

Recent Trend of Tea Research in India

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Summary

Tea research in India has been carried out since more than 100 years covering several aspects of cultivation practices (e.g. planting design/space, pruning, plucking, manuring etc.) suited for various agro-climatic conditions in different plantation areas. One of the most important areas of tea research is the plant improvement program which includes selection, hybridization followed by long term trial in the field for the assessment of mainly yield and quality and other agronomically desirable traits (resistance to biotic and abiotic stresses). Biotechnological intervention (e.g. different tissue culture methods, genetic transformation, molecular marker analysis and marker assisted selection, gene expression and candidate gene identification and various functional genomics approach etc) in tea breeding for more than two decades have contributed immensely although full potential is yet to be achieved. Integrated approach (both breeding and biotechnology) is given critical attention for tea improvement. Quality improvement, Pest management, and health benefits of Indian black teas are also being discussed, emphasizing the applied, basic and regulatory aspects.

Introduction

Tea Board of India conducts, coordinates and promotes tea research in India mainly through three tea research institutes (Tea Research Association for North East India, United Planters Association for South India and Darjeeling Tea Research and Development Centre for Darjeeling Tea Industry). Besides this, other national institutes and universities have undertaken specific problem oriented tea research projects based on their experience /expertise on a project mode. This paper aims to provide an overview of tea research in India with a focus to only few important areas as mentioned hereunder.

Plant improvement

The collection, characterization, conservation and utilization of diverse types of tea germplasm has been given due importance in connection with the tea improvement activities since the inception of tea research in general and tea breeding in particular. Conventional breeding including selection and hybridization followed by long term field trial has contributed immensely in developing high yielding quality tea cultivars (more than 200 numbers) which are being used by Indian Tea Industry. Selection of high yielding quality tea cultivars from the old seed grown areas of commercial tea plantation has been continuing to develop superior tea cultivars suitable for different agroclimatic conditions.

Biotechnological intervention has been in place since more than two decades to expedite selection process and strengthen overall tea improvement research covering different areas of genomics (structural, functional and comparative genomics). Studies on tea metabolomics through secondary metabolic pathways and metabolite profiling has already been in progress. Genetic diversity studies using population genetics approach followed by development of genetic linkage map and expressed sequence tag (EST) sequencing in tea have generated large amount of information useful for marker assisted selection. Genetic transformation and gene expression studies have also been undertaken in great detail by Indian scientists. The present focus is on the integration of both conventional and molecular genetics approach in order to get maximum benefit of the frontier areas of science and technology for the ultimate goal of producing superior tea cultivars having high yield and quality planting materials having resistance to biotic and abiotic stresses (Sharma *et al.*, 2013; Gohain *et al.*, 2012). Genome mapping and sequencing work are considered to be important in the

future activities of tea research particularly for the cultivar development programme.

Quality Improvement and Product Diversification

India has been continuously trying to strengthen research work on tea quality as one of the priority area considering important aspects of tea trade (Tea Board of India Website). Apart from cultivars and climatic conditions, quality of tea is dependent on plucking standards and processing/manufacturing system. Recent research findings corroborate that mechanical harvesters or shears are economical and produce good quality black tea which are comparable to hand plucking (Ravichandran and Parthiban 1998). The quality of black tea is mainly assessed by the taste and aroma characters and often refers to a composite character, which depend on many factors from field to factory (Muthumani *et al* ,2013). Some of these factors can be controlled by human intervention. They include harvesting style, pest, disease and nutrient management, manufacturing conditions and storage. Some factors that cannot be controlled but have major impact on black tea quality include altitude of planting, climatic conditions, seasonal variation and cultivars. The chemical fingerprinting of black tea from various region of India, are being done considering the seasonality and altitude keeping the manufacturing conditions of the particular region constant. The biochemical constituents responsible for quality of black tea have been studied under various manufacturing conditions. The optimum fermentation time of digallate equivalent of theaflavin, colour index and briskness index have been identified as important parameters for assessing the quality of CTC and orthodox tea (Tea Boards Website). The principal component analysis are now used to study the physical attributes that determine the quality of tea during organoleptic verification. Methods have been developed to estimate tea quality based on textural features using dark field illumination techniques (Laddi *et al* ,2013). Aroma, being a major factor for quality evaluation of finished tea, quantification of volatile flavor components (VFC) from various regions are being done which helps the industry in the choice of right kind of planting materials and manufacturing practice. Studies have revealed that, tea nutrition had impact on quality of tea and flavour index was found to be influenced by mineral components of soil. The proper storage of black tea is very important for maintaining its quality as high humidity enhances its moisture content, and encourages microbial growth. γ irradiation has been found to be one of the most efficient techniques for the reduction of microorganisms and enhancing the shelf life of tea.(Thomas *et al*, 2008).

