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Microbial fermented tea: a potential source of natural food preservation

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ABSTRACT:
In recent years, microbially fermented tea has become more and more well-liked as a beverage with health benefits. However, studies have revealed that microbial fermented tea can also be a possible source of natural food preservation in addition to its potential health advantages through extensive research is not yet done on its potential as a natural food preservative. The antibacterial qualities of microbially fermented tea are highlighted in this review paper, along with the activity of substances obtained from tea such as catechins, peptides and organic acids that are produced during fermentation. In this review paper, we have provided a summary of the recent studies and researches on the antimicrobial effects of microbially fermented tea and discussed some possible uses in food preservation. There are many variables that influence tea extraction, such as temperature, time, water quality, and processing techniques. Many methods of tea extraction are there which are discussed such as infusion method, decoction method, cold brew method, concentration method and sun tea method. We have reviewed the detailed procedure of the tea extraction and types of microbial fermented tea like Fuzhuan brick tea, Pu-erh tea and Kombucha and their potential as natural preservative. This paper also encompasses potential and difficulties of employing microbial fermented tea as a natural food preservative, as well as the sensory effects on food items and regulatory issues. Overall, this analysis indicates that additional study is required to fully explore the potential of microbial fermented tea as a beneficial natural food preservation technology in the food industries.

Keywords: Microbial fermentation, tea extracts, preservatives, anti-microbial properties.

I. INTRODUCTION:

Food is one of the most essentialunits that humans need to survive. Food is required to be preserved properly for future use without being spoiled. The primary attribute that food must contain is quality. Quality loss of food may cause various reactions in our body such as poisoning and it may be caused by postharvest loss, preservation failure, some physical measures like freezing/thawing, variation in moisture content, evaporation, chemical measures, enzymatic reactions, and microbiological activities. Spoilage may be prevented or minimised by proper processing, packaging, preservation, and storage techniques which helps in preventing or delaying microbial growth.

Beside preserving and increasing the palatability of food, preservative chemicals also protect humans from cancer-causing reactive oxygen species (ROS). In food preservation, maintaining nutritional values, texture and flavour is crucial. There are different types of preservation techniques.Some techniques, like drying for extended periods without any special containment, must be sealed after the process to prevent recontamination. Drying, spray drying, freezing, vacuum packaging, canning, syrup preservation, irradiation, and adding preservatives are a few of the techniques. Other techniques like pickling, salting, smoking, and curing help maintain flavour and aroma while also preserving food.Some foods have natural protection against spoilage. Strawberries which are highly acidic require no preservatives, while less acidic foods need pressure canning. In canning or bottling techniques, food spoilage starts once containeris opened. Microorganism proliferation might be caused by an insufficient amount of quality control during the canning process.Additionally, there have been instances where food in cans or bottles was contaminated due to poor manufacturing and hygiene practises.

Antimicrobial preservatives like calcium propionate, sodium nitrate and nitrite, sulphur dioxide, sodium bisulphite, and potassium hydrogen sulphite block the growth of fungi, mould, andantioxidants (substances which inhibit food oxidation). While the advantages and safety of artificial food additives are subjects of debate. Alcohol, salt, sugar, vinegar, and other traditional or natural preservatives are well known. Natural preservatives primarily aim to keep out air, moisture, and microorganisms while also giving them an aseptic environment. Jams and jellies, for instance, are preserved by adding a lot of sugar to a solution, whereas meat and fish are preserved by salting. As a result, we conducted extensive research on the various preservative types, and their reactions.

TYPES OF PRESERVATIVES:

Modern and traditional preservation methods are divided into two categories when it comes to food preservation techniques. Currently, traditional food preservation typically uses natural food preservatives like salt, sugar, vinegar, etc. and uses natural preservation methods, whereas modern preservation uses chemicals or synthetic preservatives like sulphates, benzoates, and other similar substances. The overuse or consumption of artificial preservatives causes several health hazards. Natural preservatives are much safer than synthetic preservatives for people and the environment. Furthermore, as their sources come from microbes, plants, and animals, natural preservatives are simple to locate. The review paper focuses primarily on preservative types, tea preservative microbial fermentation, and microbiological and antimicrobial activities, among other topics.

Artificial/Synthetic Preservatives: -Preservatives act as barriers against the microbial activity, further extending shelf life of the food product. Sodium chloride is one of the oldest food preservatives. Acetic acid, benzoic acid, propanoic acid, and sorbic acid are all employed as preservatives in low pH foods.To inhibit Clostridium botulinum, nitrates and nitrites are used in foods containing raw meat. On the other hand, sulphur dioxide and sulphites are vastly used in dry fruits, juices, and wines. To inhibit the bacteria and fungi multiplication, the food industry uses nisin and natamycin in their food materials.

Sulphites– Sulphites inhibit the growth of yeast, fungi, and bacteria. Sulphite's reaction is inversely proportional to pH. These additives are also utilised as antioxidants.These are frequently added to meat, sweets, jams, jellies, pie filling, glucose syrups, cookies, wine, beer, and other alcoholic beverages because sulphites are eliminated from our bodies in the urine as sulphates, but sulphur dioxide may damage the structure of thiamine, and it has been shown in some cases that these additives can cause vitamin B1 to be lost. Although there is insufficient proof, it has also been suggested that certain allergic reactions, such as asthma, headaches, stomach or skin irritation, nausea, and diarrhoea are observed in some delicate people [1,2]. 4-hexylresorcinol has been authorised to be utilised as an alternative to sulphites.Sulfite is a strong nucleophile and reacts with many biomolecules by substitution at electrophilic positions causing a myriad of potential cell damaging reactions. These reactive molecules have been shown to inhibit key enzymes in living cells such as those involved in ATP and NADH production leading to cell death.

Sorbates –An unsaturated carboxylic acid called sorbic acid, also known as 2,4-hexadienoic acid, is frequently used in preservation. When used at the recommended concentration (0.3%), sulfuric acid has no flavour or odour. Rowan berries can be used to extract this acid, or it can be manufactured chemically. Sorbic acid is an essential ingredient found in beverages, pastries, cheese, bakery goods, olives, and other foods and is effective against yeast and some bacteria [2,7].Certain dehydrogenases that are involved in the β oxidation of fatty acids are inhibited by sorbic acid.β oxidation of fatty acids by moulds produces unsaturated fatty acids as an intermediate product. The dehydrogenase enzymes will not work if there is an accumulation of β unsaturated fatty acid which is caused by the addition of sorbic acid,which would hinder Mould metabolism and growth.

Benzoates –Benzoic acid, benzoates, and p-hydroxybenzoates are employed as antioxidants and preservatives in the agro-food industry. These chemicals are usually applied in fruit juice and soft drinks as preservatives because of its poor solubility in water. It is found in glucoside, blueberries, plums, cloves, and cinnamon.Though, it is primarily manufactured artificially and serves as a defence against bacteria, yeast, and fungus. For the preservation of acidic foods, benzoic acid is utilised in conjunction with other chemicals. Furthermore, preservatives with additive code ranging between E210 and E2123 are suspected to show allergic reactions especially in people who are medicating with anti-inflammatory drugs or suffering with asthma or urticarial [1,2,7]. It acts by penetrating the food cells and balancing the pH level, raising its overall acidity. Sodium benzoate

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inhibits the growth and spread of fungus by reducing the intracellular pH of some foods.

Nitrites and nitrates –Potassium and sodium nitrates are widely used preservatives in meat productswhich includehams, bologna, and bacon. Nitrites act as inhibitors to Clostridium botulinum.Due to the development of methaemoglobin, it may destroy vitamins A, B1, and B2, and has antihypertensive and toxic side effects, particularly on infants[4,5,6].It causes oxidative stress by being the precursor of peroxynitrite, which is a strong oxidant. it results in disruption to the cell membrane and metabolism, building up of toxic anions, and oxidative stress.

