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MINI REVIEW

A review on current trend of next generation of teas

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Abstract

Several herbs are presently used in the food industry as functional additives, such as botanic extracts in healthy drinks. Rapid population growth uses healthy drinks for slimming, weight control, and various other beauty applications. In Asian countries, the custom of tea consumption is highly prevalent. Caffeine is the most commonly used behaviourally active ingredient in the world. Tea and coffee are the main product of daily caffeine intake. The review aimed to describe the word 'next-generation tea' and the implication of herbal tea/drinks which typically refers to healthy drinks produced using fresh or dried herbs, leaves, immature berries, seeds, and roots of the source material, such as infusion or boiling. Next-generation teas are rich in natural, bioactive compounds, including carotenoids, flavonoids, phenolic acids, alkaloids, coumarins, polyacetylene, terpenoids, and saponins. Traditional review methodology with practical and methodological screening was done to determine the appropriate reference sources. Various empirical research has demonstrated that bioactive compounds are responsible for multiple diversified biological functions, including anticarcinogenicity, antimutagenicity, and antiaging effects such as antibacterial, antioxidant, and antiviral. The next generation tea has more diverse bioactive compounds than *Camellia sinensis* L. based teas which make it potential as a healthy drink.

1. Introduction

The increasing number of degenerative diseases and more consumer awareness of food and health connections have increased the functional food demand. Tea is a boiling soft drink, macerating or infusion in the hot or cold water of plant materials, for example, fresh or dried leaves, flowers, roots, and stems (En and Willy, 2016). Tea is a significant source of polyphenols in human consumption due to the widespread application thereof. Tea is one of the cheapest beverages globally and is consumed by a wide range of age groups at any level of society. *Camellia sinensis* L. is the most popular tea plant, the evergreen shrub, and it is an essential industrial plant with a long history of fresh tea leaves and buds (Theppakorn *et al.,* 2014; Chen, Ding, Chen *et al.,* 2020). *Camellia sinensis* L. is an eastern and southeast Asian plant commonly grown and consumed in Japan, China, Sri Lanka, Taiwan, and India (Granato *et al.,* 2014). Every day there are more than 13 million consumers worldwide (Spizzirri *et al.,* 2019).

Tea is considered a part of the worldwide drinks market and is not seen as a commodity in isolation and the active ingredients are of concern to the demand for functional foods. Caffeine is the most widely consumed behaviorally active substance in tea. The amount of caffeine literature focuses on the level of use and its physiological consequences. However, youth can use caffeine beverages for social reasons or gain an energy boost in their activities (Tseng *et al.,* 2014).

Chemical ingredients of tea have been shown as tea polyphenols (TPP), amino acid, organic acid, tea polysaccharide (TPS), protein, lignin, lipid, pigment, and inorganic elements (Du *et al.,* 2016; Verloop *et al*., 2016). These chemical ingredients include alkaloids (methylxanthines, e.g., caffeine, theophylline, theobromine), polyphenols (flavonoids and catechins), volatile oils, amino acids (γ-n-ethyl glutamine), non-protein amino acids (GABA and L-theanine), polysaccharides, lipids, inorganic elements (e.g., fluorine, manganese, and aluminium), vitamins (e.g.,

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vitamin C), and polyamines (e.g., spermidine and spermine) are found in tea leaves, and infusions (Nie and Xie, 2011; da Silva Pinto, 2013; Sahab *et al.,* 2020).

Flavonoids and polysaccharides are major components of tea. Tea is one of the most abundant sources of polyphenols, with a 30% antioxidant component, and is widely consumed (Drywień *et al*., 2015). Recent research has shown the potential for one of the polyphenols, EGCG, and theaflavins contained in black tea as a potential antiviral for SARS-CoV-2 with an inhibitory mechanism of RdRp SARS-Cov-2 (Mhatre *et al.*, 2020). Furthermore, polysaccharides of tea serve as a structural feature of the tea cell wall, and the extraction process will depend on the cell wall composition (Nie and Xie, 2011). The quality of polysaccharides, physicochemical attributes, and bioactivity of tea polysaccharides (TPS) are closely connected to the source of tea (Chen *et al.,* 2009; Scoparo *et al.,* 2013). The potential of TPS to improve human health through several pharmacological and bioactivity such as hepatoprotective, antioxidant, immune-stimulating, antiviral, antidiabetic, antibacterial, and antitumour activities (Chen *et al.,* 2016).

According to many *in vivo* and *in vitro* studies, green tea is one of the most effective cancer preventives. Sueoka *et al.* (2001) focused on its inhibitory effect on the expression of TNF genes mediated by inhibition of NF-B and activation of AP-1. This study found that individuals who consumed more than 10 cups of green tea per day had a lower relative risk of coronary disease. These findings indicate that chronic inflammatory disorders and lifestyle-related diseases have protective effects on tea, such as cancer and cardiovascular disease.

While the famous green and black tea are made from *Camellia sinensis L.* leaves, tea can be made with water infusion of the roots, leaves, blossoms, flowers, immature berries, seeds, and other segment portions of an immensely different part of plant species. These teas contain an abundance of mixtures and could assume a critical part in conveying supplements and synthetic substances to increase low-quality diets (Poswal *et al.,* 2019). The term tea is less precise, as it does not contain any *Camellia sinensis L.* leaves. The typic tisane is the proper term for the herbal mix. Herbal Tisanes (teas) are made up of various flowers, spices, flavours, and dried organic items that are generally caffeine-free (Rabade *et al.,* 2016). Herbal tisane, a tea that is not made from *Camellia sinensis L.,* which is rich in natural bioactive compounds, has the potential to be the next-generation tea. This review aimed to define the term "next-generation tea" which often refer to healthy drinks made from fresh or dried plant material, such as infusion or boiling.

2. Tea production

More than 200 types of most representative commercial tea products in China have been attempted to classify tea in various methods, including form, tenderness of tea leaves, production season, cultivation area, manufacturing method, and sensory profile (Feng *et al*., 2019). Generally accepted concepts of tea classification are divided into six groups in China: unfermented (green tea), mildly (white tea, yellow tea), semi-fermented (oolong tea), and post-fermented (dark tea) (Ning *et al.,* 2017). Table 1 shows *Camellia sinensis L.* tea with various levels of fermentation. The fermentation levels are then described as dark or black tea - oolong - white or yellow tea - green tea (Teshome, 2019). Tea properties are dependent primarily on the quality of nitrogen, caffeine, amino acids, polyphenols, catechin (C), catechin gallate (CG), gallocatechin (GC), epigallocatechin (EGC), epicatechin gallate (ECG), complete catechin, epicatechin (EC), theaflavin-30-gallate (TF30G) and theaflavin (TF) and pigments (Liang *et al*., 2003; Yan *et al*., 2020; Musial *et al*., 2020). The free amino acids in green tea are the main contributors to sweet taste. At the same time, catechin and its oxidation derivatives are mainly responsible for tea drinks' bitter tastes and astringents (Scharbert and Hofmann, 2005). The bitterness of pure caffeine is unpleasant to taste, but the bitterness is reduced by combining catechin and theaflavins (TFs).

Plucking takes in the fields between 0-1200 m and 1200-2000 m every ten days. Flush or fresh tea picked with two leaves and buds or more. Approximately 20-30 kg were picked, weighed, and delivered to the factory in baskets or gunny bags. Black tea is produced by withering, rolling, roll-breaking, green leaf sifting, fermenting, drying, sorting or grading, and packaging and labeling for shipping (Narukawa *et al.,* 2010).

