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AN INDEX FOR ASSESSING THE QUALITY OF UVA SEASONAL BLACK TEA *

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Studies of the methylene chloride extractable steam volatiles of seasonal black teas from Uva district showed that pentanal, (E)-2-hexenal, (Z)-3-hexenyl acetate, (Z)-3-hexenol, linalool oxide I, linalool oxide II, linalool, phenyl-acetaldehyde, (Z)-3-hexenyl hexanoate, nerol, methyl salicylate, geraniol, B-ionone/cisjasmone, nerolidol and indole are the main flavour contributing constituents found in the aroma complex.

Analysis of the flavour profiles of teas obtained during the Uva flavour season from several estates in the Uva revealed the existence of a correlation between linalool/(E)-2-hexenal ratio and the prices they fetched at the tea auctions. The significance of employing this index in assessing the quality of seasonal teas from Sri Lanka is discussed.

INTRODUCTION

Sri Lankan teas are renowned the world over mainly for its flavour characteristics. In particular, the teas grown in the Western (Dimbulla District) and Uva regions produce a tea with a distinct flavour during January to April and July to September respectively for which high prices are realised. These months are characterised by dessicating winds, cold nights and hot day temperatures which are said to shift the site of biosynthesis of certain volatiles from within the chloroplast to a location outside the chloroplast of the tea leaf cell (Wickremasinghe, 1978). This shift, in effect, is assumed to accentuate the formation of certain desirable volatiles that contribute to the overall aroma of black tea. To preserve flavours that are formed and to further heighten any underlying flavour characteristics in made tea, manufacturing conditions are altered during this season (Yamanishi *et al.*, 1966); these conditions include shorter withering period, rolling time and fermentation.

Much work on the aroma complex of tea has been done and a comprehensive treatise on this subject reviewed (Yamanishi, 1975). Analysis of the flavour profile of Sri Lankan seasonal black teas have revealed the presence of over 300 compounds

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in the volatile fraction. Of these, pentanal, (E)-2-hexenal, (Z)-3-hexenyl acetate (Z)-3-hexenol, linalool oxide II, linalool, phenylacetaldehyde, (Z)-3-hexenyl hexanoate, nerol, methyl salicylate, geraniol, B-ionone/cis-jasmone, nerolidol and indole are the major compounds that contribute to overall flavour in black tea. Except (E)-2-hexenal the rest of the fourteen compounds have a desirable effect on the overall aroma of black tea (Wickremasinghe, Wick and Yamanishi, 1973).

In spite of the volume of work done on the aroma complex of tea no relation as yet, been shown between the flavour compounds in tea and the commodity prices realised for such teas. This study is an attempt to develop an index to assess the quality of Sri Lankan seasonal black teas by analysing the flavour profiles of teas processed in the Uva region and the prices fetched by them.

The term quality is not well defined in tea biochemistry. While some tend to correlate quality to the level of theaflavins, others tend to relate this term to flavour yet others use a combination of both theaflavins and flavour to connote quality. In this study the term quality refers to flavour. In whichever sense it is used, quality of tea is objectively assessed only in terms of the price the tea fetches, a tea with a higher flavour index (during the flavour season) would fetch a higher price compared to a tea with a lower flavour profile.

EXPERIMENTAL

Black tea samples (250 g) of different grades (BOP, BOPF and PEKOE) of tea were collected during the Uva flavour season from six estates of the Malwatte region (Uva Highlands, Wewessa, Attampitiya, Neluwa, Aislaby and Chelsea) of Uva. The volatiles from the above samples were extracted using simultaneous distillation and extraction (SDE) procedure. A schematic diagram of this appartus is shown in Fig. 1.

