World Report: Brazil

New Natural Linalool Sources

Research and industrial application

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The uncontrolled extraction of flora has been common practice in Brazil's economic and industrial history. This reality is apparent in many different parts of the country, a clear example being the Amazon Forest. The same is true if we investigate the economic exploitation of the Aniba rosaeodora Ducke tree, whose common name is rosewood and which is an important source of raw material for the global perfume industry. The essential oil obtained from its wood contains a high concentration of linalool, but since the species is endangered, research is now focused on finding new vegetal sources capable of yielding an essential oil with a high proportion of this chemical while permitting management practices that conserve the world's biodiversity.

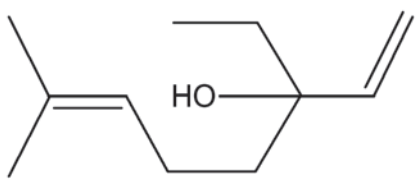
Background

The first registered observation of the rosewood tree on the American continent was in French Guiana in 1870. This date marks the beginning of its commercial exploitation by the European perfume industry, for which rosewood essential oil is very important as an ingredient in perfume products. The stability of this product against the action of alkalis meant the industry was quick to apply it in the manufacture of perfumed soap.[1]

Production and Marketing of Rosewood Essential Oil in Brazil

The scientific name of the rosewood tree is *A. rosaeodora* Ducke, though some scientists working in the area also accept the scientific name *A. duckei* Kostermans, or even *A. rosaeodora* var. amazonica.

Chemical structure of linalool[4] **F-1**



SOURCE: CHEMFINDER, 2002

Independent of the scientific name adopted, the tree belongs to the Lauraceae family. The product extracted from its wood, called rosewood essential oil, is of great importance to the international perfume industry because it contains linalool (3,7-dimethyl-1,6-octadien-3-ol), which is part of the terpene family.[2] Rosewood essential oil from Brazil contains more than 80 percent linalool in its composition, and has a low extraction yield between 0.7 and 1.2 percent of the vegetal mass used in the process[3] (F-1).

From its discovery, the raw vegetal material (rosewood tree trunk) from French Guiana was shipped to Europe to be distilled by companies in France, Germany and England to obtain the desired oil. When the First World War broke out, shipping activities were hampered, raising the cost of the raw material and stimulating the installation of distilleries *in-situ* in French Guiana.[5]

The overexploitation of the French Guianese product meant it started to become increasingly scarce on the international market, so new specimens of rosewood from which the essential oil could be extracted had to be found. The answer was found in the Brazilian states of Amazonas and Pará.

The specimens of *A. rosaeodora* Ducke found there had a high linalool content and started to dominate the world market. In fact, Brazilian rosewood oil came to account for 90 percent of total world supply.[6]

The catalyst for the surge in production, then, was the gap caused by the disappearance of French

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Production, exportation and unit price of rosewood essential oil between 1960 and 2000[5,14] **T-1**

	1960	1966	1970	1975	1980	1990	2000
Production (t)	320	256	321	120	-	150	-
Exports (t)	289	204	281	95	155	95	32
Unit price (US $ FOB/kg)	3.73	4.80	5.07	11.00	13.20	24.31	33.00

Unit prices of Brazilian, Chinese and synthetic rosewood essential oils in 1970 and 2000 (US$ FOB/kg)[4, 5, 14] **T-2**

Type	1970	2000
Aniba rosaeodora (Ducke) (Brazilian)	5.07	~33
Cinnamomum camphora (Ness) (Chinese)	-	11-14
Synthetic	3.53	12

Guianese rosewood essential oil from the market. To fill this gap, the production of Brazilian rosewood oil grew from 83 t in 1935 to 481 t in the middle of the 1950s, partially thanks to the efforts of a cooperative set up by essential oil producers in Pará State.[1]

Throughout the 1950s and 1960s, average production stood at 300 t/year, enough for the product to hold onto its number one position worldwide. However, in the 1970s the situation changed, with both production and sales declining (T-1) due to a lack of investment in the sector. The areas that had been exploited were not replanted, nor was there any organized resource management. This was quite unlike the situation encountered for other crops, including crops like coffee, corn, wheat and soybeans.[4]

The Entry of Substitute Products on the World Market

With the growing scarcity of the species and the historically destructive exploitation practices, it came to be added to the national list of endangered forest species in 1992 under category "E" (endangered).[7] With this, it was forbidden to fell rosewood trees, unless with an approved action plan and the replanting of one or more trees per tree cut down.[8]

The shortage of the Brazilian raw material on the global marketplace opened the door for substitutes: a synthetic linalool and a version derived from nature from the Chinese *Cinnamomum camphora* tree known as 'Ho' (also a member of the Lauraceae family).[9] Notwithstanding the presence of substitutes on the world market, Brazilian rosewood essential oil is still in demand by North American, British, French and German perfume companies because it contains a higher concentration of the levorotary sterioisomer of linalool, the chemical compound (3R)-(-)-linalool.[4]

