

FURTHER STUDIES ON THE EFFECT OF CLIMATE ON THE CHEMICAL COMPOSITION OF FRESH TEA FLUSH

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Introduction

The effect of climate on the chemical composition of the starting material in tea manufacture, namely fresh tea flush, is of importance because it is the chemical composition of this material which determines its potential to make quality tea. This thesis was developed in an earlier paper (Sanderson, 1964b) and we wish to expand it somewhat in the light of more recent results.

The results reported previously (Sanderson, 1964b) were for an investigation carried out between April and December, 1963, which is the wet, or monsoon, season at the Tea Research Institute near Talawakele. Therefore, it was desirable to extend the earlier investigation to include a period during the dry, or flavoury, season in order to study the effect of season on the chemical composition of fresh flush. It is well known that vastly superior teas are made during the dry season as compared to the wet season and it is therefore desirable to know how the chemical composition of the flush varies between the two seasons. This information is necessary for an understanding of the chemical basis of quality in tea which we seek (Sanderson, 1964a).

Design of the Experiment

Sampling was carried out in the same way as in the initial investigation (Sanderson, 1964b). In summary, flush from the two clones TRI. 740 and TRI. 777 of high (A₁ grade) and low (C grade) quality potential (Keegel, 1959), respectively, was plucked simultaneously from adjacent plots on a 10-day plucking round. Plucking was carried out between 31 January and 30 April 1964 during the Dimbula Valley dry season. Normally the latter part of this plucking period would have been during the beginning of the south-west monsoon but the rains were delayed in 1964 and all samples were taken during typical Dimbula "dry" weather (Superintendent, 1964, 1965). As before, samples were removed from the flush obtained on each plucking for laboratory analysis. The remainder of the flush was used for the manufacture of black tea by the Technology Division staff. This tea was then sent to four Colombo tea tasters for evaluation (Keegel, 1959).

Eleven chemical quantities were determined on the samples collected, and these were compared with the earlier results (Sanderson, 1964b) on the following basis:

Wet Season — 27 March to 2 December 1963.

Dry Season — 31 January to 30 April 1964.

Comparison of the Two Clones

Before considering the effect of season specifically, it is useful to compare the two clones under study for their behaviour in the dry, or flavoury, season. As shown in Table 1, tea made from TRI. 777 was superior to that made from TRI. 740. It is interesting, however, to note that the difference in strength between the two clones found in the wet season (Table 1 in Sanderson, 1964b) disappeared in the dry season while the difference in quality has increased from the wet to the dry season. Marks for quality and valuation appeared to be higher in the dry season than in the wet season and marks for colour appeared to be lower in the dry season as compared to the wet season as would be expected (Evans, 1930; Ramaswamy, 1964). Finally, the tasters (who were the same for both seasons) were found to be in better general agreement during the dry season than during the wet season.

TABLE 1.—Average marks given by Colombo Tea Tasters to nine teas made from Clones TRI 740 and TRI 777 over the period 31 January to 30 April 1964 (Dry Season) (Table supplied by Technology Division)

Characteristic	Clone	Tea Taster				Totals
		A	B	C	D	
Infusion	777	5.11**	6.89**	7.33**	8.11**	27.44**
	740	2.89	4.67	5.22	6.89**	19.67**
Colour	777	5.67n.s.	8.67**	7.11*	7.33*	28.78**
	740	4.89	6.56	5.44	5.00	21.89
Strength	777	5.11n.s.	6.44	5.33n.s.	7.56**	24.44n.s.
	740	5.11	6.78n.s.	5.00	5.11	22.00
Quality	777	4.38n.s.	5.00n.s.	6.89**	6.89n.s.	23.16**
	740	4.00	4.67	5.11	6.22	20.00
Flavour†	777	—	0.22	—	6.78	—
	740	—	0	—	6.22	—
Valuation	777	Rs.2.38*	Rs.2.53n.s.	Rs.2.56*	Rs.2.82*	Rs.10.29**
	740	2.24	2.30	2.35	2.29	9.18

n.s. = no significant difference.