Fermentation or oxidative processing refers to the oxidative enzymes process, for example, Polyphenol Oxidases (PPO), which cause enzyme browning reactions in tea leaf cells. The various varieties of tea vary fundamentally in the degree to which the oxidative processing contributes to the conversion of flavon-3-ols in green tea (minimally processed) into theaflavins (dimeric form) and thearubigin (oligomeric/polymeric structure) in oolong (partially oxidized) and black tea (complete oxidation) (da Silva Pinto, 2013). Major compound changes in fermentation are shown in Figure 1. This procedure, therefore, does not only affect the content of the primary tea polyphenols. It is the most critical process of developing tea pigments and unique flavours such as theaflavin and thearubigins (Zhang *et*

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Table 1. *Camellia sinensis L.* tea with various levels of fermentation

Type	Process	Characteristic	Chemical compound	Sources
Green tea	Dried and heated to prevent enzymatic oxidation of catechin	Dominant features of acidic taste, astringent aftertaste, green flavor, dried taste, and dry scent.	Flavonoids, phenolic acids, and other more minor compounds.	Adawiyah *et al.* (2019); Granato *et al.* (2014)
Yellow tea	Similar to green tea with a different phase of chlorophyll hydrolysis. The mechanism of inactivation of the enzyme in yellow tea is slower so that through oxidizing enzymes, the fresh tea leaves can become yellow.	Similar characteristics as compared to green tea	Theanine, aspartic acid, glutamic, catechin, flavonoid, flavonoids, caffeine, soluble sugars, and free amino acids	Granato *et al.* (2014); Wei *et al.* (2021); Zhang *et al.* (2019)
White tea	White hairs on the tea surface will be withered after harvested fresh and immediately dried to prevent enzymatic oxidation of catechin.	A rich pubescence and tea infusion are more evident than black tea.	Chlorophyll is retained during the processing of white tea	Granato *et al*. (2014)
Oolong tea	Semi-fermented, the degree of enzymatic oxidation performed is lower than that of black	Flavor and color between green and black tea.	Amino acids, Glycosides, flavonol, proanthocyanidin, flavonol, terpenoid	Chen, Liu, Zhao *et al.* (2020)
Black tea	Fresh tea leaf catechin is oxidized completely by polyphenol oxidases and peroxidases.	The enzymatic oxidation of polyphenols initiates the formation of the color chemical components, TFs and TRs.	Theaflavins, thearubigens, 14 flavon-3 -ol, catechin, glycopyranoside,	Granato *et al.* (2014); Liang *et al.* (2003); Scharbert and Hofmann (2005)
Red Tea	Fully oxidized and fermented in a solution of dark-colored (reddish).	Red-brown infusion color.	Contain the lowest content of catechin, epicatechin, epigallocatechin, and	Chen *et al.* (2016); Granato *et al.* (2014)
Dark Tea	Use aerobic or anaerobic microbial heat fe[illegible] le[illegible]	Dark-brown infusion color.	Free amino acids, gallic acid, and six tea catechins	Chen *et al.* (2016); Gong *et al.* (2020)

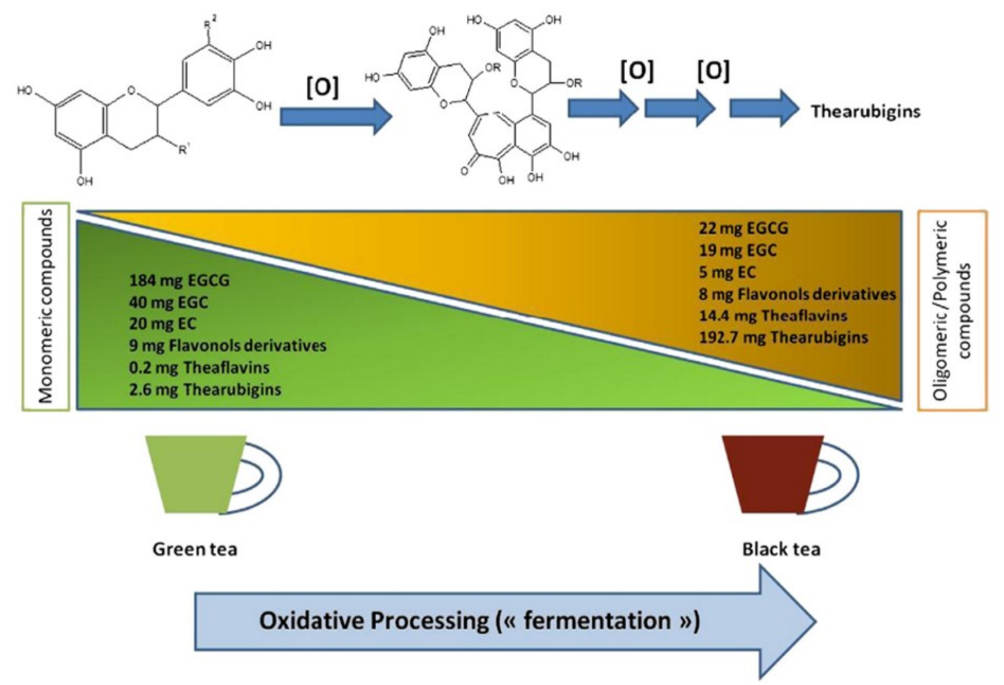

Figure 1. Major compounds change in green and black teas on fermentation (da Silva Pinto, 2013)

al., 2011).

Since oxidation starts at the rolling stage itself, the time between these stages is a critical factor as the degree of oxidation decides the consistency of the tea. The lower content of catechin gallate was closely associated with the low astringency and bitterness infusion of yellow tea, leading to umami and sweetness by aggregating soluble sugars and free amino acids (Narukawa *et al.,* 2010). The aggregation of soluble sugars and free amino acids improved the tea infusion's clarity and yellow colour, resulting in pre-drying leaves with lower water content (Wei *et al.,* 2020). Then the leaves are dried with hot air to avoid the oxidation process. In the end, the leaves are sorted into grades according to their sizes (whole leaf, split-leaf, fanning, and dust) (Adawiyah *et al.,* 2019).

The tea processing differentiates between tea and other types, such as the processing of dark tea and oolong tea. The primary step in processing dark tea is known to be microbial fermentation. The stacked rolling leaves should be kept for 24-40 hours in a room above 25°C during the microbial fermentation phase, the relative humidity (RH) of these leaves should be 85%, to initiate complex oxidation, condensation, and degradation of chemical tea components (Zheng *et al.,* 2015). Meanwhile, the oolong tea process commonly takes two days for traditional oolong tea processing, including leaf plucking, withering, zuoqing or bruising and withering, shaking or green-making, fixation or fixation de-greening (Granato *et al.,* 2014; Chen, Ding, Chen *et al.,* 2020). The variations in the related tea processing processes are described in Figure 2.

Figure 2. Various *Camellia sinensis* L. tea with different process (Zhu *et al.,* 2020).

The effect of various processes influences variations in the sensory characteristics of tea. During oolong tea fermentation, modifications of flavour-related metabolites associate with several stresses (Zeng *et al.,* 2020). Injury tension from YaoQing's step changes the flavanols mixture, proanthocyanidins, glycosides of flavonol, theaflavins, and amino acids. This compound enriches the distinctive flavour of oolong tea (Chen, Liu, Zhao *et al.,* 2020). Moreover, oolong tea induces unique aromas such as jasmine lactone α-farnesene, indole, (E)-nerolidol, phenyl ethyl alcohol, ocimene, and acetaldehyde benzene (Mei *et al.,* 2017). In addition, the prolonged TanQing process is essential for aroma accumulation; apart from YaoQing, these findings will provide a valuable framework for improving processes for high-quality oolong tea production (Chen, Liu, Zhao *et al.,* 2020).

