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Studies on the *Pinus* Species Growing in Sri Lankan Plantations IV. Composition of Oleoresin and Turpentine of *Pinus patula* and *Pinus caribaea* of the Kottawa plantation.

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Abstract : Both the *Pinus patula* plantation at Nuwara Eliya and the *Pinus caribaea* (var. Hondurensis) plantation at Kottawa, Galle, produce low oleoresin yields; only 10%–20% of the plants producing> 10 g per tapping day. Turpentine content was also low with mean values of 15.2% and 12.6% being recorded for *P. patula* and *P. caribaea* respectively. The major component of *P. patula* turpentine was β—phellandrene (70%), the next largest component being longifolene (12%). The α—pinene levels of *P. caribaea* of Kottawa plantations were relatively low (55%), with β—phellandrene being relatively high for this species in Sri Lanka (26%). The composition of turpentine of *Pinus montezumae* (69% β—phellandrene) and *Pinus insularis* (97% α—pinene) growing under Sri Lankan conditions was also studied.

1. Introduction

The bulk of the *Pinus* plantations of Sri Lanka are located in the Central Province (between 1000 and 1700 m elevation). Nearly all of this comprises *Pinus caribaea*.[2] However, this species is not restricted to the Central Province but is also found on smaller plantations in other parts of the island; the plantation at Kottawa (Galle District) being one such example. Having previously reported detailed studies on the oleoresin of *P. caribaea* of the 'Up-country' region[3,4,6] (Erabedde, Welimada) similar studies on the *P. caribaea* grown in the 'Low country' are now reported.

Studies on *Pinus patula* are also reported here. *P. patula* is a Mexican pine which grows well only under cool and humid conditions, usually at elevations > 1600 m. This pine has been grown in Nuwara Eliya for some years and is commonly known in Sri Lanka as the Nuwara Eliya pine. The acreage under *P. patula* in the country is of the order of 5,000 acres.[2] Very little data on this oleoresin pine is available in the literature,[7] probably due to the low commercial value of the plant. Also reported here is the turpentine composition of *Pinus montezumae* (another pine of Mexican origin) and that of the Philipine pine *Pinus insularis;* the latter being reported previously for high α—Pinene content.[8]

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2. Experimental

2.1. Plantations. The forests used for this study were the Kandepola (Nuwara Eliya) plantation for *P. patula* and the Kottawa (Galle) plantation for *P. caribaea*, var Hondurensis.

2.2. Tapping. Tapping of trees was carried out by the open-face, V-cut method as described previously.[3] Oleoresin yield was calculated over a tapping cycle comprising 3 tapping days; tapping being carried out every other day.

2.3. Separation of Turpentine. Turpentine was isolated by water distillation by the method described previously.[6]

2.4. Analysis of Turpentine Composition. Turpentine composition was determined by gas liquid chromatography. A Varian Aerograph Moduline Model 1700 Gas liquid chromatograph was used. Operating conditions were as reported previously.[4]

3. Results

3.1. Yield of Oleoresin. Yields of oleoresin of both plantations that were tested were low; only 10%-20% of the trees yielding significant quantities (> 5g/day) of oleoresin. However, seasonal fluctuations in oleoresin yield were not investigated.

3.2. Turpentine content of Oleoresin. The turpentine content of both species was low; mean values of 12.6% and 15.2% being shown by *P. caribaea* and *P. patula* respectively. Further variations between trees were observed.

It was also noted that turpentine content also declined from day to day in the tapping cycle.

3.3. Turpentine Composition.

3.3.1. *P. caribaea.* The major component was α- pinene. However, mean α- pinene levels (56%) were significantly lower than that in the turpentine of *P. caribaea* of the Erabedde plantation (79%). β- phellandrene content (26%) was relatively high and this was the only other component present in significant quantity (Table 1). The other point of variance with the Erabedde turpentine was low longifolene levels. α- pinene and β- phellandrene levels in this plantation were very similar to that in data quoted in the literature for *P. caribaea* Hondurensis. [1,5,9]

3.3.2. *P. patula.* The turpentine composition of *P. patula* (Nuwara Eliya) was very similar to analyses reported previously in the literature[7] and shows characteristic high levels of β- phellandrene (70%) and longifolene (12%) and low levels of α- pinene (Table 1). Like in the case of *P. caribaea* there was considerable variation in composition of turpentine when individual trees are considered (Table 2).

