



## Tea and Tea Product Diversification: A Review

Kanij Fatema Tuz Zohora<sup>1,a,\*</sup>, Md. Riyadh Arefin<sup>2,b</sup>

<sup>1</sup>Soil Science Division, Bangladesh Tea Research Institute, Srimangal-3210, Moulvibazar, Bangladesh

<sup>2</sup>Botany Division, Bangladesh Tea Research Institute, Srimangal-3210, Moulvibazar, Bangladesh

\*Corresponding author

### ARTICLE INFO

### ABSTRACT

Review Article

Received : 19/05/2022

Accepted : 16/09/2022

Keywords:

Tea  
Tea products  
Value added tea  
Tea industry  
Diversification

Tea is the most consumed drink after water as well as is one of the prevalent and the cheapest beverage which consumed globally. Tea is considered a healthy beverage due to the presence of several antioxidants and minerals such as potassium, magnesium, calcium & manganese. Different kinds of teas are manufactured in different countries based on taste, habit and culture of the people. Normally, tea can be categorized into three groups: green tea (unfermented), Oolong tea (partially fermented) and black tea (fully fermented) based on tea processing. Tea is a rich source of polyphenols and now-a-days interest in the possible health benefits of polyphenols, particularly flavonoids, has increased owing to their antioxidant and free-radical scavenging abilities. The rising demand of tea is considered one of the significant components for the worldwide beverage market growth. Tea industry makes a vital contribution to the economy of the respective tea producing countries like China, Japan, India, Sri Lanka, Bangladesh, Kenya etc. At the present time with the rising demand of tea it is needed to emphasize for exploring alternative means of increasing profits from tea cultivation. The tea market price is low in Different countries like Srilanka, India, Bangladesh, Kenya etc. comprises with high cost of production. For this reason, there is no alternatives rather than product diversification of tea through value addition which can be an important approach to mitigate the impacts of low market price and high production costs. This review broadly focuses on the issues leading to the development of wide range of tea and tea product diversification. This paper is also associated health benefits with different types of tea, nutraceutical beverage, confectionary items, toiletries and cosmeceuticals which being commercialized in different parts of the world which are gaining consumer acceptance and also face the challenges of global marketing by tea industries that's are described in this paper.

<sup>a</sup> [kanij@btri.gov.bd](mailto:kanij@btri.gov.bd)

<sup>b</sup> <https://orcid.org/0000-0002-0234-7222>

<sup>b</sup> [riyadh.btri@gmail.com](mailto:riyadh.btri@gmail.com)

<sup>b</sup> <https://orcid.org/0000-0003-3290-7814>



This work is licensed under Creative Commons Attribution 4.0 International License

## Introduction

Tea is the most popular and inexpensive beverage throughout the world because of its characteristic aroma and flavour produced from the shoots of the commercially cultivated tea plants [*Camellia sinensis* (L.) O. Kuntze] (Saha et al., 2022). Tea plants grow best in regions where the temperature is around 65–77 degrees Fahrenheit, with humidity levels between 75% and 85% and an annual distributed rainfall amount between 72 and 100 inches (Francis et al., 2003). Cultivated tea plants can be pruned into many shapes and sizes, but the bulk of world tea production relies on the cultivation of small tea plants pruned into waist-high rows for ease of harvest. Tea plants prefer well-drained soils with good organic matter content, pH in the range of 5 and 5.8 and sandy loam soil (Tocklai-TRA, 2022). *Camellia sinensis* is a cultivated crop in over 49 countries between longitudes 42 degrees north and 33

degrees south (FAOSTAT Gateway, 2022; William, 1935). It is often said that high elevation is required to grow good tea, but the climate is more beneficial than the elevation. Typical conditions at high elevations-cool air, clouds, and mist-slow the growth of the tea plant and produce tastier teas (Gebely, 2016).

Tea is a cash crop as well as also an export item all over the world. Different kinds of teas are manufactured in different countries based on taste, habit and culture of people. Normally, tea can be categorized into three groups: green tea (unfermented), Oolong tea (partially fermented) and black tea (fully fermented) based on tea processing (Arefin et al., 2020). Khan and his co-scientists (2013) gave a statement that, tea (*Camellia sinensis*) is also a long established plantation crop of enormous economic importance that can meet the domestic demand of this

cheapest health beverage. An often-surprising fact to tea novices is that all teas come from the same plant. At present global tea production has exceeded 6.3 million tones and others tea about 1.1 million tons in 2020 (ITC, 2021). From the ITC report (2021), it has been shown that the world tea production both CTC and orthodox in 2020 are 2078 and 1358 million Kg, respectively. The trend of production is continuously increasing with percentage of world production 85.7% in Asian tea producing countries, 12.7% in African tea producing countries and 1.6% in others (ITC, 2021). Now a days, the demands of tea in the world has increased rapidly. According to International Tea Committee (ITC, 2021), the world tea production, retention, imports and global consumption in 2020 are 6269 metric tons, 4444 metric tons, 1735 metric tons and 5879 metric tons, respectively.

Tea product diversification holds immense possibilities for the future and is an important area of research. Tea contains numerous chemical constituents having diverse chemical properties as well as having pharmaceutical and therapeutic values. Keeping in mind of the target of various groups of consumers according to their choice these chemical components are being attempted to be exploited for producing different categories of tea products. There are various diversified products developed such as tea tablet, tea cola, tea toffee and confectionary products such as tea biscuit and tea cake (Baruah et al., 2005). It was found that the premium segment of tea drinkers still prefers the traditional orthodox type of tea containing the original characteristics of distinct liquor and flavor (Baruah, 2015). In different sub-continent and the neighboring countries like India, Bangladesh, Sri Lanka etc has gain the popularity of the CTC type tea over time due to more cup obtained from it.

Tea contains a range of soluble substances such as catechins, caffeine, theanine, chlorophyll, organic acids, and vitamins (Graham, 1992). A study found that, in green tea the major polyphenols are: epigallocatechin-3-gallate (EGCG), epigallocatechin, epicatechin-3-gallate, and epicatechin (Ghosh, 2006). Research studies shows evidence that catechins in tea serve as potential in lowering the risk of several chronic diseases and other diseases (Ghosh, 2006).

Initially, tea-based nutraceuticals, functional drinks and tea-based health, beauty-and body-care formulas have been started in the research laboratories and research centers of different companies of Japan and China. At the present time different tea growing countries has started the industrial applications of tea. Tea products that have practical and industrial applications have gained wide popularity in Japan, China, South Korea and some other countries. This review provides an insight on 'some basic information about tea' as well as 'different types of tea and diversified tea products' developed in different countries.

### What is Tea?

*Camellia sinensis* is a subtropical plant native to Asia but is now grown around the world. The tea plant grows naturally in the wild throughout much of Asia is cultivated in a variety of settings from small family garden to giant estates covering thousands of acres. The taxonomic

classification (Anonymous, 2011) of tea plant is given below:

Kingdom: Plantae  
 Subkingdom: Viridiplantae  
 Infrakingdom: Streptophyta  
 Superdivision: Embryophyta  
 Division: Tracheophyta  
 Subdivision: Spermatophytina  
 Class: Magnoliopsida  
 Superorder: Asteranae  
 Order: Ericales  
 Family: Theaceae  
 Genus: *Camellia* L.  
 Species: *Camellia sinensis* (L.) Kuntze

### Origin of tea

The home of the tea plant is East Asia, and indigenous plants can be found in Japan, China, Burma, India, and other countries. The place of origin for all tea plants is thought to lie in the mountain range between Yunnan in China and Assam in India. Stuart (1919) noted that considerable differences in character existed between tea plants indigenous to Assam in India and those in China, and asserted that small leaf varieties in China originated in Eastern and South eastern China where they were cultivated, while large-leaf varieties originated independently in India and Yunnan. Harler (1933) reported that the intermediate types were all hybrids of Chinese and Assam types. Since these two studies, tea plants have been classified generally into two major varieties: *var. sinensis* from the temperate regions and *var. assamica* from the tropical regions. Thus, a two-location origin of the tea plant has become the accepted theory.

Normally, the tea origin center general can gather rich sources of primary gene, that is to say, the tea tree keeps the primitive traits. In the process of propagation, due to the increase in variation and accumulation of gene, it can form a secondary center and a second center of origin. In China, such secondary center or the second center of origin of tea is mainly refers to areas in southwest China, the Yangtze River area, the three gorges region. In one word, people will tend to unify the origin of tea tree center and secondary center as a whole, and call the southwest China is the origin area of the tea plants (Huang et al., 2016).

Today, Tea Horizon of modern world is seen to extend from the latitude 43° N (Georgia, USSR) to 27°S (Corrientes, Argentina). Most of tea growing countries like China, Japan, Formosa, Java, Sumatra, Sri Lanka, India, Bangladesh, etc. (Figure 1) lie however, within a restricted range of 43°N of latitude from 6°S in Java to 35°N in Japan, and 60° of longitude from 80° to 140° E (Sana, 1989).

### Major component of tea leaf

The component of tea leaf is divided into 3 categories:

- Physical components of fresh tea leaves.
- Chemical components of fresh tea leaves.
- Components of brewed tea.



Figure 1. World Tea Horizon (Sana, 1989)

### Physical components of fresh tea leaves

Fresh leaf refers to the tips and leaves harvested from tea trees. 'Quality Fresh Tea leaves' have some criteria, such as:

- Tenderness ('only bud', 'one/two/three leaf and one bud'),
- Evenness (consistency of physical properties of leaves),
- Freshness (degree of physical properties of fresh tea leaves).

### Chemical Compounds of Tea Green Leaf

The most important compounds in fresh tea leaves are polyphenols, amino acids, enzymes, pigments, carbohydrates, methylxanthines, minerals and many volatile flavor and aroma compounds (Balentine et al., 1998). These components are responsible for producing teas with desirable appearance, aroma, and taste. During tea processing the various compounds undergo changes to produce what we'll call a finished or made tea-one that has been processed and is ready for packaging or steeping. Tea shoots hairs are rich in polyphenols, caffeine and amino acids (Bhatia, 1961). Biochemical composition young shoots of tea are given in Table 1.

Table 1. Approximate biochemical composition young shoots of Assam Variety tea (Roberts, 1962)

Components	% of dry weight
Soluble in cold water	
Flavanols: Epigallocatechin gallate	9-13
Epigallocatechin	3-6
Epicatechin gallate	3-6
Epicatechin	1-3
Gallocatechin	1-2
Catechin	1-2
Flavanols and their glycosides	3-4
Leucoanthocyanins	2-3
Phenolic acids: Theogallin	2
Others	2
Total phenolics	30
Caffeine	3-4
Amino acids: Theanine	2
Others	2
Carbohydrates	4
Organic acids	0.5
Volatile substances	0.01
Partially soluble in hot water	
Polysaccharides: Starch	2-5
Others	12
Protein	15
Ash (inorganic material)	5
Insoluble in water	
Cellulose	7
Lignin	6
Lipids	3

### Components of Brewed Tea

Tea green leaves contain thousands of chemical compounds. When tea leaves are processed, the chemical compounds within them break down, form complexes with one another and form new compounds. When steeping tea leaves, our senses are tingled by the thousands of volatile compounds (collectively known as the "aroma complex") rising from the tea liquor and the thousands of non-volatile compounds that are floating within the tea liquor. Because of this, tea is known as "the ultimate master of chemical diversity" (Kuhnert et al., 2010). Chemical components of tea liquor depends on different kinds on teas, manufacturing procedure, tea leaf quality brewing time etc. (Sezai et al., 2008).

