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Analysis of Sandalwood (*Santalum album* L.) oil: A brief report from West Bengal

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Abstract

Santalum album L. belongs to the family Santalaceae is a very important as well as valuable plant from both the ancient medicinal and commercial aspects. Quality timbers obtained from the white sandalwood have high value internationally. This plant is also proved as an important medicinal plant in different pharmaceutical industries and has also been used in several cosmetics industries. *Santalm album* L. is so important and valuable for its essential oils like alfa santalol, beta santalol etc. These essential oils are mainly present in the heartwood and the older large roots.

Several other components like santyl acetate, santalene etc are also present. But the alfa and beta santalol are responsible for characteristics sweet odor.

The aims and objects of this study were to analyse the santalol quantity as well as quantity of oil extracted from white sandalwood procured from different parts of the state of West Bengal.

Key words : Essential oil, Santyl acetate, Sesquiterpene fragrance, Santalene, α-santalol and β-santalol.

***S**antalum album* is a hemiparasitic plant with worldwide distribution. It is also known as East Indian sandalwood plant. Though ecologically sandal wood plants have adopted various soil condition but they can tolerate water logged condition. They generally prefer elevated land with water flow system. This plant has been used form the ancient era in various wood, pharmaceutical, cosmetic and perfumery industries. Presence of the essential

oil like alfa santalol, beta santalol make the plant so costly, important and valuable. Several other components like santyl acetate, santalene are also present but are not so valuable as alfa and beta santalol. *Santalum album*, also known as tropical or Indian sandalwood, is the most valuable of the commercially used species due to the high heartwood oil content (6–10% by dry weight) and desirable odour characteristics. Approximately 90% of *S. album* essential oil is composed of the sesquiterpene alcohols α-, β-, and *epi*-β-santalol and α-*exo*-bergamotol. The α- and β-santalols are the most important contributors to sandalwood oil fragrance[1,2]. Lanceol and α-bisabolol are also found in modest concentrations[11]. While the demand for sandalwood oil is increasing, disease, grazing animals and unsustainable exploitation of sandalwood trees has led to the demise of many natural populations. Plantations provide a more sustainable alternative to wild harvesting; however, slow growth rates, high potential for disease and substantial variation in oil yield hamper productivity. Alternatively, chemical approaches to synthesize the santalols have been attempted[5-7], but multiple low-recovery steps make chemical synthesis uneconomical at an industrial scale.

These essential oils are mainly present in the heart wood and older large roots. Heart wood formation start after attained the age of five years and is rapidly formed after the age of ten years. Huge amount of heartwood can be obtained from 30 to 60 years old plants[8]. The sandal wood materials are procured from different parts of West Bengal for analizing the santalol quantity as well as quality. Sandal woods of newly grown plants were procured from Hirbandh Beat office campus, Bankura (S) Forest Division, Bagaldhora garde, Hirbandh Range, Bankura (S) Forest Division, Khandari Beat office campus, Panagarh Range, Burdwan Forest Division, Guskara Range, Burdwan Forest Division. Because, the concept of general peoples of the state is that there is a hidden cause not to develop adequate quality and quantity of santalol in the white sandal tree while it is grown in this environment of West Bengal.

Environmental factors play an important role in sandalwood plants specially for the production of quality as well as quantity of santalol.

West Australian sandalwood (*Santalum spicatum*) belongs to the genus of hemi-parasitic *Santalum* (Santalaceae) trees widely exploited for their fragrant heartwood which is used in perfumes, pharmaceuticals, incense and ornamental carvings. The fragrance contained in the heartwood of mature sandalwood trees (>10 years) consists of a complex mixture of sesquiterpenoids, with unique compositions apparent across, and often within species[11-13,14,15]. Historically, Indian sandalwood (*S. album*) has provided the bulk of sandalwood products; however, *S. spicatum* is frequently used as a supplement to incense feedstock and to a lesser extent as extracted fragrance oil. The international standard for *S. album* oil requires 41%–55% of the sesquiterpene alcohol á-santalol and 16%–24% β santalol[10]. At present, *S. spicatum* extracts do not meet these industry standards for two reasons; the combined santalol content is too low, and levels contain E-farnesol, a suspected allergen, are too high[3,4,9,16].

Sandal wood sample (100g) from five

different plants from each location, Gas chromatography instrument, pen, Laboratory record book etc., were used in the present in -vestigation.

Samples collected from the Hirbandh beat office campus in the Bankura (S) forest division are denoted as SA001, samples collected from the Bagaldhora garde in the Hirbandh Range in the Bankura (S) forest division are denoted as SA002, samples collected from the Khandari Beat office campus in the Panagarh Range in the Burdwan forest division are denoted as SA003, and samples collected from the Guskara Range in the Burdwan forest division are denoted as SA004.

