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CHEMICAL CONSTITUENTS IN DIFFERENT PARTS OF FRESH TEA FLUSH AND THEIR CONTRIBUTION TO OVERALL QUALITY IN MADE TEA

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Chemical and organoleptic studies were carried out to investigate the contribution made by different parts of tea flush (bud, 1st leaf, 2nd leaf and stalk) to the overall quality of made tea.

Flush of two clones (DT 1and TRI 2025) were collected during the Dimbulla flavoury season and separated into individual components and manufactured. Gas liquid chromatographic studies of the volatile fractions of each sample indicated that their levels increased during the flavour season but this was interrupted with the onset of the rains. The overall levels of desirable volatiles were higher in clone DT 1 compared to that in clone TRI 2025. Organoleptic assessment of each sample indicated that to obtain the overall quality of tea, contribution from all parts of the tea flush was a prerequisite. Of the two clones, DT 1 was found to be a superior quality clone than TRI 2025.

INTRODUCTION

Sri Lankan teas are renowned the world over for its flavour characteristics. In particular the teas that are manufactured during certain months of the year in the Uva (Eastern sector) and Dimbulla districts (Western sector of the Up Country) fetch premium prices at the auctions mainly for the distinct flavours formed during these seasons. During these months the manufacturing conditions are adjusted in a manner to bring out all the inherent flavours to the surface of the leaf. These include a shorter withering period, very light rolling and a short fermentation period. These conditions preserve the seasonal flavours of the leaf *in situ* with only a minimal loss as against what occurs during the off seasonal manufacturing conditions. In general a typical Sri Lankan seasonal tea possesses a light and bright liquor with a moderate strength and a distinct aroma specific to the region from where the leaf was harvested and manufactured (Yamanishi *et al.*, 1968)

In harvesting of tea it is the practice to harvest a high proportion of bud and two leaves which are really suitable for making the best quality teas. However, if coarse plucking is resorted to, the harvested shoots would contain a considerable percentage of the third leaf which would result in an increase in crop but in the loss of liquor characters (Bhatia – 1963). The third leaf would be included in the harvest if it is in an immature stage when it is considered to be acceptable for manufacture. However, the individual contribution that different parts of the flush makes to the overall cup quality is still not known. A study was therefore initiated during the Dimbulla flavoury season to identify the chemical constituents that are formed in different parts of the flush during black tea manufacture and to assess their contribution on the overall quality of made tea.

MATERIALS AND METHODS

The study commenced in the month of February during the Dimbulla flavour season in the Up Country employing two popular clones (DT 1 and TRI 2025) with rather polarised quality characteristics. While DT 1 is rated as a good quality clone, TRI 2025 is a high yielding clone with a poor quality tea (Kirtisinghe, de Silva and Samarasingham, 1968). Fresh tea flush of these clones were harvested from St Coombs Estate (elevation 1382 m amsl), Talawakele at weekly intervals according to the prevailing frequency of plucking over a period of 7 weeks commencing from 22nd February, 1989. The flush was separated into its components (bud, 1st leaf, 2nd leaf and stalk and manufactured individually using a miniature manufacturing system (Landreth, 1954).

From each of the above samples, 20 g of manufactured tea was subjected to simultaneous distillation and extraction (SDE) to extract the volatiles (Yamanishi, Botheju and de Silva, 1989) which were then concentrated to 10 ul using distillation and a stream of inert gas and 0.8 μl of it was injected onto a preprogrammed gas liquid chromatograph (GLC).

GLC Conditions

A Varian gas liquid chromatograph (Model 3400) with a Flame Ionising Detector (FID) was used for the analysis. A stainless steel column (2m x 3mm i.d.) packed with 15% FFAP on chromosorb (80 – 100 mesh) was used with carrier gas (N_2) flow at 30ml per min. The temperature was programmed from 60° C to 190° C at a rate of 1°C per min.

RESULTS

In the present investigation the levels of six important volatile compounds which influence the overall aroma of black tea (*trans* – 2 – hexenal, linalool oxide I, linalool oxide II, linalool, methyl salicylate and nerolidole) were determined in the components of the flush of two clones (Table 1).