Tea has a complex chemical composition, containing over 2000 components. The composition of the same type of tea may vary significantly depending on the place where it was grown (i.e., soil, climate, height, precipitation, etc.), production technology, storage conditions, etc (Yashin et al., 2015). The composition of green and black teas are provided in Table 2 (Robb and Brown, 2001; Peterson et al., 2005).

### Quality of Tea

Quality of tea depends mainly on the polyphenolic compounds present in the fresh tea leaves. Standard plucking of tea, proper handling of fresh leaves & manufacturing process- all these contribute to the quality of tea. According to ISO standard (Table 3), tea quality can be assessed in two ways- biochemical test and organoleptic test (Table 4).

### Basic Classification of Tea

The goal of tea classification is to provide a clear foundation for education and evaluation by grouping together teas with similar qualities. Throughout history, tea has been classified many ways, including: classification by the color of the finished tea leaves, classification by the color of the tea liquor and classification by the percentage of oxidation the tea leaves have gone through during processing (Figure 2). Tea can be named according to the level of fermentation. There are six kinds of tea in the world are mentioned in Table 05 (Reeves et al., 1987; Karori et al., 2007; Gebely, 2016).

### Green Tea

Green tea is consumed all over the world in various forms. The safe consumption of this beverage which supported by numerous studies showing health benefits, warrant a general recommendation to consume it on regular basis (Hossain et al., 2017). It has been reported as a rich source of catechin and its derivatives that contribute to antioxidant capacity and organoleptic properties (Kupeli et al., 2007). Unlike black tea which is fully fermented, green tea is unfermented but involves fixation process. The goal of green tea production is to preserve the natural polyphenols in the leaves by preventing oxidation. Nowadays, green tea is being studied extensively worldwide as it is considered as one of the most promising dietary agents for the prevention and treatment of many diseases (Sinija & Mishra, 2008). The Japanese are also

well-known for their production of steamed ryokucha, literally green tea. In Japan's most notable steamed green teas are sencha, kabusecha, gyokuro, and the powdered tea matcha. In fact, nearly 98% of all tea produced in Japan is steamed green tea. About 42% of Japanese green tea production comes from Shizuoka Prefecture and 18% comes from Kagoshima Prefecture (Chen et al., 2012). Recently, Bangladesh produces green tea to meet internal consumption (Figure 3 and 4).

### Black Tea

Black teas are often described as fully oxidized teas. The leaves are withered, rolled, oxidized and dried. Tea polyphenols are oxidized to theaflavins and thearubigins, then turning into dried tea with the color of dark red and the tea liquor is also dark red. It's a unique feature of black tea. Harvested tea leaves are processed in the factory and accordingly there are two types of tea: Orthodox, and CTC

(Crushing Tearing Curling). The Orthodox tea is the whole leaf tea whereas CTC tea is widely popular and processed through the crush, tear and curl (CTC) method (Fatima and Rizvi, 2011). CTC black tea is most popular in Bangladesh, India, Nepal, and Pakistan (Figure 5 and 6) while orthodox black tea is popular in Sri Lanka, China, Japan, Vietnam etc (Figure 7 and 8).

Composition of Black tea solid extract includes: Polyphenolic compounds including catechins in monomeric, dimeric and oligomeric form, other flavonoids (including myricetin, quercetin and kaempferol etc.); amino acids (including l-theanine); methylxanthines, carbohydrates, proteins, and minerals. Black tea is also considered as a dietary source of antioxidant nutrients like carotenoids, tocopherols, minerals such as Cr, Mn, Se, or Zn, and certain phytochemical compounds. These compounds enhance beneficial health effects of consumption of Black tea (Luczaj and Skrzydlewska, 2005).

Table 2. The composition of green and black teas (Robb and Brown, 2001; Peterson et al., 2005)

No. Compound	Green tea	Black tea
Catechins	10-30%	3-10%
Theaflavins	0	2-6%
Thearubigins	0	10-20%
Phenolic acids	2%	1%
Flavonols	2%	1%
Other polyphenols	3-6%	3-10%
Caffeine, theobromine, and theophylline	3-6%	3-6%
Amino acids	~10 mg/g	~5 mg/g
Theanine	2%	-
Peptides, proteins	6%	6%
Organic acids	2%	2%
Mono- and disaccharides	11 mg/g	11 mg/g
Mineral substances	10-13%	10-13%

Table 3. ISO requirements for black tea (ISO, 2011)

Characteristics	ISO Requirements
Water extract (%) minimum	32.0
Total Ash (%)	4.0-8.0
Water soluble ash as percentage of total ash (minimum)	45.0
Alkalinity of water-soluble ash (as KOH) %	1.0-3.0
Acid insoluble ash %	1.0
Crude Fibre%	16.5
Total Polyphenols%	9

Table 4. Biochemical test and organoleptic test for tea quality (BTRI, 2022)

Biochemical Quality		Organoleptic Quality
• Total Polyphenols	• Total color	• Infused leaf
• Theaflavin + Thearubigin	• Brightness	• Liquor color
• Caffeine	• Vitamins	• Briskness
○ Theobromine	• Fiber	• Strength
○ Theophylline	• Alkalinity of water-soluble Ash	• Creaming down
• Minerals (Soluble + Insoluble)		

Table 5. Basic classification of tea (Reeves et al., 1987; Karori et al., 2007; Gebely, 2016).

Unfermented	Slightly fermented	Slightly fermented	Semi fermented	Fully fermented	Post fermented
Green Tea	White tea	Yellow tea	Oolong Tea	Black tea	Dark tea





Figure 2. Different types of Tea



Figure 3. Green Tea dry leaf of Bangladesh

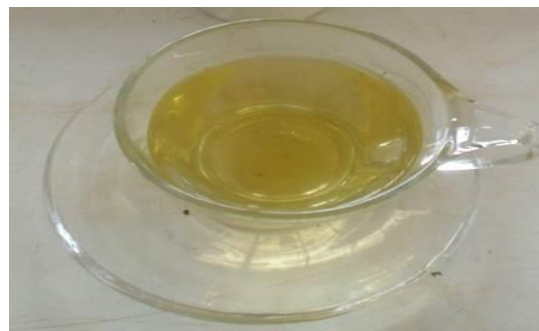


Figure 4. Green Tea liquor of Bangladesh



Figure 5. Black Tea Dry leaf



Figure 6. Black Tea Liquor



Figure 7. Orthodox Tea Dry leaf



Figure 8. Orthodox Tea Liquor

### ***Oolong Tea***

Intermediate between the fully-fermented black tea and the unfermented green tea is a variety of partially-fermented tea called Oolong tea (Devanathan, 1974). In China and Japan Oolong tea is most popular tea for not only drinking purpose but also making different tea products. Oolong tea is made by withering and then putting

through a series of light rolling before is called as semifermentation and results in partial oxidation (Figure 9, 10). Taiwan is a small island that lies on the Tropic of Cancer just off the east coast of Fujian province and famous for its production of oolong tea; 90% of tea produced there is oolong (Luo, 2012).

Among three types of tea, black tea is the most popular tea produced and consumed preferentially in the United State, England, and other Western countries with 78% of global market, followed by 20% of green tea consumed primarily in Asian and Northern African countries, and about 2% of oolong tea consumed mainly in Taiwan, southern China, and most Eastern countries (Bode and Dong, 2003; Yang et al., 2000).

### White Tea

White tea is non-oxidized tea produced from young shoots of *Camellia sinensis* (Figure 11) (Alcazar et al., 2007). It is non-fermented tea and usually protected from sunlight to avoid polyphenol degradation. It is exclusively prepared from very young tea leaves and/or only buds, which are harvested before being fully open and are processed by air drying (Venditti et al., 2010). This less extended processing confers to white tea its special and highly appreciated odour and flavour characteristics (Müller et al., 2010; Rusak et al., 2008).

China's Fujian province is the home of white tea and it is most closely associated with the counties of Fuding and Zhenghe. Bai Mu Dan (White Peony), Gong Mei (Tribute Eyebrow), Shou Mei (Longevity Eyebrow), Yue Guang Bai (Moonlight White) are the most popular white tea in China. There are two notable white teas coming out of Darjeeling, India these days. One is Silver Tips from Okayti Estate, from the *Camellia sinensis var. sinensis*

'AV2' and *Camellia sinensis var. sinensis* 'P312' cultivars. Another notable white tea from Sri Lanka, Silver Tips hails from the gardens of PMD Tea in the Dimbula region. The cultivar in use there is *Camellia sinensis var. sinensis* 'TRI 2043' (Gebely, 2016). In Bangladesh, special blended white tea (blending of 80% BT2 and 20% BT4) produced the best quality of white tea in respect of color, flavour, astringency and strength (Hossain et al., 2018).

### Yellow Tea

Yellow tea, also known as *huángchá* in Chinese, is a lightly fermented tea unique to China (Figure 12). As a rare and precious variety of tea, it has gained increasing popularity in recent years because of its pleasant mellow taste and known health benefits such as anti-oxidation, anti-inflammation and anti-cancer properties (Jingyi et al., 2018). Yellow tea is a lightly fermented tea, and its processing steps mainly include fixing, rolling, yellowing, and drying. Except for yellowing, these steps are similar to those for green tea processing (Yuming et al., 2021). Yellow tea has the highest theanine, glutamic and aspartic acid, and flavonoid levels. By comparing the differential metabolites of green, yellow, and white teas, it was found that the yellow tea had the highest flavonoid levels (Zhang et al., 2019). Furthermore, in more studies, it was indicated that yellow tea has high levels of phenolic and amino acids, soluble sugars, vitamins, and other nutrients (Jiao et al., 2016; Horžić et al., 2012).



Figure 9. Oolong Tea Dry leaf



Figure 10. Oolong Tea Liquor



Figure 11. White Tea (Source.01 & 02)



Figure 12. Yellow tea (Source.03)



Figure 13. Dark Tea (Source.04)



Figure 14. Loose tea (Source.05)



### Dark Tea

Dark tea (Figure 13) differs from other types of tea because it is uniquely processed by solid-state fermentation involving microorganisms that modify the phytochemicals of tea leaves by performing a multitude of reactions, including degradation, oxidation, condensation, methylation, and glycosylation (Li et al., 2018 and Zhu et al., 2020.). Dark tea is traditionally used for treating gastrointestinal dysmotility, including dyspepsia, bloating, and constipation (Zheng et al., 2015 and Zhang et al., 2013).

### Loose Tea

Loose tea (Figure 14) is a tea that does not come prepackaged in tea bags. Unlike bagged tea, loose leaf tea isn't crushed into a teabag, allowing it to keep its flavor, aroma, and health benefits. Tea leaves are packaged loosely in a canister, paper bag or other container such as a tea chest. This kind of tea is available all over the world. Loose leaf tea is significantly different in both flavor and quality compared to bagged teas. In addition to the quality of the tea, loose leaf tea is more environmentally friendly as well, since you can compost loose leaf tea easier, and teabags aren't required (Gebely, 2016).