* = significantly different at 5% level ($P < 0.05$).

** = significantly different at 1% level ($P < 0.01$).

† = not analyzed statistically because of insufficient data.

All eleven chemical quantities measured were found to be present at significantly different levels in the two clones during the dry season (Tables 2 and 3). Noteworthy is the finding that differences in levels of moisture and pectin, which were not significantly different in the two clones during the wet season (Table 2 in Sanderson, 1964b) became significantly different during the dry season.

TABLE 2.—Average Level of Chemical Constituents in fresh Tea Flush of Clone TRI 740 and TRI 777 which were not significantly affected by season

(34 pluckings were made between 27 March 1963 and 30 April 1964)

Constituent	No. of Pluckings Analyzed	Clone		Level of Significance of Difference between Clones
		TRI 740	TRI 777	
Moisture	33	% Fresh Weight†		2%
		77.3 ± 0.3	77.7 ± 0.2	
Total nitrogen	34	% Dry Weight†		1%
		4.58 ± 0.07	4.84 ± 0.06	
Caffeine	34	3.16 ± 0.06	3.66 ± 0.04	1%
Protein	34	22.9 ± 0.4	23.7 ± 0.4	1%
Total flavanols	31	25.5 ± 0.9	26.6 ± 0.7	1%
Crude fats	19	1.25 ± 0.03	1.13 ± 0.02	0.1%

† Figures given are the mean values found ± the standard error. The standard error gives a measure of the day to day variation.

The above findings indicate that inherent differences between the two clones studied become more pronounced during seasons most favourable for the development of quality

Effect of Season

Analyses of the combined results for the wet and dry seasons showed that five of the chemical quantities measured were significantly affected by season. The other six chemical constituents remained unaffected. Accordingly, the latter have been averaged for both seasons and are shown in Table 2; the former, however, are shown in Table 3 where the data for each season are given separately for comparison.

TABLE 3.—Average Level of Chemical Constituents in Fresh Tea Flush of Clones TRI 740 and TRI 777 which were significantly affected by Season. (The Wet Season was taken as the period 27 March to 2 December 1963 and the Dry Season was taken as the period 31 January to 30 April 1964.)

Constituent	WET SEASON				DRY SEASON				Level of Significance of Difference between Seasons
	No. of Pluckings Analyzed	Clone		Level of Significance of Difference between Clones	No. of Pluckings Analyzed	Clone		Level of Significance of Difference between Clones	
		TRI 740	TRI 777			TRI 740	TRI 777		
Ash	25	% Dry Weight*		1%	9	% Dry Weight*		1%	
		5.35 ± 0.05	4.82 ± 0.05	1%		5.28 ± 0.08	5.03 ± 0.06	1%	
Pectin	25	5.42 ± 0.23		None	9	5.77 ± 0.12		5%	
Total soluble solids	25	42.2 ± 0.6		1%	9	44.6 ± 0.7		5%	
Crude fibre	12	10.5 ± 0.1		None	9	9.85 ± 0.15		5%	
		Enzyme Units**				Enzyme Units**			
Polyphenol oxidase activity	24	12.5 ± 1.1		1%	8	7.0 ± 1.1		1%	
		28.9 ± 2.3				15.3 ± 0.4			

*Figures given are the mean values found ± the standard error. The standard error gives a measure of the day to day variation.

**Enzyme units are given as micromoles catechol oxidized/minute/gram acetone powder.

It is noteworthy that the level of all the nitrogenous constituents determined; namely, total nitrogen, caffeine, and protein were not affected by season (Table 2). Furthermore, when the entire period of investigation (27 March 1963 to 30 April 1964) is considered, the high quality clone TRI. 777 contained significantly higher levels of these constituents than the low quality clone TRI. 740. These results confirm the results for the wet season alone which were discussed previously (Sanderson, 1964b).

