4. SUMMARY

Tea of commerce obtained from the plant *Camellia sinensis* (L) O.Kuntze is widely consumed throughout the world because of its taste and unique flavour besides its nutritional and therapeutic values. Flavanoids found in tea show 20 times more powerful antioxidant activity than vitamin C. Owing to new agricultural innovations and improved cultural operations, productivity level of our nation attained the level of 1582 kg/hectare in 2004. While concentrating on the crop productivity, simultaneous efforts are required to upgrade the quality of commercial black teas or tea based products. To keep the predominant position in global market India has to concentrate more on production, product diversification and improve the quality of black teas besides marketing strategies.

Studies on the biochemical constituents of tea shoot established the importance of raw material on the quality of CTC black tea. The finer fractions of the crop shoot possessed the desirable quality precursors at higher level and improved the overall quality of the end product. Both the substrates as well as the enzymes were found to be high in the finer fractions of the crop shoot.

Observations on the structural polysaccharides of various clones revealed hemicellulose as the maximum contributor towards the dry matter content followed by cellulose. Hence, focus towards the exploitation of these complex molecules is of much significance.

Experiments on process optimization have revealed that withering for a duration of sixteen to eighteen hours resulted in teas with better flavour characters. The quality constituents such as TF, TR, HPS, TLC and water extract had the maximum levels in tea withered for sixteen hours. The optimum withering temperature was found to be between 25 & 30 °C under Anamallais condition. Studies on fermentation revealed an optimum temperature of 25°C and duration of sixty minutes for the clone UPASI – 9 under Anamallais condition.

*Pacha* taint, a peculiar region specific and season specific problem had been studied and was found to be due to inherently high level of total lipids and lower...
activities of the lipoxygenases in that particular season. The improperly degraded lipid intermediates are acted upon by residual lipoxygenases resulting in the production of C-6-aldehydes and C-6-alcohols which causes the *pacha* taint/odour. Certain process modifications and the use of lipase have been found as the remedial measures for the problem.

Under the current crisis in the tea industry, further improvement in the raw material by way of fine leaf plucking is no more a practical solution. To produce good quality tea from a medium standard leaf is a real challenge and the use of food grade enzymes during processing, to improve the quality constituents appears to be a promising proposition. Pilot as well as large scale trials were carried out using commercial formulations of pectinase, cellulase, lipase and polyphenol oxidase. Almost all the treatments utilizing cellulolytic and oxidative enzymes significantly increased the liquor constituents as well as the flavour of the resultant black tea.

Methodology for the assay of native pectinase and cellulase in the crop shoots of tea has been developed and the data generated on selected UPASI clones shall be a useful complement of knowledge towards the understanding & utilization of the above clones for quality tea production. Exogenous addition of pectinase and cellulase either alone or in combination improved the overall quality of black tea in terms of TF, TR, DGETF and water extract, which is directly correlated to cuppage, is a significant outcome from the use of the cellulolytic enzymes during tea processing. As a result of the increase in major biochemical quality constituents, the value realisation also improved without any deleterious effect on the liquor characteristics/ appearance of black tea.

The stage, dosage and mode of enzyme addition have been standardized. Keeping quality of the enzyme treated black teas have been established. Consistent improvement in the water extract had been noticed throughout the enzyme treatment studies.

Methodology for the production of microbial enzymes (pectinase & cellulase) had been validated under the present study and the partially purified enzymes from four different species of fungi had been tested for their influence on the quality of CTC black
Pectinase obtained from *Aspergillus awamori* had the maximum activity and was found to have the best effect in improving the quality of black tea. The activity was very much comparable to that of the commercial formulation.

Partial characterisation of the pectinases from selected fungal sources has been carried out using SDS PAGE and a prominent band at 35 k Da had been obtained. The optimum temperature was found to be 50°C for the enzymes obtained from the present study.

Addition of commercial (sources of) enzymes such as protease, lipase and PPO also led to a significant increase in the quality parameters of black tea such as the theaflavins, total liquor colour, water extract and volatile flavour constituents in the resultant black tea.

Studies on the shelf life of enzyme treated black tea revealed no deterioration in the quality constituents. No taint or odour was observed and under the prevailing cost of enzymes and tea, the process of enzyme addition for quality improvement is economically viable.

As the enzymes are from microbes considered to be generally regarded as safe (GRAS) and also as these (enzymes) are used in minute quantities at the processing stage, no breach of food laws could be expected. The use of pectinase during black tea processing at the rate of 0.2% on black tea basis has already been cleared by the PFA Act, 1954. The observations of the present study indicate ample scope for commercial launch of addition of other food grade enzymes during tea processing with the concurrence of government agencies, for quality improvement of black tea.