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Short communication

ESSENTIAL OILS OF RESINS FROM THREE *PINUS* SPECIES GROWING IN ETHIOPIA AND UGANDA

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ABSTRACT: The chemical composition of the hydro-distillates obtained from resins of *Pinus caribaea*, *P. radiata* and *P. patula* growing in Ethiopia and *P. caribaea* from Uganda, were investigated by GC and GC-MS. Twenty compounds were identified representing *ca* 92–99% of the total oil. The only major constituent of *P. caribaea* of Uganda was α-pinene (87%) whereas α-pinene and bornyl acetate, together accounted for 70.8% of the same oil obtained from Ethiopia. α-Pinene and β-pinene were identified as the major constituents of *P. radiata* oil. *P. patula* oil is characterized by large amount of α-farnesene (33.2%).

Key words/phrases: Essential oil, *Pinaceae*, *Pinus caribaea*, *Pinus radiata*, *Pinus patula*

INTRODUCTION

Pinus caribaea Morelet is a tropical pine tree native to the Caribbean and Central America. The plant has been introduced into many parts of the world including several countries in Africa. The species is further subdivided into three varieties namely *P. caribaea* var. *caribaea*, *P. caribaea* var. *bahamensis* and *P. caribaea* var. *hondurensis* (Coppen *et al.*, 1993). Analysis of resin samples from the three varieties of this species growing in Zimbabwe (Coppen

et al., 1993) showed that α-pinene and β-phellandrene were the major constituents accounting for 80–90% of the volatile (turpentine) part. The turpentine and rosin oils from other *Pinus* species have also been studied (Banthorpe *et al.*, 1984; Coppen, *et al.*, 1988).

Pinus patula is probably one of the most widely planted pine trees in agro-forestry projects in tropical Africa. Although it grows best when water supply is good, it can also survive adverse conditions. *Pinus radiata* is now widely introduced in Ethiopia in moist agroclimatic zones of Shewa, Kefa and Arsi regions (Bekele Tesemma *et al.*, 1993).

This paper reports the results of analyses of the volatile components of *P. caribaea* (variety not known) growing in Ethiopia and Uganda and also *P. radiata* and *P. patula* from Ethiopia.

MATERIALS AND METHODS

Sample collection

In Ethiopia, the gum resins of the three *Pinus* species were collected from identified trees growing in the Arboretum of the Wondo Genet College of Forestry (WGCF). Specimens were deposited at the National Herbarium, Addis Ababa University under the cipher number *P. patula* S1023 (Herbarium No. 073227), *P. caribaea* S1024 (Herbarium No. 073226) and *P. radiata* S1025 (Herbarium No. 073228) (Table 1). *Pinus caribaea* was also collected from Katugo plantation, Uganda, where the tree was identified by Mr David Afasimana of Forest Department, Ministry of Natural Resources, Uganda.

Table 1. Data on collection of the resins from *Pinus* trees of Ethiopia.

Name	No. of trees tapped	Wounded on	Collected on	Planting year
Pinus Caribaea	10	April 4, 1998	April 10, 1998	1983
Pinus patula	20	April 4, 1998	April 10, 1998	1979
Pinus radiata	30	April 4, 1998	April 10, 1998	1981

Isolation of essential oils

The essential oils were obtained by hydrodistillation of the gum resins for 3 h in a Clevenger-type apparatus. The essential oil yields (w/w, from gum resin) are given in Table 2.

Table 2. Chemical composition (%) of the essential oils obtained from the gum resins of three *Pinus* species collected from Uganda and Ethiopia.

Components	*P. caribaea*		*P. patula*	*P. radiata*	Conformation
	Uganda	Ethiopia	Ethiopia	Ethiopia	
α-pinene	87.0	50.7	5.3	38.6	PE, NMR
camphene	0.9	2.0	t	1.9	PE
β-pinene	t	8.2	2.4	44.5	PE
myrcene	3.4	–	–	–	PE
α-phellandrene	–	–	1.6	–	
limonene	0.8	1.2	6.5	1.7	PE
β-phellandrene	t	8.9	10.2	1.4	
p-cymene	–	–	5.2	–	
γ-terpinene	–	–	0.8	–	PE
terpinolene	–	–	2.6	–	
longipinene	0.3	1.7	5.3	–	
linalool	1.5	–	t	–	PE
pinocarveol	–	1.1	1.5	3.8	
4-terpineol	–	–	5.5	–	
α-terpineol	0.4	–	–	3.5	PE
anisole, *p*-allyl	3.5	3.6	3.6	–	
longicyclene	–	–	3.6	–	
(+)-sativene	1.2	–	2.7	–	
bornyl acetate	–	20.1	2.0	–	
α-farnesene	–	–	33.2	–	
Total % of components identified	99.0	97.5	92.0	95.4	
Yield of oil (%,w/w from resin)	15.0	2.5	0.6	3.3	

Components are arranged in order of their elution from DB-17 capillary column; PE, peak enhancement; nmr, ^{13}C-NMR; t, trace (< 0.1%).

GC and GC-MS analysis

The composition of the essential oils of all resins was analyzed by GC and GC-MS. GC was performed on Hewlett-Packard HP6890 GC series using HP-5 fused silica capillary column (30 m × 0.32 mm i.d.). The oven was programmed at 50–210° C at the rate of 3° C min^{-1} using N_2 as carrier gas, injector and detector (FID) temperatures were 220° C and 270° C, respectively. GC-MS was performed on Fisons GC model 8000 series coupled to MD 800 mass selective detector operating at 70 eV. The capillary column type was DB-17 (30 m × 0.25 mm i.d), Helium was used as carrier gas and GC parameters were the same as above. The constituents were identified by matching their mass spectra with NIST and Wiley databases and further confirmed by peak enhancement, GC retention times and in the case of α-pinene by ^{13}C-NMR measurement, recorded on a Joel FX 90Q instrument at 22.5 MHz using $CDCl_3$ as solvent.

RESULTS AND DISCUSSION

Hydrodistillation of the resin of *P. caribaea* from Uganda gave the volatile (turpentine) oil with α-pinene (87%) as the major component. On the other hand α-pinene and bornyl acetate, together accounted for 70.8% of the oil of *P. caribaea* from Ethiopia. In addition, *P. caribaea* from Ethiopia, contains β-phellandrene (8.9%). As shown in Table 2, a total of twenty compounds were identified from the three *Pinus* species by GC-MS. Previous reports in the literature by Coppen *et al.* (1993) indicated α-pinene (20-67%) and β-phellandrene (19-60%) to be the major components of resins of three varieties of *P. caribaea* namely *P. caribaea* var. *caribaea*, *P. caribaea* var. *bahamensis* and *P. caribaea* var. *hondurensis*. *P. caribaea* in both Uganda and Ethiopia are most likely *P. caribaea* var. *hondurensis*, because this has always been the most readily available seed source and due to the presence of longipinene in the turpentine (Coppen, J. J. W., personal communication).

α-and β-pinene were the main components of *P. radiata* oil, representing 83.1% of the total oil. As shown in Table 2, unlike the above two species, the essential oil of the resin of *P. patula* is characterized by high sesquiterpene but low α-and β-pinene content.

As α-and β-pinene are important intermediate in the manufacture of synthetic aroma compounds and flavouring ingredients, *P. caribaea* and *P. radiata* resins may serve as good sources of these compounds.

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