A Thesis
entitled

TRACE METAL STUDIES OF TEA

Presented by

S. Palamakumbura

For
The Award of the Degree of
Master of Philosophy
of the
University of Colombo

Centre for Analytical
Research and Development
Department of Chemistry
University of Colombo.

September 1984

Abstract

Trace metal content in food is a significant study for environmental effects, toxicity and nutrients. Improved analytical methods for the estimation of trace levels of metal ions have led to studies of their signifi-cance in life processes. The methods of special signifi-cance include flame atomic absorption spectophotometry (sensitivity 10^{-9}g), flameless atomic absorption spectopho-tometry (sensitivity 10^{-12}g) and neutron activation analysis (sensitivity 10^{-12}g).

Deficiency and excess of trace metals have been shown to be hazardous. Trace levels of cadmium and lead are recognised as environmental pollutants with consequent long term toxic effects, due to their cumulative nature in life processes. In contrast, copper and zinc are essential trace elements. Increasing effects of environmental pollu-tion affects the dynamic equillibrium of natural metabolic pathways, by control of the trace metal levels in the environment. Monitoring of trace metal levels in associat-ed natural systems is thus of much importance.

Tea is a national export commodity. Besides being a most popular stimulant beverage, its nutritional effects, as well as its toxic manifestation should be considered. Literature reports trace metal status in 'made' tea. However, these were found to be highly inconsistent not only among different varieties, but within the same variety

as well[5]. These variations have often been attributed to different agricultural, climatic, seasonal and soil conditions as well as to environmental contamination in specific instances. Non nutritive trace metal levels as lead which have sometimes been observed was found to be reduced upon washing of tea leaves, thus being attributed to aërial atmospheric contamination[8]. Trace metal contamination in tea processing has also been reported to be due to the use of machinery and metal foils as wrappers.[4] However, these isolated investigations are inadequate to understand the trends in trace metal contents in tea. Little has been reported on trace metal translocation from additives, fertilizers, biocides and the environment to 'made' tea.

This thesis investigates the variables that influ-ence trace metal levels in tea, as well as their translo-cation in the tea plant. The study has included determi-nation of trace metal levels in different varieties of tea, as well as their possible association with other tea leaf constituents as caffeine, polyphenols etc. Parameters related to quality assessment and those identified by the International Standard Organisation have also been deter-mined, in order to assess their correlation with trace metal levels.

The possible translocation of trace metals in tea from additives, fertilizers and soil has been studied for purposes of determining the 'uptake' of trace metals by plant and their response to different Zinc based fertilizers.

Trace metal contamination in 'made' tea manufacture and translocation in tea 'brewing' as a direct index of trace metal intake in tea consumption are also reported.

Study of processing of samples for trace metal analysis showed that oxidative 'wet digestion' with a mixture of Conc.H_2SO_4 and Conc.HNO_3 acids was most effect-ive. Comparison of the methods for the analysis of caffeine showed that the methods used were statistically comparable. For studies on trace metal translocation from soil to plant, acid digestion with a mixture of HF and $HClO_4$ was found to give highest total trace metal levels in soil, whereas 0.1N HCl and 0.1M EDTA (pH 7) proved satisfact-ory as extractants in the determination of available trace metal levels in soil.

The trace metal status among different varieties of tea was also investigated and found to be inconsistent. The variations were attributed to growth parameters and effects of environmental pollution. Trace metal status also showed significant correlation with other tea leaf constituents as phosphate, polyphenol and caffeine levels. Comparision of trace metal status in soil and different plant portions as flush, stem, mature leaf showed strong correlation regards nickel and lead. Variation in the trace metal status of tea leaves during tea manufacture was significant regards lead and nickel, whereas zinc

and copper levels remained almost constant. The percentage, amounts of translocation during tea 'brewing' showed high value for lead and cadmium (34.6% and 45.5% respect -ively). It was also found that the amounts translocated increased with the time of brewing and decrease in particle size.