### Tea Bag

A tea bag, or the compound teabag, is a small, porous, sealed bag or packet, typically containing tea leaves or the leaves of other herbs, which is immersed in water to steep and make an infusion. Tea bags are commonly made of filter paper or food-grade plastic, or occasionally of silk cotton or silk. The tea bag performs the same function as a tea infuser. Tea bags can be used multiple times until there is no extraction left. Some tea bags have an attached piece of string with a paper label at the top that assists in removing the bag, while also displaying the brand or variety of tea (Hernandez et al., 2019). Tea bag patents date

from 1903 (Figure 15), and the first modern tea bags (Figure 16) were hand-sewn fabric bags. Appearing commercially around 1904, tea bags were successfully marketed in about 1908 by Thomas Sullivan, a tea and coffee importer from New York, who shipped his silk tea bags around the world (Dubrin, 2012).

### Handmade Tea

Baruah (2015), stated that Handcrafted or handmade tea (Figure 17-20) is made in smaller quantities meticulously at the garden level generally for exclusive marketing. Handmade tea is sometimes also called "artisanal tea". A handmade tea is not processed by the ton in a tea factory that uses big machines. The tea leaves are harvested by machine or hand (although usually by hand) and there are a couple of levels of hand-crafting them: 1. Full (all steps in the processing are done by hand, usually in small) and 2. Partial (most steps in the processing are done by hand, usually in small batches). Popular handmade teas are produced in china, Japan, India etc such as: White teas such as Silver Needle, Blooming/flowering teas, Premium oolongs such as Wuyi yancha, Assam orthodox black tea, Assam orthodox green tea, and Singpho/Darjeeling handcrafted designer tea in form of flowers, balls, and many other shapes etc (Baruah et al., 2005).

### Tea Diversification

Tea consumption is gaining popularity because of its myriad health properties. Recently, there is an increased demand for high-quality and high-value teas with specific health benefits and new flavors (Hicks, 2009). There is a range of preferences for tea styles and drinking habits among different consumers in various countries (Kumar and Bhavan, 2016).



Figure 15. Lipton tea bags over the years, from 1920 to 1951 (Source.06)



Figure 16. Modern Tea Bag (Source.07)



Figure 17. Handmade Green Tea



Figure 18. Green Tea Dry Leaf



Figure 19. Green Tea liquor



Figure 20. Green tea Infused leaf

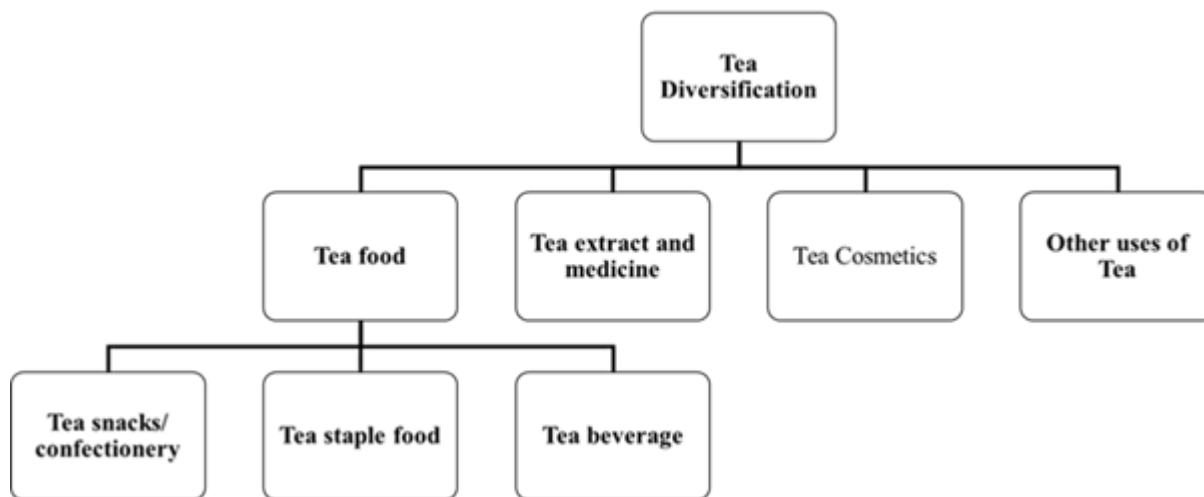


Figure 21. Tea Diversification in Worldwide (Anonymous, 2022)



Figure 22. Tea- Tuna Salad (Source.08)



Figure 23. Lahpet thoke (Source.09,10)



Figure 24. Tea Vorta

The introduction of new types of flavors into tea blends such as spices (cinnamon, cardamom etc.), fruit and flavor combinations, flower and herbs (jasmine, mint etc.) as well as different tea diversified products are expected to boost the global tea industry substantially over the next few years (Takeda, 2007). Diversification of tea is the process to make new different products and brand of tea. Now diversification of tea is introducing a new era in tea industry all over the world. Many tea producing countries such as China, Japan, India, Sri Lanka, Kenya, Korea, Bangladesh etc. are now making different diversified product of tea (Hajra and Yang, 2015). By different literature review authors have shown a pattern of tea diversification (Figure 21) and objectives of diversification were given below:

**Objectives of diversification of tea**

- To make the tea as multiple products from only drinking tea.
- To acquire tea market and to move it forward
- To Increase competition in the global tea market.
- To improve the new productivity of tea.

**Tea Food**

Tea is used as fresh tea leaves, dried tea, tea extract as raw material as well as tea powder mix with edible substances or flavoring agents. Tea dishes are divided into three categories such as: 1. Tea snacks/ confectionery (bread, cake, pastry, tea cookies tea pudding etc.; tea preserved fruit, tea sugar, tea cool), 2. Tea staple food (made with tea leaves or tea extract as main ingredients such as green tea noodles, green tea rice, tea dumplings etc)

and 3. Tea beverage (different types of tea, artisan tea, value added tea etc. Details of these three categories food were given below. In Thailand, fresh tea leaves used in salad as well as with tuna fish (Figure 22). Lahpet thoke (Figure 23), Burmese tea leaf salad or pickled tea salad is a favorite national dish in Myanmar (Han and Aye, 2015). Tea Vorta (Figure 24) is a common food item for the labor community of Bangladesh especially in tea growing regions. Now a days, it become very popular all over the country people.

**Tea snacks/ confectionery**

Flour confectionery products are traditionally in demand among consumers. Tea extract or tea powder were used to enrich the recipes of flour confectionery products with components of plant origin containing physiologically significant micronutrients and have good digestibility (Nilova et al., 2017). It has been established that the addition of green tea infusion slows down bread (Figure 25) staling (Edygova, 2018). Phongnarisorn and his co-scientists (2018) reported that, there is a lot of medical and physiological significance of green tea biscuit. By adding green tea powder as a flavoring agent to ice cream (Figure 26), beneficial constituents of green tea may contribute to enhance the nutritional value of ice cream (Swarnathilake and Don, 2020). Green tea sponge cake (Figure 27) was found to be a food with more effective antioxidant properties (Lu et al., 2010).

**Tea staple food**

Different dishes were made with tea leaves or tea extract where tea is the main ingredients, such as green tea



noodles (Xu et al., 2019), green tea rice, tea dumplings etc. Green tea rice or *ochazuke* (Figure 28) is a Japanese comfort food made of steamed rice and savory green tea. It's healthy, simple, and goes well with a variety of entrees. This dish doused in a savory green tea, which is totally refreshing, hearty, and filling on warm summer days (Anonymous, 2022). "Cha soba" (Figure 29) is a thin Japanese soba noodle infused with green tea or "ocha" or "cha" for short. It is made of buckwheat flour or "soba-ko," wheat flour or "komugi-ko," and the addition of green tea (Anonymous, 2022 and Li et al., 2012).

#### Tea beverage

Tea extract or concentrate tea powder as raw materials mixed with different materials such as: water sugar solution, sour agents, edible essence and food additive; where the original flavor of the tea juice is kept. This types of original liquid beverage is known as Tea beverage such as different tea, tea coke, tea cola, fruit flavored tea, concentrated tea, flower tea, herbal tea etc.

#### Canned tea

Canned tea (Figure 30) is a relatively recent method of marketing tea which has been sold traditionally as leaf tea and also, for the last 100 years, in tea bag form. It utilizes the canning process to produce a ready-made drink. Perceived advantages are ease of use (minimal or no preparation time) and the possibility of additives (Friedlander and Blaine, 2000). In 1981, the first canned tea product, unsweetened oolong, was introduced in Japan by *Ito En (Japanese multinational drinks company)*. The introduction very quickly led to more than one hundred variations, offered in cans (Hall, 2000).

#### Bottled tea

The first bottled tea introduced by Indonesian tea company *Sosro* in 1969 with brand name *Teh Botol Sosro*. The Swiss based *Bischofszell* was the first company to bottle ice tea on an industrial scale in 1983. This type of tea is now available in Japan, China, India, Korea & Srilanka etc. for example: *Bottle Catechin Drinks* prepared mainly from the extracts from useful herbs are mixed with tea catechins and  $\beta$ -carotene. In combination with vitamins, tea catechin found to have a strong scavenging action on active oxygen (Kuroda and Hara, 2004). These drinks are very common among Japanese (Figure 31).



Figure 25. Tea bread (Source.11)



Figure 26. Tea ice-cream (Source.12)



Figure 27. Tea cake (Source.13)

#### Instant Tea

Instant tea (Figure 32) is a powder in which water is added, in order to reconstitute it into a cup of tea. The earliest form of instant tea was developed in the United Kingdom in 1885. A patent was granted for a paste made of concentrated tea extract, sugar, and evaporated milk, which became tea when hot water was added (Wilson, 1992). In 2020 India, Sri Lanka and Kenya produced 4895.000, 3063.331, 1157.366 million kg instant tea respectively where total export was 2893.329 million kg (ITC, 2021).

#### Carbonated Tea

Apart from instant tea, carbonated tea (Figure 33) also seems to have a limited foreign market. Within Sri Lanka prospects for bottled carbonated tea appear rather dim for the reason that the cost of bottling and transport and distribution forms a very large fraction of the price paid by the consumer for the bottled beverage (Devanathan, 1974).

#### Tea Wine

Tea Wine (Figure 34) is developed by IHBT which is made as per the conventional procedure involving yeast (*Saccharomyces cerevisiae*) using secondary grade black tea dust fortified with specific proportion with sugar. It is matured over a period of one year. It contains 12-15% alcohol. There are two types of tea wines, 'pure tea wine' and 'Palam Belle' a mild and sweet fruit tea wine have been developed (CSIR-IHBT, 2014).

#### Tea Cider

Tea Cider (Figure 35) is a refreshing alcoholic beverage can be prepared by fermenting sugar using a composite culture of two micro-organisms, *Saccharomyces ludwigii* and *Bacterium xylinum*. The organism complex utilizes amino acids and vitamins from tea liquor for its growth. The product compares very favorably with apple ciders and champagne perrys (Devanathan 1974).

#### Blended Tea

Tea blending is the blending of different teas together to produce a final product. This occurs chiefly with black tea that is blended to make most tea bags but can also occur with such teas as *Pu-erh*, where leaves are blended from different regions before being compressed.