TABLE 1 – *Amounts (area counts) of volatile compounds in components of flush*

		Bud		1st Leaf		2nd Leaf		Stalk	
		DT1	TRI 2025	DT1	TRI 2025	DT1	TRI 2025	DT1	TRI 2025
1st week	*Trans*-2-hexenal	4.62	7.73	9.92	8.24	7.14	11.60	0.82	4.65
	Linalool oxide I	47.06	3.05	22.27	3.13	17.23	3.38	26.45	9.75
	Linalool oxide II	172.32	9.65	107.22	10.39	81.78	9.48	98.88	20.86
	Linalool	220.20	28.99	102.82	30.06	87.11	31.88	20.91	30.01
	Methyl salicylate	72.76	16.74	66.45	16.52	71.40	19.12	28.41	32.99
	Nerolidol	17.02	3.66	10.33	3.05	9.04	3.30	3.52	2.73
2nd week	*Trans*-2-hexenal	3.02	7.35	4.76	14.61	8.86	8.65	2.50	1.55
	Linalool oxide I	23.64	3.58	13.42	4.14	17.06	3.54	47.20	10.02
	Linalool oxide II	90.83	9.78	66.21	14.98	80.60	13.18	176.11	22.16
	Linalool	200.00	129.53	51.62	34.54	69.64	32.31	55.06	27.37
	Methyl salicylate	46.33	40.23	28,94	37.76	36.43	34.18	26.08	33.22
	Nerolidol	2.77	4.73	5.36	5.66	5.16	6.66	3.77	2.14

		Bud		1st Leaf		2nd Leaf		Stalk	
		DT1	TRI 2025	DT1	TRI 2025	DT1	TRI 2025	DT1	TRI 2025
	Trans-2-hexenal	11.95	4.37	13.79	24.55	7.78	9.92	2.06	5.56
	Linalool oxide I	27.86	3.47	16.58	4.27	12.28	2.15	50.10	8.04
3rd	Linalool oxide II	119.94	9.49	79.75	14.48	56.55	7.40	186.46	20.55
week	Linalool	289.02	89.75	63.66	31.89	46.22	13.67	59.40	19.41
	Methyl salicylate	58.60	41.75	53.57	35.68	33.30	16.17	26.86	53.15
	Nerolidol	10.80	4.24	6.18	7.15	4.47	3.77	3.62	3.85
	Trans-2-hexenal	7.62	11.24	11.08	20.40	18.68	14.27	5.35	3.89
	Linalool oxide I	29.04	5.39	21.65	5.96	23.57	5.29	118.12	15.64
4th	Linalool oxide II	110.59	20.47	107.94	25.76	117.15	24.49	457.26	40.96
week	Linalool	329.58	558.82	115.58	98.44	114.59	68.20	97.98	50.35
	Methyl salicylate	56.69	170.55	102.04	91.28	102.47	72.46	151.27	105.86
	Nerolidol	18.03	19.74	18.11	15.38	18.29	13.27	29.16	10.57
	Trans-2-hexenal	1.94	1.73	8.22	3.37	8.03	6.53	1.10	2.85
	Linalool oxide I	9.51	2.20	10.95	1.54	11.00	3.50	26.36	16.33
5th	Linalool oxide II	35.66	5.79	48.65	5.63	49.45	13.01	99.95	41.93
week	Linalool	128.41	76.08	60.63	16.33	58.99	32.03	26.48	40.99
	Methyl salicylate	17.49	32.89	38.71	17.93	41.00	39.75	14.44	102.84
	Nerolidol	1.91	4.48	6.63	3.85	5.22	5.91	3.51	4.47
	Trans-2-hexenal	0.84	3.82	3.36	2.47	6.10	6.75	1.91	1.33
	Linalool oxide I	3.01	4.35	5.36	2.13	9.28	2.66	31.66	8.91
6th	Linalool oxide II	11.58	11.25	24.71	8.28	42.54	9.37	123.53	24.14
week	Linalool	34.10	117.68	23.27	20.92	42.66	21.88	32.18	19.13
	Methyl salicylate	6.83	51.56	16.84	31.44	28.02	30.05	14.79	52.94
	Nerolidol	0.98	6.49	2.47	8.10	5.42	5.15	3.45	3.32
	Trans-2-hexenal	1.70	3.40	3.62	11.19	5.30	6.21	2.09	1.06
	Linalool oxide I	7.69	3.20	5.29	5.14	7.04	3.42	32.93	7.06
7th	Linalool oxide II	32.34	7.21	24.83	18.66	32.73	12.09	127.07	18.54
week	Linalool	91.65	86.31	29.65	31.22	29.77	29.18	25.00	14.96
	Methyl salicylate	17.05	34.26	20.64	50.08	27.91	40.20	22.14	45.96
	Nerolidol	3.80	4.49	2.51	9.00	3.82	6.41	3.19	2.25

