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QUALITY OF CTC TEAS MADE FROM DIFFERENT TEA (*Camellia sinensis* L) CLONES

*A. S. Ranaweera and D. S. A. Samaraweera**

(Tea Research Institute of Sri Lanka, Talawakele, Sri Lanka)

FAO prediction implies that CTC teas would have a better demand than that of Orthodox teas in the near future. Manufacturing of quality CTC teas, using higher yielding clones is very important to obtain premium prices on par with others in the field or in the world tea trade. The quality of CTC teas made from eight popular clones which were given their optimum fermentation periods were analysed and grouped accordingly. Considering the revenues of these clones we recommend clones DT 1, TRI 2025, TRI 2024, TRI 2026, TRI 2027 and TRI 2023 for better CTC production.

INTRODUCTION

In Sri Lanka clonal tea is used for replanting and new planting programmes as higher yields could be obtained from them compared to the yields from seed tea. In selecting clones for particular locations, the choice is dependent on the soil, climatic conditions, tolerance to pests, diseases, drought as well as to yield and quality. The overall quality of black tea processed from recommended clones depends on the clonal characteristics (genetic constitution of the clone) and the processing technique. Thus clones selected for orthodox manufacture may or may not be the ideal for CTC (crush, tear, curl) processing. The CTC method produces a large percentage of small leaf grades which are intensively used for tea bags. The FAO prediction of global production of teas in M. kg by 1995 are given below (FAO Technical Report, 1989):

	Orthodox	*CTC*	*Total*
Production	1127	1063	2190
Export availability (EA)	665	427	1092
Import requirement (IR)	627	433	1060
EA – IR	+38	–06	+32

Surplus availability of orthodox teas and a deficit of CTC teas indicate a suppressed market for the former and an improving market for the latter. Thus a need has arisen for Sri Lanka to divert at least a fraction of her output into CTC teas. Whilst selection of lands based on agroclimatic factors for CTC production should be the first consideration, replanting and new planting in lands thus selected with clones more suited for CTC production needs consideration.

Fermentation is a very important aspect in black tea processing. Fermentation period should be selected to optimize those characteristics which contribute to overall

*Present Address: Sapekoe Technical Services, Tzaneen 0850, Republic of South Africa.

Note: Quality refers to overall excellence which is directly related to the valuations. Thus the term quality used here does not refer to the quality of liquors/flavour.

quality such as colour of infused leaf, and colour, strength and quality/brightness of the tea liquor. The optimum fermentation period varies from clone to clone (Samaraweera and Ranaweera, 1988).

Total revenue (T) is also an important factor for a clone when it is used in replanting. This is represented by yield (Y) and quality (or price P) of made tea. Taking these factors into consideration one can recommend a suitable clone for CTC tea processing.

The objective of this study was to investigate whether there was any significant quality difference in CTC tea made from popular clones given the optimum period of fermentation and to recommend clones for CTC manufacture based on their total revenues.

MATERIALS AND METHODS

The experiment was carried out from May 1987 to April 1988 at St Coombs tea factory (elevation 1382 m AMSL) in Talawakele. Approximately 800 g of tea flush (two and a bud) from some popular clones namely TRI 2023, 2024, 2025, 2026, 2027, 2142, 777 and DT1 were separately withered for about 12 h to achieve approx. 70% moisture content (wet basis) and separately macerated (three passes) using miniature CTC roller with fixed gap setting (gap setting was decided to achieve a similar CTC teas to that of a commercial standard and only two segments were employed in the miniature CTC roller). One and a half inch thick layers of rolled dhools were fermented on trays with the length of the fermentation period being varied for each clone based on an earlier work (Samaraweera and Ranaweera, 1988). The average fermentation temperature was about 25°C. Fermented dhools were dried using a miniature drier (inlet temperature was maintained at 88°–93°C (190°–200°F) to obtain approx. 3% moisture content in made tea and hand sieved (10 mesh size) to remove lumps. In the case of CTC manufacture it was assumed that the resultant 'Grade Mix' of fired teas was independent of any clonal effects. Duplicated, coded ungraded tea samples from each clone were sent weekly over the given period to three professional Tea Tasters for their sensory evaluation. In the sensory evaluation, the taster's opinion was obtained for colour of infused leaf; and colour, strength and quality of the tea liquors. However the overall valuations have been considered for the total revenue earned for each clone. Due to the poor response, evaluation of one of the tasters was not considered for the analysis.