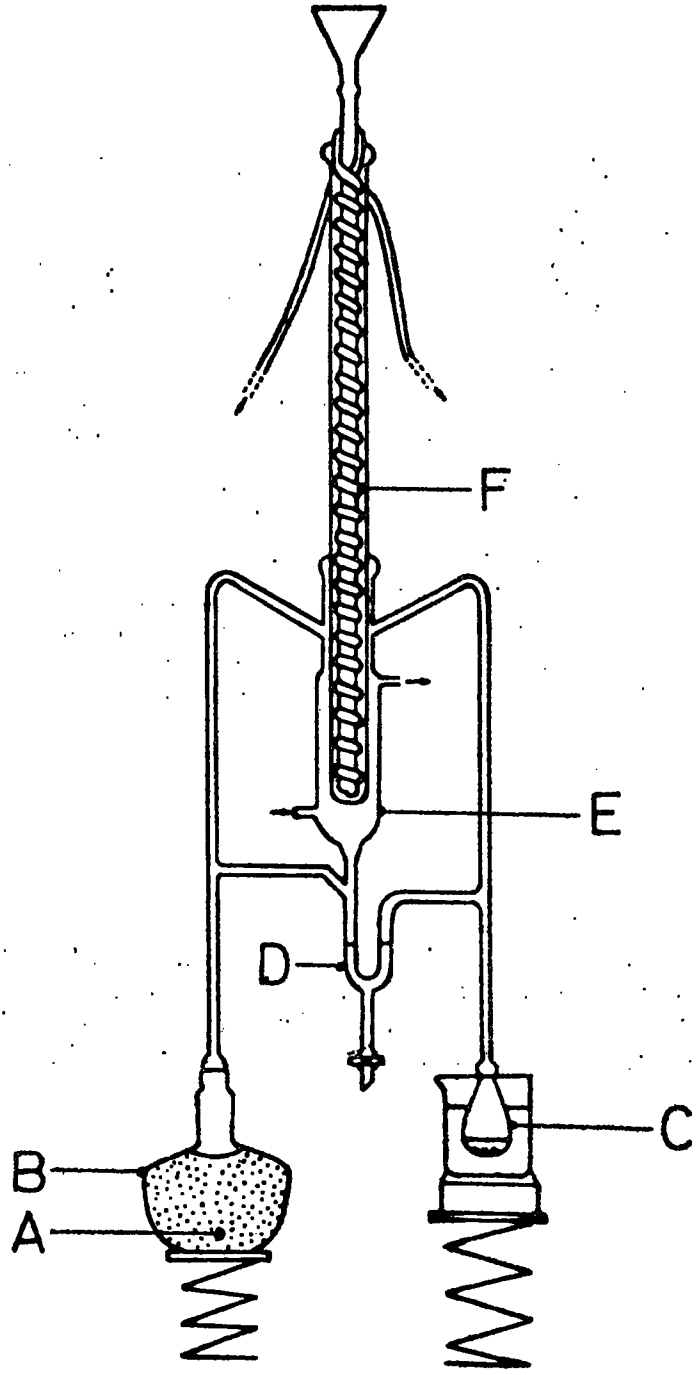

Fig. 1 — Schematic diagram of the Simultaneous Distillation and Extraction (SDE) apparatus.

A. Round bottom flask with 20g of the black tea sample and 250 ml distilled water at 60°C.
B. Heated mantle at 100°C.
C. Flask with 20 ml methylene chloride and glass beads.
D. U-tube with 10 ml methylene chloride.
E. Condenser I.
F. Condenser II

Simultaneous Distillation and Extraction Procedure

A sample (20 g) of black tea was placed in a single neck round bottom flask (500 ml) and covered with distilled water (250 ml) at 60°C. This was placed in a heated mantle (100°C) and linked to one arm of the SDE apparatus, whilst a small flask (50 ml) which contained 20 ml methylene chloride at 40°C (in a water bath) was simultaneously connected to the other arm of the apparatus. Along with the above connections a small volume of methylene chloride (10 ml) was added into the U-tube located in the middle of the apparatus. Distillation was limited to one hour. The condensate of methylene chloride was dried with anhydrous sodium sulphate (2.5 g) for a further period of one hour and concentrated to a known volume (10 µl). A small aliquot (0.4 µl) of this concentrate was injected to a pre-programmed gas chromatograph (GC).