3. Diversity of next-generation tea

Next-generation tea has become popular in various regions such as Asia, Africa, America, and Europe. Herbal teas or tisane are next-generation tea and are well known as herbal beverages consumed globally for centuries (Poswal *et al.,* 2019). Herbal drinks, known as next-generation tea and popular drinks such as tea, coffee, and cocoa produced from plant ingredients, have penetrated an emerging niche market (Chandrasekara and Shahidi, 2018).

Nevertheless, next-generation tea refers to fruit infusions or other herbs that do not contain *Camellia sinensis L.* to prevent confusion with common teas; next-generation tea drinks are often called tisane, herbal or botanical infusion (Sivakumaran and Amarakoon, 2018). As shown in Table 2, various herbal drinks are consumed globally based on their regional origin. Some beverages have achieved more popularity than others. In the age of globalization, regional boundaries have progressively been eliminated, and such products have become widely accessible as foreign health products, although from different areas (Chandrasekara and Shahidi, 2018). Each region has its characteristics in producing a new generation of tea, following the commodities grown in the region, amount, and type of secondary metabolite in a plant depending on environmental factors (Carabajal *et al.,* 2017).

Varieties next generation tea as herbal infusion referred to as tisane, or herbal teas is produced from blends of dried or fresh herbs, bulbs, nuts, grasses, fruits, or other parts of plants that may provide unique flavour, taste, and health benefits (Theuma and Attard, 2020). Tea has a long medical and dietary history. Other plant infusions such as rosehip (*Rosa sp.*), rooibos (*Aspalathus linearis*), and chamomile (*Matricaria recutita L.*) have become very popular (Malongane *et al.,* 2017). Still, it is essential to emphasize that the words next-generation tea as herbal teas or tisanes are better applied to this collection of drinks (da Silva Pinto 2013).

4. Bioactive compound and functional effect of next generation tea

Next-generation tea as herbal infusions initiate an essential supplementation source; proteins, peptides, amino acids, enzymes, pectin, volatile compounds, vitamins, and minerals are other significant chemical

Table 2. Diversity of next-generation tea

Raw Material	Compound	Functional activity	Sources
Beli, bael, Bengal, quince, vilva tree (*Aegle mermelos)*- leaves, buds, flowers, immature, fruit, bark	Alkylated, terpenes, alkanes and alkenes, fatty acids and fatty alcohols, sterols, coumarins, and indazole derivatives.	Anticancer, antidiabetic, antihyperglycemic, anti-inflammatory, and anti-dyslipidaemia,	Chandrasekara and Shahidi (2018); Tiwari *et al. (*2020)
Borututu (*Cochlospermum*	Gallic acid, Protocatechuic acid.	Anti-hepatocelluar carcinoma, antioxidant	Chandrasekara and Shahidi
Chamomile (*Matriacaria chamomilla, Chamomelum nobile*)-Flowers	Sesquiterpenes, flavonoids, coumarins, vitamins, phenolic acids and glucosides.	Antioxidant, hypocholesterolemic, anticancer, anti-inflammatory	Chandrasekara and Shahidi (2018); Žlabur *et al.* (2020)
Chamomile (*Matricaria recutita L*)	Volatile terpenoids (bisabolol oxide,α-bisabolol, β-trans-farnesene and chamazulene), phenolic compounds (coumarins, flavonoids, and phenolic acids), and	Antiallergic, antibacterial, increased intestinal absorption of glucose against obesity, hyperglycemia and hyperlipidemia.	Jabri *et al.* (2017); Jamalian *et al.* (2012); Sharifi-Rad *et al.* (2018)
Dag cayl (*Sideritis montana L. ssp.*)-aerial part	Phenolic compound, flavonoid.	Antioxidant, antibacterial.	Chandrasekara and Shahidi (2018); Akbaba (2021)
Ginger (*Zingiber officinale*)-Rhizomae	Gingerol, shogaols, gingerdiol, and gingerdione. Phenolic acid and flavonoid.	Anti-inflammatory, hypoglycemic. antioxidants, antibacterial, anti-inflammatory, antiseptic, antiparasitic, and immunomodulatory properties	Chandrasekara and Shahidi (2018); Herve *et al.* (2019); Zahid *et al.* (2021)
Heart leave mooseed, Guduchi (*Tinospora cardifolia*)-Stem, roots	Phenolic and flavonoid compounds.	Antidiabetic, antioxidant, anti-inflammatory.	Chandrasekara and Shahidi (2018); Sahu *et al.* (2018); Reddi *et al.* (2019)
Helichrysum italicum (Roots, stems, leaves, and flowers)	Polyphenolic and several phenolics; (quinic acids and chlorogenic is the main compound, dicaffeoylquinic-acid isomers, and gnaphaliin-A), caffeoylquinic acids and	High antioxidant, medium antidiabetic, anti-obesity.	Pereira *et al.* (2017); Kramberger *et al.* (2020); Kenig); *et al.* (2021)
Kemuning Leaves (*Murraya paniculate*)	B-cyclocitral, α-cubebene, methyl salicylate, cubenol, trans-nerolidol, β-isogermacrene and cubebene.	Antihypertensive	Cuong *et al.* (2014); Olawore *et al.* (2005); Primiani *et al.* (2018)
Mangosteen pericarp (*Garcinia mangostana L.*)	Isoprenylated xanthones.	Antioxidant, neuroprotective, anticancer, hypolipidemic, antidiabetic, analgesic, anti-skin cancer	Lalas *et al.* (2017); Ovalle-Magallanes *et al.* (2017); Primiani *et al.* (2018)
Moringa oleifera	Vitamins C and E, amino acids, minerals (natural iron and calcium), lipids, phenols and flavonols, fatty acids, ash, carbohydrates, dietary fiber and carotenoids.	Antioxidant.	Lalas *et al.* (2017); Manuwa *et al.* (2020); Primiani *et al.* (2018)
New Zealand kawakawa (*Piper excelsum*)	Phenylpropanoids, terpenoids, lignans, and amides.	Anti-inflammatory.	Butts *et al.* (2018)
Peppermint (*Mentha piperta*)-leaves	fatty acids (linoleic, linolenic, and palmitic acid, variety of volatile compounds, mainly menthol, menthone and isomenthone have also been identified along with b-carotene, chlorophyll, a- and c -tocopherols and ascorbic acid.	Antioxidant, antitumor.	Chandrasekara and Shahidi (2018); Frész *et al.* (2014)