TABLE 1. Mean Turpentine Composition of 4 Species of Pinus

Component	Retention time (sec)	Percentage			
		P. patula	*P. caribaea*	*P. montezumae*	*P. insularis*
αpinene	192	4.03	56.8	27.0	97.4
Camphene	252	0.28	0.94	0.28	0.42
βpinene	300	0.22	7.97	0.63	0.53
Sabinene	288	0.57	—	—	—
Limonene	456	—	0.85	—	—
α-phellandrene	384	1.07	1.19	0.65	0.18
myrcene	360	0.65	—	—	—
trans-ocimene	564	0.19	—	1.67	0.12
β-phellandrene	480	70.4	26.1	68.8	0.97
α-terpenene	624	0.13	—	0.16	—
P-cymene	660	0.65	0.10	0.89	—
Unidentified	1248	1.47	—	—	—
Unidentified	1308	0.46	—	—	—
Camphor	1356	1.01	—	—	—
Longifolene	1404	12.2	trace	—	—
Caryophyllene	1488	1.01	3.33	—	—
Methylchavicol	1704	0.20	—	—	—
αterpeneol	1584	0.93	—	—	—
Geranylacetate	1934	0.78	—	—	—
Unidentified	2064	0.61	1.34	—	—
Unidentified	2280	1.21	—	—	—

TABLE 2. Variation in Turpentine Content of Individual Plants

	P. patula					*P. caribaea*			
Code No.	35	38	44	45	47	14	18	19	20
Component									
α-pinene	3.22	2.78	3.79	3.01	5.24	53.2	36.9	62.6	78.4
β-pinene	0.12	0.18	0.31	0.30	0.28	3.0	2.6	3.2	8.0
β-phellandrene	83.0	62.3	75.9	53.2	87.6	31.1	53.3	20.7	2.5
Longifolene	7.7	25.5	4.1	21.8	2.1	—	—	—	0.2

Trees 35, 47, 14, 18 and 19 gave relatively high oleoresin yields while the remaining trees were poorer oleoresin yields. The results reported are selected to illustrate the type of variation observed. Only the components of interest are given.

3.3.3. *Other Pines.* The turpentine of two other species of pines that grow well in Sri Lanka were also analysed for volatile constituents. They were: *P. insularis* (from Nuwara Eliya) and *P. montezumae* (from Welimada). Investigations showed that *P.insularis* contains a very high α– pinene content (Table 2) while *P. montezumae* yielded a turpentine rich in β– phellandrene with α– pinene being the second major component.

4. Discussion

This investigation revealed that the main components of the turpentine of all species studied were identical to the normal constituents of pine gum turpentine. Due to the above reason, the separation of individual components and their identification by spectroscopic and other methods were not considered vital and as a result identifications were confined to retention time and peak enrichment data.

In previous studies we reported [3, 4, 6] in detail, investigation carried out on the *P. caribaea* plantations at Erabedde. This study showed that the *P. caribaea* oleoresin from the plantation at Kottawa differed markedly from the one at Erabedde in the following respects (i) Oleoresin yields appeared to be lower (ii) Turpentine content of oleoresin was lower (iii) α – Pinene content was lower and (iv) β-phellandrene content higher.

Several factors could be responsible for these differences. (i) The original seed stock for these two plantations being obtained from a different provenance. (ii) Environmental differences between Kottawa (Galle) and Erabedde (Welimada) (iii) The maturity of the trees (vi) Seasonal variations.

The maturity of the trees could be of significance as although the trees were the regulation 8 years of age (and therefore considered fit for tapping) their vegetative development was less than expected; the average girth of the trees being around 60cm. It is possible that the low yield of oleoresin was due to insufficient vegetative growth. Further, it has been shown that oleoresin flow is affected by seasonal variation[3] and it is possible that better yields of oleoresin could be obtained from this plantation at more 'favourable' times of the year. It is intended to study this aspect of oleoresin yield in detail when the trees of this plantation have doubled in girth.

Turpentine content of the oleoresin is also lower than at Erabedde but as tapping was done by the open-face method, this could be partly due to an artifact caused by climatic factors.

Turpentine composition was of more significance for while the α – pinene (56%) and β-phellandrene (26%) content was very similar to data quoted in the literature[1,5,9] it was very unlike the Erabedde turpentine which contains high (80%) α – pinene levels. As a result, this turpentine is of lower commercial value. It appears that the commercial value of the Kottawa plantation for oleoresin-based industries is not very promising.

The *P. patula* plantation also yields low oleoresin although the trees were over 110 cm in girth. Here again, this could be due to seasonal variation. However, further studies were not carried out as the turpentine quantity was low, the oil containing high sesquiterpene content. The composition of turpentine was very similar to that previously reported for the species.[7] The reported[7] sweet smell the turpentine of this species (also observed in this study) is probably due to the small amounts of camphor and geranylacetate present in the oil.

P. montezumae and *P. insularis* are not grown on a commercial scale in this country. The composition of turpentine is reported merely for interest and has low significance as only a single tree each was used for the analyses.

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