Analysis of the flavours using the GC and Theaflavin analysis

The flavour analysis was carried out using a Varian model 3400 Gas chromatograph fitted with a stainless steel packed column (200 cm x 0.31 cm O.D.), which contained 15 % FFAP on 80-100 mesh WAW chromosorb. A temperature program was used (60° - 190°C) at a rate of increase of 1°C per min. The carrier gas was argon and the compounds separated were detected using a flame ionization detector (FID). The injector temperature was 200°C whilst the detector temperature was 250°C.

Theaflavins (TF) were estimated using the flavagnost reagent (Brit. Pat., 1966).

RESULTS AND DISCUSSION

At the time of this investigation the weather pattern in the Uva region during the months of July to September was consistent and hence the flavours formed in the teas under analysis were considered typical of the well known Uva season (altered weather conditions are known to upset the seasonal flavour formation).

In the present study the extraction of flavours from black tea was obtained using the SDE procedure which was different to the ether extraction method used in the past in this laboratory. In the earlier method (Yamanishi, Wickremasinghe and Perera, 1978), difficulties in the extraction of volatiles and loss of flavours due to poor miscibility (between ether and volatiles) in the liquid phase, occasionally gave rise to unreproducible results. However, the present method was free of the above drawbacks.

A typical chromatogram of black tea aroma is shown in Fig. 2. Of the more than 300 volatile compounds found in the aroma complex, fifteen volatiles that mainly contribute to the aroma of black tea were computed to interpret the results in relation to the quality of Uva seasonal teas under investigation.

