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REVIEW ARTICLE

Typology of Processed Tea (*Camellia sinensis* [L.] O. Kuntze): A Review

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ABSTRACT

Tea typology is the science of classifying tea. The main objective of this study carried out between November 2023 and August 2024, was to investigate and compare the typological classification nomenclature of processed tea worldwide. The study utilized a paper review methodology to analyze existing literature and research on tea typology, processing methods, and global classification systems. While the Asian tea-producing countries categorize tea products based on the decreasing oxidation levels during the manufacturing process, namely, Black, green, oolong, and instant teas, Kenya's tea typology system is based on the degree of the fermentation process, that is, black tea, purple tea, green tea, and white tea. Tea is also classified into five categories: Black, green, white, oolong, and pu-erh or dark teas. The most common typology is by oxidation, and more specifically, by the production methods within the oxidation categories. The main tea processed and exported in Kenya is black tea, a brand that makes up approximately 80% of all teas consumed globally. Manufacturing of black tea is done by withering, rolling, or by use of a cutting-tearing-curling method that ensures efficient conversion of leaf herbage to make tea, which is oxidized and dried before sorting into different grades. This study concluded that tea typology nomenclature differs from country to country, region to region, and classification of this popular thirst-quenching beverage mainly based on the plant origin, historical background, region where tea is (was) grown, scientific system, market niche, economic reasons, cultural beliefs, fermentation, education, and oxidation levels. To achieve coherence in the tea sector, it is recommended that a global tea regulator be established to standardize tea typology.

Key words: Classification, fermentation, nomenclature, oxidation, tea, typology

INTRODUCTION

The young tender shoots of tea (*Camellia sinensis* [L.] O. Kuntze), grown in some tropical and temperate countries, are the source of one of the world's oldest, cheapest, and the second most popular non-alcoholic caffeine-containing beverages in the world after pure water, with immense economic, health and cultural importance, manufactured and served in different ways.[1-4] As early as 3000 B.C., the Chinese used it not only as a stimulant but as a medicinal beverage because its plant-derived polyphenols provide many health benefits.[5] The leading tea-producing countries in Asia and Africa cultivate a rich array of tea clones and employ various processing techniques of tea leaves and buds, resulting in multiple unique flavors, soothing aromas, and tastes.[6] In 2023,[1] estimated that more than 3 billion people across 160 countries were tea-drinking. Some tea types have a cooling, slightly bitter, and astringent flavor, while others have profiles that include sweet, nutty, floral, or grassy tastes. In addition to its addictive aroma, pleasant taste, and rich flavor, the tea beverage confers numerous health benefits such as reduced cases of cancer,[7] anti-inflammatory, antioxidant,

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and significant weight loss effects[2] to those who drink it. These positive attributes are contributed by the green tea leaf, which contains over 700 chemical components of this plant that range from secondary metabolites such as polyphenols (catechins-30%, bioactive flavonoids-2%), alkaloids (caffeine-3%, theobromine, theophylline), proteins-6%, theanine-3%, theaflavins-4%, organic acids-2%, vitamins, carbohydrates-4%, sugars-7%, volatile oils or lipids-3%, potassium-5%, other minerals-5%, and aroma compounds in trace amounts.[8,9] The catechin fractions, epigallocatechin 3-gallate, and epicatechin 3-gallate, are the main components of tea that has strong antioxidant and medicinal properties.[5] Black tea, derived from the leaves and buds of the *C. sinensis* plant, is the most popular in the world, accounting for about 80% of tea consumed followed by green tea (15%), while oolong (also spelled Wulong in China) tea (4%) and white tea are least on the demand scale.[10] Before the mid-17th century, all Chinese tea was green tea, but not anymore. In 2022, China produced 3.2 million metric tons (mmt) of tea, out of which 58.3% of it was green, 15.2% black, 13.2% dark and pu-erh, 9.8% Wulong (oolong), and while 3.4% constituted the remainder.[11] Majority of the people worldwide prepare tea beverages by pouring hot or boiling water over cured tea leaves harvested from the *C. sinensis* plant. It is a calorie-free beverage when drunk without milk and sugar. Tea is consumed in various forms across the globe. In India, crushed black tea leaves are consumed with milk, sugar, and spices. In Morocco, there is a tradition of preparing tea mixed with fresh mint and sugar and pouring it from a height of 30 cm into a cup. In China, tea is offered in porcelain cups, while in Taiwan, tea is consumed in the form of iced tea mixed with small balls made of tapioca or fruit jelly.[12] Closer home in Kenya, mixed tea is preferable, served with or without sugar.[13] Tea was used for medical reasons initially but has gained popularity over time to become a recreational beverage,[3] and has now proven to be an important raw material for the pharmaceutical industry.[14]

Tea can grow to over 9 m tall in a climate that experiences temperature ranges as high as 35°C (recorded in Assam) and freezing point (Mount Kenya), the optimum temperature being 13–30°C. Tea bushes thrive in slightly acidic soils with a pH range of 4.5–5.5 and a minimum annual rainfall of 1200 mm, but rainfall of 2500–3000 mm is considered optimal.[15] Relative humidity of about 80% is ideal, but should not be <40%. At present, tea is grown in latitudes ranging from the equator to 33°S (Natal, South Africa) and 49°N (Georgia, USA), and between sea level (Bangladesh) to an elevation of 2,700 m (Mt. Kenya region).[15,16]

Tea is classified in different countries and regions on the basis of diverse definition methods.[17] Tea typology is the science of classifying tea.[18] Tea names are descriptive. The purposes of classifying tea are numerous:

