecting diverse consumer preferences (Hicks, 2009; Kumar and Bhavan, 2016).

This diversification trend aims to achieve various objectives, as outlined below:

#### Objectives of diversification of tea

- Transforming tea into a versatile range of products beyond just beverage consumption.
- Capturing a larger share of the tea market and propelling it forward.
- Enhancing competition within the global tea market.
- Promoting innovative approaches to tea production and productivity.

#### Tea Food

Tea is a versatile ingredient, available in various forms like fresh leaves, dried tea, extracts, and powdered versions blended with edible components or flavour enhancers. Tea-based culinary creations fall into three categories:

1. **Tea Snacks/Confectionery:** This group includes treats like bread, cakes, pastries, tea cookies, and puddings, along with tea-infused preserved fruits, sugars, and cooling treats.
2. **Tea Staple Food:** These dishes feature tea leaves or extract as key ingredients, such as green tea noodles, rice, and tea-infused dumplings.
3. **Tea Beverages:** This category spans various tea types, artisanal teas, and value-added tea products.

#### Tea snack and Confectionery

Flour-based confectionery products, a consumer

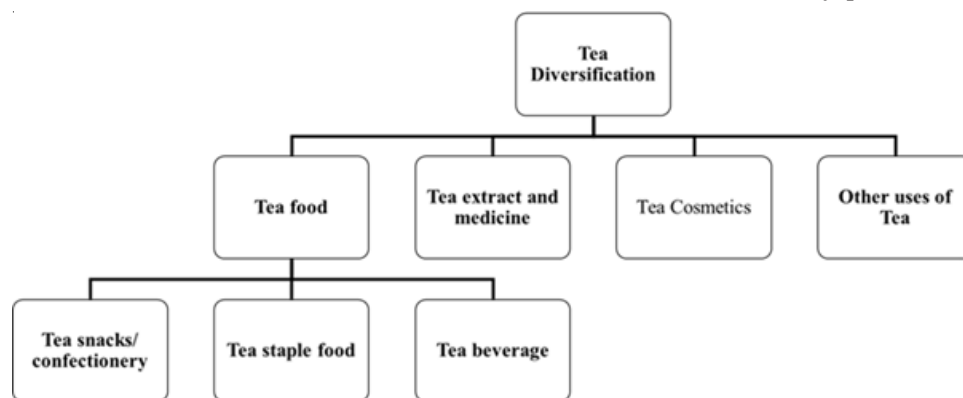


Fig. 1. Tea Diversification in Worldwide (Anonymous, 2022)

favourite, benefit from the addition of tea extract or powder, introducing plant-based micronutrients and enhancing digestibility (Nilova *et al.*, 2017). Incorporating green tea infusion in bread retards staling (Edygova, 2018), while green tea-infused biscuits offer substantial medical and physiological advantages (Phongnarisorn *et al.*, 2018). Green tea powder flavoring ice cream boosts its nutritional value (Swarnathilake and Don, 2020). Furthermore, green tea sponge cake is renowned for its potent antioxidant properties (Lu *et al.*, 2010).

### Tea staple food

Tea leaves or tea extract serve as key ingredients in various dishes, including green tea noodles (Xu *et al.*, 2019), green tea rice, and tea dumplings. Green tea rice, known as ochazuke, is a comforting Japanese dish where steamed rice is immersed in savoury green tea. It's a healthy and straightforward dish that pairs well with various main courses, offering a refreshing and satisfying option, especially on warm summer days (Anonymous, 2022). Another delightful choice is "cha soba," thin Japanese soba noodles infused with green tea, adding a unique flavour twist (Anonymous, 2022; Li *et al.*, 2012).

### Tea Beverage

Tea extract, concentrate tea powder, and various ingredients are combined to create a wide range of tea beverages, including tea variants, colas, fruit, floral, and herbal teas.

### Canned Tea

Canned tea is a recent departure from the traditional loose leaf or tea bag forms. It offers ready-to-drink convenience, with the first product, unsweetened oolong, introduced by Ito En in 1981. This innovation has since led to a wide array of canned tea options, emphasizing convenience and the potential for additives.

### Instant Tea

Instant tea, in powder form, allows for easy preparation by simply adding water. Its origins trace back to the UK in 1885 when a patent was granted for concentrated tea extract paste. In 2020, India, Sri Lanka, and Kenya collectively produced significant quantities of instant tea, with a substantial export volume.

### Carbonated Tea

Carbonated tea has a limited presence in

international markets. In Sri Lanka, prospects for bottled carbonated tea appear challenging due to the significant costs associated with bottling, transport, and distribution, which constitute a substantial portion of the final beverage price (Devanathan, 1974).

### Tea Wine

Tea wine is a creation of IHBT, made using a conventional process involving yeast (*Saccharomyces cerevisiae*) and secondary grade black tea dust fortified with sugar. It matures over a year and contains 12-15% alcohol content. Two types of tea wines, 'pure tea wine' and 'Palam Belle,' a mild and sweet fruit tea wine, have been developed (CSIR-IHBT, 2014).

### Decaffeinated Tea

Caffeine is naturally found in all *Camellia sinensis* teas, even in decaffeinated versions, albeit in trace amounts. The decaffeination process typically involves solvents like Methylene Chloride, which was banned in the US due to health concerns. Ethyl Acetate and Supercritical Carbon Dioxide are now commonly used solvents for decaffeination (Chin *et al.*, 2008).