The chemical constituents in Table 3 are of particular interest because they were found to be affected by season which indicated the likelihood of their being involved in determining the difference in quality observed in the two seasons. The effect of season on these chemical constituents is also shown graphically in Figure 1.

The ash content of flush was significantly influenced by season as was expected from earlier reports (Ramaswamy, 1964; H. N. Hasselo, unpublished results). However, in this investigation the ash content of flush from clone TRI. 777 increased instead of decreasing as would be expected from earlier reports of the negative correlation existing between quality and ash content (Ramaswamy, 1963, 1964; Sanderson 1964b). The ash content in the flush of clone TRI.740 behaved in the expected way in that it was lower in the dry season than in the wet season.

The increase in pectin content of flush in the dry season was of interest because of the suggestion of its importance in governing fermentation rates in tea manufacture (Lamb & Ramaswamy, 1958).

It was also found that the level of total soluble solids increased from wet to dry season and that the level of crude fibre decreased at the same time.

The level of polyphenol oxidase activity dropped sharply during the dry season in both clones. However, the level of activity in clone TRI.777 remained about double that of clone TRI. 740.

Discussion and Conclusions

Season has been shown to have a marked effect on tea quality (Ramaswamy, 1964) and on the chemical composition of the starting material in tea manufacture; fresh tea flush (Torii *et al.*, 1954; Ramaswamy, 1963; Wood, *et al.*, 1964; H. N. Hasselo, unpublished results; and the present report). It has been argued that the chemical composition of the freshly plucked flush determines the potential of that flush to make tea (Sanderson, 1964b) and this argument is supported by the above observations. However, the specific way in which the level of the various chemical constituents affect the quality of made tea is as yet only very poorly understood. Additional research is required before we can begin to adequately answer this question.

It should be recognized, however, that the influence of season on quality in made tea has, under present manufacturing conditions, two important aspects. That is, season affects field conditions with its attendant influence on the chemical composition of the flush and it also affects the manufacturing conditions prevailing in the factory. In other words, the quality potential of the fresh tea flush is affected by season but the chance of realizing the full potential of the flush is also affected by season. Wet weather is likely to reduce the quality potential of the flush in the field but it also adversely affects the conditions prevailing in the factory making it difficult, or perhaps even impossible in present day factories, to retain what quality is inherent in the plucked flush.