1. Named after geographical region: Mostly named after the geographical region they came from, for example, Assam tea is named after Assam, the region in India; Yunnan tea is produced in the Yunnan region of China, Darjeeling tea from the Darjeeling region in West Bengal, India, having light-color floral aroma with tannic characteristics. Others are Nilgiri tea grown in the hills of the Nilgiri district, Tamil Nadu, India; and Ceylon tea cultivated in Sri Lanka, among others.[19]
2. Historical background:[20] Documented that green tea came first followed by brown and black, white and red, and lastly blue. China teas to date are divided into six major categories- green, brown, black, white, blue, and red on the basis of historical nomenclature.
3. Typology by provenance (origin): Yunnan in China is the birthplace of the first-ever tea plants and the home of the widely acclaimed variety known as "Pu-erh" tea, Assam, Ceylon, Darjeeling, East or West of Rift Valley in Kenya, Java.[21]
4. Scientific method: Must meet two conditions. First, it must show how the characters of teas are interrelated. Second, it must show how processing methods are interrelated. At the same time, a scientific classification must embody the important interrelationships among material changes.[20]
5. Market niche: Tea can be branded on the basis of the region where the product first became popular, where is sold, or where it is a household name, for example, English breakfast popular in the UK and English-speaking (cultured) countries.

6. Fermentation and oxidation levels subjected to tea during processing: Fermentation in tea refers to the natural browning reaction catalyzed by enzymes endogenous to the plant,[7] during which tea leaves break down and decompose, for example, aged teas, such as pu-erh. A fermentation typology criteria is used in the Kenyan tea processing factories. Oxidation is a process in which tea leaves are exposed to the air to dry and darken, contributing to the flavor, aroma, and strength of different teas. This typology is applied mainly in the Asian countries.
7. General education to the drinkers on the type of tea they take, and cultural reasons.

STATEMENT OF THE PROBLEM

Absence of global regulator, resulting in divergent tea classification criteria in different regions of the world.

Arising from the divergent classification criteria in different regions, this review paper explores the typology of processed tea in the leading tea-producing countries. This study was carried out between 3rd November 2023 and 15th August 2024.

Main Research Objective

The main research objective was to investigate and compare the existence of variability in the typological classification nomenclature of processed tea worldwide.

Research Methodology

The study utilized a paper review methodology to analyze existing literature and research on tea typology, processing methods, and classification systems.

Analysis Procedures

The analysis involved comparing and contrasting the typological classification systems of processed tea in various regions of the world.

Questions Addressed

The study addressed the variability in tea classification methods globally, and the need for standardization through a global regulatory body.

DISCUSSION

Centers of Origin of Tea

Based on latitude and longitude, the centers of origin of tea were the point of intersection between 29°N and 98°E near the source of the Irrawaddy River at the confluence of North-East India, North Myanmar, South-West China, and Tibet provinces,[15] Thailand to Vietnam.[22] Ancient archeological evidence indicates that Yunan in China was the first home of the pu-erh tea variety, also known as dark tea (hēichá in Chinese), the name pu-erh derived from the market town in which it was first developed.[23] The expansive present-day tea production areas were opened up and planted using germplasm introduced from the original centers of origin covering South-East Asia, North Myanmar, and southwest China, although the exact place where the plant first grew is not known.[2] The world tea-producing countries and regions are more than 60, primarily in Asia, Africa, South America, and parts of Eastern Europe, with China remaining by far as the largest in production, consumption, and offering outstanding tea quality.[1]

Botanical Description of Tea Plant

Documented tea plant botanically as follows: Scientific name: *C. sinensis* (L) O. Kuntze); Family: *Theaceae*; Morphology: Evergreen shrub/small tree.[24,25] The China-type tea is dwarf, with small, dark green, narrow, serrated leaves, while Assam-type tea is a larger plant, with green, less serrated leaves. Leaves: Simple, alternate, serrated; Flowers: Bisexual, regular; Sepals and petals: Mostly five; Stamen: Numerous, anthers, two-celled; Ovary: Superior, 2–4 locular, rarely solitary axile; Fruit: A capsule; Seed: Recalcitrant (losses viability on drying); Chromosomes: 15 chromosomes ($n = 15$) are present in the first division metaphase of the pollen mother-cell gametes of *C. sinensis*, hence diploid tea plant has 30 chromosomes (2 $n = 30$); Breeding system: Cross-pollinated self-incompatible; Extent

of selfing: 6–40%, lowest in Assam type and highest in China type; inbreeding depression: Very high, leads to loss of vigor and quality.

Sub-Species of Tea

Although *C. sinensis* is a single species, several sub-species have developed over time, each with unique characteristics that influence the taste, aroma, and appearance of the tea bushes and leaves they produce. 100–250 *Camellia* species are recognized.[24] The cultivated and processed tea taxa in Kenya comprise of three distinct natural sub-species, derived from two taxa: *Sinensis* and *assamica*. They are (1) China-type *C. sinensis* (L.) O. Kuntze var. *sinensis*, (2) Assam-type sub-species *C. sinensis* var. *assamica* (J. W. Masters) Kitamura, and (3) Cambod tea or Southern type *C. sinensis* var. *assamica* spp. *lasiocalyx* [Planchon ex Watt] or *Camellia cambodiensis*.[14,15] Besides the three, two other *C. sinensis* tea varieties are recognized: *C. sinensis* var. *pubilimba* Hung T. Chang and *C. sinensis* var. *dehungensis* (Hung T. Chang and B. H. Chen) T.L. Ming. These two are also known as Mao chá (Mao tea) and used for pu-erh (dark or hēichá) tea.[26] Demographic modeling studies by[27] documented that China and Assam tea types split 22,000 years ago during the last glacial into the Chinese Assam-type tea and Indian Assam-type tea lineages.