### Flavoured and Scented Teas

Tea blends often incorporate flavours through flowers, herbs, spices, or perfumes. Companies like Marriage Frères and Kusmi Tea are known for perfumed teas. Jasmine is used to scent white and green teas, while bergamot oil enhances the aroma of Earl Grey tea (Rubin and Gold, 2002).

### Tea Extracts for Medicinal Use

Chemically brewed tea comprises a range of components, including protein, fatty materials, carbohydrates, pectins, crude fibers, minerals, caffeine, polyphenols, and total water-extractable solids. These components are often extracted for pharmaceutical and other applications. Many countries, including China, Japan, and the USA, utilize these extracts for medicinal and dietary supplements (Amarakoon and Grimble, 2017).

### l-theanine

l-theanine, accounting for approximately 1-2% of the total leaf weight, is the primary bioavailable form found in tea. It constitutes roughly half of the total free amino acids present in tea and has relaxing effects on both humans and animals. Structurally, l-

theanine is an amino acid that resembles glutamate and can bind to glutamate receptors (Dramard *et al.*, 2018).

### **Catechin Extracts and Capsules**

Catechin extracts and capsules are in high demand globally for their health benefits, including illness prevention and overall health maintenance. Various products, such as tablets like Catechin 100, Catechin 50, Catechin 100 Plus Oligo, and Catechin ACE, offer different health advantages (Hara, 2001).

### **Tea Polyphenols**

Green tea leaves contain a variety of polyphenols, with the most significant ones being flavanols (catechins), flavanols, and flavanol glycosides. Tea catechins are colourless, water-soluble compounds that contribute to the bitter and astringent characteristics of green tea. Large quantities of green tea polyphenols from Japan and China are exported to Europe and North America (Bharadwaz and Bhattacharjee, 2012).

### **Matcha Powder**

Matcha is a finely ground green tea powder produced from shade-grown tea leaves. The leaves are processed with stems and veins removed, resulting in a vibrant green powder that's traditionally consumed in East Asia. Matcha is mixed with liquid, often water or milk, setting it apart from regular tea leaves or bags (Horie, 2017).

### **Tea in Cosmetics**

Tea-based cosmetic ingredients are often used for their antioxidant and skin-conditioning properties. Various components, including tea flower extract, tea seed oil, leaf powder, and water, are incorporated into cosmetics such as soaps, creams, serums, oils, and lotions (Koch *et al.*, 2019).

### **Tea in Sunscreen Cosmetics**

Tea leaf extract is utilized in sunscreens due to its ability to absorb UV radiation and provide protection against its harmful effects. The polyphenols in tea, such as EGCG, offer antioxidant benefits, countering free radicals generated by UV radiation. EGCG has various skin benefits, including collagen protection and anti-inflammatory properties (Mishra *et al.*, 2011; Yarnell and Abascal, 2012).

### **Tea in Hair Treatment Cosmetics**

Cosmetics containing tea extracts are recommended

for individuals dealing with androgenetic alopecia and hair loss. Tea polyphenols, essential oils, and caffeine inhibit 5 $\alpha$ -reductase activity, reducing DHT formation, and stimulate hair roots while prolonging the hair growth phase. These ingredients are especially beneficial for those with oily hair and dandruff (Biernikiewicz, 2010; Lamer-Zarawska *et al.*, 2012; Majewska *et al.*, 2010).

### **Other Uses of Tea**

#### **Tea Furniture and Showpieces**

Tea root-based furniture and showpieces, such as tables and decorative items, have gained popularity worldwide. This practice has become a significant cultural phenomenon in tea-producing countries like China, Japan, India and Bangladesh. Tea museums across the globe often showcase ancient tea plants, stems, tea root/shoot furniture, and decorative pieces.

#### **Tea Residues**

Tea oil residues have proven effective in controlling various pests, including rice blast, sheath and culm blight of rice, wheat rust, rice hoppers, cutworms, cotton aphids, certain scale insects, long-horned beetles, and leeches (Shanan and Ying, 1982). Extracts from the seed cake left after processing tea are known to deter larval development in insects (Duke and Ayensu, 1985).

#### **Possibilities of Diversification of Tea Product in India for Future Contribution in World Tea Market**

India, one of the world's leading tea producers, possesses immense potential to diversify its tea product offerings and make a significant impact on the global tea market. With its diverse climatic regions and rich biodiversity, India can cultivate a wide range of tea varieties, each with its own distinctive flavours and characteristics. To leverage this potential, India can explore the production of specialty teas like white teas, yellow teas, and artisanal oolongs, which are increasingly favoured by tea enthusiasts worldwide. Infusing traditional Indian spices and herbs into tea blends, such as masala chai or herbal infusions, can create unique and appealing products for global consumers. Moreover, investing in organic and sustainable tea production can cater to the growing demand for eco-friendly and health-conscious teas. Through innovation and diversification, India can solidify its position as a dynamic contributor to the ever-

evolving global tea market.

## CONCLUSION

The integration of value-added and diverse tea products serves a dual role, benefiting both the global competitiveness of the tea industry and meeting the diverse needs of consumers. Research suggests that enhancing tea through value addition can enhance its pharmacological, aesthetic, and socio-economic impacts. With stagnant world market tea prices and rising production costs, diversifying tea products through value addition becomes a critical strategy to address these challenges. These additional product lines also empower tea growers to address the overall well-being of consumers. However, tea-producing nations must commit to long-term research and formulate government policies to effectively address the upcoming challenges associated with the development and dissemination of these innovative products in both domestic and international markets.

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## Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this review paper.

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