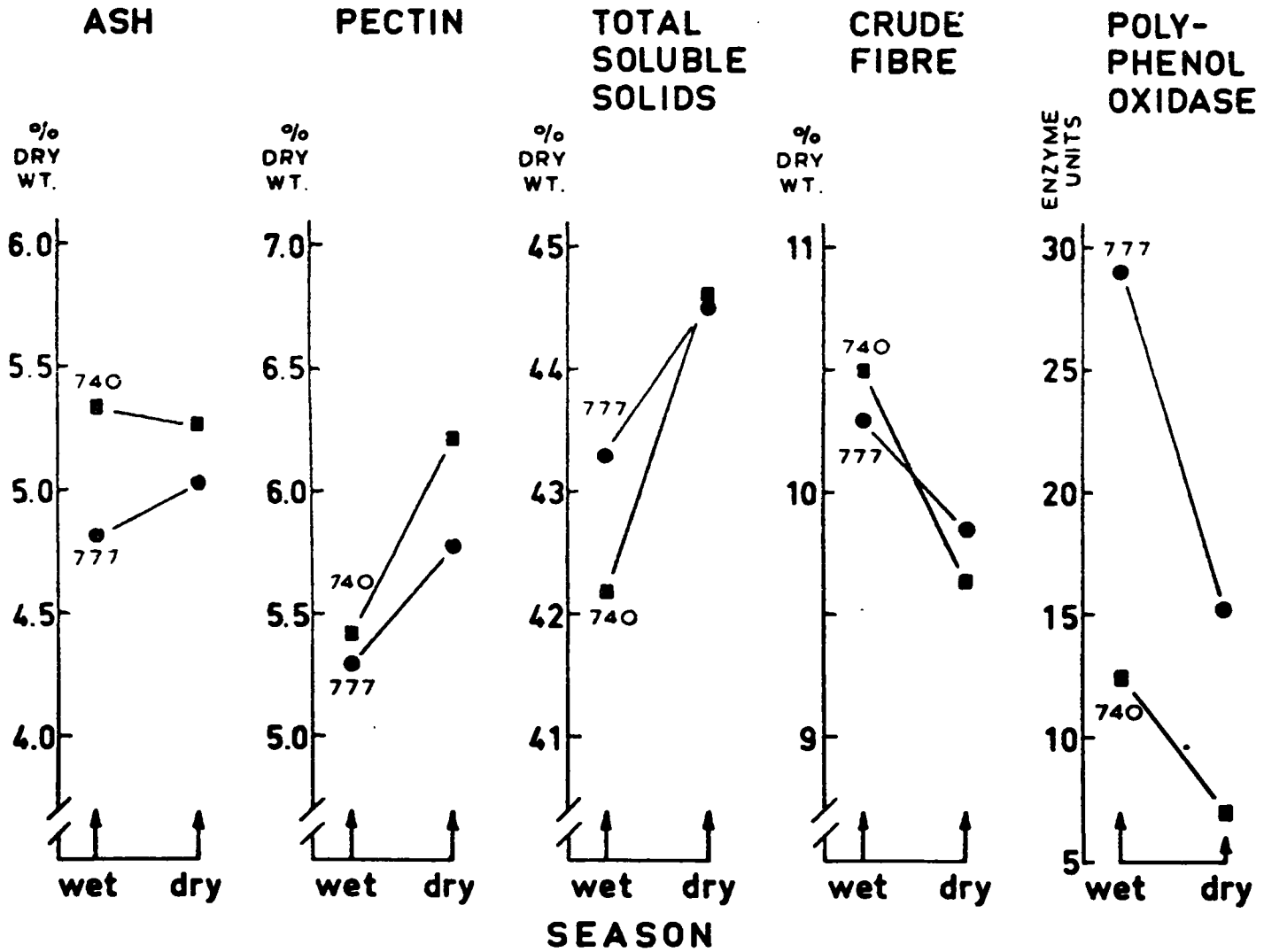


Figure 1.—Changes in the Level of Five Chemical Constituents of Fresh Tea Flush which are Affected by Season. The mean levels found in the flush of clones TRI 740 and TRI 777 in the Wet Season and in the Dry Season are shown.

The above ideas are represented diagrammatically in Figure 2. The actual figures given in Figure 2 are entirely hypothetical and they are only given for clarity of meaning. The important point illustrated is the proposition that season affects the quality of made tea at two important places; namely, in the field and in the factory. During dry, or flavoury, seasons weather conditions are often ideal in both places and a tea with the maximum possible quality is produced. On the other hand, during wet seasons it is probable that unfavourable climatic conditions prevent the realization of even the reduced quality potential of the fresh flush.

