Chapter – VII

OUTCOME OF THE STUDY

7. OUTCOME OF THE STUDY

7.1 Relationship of soil fertility with antioxidant properties

The results have undoubtedly shown that the antioxidant quality of tea is best, if the soıı is sandy loam, pH is in between 4.50-5.00, EC below 0.5mmhos, moisture content at 15-20%, nitrogen status 0.13%, available phosphorous as P_2O_5 is in between 15-45 ppm and available potassium as K_2O is in between 80-100ppm, available sulphur is in between 15-30ppm, chloride below 0.05ppm. It is also reported that restoring high antioxidant activity of tea depends on agronomic practices and leaf maturation.

7.2 Optimum climatic condition for enhanced antioxidant property

These works seem to suggest that the harvest time is crucial to determining the antioxidant potential of fresh tea shoots. Climatic variation of anti-oxidative properties, Phenolics and mineral nutraceuticals in fresh tea shoots, consisting of one apical bud and two adjoining leaves sampled from TV1, TV20, TV26, TV29, TV30 (Tocklai Vegetative) clone and Tingamara, Dangri Manipuri and Sundaram B/5/63(Seed jat) grown in Terai region in Darjeeling district, North Bengal was investigated during three harvest seasons (March, June and December). The total Phenolics of all clones were lower in cool months of December in three years (average 36.02-93.29 mg GAE/g dry weight basis). Thereafter, the levels of total Phenolics increased throughout the warmer months from March to September. Antioxidant activity determined by Antioxidant activity determined by DPPH based free-radicals scavenging assay showed similar trends which increased from 1st harvest (March) to 3rd harvest (December). All clones showed nearly 100% antioxidant activity at 2nd and 3rd harvest season which higher than standard synthetic antioxidant BHA (Butylated hydroxyl anisole). However, seasonal variation of minerals (N, P, K, Ca, Mg, Na, Fe, Cu, Mn, and Zn) showed different results according to clones used. Tea grows well and showing potential antioxidant properties in the following optimum climatic factors; Rainfall 700-2500mm, sunshine hour not below 4.00hrs, temperature minimum:12-13°C, maximum: 30°C , cloud 8-40%, wind speed 6.00, pressure 1000mb , UV index 6.00.

7.3 Age of the and their antioxidant property

This study suggested that age of the bush affect the plants ability to cope with environmental stress. Various biochemical changes occurs during aging process in tea bush which could be correlated with age induced loss in growth and productivity. It was observed that total phenolic content of leaves increased with age of a plant, but it is not sufficient to balance between ROS generation and antioxidant function of plant because of increased MDA content of the leaf thus making the aged plant tissue less capable of coping with the prevailing environmental stress and regulation of nutrient transport during aging process. Age dependent environmental stress adaptation mechanism changes in mineral nutrition absorption from soil and its effect on antioxidative defense mechanism. Therefore, maintaining sustained productivity as well as antioxidants quality of tea, young bush are suitable.

7.4 Antioxidant of different tea varieties and processed optimization

Tea, which is one of the most popular beverages worldwide, is obtainable from aqueous infusion of processed tea leaves (*Camellia sinensis* L.). In India, mainly three types of tea are produced: viz. Crush-Tear-Curl (CTC), Green and Orthodox tea. From therapeutic viewpoint, green tea has been most widely studied due to its richness in different catechin derivatives. CTC and Orthodox tea is mainly used as beverage due to high aroma, flavour and brilliant colour. Conventional orthodox processing consists of rolling the leaf, stretching and tearing followed by fermentation, which during CTC preparation, being replaced by quicker and more severe leaf disruption followed by more oxidation process due to wider surface area of interaction of polyphenols with oxygen by polyphenol oxidases (PPO) and peroxidases (PO) enzyme. However, in case of green tea, withered leaves are steamed and dried for minimizing chemical and enzymatic reactions. Industrial processing of tea starts with harvesting phase. Our study suggests that harvest time is crucial for determining antioxidant potential of fresh tea shoots. The total phenols of TV clones were lower in cold season, whereas increased throughout the warmer months from March to September. Antioxidant activity showed similar trend which increased from 1st to 3rd harvest comparable with standard synthetic antioxidant BHA (Butylated hydroxyl anisole). Among different tea cultivars PPO activity was found to be highest in TV1.

There are biochemical and enzymological changes associated with withering periods. PPO enzyme showed maximum activity after 10 hours of withering whereas PO activity increased continuously with withering time. Highest polyphenols was recorded after 14 hours of withering. Withering temperature is also important for individual catechin species and total catechin accumulation. Higher temperature particularly degrades the level of catechin to a substantial extent along with antioxidant activity as measured by scavenging of DPPH and $ABTS^{\cdot+}$ radicals. Metal chelating activity on the other hand, was enhanced with withering temperature. In case of CTC processing, antioxidant activity was drastically reduced immediately after rapid crush-tear and curl process. However the antioxidant activity of Orthodox tea is quite high even after firing indicating that slow and limited oxidation during fermentation is helpful for restoration of antioxidant activity. Also polymerization of phenols by enzymatic oxidation reduces antioxidant activity in CTC tea as revealed from higher abundance of hydrolysable tannins and quinone in those grades. When different CTC grades were compared, OF and PD was found superior than others in terms of quality and quantity of antioxidants and phytochemicals. Flavour index along with antioxidant activity vary widely with fermentation time and temperature and best fermentation environment was optimized at 60 minutes with 35º C temperature for preparation of better quality tea. Changes in profiles of flavonoid pattern during industrial processing were also revealed from thin layer chromatographic analysis. When compared with different industrially prepared tea of North Bengal, CTC black tea was found to be inferior in antioxidants and bioactive compounds. In a nutshell, it can be stated that physicochemical attributes during industrial processing might have profound influence for determining quality framework of made tea. Optimum time required for withering of 10-14 hrs depending on the moisture of the leaf and season, and the fermentation time is in between 40 to 90 min in temperature 32° C and 60-110 min in temperature 28° C.

The results of this study justify the antioxidant potential of tea, especially in diseases where the antioxidant activities are the important component. The results also suggest that organically produced tea is comparatively better than the non-organically produced tea and the antioxidant property should be important criterion for gradation of tea.