The existence of a chiral carbon within the chemical structure of linalool permits the occurrence of two optical isomers with different scent properties:[9] a) the levorotary version, also known as (3R)-(-)-linalool, which has a woody aroma similar to lavender; and b) the dextrorotary version, or (3S)-(+)-linalool, which has a sweet fragrance like citrus. The subtle distinction is what accounts for the demand for a source of essential oil rich in the levorotary linalool and correspondingly poor in the detrorotary linalool. The essential oil obtained from *C. camphora* in particular has a significantly camphoraceous odor resulting from the presence of camphor (1.7.7-trimethyl-bicyclo-2.2.1-heptan-2-one) in the extract obtained, which is considered undesirable by specialists and consumers alike.

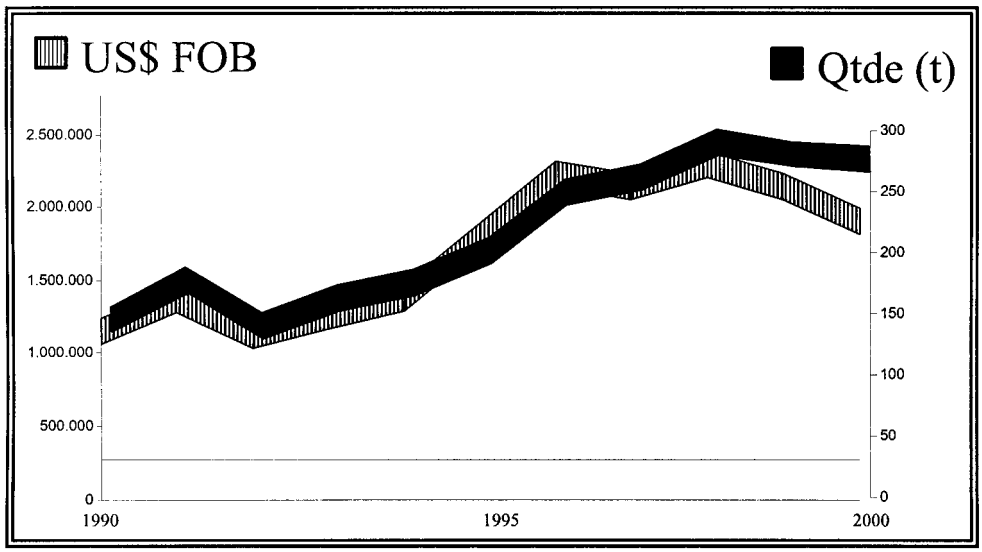
These 'differences' end up being reflected in the unit price of the two essential oils in question, as can be seen in T-2.

The Brazilian domestic producers have never been able to single-handedly control the market for essential oil obtained from rosewood. Rather, the selection of the species to be cultivated and the sale of the product have been dictated by the needs of the international perfume industry. As a result, companies in Brazil that depend on the use of an essential oil rich in linalool, or even pure linalool, have come to depend increasingly on imports of the product (F-2).

The Search for Solutions Adjusted to Good Environmental Practices

The perfume industry has always considered the best source of this type of essential oil to be that which is extracted from mature specimens (more than 20 years old) of the rosewood tree grown in Brazil (*A. rosaeodora* Ducke), because this oil possesses the desired bouquet. Yet, with the long natural

Imports of linalool in its isolated form in the 1990s[14] **F-2**



SOURCE: SECEX/DECEX (2001)

growth cycle of the plant and the overproduction that has occurred, there is now a shortage of raw material available and the supply of the essential oil is insufficient to meet demand. To redress this imbalance, new research is underway, concentrating on:[4]

a) setting up sustainable development practices together with replenishment of stocks of Brazilian rosewood trees
b) producing the essential oil in question from the leaves ('green leaf oil') rather than its trunk
c) introducing a 'new' similar essential oil obtained from the cultivation of sweet basil, to develop a substitute product for sale

Some further clarification of the second and third items is required. In an attempt to respond to the burning issues of sustainable development and biodiversity, professionals from the Instituto de Química at Unicamp, Universidade Federal do Pará, the Museu Goeldi and Instituto Pró-Natura, among others, have altered some rosewood specimens to obtain a smaller tree with a greater number of leaves per branch than trees found in the wild.[4] This reduced the growth cycle of the plant, which in nature grows for 25 years before maturity, and created a market for a new product for the perfume industry: rosewood, or green, leaf essential oil.[10]

The process for obtaining essential oil from the leaves is similar to the traditional system. Leaf oil yield is greater than ~1.5 percent and the scent characteristics similar to wood-derived oil. At the same time, its production is sustainable, a factor that is crucial if forests are to be used adequately and preserved as a matrix for clones. Researchers and small regional producers have set up a sustainable management and development program together with the local communities to grow and produce this new raw material.