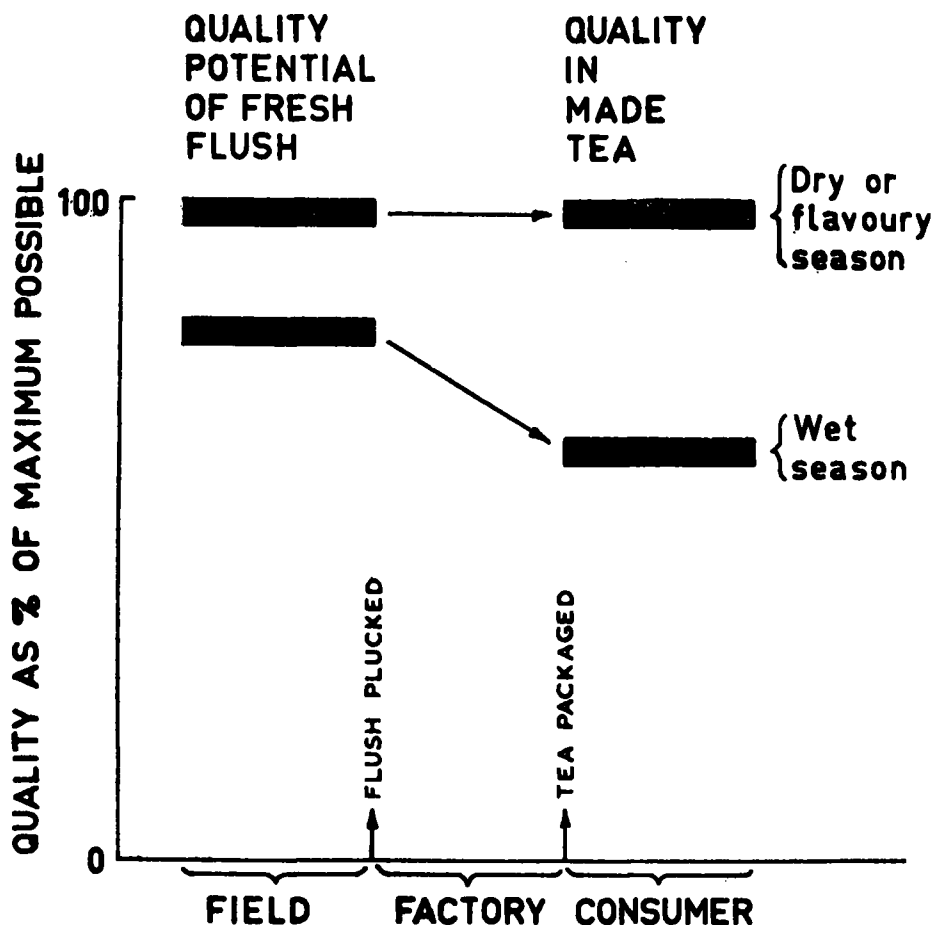


Figure 2.—Hypothetical Scheme Showing Possible Relationships between Quality Potential of Fresh Flush and Quality in the Made Tea during Wet and Dry Seasons.

The influence of conditions prevailing during tea manufacture on the quality of the tea produced, particularly as regards withering, has been recently discussed (Sanderson, 1964c). The climatic conditions in the field are largely uncontrollable which means that the quality potential of freshly plucked flush must be accepted as a limiting factor in the production of quality tea. However, factory conditions are controllable to a certain extent even at present, and it is practically possible to control them to a much greater extent, if that were shown to be economically advantageous. Future research is designed to determine how to keep the quality potential of the flush at a maximum at all times and how to insure that the quality in the made tea is at all times equal to the quality potential of the freshly plucked flush, *i.e.*, how to keep the line connecting the quality potential of fresh flush and quality in made tea horizontal at all times (cf. Figure 2).

Summary

1. Clone TRI. 777 made a better tea than clone TRI. 740 in the dry season and both clones made better teas in the dry season than in the wet season.
2. The level of crude fat was higher in the flush of clone TRI. 740 than in clone TRI. 777. The levels of moisture, total nitrogen, caffeine, protein, and total flavanols were lower in the flush of clone TRI. 740 than in clone TRI. 777. The level of these chemical constituents did not differ significantly between wet and dry seasons.
3. The levels of ash, pectin, total soluble solids, crude fibre, and polyphenol oxidase activity were significantly different in the dry season as compared with the wet season. The following relationships were found (dry season levels are compared with wet season levels): Ash decreased in clone TRI. 740 and increased in clone TRI. 777; pectin and total soluble solids increased, and crude fibre and polyphenol oxidase activity decreased in both clones.
4. The importance of climate in determining the quality potential of fresh tea flush and in the realization of this potential in the made tea is discussed.

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