The three tea sub-species: *Sinensis*, *assamica,* and *cambodiensis* have been widely investigated, bred and bulked by Kenyan breeders, and released for commercialization by smallholders in the country. Tea is highly heterogeneous, and there have been many cross-pollinations between the China and Assam types over the years.[15] China (*C. sinensis*) and Assam (*C. assamica*) sub-species can be distinguished from each other mainly on leaf form and floral characters.[22]

China tea: C. sinensis var. sinensis [Linus] variety

The Chinese variety (*C. sinensis* var. *sinensis*) is native to southeast China and was used to produce tea way back 4,000 years ago.[24] *Sinensis* in Latin means Chinese or pertaining to the Far East, a name for the small and narrow-leaved tea cultivar.[12] Var. *sinensis* is a slow-growing, hardy dwarf trees, grown in high altitudes of 1,500–2,700 m above sea level.[15] In the wild, China tea is a multi-stemmed, slow-growing shrub or small tree attaining 1–6 m in height. It has a strong taproot and its flowers are yellow-white, 2.5–4.0 cm in diameter, with seven or eight petals. Improved China hybrids can reach a height of 5–8 m tall shrub if they are allowed to grow uninterrupted.[15] The seeds of *C. sinensis* can be pressed to yield tea oil, a sweetish seasoning, and cooking oil. Fresh leaves contain about 4% caffeine. The young, light-green leaves are preferably harvested for tea production when they have short, white hairs on the underside. Older leaves are deeper green. Different leaf ages produce differing tea qualities because their chemical compositions vary. Tea is harvested by either hand-plucking or by mechanical means. Quality teas are processed using the first 2 leaves and a bud. Harvesting of tea leaves is done by hand picking at every 7–14 days' interval, depending on the tea cultivar, soil moisture content (precipitation), temperature, fertilization, and field agronomic practices.[28] Mechanical harvesting is popular where labor is expensive and where tea is grown on flat terrain, and not on steep mountain slopes.

Assam tea: C. sinensis var. assamica [masters] Kitamura

Assam is indigenous to the north-eastern part of India called Assam, said to have evolved as an understorey tree in a forest environment, typified by large, horizontally held, broad, mostly non-serrated, light green leaves. It grows fast in the wild and is a single-stemmed, loosely-branched tree about 17 m tall.[29] Assam has an erectophile leaf angle of more than 70°. It is a tropical cultivar, sensitive to dry and cold weather conditions. Hybrids of Assam can grow naturally to 10–15 m tall tree.[30]

Assam is Kenya's most predominant tea germplasm due to its high. Many of these Assam clones are genealogically related.[29] Genetic variability in tea is desirable because it provides a buffer against co-evolving factors of natural hazards, such as diseases, pests, and changing environments.[31]

Cambod tea: C. sinensis var. assamica spp. lasiocalyx [Planchon ex Watt]

The Cambod tea type is a medium-leaved tiny tree with multiple stems and leaves, a hybrid between China and Assam teas from Cambodia.[12] It is also known as Shan tea, the name Shan being the tribes

of Burma (present Myanmar) who pickled the tea leaves.[6] Cambodian variety growth characteristics are intermediate between the Assam and Chinese varieties as the two types cross freely. The normal growth habit of the Cambodian variety is that of small shrubs. Early tea planters deliberately produced hybrids that combined the characteristics of both types, constituting major germplasm being bulked presently. Cambodia has semi-erect leaves, not commonly grown in Africa but mainly cultivated in Indonesia, the Democratic Republic of Congo, and Reunion.[24]

Clonal tea: C. sinensis var. assamica and var. sinensis

Tea is propagated either through seeds or cuttings. Clones are genetically identical plants and give uniform yield and quality. Kenya's tea germplasm is predominantly of the *C. sinensis* var. *assamica* type and is highly diverse though many of the clones are genealogically related. Genetic variability in tea is desirable because it provides a buffer against co-evolving factors of natural hazards, such as diseases, pests, and changing environments.[31] About 60% of all tea in Kenya are clones mostly bred to thrive in adverse tea growing locations and tolerate pest infestation or diseases. In 2001, the first clones of var. *sinensis* tea genetic resources from Japan and China were introduced, and have since been cloned and transplanted into field trials where they have established well. In 2003, the Tea Research Foundation of Kenya (TRFK) imported clonal cuttings of 10 accessions of tea from Tanzania: TRIT 201/10, TRIT 201/16, TRIT 201/43, TRIT 201/44, TRIT 201/47, TRIT 201/50, TRIT 201/55, TRIT 201/73, TRIT 201/75, and TRIT 201/82. Introductions of seed from China in 2004 were cloned and used to develop improved green tea cultivars. TRFK has developed over 1,000 improved clones, out of which 50 clones have been selected for consistent superiority in yield, some yielding 5–8 tons/mt/ha/year, good cup quality characters, and have been released to the farmers to plant.[32]

Commercial Tea Production

Tea is cultivated commercially on a massive scale in more than 100 countries globally.[33] Out of about 13 million people employed in the global tea sector, 9 million of them are smallholder farmers domiciled in developing countries, producing 60% of the world's tea.[1] The profitability of the tea operation is determined by the quantity and quality of the plucked shoots.[34]