Acetates and Propionates –They inhibit the growth of yeast, bacteria and fungi and is used in many food products mainly mustard, vinaigrette sauce, mozzarella cheese and cream cheese, instant puddings, and in baby food. There are no discovered side effects for the usage of acetates as food preservatives.Propionates are active in controlling fungi mostly. It is used usually in breads and bakery products as being a good inhibitor of mould. Propionates and propionic acid do not show any toxicity if the food industry uses it in a permitted amount[2].

Additive Code	**Chemical**	**Chemical formula**	**Food stuff**
E200	Sorbic Acid	CH3 CH=CHCH=CHCOOH	cheese products, baked foods, fruit beverages, pickles, fresh fruits and vegetables, some fish and meat products, and wines.
E220	Sulphur dioxide	SO2	beverages including dried fruits, pickled vegetables, sausages, fruit and vegetable juices, cider, vinegar, wine.
E221	Sodium sulphite	Na2SO3	Dry potatoes, gravies, sauces, fruit toppings, maraschino cherries, pickled onions, Maple syrup, jams, jellies, biscuits, bread, pies, pizza dough, dried apricots.
E222	Sodium hydrogen sulphites, sodium bisulphite	NaHSO3	baked goods, wine, dried fruit and jams.
E260	Acetic Acid	CH3 COOH	Vinegar, pickles, sauces and ketchup.
E210	Benzoic acid	C6 H5 COOH	soft drinks, fruit juices, fermented vegetables, and high-sugared foods.
E211	Sodium benzoate	C6 H5 COONa	fruit pulp and purees, jams, pickles, pickled herring and mackerel, margarine, olives, beer, fruit yogurts, canned vegetables, and salads
E251	Sodium nitrate	NaNO3	Sausage and smoked products, including blood and other sausages Products of meat pickled 300 250d
E252	Potassium nitrate	KNO3	Hard cheese, semi-hard and semi-soft Substitutes for cheese-based dairy products Pickled herring and sprat

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NATURAL/CONVENTIONAL PRESERVATIVES: -

Chemical additives have been used extensively to prevent contamination, but it is unclear how they will affect people's health. Since eliminating microorganisms has become one of the top priorities, the focus is on natural substances that are remarkably safe to consume. Preservative safety is understood, and chemicals in food that have negative long-term effects must be avoided. Body-harming side effects from chemicals like BHT, TBHQ, and BHA include allergy, headache, asthma, and skin infections. Conventional, traditional, or natural preservatives that are derived from plants and animals are the best substitute for synthetic preservatives. When chemicals are replaced with natural preservatives, conventional preservatives promote a safe and healthy lifestyle while continuing to contribute to a more effective preservation of both the environment and humans. Jams, pickles, and other food products are preserved with ingredients like sugar, honey, alcohol, and salt. Chelating substances, like the rice bran-derived ferulic acid, function as a natural preservative. Fruit seed oils are used far more frequently than they are consumed. The oil is made from a Mexican cactus pear variety, which contributes to its antioxidant and antimicrobial properties.

Antimicrobial effect of plant parts– Some researchers conducted research to look for activity related to the classes of organisms that include yeast, mould, and bacteria.A cursory inspection of the data revealed the subsequent standard citations for all of the creatures examined. According to accounts by Peter Houghton, Elsa Gomes, Aida Duarte, Alexandra Paulo, and others, traditional African medications makes use of a variety of Cryptolepis species. In Mozambique, the decoction of Cryptolepisobtusa N.E. Brown's roots and leaves is primarily used as an anti-parasitic and anti-abortive. This species' roots and leaves, which were bought in Maputo, were examined for their chemical composition and antimicrobial activity. According to Greenburg, the root's antimicrobial and antibiotic activity has been linked to the presence of plumbagin, a yellow naphthoquinone. Tea made from the inner bark of these trees have reportedly been used to cure a variety of ailments for ages, according to stories in Brazilian and American lay press. Recently, topically applied plant extracts have been utilised to treat infections caused by Candida albicans. Taheebo's inner bark and heartwood have been chemically analysed, resulting in the identification of various quinone components and a number of minor chemicals. Antimicrobial activity of lapachol and the similar substance xyloidine has been tested; lapachol was effective against gram positive as well as acid-fast bacilli but ineffective against yeast and fungi, whilst xyloidine was effective towards Brucella and Candida. Lapachol is a potent anti-trypanosome and anti-malarial drug. Tea tree terpenes combine with sebaceous secretions in a way that allows them to permeate the upper layers of skin. As a result, they convey the antiseptic qualities farther than most emollient creams**.**

TEA EXTRACT:

Tea is among the most popular drinks in the world and is well-known for its variety of health advantages as well as its distinct flavor. The extraction of tea involves the removal of water-soluble compounds from tea leaves or other parts of the tea plant. This process is critical for producing a high-quality tea extract with desirable sensory and health-related properties.The various factors that affect tea extraction include temperature, time, water quality, andprocessing methods[16].

The temperature of the water used for tea extraction plays an important role in the final quality of tea extract. Generally, higher temperatures lead to more efficient extraction of tea compounds, but excessive heat can also lead to the degradation of desirable compounds and the formation of undesirable flavors[17]. For example, brewing green tea at high temperature can lead to the release of bitter-tasting compounds such as tannins. In contrast, brewing black tea at a lower temperature can result in a weak and insipid flavor. The ideal temperature for tea extraction depends on tea type and personal preference. The duration of tea extraction also affects the final quality of the tea extract.

The quality of water used for tea extraction also has a major influence on the final quality of tea extract. Hard water, which contains high levels of minerals, can lead to a less flavorful tea extract due to the generation of insoluble complexes with tea compounds. Conversely, soft water, which contains low levels of minerals, can result in a more flavorful tea extract with better clarity. The final tea extract's quality might be impacted by the procedures employed to prepare the tea. For instance, the concentration of beneficial substances like theaflavins and thearubigins in black tea can be influenced by the degree of oxidation of the tea leaves. Similarly, the drying method used for tea leaves can affect the aroma and flavor profile of the final tea extract. Selecting high-quality tea leaves and using appropriate processing methods can help ensure a high-quality tea extract.

Types of tea extraction methods:

There are several types of tea extraction methods, each with unique characteristics that influence the final flavor and aroma of the tea extract. In this research paper, we will discuss the various types of tea extraction methods and their impact on quality of the tea extract.

The infusion method is the most common method of tea extraction, involving steeping tea leaves or tea bags in hot water. This method is simple, quick, and easy to use. The temperature and time of infusion can be adjusted to achieve the desired flavor and aroma profile. The infusion method is used for all types of tea, including green, black, oolong, and herbal teas. The decoction method is commonly used for preparing herbal teas. In this method, the tea ingredients, such as roots, bark, or berries, are boiled in water for an extended period to extract the flavor and medicinal properties. The decoction method is suitable for extracting water-insoluble compounds, such as essential oils and resins.In the cold brew technique, tea leaves are steeped for a long time—typically overnight—in room temperature or cold water.This method produces a smoother and less bitter tea extract with a different flavor profile than hot infusion. The cold brew method is commonly used for green and herbal teas. The concentration method involves brewing tea at a higher strength than usual and then diluting it with water before consumption. This method produces a stronger and more robust tea extract with a higher concentration of desirable compounds. The concentration method is commonly used for black teas.The sun tea method involves steeping tea leaves in a container of water placed in direct sunlight for several hours. This method produces a milder tea extract with a different flavor profile than the infusion method. However, the sun tea method has been associated with the risk of bacterial growth due to the prolonged exposure to warm temperatures.

Tea extraction is a crucial step in producing high-quality tea extracts with desirable sensory and healthrelated properties.Infusion, decoction, cold brew, concentration, and sun tea methods are the most used methods for tea extraction.