Table 2 (Cont.). Diversity of next-generation tea

Raw Material	Compound	Functional activity	Sources
Pegaga, Indian pennywork, gotukola (*Centella asiatica*)	Hydroxycinnamic acids, flavonoids, and triterpenoids.	Anticancer, increase the activity of antioxidant enzymes.	Chandrasekara and Shahidi (2018); Ncube *et al.* (2017)
Polpala (*Aerva lanata*)	Canthin- 6-one (aervine, aervoside) and β-carboline alkaloids (aervolanine), flavonoids (kaempferol, quercetin), β-sitosterol, phenolic acids (syringic acid, vanillic acid), botulin.	Antihyperglycemic, anti-inflammatory, anti-urolithic, anticancer.	Chandrasekara and Shahidi (2018); Mandal *et al.* (2020); Rajesh, Chitra and Paarakh (2011); Rajesh *et al.* (2011)
Rooibos (*Aspalathus linearis*)	Essential oils, 50 volatile compounds.	Hepatoprotective, anti-inflammatory and antimycobacterial for therapy in tuberculosis patients	Reid *et al.* (2020); Song *et al.* (2021)
Rosa hip (*Rosa sp.*)	Polyphenols (proanthocyanidins, triterpene acids, catechin), flavonoids (delphinidin, cyaniding and their glycosides, quercetin) and their glycosides, galactolipid, folate, vitamin A, C, and E, mineral, and essential fatty acids.	Antioxidant, anticancer, anti-inflammatory, cardioprotective, immunomodulation, antidiabetic, antimicrobial and neuroprotective.	Frész *et al.* (2014); Patel (2017)
Rosa rugosa tea	Polyphenols and flavonoids.	Antibacterial	Zhang *et al.* (2014)
Rosehips, dog rose (*Rosa canina L*)-Fruits	Trans tiliroside, flavonols (glycosides of quercetin and kaempferol), 3-O-caffeoylquinic and 5-O-caffeoylquinic acid, ellagic acid and hydrolysable tannins, gallotannins and ellagallotannins.	Anti-inflammatory, antioxidant.	Chandrasekara and Shahidi (2018); Ieri *et al.* (2015);
Roselle (*Hibiscus sabdariffa L.)*	Anthocyanins (such as delphinidin and cyanidin derivatives), polysaccharides, organic acids (hydroxycitric and hibiscus acids), phenolic acids and flavonoids (quercetin (Q), luteolin and their derivatives) .and 24 aroma-active compounds.	Antibacterial, antihypertensive, antidiabetic.	Andzi and Feuya (2016); Primiani *et al.* (2018); Sahebkar *et al.* (2015); Zannou *et al.* (2020); Herranz -Lopez *et al.* (2020)
Sage, adacayl, minchi (*Salvia officinalis*)	Volatile oil components (α-pinene, β-pinene, limonene, α-thujone, β-thujone, camphor, and 1,8-cineole in the oil), total phenolic and flavonoid.	Antioxidant, increase liver antioxidant status.	Chandrasekara and Shahidi (2018); Vosoughi et *al.* (2018)
Soursop Leaves (*Annona muricata L*)	Alkaloids anonaine, nornuciferine, asimilobine, lirioderine, corypalmine, xylopine, reticuline.	Antibacterial against Gram-positive and Gram-negative bacteria (*Staphylococcus aureus, Salmonella enterica* serovar Typhimurium and *Enterococcus faecalis*).	Pinto *et al.* (2017); Primiani *et al.* (2018)

Table 2 (Cont.). Diversity of next-generation tea

Raw Material	Compound	Functional activity	Sources
Tanner's Cassia, avartaki, ranawara (*Casia auriculata*)- Leaves, flowers.	Valine and norvaline mainly present in the leaf, and alanine, phenylalanine, beta-alanine, aspartic acid, asparagine, 5-oxoproline, proline, gamma aminobutyric acid (GABA), and tryptophan mainly detected in the flower. Sugar acids, sugar, sugar alcohols, nucleosides, fatty acids, phenolic compound, and miscellaneous composunds.	Antihyperglycemic, antidiabetic.	Chandrasekara and Shahidi (2018); Tietel *et al.* (2021)
Tea flower extract (TFE)	Phenolic compounds, carbohydrates, saponins, and crude proteins.	Improving the intestinal barrier, improve liver function, induced immunosuppression and hepatic injury.	Chen *et al.* (2020a)
Vine tea (*Ampelopsis grossedentata*)	Flavonoids.	Antioxidant.	Jia *et al.* (2021)
Yerba mate (*Ilex paraguariensis*)	Phenolic, alkaloids.	Hypocholesterolemic, hepatoprotective, cardiovascular system protective, antioxidant, antidiabetic, antirheumatic and anti-inflammatory and diuretic activities.	Chandrasekara and Shahidi (2018); Konieczynski *et al.* (2017)

materials available in herbs used for infusions (Theuma and Attard, 2020). For instance, polyphenolic antioxidant activity is primarily due to its redox properties, which enable it to act in the form of reducing agents, metal chelators, hydrogen donors, and single oxygen quenchers (Ivanova *et al.,* 2005).

Several ingredients of next-generation tea have shown their functional effects. *Moringa oleifera* tea has a strong antioxidant potential in solid to liquid ratio *M. oleifera* tea of 1:20 mg/mL, with a temperature of 97°C and a duration of 35 min which results in yields of 56.96, 34.66, and 3.53 mg/100 mL for total phenolic compounds (TP), total flavonoids (TF), total tannins (TT); respectively, and it helps reduce stress-related chronic diseases (En and Willy, 2016). *Hibiscus sabdariffa L.* beverage rich in anthocyanins, polyphenols, organic acids, volatile components, and polysaccharides beneficial to cardiovascular disease, revealed an essential role in minimizing both diastolic blood pressure (DBP) and systolic blood pressure (SBP) (Sahebkar *et al.,* 2015). A potent antioxidant and anticancer activity are shown by Mangosteen pericarp tea which was tested for skin cancer cells and mediated by the action pathways through apoptosis induction via intrinsic pathways and proliferation inhibition (Wang *et al.,* 2012). Meanwhile, the antimicrobial activity of *A. Muricata* tea has a wide range of actions, and the main targets of the bioactive compound's antimicrobial activity are outer bacterial membranes and plasma (Pinto *et al.,* 2017).

In the traditional medicine of several regions, fruit seeds and pericarps have a long tradition of being applied as drinks. Isoprenylated xanthones, a class of secondary metabolites with numerous records of biological effects such as antiproliferative, pro-apoptotic, antioxidant, ant nociceptive, neuroprotective, anti-inflammatory, antiobesity, and hypoglycemic, are the major phytochemicals found in the seeds and pericarps (Ovalle-Magallanes *et al.,* 2017). Almost any simple essential ingredient has a functional effect, with the tea production process providing an opportunity to increase its functional effect.

While the intake of next-generation tea, such as herbal teas, provides many health benefits, they can also pose a health risk because toxins and toxic metals are included. Concentrations of polyphenols are found in herbal infusions than in untreated herbal compounds and residual herbal extracts (Theuma and Attard, 2020). Heavy metals such Fe, Mn, and Zn were found at the largest concentrations in both the infusions and untreated medicinal compounds, with the least concentrated in these matrices were Cr, Cd, Cu, and Pb (Zhang *et al.,* 2018).

5. Conclusion

A wide variety of tea products is generated as more

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expanding and increasingly dynamic market share. Through product and process value-added development, market shares become more sophisticated and highly competitive. The tea industry must face these challenges with confidence. Combining tea with a variety of other natural products that have health benefits is a required innovation. Many bioactive components of traditional herbal beverages remain undiscovered. Furthermore, the mixing of different herbal elements as a "blended tea" tea has the potential to create a new generation of tea with varied health benefits. Thus, further study of bioactive compounds and their roles is still needed.

It is vital to illustrate the ongoing need to classify and examine the circulating metabolites. The specific mechanisms or compounds that benefit health associated with the intake of tea and the amounts of metabolites used are much greater than the physiological aspect and should be more investigated. Bioavailability study is critical for bioactive substances since interactions may affect their metabolism with other nutritional components, cellular transporters, molecular transformations, solubility, metabolism, and the function of gut microbiota. More safety studies may be needed to examine the chronic and sub-chronic toxicity of the next generation of tea and the safety of daily intake of traditional tea over a longer exposure span. Next-generation tea is a mixture of possible bioactive compounds, a potential source of new and valuable herbal drinks. Thus, the next generation of teas could be used as a new functional drink trend to improve health function.

Conflict of interest

The authors declare no conflict of interest.