Sandalwood oil extraction and biosynthesis:

Sandalwood's volatile oil was extracted using liquid CO_2 extraction, supercritical fluid extraction (SC-CO_2), solvent extraction, hydro-distillation, and steam distillation, which are the major techniques for extracting essential oils from plant materials. The most popular technique among these utilised by sandalwood companies is steam distillation. Boiling, steaming, condensation, and separation are all steps of a four-step process that results in the reaction. High-temperature water (between 140 and 212 °F) is pumped through the wood. The high heat of the steam causes the oil to be released since it is so securely linked inside the cellular structure of the wood. After cooling and being separated, the steam-oil mixture is next used to extract the essential oil. This procedure takes 14 to 36 hours to complete, taking significantly longer than the distillation of any other essential oil, but often results in oil of much higher quality. The more conventional way of extracting sandalwood involves soaking the wood in water and then boiling it to liberate the oil. This process is called water, or hydro, distillation. Due of the significant expenses and time required to heat a big amount of water, this method is no longer as popular. Alternative techniques that use microwaves have been developed to speed up the extraction process, increase the extraction yield, and lower operating expenses. Essential oil isolation techniques aided by microwaves have gained popularity for usage in research facilities and industry. More efficient heating, quick energy transfer, quicker response to process heating control, quicker start-up, greater production, and the elimination of some steps are all benefits of using microwave energy for oil extraction. According to the research of Hettiarachchi *et al*., the yield of sandalwood oil obtained after 9 hours of traditional hydro-distillation is 0.43%. The foundations of the microwave-assisted hydro-distillation process differ from those of conventional methods because the extraction results changes in the cell structure brought on by electromagnetic waves. The process acceleration and high extraction yield in microwave-assisted hydro-distillation may be the result of the synergistic interaction of two transport phenomena: heat and mass gradients moving in the same direction. Therefore, micro-wave distillation may be a novel method for obtaining sandalwood oil. In this study, the number and amount of specifics contained in the freshly harvested sandal wood are studied by the quantification of essential volatile oil using gas chromatography (GC analysis) and the identification of the peak using GC based peak analysis and reference/control.

The result of analysis is given below in tabular form :

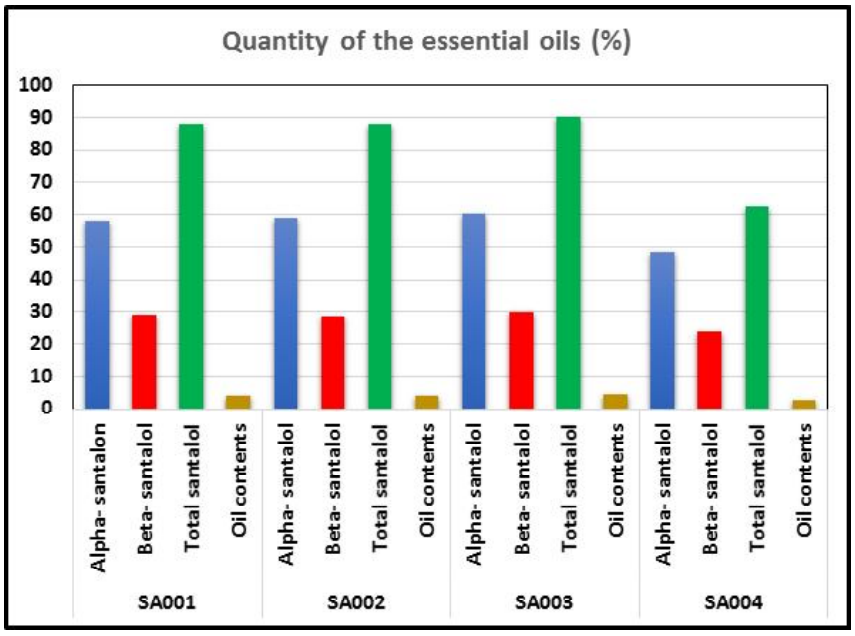
Table-1. Analysis of α and β santanol and oil contents

Sample	Particulars	Quantity %	Average in %
SA001	α- santalol	55.3	58.2
		60.4	
		59.9	
		56.2	
		59.2	
	Total α- santalol	**291**	
	β- santalol	28.6	29.2
		28.1	
		29.3	
		27.8	
		32.2	
	Total β - santalol	**146**	
	Total santalol = 87.4 %		
	Oil contents	3.6	4.1
		4.2	
		5.3	
		4.7	
		2.7	
	Total oil content	**20.5 %**	
SA002	α- santalol	58.7	59.1
		59.6	
		57.4	
		59.2	
		60.6	
	Total α- santalol	**295.5**	
	β- santalol	30.4	28.7
		29	
		27.4	
		27.2	
		29.5	