Extraction process: Tea extraction refers to the process of removing the soluble compounds from tea leaves by steeping them in hot water. This allows the flavor, aroma, and other beneficial compounds such as antioxidants and caffeine to be extracted and infused into the water[24]. Generally, tea is brewed in water that is heated to around **175-212°F (80-100°C)** for 1-5 minutes, depending on tea type and personal preference.During the extraction process, compounds such as polyphenols, catechins, and theanine are released from the tea leaves and dissolve in the water. These compounds give tea its characteristic flavor, color, and health benefits.

Biological effects of tea:

Tea can be contaminated with a range of pathogenic microorganisms, including Salmonella, Escherichia coli, and Staphylococcus aureus. A variety of diseases, from minor gastrointestinal symptoms to potentially serious infections, can be brought on by these bacteria. The risk of contamination is particularly high in areas where tea is grown and processed under poor sanitary conditions. To minimize the risk of pathogen contamination, tea manufacturers must adhere to strict quality control measures, including regular testing for microbial contaminants. In addition, consumers can reduce their risk of exposure by purchasing tea from reputable sources and following proper storage and preparation methods.Tea fermentation is a process that involves the proliferation of beneficial microbes, such as bacteria and fungi. The most well-known example of this is the fermentation of black tea, which includes the growth of the fungus Aspergillus niger and the bacterium Bacillus subtilis. These microbes play a critical role in development of the tea's flavor and aroma. In addition to their role in fermentation, certain microorganisms found in tea may also have health benefits. For example, some studies have suggested that probiotic bacteria found in tea may have immunomodulatory and anti-inflammatory effects, which could help prevent or alleviate certain diseases.

Microbiological effect:

Tea can be contaminated with various pathogenic microorganisms, including Salmonella, Escherichia coli, and Staphylococcus aureus. These can cause foodborne illnesses in consumers if the tea is not properly handled, stored, or processed. Several studies have reported the presence of these pathogens in tea samples. For example, a study

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conducted in India found that 11% of tea samples were contaminated with Salmonella. Similarly, a study in China reported the presence of Escherichia coli in 8% of tea samples. Tea leaves contain naturally occurring microorganisms that can ferment the tea and change its flavor and aroma. This is desirable for certain types of tea, such as black tea, but unwanted for others, such as green tea. The fermentation process involves the growth of microorganisms that oxidize the tea polyphenols and convert them into theaflavins and thearubigins, which give black tea its characteristic colour and flavour. However, fermentation can also lead to the growth of undesirable microorganisms that can spoil the tea.

Tea can spoil due to the growth of microorganisms, such as molds and yeasts, which can cause changes in taste, odor, and color. The growth of spoilage microorganisms can be prevented by proper storage conditions, such as keeping the tea in a cool, dry place away from direct sunlight. Several studies have reported the presence of spoilage microorganisms in tea samples. For example, a study conducted in Japan found that 75% of green tea samples were contaminated with mold [22].To preserve tea, various methods are used, such as drying, pasteurization, and irradiation.

Chemical composition of tea:

The complex chemical makeup of tea is influenced by several variables, including the type of tea plant, the growing environment, the timing of the harvest, and the processing techniques. Tea contains several bioactive substances that contribute to its flavour, aroma, and health advantages, including polyphenols, caffeine, theanine, and volatile compounds. The chemical makeup of tea will be covered in this review paper, with an emphasis on the main bioactive substances and their contributions to the flavour and health benefits of tea [21].

The primary bioactive components in tea have been determined to be a class of secondary metabolites called polyphenols. Tea polyphenols are primarily made up of flavan-3-ols called catechins and their derivatives. Tea's astringent flavour and antioxidant and anti-inflammatory properties are attributed to catechins. The most prevalent and biologically active catechin in tea, epigallocatechin gallate (EGCG), has been shown to have a number of health advantages, including anti-carcinogenic and neuroprotective effects[20].

The natural stimulant caffeine can be found in tea as well as other drinks like soda and coffee. Based on tea type and brewing technique, tea's caffeine content varies. Numerous physiological effects of caffeine have been identified, including heightened alertness, enhanced cognitive function, and accelerated metabolism. However, consuming too much caffeine can have negative effects like insomniaand anxiety [19].

Tea contains a special amino acid called theanine, which research has demonstrated to possess several advantageous impacts on human well-being [20]. Tea's umami flavour comes from theanine, which has also been found to calm the mind and body. Theanine has been demonstrated to enhance mental performance, lessen anxiety, and stress, and enhance sleep quality.

Composition:

Bioactive substances are abundant in tea plants. It consists of roughly 4000 metabolites, of which the polyphenol group accounts for more than a third, according to scientific literature [23]. Due to their lower polarity, flavanol aglycones frequently remain in the plant matrix after water extraction, whereas tea infusions deliver about 2-3% flavanol glycosides (kaempferol, myricetin, and quercetin). Up to 20–30% of the dry matter in tea is made up of catechins, which are also known as flavanols. They are in charge of giving it a bitter and astringent flavour. [24].

Depending on the type of fermentation used, tea's composition differs. Black tea includes (−)-epigallocatechin gallate (EGCG), (−)-gallocatechin gallate (GCG), (−)-gallocatechin (GC), (+)-catechin (C), (−)-epicatechin (EC), gallate (−)- epicatechin (ECG) and (−)-epigallocatechin (EGC) [10,11,12] compared with green tea which is rich in EGCG —present in the greatest concentration, ECG, EC and EGC [26]. These two products' different compositions are solely a result of different production methods.

Getting green tea Camellia sinensis leaves that have just been plucked are heated to prevent fermentation before being dried. On the contrary, to make black tea, the leaves must first be dried, rolled, powdered, and then fermented. This fermentation process causes polyphenols to oxidize as a result of the action of polyphenol oxidase enzymes [27]. Simple flavonoids (like catechins) are converted by this process into more complicated compounds such as thearubigins (TR), theaflavins (TF), and theobrownins (TB). As a result, the content of catechins is inversely related

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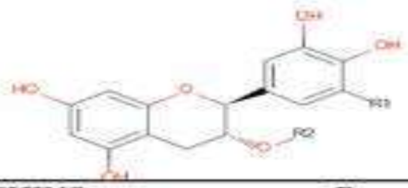
to the level of leaf processing [28].Green tea has the largest concentration of them, followed by oolong tea and black tea at the very end. This is because black tea undergoes a significant fermentation process.

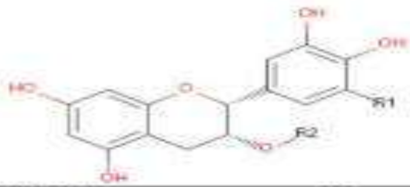
Contrarily, oolong tea and black tea are both excellent sources of theasinensins along with additional compressed phenolic compounds [29]. TR, having molecular weight ranging between 700 to 40,000 Da, imparts flavour and a reddish-black hue to black tea [30]. Theaflavins, on the other hand, are in charge of giving the infusion its golden yellow hue [32]. The chemicals of plant origin that have been most thoroughly researched are catechinsTheogallin and chlorogenic acid, as well as the simple phenolic chemicals gallic acid (GA), p-coumaric acid, and caffeic acid, are abundant in various varieties of tea.

Purine alkaloids (theophylline, theobromine, and caffeine, or theine) as well as amino acids, theanine [33], carbohydrates, lipids (linoleic and linolenic acids), volatile compounds, pigments (carotenoids and chlorophylls), vitamins (A, C, E, K, and B), and chlorophylls [34] are additional substances found in tea. It also includes a large number of mineral elements, including bromine, titanium, manganese, nickel, copper, aluminum, sodium, magnesium, phosphorus, chromium, and potassium [35,36,37].