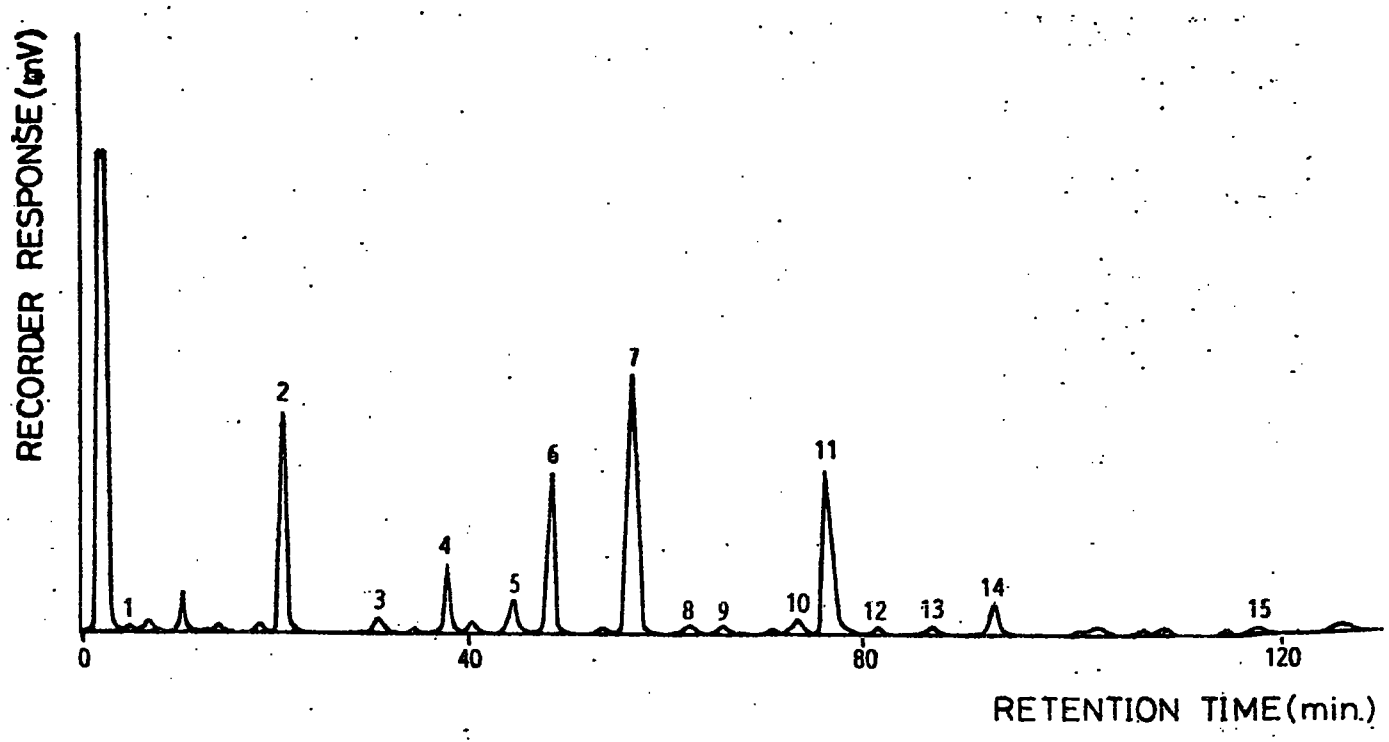

Fig. 2 — A typical gas chromatogram of the flavour profile of black tea manufactured during the Uva flavoury season.

1. *Pentanal* 2. *(E)–2-hexenal* 3. *(Z)-3-hexenyl acetate*
4. *(Z)-3-hexenol* 5. *linalool oxide I* 6. *linalool oxide II*
7. *linalool* 8. *phenyl acetaldehyde* 9. *(Z)-3-hexenyl hexanoate*
10. *nerol* 11. *methyl salicylate* 12. *geraniol*
13. *B ionone/cis-jasmone* 14. *nerolidol* 15. *indole*

In the past, many attempts have been made to find a chemical parameter that could be used in assessing the quality of black tea (Fernando and Roberts, 1984). Theaflavins had been one such parameter, but it had been observed that the values obtained for theaflavins (as opposed to the quality) often deviated from the expected behaviour (teas of good quality is considered to have a high level of theaflavins). Thearubigins on the other hand was not used as a parameter owing to the heterogeneous and the complex nature of this group of compounds.

The results of the present study reveal that of the quantities of flavours corresponding to the 15 peaks obtained, the quantities corresponding to 13 peaks showed no significant change in their amounts with different samples. Hence, although from an organoleptic point of view these 13 compounds were important, their steady behaviour from sample to sample restricted their use as an index against quality of teas under investigation.

However, in the case of linalool and (E)-2-hexenal rapid variation in their levels were observed with different samples. Observations made on the basis of the data from the gas chromatograms in the above samples revealed the existence of a direct relationship between the ratio of linalool/(E)-2-hexenal and the prices the respective teas obtained at the auctions: higher the value of the above ratio, higher was the price the respective tea obtained at the auctions (Table 1*a*,*b*,*c*.). In this instance it should be noted that, while linalool positively contributes to the aroma of tea, (E)-2-hexenal has a negative effect. Thus the above ratio indicates that if a specific tea has more desirable aroma it would fetch a higher price at the tea auctions. Although such a relationship is to be expected no direct relationship has so far been shown.

TABLE I *a* — *Quality parameters of black tea grades obtained from Uva Highlands and Wewessa during the flavour season.*

Estate	*Uva Highlands (JEDB)*				*Wewessa (JEDB)*	
Grade	BOP	BOP	BOP	BOP	BOP	BOPF
Date of manufacture	3.7.87	15.7.87	20.7.87	3.8.87	3.7.87	4.8.87
Price (Rs.)	100.00	242.00	172.00	200.00	201.00	175.00
TF Comma moles g^{-1})	5.1	5.9	4.9	7.9	7.4	7.6
(E)-2-hexenal (peak area %)	9.2802	8.3748	10.3498	9.9841	7.8291	8.7647
Linalool (peak area %)	13.4704	12.9155	13.0348	10.4373	11.1987	10.6747
Quality Index $\rightarrow \frac{\text{Linalool}}{\text{(E)-2-hexenal}}$	1.451	1.542	1.259	1.045	1.430	1.218