Tea is grown in the Kenya highland regions with an elevation of 1,500–2,500 m above sea level,[35] with an ideal climate consisting of tropical volcanic red soils, well-distributed rainfall of 1,200–1,400 mm per annum, conducive long sunny days needed for photosynthesis, giving the Kenyan tea a unique quality and taste.[36] Other than fertilizers added regularly to replenish nutrients mined by the tea crop for optimum growth and yield, no pesticides and chemicals are applied to tea farms, guaranteeing health and safety to consumers.[16]

Kenya being the largest tea-producing country in Africa, this C-3 woody perennial is the leading foreign exchange earner to the country, contributing 24% of gross domestic product, accounting for 70% of the total export earnings. In 2022, total global tea production stood at 6.4 mmt, China has contributed the largest quantities of 3.2 mmt (49.7%), followed by India with 1.34 mmt (21%), Kenya (8.3%), Turkey (4.4%), and Sri Lanka (3.9%) whose production declined by a 16% margin as compared with the 2021 yields mainly due to political upheavals, economic turmoil, and poorly executed shift in agricultural Policy. The rest of the countries produced the remaining 12.7% [Figure 1].[11]

In 2023, tea earned the country over USD 0.93 billion (Ksh. 120 billion) in export earnings, and USD 0.17 billion (Ksh. 22 billion) in local sales, making it the third largest exporter of tea worldwide after China and India, and the biggest exporter of black tea. The Kenyan tea industry supports about 5 million people directly and indirectly while an estimated 650,000 tea growers depend on tea, making the sub-sector one of the leading sources of livelihood in the country.[10]

Kenya consumes 6.6% only of its processed tea, exporting the surplus, making Kenya's tea sector a major contributor to the much-needed foreign exchange earnings and employment creation, particularly for the youth and the women. About 90% of the tea consumed worldwide is black tea, where Kenya contributes 16.3% of the total, ranking second in the global tea export value in 2021 after China (28.6%).[37]

During the January-April 2024 tea harvest period, Kenya was third in tea production (0.305 mt) after China (2.4 mmt) and India (0.9 mmt).[38] In 2023, Kenya shipped tea to 92 export destinations as compared to 82 in the year 2022, signifying growth in the global black tea market niche. The Kenyan tea industry is bright following a steady increase in production from 2019 to 2023 [Figure 2].[10]

Tea Typology Globally

Nomenclature is an important stage in the classification of teas. Variety is the species of any plant that is naturally grown, while the term cultivars are the species that grow due to human intervention, such as breeding.[12] Thousands of tea varieties exist.[7] Categories manufactured tea into three types: Green (unfermented), oolong (partially fermented), and black (fully fermented),[3] places it into four main categories: Black, green, white, and oolong, all of which are produced from the same *C. sinensis* plant. Types of tea do not depend on the plant but on the picking of the leaves and the level of oxidation done.[12] There are many different types

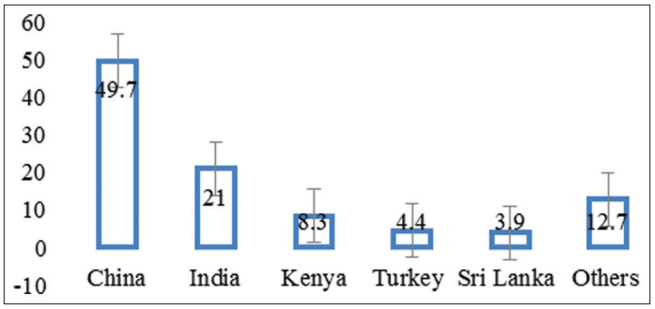

Figure 1: The 2022 global tea production (%)

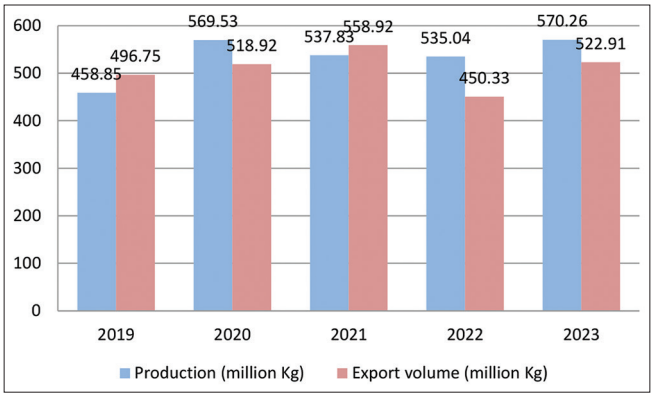

Figure 2: Tea production and export volumes in million kg, 2019–2023 (Source: Tea Board of Kenya[10])

of tea in existence.[1] Documented that all types of processed tea come from the *Camelia sinensis* plant, producing five different types of tea: Black tea (about 80% of total), green tea (about 17% of total), oolong tea (about 2%, mainly consumed in Japan and China), white tea (trace) and pu-erh tea (trace).[39] In China, tea is divided into six major tea lines based on the degree of oxidation: Unoxidized tea (green and white tea), slightly oxidized tea (yellow tea), semi-oxidized tea (oolong tea), fully oxidized tea (black tea), and post-oxidized tea (dark tea).[17,40] Black and green teas are two types of tea products that are most widely consumed globally.[5] The most common tea typology is by oxidation, and specifically by production methods within oxidation categories, determined by several factors, that is, oxidation level, production method, and growing region, among others. Oxidation is a process by which tea leaves are exposed to the air to dry and darken, contributing to the flavor, aroma, and strength of different teas. Tea leaves that are fully oxidized turn brown and black, while tea leaves that are not oxidized at all will remain green. Tea leaves that are partially oxidized, such as the leaves of white and oolong teas, vary in color from green to grey to black depending on their level of oxidation, along with other characteristics of the leaves such as size and harvest date. Leaves of tea begin to oxidize as soon as they are plucked.[6] Documented four types of tea based on the manufacturing process, namely, black, green, oolong, and instant teas, while.[5,41] Categorized them using the degree of fermentation: Non-fermented aerated green tea, fully-fermented black tea, partially fermented oolong and red teas, and white tea from tea buds and leaves. Most of the tea produced in the world is classified as non-fermented (green tea). Processing has also diversified to the production of specialty teas, notably white tea, flavored teas, organic teas, decaffeinated teas, herbal teas, scented teas, and various other blends.[42] Lists green tea, crush, tear and curl(CTC), and orthodox as the three main types of processed teas that are popularly traded globally. Most authors, therefore, categorize tea conventionally into five types based on the degree of oxidation: Totally, fermented black tea, raw or unfermented green tea, white, oolong, and dark teas. Processing of the Kenyan CTC-tea starts at the harvesting stage of the leaves and buds, manufactured