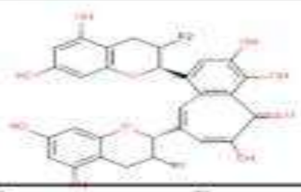
The structures of catechins and theaflavins:



CATECHINS	R_1	R_2
(+)-catechin	H	H
(−)-gallocatechin	OH	H
(+)-catechin gallate	H	Gallic acid
(−)-gallocatechin gallate	OH	Gallic acid



CATECHINS	R_1	R_2
(-)-epicatechin	H	H
(−)-epigallocatechin	OH	H
(−)-epicatechin gallate	H	Gallic acid
(−)-epigallocatechin-3-gallate	OH	Gallic acid



THEAFLAVINS	R_1	R_2	Monomers
Theaflavin (TF_1)	OH	OH	EC+EGC
Theaflavin-3-gallate (TF_2A)	Gallic acid	OH	EC+EGCG
Theaflavin-3'-gallate (TF_2B)	OH	Gallic acid	EGC+ECG
Theaflavin-3,3'-digallate (TF_3)	Gallic acid	Gallic acid	ECG+EGCG

Chemical structures of the major secondary metabolites present in tea leaves (Tadesse S.A. et.al, 2019)

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TYPES OF MICROBIALLY FERMENTED TEA BASED ON DIFFERENT AREAS OF PRODUCTION –

Fuzhuan brick tea:

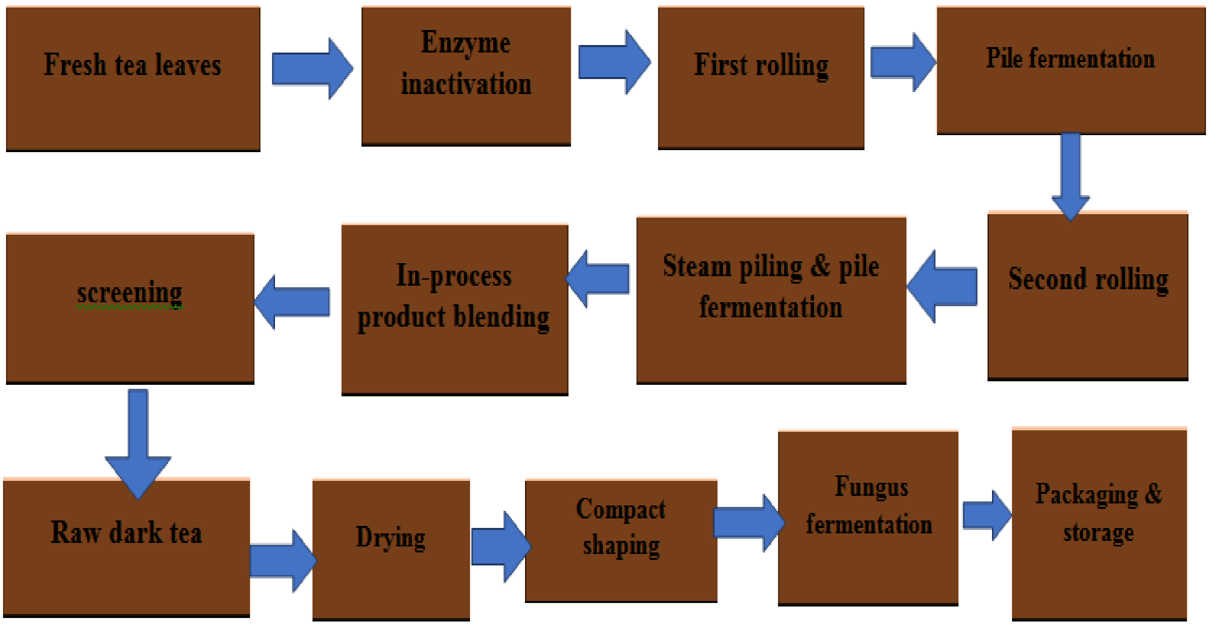
China's Hunan province is home to the widely consumed traditional beverage known as Fuzhuan brick tea (FBT).It is a variety of compressed tea created from tea buds, stems, and leaves and is renowned for its distinct flavour, fragrance, and health-improving properties. FBT is a black tea made using the microbial fermentation process. The 'Golden flower' fungus, or Aspergillus cristatus, predominate the microbial population in FBT [38].

Dark tea first appeared in the Ming Dynasty of China in the early 16th century.

Black and green teas are often made from tender plant shoots, whereas dark tea is made from older, coarser plant shoots and leaves. Likewise, tea plant coarse leaves along with plant shoots are the primary raw materials used in the manufacturing of FBT. After being picked, fresh tea leaves are given time to wither in sunlight or inside.This helps to reduce their moisture content and prepare them for rolling.The withered tea leaves are rolled to break down their cell walls and release their natural oils, which enhances the flavour of the tea. The rolling process can be done by hand or by machine.The rolled tea leaves are left to ferment in a warm, humid environment for several hours or days. This step is essential for Fuzhuan brick tea, as it promotes the growth of beneficial bacteria and fungi that give the tea its unique flavour and aroma. After fermenting, the tea leaves are dried to stop the fermentation process and preserve their flavour. The drying can be done by sun-drying, oven-drying, or pan-firing. The dried tea leaves are then compressed into bricks or other shapes. Fuzhuan brick tea is typically compressed into rectangular blocks, with each block weighing about 200 grams. Once the tea is compressed, it is usually aged for several years to allow the flavours to mature and develop. Klebsiella and lactobacillus are the bacterial populations that are cultured from both the fresh tea leaves and the post-fermentation of Fu brick tea.

FBT demonstrates a range of biological actions, including anti-inflammatory, anti-obesity, anti-bacterial, and antioxidant properties.

The excellent anti-dysentery properties of fuzhuan brick tea are enhanced by the microbial fermentation process. The dominant fungi in this tea produces some non-phenolic anti-microbial chemicals since the level of polyphenolics declined during fermentation.



It has been shown to inhibit the growth of certain pathogenic bacteria, such as E. coli and Salmonella, in meat and poultry products. Fuzhuan brick tea has also been used to preserve vegetables, such as cucumbers and cabbage, by fermenting them with tea leaves. The tea imparts a unique flavour to the vegetables while also preserving them.

Chemical composition: High concentrations of polyphenols, a kind of antioxidant which can aid in protecting the body against damage caused by free radicals, decrease inflammation, and improve heart health, can be found in FBT. Some polyphenols can vary depending on the tea used & roasting process. Higher content in darker teas. It also contains caffeine, which is a stimulant that can help to improve focus, concentration, and alertness [42]. It is rich in theanine, which is an amino acid. Theanine can help to reduce stress and anxiety. Essential oils are volatile compounds that give FBT its unique flavour and aroma. These compounds can help to improve digestion, reduce stress, and boost the immune system [43].

For storage, it should be kept in a dry place. Moisture is the enemy of tea.FBT must be kept dry, away from moisture sources, and in direct sunshine. Store it in an airtight container: FBT should be stored in an airtightcontainer to prevent it from absorbing any odours or flavours from its surroundings. Exposure to air can cause FBT to lose its flavour and aroma over time.

Kombucha tea:A fermented beverage called kombucha tea is prepared from sweetened tea, yeast, and bacteria. The craft of probiotic beverage has reportedly existed for generations and is believed to have its roots in China. It obtained by the Camellia sinensis tea plant's fermentation process and a cellulose-based biofilm that contains symbiotic culture of bacteriaand yeast (SCOBY) , that is a gelatinous substance that contains a mixture of helpful bacteria and yeast [45]. During fermentation, the SCOBY breaks down andits sugar creates several organic acids, vitamins, and other substances. Probiotics, a type of beneficial bacteria that encourage healthy digestion and balance the gut flora, are abundant in kombucha tea. It is also high in antioxidants, which help to reduce inflammation, fight free radicals, and protect the body from disease[46].