Value added functional food products like tea ice creams, soft drinks and wine have been developed from tea. These are not only commercially beneficial but also provide the health benefits of black tea to those who abstain from drinking tea. Extraction of coloured pigments from black tea has been done for development of various cosmetic products.

Pest and Disease Management

Tea, like other agricultural crops in India is infested with a number of insect pest and diseases. Most of the tea pests are highly seasonal; many attack tea only during dry season while a few are abundant in wet weather; there are a few perennial pests too. The crop loss in tea due to pests, diseases and weeds varies between 15 and 20 percent depending upon the intensity of attack (Muraleedharan, 2005). In India, pest control in tea is mainly focused on the usage of all the available components of Integrated Pest management in order to avoid residue problems of chemical pesticides, tainting of tea, toxic hazards to operators and natural enemies of insect-pests. Eco friendly approaches in pest management have already gained momentum and emphasis has also been given to the alternative measures complemented with the current practices of chemical control (Gurusubramanian *et al.*, 2005; Rahman *et al.*, 2005). Cultural control by modifying the microclimate of the tea bush, sanitation, removal of alternate hosts, weeds, cleaning/debarking of shade trees, maintenance of bush hygiene etc., mechanical and physical control by means of hand collection of insect pests, light trapping, sticky trapping etc. are some of the most commonly used pest control means adopted by the Indian tea industry. Further research on development of target

specific microorganism based pesticides for major pests of tea, behavior modifying chemicals such as pheromones of major tea insects, rearing and potentiality studies of parasite predators of major insect pests and botanical based pesticides are on progress. The determination of pesticide residues in tea plant, soil, water, black tea and brew is another domain of much importance. Data generation on the residues of chemical pesticides as required by both national and international bodies vis a vis new safer protectants which can be used in tea are being carried out regularly. Stricter monitoring of pesticides residue in made tea samples are also being carried out on continuous basis.

Tea and Health Benefits

It is well known that tea is an important source of dietary anti-oxidant. During the manufacture of black tea, monomeric catechin found in green leaves are converted into dimeric and oligomeric catechins. Studies indicated that these dimeric and oligomeric catechins (theaflavins and thearubigens) are benzotropolone-linked hetero-dimers or hetero-oligomers of catechins, that are responsible for the characteristic color and taste of black tea. Theaflavin and thearubigin not only provide the chemical signature to black tea but are responsible for the host of health benefits attributed to the consumption of black tea. The research findings by Indian Scientists for more than two decades on health benefits of black tea, particularly its potential to fight chronic diseases, has been intriguing (Tea Board of India website; Sharma and Rao, 2009; Sen and Bera, 2014). Black Tea has been attributed with a plethora of cancer preventive actions for more than a decade. The anti-carcinogenic activity of black tea was identified in tumorigenesis of endodermal and epidermal origin. It was not only effective in restoring balance of anti-oxidant – oxidants in cellular milieu, it also inhibits genotoxicity and chemical carcinogenesis by modulating oncogene expression. It promotes apoptosis of cancer cells. Black tea augmented the expression of proteins involved in cell cycle. The role of black tea (at least above four cups) on reduction of prevalence of human papilloma virus has been fascinating and calls for introduction of black tea in the diet of cancer patients.

As laboratory studies have provided overwhelming evidences on protective effect of black tea in type 2 diabetes and cardiovascular diseases, scientist are now concentrating on epidemiological studies on role of black tea as an adjuvant in combating type 2 diabetes, dyslipidemia and cardiovascular diseases. Not only does black tea possess potential anti-inflammatory and immunomodulatory action, it has gastro kinetic and antidiarrhoeal effects favouring probiotics in intestinal flora. With changing patterns of infectious diseases and the emergence of microbial strains resistant to current antibiotics, black tea may be a potent antimicrobial agent to be used as adjuvant during antibiotic therapy. Recent studies on infant animal model have indicated that consumption of black tea does not exert any toxic effect and can prevent hemolytic anemia associated with Indian childhood cirrhosis (Mandal *et al* 2013). Future studies should assess the volume of consumption required for protective effect of tea during various disease conditions, bioavailability of the components and report particularly risk factors known to relate the incidence of chronic diseases.

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