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References

Adawiyah, D.R., Azis, M.A., Ramadhani, A.S., Chueamchaitrakun, P. and Mae F.L. (2019). Comparison of Sensory Profile of Green Tea UsingQDA (Quantitative Descriptive Analysis) and CATA(Check-All-That-Apply) Methods. *Jurnal Teknologi dan Industri Pangan*, 30(2), 161–172. https://doi.org/10.6066/jtip.2019.30.2.161

Akbaba, E. (2021). Characterization of Bioactive and Antioxidant Composition of Mountain Tea (*Sideritis montana* ssp. montana): Microwave-Assisted Technology. *International Journal of Secondary Metabolite*, 8(2), 159-171. https://doi.org/10.21448/ijsm.926926

Andzi, B.T. and Feuya T.G.R. (2016). Comparative study of the antioxidant activity of the total polyphenols extracted from *Hibiscus sabdariffa* L., *Glycine max* L. Merr., yellow tea and red wine through reaction with DPPH free radicals. *Arabian Journal of Chemistry*, 9(1), 1–8. https://doi.org/10.1016/j.arabjc.2014.11.048

Butts, C.A., Van Klinik, J.W., Nigel, J.I., Paturi, G., Hedderley, D.I., Martell, S. and Harvey, D. (2018). Composition and safety evaluation of tea from New Zealand kawakawa (*Piper excelsum*). *Journal of Ethnopharmacology,* 232, 110-1183. https://doi.org/10.1016/j.jep.2018.12.029

Carabajal, M.P.A., Isla, M.I. and Zampini, I.C. (2017). Evaluation of the antioxidant and antimutagenic activity of herbal teas from native plants used in traditional medicine in Argentina. *South African Journal of Botany*, 110, 258–265. https://doi.org/10.1016/j.sajb.2016.10.006

Chandrasekara, A. and Shahidi, F. (2018). Herbal beverages: Bioactive compounds and their role in disease risk reduction - A review. *Journal of Traditional and Complementary Medicine*, 8(4), 451–458. https://doi.org/10.1016/j.jtcme.2017.08.006

Chen, D., Ding, Y., Chen, G., Sun, Y., Zeng, X. and Ye, H. (2020). Component identification and nutritional value exploration of tea (*Camellia sinensis* L.) flower extract: Evidence for functional food. *Food Research International*, 132, 109100. https://doi.org/10.1016/j.foodres.2020.109100

Chen, G., Yuan, Q., Saeeduddin, M., Ou, S., Zeng, X. and Ye, H. (2016). Recent advances in tea polysaccharides: Extraction, purification, physicochemical characterization, and bioactivities. *Carbohydrate Polymers*, 153, 663–678. https://doi.org/10.1016/j.carbpol.2016.08.022

Chen, H., Qu, Z., Fu, L., Dong, P. and Zhang, X. (2009). Physicochemical Properties and Antioxidant Capacity of 3 Polysaccharides from Green Tea, Oolong Tea, and Black Tea. *Journal of Food Science*, 74(6), C469–C474. https://doi.org/10.1111/j.1750-3841.2009.01231.x

Chen, S., Liu, H., Zhao, X., Li, X., Shan, W., Wang, X., Wang, S., Yu, W., Yang, Z. and Yu, X. (2020). Non-targeted metabolomics analysis reveals dynamic changes of volatile and non-volatile metabolites during oolong tea manufacture. *Food Research International*, 128, 108778. https://doi.org/10.1016/j.foodres.2019.108778

Cuong, N.M., Khanh, P.N., Duc, H.V., Huong, T.T., Tai, B.H., Binh, N.Q., Durante, M. and Fusi, F. (2014). Vasorelaxing Activity of Two Coumarins from *Murraya paniculata* Leaves. *Biological and Pharmaceutical Bulletin*, 37(4), 694–697. https://doi.org/10.1248/bpb.b13-00905

Da Silva Pinto, M. (2013). Tea: A new perspective on health benefits. *Food Research International*, 53(2), 558–567. https://doi.org/10.1016/j.foodres.2013.01.038

Drywień, M., Podkowska, J., Frąckiewicz, J. and Górnicka, M. (2015). Consumption of black and green teas as a dietary source of polyphenols in Polish inhabitants of the Mazovian region. *Roczniki Państwowego Zakładu Higieny*, 66(1), 35–38.

Du, L.L., Fu, Q.Y., Xiang, L.P., Zheng, X.Q., Lu, J.L., Ye, J.H., Li, Q.S., Polito, C. and Liang, Y.R. (2016). Tea Polysaccharides and Their Bioactivities. *Molecules*, 21(11), 1449. https://doi.org/10.3390/molecules21111449

En, F. and Willy S.A.A.R. (2016). Production of a Functional Tea from *Moringa oleifera* LAM Leaf Powder: Optimization of Phenolic Extraction Using Response Surface Methodology. *Journal of Nutrition and Food Sciences*, 6(6), 1000556. https://doi.org/10.4172/2155-9600.1000556

Feng, Z., Li, Y., Li, M., Wang, Y., Zhang, L., Wan, X. and Yang, X. (2019). Tea aroma formation from six model manufacturing processes. *Food Chemistry*, 285, 347–354. https://doi.org/10.1016/j.foodchem.2019.01.174

Frész, T., Nagy, E., Hilbert, Á. and Tomcsányi, J. (2014). The role of flavonoids in false positive digoxin assays caused by the consumption of hibiscus flower and rose hip tea. *International Journal of Cardiology*, 171(2), 273–274. https://doi.org/10.1016/j.ijcard.2013.11.090

Gong, Z.P., Ouyang, J., Wu, X.L., Zhou, F., Lu, D.M., Zhao, C.J., Liu, C.F., Zhu, W., Zhang, J.-C., Li, N.-X., Miao, F., Song, Y.-X., Li, Y.-L., Wang, Q.-Y., Lin, H.-Y., Zeng, X., Cai, S.-X., Huang, J.-A. and Zhu, M. Z. (2020). Dark tea extracts: Chemical constituents and modulatory effect on gastrointestinal function. *Biomedicine and Pharmacotherapy*, 130, 110514. https://doi.org/10.1016/j.biopha.2020.110514

Granato, D., Grevink, R., Zielinski, A.A.F., Nunes, D.S. and van Ruth, S.M. (2014). Analytical Strategy Coupled with Response Surface Methodology to Maximize the Extraction of Antioxidants from Ternary Mixtures of Green, Yellow, and Red Teas (*Camellia sinensis* var. *Sinensis*). *Journal of Agricultural and Food Chemistry*, 62(42), 10283–10296. https://doi.org/10.1021/jf504480f" https://doi.org/10.1021/jf504480f

Herranz-Lopez, M., Olivares-Vicente, M., Gallego E.A., Encina J.A., Perez-Sanchez, A., Ruiz-Torres, V., Joven J., Roche, E. and Micol, V. (2020). Quercetin metabolites from Hibiscus sabdariffa contribute to alleviate glucolipotoxicity-induced metabolic stress *in vitro*. *Food and Chemical Toxicology,* 144, 111606. https://doi.org/10.1016/j.fct.2020.111606

Herve, T., Raphaël, K.J., Ferdinand, N., Victor Herman, N., Willy Marvel, N.M., Cyril D'Alex, T. and Laurine Vitrice, F.T. (2019). Effects of ginger (*Zingiber officinale*, Roscoe) essential oil on growth and laying performances, serum metabolites, and egg yolk antioxidant and cholesterol status in laying Japanese quail. *Journal of Veterinary Medicine*, 2019, 7857504. https://doi.org/10.1155/2019/7857504