Kombucha tea contains several bioactive substances, including organic acids, vitamins, minerals, and polyphenols. These compounds are responsible for the its's antioxidant activity, which helps to protect against oxidative damage and reduce inflammation. The chemical compounds are acetic acid, lactic acid, ethanol, and glucuronic acid. It helps to protect against oxidative damage and reduce inflammation. The tea is rich in polyphenols, that are powerful antioxidants which help to fight free radicals and protect cells from damage.

the tea is known for its anti-aging properties, which can help to reduce the visible signs of aging. During the fermentation process, various types of microbes, including bacteria and yeast, consume the sugar in tea and produce organic acids, carbon dioxide, and small amounts of alcohol[47]. The main types of bacteria found in Kombucha tea include Acetobacter, Gluconacetobacter, Gluconobacter, and Lactobacillus, while the main types of yeast include Saccharomyces, Brettanomyces, and Candida. These microbes work together to ferment the tea and create the unique taste and properties of Kombucha.

Acetobacter is a type of bacteria that converts alcohol produced by yeast into acetic acid, which gives Kombucha its tangy flavour. Lactobacillus is a lactic acid-producing bacteria that also contributes to the sour taste of Kombucha. Yeast, on the other hand, produces ethanol, which is further converted into other organic acids like gluconic acid and glucuronic acid [48].

organic acids including acetic acid, lactic acid, and gluconic acid are created during the process of fermentation and are in charge of giving the beverage its distinctive flavour. Vitamin B1 (thiamine), vitamin B2 (riboflavin), vitamin B3 (niacin), vitamin B6, vitamin B12, vitamin C, and iron are all present in trace levels. While vitamin C supports a stronger immune system, vitamin B is crucial for the generation of energy. There are traces of additional minerals in kombucha, including calcium, magnesium, and potassium. Minerals and vitamins are necessary for optimal health.Polyphenols, antioxidant substances associated to a number of health advantages, including decreasing inflammation, are abundant in kombucha tea. It also includes a range of proteins called enzymes, which assist the body's chemical processes go along more quickly. These enzymes include lipase, which aids in the breakdown of fats, and amylase, which aids in the breakdown of carbohydrates. Proteases, which aid in breaking down proteins, are present in kombucha.A small amount of alcohol less than 1 % by volume due to fermentation process is also present.

Kombucha tea as a preservative: It has been used for centuries for its health benefits and as a natural preservative. Kombucha tea is a great way to preserve food, as it is rich in probiotics and antioxidants, which help to keep food fresh and extend its shelf life. The fermentation process of kombucha tea also helps to create a pH level that is too acidic for harmful bacteria to live. This makes it an effective preservative that can help to keep food safe and free from spoilage. Additionally, the

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antioxidants and probiotics in the tea can help to enhance the flavour and nutritional value of food, making it an ideal choice for preserving food. Kombucha tea is known to contain several organic acids, including acetic acid, lactic acid, and gluconic acid, which can inhibit the growth of some bacteria and fungi. However, the concentrations of these organic acids in kombucha tea may not be high enough to prevent spoilage or bacterial growth in food or other perishable items.
Kombucha can be stored at room temperature for a short period of time (1-2 days) in a covered jar or bottle. It can also be stored in the refrigerator for longer periods of time (up to 1 month) in a covered jar or bottle. This slows down the fermentation process, which can help maintain the flavour and quality of the tea.

Pu-erh tea:

The two major types of commercial Pu-erh tea—"raw"(green) and "ripe"(black)—are made from the fermentation of dried leaves of the Assamese tea plant (Camellia sinensis). Its origin is Chinese province of Yunnan, It is a special microbiological fermented tea that is frequently fermented for many years, which improves its flavour and complexity even more. Pu-erh tea has a smooth, mellow, and somewhat sweet flavour that is well-known for being earthy and powerful. It is also thought to provide several health advantages, including as improving digestion, lowering cholesterol, and encouraging weight reduction.RawPu-erh is made from unprocessed leaves that are aged over time, while ripe Pu-erh undergoes a faster fermentation process that involves adding moisture and heat to the tea leaves.

Pu-erh tea is typically made from large-leafed tea varieties, such as the Camellia sinensis var. assamica. The leaves are hand-picked during the early spring season.The freshly picked tea leaves are spread out on large trays and left to wither in the sun for several hours. This helps to reduce the leaves' moisture content and to develop their flavour.The withered leaves are then pan-fried in a large wok to stop the oxidation process. This step also helps to shape the leaves and to further develop their flavour.The pan-fried leaves are then rolled by hand or by machine to break down their cell walls and to release their flavour.The rolled leaves are then spread out in the sun to dry. This helps to reduce their moisture content and to further develop their flavour.After the sun-drying process, the tea leaves are often subjected to a process called wet-piling. This involves stacking the leaves in a humid environment and allowing them to ferment and age for several months or even years. During this process, microorganisms break down the complex compounds in the tea leaves and produce a rich, earthy flavour.Some Pu-erh teas are compressed into cakes, bricks, or other shapes before being aged. This allows the tea to age more evenly and can also affect its flavour.

Heat water to around 200°F (93°C).The leaves are first picked and sorted according to their quality and size. Rinse the Pu-erh tea leaves with hot water to remove any impurities.Place the tea leaves in a teapot or infuser and pour hot water on it. Steep the tea for 1-3 minutes for the first infusion, and longer for subsequent infusions.

Pu-erh tea contains natural microorganisms such as bacteria and fungi that are produced during fermentation process. These microbes can help to inhibit the growth of harmful bacteria and fungi that can spoil food. Therefore, it is commonly used in Chinese cuisine as a natural preservative for foods such as meat, fish, and vegetables. To use Pu-erh tea as a preservative, it is often ground into a powder and sprinkled over the food, or the food is wrapped in Pu-erh tea leaves. The tea leaves or powder can help to control the growth of bacteria and fungi by creating an acidic environment and by producing natural preservatives such as acetic acid and lactic acid. Pu-erh tea is also known to have antioxidant properties, which can help to prevent the oxidation of fats and oils in food, further extending their shelf life.

The techniques of disc diffusion and broth dilution procedures are used to assess the antibacterial effects of Pu-erh extracts. When compared to mature Pu-erh, raw Pu-erh contains a greater strictinin concentration [52,53], which is what gives Pu-erh its antibacterial properties. This shows that additional components may also be involved in this action, and the significant concentration needed for the hydroalcoholic extract to inhibit suggests that these additional components may be water-soluble substances.

Chemical composition of Pu-erh:

Caffeine, a natural stimulant which can increase alertness and attention, is a component in Pu-erh tea. Antioxidants called polyphenols may be present in tea leaves and assist to shield the body from harm caused by free radicals. High quantities of polyphenols found in Pu-erh tea are beneficial to general health[54,55]. theaflavins and thearubigins are its fermented compounds. They provide several health advantages, including lowering cholesterol and enhancing heart health. Microorganisms like fungus and bacteria can develop during fermentation. Contains minor amounts of minerals which include magnesium, potassium, and calcium, which are important for maintaining good health.

Storage: Pu-erh tea must be kept in a cold, dry location away from strong smells and sunshine. Ideal temperatures fall between 20 and 25°C (68 and 77°F).It should be stored in airtight containers, such as tea tins or ceramic jars, to prevent the flavour of the tea. If storing Pu-erh tea cakes or bricks, it is recommended to use breathable storage containers, such as bamboo baskets or unglazed ceramic jars. This allows the tea to "breathe" and promotes the aging process. High humidity can cause Pu-erh tea to develop mould or lose flavour.

Liubao tea:

Wuzhou big tea leaves from China are used to make Liubao tea. It is a speciality tea produced using a variety of techniques, including pile fermentation, natural fermentation, drying, autoclaving, and ageing. Liubao tea is a type of post-fermented black tea as a result [55].Its name reflects where it was grown, precisely Liubao County in Wuzhou City, Guangxi Region, China. In the past, Liubao tea was used as a preventative medication [57].

Liubao tea has been found to decrease cholesterol, regulate glucose and lipid biochemistry, serve as an antioxidant, and affect gut flora and immune system function, according to recent studies. These health benefits are brought on by the polyphenols, flavonoids, caffeine, free amino acids, and soluble carbohydrates in Liubao tea [59,60,61].In the aqueous extract of Liubao tea, the quantities of GA, procyanidins, EGCG, ECG, and GCG are strongly linked with their antioxidant activity. Procyanidin and EGCG concentrations also shows a major association. According to the findings, variations in its composition during manufacture changes its antioxidant activity.