majorly by withering, rolling, or cutting-tearing-curling (CTC) method, oxidizing, and drying before being sorted into grades.[16] More than 300 cultivars of tea have been documented.[5] Global teas typologized in Table 1 are mainly categorized based on the process of manufacturing.

Tea Typology in Kenya

The cultural production practices maintain tea in a bushy vegetative stage so that young leaves and buds can be harvested and processed into four main tea types: Black tea (oxidized) (e.g. Darjeeling, Assam, and Nilgiri teas), green tea (non-oxidized) and oolong tea (semi-oxidized) and white tea. Tea genotypes have different flavors and tastes.[4]

The largest volume of tea processed in Kenya is black tea, with green tea, yellow tea, white tea, purple tea (a product whose leaves are naturally colored by inherent anthocyanins) as well as orthodox tea produced on order by major tea-consuming countries.[45] Kenya Tea Development

Table 1: Popular tea types classified on the basis of manufacturing process

No	Tea type	Characteristic features	Source
1	Black tea	Black tea is extensively oxidized before being processed. It is a fully fermented form of tea	[39]
		Black tea is prepared from mature tea leaves, fermented, and fully oxidized	[43]
		It brews as reddish-purple with a rich, strong aroma, characterized by malty and peppery flavor	[19]
		Black tea can improve heart and intestinal health and lowers body cholesterol levels and blood pressure	
		The most popular types of black teas are bold breakfast teas (English breakfast, Irish breakfast) and Darjeelings	
		The chemical composition of black tea includes polyphenols (catechins, flavonoids, bisflavonols, theaflavins), amino acids, vitamins, proteins, carbohydrates, and alkaloids (theobromine, caffeine, theophylline)	[9]
		Polyphenols being large and highly polar aren't absorbed directly after oral ingestion but undergo hydrolysis by bacterial enzymes	[39]
		Flavan-3-ol monomers are oxidized and polymerized to form polyphenols (theaflavins and thearubigins) while manufacturing black tea	
		Constituents of black tea are catechins (9%), theaflavins (4%), polyphenols, theanine, lipids, caffeine (3%), protein (6%), organic acids (2%), sugars (7%), potassium (5%), and aroma compounds (trace). The content of volatile flavor compounds, that is, aroma compounds in black tea is an important parameter	[8]
2	Green tea	The first tea to be discovered. Leaves are pan-fried or steamed, which inactivates the polyphenol oxidase enzymes, thus preserving the polyphenols from being oxidized and retaining more natural substances in fresh leaves. Prepared from mature tea leaves, green tea is unfermented and non-oxidized, prepared by destroying the enzymes of fresh tea leaves by steaming, followed by rolling, then fired to dry	[17] [19] [43]
		Green tea components possess antioxidants, antimutagenic, and anticarcinogenic prevention of many types of cancer, including lung, colon, esophagus, mouth, stomach, small intestine, kidney, pancreas, and mammary glands	[17]
3	White tea	Originally from China, white tea is withered and dried, causing light oxidation. It has the least processing steps of all the teas	[12]
		White tea is a rare specialty type that has silvery tip, is unfermented (15–80% oxidized), made from young shoots of *Camellia sinensis* protected from sunlight to avoid polyphenol degradation	[43] [44]
		It is protected from sunlight to avoid the degradation of polyphenol (catechins) compounds	[5]
		Withering is done for 4–5 h, preferably in the sun. The withered leaves are further subjected to drying to obtain the final product	[44]
4	Oolong (Wulong) tea (red or yellow)	Produced mainly in China and Taiwan, and is prepared from mature tea leaves, and is partially fermented and semi-oxidized (15–80%)	[43]
		Oolong consumption is mainly confined to Southeastern Asia and Taiwan	
		Oolong tea is prepared by soaking tea in hot water, that is >90°C followed by careful stirring and steeping procedures for the extraction of catechins or theaflavins	[44]
5	Dark tea	Unfermented type of tea (can be post-fermented), containing brick tea and pu-erh tea. It is brownish yellow or brownish red in infusion, stale aroma, and has a smoky taste	[40]
6	Pu-erh tea, also spelt pu'er	Pu-erh comes types exclusively from China, famous for its distinctively earthy flavor. It can be fermented, often stored underground for several years. Traditionally, pu-erh is compressed into round cakes	[40]
		Prepared from tender tea leaves and is post-fermented and semi-oxidized	[43]
		Pu-erh is a fermented Chinese tea with characteristics of mild, woody flavor and dark red color.	[40]

Agency (KTDA) has also diversified production of black orthodox and other specialty teas by order.[46]