The overall valuation for duplicate CTC samples in rupees were averaged (Tables 1a and 1b). Randomized Complete Block Design was employed to find out whether there was significant quality differences among the clones from the evaluation of two tasters separately. Duncan's New Multiple Range Test (DNMRT), was used to find out the quality differences in clones.

There is no need to consider the total revenue when there is no significant difference in quality among the clones. Then the yield becomes the deciding factor.

If there is a quality difference in clones taken individually or as a group, clone/group (a) is preferred to clone/group (b)

TABLE 1a – *Mean valuations given by first taster for CTC teas made by different clones*

Treatment			Dates of Manufacture 01	02	03	04	05	06	07	08	09	10	11
DTI		:	75.00	76.25	62.50	53.25	46.50	47.50	44.00	39.00	43.50	39.00	47.50
TRI	777	:	47.50	78.75	82.50	56.00	67.50	65.00	45.00	45.00	50.00	47.50	72.50
TRI	2025	:	51.25	47.50	60.00	48.50	42.50	47.00	48.50	47.50	55.00	55.00	44.00
TRI	2026	:	60.00	62.50	52.50	45.25	45.00	65.00	37.50	50.00	40.00	44.00	40.00
TRI	2027	:	68.75	48.75	52.50	47.50	47.50	55.00	43.50	60.00	46.00	44.50	43.00
TRI	2142	:	65.00	75.00	65.00	52.50	60.00	60.00	36.50	57.50	49.00	62.50	55.00
TRI	2023	:	67.50	62.50	53.75	60.00	45.00	55.00	42.50	46.50	44.50	47.50	43.50
TRI	2024	:	76.25	60.00	63.75	51.00	52.50	52.50	38.00	45.00	46.50	45.00	49.00

TABLE 1b – *Mean valuations given by second taster for CTC teas made by different clones*

Treatment			Dates of Manufactoure 01	02	03	04	05	06	07	08	09	10
DT	1	:	50.00	50.00	50.00	45.00	49.00	50.00	49.00	44.00	45.00	48.00
TRI	777	:	50.00	50.00	48.50	45.00	48.00	50.00	50.00	45.00	44.50	50.00
TRI	2025	:	44.50	42.50	44.00	40.00	40.00	42.50	43.00	40.00	40.00	44.00
TRI	2026	:	46.50	46.00	44.00	41.50	42.50	42.50	43.00	43.00	40.00	45.50
TRI	2027	:	43.00	42.50	44.00	41.50	45.00	42.50	43.00	40.00	40.00	44.00
TRI	2142	:	46.50	44.00	47.00	42.50	46.00	47.00	46.50	44.00	43.00	48.50
TRI	2023	:	47.00	43.00	45.00	40.00	42.50	42.50	45.00	40.00	40.00	47.00
TRI	2024	:	46.50	46.50	46.00	43.00	45.00	47.00	47.50	43.00	41.50	47.00

Analysis of variance of data is given in the appendix I and II.

When T (a)/T (b)> 1

but

$$T(a)/T(b) = \frac{Y(a).P(a)}{Y(b).P(b)}$$

$$\text{and hence} = \frac{Y(a).P(a)}{Y(b).P(b)} > 1$$

$$\text{i.e. } \frac{P(a)}{P(b)} > \frac{Y(b)}{Y(a)}$$

Therefore preference should be given to a clone or a group of clones after considering the price and yield ratios of one with the other. But within a group preference should be given to a clone with better tolerance to other unfavourable conditions.

RESULTS AND DISCUSSION

Average values (from duplicated samples) for CTC teas made from different clones (treatment) and at different dates are given below.

Calculated F ratios (47.27 and 2.78) for clones are statistically significant at 0.05 level thereby showing that in the case of CTC manufacture, the clones investigated have different quality potential. The correlation coefficient between mean valuations given by the two tasters is 0.70. This shows fair consistency of the quality evaluation made by both tasters at 0.05 significance level. Two DNMRT were done separately to investigate quality differences on each taster's evaluation and the results are given in Tables 2a, 2b and 3a, 3b for taster 1 and taster 2 respectively.