Ieri, F. Innocenti, M., Possieri, L., Gallori, S. and Mulinacci, N. (2015). Phenolic composition of "bud extracts" *of Ribes nigrum L., Rosa canina L.* and *Tilia tomentosa M. Journal of Pharmaceutical and Biomedical Analysis,* 115, 1–9. https://doi.org/10.1016/j.jpba.2015.06.004

Ivanova, D., Gerova, D., Chervenkov, T. and Yankova, T. (2005). Polyphenols and Antioxidant Capacity of Bulgarian medicinal plants. *Journal of Ethnopharmacology*, 96(1–2), 145–150. https://doi.org/10.1016/j.jep.2004.08.033

Jabri, M.A., Sakly, M., Marzouki, L. and Sebai, H. (2017). Chamomile (*Matricaria recutita* L.) Decoction Extract Inhibits *In Vitro* Intestinal Glucose Absorption and Attenuates High-Fat Diet-Induced Lipotoxicity and Oxidative Stress. *Biomedicine and Pharmacotherapy*, 87, 153–159. https://doi.org/10.1016/j.biopha.2016.12.043

Jain, D., Chaudhary, P., Kotnala, A., Hossain, R., Bisht, K. and Hossain, M.N. (2020). Hepatoprotective activity of medicinal plants: A mini review. *Journal of Medicinal Plants*, 8(5), 183-188. https://doi.org/10.22271/plants.2020.v8.i5c.1212

Jamalian, A., Shams-Ghahfarokhi, M., Jaimand, K., Pashootan, N., Amani, A. and Razzaghi-Abyaneh, M. (2012). Chemical composition and antifungal activity of *Matricaria recutita* Flower Essential Oil Against Medically Important Dermatophytes and Soil-Borne Pathogens. *Journal de Mycologie Médicale*, 22(4), 308–315. https://doi.org/10.1016/j.mycmed.2012.09.003

Jia, C., Li, J., Zhang, M., Ma, W., Zhao, S., Liu, R., Rong, J. and Li, X. (2021). Antioxidant Properties of The Extracts of Vine Tea (*Ampelopsis Grossedentata*) With The Different Color Characteristics and Inhibition of Rapeseed And

Sunflower Oil Oxidation. *LWT*, 136, 110292. https://doi.org/10.1016/j.lwt.2020.110292

Kenig, S., Kramberger, K., Petelin, A., Bandelj, D., Baruca Arbeiter, A., Miklavčič Višnjevec, A., Peeters, K., Mohorko, N., Novak, K.S. and Pražnikar, Z.J. (2021). *Helichrysum italicum* ssp. *italicum Infusion* Promotes Fat Oxidation in Hepatocytes and Stimulates Energy Expenditure and Fat Oxidation after Acute Ingestion in Humans: A Pilot Study. *Plants*, 10(8), 1516. https://doi.org/10.3390/plants10081516

Konieczynski, P., Viapiana, A. and Wesolowski, M. (2017). Comparison of Infusions from Black and Green Teas (*Camellia sinensis* L. Kuntze) and Erva-mate (*Ilex paraguariensis* A. St.-Hil.) Based on the Content of Essential Elements, Secondary Metabolites, and Antioxidant Activity. *Food Analytical* Methods, 10, 3063–3070 https://doi.org/10.1007/s12161-017-0872-8

Kramberger, K., Barlič-Maganja, D., Bandelj, D., Baruca Arbeiter, A., Peeters, K., Miklavčič Višnjevec, A. and Jenko Pražnikar, Z. (2020). HPLC-DAD-ESI-QTOF-MS Determination of Bioactive Compounds and Antioxidant Activity Comparison of the Hydroalcoholic and Water Extracts from Two Helichrysum italicum Species. *Metabolites*, 10(10), 403. https://doi.org/10.3390/metabo10100403

Lalas, S., Athanasiadis, V., Karageorgou, I., Batra, G., Nanos, G.D. and Makris, D.P. (2017). Nutritional Characterization of Leaves and Herbal Tea of *Moringa oleifera* Cultivated in Greece. *Journal of Herbs, Spices and Medicinal Plants*, 23(4), 320–333. https://doi.org/10.1080/10496475.2017.1334163

Liang, Y., Lu, J., Zhang, L., Wu, S. and Wu, Y. (2003). Estimation of black tea quality by analysis of chemical composition and colour difference of tea infusions. *Food Chemistry*, 80(2), 283–290. https://doi.org/10.1016/S0308-8146(02)00415-6

Malongane, F., McGaw, L.J. and Mudau, F.N. (2017). The synergistic potential of various teas, herbs and therapeutic drugs in health improvement: A review: Potential of teas, herb and drug in health improvement. *Journal of the Science of Food and Agriculture*, 97(14), 4679–4689. https://doi.org/10.1002/jsfa.8472

Mandal, B., Madan, S., Ahmad, S., Sharma, A.K. and Ansari, M.H.R. (2021). Antiurolithic efficacy of a phenolic rich ethyl acetate fraction of the aerial parts of *Aerva lanata* (Linn) Juss. ex Schult. in ethylene glycol induced urolithic rats. *Journal of Pharmacy and Pharmacology*, 73(4), 560-572. https://doi.org/10.1093/jpp/rgaa071

Manuwa, S.I., Sedara, A.M. and Tola, F.A. (2020). Design, fabrication and performance evaluation of *Moringa oleifera* dried leaves pulverizer. *Journal of Agriculture and Food Research*, 2, 100034. https://doi.org/10.1016/j.jafr.2020.100034

Mei, X., Liu, X., Zhou, Y., Wang, X., Zeng, L., Fu, X., Li, J., Tang, J., Dong, F. and Yang, Z. (2017). Formation and emission of linalool in tea (*Camellia sinensis*) leaves infested by tea green leafhopper (*Empoasca (Matsumurasca) onukii* Matsuda). *Food Chemistry*, 237, 356–363. https://doi.org/10.1016/j.foodchem.2017.05.124

Mhatre, S., Srivastava, T., Naik, S. and Patravale, V. (2020). Antiviral activity of green tea and black tea polyphenols in prophylaxis and treatment of COVID-19: A review. *Phytomedicine*, 85, 153286. https://doi.org/10.1016/j.phymed.2020.153286

Musial, C., Kuban-Jankowska, A. and Gorska-Ponikowska, M. (2020). Beneficial properties of green tea katekins. *International Journal of Molecular Sciences*, 21(5), 1744. https://doi.org/10.3390/ijms21051744

Narukawa, M., Kimata, H., Noga, C. and Watanabe, T. (2010). Taste characterisation of green tea catechins: Taste characterisation of catechins. *International Journal of Food Science and Technology*, 45(8), 1579–1585. https://doi.org/10.1111/j.1365-2621.2010.02304.x

Ncube, E.N., Steenkamp, P.A., Madala, N.E. and Dubery, Ian A. (2017). Metabolite profiling of the undifferentiated cultured cells and differentiated leaf tissues of *Centella asiatica*. *Plant Cell, Tissue and Organ Culture,* 129(3), 431–443. https://doi.org/10.1007/s11240-017-1189-4

Nie, S.P. and Xie, M.Y. (2011). A review on the isolation and structure of tea polysaccharides and their bioactivities. *Food Hydrocolloids*, 25(2), 144–149. https://doi.org/10.1016/j.foodhyd.2010.04.010

Ning, J., Sun, J., Li, S., Sheng, M. and Zhang, Z. (2017). Classification of five Chinese tea categories with different fermentation degrees using visible and near-infrared hyperspectral imaging. *International Journal of Food Properties*, 20(Sup2), 1515–1522. https://doi.org/10.1080/10942912.2016.1233115