TABLE 1 *b* — *Quality parameters of black tea grades obtained from Aislaby and Chelsea during the flavour season*

Estate	*Aislaby (SLSPC)*			*Chelsea (SLSPC)*	
Grade	PEKOE	BOP	BOP	PEKOE	BOPF
Date of manufacture	8.7.87	13.8.87	29.8.87	4.7.87	26.8.87
Price (Rs.)	167.00	301.00	108.00	170.00	134.00
TF Comma moles g^{-1})	5.1	7.7	9.6	5.5	8.9
(E)-2-hexenal (peak area %)	6.7214	5.6583	8.5078	7.2466	7.1951
Linalool (peak area %)	10.1543	9.5731	12.6617	10.9534	7.8098
Quality Index $\longrightarrow$ $\frac{\text{Linalool}}{\text{(E)-2-hexenal}}$	1.511	1.692	1.474	1.512	1.085

TABLE I c — *Quality parameters of black tea grades obtained from Attampitiya and Neluwa during the flavour season.*

Estate	*Attampitiya (JEDB)*					*Neluwa (JEDB)*			
Grade	PEKOE	BOP	BOP	BOPF	BOP	BOP	BOP	BOPF	BOPF
Date of manufacture	6.7.87	7.7.87	22.7.87	11.8.87	4.8.87	11.8.87	15.8.87	7.8.87	15.8.87
Price (Rs.)	150.00	200.00	100.00	150.00		150.00	250.00	150.00	200.00
TF Comma moles g^{-1})	6.6	7.8	8.1	7.2	6.7	7.4	7.5	8.2	7.6
(E)-2-hexenal (peak area %) ...	8.7038	13.5638	10.7275	7.9095	7.4904	9.6967	6.3455	9.3609	6.1929
Linalool (peak area %) ...	11.0434	10.9138	9.4644	7.7143	10.3159	12.5811	8.9664	9.6804	6.0905
Quality Index → $\frac{\text{Linalool}}{\text{(E)-2-hexenal}}$	1.269	0.805	0.882	0.977	1.377	1.297	1.413	1.034	0.983

It is to be noted that in certain instances, theaflavins could contribute (as in the case of teas from Uva Highlands estate) to the overall determination of quality as assessed by the prices they obtain at the tea auctions. However, such instances being relatively rare during the flavour seasons, it is proposed that the above ratio may be used as a reliable index in assessing the quality of seasonal teas of Sri Lanka.

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REFERENCES

BRIT, PAT, 1034, 670 (June 29, 1966) to Nestles products Ltd.

FERNANDO, V. and ROBERTS, G. R. (1984). The effect of process parameters on seasonal development of flavour in black tea. *J. Sci. Food, Agri.* **35**, 71-76.

WICKREMASINGHE, R. L. (1978). Facets of Tea Research in practice. Monographs on tea production in Sri Lanka No. 7 Tea Research Institute of Sri Lanka.

WICKREMASINGHE, R. L., WICK, E. L. and YAMANISHI, T. (1973), Gas Chromatograpic Mass Spectroscopic analysis of flavoury and non-flavoury Ceylon black tea aroma concentrates prepared by two different methods: J. *Chromatogr*, **79**, 75-80.

YAMANISHI, T. (1975). Tea Aroma. Nippon Nogei Kagaku Kaishi, **49**, 1-9.

YAMANISHI, T., KOBOYASHI, A., SATE, A., NAKAMARA, K., MORI, S. and SAIJO, R. (1966). Flavours of black tea, Part IV, Changes in flavour constituents during the manufacture of Black tea *Agri. Biol. Chem.* **30**, 784-792.

YAMANISHI, T., WICKREMASINGHE, R. L. and PERERA, K. P. W. C. (1978). Studies on the flavour and quality of tea in Gas Chromatograpic analysis of the aroma complex. *Tea Q.* **39**, 81-86.