It is apparent that in both clones (except for TRI 2023 in the first week) the levels of linalool is higher in the bud compared to the levels in the other parts of the flush. It was also observed that in general, the level of linalool in the flush is greater in clone DT 1 than in clone TRI 2025. In both clones, the highest level of linalool was found during the 4th week since commencement of this study.

Linalool oxide I and linalool oxide II are furanoid hydroxy ethers which are believed to be derived from linalool (Ohloff, Flament and Pickenhagen, 1985) (Fig. 1)

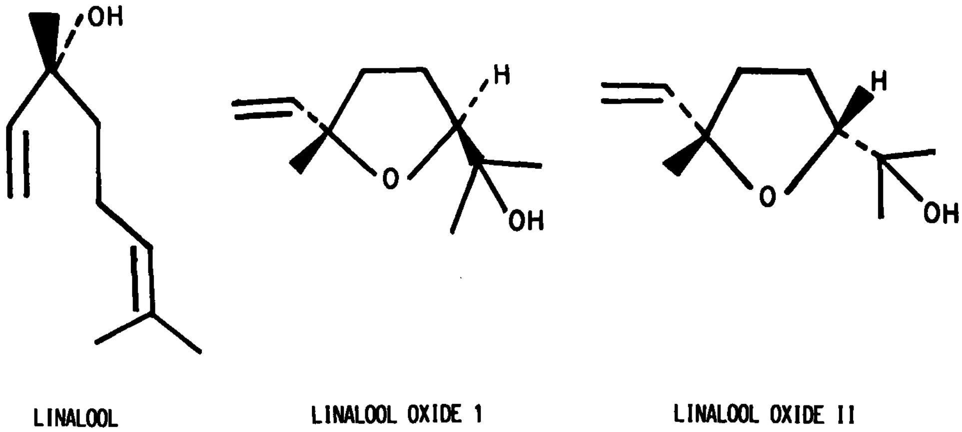

Fig. 1 – Structure of linalool, linalool oxide I and linalool oxide II

Throughout the period of the experiment, the levels of both oxides in the flush were higher in clone DT 1 than in clone TRI 2025. In the analysis of the components of the flush it was noted that except in the first week the highest levels of both the above flavours were found in the stalk from the second week onwards. As seen with the levels of linalool the highest levels of oxides were also observed during the 4th week of commencement of the study.

Though a general trend of higher levels of methyl salicylate was seen in clone DT 1 in the first few weeks of this study, a consistent trend was not seen during the later stages.

Unlike the other volatiles, in both clones, nerolidol was fairly uniformly distributed in all components of the flush. In general, the level of this compound was relatively low in contrast to the levels of the others. The highest level of this compound too was seen at the 4th week since commencement of this study, as in the case of the other volatiles.

The present study reveals that the level of *trans*–2–hexenal was generally lower in the stalk in both clones under investigation. The overall level of *trans*–2–hexenal was higher in TRI 2025 than in DT 1.

TABLE 2 – *Average percentage of theaflavins (TF) and thearubigins (TR) in component of flush.*

	DT 1		TRI 2025	
	TF	TR	TF	TR
Bud	0.72	4.29	0.34	3.89
1st leaf	1.04	13.79	0.67	12.39
2nd leaf	0.95	13.16	0.68	12.23
Stalk	1.50	7.35	1.14	8.24

Table 2 presents the mean values of the levels of theaflavins (TF) and Thearubigins (TR) in different parts of the flush when manufactured separately. The values indicate that the level of TF in the bud of clone TRI 2025 was relatively less than the level in the bud of clone DT 1 while the levels of TR was less in the buds of both clones compared to the levels in the other parts of the flush. Liquors obtained in this instance were found to be thin in their organoleptic character. On the other hand in both clones the stalk had a high level of TF.