Oolong tea:

Oolong tea is a semi-oxidized, unfermented tea that was first produced in southern China. It takes shorter time to oxidise (a few hours to a few days). It has anti-bacterial activity against Streptococcus mutans and Streptococcus sabrinus.

Green tea:

The most popular microbially unfermented tea is green tea, which is renowned for both its beneficial health properties and its distinctively reviving flavour and scent. As the heat fixing is done as soon as the tea leaves are harvested and disturbed, it has the lowest amount of oxidation. As a result, the chemical components of fresh tea leaves, such as polyphenols, amino acids, and vitamins, are preserved[63].

MAJOR PHYSIO-CHEMICAL CHANGES PRODUCED IN MICROBIAL FERMENTED TEA:

Bacterially fermented tea, mould-fermented tea, yeast-fermented tea, and edible and medicinal fungi-fermented tea are the four different types of microbially fermented tea.These types can be categorised based on the type of microbiota present. Its antibacterial and antioxidant properties were improved after brewing because of the rise in phenolic compounds. After fermentation, the caffeine content is reduced, improving its flavour.

Bacterial fermentation of tea:

The process of using microbes to ferment tea is called bacterial fermentation.During the kombucha fermentation process, the sugar and acid content change, giving it a new flavour; aromatic compounds are produced, enhancing its flavour; and phenolic substances change, enhancing its antioxidant properties.Its pile-fermentation is primarily carried out by the microbial species Cyberlindnera, Aspergillus, Eurotium, Uwebraunia, Debaryomyces, Lophiostoma, Peltaster, Klebsiella, Aurantimonas, and Methylobacterium.Fermented teas can be categorised based on how they are prepared. In relatively dry conditions, naturally occurring fungus is used to ferment piled teas like the Toyama kurocha which is developed in Japan and the Chinese post-fermented teas. Other fermented teas, often known as pickled teas, are fermented using lactic acid bacteria in a moist process.

kombucha is a another type of microbially fermented tea which is mostly preferred, for its distinctive flavour and aroma.

Mould fermentation of tea:

Since tea polyphenols do not prevent the growth of mould, certain mould metabolites can cause a number of reactions in tea, such as oxidation, methylation, and degradation, which can enhance the tea's quality. Therefore, some researchers chose Streptomyces, Mucor, and, Aspergillus niger to perform fermentation studies on tea that has been fermented with mould.when black and green teas were fermented with moulds and yeasts, the amount of caffeine of the moulds rose because of the methylation process and an increase in the main component of caffeine, while the caffeine content of the yeasts decreased. Aspergillus niger have the best fermentation performance

Eurotiumcristatum has recently been employed for tea brewing. The bacteria create amylase and oxidase, which can facilitate the transformation of the proteins and starches in tea to simple sugars and polyphenol compounds' oxidation to chemicals beneficial to human health, to improve and maximise the flavour and additional qualities of tea. Raw dark tea extract was fermented with Eurotiumcristatum, the mycelia's dry weight increased by about ten times right after fermentation.The bulk concentrations of tea polyphenols, total protein, and water extract decreased.The proportions of total flavonoids, free amino acids, and theobrownins improved and the proportions of 12 different aromatic compounds—the majority of which were esters and alcohols—also increased

Yeast fermentation of tea:

By adding yeast to the tea fermentation process, user can enhance not only the activity of the process but also the sensory attributes of microbial fermentation of tea by creating ethanol, acids, and esters as well as other flavouring compounds. Consuming fermented tea is better than black tea because researchers have demonstrated that fermentation process used by Dabaryomyceshansenii reduces the amount of caffeine and tannins in black tea while improving its medicinal and nutritional worth.

The study also found that the catechin, theaflavin, and polyphenol contents rose following yeast fermentation while amino acids, flavonoids, caffeine, thearubigins, and theobrownins diminished. This discovery was supported by the isolation of yeast strains from raw and fermented Pu-erh tea samples. The flavour of tea is influenced by the amounts of caffeine, catechins, and amino acids, and the colour of tea soup is determined by the amount of tea pigment. While theaflavin content increased and theanine content decreased, both effects enhanced the bitterness of the tea's flavour. Consequently, yeast plays a significant role in the development of Pu-erh tea's quality.

Changes in odour/aroma of fermented tea:

As a consequence of the thorough study of tea and the modulation advantages of microorganisms on tea beverages in the process of fermentation, several researchers have also created medicinal and edible fungus for tea fermentation. Whenever medicinal and edible fungi are utilised, the tea that is fermented by microorganisms experiences a biochemical reaction to create fragrance components like esters and alcohols. Proteins and polyphenols witnessed alterations as well, which enhanced the astringent, sour, and stale flavours of tea while imparting a fresh fragrance.

Poriacocos was used by Rigling et al. to modify the aroma of green tea. The research discovered that Poriacocos transformed the distinctive aroma of green tea into a jasmine flower and slightly citrus flavour after immersion and fermentation for 17 hours. This was accomplished by the creation of linalool, methyl anthranilate, 2-phenylethanol, and geraniol. Antioxidant of Green tea action is still prevalent for the time being.Additionally, after fermentation with the therapeutic mushrooms Grifolafrondosa and Tianzhi (new varieties of Ganoderma lucidum)polysaccharide, free amino acid, and protein contents of fermented jinxuan oolong tea rose substantially. The decreased amounts of tea polyphenols, caffeine, and water extract in the fermented products greatly lowered the turbidity, bitterness, and water extract content of tea juice. This gave the juice a sweeter flavour and aroma.

MICROBIAL ENRICHMENT EVALUATION DURING FERMENTATION OF ENSILING PRUNED BRANCHES FROM TEA PLANTS:

Microorganisms have a crucial part in the production of silage quality during the anaerobic fermentation process known as ensiling, in which they interact with chemicals present in the ingredients. A more prominent role has been given to ensiling as a conventional technique for preserving fresh fodder. Water-soluble carbohydrates are broken down by microbes to create organic acids, which lower pH and stop decomposing bacteria from proliferating, resulting in the creation of silage. According to the study, due to its capacity to conserve nutrients, ensiling has emerged as a popular method for using agricultural leftovers.The quantity of waste like pruned tea branches and leaves is rising quickly as the demand of tea is increasing, which not only causes a significant loss of biomass but also puts more strain on the environment. In the past several

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years, there has been a lot of study done on the exploitation of tea waste biomass. Pruning tea leaves and tea leftovers result in the accumulation of lignin and holocellulose, both of which are rich in carboxyl, hydroxyl, phenolic hydroxyl, oxylcompounds along with oxygen- and heteroatom-containing groups.According to reports, thermo-chemical processes like pyrolysis can turn used tea leaves into carbonaceous compounds that can be used as adsorptive materials. In most cases, the converted bio-adsorbents have a lot of functional groups, porous structures, and a relatively big surface area. Biochar is advantageous as a nitrogen-rich biomass precursor for creating contaminant adsorbents since pruned tea leaves and branches have a high amount of nitrogen functionalities (amino acids and caffeine) that may be added to it. An experiment was conducted to figure out new ways of disposing agricultural waste from tea plantation for which they studied tea plant pruning debris throughout 60 days of ensiling allowed researchers to better understand the dynamics of its chemical composition and microbial communities.The findings revealed that after a significant initial pH which was around 3.9 value decline,but the pH was stabilized in next 21 days. By the time the ensiling process was complete, the silage had been supplemented with lactic and acetic acids while still retaining the majority of distinctive elements of tea , such as polyphenols, theanine, and caffeine. An examination of the microbiome was also done in that experiment which revealed that from day three Lactobacillus' relative abundance grew quickly from about 73.2% to 98.6%. Moreover, the chemical compositions and the fermentation metabolites were connected to the microbial community's dynamics at the time of fermentation. By this study they proved that silage is one of the most effective way to utilize the pruned branches and leaves of tea plants.The composition and quality of the silage produced might vary depending on how tea plants are pruned. In one study, clipped branches from tea plants that had been mechanically harvested were ensiled, and the results showed greater amounts of acetic acid and butyric acid, which can signify poor silage quality. Nonetheless, silage from hand-pruned branches had a greater lactic acid content, which is a desired result.