Figure 28. Green tea rice or *ochazuke* (Source.14)



Figure 29. Japanese soba noodle or *Cha soba* (Source.15)



Figure 30. Canned tea (Source.16)



Figure 31. Bottled tea (Source.17)



Figure 32. Instant Tea (Source.18)



Figure 33. Carbonated Tea (Source.19)



Figure 34. Tea Wine (Source.20)



Figure 35. Tea Cider (Source.21)

**Varieties of blended tea**

- Breakfast: Generally a blend of different black teas that are robust and full-bodied, and go well with milk. Some types are English breakfast, Irish breakfast and Scottish breakfast.
- Afternoon tea: These blends (of black teas) are generally lighter than breakfast blends. Both breakfast and afternoon blends are popular in the British Isles, for example, Prince of Wales tea blend.
- Russian Caravan: A popular blend, Russian Caravan harks back to the days when tea was hauled to Russia from China on camelback. It often contains a bit of smoky lapsang souchong, though its base is typically Keemun or Dian Hong. Some also contain oolong (Smith, 2016).

**Altered Tea**

Altered teas (Figure 36) refer to teas that go through additional processing steps during or after primary processing before being sold. This can refer to flavoring, scenting, blending, smoking, aging, decaffeinating or grinding. The majority of teas sold in the United States are altered in some way (Anonymous, 2022).

**Roasted Tea**

Roasting is a form of drying used to enhance flavor. Roasting tea (Figure 37) is most common among the oolongs of China and Taiwan and in the production of Japanese Hojicha. Most roasting of tea leaves is done in an electric oven, but tea roasting was traditionally done on bamboo baskets over charcoal. During roasting, amino



acids in the tea leaves are transformed into aromatic compounds by way of the Maillard reaction, resulting in a toasty, nutty flavor development in the tea. Roasting is also a useful tool when aging oolongs, as it aids in reducing the moisture content in the leaves absorbed during aging (Kiple and Ornelas, 2000).

**Decaffeinated tea**

All teas made from *Camellia sinensis* contain caffeine; even those that have been decaffeinated retain a small portion of caffeine. Decaffeination (Figure 38) is a process wherein a solvent is used to remove the caffeine from tea leaves. Methylene Chloride used to be the solvent of choice, but health concerns resulted in its use being banned in the United States. Today, Ethyl Acetate and Supercritical Carbon Dioxide are the commonly used solvents (Chin et al., 2008).

**Flowering Tea**

Flowering tea or blooming tea (Figure 39) consists of a bundle of dried tea leaves wrapped around one or more dried flowers. These are made by binding tea leaves and flowers together into a bulb, then setting them to dry. When steeped, the bundle expands and unfurls in a process that emulates a blooming flower, and the flowers inside emerge as the centerpiece. Typically they are sourced from the

Yunnan province of China. Flowers commonly used in flowering teas include globe amaranth, chrysanthemum, jasmine, lily, hibiscus, and *osmanthus* (Richardson, 2009).

**Bubble Tea**

Bubble tea (also known as pearl milk tea, bubble milk tea, tapioca milk tea, or boba tea or boba) is a tea-based drink that originated in Taiwan in the early 1980s. It most commonly consists of tea (Figure 40) accompanied by chewy tapioca balls (“boba” or “pearls”), but it can be made with other toppings as well (Wu, 2020).

**Flavored and Scented Teas**

Although many teas are still flavored directly with flowers, herbs, spices, or even smoke, teas with more specialized flavors are produced through the addition of flavorings or perfumes. This is particularly true for tea blends with pronounced fruit or flower aromas, which cannot be achieved with the original ingredients. Some firms such as Mariage Frères and Kusmi Tea have become quite famous for their perfumed teas. The most commonly used scents are jasmine, traditionally used to scent delicate white and green teas, and bergamot oil, which is used to scent Earl Grey tea (Rubin and Gold, 2002). The following section will concentrate on teas flavored directly with the original scent materials (Flowers and Herbs):



Figure 36. Altered Tea (Source.22)



Figure 37. Roasted tea (Source.23)

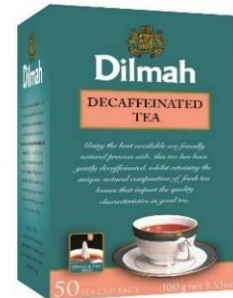


Figure 38. Decaffeinated tea (Source.24)



Figure 39. A cup of flowering tea and various bundles in dry form (Source.25)



Figure 40. Bubble tea (Source.26)



Figure 41. Jasmine Tea (Source.27)



Figure 42. Osmanthus Tea (Source.28)



Figure 43. Rose Congou Tea (Source.29)



Figure 44. Chrysanthemum tea (Source.30)



## Flowers

A variety of flowers are used to flavour teas. Although flowers are used to scent teas directly, most flower-scented teas on the market use perfumes and aromas to augment or replace the use of flowers. The most popular of these teas include the flowers of the following:

### Jasmine Tea

Spread with jasmine flowers while oxidizing, and occasionally some are left in the tea as a decoration. Jasmine is most commonly used to flavour green teas to produce jasmine tea (Figure 41), although sometimes it is used to flavour light oolong teas such as *baozhong tea* (Campbell, 1995).

### Osmanthus Tea

In China, *osmanthus* tea (called *guì huā chá*) is produced by combining dried sweet osmanthus (*Osmanthus fragrans*) flowers (*guì huā*) with black or green tea leaves in much the same manner the more familiar jasmine tea combines jasmine flowers with tea leaves. The flowers are spread while oxidizing, and occasionally some are left in the tea as a decoration. This flower gives the tea a mild peach flavour. It is the second most popular scented tea (after jasmine) in China (Figure 42) (Cynthia and Lise, 2010).

### Rose Tea

Rose flowers are spread while oxidizing, occasionally some are left in the tea as a decoration. In China, roses are usually used to scent black tea and the resulting tea is called rosgou (Figure 43).

### Chrysanthemum Tea

Chrysanthemum tea (Figure 44) is a flower-based infusion beverage made from the chrysanthemum flowers of the species *Chrysanthemum morifolium* or *Chrysanthemum indicum*, which are most popular throughout East and Southeast Asia. The flowers are often brewed alone as a chrysanthemum tisane, but it is also commonly mixed with pu-erh tea to make *chrysanthemum pu-erh* (Campbell, 1995).

### Lotus Tea

Lotus tea (Figure 45) is an infusion made from lotus leaves, flowers, roots, fruit, seeds, or embryos. It is known as *liánchá* in Chinese and *yeoncha* in Korean. It is also known as *trà sen* in Vietnamese. Vietnamese lotus tea is made by stuffing green tea leaves into the blossom of *Nelumbo nucifera* and allowing the scent to be absorbed overnight. Another common technique for making this tea is by jarring or baking the tea leaves with the fragrant stamens of the flower multiple times (Jeong et al., 2012).

## Herbs

### Mint Tea

Mint tea is an herbal tea made by infusing mint leaves in hot water. Mint tea made with peppermint leaves is called peppermint tea, and mint tea made with spearmint is called spearmint tea. In Korea, traditional mint tea called *bakha-cha* (Figure 46) is made with East Asian wild mint leaves (Chumpitazi et al., 2018).

### Pandan Tea

*Pandanus amaryllifolius* is a tropical plant in the *Pandanus* genus, which is commonly known as pandan. It has fragrant leaves which are used widely for flavouring in the cuisines of Southeast Asia and South Asia. Pandan, also

known as screwpine, is a popular additive to green or black tea in Malaysia, Indonesia, and the Philippines (Figure 47) (Aini and Mardiyarningsih, 2009).

### Earl Grey Tea

Earl Grey tea (Figure 48) is a tea blend which has been flavored with oil of bergamot. The rind's fragrant oil is added to black tea to give Earl Grey its unique taste. Traditionally, Earl Grey was made from black teas such as Chinese *keemun*, and therefore intended to be drunk without milk (Finsterer, 2002).

### Genmaicha or Brown Rice Tea

*Genmaicha* (Figure 49) is a Japanese brown rice green tea consisting of green tea mixed with roasted popped brown rice. It is sometimes referred to colloquially as "popcorn tea" because a few grains of the rice pop during the roasting process and resemble popcorn, or as "people's tea", as the rice served as a filler and reduced the price of the tea, making it historically more available for poorer Japanese (Gascoyne et al., 2018).

### Lapsang souchong or Smoked tea

Lapsang souchong or Smoked tea (Figure 50) is a black tea consisting of *Camellia sinensis* leaves that are smoke-dried over a pinewood fire. This smoking is accomplished either as a cold smoke of the raw leaves as they are processed or as a hot smoke of previously processed (withered and oxidized) leaves. Lapsang souchong is found in many Russian Caravan blends (Newman, 2007).

### Spice Tea or masala chai

Tea such as Indian and Middle Eastern masala chai (Figure 51), flavoured with different spices such as ginger, cardamom, cinnamon, cassia, black pepper, clove, anise, fennel, Indian bay leaf and sometimes vanilla, nutmeg and mace (Perry, 2001).

## Tea Extract and Medicine

Chemically brewed tea contains protein, fatty materials, carbohydrates, pectins, crude fibers, minerals, caffeine, polyphenols, total water extractable solid etc components. These components were generally extracted for pharmaceutical and other purposes. These extracts been used as medicinal and dietary supplements in many countries such as China, Japan and the USA (Amarakoon and Grimble, 2017).

### L-theanine

L-theanine is the main bioavailable form present in tea (1–2% of total leaf weight), and represents around 50% of total free amino acids in tea (Juneja et al., 1999). L-theanine is an amino acid found in tea leaves which has relaxing effects in humans and animals. It is a structural analogue of glutamate which can bind glutamate receptors (Dramard et al., 2018).

### Catechin extract and Capsules

All over the world, catechin extract and capsules offers all-round benefits of health maintenance and prevention of illness. Such tablets are also available in world market (Miyazawa et al., 2005). Some other catechin form, such as: Catechin 100 (prevent bacterial infection), Catechin 50 (reduce unpleasant faecal odours), Catechin 100 Plus Oligo (inhibits the growth of putrefactive bacteria and increase of *Bifidobacteria* or *Lactobacillus*) and Catechin ACE etc (Hara, 2001).



Figure 45. Lotus tea  
(Source.31)



Figure 46. Bakha-Cha  
(Source.32)



Figure 47. Pandan Tea  
(Source.33)



Figure 48.: Earl Grey Tea  
(Source.34)



Figure 49. Genmaicha or Brown Rice  
tea (Source.35)



Figure 50. Lapsang souchong Tea  
(Source.36)



Figure 51. Spice Tea or masala chai  
(Source.37)



Figure 52. Tea Saponin  
(Source.38)



Figure 53. Tea Oil  
(Source.39)



Figure 54. Matcha Powder  
(Source.40)



Figure 55. Tea Soap  
(Source.41)



Figure 56. Tea cream  
(Source.42)



Figure 57. Tea shampoo  
(Source.43)



Figure 58. Tea cleansing foam  
(Source.44)



Figure 59. Tea toothpaste  
(Source.45)

### Tea Polyphenols

Green tea leaves contain many types of polyphenols, the most important of which are the flavanols (catechins), the flavonols and the flavanol glycosides. Tea catechins are water-soluble, colourless substances, which impart the bitter and astringent characteristic of green tea. Large amount of green tea polyphenols from Japan and China are exported to Europe and North America (Bharadwaz and Bhattacharjee, 2012).