Olawore, N.O., Ogunwande, I.A., Ekundayo, O. and Adeleke, K.A. (2005). Chemical composition of the leaf and fruit essential oils of *Murraya paniculata* (L.) *Jack. (Syn.Murraya exotica* Linn.). *Flavour and Fragrance Journal*, 20(1), 54–56. https://doi.org/10.1002/ffj.1365

Ovalle-Magallanes, B., Eugenio-Pérez, D. and Pedraza-Chaverri, J. (2017). Medicinal properties of mangosteen (*Garcinia mangostana* L.): A comprehensive update. *Food and Chemical Toxicology*, 109(Part 1), 102–122. https://doi.org/10.1016/j.fct.2017.08.021

Patel, S. (2017). A critical review on serine protease: Key immune manipulator and pathology mediator. *Allergologia et Immunopathologia*, 45(6), 579–591. https://doi.org/10.1016/j.aller.2016.10.011

Pereira, C.G., Barreira, L., Bijttebier, S., Pieters, L., Neves, V., Rodrigues, M.J., Rivas, R., Varela, J. and Custódio, L. (2017). Chemical profiling of infusions and decoctions of *Helichrysum italicum* subsp. Picardii by UHPLC-PDA-MS and *in vitro* biological activities comparatively with green tea (*Camellia sinensis*) and rooibos tisane (*Aspalathus linearis*). *Journal of Pharmaceutical and Biomedical Analysis*, 145, 593–603. https://doi.org/10.1016/j.jpba.2017.07.007

Pinto, N.deC.C., Campos, L.M., Evangelista, A.C.S., Lemos, A.S.O., Silva, T.P., Melo, R.C.N., de Lourenço, C.C., Salvador, M.J., Apolônio, A.C.M., Scio, E. and Fabri, R.L. (2017). Antimicrobial *Annona muricata* L. (soursop) extract targets the cell membranes of Gram-positive and Gram-negative bacteria. *Industrial Crops and Products*, 107, 332–340. https://doi.org/10.1016/j.indcrop.2017.05.054

Poswal, F.S., Russell, G., Mackonochie, M., MacLennan, E., Adukwu, E.C. and Rolfe, V. (2019). Herbal Teas and their Health Benefits: A Scoping Review. *Plant Foods for Human Nutrition*, 74(3), 266–276. https://doi.org/10.1007/s11130-019-00750-w

Primiani, C.N., Pujiati, Mumtahanah, M. and Ardhi, W. (2018). Kombucha fermentation test used for various types of herbal teas. *Journal of Physics: Conference Series*, 1025, 012073. https://doi.org/10.1088/1742-6596/1025/1/012073

Rabade, V.S., Gurunani, S.G. and Chaple, D.R. (2016). Appraising Herbal Tea as a Medicated and Nutritive drink. *Research Journal of Pharmacy and Technology*, 9(5), 613-616. https://doi.org/10.5958/0974-360X.2016.00117.7

Rajesh, R., Chitra, K. and Paarakh, P.M. (2011). *Aerva lanata* (Linn.) Juss. ex Schult. An overview. *Indian Journal of Natural Products and Resources*, 2(1), 5-9.

Rajesh, R., Chitra, K., Paarakh, P.M. and Chidambaranathan, N. (2011). Anticancer activity of aerial parts of *Aerva lanata* Linn Juss ex Schult against Dalton's Ascitic Lymphoma. *European Journal of Integrative Medicine,* 3(3), e245-e250. https://doi.org/10.1016/j.eujim.2011.05.001

Reddi, K. and Tetali, S.D. (2019). Dry leaf extracts of Tinospora cordifolia (Willd.) Miers attenuate oxidative stress and inflammatory condition in human monocytic (THP-1) cells. *Phytomedicine,* 631, 152831. https://doi.org/10.1016/j.phymed.2019.152831

Reid, A., Oosthuizen, C.B. and Lall, N. (2020). *In vitro* antimycobacterial and adjuvant properties of two traditional South African teas, *Aspalathus linearis* (Burm.f.) R. Dahlgren and *Lippia scaberrima Sond. South African Journal of Botany*, 128, 257–263. https://doi.org/10.1016/j.sajb.2019.11.007

Sahab, N.R.M., Subroto, E., Balia, R.L. and Utama, G.L. (2020). γ-Aminobutyric acid found in fermented foods and beverages: Current trends. *Heliyon*, 6(11), e05526. https://doi.org/10.1016/j.heliyon.2020.e05526

Sahebkar, A., Serban, C., Dragan, S., Urosniu, S., Florina, A., Rysz, J. and Banach, M. (2015). Effect of sour tea (*Hibiscus sabdariffa* L.) on arterial hypertension: A systematic review and meta-analysis of randomized controlled trials. *Atherosclerosis*, 241 (1), e190–e191. https://doi.org/10.1016/j.atherosclerosis.2015.04.933

Sahu, R., Ahmed, T., Sanghana, R., Punde, R. and Subudhi, B.B. (2018). Effect of *Tinospora cordifolia* aqua-alcoholic extract on pharmacokinetic of Glibenclamide in rat: an herb-drug interaction study. *Journal of Pharmaceutical and Biomedical Analysis,* 151, 310-316. https://doi.org/10.1016/j.jpba.2018.01.010

Scharbert, S. and Hofmann, T. (2005). Molecular Definition of Black Tea Taste by Means of Quantitative Studies, Taste Reconstitution, and Omission Experiments. *Journal of Agricultural and Food Chemistry*, 53(13), 5377–5384. https://doi.org/10.1021/jf050294d

Scoparo, C.T., de Souza, L.M., Rattmann, Y.D., Dartora, N., Paiva, S.M.M., Sassaki, G.L., Gorin, P.A.J. and Iacomini, M. (2013). Polysaccharides from green and black teas and their protective effect against murine sepsis. *Food Research International*, 53(2), 780–785. https://doi.org/10.1016/j.foodres.2012.11.006

Sharifi-Rad, M., Nazaruk, J., Polito, L., Morais-Braga, M.F.B., Rocha, J.E., Coutinho, H.D.M., Salehi, B., Tabanelli, G., Montanari, C., del Mar Contreras, M., Yousaf, Z., Setzer, W.N., Verma, D.R., Martorell, M., Sureda, A. and Sharifi-Rad, J. (2018). Matricaria genus as a source of antimicrobial agents: From farm to pharmacy and food applications. *Microbiological Research*, 215, 76–88. https://doi.org/10.1016/j.micres.2018.06.010

Sivakumaran, K. and Amarakoon, S. (2018). Bioactivity of fruit teas and tisanes – A review. *Journal of*

Pharmacognosy and Phytochemistry, 7(1), 323–327.

Song, N.E., Kim, M.K., Lee, K.G. and Jang, H.W. (2021). Analysis of volatile compounds in rooibos tea (*Aspalathus linearis*) using different extraction methods and their relationship with human sensory perception. *Food Research International*, 141, 109942. https://doi.org/10.1016/j.foodres.2020.109942

Spizzirri, U.G., Carullo, G., De Cicco, L., Crispini, A., Scarpelli, F., Restuccia, D. and Aiello, F. (2019). Synthesis and characterization of a (+)-catechin and L-(+)-ascorbic acid cocrystal as a new functional ingredient for tea drinks. *Heliyon*, 5(8), e02291. https://doi.org/10.1016/j.heliyon.2019.e02291

Sueoka, N., Suganuma, M., Sueoka, E., Okabe, S., Matsuyama, S., Imai, K., Nakachi, K. and Fujiki, H. (2001). A new function of green tea: Prevention of lifestyle-related diseases. *Annals of the New York Academy of Sciences*, 928(1), 274–280. https://doi.org/10.1111/j.1749-6632.2001.tb05656.x

Teshome, K. (2019). Effect of tea processing methods on biochemical composition and sensory quality of black tea (*Camellia sinensis* (L.) O. Kuntze): A review. *Journal of Horticulture and Forestry*, 11(6), 12.