TABLE 2a – *DNMRT on the separation of the mean values (Rs) of different clones as given by taster 1*

Clone	: Mean Value $\bar{X}$ (Rs)	$\bar{X}$-49.25	$\bar{X}$-49.70	$\bar{X}$-50.64	$\bar{X}$-51.66	$\bar{X}$-52.18	$\bar{X}$-52.68	$\bar{X}$-58.00
TRI 77	: 59.75	10.50*	10.05*	09.11*	08.09*	07.57*	07.07	01.75
	:	(P_8=7.57)						
TRI 2142	: 58.00	08.75*	08.30*	07.36*	06.34	05.82	05.32	–
	:	(P_7=7.45)						
TRI 2024	: 52.68	03.43	02.98	02.04	01.02	00.50	–	–
	:	(P_6=7.33)						
DT 1	: 52.18	02.93	02.48	01.54	00.52	–	–	–
	:	(P_5=7.22)						
TRI 2023	: 51.66	02.41	01.96	01.02	–	–	–	–
	:	(P_4=7.03)						
TRI 2027	: 50.64	01.39	00.94	–	–	–	–	–
	:	(P_3=6.82)						
TRI 2025	: 49.70	00.45	–	–	–	–	–	–
	:	(P_2=6.48)						
TRI 2026	: 49.25	–	–	–	–	–	–	–

* Values are higher than the values of corresponding critical difference

TABLE 2b – *Categorization of quality evaluated by taster 1 for CTC teas made from different clones*

Clone	TRI 777	TRI 2142	TRI 2024	DT 1	TRI 2023	TRI 2027	TRI 2025	TRI 2026
GROUPING	a	a						
		b	b	b	b			
			c	c	c	c	c	c

(Same letter is denoted when there is no significant difference)

TABLE 3a – *DNMART on the separation of the average values (Rs) of different clones as given by taster 2*

Clone	: Mean Value $\bar{X}$ (Rs)	$\bar{X}$-42.05	$\bar{X}$-42.55	$\bar{X}$-43.20	$\bar{X}$-43.45	$\bar{X}$-45.30	$\bar{X}$-45.50	$\bar{X}$-48.05
TRI 777	: 48.10	06.05*	05.55*	04.90*	04.65*	02.80*	02.60*	00.05
	:	(P_8=1.13)						
DT 1	: 48.05	06.00*	05.50*	04.85*	04.60*	02.75*	02.55*	–
	:	(P_7=1.12)						
TRI 2142	: 45.50	03.45*	02.95*	02.30*	02.05*	00.20	–	–
	:	(P_6=1.10)						
TRI 2024	: 45.30	03.25*	02.75*	02.10*	01.85	–	–	–
	:	(P_5=1.08)						
TRI 2026	: 43.45	01.40*	00.90	00.25	–	–	–	–
	:	(P_4=1.06)						
TRI 2023	: 43.20	01.15*	00.65	–	–	–	–	–
	:	(P_3=1.03)						
TRI 2027	: 42.55	00.50	–	–	–	–	–	–
	:	(P_2=0.97)						
TRI 2025	: 42.05	–	–	–	–	–	–	–

* Values are higher than the values of corresponding critical difference

TABLE 3b – *Categorization of quality evaluated by taster 2 for CTC teas made from different clones*

Clone	TRI 777	DT 1	TRI 2142	TRI 2024	TRI 2026	TRI 2023	TRI 2027	TRI 2025
GROUPING	a	a						
			b	b				
					c	c	c	
							d	d

(Same letter is denoted when there is no significant difference)

The above results can be grouped together for both tasters' evaluations and the conclusions derived from these are given below:

Clone	*Remarks*
TRI 777	First preference in quality
TRI 777, 2142	These clones can be considered as good
DT 1, TRI 2024	quality clones for CTC manufacture
TRI 2026, 2023	These four can be selected as average
TRI 2027, 2025	quality clones for CTC manufacture

The maximum and minimum valuations expected for each clone by taster 1 and 2 are given in Table 4.