### Tea Polysaccharide (TPS)

TPS is a nonstarch protein-bound acidic polysaccharide, which contains 44.2% neutral sugar, 43.1% uronic acid and 3.5% protein. TPS has many bioactive activities, including relieving oxidative stress by enhancing endogenous antioxidant enzymes or directly scavenging free radicals; antitumor activity by suppressing the expression of VEGF and TNF and inhibiting tumor cell proliferation; anti-hyperglycemic activity by increasing IL-2 production and inhibiting starch digestive enzymes etc (Ling-Ling et al., 2016).

### Tea Saponin

Tea saponins (Figure 52), found in *Camellia* plants, are natural non-ionic surfactants that offer obvious beneficial effects in soil remediation. Saponin is used as an emulsifying agent in pesticides, for foam-forming fire extinguishers and in detergents (Shanan and Ying, 1982). Most tea saponins are extracted from the *Camellia oleifera* seed meal, with the leaves and flowers of *Camellia sinensis* as potential sources (Ribeiro et al., 2013). Applied in leaching remediation, phytoremediation and microbial remediation, tea saponins desorb heavy metals from contaminated soil as well as enhancing their bioavailability. Tea saponins improve the accumulation of pollutants by hyper accumulators as well as the degradation of organic pollutants by microorganisms (Yu and He, 2018).

### Tea Seed Oil

Tea oil (Figure 53) is a good raw material for industrial uses and is used to manufacture soap, margarine, hair oil, lubricants, paint, synthesis of other high-molecular weight compounds, and a rustproof oil. *Camellia* oil has been proven to have its place in all emulsions used in the cosmetology and dermatology fields (Sabetay, 1972). Tea oil is the main cooking oil in China's southern provinces, especially Hunan where more than 50% of the vegetable cooking oil is from *Camellia*. Tea oil is a high quality cooking oil which is comparative to olive oil and it stores well at room temperature. Oil content of tea seed is 40% to 50% and oleic acid constitutes up to 88% of the fatty acids (Shanan and Ying 1982; Xia et al., 1993).

### Matcha Powder

Matcha (Figure 54) is finely ground powder of specially grown and processed green tea leaves, traditionally consumed in East Asia. The tea plants used for matcha are shade-grown for three to four weeks before harvest; the stems and veins are removed during processing. During shaded growth, the plant *Camellia sinensis* produces more theanine and caffeine. The powdered form of matcha is consumed differently from tea leaves or tea bags, as it is suspended in a liquid, typically water or milk (Horie, 2017).

**Tea Cosmetics**  
Tea derives cosmetic ingredient function mostly as antioxidants & skin conditioning agents. Tea flower extract, tea seed oil, leaf powder, water etc reported to be used in different cosmetics products such as soap (Figure 55), cream, sirum, oil, lotion etc. Tea extracts possess a wide spectrum of biological activities, which makes them precious components not only for pharmaceutical applications, but also for cosmetics industry (Koch et al., 2019).



Figure 60. Tea face mask (Source.46)



Figure 61. Tea Showpieces in China



Figure 62. Tea Showpieces in Bangladesh



Figure 63. Table made from Tea stump in Bangladesh



### **Tea Sun Skin Cosmetics**

Tea leaf extract absorbs ultraviolet radiation, due to which it protects the skin against its harmful effects. It is a component of photo protective cosmetics for daily care. Additionally, polyphenol compounds present in tea have strong antioxidant activity and due to it scavenging different free radicals, which are produced during UV radiation. Tea extracts and the active compounds that they contain are increasingly applied in sunscreen cosmetics. EGCG prevents the negative effects of UV radiation on the skin, through the inhibition of collagenases, anti-inflammatory and anti-cancer properties towards the skin cells (Mishra et al., 2011; Yarnell and Abascal, 2012).

### **Tea body lotion, cream etc**

Tea extracts, due to their rich composition and various biological actions, play an important role among different skin care cosmetics (Wojciech et al., 2019). Tea catechins (EC, EGCG, EGCG) provide antioxidant activity which significantly increase endogenous antioxidant enzymes production (SOD, glutathione) (Heinrich et al., 2011), increase skin moisture (Kukula-Koch et al., 2013), improve skin micro relief (skin texture) especially after 15–30 days of treatment (Vinson et al., 2004), also provide significant improvement in the elastic tissue content (Arent et al., 2010).

### **Hair Treatment Tea Cosmetics**

Cosmetic containing tea extracts are recommended for patients with androgenetic alopecia and hair loss, regardless of gender. The occurrence of androgenic alopecia is directly related to the conversion of testosterone into more active dihydrotestosterone (DHT), which is mainly responsible for baldness (Mnich et al., 2009). Tea polyphenols, essential oils and caffeine present in tea plant leaves inhibit the activity of 5 $\alpha$ -reductase, which results in a decreased DHT formation (Majewska et al., 2010). The former compounds were also found stimulate hair roots and extend the hair growth phase (anagen phase) (Lamer-Zarawska et al., 2012). Therefore, constituents of tea are important ingredients of hair and scalp care cosmetics, which are especially recommended to individuals having excessive greasy hair and dandruff (Biernikiewicz, 2010).

### **Other cosmetics**

Tea plant itself and its extracts together with their centuries-old tradition of use play an important role on the cosmetics market. The frequent use of *Camellia sinensis* extracts is due to its multidirectional effect. Tea extracts are also important components of many cosmetics including eye cream, antiwrinkle cream (Figure 56), shampoo (Figure 57), cleansing foam (Figure 58), toothpaste (Figure 59), face mask (Figure 60), tonics, shower gels, conditioner, facial masks, toilet water etc (Wojciech et al., 2019).

### **Other uses of Tea**

#### **Tea Furniture and Show pieces**

Tea Root based furniture such as: showpieces (Figure 61 & 62), Table (Figure 63) are very popular all over the world. It becomes an incredible culture in the tea growing countries like China, Japan, Bangladesh, India etc. There are many tea museum all over the world containing many ancient tea plants, stem and tea root/shoot furniture and showpieces.

### **Tea residues**

Tea oil residues have been used for effective control of the following pests: rice blast, sheath and culm blight of rice, wheat rust, rice hopper, cutworms, cotton aphids, certain scale insects, long-horned beetles, and leeches (Shanan and Ying, 1982). Extracts of the seed cake left over after processing are known to deter larval development in insects (Duke and Ayensu, 1985).

### **Health Benefits of Drinking Tea**

- Help to prevent heart disease and reduce the risk of heart attack.
- Lowering blood pressure, diabetes, blood sugar and prevents osteoporosis.
- Protect against cancer and burn fat as fuel and thus aid weight loss.
- Tea has tooth decay prevention, antibacterial effect, anti- influenza effect.
- Prevent cavities action and fight against indigestion and skin infection.
- Tea removes tiredness and gives energy to the body (Linda Carroll and Danielle Wolf, 2016)

### **Contribution in World Tea Market with Present Status of Tea in Case of Bangladesh**

In 2020 the total tea production of Bangladesh is 86,394 million kg in where 79 million kg is CTC Tea and 7 million Kg is orthodox tea (ITC, 2021). Due to high internal consumption, tea export is gradually decreasing from Bangladesh; the export was 30.98 million kg in 1980, whereas 2174 million kg in 2020. At present, to fulfil consumers' demands, different companies in Bangladesh such as Finlay's, Kazi & Kazi, Ispahany, Tetly, Dancan brother Ltd, National tea co. etc are producing different types of tea. Though all the companies produce mainly Black tea, especially Finlay's produces both black tea and green tea, but recently Kazi & Kazi and other tea manufacturers also started to produce green tea as well as value added teas which have gained market demand gradually.

Recently Bangladesh Tea Board took a great step for producing different kinds of tea and tea products with the help of advanced technology and methods adopting by Bangladesh Tea Research Institute and already succeed launching of orthodox tea, Satkora tea, tulshi tea etc. as a brand of Bangladesh tea which have also gained a huge market demand. Recently different tea products such as: tea biscuits, tea facial mask, tea achar, tea candy etc. also produced by Bangladesh Tea Research Institute and further researches is still going on for the betterment of the products.

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

Value addition in tea is an important aspect to the market development for tea and tea products. Like other tea product producing countries, Bangladesh also came forward to produce value added teas and tea products not only to introduce new products to the consumers level but

also to compete with global tea market. Bangladesh Tea Research Institute has started different research on tea chemical compounds such as tea polyphenols, tea essential oil, coloring agents, antioxidants etc. and also trying to make some value-added teas like lemon tea, ginger tea, tea cola etc. To increase the interest of the consumers as well as for public awareness, Bangladesh Tea Board has already arranged two International Tea Expo, one tea fair and established some 'Tea Display and Sales Center' at different places of the country. There is a great expectation from the tea professionals of Bangladesh that the tea industry of Bangladesh will flourish in the near future by higher production, product diversification and improving the marketing system by adopting tea e-commerce, making tea house and arraigning wholesale market etc as well as will contribute in world tea market by increasing export potentialities of tea .

## Conclusions

Value added tea and diversified tea products not only can help the tea industries to win over the competitive global market but also the consumers' to fulfill their diversified demands. Considering the health aspects, research evidences have shown that value addition in tea is found to potentiate its pharmacologic effect, aesthetic effect as well as socio economic effect on people.

With world market price of tea becoming stagnated product diversification of tea through value addition seems to be an important approach to mitigate the impacts of low market price and high production costs. Despite, these additional outlets will enable tea growers to cater to the well-being of the consumers. However, tea growing countries should take necessary long term research as well as government polices to face more challenges in near future in further application and dissemination of these new products on domestic and international markets.