COMPARATIVE ASSESSMENT OF ANTIBACTERIAL EFFICACIES AND MECHANISMS OF DIFFERENT TEA EXTRACT:

One of the biggest challenges to food safety has been the rise in foodborne illness brought on by pathogenic bacteria and foodborne deterioration. According to reports, pathogenic microorganisms can seriously threaten human health by causing infections, toxic shock syndrome, and food poisoning.Chemical food preservatives have reportedly been linked to respiratory ailments or other health hazards in recent years. Consequently, it is essential to make novel kinds of functional plant-derived antibacterial compounds that are safe,biodegradable, and have less adverse effects. The development of antimicrobial supplements may be aided by a few plant extracts, such as tea foliage (Camellia sinensis), which has potent inhibitory effects against pathogenic microorganisms.

Among the most renowned beverages consumed worldwide is tea, which has a number of pharmacological benefits, including hypoglycaemic, anti-obesity, anti-carcinogenic, antioxidant, anti-arteriosclerotic, and antibacterial activity. There are currently more than 300 commercial tea varieties manufactured and consumed worldwide.Tea can be majorly divided into four types based on the manufacturing process: semi-fermented tea (oolong tea), fully fermented tea (black tea), non-fermented tea (green tea), and post-fermented tea (dark tea).

Catechins are the known active components that have a significant impact in the biological functions of tea. Various teas contain diverse catechins and their derivatives, which allows these substances to have a range of biological actions. Green tea is steamed which prevents catechin oxidation and effectively keeps polyphenols like (-)-epicatechin (EC), (-)-epicatechin gallate (ECG), (-)-epigallocatechin (EGC), and (-)-epigallocatechin gallate (EGCG) in their monomeric forms.Crushing, withering, and a thorough process of fermentation are applied to black tea leaves, allowing enzyme-mediated oxidation to produce theaflavins and Thearubigins from catechin derivatives. Oolong tea includes both catechins and theaflavins and goes through a similar processing procedure to black tea, however in a shorter oxidation time. Dark teas undergo controlled post-fermentation with fungi under high humidity and temperature, which drastically reduces the amount of catechins while producing tea pigments includingTheabrownin.

Extracts of tea flush and various tea products have shown a wide range of antimicrobial activities against Bacillus cereus, Campylobacter jejuni, Escherichia coli, Clostridium perfringens, Helicobacter pylori, Legionella pneumophila, Staphylococcus aureus, Salmonella typhimurium, Shigella flexneri, Pseudomonas aeruginosa, Vibrio cholerea,and more.Green tea has greater antibacterial properties than black tea, according to a study of antimicrobial activity. Catechins from green tea are responsible for stopping bacterial development. The green tea has strong antibacterial properties against methicillin-resistant and penicillinase-producing S. aureus.Due to the presence of organic acids like acetic acid, kombucha, tea-leaf-fermented beverage, provides antibacterial properties.

Green tea extracts exhibit the strongest antibacterial activity towards Gram-positive as well as Gram-negative bacteria and possess the greatest DIZ (diameter of inhibition zone). Green tea kombucha provides a wider spectrum of pathogenic bacterial inhibition than black tea kombucha. Oolong, Fuzhuan, and black tea extracts are followed by green tea extracts in terms of antibacterial potency against microorganisms with lowest MIC (minimum inhibitory concentration) values.

The major contributor to antibacterial efficacy are catechins. The greatest polyphenol (27.10%) and catechin (21.30%) concentrations were found in green tea extracts, which were followed by oolong (21.60 and 2.22%), Fuzhuan tea (19.60 and 2.22%), and black tea (17.26 and 1.67%). During the fermentation process, large amounts of catechins are reduced and oxidised to form tea colours. The quantities of theaflavin (1.8%), thearubigins (16.13%), and theabrownins (17.80%) are highest in black tea extracts, whereas they are lowest in oolong tea extracts (0.87%, 3.13%, and 3.19%, respectively).

Extracts of black tea and Fuzhuan tea had the greatest quantities of gallic acid and caffeine (0.78 and 5.23%, respectively), respectively. Green tea extracts had the lowest concentration of these substances (0.13% and 3.40%, respectively), followed by oolong tea extracts (0.55% and 4.12%, respectively). Carbohydrates were utilised as a source of carbon by microbes throughout the unique pile-fermenting and fungal-fermenting processes; the Fuzhuan tea extracts (8.91%) have the least carbohydrate content. The amount of amino acids in each of the four extracts of tea is same [86].

EGCG (epigallocatechin gallate) is the primary component of green tea extracts which shows antibacterial properties against B. anthracis, E. coli, and S. aureus. EGCG MIC values is 1250 µg/mL against E. coli, 625 µg/mL against S. aureus,130 µg/mL against bacillus subtilis and 620 µg/mL against Yersinia enterocolitica. EGCG is effective against Gram-positive bacteria as compared to Gram-negative bacteria.

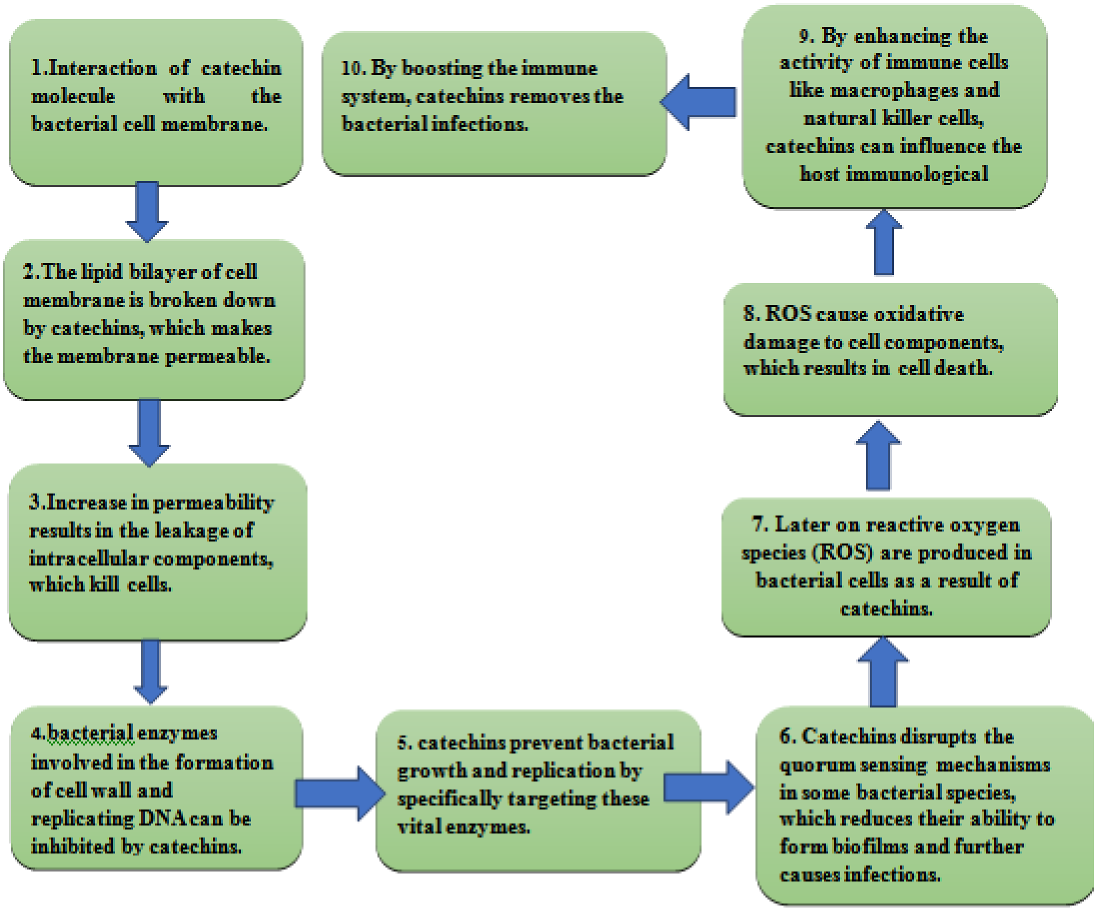
Antibacterial mechanism of catechins:

Catechins have a strong affinity for biomacromolecules which includes lipids, proteins, hydrocarbons, and nucleic acids because they are rich in phenolic hydroxyl groups and polycyclic structures. Because of their high affinity, catechins can interact with the bacterial cell membrane, leading to changes in the fluidity which results in unstable cell structure. EGCG octa acetate has two-fold stronger antibacterial activity against E. coli than EGCG, due to its higher lipophilic properties.

A study that investigated the antibacterial mechanism of catechins was conducted.They investigated the efficacy of several catechins as antibacterial agents against a variety of bacteria, including both Gram-positive and Gram-negative strains. The scientists discovered that catechins effectively inhibited the bacterial development and had a stronger bactericidal effect on Gram-positive bacteria (Cushnie, Lamb. et al.,2005).

Another study studied the antibacterial properties of a specific catechin present in green tea, epigallocatechin gallate (EGCG). The scientists discovered that EGCG interacts with the integrity of bacterial cell membrane causing the leakage of cellular contents and eventually the bacterial death. A possible combination between catechins and traditional antibacterial medicines has been suggested by their observation that EGCG increased the action of some antibiotics against bacteria (Ota et al.,2008).

Step wise antibacterial mechanism of catechins:



SIGNIFICANCE OF FERMENTED TEA AND ITS TYPES:

Due to its distinctive flavour profiles and potential health advantages, fermented tea has grown its popularity in recent years. Examples are; kombucha and Pu-erh tea.

The importance of fermented tea can be found in numerous areas:

1.probiotic properties: Probiotics are a well-known component of fermented tea. The components of the tea are metabolised by beneficial bacteria and yeast cultures during the fermentation process, producing organic acids, vitamins, and enzymes. By introducing beneficial microbes, which could assist in digestion and overall gut health, these fermented tea products can maintain a healthy gut microbiota.

2. Potential health benefits: Fermented tea has been linked to a number of potential health advantages. According to some research, consuming fermented tea may have anti-inflammatory and antioxidant effects, manage blood sugar levels, support liver health, and enhance cardiovascular health. It's crucial to remember that additional scientific study is required to confirm specific health advantages.

3. Unique flavour profile: Compared to traditional teas, fermented tea has a unique flavour. Depending on the particular variety of fermented tea, the fermentation process can add different flavours, such as a slightly acidic, tangy, or vinegar-like taste. fermented tea is a fascinating and pleasurable drinking option because of its distinctive flavours.

4.historical and cultural importance: fermented tea has a deep historical and cultural importance. For instance, kombucha has a origin of east Asia, whereas Pu-erh tea originated from China.

A culture of bacteria and yeast known as a SCOBY (symbiotic culture of bacteria and yeast) is added to sweetened black or green tea to create kombucha, a fermented tea. Over time, the SCOBY causes the fermentation of tea, breaking down the sugar to create organic acids, vitamins, and enzymes. The texture and flavour of kombucha are sour and acidic.

Pu-erh tea goes through a special microbial fermentation process that can take months or years to complete. Tea leaves undergo an alteration during fermentation, giving the beverage a distinctive earthy flavour. Pu-erh tea is frequently aged, and as a result, its flavour profile can change and evolve with time.

In contrast to kombucha, which is produced with black tea and sugar, Jun tea is made with honey and green tea. The green tea base and honey fermentation gives it a lighter and more delicate flavour profile than kombucha using the same SCOBY strain.

Water kefir is a fermented beverage made by the fermentation of water with kefir grains, though it is not specifically a tea. Kefir grains are a blend of yeast and bacteria cultures that break down sugars to produce a frothy, moderately sour beverage. To generate different flavour profiles, water kefir can be flavoured with fruits or other components.

FUTURE PROSPECTIVE:

The popularity of fermented teas has grown significantly in recent years, and they appear to have an optimistic future. Here are some possible directions and developments for fermented teas:

1.Scientific study aimed at understanding the health advantages, mechanisms of action and potential applications of fermented teas is going to rise as they continue to gain attention. The specific molecules and bacteria involved in the fermentation process, as well as their effects on human health, may be elucidated.

2.Numerous product improvements have already resulted from the growing popularity of fermented teas. With new flavors, combinations, and formulations being produced for various tastes and preferences, this trend is predicted to continue.

3.Fortified fermented tea products may become more popular as there is a rising interest in functional meals and drinks. To increase the health benefits of fermented teas and address certain health concerns, this may involve the addition of particular minerals, vitamins, or probiotic strains.

4.Kombucha and other fermented teas are usually available in health food stores and specialized markets. However, as the demand for fermented tea grows, they are likely to become more generally accessible to a wider consumer base by becoming more readily available at grocery shops and online marketplaces.

5.In order to include fermented teas in dishes, cocktails, sauces, and marinades, chefs and mixologists are discovering their distinctive flavors and profiles. As fermented teas gain popularity for their numerous culinary uses, this can get more recognition.

6.There may be a greater focus on the sustainable sourcing and manufacturing techniques for fermented teas as consumers become more concerned with sustainability and environmental effect. This could enhance using organic tea leaves, operating production facilities on renewable energy, reducing packaging waste, and bringing environmentally friendly practices.

II. CONCLUSION:

Beneficial bacteria in fermented tea produce organic acids like acetic acid and lactic acid throughout the fermentation process. These organic acids produce an acidic environment that prevents some bacteria from growing. Catechins, a type of polyphenol found in tea leaves utilised in the fermentation process, have been studied for their potential antibacterial effects.The growthof pathogens may be prevented by beneficial microbes in fermented tea. Fermented tea has antioxidant properties, specifically those that are rich in polyphenols.The antibacterial qualities of fermented tea can differ based on the factors including the type of tea, the fermentation method, and particular microbial strains involved. Additionally, various bacterial strains may respond variably to the antibacterial properties of fermented tea.In the food industry, fermented tea is a stand-alone beverage. With its tangy and effervescent characteristics, kombucha has gained popularity as a probiotic-rich, pleasant beverage. Many cafes, restaurants, and supermarkets sell it in bottles or on tap.By contributing in the preservation of food and beverages, fermented tea can be utilized as a flavouring component or ingredient in a variety of foods and beverages.Health benefits and flavours of fermented tea can be infused into many food industry products. For example, it can be used to flavour ice cream, yogurt, chocolates, candies, and baked goods. It imparts a unique taste and probable health benefits to these products.Its derivatives may be used in products that support digestive health, gut health, or general wellbeing. such as fermented tea-based snack chips, probiotic granola bars, and energy drinks.Due to the popularity of fermented tea, the food industry has seen a rise in private label and specialised goods. Retailers and companies are can develop their own lines of products, including kombucha concentrates, ready-to-drink kombucha or kombucha kits for home brewing.their use in the food industry is anticipated to increase, giving consumers more innovative food product options.Due to its bacterial content, organic acids, and antioxidants, fermented tea shows an intriguing combination of possible health advantages. Despite it can be an appealing and refreshing addition to one's diet, it should be consumed in moderation as part of a healthy lifestyle. People with particular health conditions or concerns should consult with a medical professional before introducing fermented tea into their routine.

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