Black tea

Black tea, also called black CTC tea in Kenya, is derived from the leaves and buds of the *C. sinensis* plant. About 90% of it is consumed worldwide, making black CTC tea the most popular type of tea globally.[47] Kenya is the largest exporter of black tea, despite China being the highest manufacturer as much of it is consumed by the Chinese local population.[10] The steps involved in the production of black tea include plucking (done at an interval of 7–14 days throughout the year), withering (removes moisture content, involves biochemical and physiological changes which assist the process of rolling and fermentation which result in the final quality of tea), leaf distortion or rolling or cutting (e.g., CTC for intensive maceration of the tea leaf to ensure rapid and complete fermentation), fermentation (takes 45 min to 3 h, where it is spread in thin layers 5–8 cm deep, subjected to heat (24–27°C), controlled using humidifiers or cool air. The leaf color changes from green to coppery red along with the development of a pleasant characteristic aroma at the end of the fermentation process), drying or firing (Hot air up to 90°C is blown against the leaves for the polyphenol oxidize enzyme to be properly inactivated. As moisture content is reduced to 3.5%, the aroma becomes established, and the leaves color turns black), grading (sieved to obtain grades based on particle size), packing, and storage (in moisture and oxygen-proof area to retain flavor and aroma developed in fermented tea for more than 1 year).[44]

Black tea is more oxidized than oolong, yellow, white, and green teas. It is stronger in flavor than other teas, containing about 17 mg of caffeine/100 mL. The caffeine in black tea increases mental alertness through mild stimulation of the human brain.[39] The chemical constituents of black tea are polyphenols (catechins, flavonoids, bisflavonols, theaflavins), amino acids, vitamins, proteins, carbohydrates, and alkaloids (theobromine, caffeine, theophylline).[9] Polyphenols in black tea can prevent carcinogenic cells such as ovarian cancer and prostate, while flavonols prevent heart diseases, while tannins improve digestion.[10] Broken pekoe 1, pekoe fanning 1, dust and pekoe dust are four Kenyan black CTC tea grades determined based on the particle size and shape.[47]

Purple tea

Purple tea, *C. sinensis* var. *assamica*, is a unique variety derived from the leaves, buds, and shoots of a crossbreed variety of the *C. sinensis* [Figure 3]. Unlike other teas, the purple tea plant and its anthocyanins are purple-red in color.

Purple tea was first planted at Gatura Greens Farm in Aberdare Ranges, Kenya, in 2008 after a 20-year of trial by the TRFK. In 2011, it was released for commercialization. Purple tea does in an elevation of 1,500–2,700 m.[48] It is preferably grown sustainably under the mantle of a smart agriculture system that focuses on preserving the natural environment.[16] This tea has red-purple-colored leaves and is renowned for its anthocyanin content and distinctive purple hue. The anthocyanin content in purple tea is more than thrice that of traditional green-leaf tea. High exposure of purple tea to ultraviolet light in its growing environment makes purple tea cultivars naturally rich in polyphenols.[35] Due to its low-calorie levels, purple tea controls blood sugar levels, thus preventing diabetes. Its anti-aging compounds even the skin tone, improving complexions. Catechins reduce body fat and help in weight loss. Its antioxidants prevent forms of cancer such as prostate cancer, breast cancer, and colon cancer.[10] When brewed, purple tea yields a light refreshing and flavory purple liquor.[46]

Green tea

Green tea is derived from the green leaves, buds, and shoots of the *C. sinensis* plant, and is processed

Figure 3: A smallholder purple tea farm in Sotik sub-county, Bomet, Kenya

by order in Kenya.[10] China remains the largest exporter.[11] Globally, 18 types of green tea have been documented. It is unoxidized and is achieved through both rolling and CTC machines. Heating green tea inactivates polyphenol oxidase enzymes, preserving the polyphenols.[49]

Two main factors that have been demonstrated to determine the final flavor of green tea are the plucking standards and the method used to roll tea leaves. Top quality green tea is produced by processing tender leaves and buds that should not be older than 8 days (5–8 days plucking cycle), manually plucked by skilled workers from the tea plants.[28]

The manufacturing steps of green tea are similar to fermented tea, except for the fermentation step, that is, plucking, steaming or roasting, primary heating and rolling, rolling, secondary rolling, drying, refining, firing, sorting, and packing.[17] Green tea is brewed at lower temperatures to realize a sweet and flavory liquor.[49]

Green tea has chemical ingredients that are closely related to human health.[17] Its polyphenols protect the brain against Alzheimer's disease, and catechins in green tea help in weight loss, guard against cardiovascular diseases, and lowers cholesterol levels in the body, thereby reducing the risks of high blood pressure. Green tea also prevents certain forms of cancer, such as stomach cancer, prostate cancer, and breast cancer by preventing the formation of cancerous tumors.[10]

White tea

White tea is manufactured from the buds only, or the first leaves plucked from a selected *C. sinensis* clone. It is harvested before the tea leaves are fully opened when the buds are wrapped in white hairs. White tea is the least processed tea, only undergoing withering and natural sun-drying after plucking.[10]

When white tea is brewed, liquors are light, refreshing, flavory, bear floral taste, and carry large quantities of antioxidants.[50] White tea has been demonstrated to have protective effects against cancer, diabetes mellitus, obesity, central nervous system, microbes-induced diseases, anti-thrombogenic, hypotensive, anti-inflammatory, anti-oxidant, anti-mutagenic, anti-carcinogenic, anti-diabetic, hypoglycemic, thermogenic, anti-stress, anti-depressant, anti-microbial, anti-fungal, anti-viral, and anti-aging.[10]