TABLE 4 – *Maximum (X+S.D) and minimum (X-S.D) valuation (Rs) expected for each clone by taster 1 and 2*

Clone	Taster 1		Taster 2	
	MAX	MIN	MAX	MIN
TRI 777	73.97	45.71	50.47	45.73
TRI 2142	67.99	48.01	47.49	43.51
DT 1	65.50	38.86	50.40	45.60
TRI 2024	63.26	42.10	47.38	43.22
TRI 2026	58.85	39.65	45.51	41.39
TRI 2023	60.28	43.04	45.90	40.47
TRI 2027	58.58	42.70	44.21	40.89
TRI 2025	54.88	44.54	43.93	40.17

The maximum and minimum valuations (Rs) obtained from the above Table for poor and better yielders are given along with their maximum and minimum yields in Table 5.

TABLE 5 – *Maximum and minimum valuations (Rs) given by taster 1 (T1) and taster 2 (T2) and yields (kg ha^{-1} an^{-1}) of clones*

Clone	Max. Price		Min. Price		Max. Yield	Min. Yield
	T1	T2	T1	T2		
Poor (A) TRI 777, 2142	73.79	50.47	45.71	43.51	2500	1700
Better (B) TRI 2024, 2023, 2025, 2026 DT 1, TRI 2027	65.50	50.40	38.86	40.17	4000	2500

As explained earlier the group A is preferred to B if P(A)/P(B) > Y(B)/Y(A).

Therefore, to select the preferred group all feasible ratios of P(A)/P(B) and Y(B)/Y(A) have been compared. The preference based on both tasters' evaluations and yields is represented in Table 6.

TABLE 6 – *All feasible cases and their preference for group*

Case				P (A) / P (B)		Y (B) / Y (A)	Preference		
Yield		Price		T1	T2		T1	T2	Final
A	B	A	B						
MAX	MIN	MAX	MAX	1.13	1.00	1.00	A	A,B	A
MAX	MIN	MIN	MIN	1.18	1.08	1.00	A	A	A
MAX	MAX	MAX	MAX	1.13	1.00	1.60	B	B	B
MAX	MAX	MIN	MIN	1.18	1.08	1.60	B	B	B
MIN	MAX	MAX	MAX	1.13	1.00	2.35	B	B	B
MIN	MAX	MIN	MIN	1.18	1.08	2.35	B	B	B
MIN	MIN	MAX	MAX	1.13	1.00	1.47	B	B	B
MIN	MIN	MIN	MIN	1.18	1.08	1.47	B	B	B

As shown in Table 6, group B, i.e. clones DT1, TRI 2024, 2026, 2023, 2025 and TRI 2027 are preferred in most cases when quality and yield are considered together. However the group A, i.e. clones TRI 777 and 2142 are preferred in some extreme cases.

CONCLUSIONS

1) If each clone is given the optimum period of fermentation, the clones in group B are recommended for CTC manufacture when total revenue is considered. However in practice unless the leaf from different clones are harvested separately, it may not be feasible to give different fermentation periods. In view of this, we suggest planting only quick fermenters (clones) or medium fermenters or slow fermenters in a field so that a group of clones of similar fermentation periods would be harvested together, to achieve better CTC teas.

2) It is also recommended that other aspects such as Eelworm, Blister Blight, Canker, Shot-hole borer and drought be considered when planting clones within a given group.

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APPENDIX I : *Analysis of data given in Table 1a*

Source	*D. F*	*Sum of Squares*	*Mean Squares*	*F – Ratio*
Between Blocks (Different Dates)	10	4331.05	433.10	7.40
Between Treatment (Different Clones)	07	1140.02	162.86	2.78
Error	70	4096.78	58.52	
Total	87	9567.85		

APPENDIX II : *Analysis of data given in Table 1b*

Source	*D. F*	*Sum of Squares*	*Mean Squares*	*F – Ratio*
Between Blocks (Different Dates)	09	264.32	29.37	24.78
Between Treatment (Different Clones)	07	391.95	55.99	47.27
Error	63	74.67	1.18	
Total	79	730.95		