Theppakorn, T., Luthfivyyah, A. and Ploysri, K. (2014). Simultaneous determination of caffeine and 8 catechins in oolong teas produced in Thailand. *International Food Research Journal*, 21(5), 2055–2061.

Theuma, M. and Attard, E. (2020). From herbal substance to infusion: The fate of polyphenols and trace elements. *Journal of Herbal Medicine*, 21, 100347. https://doi.org/10.1016/j.hermed.2020.100347

Tietel, Z., Ananth, D.A., Sivasudha, T. and Klipcan, L. (2021). Metabolomics of Cassia Auriculata Plant Parts (Leaf, Flower, Bud) and Their Antidiabetic Medicinal Potentials. *OMICS: A Journal of Integrative Biology*, 25(5), 294-301.

Tiwari, R., Tripathi, T., Khan, Y.A., Gupta, A., Dhobi, M., Srivastava, S., Singh, B., Shanker, K., Kalaiselvan, Vivekanadan, and Singh, G.N. (2020). Metabolite Profiling, Isolation of Cyclic Polyols, Antioxidant and Anti-inflammatory Activities of Aegle Marmelos: NMR and GC-MS Based Metabolomics Study. *Journal of Herbs, Spices and Medicinal Plants,* 27(1), 68-82. https://doi.org/10.1080/10496475.2020.1786873

Tseng, H.C., Wang, C.J., Cheng, S.H., Sun, Z.J., Chen, P.S., Lee, C.T., Lin, S.H., Yang, Y.K. and Yang, Y.C. (2014). *Tea-drinking habit among new university students: Associated factors. The Kaohsiung Journal of Medical Sciences*, 30(2), 98–103. https://doi.org/10.1016/j.kjms.2013.08.004

Verloop, A.J.W., Gruppen, H., Bisschop, R. and Vincken, J.P. (2016). Altering the phenolics profile of a green tea leaves extract using exogenous oxidases. *Food Chemistry*, 196, 1197–1206. https://doi.org/10.1016/j.foodchem.2015.10.068

Vosoughi, N., Gomarian, M., Ghasemi, P.A., Khaghani, S. and Malekpoor, F. (2018). Essential oil composition and total phenolic, flavonoid contents, and antioxidant activity of sage (*Salvia officinalis* L.) extract under chitosan application and irrigation frequencies. *Industrial Crops and Products*, 117, 366–374. https://doi.org/10.1016/j.indcrop.2018.03.021

Wang, J.J., Shi, Q.H., Zhang, W. and Sanderson, B.J.S. (2012). Antiskin cancer properties of phenolic-rich extract from the pericarp of mangosteen (*Garcinia mangostana Linn*.). *Food and Chemical Toxicology*, 50(9), 3004–3013. https://doi.org/10.1016/j.fct.2012.06.003

Wei, Y., Fang, S., Jin, G., Ni, T., Hou, Z., Li, T., Deng, W. and Ning, J. (2020). Effects of two yellowing process on colour, taste and non-volatile compounds of bud yellow tea. *International Journal of Food Science and Technology*, 55(8), 2931–2941. https://doi.org/10.1111/ijfs.14554

Wei, Y., Li, T., Xu, S., Ni, T., Deng, W.W. and Ning, J. (2021). The profile of dynamic changes in yellow tea quality and chemical composition during yellowing process. *LWT*, 139, 110792. https://doi.org/10.1016/j.lwt.2020.110792

Yan, Z., Zhong, Y., Duan, Y., Chen, Q. and Li, F. (2020). Antioxidant mechanism of tea polyphenols and its impact on health benefits. *Animal Nutrition*, 6 (2), 115–123. https://doi.org/10.1016/j.aninu.2020.01.001

Zahid, N.A., Jaafar, H.Z.E. and Hakiman, M. (2021). Micropropagation of Ginger (*Zingiber officinale* Roscoe) "Bentong" and Evaluation of Its Secondary Metabolites and Antioxidant Activities Compared with the Conventionally Propagated Plant. *Plants*, 10 (4), 630. https://doi.org/10.3390/plants10040630

Zannou, O., Kelebek, H. and Selli, S. (2020). Elucidation of key odorants in Beninese Roselle (*Hibiscus sabdariffa* L.) infusions prepared by hot and cold brewing. *Food Research International*, 133, 109133. https://doi.org/10.1016/j.foodres.2020.109133

Zeng, L., Zhou, X., Su, X. and Yang, Z. (2020). Chinese oolong tea: An aromatic beverage produced under multiple stresses. *Trends in Food Science and Technology*, 106, 242–253. https://doi.org/10.1016/

j.tifs.2020.10.001

Zhang, J., Rui, X., Wang, L., Guan, Y., Sun, X. and Dong, M. (2014). Polyphenolic extract from Rosa rugosa tea inhibits bacterial quorum sensing and biofilm formation. *Food Control*, 42, 125–131. https://doi.org/10.1016/j.foodcont.2014.02.001

Zhang, J., Yang, R., Chen, R., Peng, Y., Wen, X. and Gao, L. (2018). Accumulation of Heavy Metals in Tea Leaves and Potential Health Risk Assessment: A Case Study from Puan County, Guizhou Province, China. *International Journal of Environmental Research and Public Health*, 15(1), 133. https://doi.org/10.3390/ijerph15010133

Zhang, L., Li, N., Ma, Z.-Z. and Tu, P.F. (2011). Comparison of the Chemical Constituents of Aged Pu-erh Tea, Ripened Pu-erh Tea, and Other Teas Using HPLC-DAD-ESI-MS^n. *Journal of Agricultural and Food Chemistry*, 59(16), 8754–8760. https://doi.org/10.1021/jf2015733

Zhang, Q., Wu, S., Li, Y., Liu, M., Ni, K., Yi, X., Shi, Y., Ma, L., Willmitzer, L. and Ruan, J. (2019). Characterization of three different classes of non-fermented teas using untargeted metabolomics. *Food Research International*, 121, 697–704. https://doi.org/10.1016/j.foodres.2018.12.042

Zheng, W.J., Wan, X.C. and Bao, G.H. (2015). Brick dark tea: A review of the manufacture, chemical constituents and bioconversion of the major chemical components during fermentation. *Phytochemistry Reviews*, 14(3), 499–523. https://doi.org/10.1007/s11101-015-9402-8

Zhu, M., Li, N., Zhou, F., Ouyang, J., Lu, D., Xu, W., Li, J., Lin, H., Zhang, Z., Xiao, J., Wang, K., Huang, J., Liu, Z. and Wu, J. (2020). Microbial bioconversion of the chemical components in dark tea. *Food Chemistry*, 312, 126043. https://doi.org/10.1016/j.foodchem.2019.126043

Žlabur J., Žutić I., Radman, S., Pleša, M., Brnčić, M., Barba, F.J., Rocchetti, G., Lucini, L., Lorenzo, J.M., Domínguez, R., Rimac, B.S., Galić, A. and Voća, S. (2020). Effect of Different Green Extraction Methods and Solvents on Bioactive Components of Chamomile (*Matricaria chamomilla* L.) Flowers. *Molecules*, 25(4), 810. https://doi.org/10.3390/molecules25040810