Orthodox tea

Orthodox tea is processed in Kenya by order. As at August 2024, ten Kenyan KTDA factories had fully installed machines to process black orthodox in a bid to diversify the country's tea product offerings amidst a global glut of black CTC tea. The Kenyan black orthodox, oxidized tea produced through rolling machines and graded by leaf size, texture, and style, includes orange pekoe A (well rolled, curled, loosely wound, leggy, stylish, largest whole leaf grade), flowery orange fanning (leafy, heavy, evenly sized finings with bloom and the occasional tip, suitable for tea bags), flowery broken orange pekoe fanning (short, evenly sized flowery broken orange pekoe tea with the occasional tip), flowery orange pekoe (fairly well loosely twisted whole leaf tea), pekoe (curled, knotty, stylish, heavy, with a bloom), and flowery broken orange pekoe fanning special (stylish, short, evenly sized flowery broken orange pekoe special tea, with tips).[50]

CONCLUSION AND RECOMMENDATION

Conclusion

The following conclusions are drawn from this study:

1. Tea is the cheapest, addictive, refreshing, thirst-quenching non-alcoholic beverage after plain water, prepared and consumed in different ways by people of diverse cultures across the world
2. Tea typology nomenclature differs from country to country, and region to region, classification of this popular thirst-quenching beverage is mainly based on the plant origin, historical background, the region where tea is (was) grown, scientific system, market niche, economic reasons, cultural beliefs, fermentation and oxidation levels
3. Universally, the most commonly used method of classifying conventional tea is the degree of fermentation and oxidation the tea is subjected to during manufacturing processes
4. Kenya tea typology is based on the degree of fermentation, in contrast to oxidation levels used in the Asian countries.

Recommendation

For the purpose of coherence in the tea industry's standardization, this study strongly recommends the creation of a global tea regulator to standardize tea typology, with domestic in-country regulatory bodies in the tea-growing countries accredited to implement the global-wide classification system agreements and resolutions.

REFERENCES

1. Bermúdez S, Voora V, Larrea C, Luna E. Global Market Report: Tea prices and sustainability. International Institute for Sustainable Development; 2024. Available from: https://www.iisd.org/system/files/2024-01/2024-global-market-report-tea.pdf [Last accessed on 2024 May 16].
2. Food and Agriculture Organization of the United Nations (FAO). Food and Agriculture Organization of the United Nations. Markets and Trade. Tea; 2023. Available from: https://www.fao.org/markets-and-trade/commodities/tea/en [Last accessed on 2023 Nov 14].
3. Statista. Statista Consumer Insights; 2023. Available from: https://www.statista.com/chart/29582/share-of-people-that-drink-tea-in-selected-countries/#:~:text=kenya%2c%20a%20major%20producer%20and,saying%20they%20regularly%20drink%20tea [Last accessed on 2023 Nov 14].
4. D'Auria JC, Cohen SP, Leung J, Glockzin KM, Glockzin K, Gervay-Hague J, *et al*. United States tea: A synopsis of ongoing tea research and solutions to United States tea production issues. Front Plant Sci 2022;13:934651.
5. Karori SM, Wachira FN, Wanyoko JK, Ngure RM. Antioxidant capacity of different types of tea products. Afr J Biotechnol 2007;6:2287-96.
6. Baruah, P. (2015). Types of tea, value addition, and product diversification of Indian tea. In Proceedings of the First International Conference on Tea Science and Development (1st ed.), Karatina University, Karatina, Kenya. Karatina University Press.
7. Harbowy ME, Balentine DA. Tea chemistry. Crit Rev Plant Sci 1997;16:415-80.
8. Kumar V, Joshi VK. Kombucha: Technology, microbiology, production, composition and therapeutic value. Int J Food Ferment Technol 2016;6:13-24.
9. Adnan M, Ahmad A, Ahmed A, Khalid N, Hayat I, Ahmed I. Chemical composition and sensory evaluation of tea (*Camellia sinensis*) commercialized in Pakistan. Pak J Bot 2013;45:901-7.
10. Tea Board of Kenya. Types of tea in Kenya; 2024. Available from: https://www.teaboard.or.ke/kenya-tea/types-of-tea [Last accessed on 2024 Jul 04].
11. Firsdtea. 2023 China Tea Report; 2023. Available from: https://firsdtea.com/wp-content/uploads/2023/07/2023-china-preport-2023.07.25.pdf [Last accessed on 2024 Jul 09].
12. Lanjekar H. Tea: Varieties and types. Acta Sci Agric 2022;6:8-9.
13. Langat JK. Effect of total solar radiation and rainfall on yield of different tea (*Camellia sinensis* [L.] O. Kuntze) clones at two sites in Kenya. J Agric Sci 2018;10:40-8.
14. Mondal TK, Bhattacharya A, Laxmikumaran M, Ahuja PS. Recent advances of tea (*Camellia sinensis*) biotechnology. Plant Cell Tissue Organ Cult 2004;76:195-254.
15. Langat JK. Response of Different Tea (*Camellia sinensis* [L.] O. Kuntze) Clones to Environmental Factors at Two Sites in Kenya. Unpublished PhD thesis. Kenya: University of Eldoret; 2014.
16. Tea Board of Kenya. Kenya Tea; 2023. Available from: https://www.teaboard.or.ke› manuals-handbooks [Last *accessed on 2024 Jul 04]*.
17. Zhao T, Li C, Wang S, Song X. Green tea (*Camellia sinensis*): A review of its phytochemistry, pharmacology, and toxicology. Molecules 2022;27:3909.
18. Hugo Tea Company; 2024. Available from: https://www.hugotea.com/blogs/tea-learning/tea-typology-explained# [Last accessed on 2024 Jul 14].
19. Skotnicka M, Chorostowska-Wynimko J, Jankun J, Skrzypczak-Jankun E. The black tea bioactivity: An overview. Cent Eur J Immunol 2011;36:284-92.
20. Chen CA. Tea classification in theory and practice. J D'Agric Trad Botanique App 1981;28:329-44.
21. Dufrêne B. The 2020 Global Tea Market Report; 2020. Available from: https://www.teaandcoffee.net/feature/25850/the-2020-global-tea-market-report [Last accessed on 2024 Jul 04].
22. Carr MK. The climatic requirements of the tea plant: A review. Exp Agric 1972;8:1-14.
23. Art of Tea. What is Pu-erh Tea?; 2024. Available from: https://www.artoftea.com/blogs/tea-101/what-is-pu-erh-tea [Last accessed on 2024 May 26].
24. Kumar R. An introduction to cultivation of Darjeeling tea (*Camellia sinensis* L.). Farming Manage 2018;3:66-79.
25. Tanaka J, Taniguchi F, Hirai N, Yamaguchi S. Estimation of the genome size of tea (*Camellia sinensis*), camellia (*C. japonica*), and their interspecific hybrids by flow cytometry. J Remote Sens Soc Japan 2006;2006:1-7.
26. Teapedia. *Camellia sinensis*: The Tea Encyclopaedia; 2024. https://teapedia.org/en/camellia_sinens [Last accessed on 2024 Jul 09].
27. Meegahakumbura MK, Wambulwa MC, Li MM, Thapa KK, Sun YS, Möller M, *et al*. Domestication origin and breeding history of the tea plant (*Camellia sinensis*) in China and India based on nuclear microsatellites and cpDNA sequence data. Front Plant Sci 2018;8:2270.
28. Ponmurugan P, Gnanamangai BM, Manjukarunambika K. Architectural effect of different tea clones on the development of blister blight disease. J Appl Bot Food Qual 2019;92:7-14.
29. Willson KC, Clifford MN, editor. Tea: Cultivation to Consumption. Springer Science and Business Media; 2012.
30. Martin P, Malenga N, Mphangwe N, Nyirenda H, Rattan P.