	Total β - santalol	**143.5**	
	Total santalol = 87.8 %		
	Oil contents	4.9	4.2
		6.2	
		3.8	
		2.1	
		4	
	Total oil content	**21 %**	
SA003	α- santalol	61.5	60.3
		62.4	
		59.1	
		60.8	
		57.7	
	Total α- santalol	**301.5**	
	β- santalol	28.2	29.9
		30.9	
		28.6	
		32.5	
		29.3	
	Total β - santalol	**149.5**	
	Total santalol = 90.2 %		
	Oil contents	4.1	4.3
		3.5	
		6	
		4.3	
		3.6	
	Total oil content	**21.5 %**	
	α- santalol	46.2	48.5
		52.9	
		45.8	
		47.3	
		50.3	
	Total α- santalol	**242.5**	

SA004	β- santalol	23.5	23.9
		22.8	
		24.3	
		23.8	
		25.1	
	Total β - santalol	**119.5**	
	Total santalol = 62.4 %		
	Oil contents	3.1	2.9
		2.1	
		2.9	
		3.4	
		3	
	Total oil content	**14.5 %**	

SA001= Sample-1 i.e. Hirbandh Beat office campus, Bankura (S) Forest Division, SA002= Sample-2 i.e. Bagaldhora garde, Hirbandh Range, Bankura (S) Forest Division, SA003= Sample-3 i.e. Khandari Beat office campus, Panagarh Range, Burdwan Forest Division,
SA004= Sample-4 i.e. Guskara Range, Burdwan Forest Division



From the above analysis it found that the quantity of total santalol and other oil contents in the sample of Hirbandh Beat office campus, Bankura (S) Forest Division and Bagaldhora garde, Hirbandh Range, Bankura (S) Forest division is more or less equal. In the sample of Khandari Beat office campus, Panagarh Range, Burdwan Forest Division the quantity of total santalol and other oil contents is comparatively more than that of other three samples. In case of sample collected from Guskara Range, Burdwan Forest Division the quantity of total santalol and other oil contents is little bit lower than the other three samples.

On the basis of quality of α - santalol and β- santalol, it was found from the analytical data which seems to be upto the mark of good quality. No one sample was measured the total santalol oil below 80%.

It has been found that the edaphic factors are congenial for the physiological growth and development of white sandal (*Santalum album* L.) in all these areas where those experimental plants were grown. Indeed, it might be better in special private farming technology than forest areas where to take any special care is never possible in general.

References :

1. Adams, D.R., S.P. Bhatnagar, and R.C. Cookson, (1975), *Phytochemistry, 14:* 1459–1460.
2. Baldovini N., C. Delasalle, and D. Joulain (2011), *Flavour Fragrance J 26:* 7–26.
3. Brand J.E., J.E.D. Fox, G. Pronk and C. Cornwell (2007), *Australian Forestry, 70*(4): 235–241.
4. Brand, J.E., and G.M. Pronk, (2011), *Aust. For., 74:* 141–148.
5. Brocke C., M. Eh, and A. Finke (2008), *Chem Biodivers 5:* 1000–1010.
6. Christenson P., N. Secord, and B. Willis (1980), *J Org Chem 45:* 3068–3072.
7. Christenson P., N. Secord, ands B. Willi (1981), *Phytochemistry 20:* 1139–1141.
8. Fallick K. (2009), Relevance of the chemical constituency of East Indian sandal wood essential oil to therapeutic and traditional uses, Australasian College of Natural Therapies (ACNT) Aromatherapy Chemistry and Pharmacology Assignment.
9. Hostynek, J.J., and P.S. Magee, (1997), *Toxicol. In Vitro, 11:* 377–384.
10. Howes; Melanie-Jayne & Simmonds; Monique & Kite; Geoffrey (2004). *Journal of chromatography. 1028:* 307-12. 10.1016/j.chroma.2003.11.093.
11. Jones, C.G., E.L. Ghisalberti, J.A. Plummer and E.L. Barbour, (2006) *67:* 2463–2468.
12. Jones C.G., J.A. Plummer and E.L. Barbour (2007), *J Essent Oil Res 19:* 157–164.
13. Jones, C.G., C.I. Keeling, E.L. Ghisalberti, E.L. Barbour, J.A. Plummer and J. Bohlmann (2008). *Arch. Biochem. Biophys., 477:* 121–130.
14. Moretta P. (2001). Extraction and variation of the essential oil from Western Australian sandalwood (*Santalum spicatum*). Ph.D. Thesis, University of Western Australia, Perth, Australia.
15. Page T., I. Southwell, M. Russell, H. Tate, J. Tungon, C. Sam, G. Dickinson, K. Robson and R.R.B. Leakey (2010) *Chem. Biodivers. 7:* 1990–2006.
16. Schnuch, A., W. Uter, J. Geier, H. Lessmann, and P. J Frosch, (2004). *Contact Dermat., 50:* 117–121.