This study stands apart from others of its kind in the industry in that it establishes the technological bases for cultivation, management, extraction, identification, chemical transformation and value adding in the form of a standardized oil and linalyl acetate. This article is thus necessary because partnerships between academia and small business will help reduce the destruction of the Amazon, so long as it can generate income for small producers.

The Hunt For an Alternative

The search for other species endemic to the Amazon forest to serve as an alternative source of a linalool-rich essential oil, especially the levorotary version of the compound, led researchers from universities and research institutes in Amazonas and Pará states to start cultivating the sacaca tree.[11] The sacaca, whose scientific name is *Croton cajucara*, belongs to the Euphorbiaceae family and is characteristically small and rustic-looking. Its leaves may be used for essential oil production, but experience has shown that the yield is small (0.35 percent); in addition, linalool only ac-

counts for 10 percent of the oil produced. Neither the fragrance obtained nor the chemical and physicochemical stability of the product in any way resembles rosewood oil. Moreover, the presence of 5.45 percent farnesol (3.7.11-trimethyl-2.6.10-dodecatrien-1-ol) means this oil is commercially unfeasible.

Researchers at the Instituto Agronômico de Campinas set up a more recent experiment that identified the herb sweet basil (from the Labiadae family; scientific name: *Ocimum basilicum* L.) as a 'suitable' source of linalool-rich essential oil.[12] Approximately 50 species of basil exist in tropical Asia, Africa and America. Researchers in the area recognize that the polymorphism of this herb is responsible for a great number of subspecies.[13] For this reason, the essential oils obtained are classified according to their geographical origin and chemical composition. The plant and essential oil sold in Europe and North America are of the 'European,' or 'Mediterranean,' varieties, also known as 'alfavaca-doce.' This oil is light yellow to transparent, and has a delicate sweet, fresh scent with a touch of woody balsam. Its production is very limited and is thus one of the most expensive essential oils. Given this variety's fixing properties, it is often used for fine perfumes and in aroma production.

Sweet basil is simple to cultivate and propagates quickly, unlike rosewood, which, as stated before, needs to be at least 20 years old prior to oil extraction (sweet basil: four months). The herb's essential oil extraction yield is between 1.5 and 3 percent by mass of raw material. However, there is a commercial drawback as regards sweet basil oil's proportion of linalool: while in rosewood oil the proportion is around 80 percent, sweet basil oil's linalool quantity is merely 35 percent. Research, then, has focused on raising the mass percentage of linalool in sweet basil oil to 45 to 50 percent over two to three years.

Another species of basil that should be mentioned here is Réunion basil.[13] This variety used to be distilled on Réunion Island, but is now almost exclusively processed on Mayotte (an island of Comoros) and in the Seychelles. Its oil is yellow to light green; its scent is faintly herby and camphoraceous, which makes it of lesser commercial value than the European variant.

Conclusions

The Brazilian essential oil industry came into existence in 1935 when it took the place of the French Guianese production of rosewood oil. Brazil's acknowledged agricultural practices, with the large-scale production of different crops such as coffee, corn, wheat and soybeans, were unfortunately not adopted for rosewood oil production. Because it is the main producer of essential oils, this lack of sustainability is of great importance to the global fragrance industry. The absence of a coordinated agroindustrial policy to encourage investments in agricultural and manufacturing units resulted in a crisis in the production of the oil. If one surveys the period under study as far as the end of the 1990s, it becomes clear that on the international market, Brazilian rosewood oil is now in competition with similar varieties grown in countries with a similar or lesser degree of development. However, rosewood oil production in Brazil is buoyed by the preference of North American and European perfume manufacturers for this type over synthetically produced linalool or the Chinese version of the product, despite the fact that the Brazilian unit price is much higher than those of the alternatives. Further evidence of this preference lies in the fact that foreign companies and institutions continue to provide support for the cultivation of Brazilian rosewood for industrial use.

> [R]esearch is now focused on finding new vegetal sources capable of yielding an essential oil with a high proportion of [linalool] while permitting management practices that conserve the world's biodiversity.

The value given to natural resources should in no way minimize the importance of the industrial end of the process. Rather, the great variety of species that exist in the country as a whole should serve as a basis for essences to be cultivated in an organized way, using modern technology, both in the agricultural and industrial sectors. Research and development has been applied to a product that was traditionally extracted directly from nature, in this case from the rosewood tree, and has reduced the growth cycle of the plants and introduced a rosewood oil extracted from the leaves of this tree.

On the other hand, it will take a long time for sweet basil oil to be adopted by the highly selective fine perfume industry, because, first, extraction processes capable of producing a large enough product yield with corresponding quality will have to be developed. Only then can rosewood product be replaced.

In any case, new sources of oil, such as those discussed above, require further in-depth work in cooperation with key overseas consumers to resolve issues related to the differences in the quality of these alternate oils from those derived from traditional

sources, and to address outstanding questions regarding climate and soil, and other ecological characteristics.

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