A review of current recommendations for pruning tea. Q Newsl Tea Res Found Cent Afr 1997;126:21-33.
31. Bandyopadhyay T. Molecular marker technology in genetic improvement of tea. Int J Plant Breed Genet 2011;5:23-33.
32. Kamunya S, Ochanda S, Cheramgoi E, Chalo R, Sitienei K, Muku O, *et al*. Tea (*Camellia sinensis* (L.) O. Kuntze) production and utilization in Kenya. Tea Growers Guide, 2019. Kenya: Kenya Agricultural and Livestock Research Organization; 2019.
33. Jia, X. X., Zhang, W. Y., Fernie, A. R., & Wen, W. W. (2020). Camellia sinensis (Tea). Trends in Genetics, 36(12), 856–858. https://doi.org/10.1016/j.tig.2020.08.008
34. Ravichandran R, Parthiban R. The impact of mechanisation of tea harvesting on the quality of the South Indian CTC teas. Food Chem 1998;63:61-4.
35. Oryza. Purple Tea Extract. Ver. 1.0 SJ. Japan: Oryza Oil and Fat Chemical Company Ltd.; 2013.
36. Smith K. World Atlas of Tea. Great Britain: Mitchell Beazley; 2016. p. 135.
37. Available from: https://www.geeksforgeeks.org [Last accessed on 2024 Jul 06].
38. Available from: https://currentaffairs.adda247.com/top-10-tea-producing-countries [Last accessed on 2024 Jul 06].
39. Fatima M, Rizvi SI. Health beneficial effects of black tea. Biomedicine 2011;31:3-8.
40. Devos RJ, Barth CA, Dettmer A, Bertolin TE, Colla LM. Pu-erh tea: Fermentative process as a potentialized of sensory aspects and bioactive profile: A review. Res Soc Dev 2021;10:e3510816999.
41. Boehm K, Borrelli F, Ernst E, Habacher G, Hung SK, Milazzo S, *et al*. Green tea (*Camellia sinensis*) for the prevention of cancer: Review. Cochrane Database Syst Rev 2009;3:CD005004.
42. Sriram SA. Tea industry: Focus on Kenya. Int J Manage Commer Innov 2022;10:208-11.
43. Verma R, Kumar L, Kurba VB, Sudhakar GK. An overview on tea: A review. Int J Pharmacol Res 2013;3:36-41.
44. Kumar V, Kaur J, Tanwar B, Goyal A, Gat Y, Kumar A, Kau P. Tea processing: In: Mudgil D, Barak S, editors. Beverages Processing and Technology. Ch. 10. Jodhpur: Scientific Publishers; 2018. p. 190-209.
45. Justea. What is Purple Tea?; 2024. Available from: https://justea.com/pages/what-is-purple-tea [Last accessed on 2024 Jul 04].
46. KTDA; 2024d. Available from: https://ktdateas.com/specialty-teas [Last accessed on 2024 Aug 04].
47. KTDA; 2024a. Available from: https://ktdateas.com/black-ctc-tea [Last accessed on 2024 Aug 04].
48. Gatura Greens Farm. What is Purple Tea?; 2024. Available from: https://www.gaturagreens.com/what-is-purple [Last accessed on 2024 Jul 07].
49. KTDA; 2024c. Available from: https://ktdateas.com/green-tea [Last accessed on 2024c Aug 04].
50. KTDA; 2024b Available from: https://ktdateas.com/black-orthodox-tea [Last accessed on 2024 Aug 04].