

Note

Changes in the Chemical Composition and Quality of Black Tea Due to Plucking Standards

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In most black tea producing countries, the recommended plucking standard is tender shoots of two leaves and a bud, but occasionally some producers are known to have used less tender shoots of more than two leaves. The argument for the use of coarse plucking is the extra biomass obtained in a plucking round. However, a coarse plucking standard reduces the plucking frequency as extra time must be allowed for the production of more shoots. Over an extended period, there may not be significant advantage in the biomass production gained by coarse plucking, as fine plucking leads to more frequent pluckings.

This study was undertaken to quantify the variations in chemical composition, if any, arising from different plucking standards, and to relate such changes to the quality of black tea.

The teas used in this study were obtained from clone 6/8 at the Tea Research Foundation of Kenya. The plucked shoots were withered for 16 to 18 hours to lose 28 to 30% of their original weight. The teas were manufactured by the miniature "Crush, Tear and Curl (CTC)" method in duplicate.

Theaflavins (TF),^{1,2)} thearubigins (TR)^{1,2)} and caffeine²⁾ are necessary for high-quality teas. Although the exact contribution of TR is elusive, positive relationships between TF contents and prices or taster's evaluations have been obtained.²⁾ Ash, total water-soluble solids and crude fiber contents of tea are also important for tea quality.³⁾ High-quality teas normally have high total water-soluble solids, and low ash and crude fiber contents. TF, TR, caffeine and volatile flavor compounds (VFC) were determined by the method outlined in the previous paper,⁴⁾ the total water-soluble solids, ash and crude fiber being analysed as outlined in the International Standard Organization (ISO 3720) Standard for Black Tea.³⁾

The variation of these parameters with plucking standard is presented in Table I. A fine plucking standard produced black teas with high contents of caffeine, crude fiber, TF and total water-soluble solids, the ash content being lowest in two leaves and a bud. The highest TF content was recorded in two leaves and a bud. TF content has been shown to relate directly to prices,²⁾ but such a relationship was insignificant in Kenya although being positive.⁵⁾ The observation of a high TF content in two leaves and a bud was probably due to the fact that the polyphenol oxidase activity increases from the bud to mature leaf stages, while catechin concentration is the reverse effect.⁶⁾ The optimum levels of catechin concentration and polyphenol oxidase activity for the production of high levels of TF in the clone used probably existed in two leaves and a bud.

Although the TR content in tea is necessary for color and thickness,⁷⁾ a high amount is deleterious to quality, teas with a high TR content normally having a "muddy and flat" taste. A coarse plucking standard produced very high TR contents, the high content of TR and low TF content due to coarse plucking being attributed to the increased polyphenol oxidase level in mature shoots.

The content of volatile flavor compounds (VFC), *i.e.*, aroma compounds, in black tea is an important quality parameter.^{8,9)} Although such compounds of Group I as hexanal, 1-penten-3-ol, (*E*)-2-hexenal, 1-pentanol,^{10,11)} (*Z*)-2-pentenol,⁵⁾ 1-hexanol,^{8,9)} (*Z*)-3-hexenal, (*E*)-2-hexenal,^{8~12)} and 2,4-heptadienals^{8,9)} are necessary for the characteristic flavor of black tea, their high amount imparts an inferior quality to tea. The compounds of Group II, *i.e.*, benzaldehyde,⁸⁾ linalool and its oxides,^{8~14)} phenylacetaldehyde,^{8,15)} methylsalicylate,^{11,12)} geraniol and (*E*)-geranic acid, 2-phenylethanol,¹³⁾ and β -ionone contribute the sweet aroma to black tea. The ratio of the sum of the peak areas of Group II to that of Group I has been used as the flavor index (F.I.)^{9,14)} for black teas. Black teas with a higher F.I. normally have a better aroma, although F.I. should be regarded as a qualitative index since it is known that the thresholds for sensory aroma detection of the compounds are not the same.¹⁰⁾ The classification of the rest of compounds in Group I or II followed the method of Yamanishi *et al.*¹⁴⁾ and Wickremasinghe *et al.*⁹⁾ using retention times on a gas chromatogram.

The Group I compounds (Table) were found to be dominated by hexanal, (*Z*)-3-hexenal and (*E*)-2-hexenal, these compounds being increased with coarse plucking. Linalool and its oxides, geraniol, (*E*)-geranic acid and phenylacetaldehyde had high values in Group II compounds, and decreased with coarse plucking. While the total sum of Group I compounds increased with coarse plucking standards, the Group II compounds decreased. F.I. also decreased with coarse plucking. The fine plucking standards, therefore, produced black tea with the best aroma.

Although the plucking standards of a bud, and one leaf

TABLE I. VARIATION (DRY WEIGHT BASIS) OF THE CHEMICAL COMPOSITION OF BLACK TEA DUE TO PLUCKING STANDARDS

	Plucking standards						Mean (C.V. %)
	Bud	1 leaf & bud	2 leaves & bud	3 leaves & bud	4 leaves & bud	5 leaves & bud	
Caffeine (%)	3.89	3.42	2.11	1.56	1.29	1.22	2.25 (50.7)
Theaflavins ^a	23.21	33.43	34.71	29.99	27.33	22.42	28.52 (18.0)
Thearubigins (%)	8.26	12.93	17.91	18.19	18.99	16.68	15.49 (26.7)
Total water soluble solids (%)	48.2	50.6	47.9	45.0	41.9	42.6	46.03 (7.5)
Ash (%)	7.11	6.78	6.10	6.38	6.37	6.65	6.56 (5.5)
Crude fiber (%)	6.76	8.12	10.22	13.68	14.86	16.65	11.76 (33.7)
VFC: ^b							
Sum of Group I ^c	3.61	4.47	4.63	4.86	5.23	5.74	4.76 (15.13)
Sum of Group II ^d	8.18	8.30	6.94	5.50	5.06	4.54	6.45 (25.89)
F.I. (II/I)	2.26	1.86	1.50	1.13	0.97	0.79	1.43 (40.56)

^a $\mu\text{M/g}$.

^b Volatile flavor component, expressed as the ratio of peak area to that of an internal standard (ethyl decanoate).

^c Sum of compounds imparting an inferior flavor.

^d Sum of compounds producing a sweet aroma.

and a bud produced very high-quality teas as indicated by F.I., caffeine, TF, total water-soluble solids, crude fiber and Group II VFC contents, such plucking standards are uneconomic in practice. Plucking two leaves and a bud produced teas with acceptably high quality, this being the plucking standard that is practised in most black tea producing countries to produce an economic return. It is suggested that plucking two leaves and a bud, which comprises both yield and quality, should be practised.

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