CHAPTER I

INTRODUCTION

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1.1 Tea: an overview

Tea is the oldest non-alcoholic beverage crop in the world. Tender leaves of tea plants are plucked and processed for using as a drink in different types such as green, black and oolong. It has been socially and habitually consumed by people since 3000 B.C (Lin et al. 2003). Besides its high medicinal value, tea is refreshing, mildly stimulating, and produces a feeling of well-being (Miller-Hamilton 1995). Tea is basically a woody, perennial plantation crop, which is under large-scale cultivation in several countries including India. The cultivated tea plants are of two main varieties under the family Theacea: the small-leafed China tea (*Camellia sinensis*) and the large-leafed Assam tea (*Camellia assamica*). Cultivation of tea and its management has now become a most important agro-based, labor-intensive, employment-generating, export-oriented industry in most of the tea growing countries such as India, Kenya, Sri Lanka, China and Japan. Globally, India is in the first rank of tea production, consumption and exportation. Tea industry plays a pivotal role in Indian national economy with a total annual turnover of Rs.10000 crores. India occupies 1.016 million acres of tea growing land which is 16.4% of the total tea growing areas of the world. Tea industry directly employs over 1.1 million workers and generates income for another 10 million people. Inspite of being the largest producer in the world, total net foreign exchange earned per annum is only around Rs. 1847 crores because of its ever increasing domestic consumption (Mondal 2007).

1.2 Origin and distribution

Tea is the native of south-east Asia, specifically around the intersection of latitude 29° north and longitude 98°east, the point of confluence of the lands of north-east India, north Burma, south-west China and Tibet. Tea plant was introduced to more than 52 countries, from this 'centre of origin' (Mondal 2007). Since the development of black tea from *C. assamica* by R. Bruce in 1823, tea was introduced as a commercial venture in other parts of the world too. Now, more than 45 countries

are growing tea within the latitudinal range of 45° north to 34° south. Tea was introduced to Japan from China in the early part of the 8th century, and later during 17th century it was spreaded to Indonesia from Japan. In Sri Lanka, tea was first planted in 1839 when seeds were brought from India. Tea seed was imported to USSR from China for cultivation during the end of last century. Later, from USSR, seeds were exported to Turkey in the year 1939-40. In Europe, tea was introduced in 1740 by the East India Company's captain Goff, but those plants which were planted in the Royal Botanic Garden at Kew in England could not survive (Sealy 1958). First successful introduction was achieved by a British merchant and naturalist John Ellis in 1768 (Aiton 1789, Booth 1830). Then, it was spreaded to the African countries at the end of the 19th century.

1.3 Economic importance

Tea is an economically important plantation crop with a life span of more than 60 years. It occupies 3.07 million ha land all over the world with an average production of 3.87 million tons annually (Alkan et al. 2009). It is consumed in the form of fermented, semi-fermented or non-fermented which is known as black, oolong or green tea, respectively. In Burma and Thailand, tea leaves are consumed as vegetables which have been known as 'leppet tea' and 'meing tea', respectively. Moreover, tea has been shown to have a wide range of beneficial physiological and pharmacological effects such as strengthening capillaries, anti-inflammatory effect, anti-microbial, anti-oxidant properties and positive role in cardiovascular ailments (Miller-Hamilton 1995). Animal studies have shown that tea and tea constituents inhibit carcinogenesis of the skin, lung, oral cavity, esophagus, stomach, liver, prostate and other organs (Lambert and Yang 2003). Besides, tea seed oil is used in human consumption in certain parts of the world. Apart from being used as drink or food products, few species of this genus are used in different purposes. For example, *C. oleracea* produces oil which is used in the cosmetic industry as well as *C. japonica* and *C. reticulata* which are grown as ornamental plants for their beautiful flowers.

1.4 Cytology

Cytogenetic works in *Camellia* have a long history compared to other cultivated plants (Kondo 1977). The first report of the gametic chromosome number in *Camellia* was made from the diploid *Camellia sinensis* (n=15) by Morinaga et al. (1929). Polyploidy in *Camellia* was also reported first in *Camellia sinensis* (2n=45) itself (Karasawa 1932). Extensive investigations in chromosome number and ploidy level in *Camellia* began in the early 1950's. Later, it has been confirmed that the cultivated tea is mainly diploid (2n=30) and their chromosome structures are comparable amongst the wild relatives (Bezbaruah 1971). There are few exceptions such as Indian cultivated clones Sundaram and TV-29 are triploids. Some natural triploids (2n=45), tetraploids (2n=60), pentaploids (2n=75) and aneuploids (2n+1 to 29) have also been sampled in tea populations of Assam, but those are reported to be present in very low numbers (Singh 1980). A natural triploid of tea has also been reported in China (Zhan et al. 1987). Deviation from normal chromosome number is also known in some wild relatives. For example, *Camellia sasanqua* is recorded as a hexaploid species, but some clones show a different ploidy level including tetraploid, pentaploid, heptaploid, octoploid and even a few aneuploids (Kondo 1975). That way, *Camellia reticulata* is also recorded as hexaploid species, however some clones are triplod and heptaploid in chromosome number (Kondo 1977).

1.5 Functional genomics

Tea is an important plantation crops that is valued for its rich source of secondary metabolites. Several improved tea varieties were developed through conventional breeding and propagation techniques in the last several decades. However, due to the limitations of conventional breeding coupled with the demand of increasing productivity and quality with lower cost of production, application of biotechnology becomes an alternative approach. Different biotechnological applications have already been adopted successfully in tea such as micropropagation (Dood 1994, Mondal et al. 2002), cell and organ culture (Jain and Newton 1990, Akula et al. 2000, Kuboi et al. 1991), transgenic production (Mondal et al. 2001, Konwar et al. 1998) and DNA fingerprinting (Wachira et al. 1997, Mondal 2002, Matsumoto et al. 1994, Paul et al. 1997). Functional genomics research, which focuses on the

characterization of gene function and demonstration of the spatial, temporal and cell-dependant expression and regulatory mechanisms of genes is relatively new in tea compared to other crop species and progress has also been slow. It was initiated only two decades ago by isolating a cDNA of ribulose-1, 5-biphosphate-carboxylase (Savolainen et al. 1994). Since then, many important genes have been isolated, cloned and characterized such as chalcone synthase (Takeuchi et al. 1994), PAL (Matsumoto et al. 1994), caffeine synthase (Kato et al. 2000) etc. Tea functional genomics study has been accelerated with these successes and as on 20 September, 2010, more than 700 cds are available in NCBI (http://www.ncbi.nlm.nih.gov). Of these, many important functional genes related to metabolism, signal transduction and antioxidant responses were cloned, characterized and studied extensively. More recently, progress has been made on EST sequencing and annotation (Park et al. 2004, Chen et al. 2005, Zhao et al. 2008b), elucidation of gene expression profiling (Singh et al. 2008, Singh et al. 2009), establishment and use of cDNA microarrays (Zhao et al. 2006), data mining for marker development such as EST-SSR and STMS (Zhao et al. 2007, Jin et al. 2007, Sharma et al. 2009, Matteo et al. 2010) as well as cloning and expression analysis of genes involved in secondary metabolism and stress defense (Zhao et al. 2006, Wang et al. 2008). In the recent years, several groups have been working on tea functional genomics all over the world, and much information would be expected in the years ahead.