## References

- Aini R, Mardiyarningsih A. 2009. "Pandan leaves extract (Pandanus amaryllifolius Roxb) as a food preservative". Indonesian Journal of Medicine and Health, 7 (4): 166–173. DOI:10.20885/JKKI.Vol7.Iss4.art8
- Alcazar A, Ballesteros O, Jurado JM, Pablos F, Martin MJ, Vilches JL, Navalon A. 2007. Differentiation of green, white, black, Oolong, and Pu-erh teas according to their free amino acids content. Journal of agricultural and food chemistry, 55(15): 5960-5965.
- Amarakoon T, Grimbale RF. 2017. Tea & your health: the science behind the goodness in real tea, *Camellia sinensis*, nature's healing herb. Dilmah Ceylon Tea Co. PLC, 111 Negombo Road, Peliyagoda, Sri Lanka, ASIN: B073P72WR4
- Anonymous, 2022. Altered Tea. Available from: <https://teaepicure.com/nuances-of-tea-classification/> [Accessed 16<sup>th</sup> May 2022].
- Anonymous, 2022. Tea Staple Food. Available from: <https://www.rasamalaysia.com/green-tea-rice/> [Accessed 16<sup>th</sup> May 2022].
- Anonymous, 2022. Tea Staple Food. Available from: <https://www.thespruceeats.com/cold-green-tea-soba-noodles-2031214> [Accessed 16<sup>th</sup> May 2022].
- Anonymous, 2022. Rose Tea. Available from: [https://www.wikiwand.com/en/Tea\\_blending\\_and\\_additives](https://www.wikiwand.com/en/Tea_blending_and_additives) [Accessed 16<sup>th</sup> May 2022].
- Anonymous. 2011. Theaceae and Pentaphragaceae of North America Update, database (version 2011). Updated for ITIS by the Flora of North America Expertise Network, in connection with an update for USDA Plants. Available from: [https://www.itis.gov/servlet/SingleRpt/SingleRpt?search\\_to\\_pic=TSN&search\\_value=506801#null](https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_to_pic=TSN&search_value=506801#null) [Accessed 16<sup>th</sup> May 2022].
- Anonymous. 2022 : Diversification of Tea. Available From: <https://slideplayer.com/slide/17449659/> [Accessed 13<sup>th</sup> September 2022].
- Arefin MR, Hossain MI, Rahaman MRU. 2020. Determination of Green Tea Recovery Percentage and Its Relation to Different Weather Parameters. Asian Plant Research Journal, 5(4): 48-56.
- Arent SM, Senso M, Golem DL. 2010. The effects of theaflavin-enriched black tea extract on muscle soreness, oxidative stress, inflammation, and endocrine responses to acute anaerobic interval training: A randomized, double-blind, crossover study. J. Int. Soc. Sport. Nutr, 7:11. DOI: 10.1186/1550-2783-7-11.
- Balentine DA, Harbowy ME, Graham HN. 1998. Tea: The Plant and Its Manufacture; Chemistry and Consumption of the Beverage. In Caffeine. edited by Gene A. Spiller. Boca Raton: CRC Press.
- Baruah P. 2015. Types of tea, value addition and product diversification of Indian tea. Proceedings of the First International Conference on Tea Science and Development, 151-159.
- Baruah S, Tamuly P, Bordoloi P, Bordoloi AK, Sabhapandit S, Gogoi R, Kalita JN, Bhuyan LP, Gogoi MN, Hazarika M. 2005. Technology for Product Diversification and Value Added Items of Tea. Proceedings of 34th Tocklai Conference, Tea Research Association, Tocklai Experimental Station, Jorhat, Assam, 63-69.
- Bharadwaz A, Bhattacharjee C. 2012. Extraction of Polyphenols from Dried Tea Leaves. International Journal of Scientific & Engineering Research, 3(5): 1-5.
- Bhatia IS. 1961. Composition of Leaf in Relation to Liquor Characteristics of Made Tea. Two and a Bud, 8, 3:11–14.
- Biernikiewicz M. 2010. Inspiration. 1st ed. SpaPartners; Wrocław, Poland, Spa&Wellness; pp. 21–35.
- Bode AM, Dong Z. 2003. Signal transduction pathways: targets for green and black tea polyphenols. BMB Reports, 36(1): 66-77.
- BTRI: Bangladesh tea Research Institute. A brief note on tea culture. 2022. pp 61-65.
- Campbell DL. 1995. The tea book. Gretna: Pelican Publishing. p. 116. ISBN 978-1-56554-074-3.
- Chen L, Apostolides Z, Zong-Mao C. 2012. Global Tea Breeding: Achievements, Challenges and Perspectives (Advanced Topics in Science and Technology in China). Hangzhou: Zhejiang University Press, pp: 229–234, ISBN-13: 978-3642318771.
- Chin JM, Michele M, Goldberger BA, Sampson-Cone A, Edward JC. 2008. Caffeine Content of Brewed Teas. Journal of analytical toxicology, 32. 702-4. DOI: 10.1093/jat/32.8.702.
- Chumpitazi BP, Kearns GL, Shulman RJ. 2018. The physiological effects and safety of Peppermint Oil and its efficacy in irritable bowel syndrome and other functional disorders. Alimentary Pharmacology and Therapeutics. 47 (6): 738–752. DOI:10.1111/apt.14519.
- CSIR-IHBT: Council of Scientific and Industrial Research-Institute of Himalayan Bioresource Technology. 2014. Annual Report 2013-2014. Palampur, Himachal Pradesh, India, pp.162
- Cynthia G, Lise S. 2010. Culinary tea: More than 150 recipes steeped in tradition from around the world. Philadelphia: Running Press. p. 274. ISBN 978-0-7624-37733.
- Devanathan MAV. 1974. Product Diversification for The Tea Industry. Tea Q, 44 (4): 177-181.

- Dramard V, Kern L, Hofmans J, Rème CA, Nicolas CS, Chala V, Navarro C. 2018. Effect of L-theanine tablets in reducing stress-related emotional signs in cats: an open-label field study. *Ir Vet J*, 71:21. DOI: 10.1186/s13620-018-0130-4.
- Dubrin B. 2012. *Tea Culture: History, Traditions, Celebrations, Recipes & More*. Charlesbridge, 2010. Illustrated Edition. ISBN 978-1936140701.
- Duke JA, Ayensu ES. 1985. *Medicinal plants of China*. Reference Publ., Inc., Algonac, MI. ISBN 0-917266-20-4.
- Edyгова SN. 2018. Wheat bread development using green tea infusion, In the collection: Improving the quality and safety of foodstuff Materials of the VIII All-Russian Scientific and Practical Conference, 151-152.
- FAOSTAT Gateway. 2022. Food and Agriculture Organization of the United Nations, <http://faostat3.fao.org/home/index.html>.
- Fatima M, Rizvi SI. 2011. Health benefits of black tea. *Biomedicine*, 31 (1): 3-8.
- Finsterer J. 2002. Earl Grey tea intoxication. *The Lancet*, 359: 1484. DOI: 10.1016/S0140-6736(02)08436-2.
- Francis Z, Sato D, Keith L, Follet P, Hamasaki RT. 2003. Small-scale Tea Growing and Processing in Hawaii. Hilo: College of Tropical Agriculture and Human Resources.
- Friedlander J, Blaine P. 2000. Food scientists pinpoint why bottled green tea is inferior to fresh brewed. *Cornell Chronicle*.
- Gascoyne K, Marchand F, Desharnais J, Americi H. 2018. *Tea: History, Terroirs, Varieties*. Firefly Books; Third edition.
- Gebely T. *Tea User Guide*, 2016. Print. Eggs and Toast Media, LLC. ISBN: 9780998103006 0998103004.
- Ghosh HN. 2006. *Tea and Health – Science Behind the Myths*, UBS Publisher's Distributors Ltd., New Delhi, India, pp.161
- Graham H. N. 1992. Green tea composition, consumption, and polyphenol chemistry, *Prev. Med.*, 2: 334-350 DOI: [http://dx.doi.org/10.1016/0091-7435\(92\)90041-F](http://dx.doi.org/10.1016/0091-7435(92)90041-F).
- Hajra NG, Yang CWM. 2015. Diversification of the tea product--Global scenario. *Journal of Tea Science Research*, 5(3): 1-15, DOI: 10.5376/just.2015.05.0002.
- Hajra NG. 2015. Diversification of the Tea Products---Global Scenario. *Journal of Tea Science Research*, 5(3): 1-15. DOI: 10.5376/jtsr.2015.05.0003.
- Hall N. 2000. *The Tea Industry*. Elsevier. pp. 33–36. ISBN 9781845699222. Retrieved 27 January 2016.
- Han T, Aye KN. 2015. The legend of laphet: A Myanmar fermented tea leaf. *Journal of Ethnic Foods*, 2(4): 173-178, DOI: <https://doi.org/10.1016/j.jef.2015.11.003>.
- Hara Y. 2001. *Green tea: health benefits and application*, Marcel Dekker, New York, USA, pp.252, ISBN 9780824704704. DOI: <http://dx.doi.org/10.1201/9780203907993>
- Harler CR. 1933. *The culture and marketing of tea*. Oxford Univ. Press, London, 3- 10.
- Heinrich U, Moore CE, De-Spirt S, Tronnier H, Stahl W. 2011. Green tea polyphenols provide photoprotection, increase microcirculation, and modulate skin properties of women. *J. Nutr.*, 141:1202–1208. DOI: 10.3945/jn.110.136465.
- Hernandez LM, Xu EG, Larsson HCE, Tahara R, Maisuria VB, Tufenkji N. 2019. Plastic Teabags Release Billions of Microparticles and Nanoparticles into Tea. ACS Publications. *Journal contribution*. 53(21): 12300-12310. <https://doi.org/10.1021/acs.est.9b02540.s001>.
- Hicks A. 2009. Current status and future development of global tea production and tea products. *AU J. T*, 12:251-264.
- Horie H. 2017. Chemical Components of Matcha and Powdered Green Tea. *Journal of Cookery Science of Japan*, 50 (5): 182–188. DOI:10.11402/cookeryscience.50.182.
- Horžić D, Jambrak AR, Cvitanović AB, Komes D, Lelas V. 2012. Comparison of conventional and ultrasound assisted extraction techniques of yellow tea and bioactive composition of obtained extracts. *Food and Bioprocess Technology*, 5(7): 2858-2870. DOI: 10.1007/s11947-012-0791-z.
- Hossain MI, Arefin MR, Ali M. 2017. Developing a sustainable and cost-effective protocol for manufacturing green tea. *Tea J. Bangladesh*, 46: 11-15.
- Hossain MI, Arefin MR. 2018. Developing quality white tea (artisan tea) manufacturing protocol by using different clone with their different combinations in respect of Bangladesh. *European Academic Research*, 6(3): 1352-1358.
- Huang LL, Jin JH, Quan C, Oskolski A. 2016. *Camellia nanningensis* sp. nov.: the earliest fossil wood record of the genus *Camellia* (*Theaceae*) from East Asia, 129. <https://doi.org/10.1007/s10265-016-0846>.
- ISO: International Organization for Standardization, ISO 3720:2011(EN): Black tea — Definition and basic requirements. Available from: <https://www.iso.org/obp/ui/#iso:std:iso:3720:ed-4:v1:en> [Accessed 16 May 2022].
- ITC: International Tea Committee. 2021. *Annual Bulletin of Statistics*, International Tea Committee LTD, London.
- Jeong D, Yun B, Yi Y. 2012. “Yeonnip-cha”. *Cha saenghwal munhwa daejeon* (in Korean). Seoul, Korea: Hongikjae. ISBN 978-89-714-3351-5.
- Jiao W, Xiao Y, Qian X, Tong M, Hu Y, Hou R. 2016. Optimized combination of dilution and refined QuEChERS to overcome matrix effects of six types of tea for determination eight neonicotinoid insecticides by ultra-performance liquid chromatography-electrospray tandem mass spectrometry. *Food Chemistry*, 210: 26-34. DOI: 10.1016/j.foodchem.2016.04.097.
- Jingyi X, Wang M, Zhao J, Wang YH, Tang Q, Khan IA. 2018. Yellow tea (*Camellia sinensis* L.), a promising Chinese tea: Processing, chemical constituents and health benefits. *Food Research International*, 107: 567-577. DOI: <https://doi.org/10.1016/j.foodres.2018.01.063>.
- Juneja LR, Chu DC, Okubo T, Nagato Y, Yokogoshi H. 1999. L-theanine-a unique amino acid of green tea and its relaxation effect in humans. *Trends Food Sci Technol*, 10:199–204.
- Karori SM, Wachira FN, Wanyoko JK, Ngure RM. 2007. Antioxidant capacity of different types of tea products. *African Journal of Biotechnology*, 6 (19):2287-2296.
- Khan AQ, Biswas A, Zohora KFT, Saha AK. 2013. Effect of poultry manure on the yield of mature tea vis-à-vis soil properties. *Tea J. Bangladesh*, 42: 37-43.
- Kiple KF, Ornelas K. 2000. *The Cambridge World History of Food*. Vol. 2. Cambridge, UK: Cambridge University Press. ISBN 0-521-40216-6. Archived from the original on May 4, 2012.
- Koch W, Zagórska J, Marzec Z, Kukula-Koch W. 2019. Applications of Tea (*Camellia sinensis*) and its Active Constituents in Cosmetics. *Molecules*, 24(23): 4277. DOI: 10.3390/molecules24234277.
- Kuhnert N, Drynan JW, Obuchowicz J, Clifford MN, Witt M. 2010. Mass Spectrometric Characterization of Black Tea Thearubigins Leading to an Oxidative Cascade Hypothesis for Thearubigin Formation. *Rapid Communications in Mass Spectrometry*, 24(23): 3387–3404.
- Kukula-Koch W, Aligiannis N, Halabalaki M, Skaltsounis AL, Glowniak K, Kalpoutzakis E. 2013. Influence of extraction procedures on phenolic content and antioxidant activity of Cretan barberry herb. *Food Chem*, 138:406–413. DOI: 10.1016/j.foodchem.2012.10.045.
- Kumar SS, Bhavan NS. 2016. The problems and prospects of Indian tea industry-an analysis. *Int. J. Appl. Bus. Eco. Res*, 14 (14): 9893-9902.
- Kupeli E, Sahin FP, Calis I, Yesilada E, Ezer N. 2007. Phenolic compounds of *Sideritis ozturkii* and their *in vivo* anti-inflammatory and antinociceptive activities. *Journal of Ethnopharmacology*, 112: 356-360.
- Kuroda Y, Hara Y. 2004. *Health effects of tea and its catechin*. Kluwer Academic/ Plenum Publishers, New York, USA, pp.109, ISBN: 030648207X, 9780306482076, DOI: <http://dx.doi.org/10.1007/978-1-4757-5390-5>