The levels of TF and TR in the 1st and 2nd leaf of DT 1 was well balanced. However the overall mouthfeel with the liquors in this instance was rather plain. In this respect clone TRI 2025 was different to that of clone DT 1. Although the level of TR was within acceptable limits the level of TF both in the 1st and the 2nd leaf was low. The liquors had a muddy character.

DISCUSSION

The flavour pattern in the present study reveals that irrespective of the part of the flush that was being analysed the highest levels of the flavours were detected during the 4th week since the initiation of the experiment. On the other hand the seasonal flavours in the teas under investigation were noticed only after a prolonged delay compared to the previous years. The weather data of this period reveals that unlike previous years, during 1989 the flavour season did settle in the Up Country only after a prolonged period of uncertain weather conditions. Therefore as against the preceding years there was a delay of nearly one month for the flavour season to settle in the Dimbulla region during this year.

The conditions that induce the development of flavours during the season include dry hot day temperatures and cold windy nights. These stress conditions are known to partially desiccate the leaf and thus affect the closure of stomata. This results in the shifting of the site of biosynthesis of certain compounds from within the chloroplast of the tea leaf cell to a site outside the chloroplast (Wickramasinghe, 1978). This shift is believed to accentuate the formation of certain volatiles leading to the development of the seasonal flavour character. Although the above shift also enhanced the levels of certain undesirable volatiles appears to neutralise the effect of the former.

With the onset of the flavour season a period of 2-3 weeks has to lapse prior to the appearance of the seasonal flavour characteristics. It is believed that the above period is taken up to reorient the pathways of the biochemical reactions which are instrumental in the production of these flavours. In this study there is in all probability circumstantial evidence that indicate that the period of commencement of the investigation would have broadly coincided with the initiation of the flavour season in the Up Country. This may explain the initial progressive build-up of the levels of the volatiles which peaked 4 weeks later. However, it is to be noted that the levels of the flavours decreased in all parts of the flush by the 6th week with the onset of rainy weather as it is known that such a situation causes the factors that influence the development of seasonal flavours to revert to pre-flavour conditions. This occurs due to relocation of the biochemical reactions to the original site which is within the chloroplast.

In this study a comparative analysis was done of the levels of flavours in different parts of the flush in two clones (Table 1). From an organoleptic point of view, linalool is considered to possess a very desirable flavour and is relatively intense in its aroma on a w/w basis compared to the other flavours found in the aroma complex of black tea and its relative amounts in the flush plays a key role in the determination of the overall aroma of a specific tea and hence the quality. Though the aroma of linalool oxides are considered to be quite desirable, the aroma of linalool is found to be superior to both these derivatives. In both clones, methyl salicylate showed random variation in the different parts of the flush and this behaviour is only imperfectly understood. Nerolidole is a desirable flavour described as flowery in its aromatic property. It is to be noted that though *trans*–2–hexenal is considered an undesirable volatile its formation during black tea manufacture is inevitable (Yamanishi *et al.*, 1966).

The determination of the soluble solids from the components of the flush indicated that liquors obtained from no single part of the flush inherited the total cup quality as found in a desirable tea (Table 2). This observation is substantiated by the fact that in both clones, the liquors made from the entire flush possessed all the desirable characters which indicate that the contribution from all parts of the tea flush is a prerequisite in making a tea with a well round character.

In both clones, the levels of flavours in the different components of the flush varied according to the individual component. This suggests the likelihood that the biosynthetic apparatus involved in the synthesis of the volatiles are located in different parts of the flush in varying levels. Of course, it is also likely that they are synthesised in a particular region of the flush and transported to the components in varying levels. This aspect merits further study.

The results of this study lends credence to the conclusion that clone DT 1 is a superior quality clone compared to clone TRI 2025 (Tables 1 and 2). This is supported by the fact that over the period of this study the levels of the volatiles determined were largely greater in clone DT 1 than in clone TRI 2025. In particular, the levels of the two linalool oxides were predominantly large in DT 1, while the level of linalool too was high in this clone. It is also to be noted that the overall level of the undesirable volatile, *trans*–2–hexenal was higher in clone TRI 2025 while it was relatively less in clone DT 1. It is also to be mentioned that contrary to the established belief that the quality of TRI 2025 is low, the overall aroma prófile along with tasters' observations indicate that clone TRI 2025 is a medium quality clone.

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