- Lamer-Zarawska E, Kowal-Gierczak B, Niedworok J, Fitoterapia, Roślinie L. 1st ed. 2012. Wydawnictwo Lekarskie PZWL; Warsaw, Poland, pp. 136–140.
- Li M, Zhang JH, Zhu KX, Peng W, Zhang SK, Wang B. 2012. Effect of superfine green tea powder on the thermodynamic, rheological and fresh noodle making properties of wheat flour. *Lebensmittel-Wissenschaft und -Technologie- Food Science and Technology*, 46, 23–28.
- Li Q, Chai S, Li YD, Huang JA, Luo Y, Xiao LZ, Liu ZH. 2018. Biochemical components associated with microbial community shift during the pile-fermentation of primary dark tea. *Front. Microbiol*, 9.
- Linda Carroll and Danielle Wolf, 2016. Available From: <https://www.today.com/series/one-small-thing/top-10-health-benefits-drinking-tea-t81111> [Accessed 8<sup>th</sup> September 2022].
- Ling-Ling D, Qiu-Yue F, Li-Ping X, Xin-Qiang Z, Ji L, Jian-Hui Y, Li Q, Curt P, Yue-Rong L. 2016. Tea Polysaccharides and Their Bioactivities. *Molecules*, 21: 1449. DOI: 10.3390/molecules21111449.
- Lu TM, Lee CC, Mau JL, Lin SD. 2010. Quality and antioxidant property of green tea sponge cake. *Food Chemistry*, 119: 1090–1095.
- Luczaj W, Skrzydlewska E. 2005. Antioxidative properties of black tea. *Prev Med*, 40: 910–918.
- Luo Y. 2012. Taiwan's Green Gold-High Mountain Tea. *Art of Tea*, 13.
- Majewska K, Older D, Pawelczyk A, Zaprutko T, Żwawiak J, Zaprutko L. 2010. Aktywne kosmetyki wśród produktów spożywczych. *Homines Hominibus*, 6:65–96.
- Mishra AK, Mishra A, Chattopadhyay P. 2011. Herbal cosmeceuticals from ultraviolet B radiation: A review. *Trop. J. Pharm. Res*, 10:351–359. DOI: 10.4314/tjpr.v10i3.7.
- Miyazawa T, Nakagawa K, John S, Chi-Tang H, Fereidoon S. 2005. Functional foods and products from Japanese green tea, In: *Asian functional foods*. Marcel Dekker/CRC Press, USA, pp.525-530. ISBN: 9780429113864
- Mnich CD, Hoek KS, Virkki LV, Farkas A, Dudli C, Laine E, Urosevic M, Dummer R. 2009. Green tea extract reduces induction of p53 and apoptosis in UVB-irradiated human skin independent of transcriptional controls. *Exp. Dermatol*, 18:69–77. DOI: 10.1111/j.1600-0625.2008.00765.x.
- Müller N, Ellinger S, Altheld B, Merzenich GU, Heiner K, Berthold, Vetter H, Stehle P. 2010. Bolus ingestion of white and green tea increases the concentration of several flavan-3-ols in plasma, but does not affect markers of oxidative stress in healthy non-smokers." *Molecular nutrition & food research*, 54(11): 1636-1645.
- Newman JM. 2007. Lapsang Souchong Tea. *Flavor and Fortune*, 14 (3): 9–10.
- Nilova L, Pilipenko T, Malyutenkova S. 2017. In investigation into the effects of bioactive substances from vegetable oils on the antioxidant properties of bakery products. *Agronomy Research*, 15(52): 1399-1410.
- Perry S. 2001. *The New Tea Book: A Guide to Black, Green, Herbal and Chai Teas*. Chronicle Books. p. 40. ISBN 9780811830539.
- Peterson J, Dwyer J, Bhagwat S, Haytowitz D, Holden J, Eldridge AL, Aladesamni J. 2005. Major Flavonoids in Dry Tea. *Journal of Food Composition and Analysis*, 18: 487-501. DOI: <http://dx.doi.org/10.1016/j.jfca.2004.05.006>
- Phongnarisorn B, Orfila C, Holmes M. 2018. Enrichment of Biscuits with Matcha Green Tea Powder: Its Impact on Consumer Acceptability and Acute Metabolic Response. *Ref. Libr.*, 7(2): 116-118.
- Reeves SG, Owuor PO, Othieno CO. 1987. Biochemistry of Black Tea Manufacture. *Trop. Sci*, 27: 121-133.
- Ribeiro BD, Coelho MAZ, Rebelo LPN, Marrucho IM. 2013. Ionic Liquids as Additives for Extraction of Saponins and Polyphenols from Mate (*Ilex paraguariensis*) and Tea (*Camellia sinensis*). *Industrial & Engineering Chemistry Research*, 52 (34): 12146-12153. DOI: 10.1021/ie400529h\
- Richardson L B. 2009. *Tea with a twist: Entertaining and cooking with tea*. Eugene, OR: Harvest House Publishers. p. 12. ISBN 978-0-7369-2579-2.
- Robb CS, Brown PR. 2001. Catechins in Tea: Chemistry and Analysis. *Advances in Chromatography*, 41: 379-410.
- Roberts EAH. 1962. Economic Importance of Flavonoid substances: Tea fermentation in the Chemistry of flavonoid compounds (ed, TA Geieeman), Pergamon, Oxford, 468-512.
- Rubin R, Gold SA. 2002. *Tea Chings: The Tea and Herb Companion*. Newmarket Press. p. 101. ISBN 9781557044914.
- Rusak G, Komes D, Likić S, Horžić D, Kovač M. 2008. Phenolic content and antioxidative capacity of green and white tea extracts depending on extraction conditions and the solvent used. *Food Chemistry*, 110(4): 852-858.
- Sabetay S. 1972. *Camellia* seed oil: The seed oil of *Camellia japonica* L. and its uses in cosmetology and dermo-pharmacy. *Soap Perfumery Cosmetics*, 45: 244-252.
- Saha AK, Biswas A, Zohora KFT, Ali NM, Chowdhury FJ. 2022. Response of Organic and Inorganic Sources of Manure and Fertilizer on Soil Properties and Yield of Tea. *Tea J. Bangladesh*, 48: 1-13.
- Sana DL. 1989. *Tea Science*. Ashrafia Boi Ghar. Page 04-06.
- Sezai E, Emine O, Ozlem O, Memnune S, Neva G. 2008. Seasonal Variation of Total Phenolic, Antioxidant Activity, Plant Nutritional Elements, and Fatty Acids in Tea Leaves Grown in Turkey. *Pharmaceutical Biology*, 46, 683–87.
- Shanan H, Ying G. 1982. The comprehensive utilization of camellia fruits. *Am. Camellia Yearbook*, 37:104–107.
- Sinija VR, Mishra HN. 2008. Green tea: Health benefits. *Journal of Nutritional & Environmental Medicine*, 17(4): 232–242.
- Smith K. 2016. *World Atlas of Tea*. Great Britain: Mitchell Beazley. p. 107. ISBN 978-1-78472-124-4.
- Source.01: White Tea. Available From: <https://www.indiamart.com/proddetail/white-tea-12378687691.html>. [Accessed 8<sup>th</sup> September 2022].
- Source.02: White tea liquor. Available From: <https://www.drozshow.com/autophatea>. [Accessed 8<sup>th</sup> September 2022].
- Source.03: Yellow Tea. Available From: <https://medium.com/@denisegascoigne/yellow-tea-a-little-known-tea-with-remarkable-health-benefits-65f3059c8536> [Accessed 8<sup>th</sup> September 2022].
- Source.04: Dark Tea. Available From: <https://www.medicalnewstoday.com/articles/319646> [Accessed 8<sup>th</sup> September 2022].
- Source.05: Loose Tea. Available From: <https://www.indiamart.com/proddetail/bps-tea-20646535062.html> [Accessed 8<sup>th</sup> September 2022].
- Source. 06: Lipton Tea Bags. Available From: <https://time.com/3996712/a-brief-history-of-the-tea-bag/> . [Accessed 8<sup>th</sup> September 2022].
- Source.07: Modern Tea bags. Avail From: [https://en.wikipedia.org/wiki/File:Tea\\_bags.jpg](https://en.wikipedia.org/wiki/File:Tea_bags.jpg). [Accessed 8<sup>th</sup> September 2022].
- Source.08: Tea-Tuna Salad. Available From: <https://www.watsons.co.th/blog/th/latest-trend-th/6> [Accessed 8<sup>th</sup> September 2022].
- Source.09: Leaf Lahpet. Available From: <https://medium.com/@w7.hlaingmz.au/burmese-traditional-food-tea-leaf-lahpet-7d834ec83941>. [Accessed 8<sup>th</sup> September 2022].

- Source.10: Leaf Lahpet Available From: [https://www.researchgate.net/publication/285215682\\_The\\_legend\\_of\\_lahpet\\_A\\_Myanmr\\_fermented\\_ethnic\\_food/figure/s?lo=1](https://www.researchgate.net/publication/285215682_The_legend_of_lahpet_A_Myanmr_fermented_ethnic_food/figure/s?lo=1). [Accessed 8<sup>th</sup> September 2022].
- Source.11: Tea Bread. Available From: <https://www.bbcgoodfood.com/recipes/tea-loaf>. [Accessed 8<sup>th</sup> September 2022].
- Source.12: Tea Ice Cream. Available From: <https://www.samanthaseeley.com/matcha-green-tea-ice-cream/>. [Accessed 8<sup>th</sup> September 2022].
- Source.13: Tea Cake. Available From: <https://depositphotos.com/95933850/stock-photo-green-tea-cake.html>. [Accessed 8<sup>th</sup> September 2022].
- Source.14: Green tea rice or ochazuke. Available from: <https://www.justonecookbook.com/ochazuke/>. [Accessed 8<sup>th</sup> September 2022].
- Source.15: Japanese Soba noodle or Cha Soba. Available From: <https://www.japancentre.com/en/recipe/1265-cold-green-tea-soba-noodles>. [Accessed 8<sup>th</sup> September 2022].
- Source.16: Canned Tea. Available From: <https://www.teatulia.com/products/easy-green-canned-iced-tea-case.html>. [Accessed 8<sup>th</sup> September 2022].
- Source.17: Bottled Tea. Available From: [https://en.wikipedia.org/wiki/Teh\\_botol](https://en.wikipedia.org/wiki/Teh_botol). [Accessed 8<sup>th</sup> September 2022].
- Source.18: Instant Tea. Available From: <https://www.outsideonline.com/food/our-favorite-instant-tea-backcountry/>. [Accessed 8<sup>th</sup> September 2022].
- Source.19: Carbonated Tea. Available From: <https://www.teatulia.com/tea-soda/tea-soda-recipes.html>. [Accessed 8<sup>th</sup> September 2022].
- Source.20: Tea Wine. Available From: <https://www.delicious.com.au/drinks/wine-champagne/article/tea-wine-combines-two-worlds-favourite-beverages-into-one-bottle/qkd8ub1w> [Accessed 8<sup>th</sup> September 2022].
- Source.21: Tea Cider. Available From: <https://www.portlandcider.com/imperial-peachtea> [Accessed 8<sup>th</sup> September 2022].
- Source.22: Altered Tea. Available From: <https://www.tea-exclusive.de/media/image/product/680/md/2008-yiwu-wild-arbor-pu-erh-fladen-400g.jpg> [Accessed 8<sup>th</sup> September 2022].
- Source.23: Roasted Tea. Available From: <https://perfectsouth.com.au/shop/estate-green-tea/estate-houjicha/> [Accessed 8<sup>th</sup> September 2022].
- Source.24: Decaffeinated Tea. Available From: <https://new.igashop.com.au/sm/pickup/rsid/52511/product/di1mah-decaffeinated-tea-bag-393500> [Accessed 8<sup>th</sup> September 2022].
- Source.25: Flowering Tea. Available From: [https://en.wikipedia.org/wiki/Flowering\\_tea](https://en.wikipedia.org/wiki/Flowering_tea) [Accessed 8<sup>th</sup> September 2022].
- Source.26: Bubble Tea. Avail From: <https://www.pinterest.com/pin/294000681931768249/> [Accessed 8<sup>th</sup> September 2022].
- Source.27: Jasmine Tea. Available From: <https://kingdynasty.com.au/blog/3-teas-to-try-at-yum-cha/> [Accessed 8<sup>th</sup> September 2022].
- Source.28: Osmanthus Tea. Available From: <https://thefoodxp.com/incredible-osmanthus-tea/> [Accessed 8<sup>th</sup> September 2022].
- Source. 29 : Rose Congou Tea. Available From: <https://www.facebook.com/CrumpetsTeaShop/photos/a.651124201607070/2454892327896906/?type=3> [Accessed 11<sup>th</sup> September 2022].
- Source.30: Chrysanthemum Tea. Available From: [https://en.wikipedia.org/wiki/Chrysanthemum\\_tea](https://en.wikipedia.org/wiki/Chrysanthemum_tea) [Accessed 11<sup>th</sup> September 2022].
- Source.31: Lotus Tea. Available From: [https://commons.wikimedia.org/wiki/File:Lotus\\_flower\\_tea\\_3.jpg](https://commons.wikimedia.org/wiki/File:Lotus_flower_tea_3.jpg) [Accessed 11<sup>th</sup> September 2022].
- Source.32: Bakha Cha. Available From: [https://commons.wikimedia.org/wiki/File:Bakha\\_cha\\_1.jpg](https://commons.wikimedia.org/wiki/File:Bakha_cha_1.jpg) [Accessed 11<sup>th</sup> September 2022].
- Source.33: Pandan Tea. Available From: <https://www.shutterstock.com/search/pandan-tea> [Accessed 11<sup>th</sup> September 2022].
- Source.34: Earl Grey Tea .Available From: <https://www.amazon.com/Harney-Sons-Black-Loose-Ounce/dp/B00C1ZQHEK> [Accessed 11<sup>th</sup> September 2022].
- Source.35: Genmaicha or Brown Rice tea. Available From: [https://en.wikipedia.org/wiki/File:Genmaicha\\_tea\\_brewed\\_and\\_unbrewed.jpg](https://en.wikipedia.org/wiki/File:Genmaicha_tea_brewed_and_unbrewed.jpg) [Accessed 11<sup>th</sup> September 2022].
- Source.36: Lapsang souchong Tea. Available from: <https://www.amazon.com/Harney-Sons-Loose-Lapsang-Souchong/dp/B000PYDJU> [Accessed 13<sup>th</sup> September 2022].
- Source.37: Spiced Tea or Masala-Chai. Available From: <https://timesofindia.indiatimes.com/life-style/food-news/how-to-make-masala-chai-at-home/articleshow/69027092.cms> [Accessed 11<sup>th</sup> September 2022].
- Source.38: Tea Saponin. Available From: <https://all.biz/cn-en/tea-saponin-75-g535676> [Accessed 11<sup>th</sup> September 2022].
- Source.39: Tea Oil. Available From: <https://www.walmart.com/ip/2-Pack-Spring-Valley-Tea-Tree-Skin-Health-Oil-2-Oz/965250613> [Accessed 11<sup>th</sup> September 2022].
- Source. 40. Available From: <https://www.spiceography.com/matcha-powder-substitute/> [Accessed 11<sup>th</sup> September 2022].
- Source.41: Tea Soap. Available From: <https://www.amazon.com/Green-Natural-Aromatherapy-Herbal-Soap/dp/B00113O0DS> [Accessed 11<sup>th</sup> September 2022].
- Source. 42: Tea Cream. Available From: <https://www.refinery29.com/en-us/shop/product/matcha-pudding-antioxidant-cream-10073638> [Accessed 11<sup>th</sup> September 2022].
- Source. 43: Tea Shampoo. Available From: <https://herbaessences.com/en-us/our-products/tea-tree/tea-tree-shampoo/> [Accessed 11<sup>th</sup> September 2022].
- Source.44: Tea Cleansing Foam. Available From: <https://www.amazon.ca/Innisfree-Green-Pure-Cleansing-Foam/dp/B0119Q9FYU> [Accessed 11<sup>th</sup> September 2022].
- Source.45: Tea Toothpaste. Available From: <http://www.signee.net/home/productsdet/Mzc=Mw==> [Accessed 11<sup>th</sup> September 2022].
- Source.46: Tea Face Mask. Available From: <http://kimlovesskincare.blogspot.com/2020/06/review-skin79-green-tea-purifying-clay.html> [Accessed 11<sup>th</sup> September 2022].
- Stuart C. 1919. A Basis for tea selection. Bult. Diija,,dinBot. Buitenz., 1, 193- 320.
- Swarnathilake D, Don A. (2020). Improving the quality and the taste of green tea ice cream by identifying suitable cultivar, agronomic practices and processing techniques of Assamica tea grown in Sri Lanka. World Journal of Advanced Research and Reviews. 8. 062-068. 10.30574/wjarr.2020.8.1.0354.
- Takeda Y. 2007. Review of the tea breeding of Japan in the past one hundred years and its future objects. Tea Res. Rept, 103: 1-39.
- Tocklai TRI: Tocklai Tea research Association of India. 2022. Available from: <https://www.tocklai.org/activities/tea-cultivation/>. [Accessed 17 may, 2022]
- Venditti E, Bacchetti T, Tiano L, Carloni P, Greci L, Damiani E. 2010. Hot vs. cold water steeping of different teas: do they affect antioxidant activity?. Food Chemistry, 119(4): 1597-1604.

- Vinson JA, Teufel K, Wu N. 2004. Green and black teas inhibit atherosclerosis by lipid, antioxidant, and fibrinolytic mechanisms. *J. Agric. Food Chem.*, 52:3661–3665. DOI: 10.1021/jf0352551.
- William HU. 1935. All about Tea. The Tea and Coffee Trade Journal Company, 1: 268.
- Wilson KC. 1992. Tea: Cultivation to Consumption. London: Chapman & Hall.
- Wojciech K, Justyna Z, Zbigniew M, Wirginia K. 2019. Applications of Tea (*Camellia sinensis*) and Its Active Constituents in Cosmetics. *Molecules*, 24(23): 4277.
- Wu J. 2020. “What Makes Bubble Tea Popular ? Interaction between Chinese and British Tea Culture”. *The Frontiers of Society, Science and Technology*. 2 (16): 97–102. DOI:10.25236/FSST.2020.021614.
- Xia L, Zhang A, Xiao T. 1993. An introduction to the utilization of camellia oil in China. *Am. Camellia Yearbook*. 48:12–15.
- Xu M, Wu Y, Gary G, Du HX. 2019. Evaluation of different tea extracts on dough, textural, and functional properties of dry Chinese white salted noodle. *LWT*, 101: 456–462, ISSN 0023-6438, <https://doi.org/10.1016/j.lwt.2018.11.066>.
- Yang CS, Chung JY, Yang GY, Chhabra SK, Lee MJ. 2000. Tea and tea polyphenols in cancer prevention. *The Journal of nutrition*, 130(2): 472–478.
- Yarnell E, Abascal K. 2012. Herbal sunscreens and ultraviolet protectants. *Altern. Compl. Ther.*, 18:141–144. DOI: 10.1089/act.2012.18307.
- Yashin A, Nemzer B, Combet E, Yakov, Yashin I. 2015. Determination of the Chemical Composition of Tea by Chromatographic Methods: A Review. *Journal of Food Research*, 4. DOI: 10.5539/jfr.v4n3p56.
- Yu XL, He Y. 2018. Tea saponins: Effective natural surfactants beneficial for soil remediation, from preparation to application. *RSC Advances*, 8. 24312–24321. DOI: 10.1039/C8RA02859A.
- Yuming W, Li T, Xu S, Ni T, Deng WW, Ning J. 2021. The profile of dynamic changes in yellow tea quality and chemical composition during yellowing process. *LWT*, 139. DOI: <https://doi.org/10.1016/j.lwt.2020.110792>.
- Zhang L, Zhang ZZ, Zhou YB, Ling TJ, Wan XC. 2013. Chinese dark teas: postfermentation, chemistry and biological activities. *Food Res. Int.*, 53 (2): 600–607.
- Zhang Q, Wu S, Li Y, Liu M, Ni K, Yi X. 2019. Characterization of three different classes of non-fermented teas using untargeted metabolomics. *Food Research International*, 121: 697–704. DOI: 10.1016/j.foodres.2018.12.042.
- Zheng WJ, Wan XC, Bao GH. 2015. Brick dark tea: a review of the manufacture, chemical constituents and bioconversion of the major chemical components during fermentation. *Phytochem. Rev.*, 14 (3): 499–523.
- Zhu MZ, Li N, Zhou F, Ouyang J, Lu DM, Xu W, Li J, LiN HY, Zhang Z, Xiao JB, Wang KB, Huang JA, Liu ZH, Wu JL. 2020 Microbial bioconversion of the chemical components in dark tea. *Food Chem.*, 312: 126043.