Paper presented at the IFEAT International Conference in Singapore, 4 - 8 November 2012 '*Essential Asia*'
Pages 131-138 in the printed Conference Proceedings

OVERVIEW OF THE AGARWOOD OIL INDUSTRY

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INTRODUCTION

Agarwood is a resinous, fragrant and highly valuable heartwood. The scientific name is *Aquilaria*. It is also known as aloeswood, eaglewood, krissana in Thailand, gaharu in Malaysia and Indonesia, Oudh in the Middle East, chen-xiang in Chinese and jin-koh in Japan.

Healthy agarwood is relatively light and pale coloured. When the wood is infected by a disease in the wild, the infection process produces a dark aromatic resin in response to the attack. This results in a very dense, dark, resin embedded hardwood. This resin is highly prized and commands an exceptionally high value because of its distinctive fragrance and medicinal benefits.

The international trade in agarwood involves wood, wood chips, powder and oil.

Agarwood oil is also known as Oudh oil or Oud oil. The oil is conventionally obtained by the water-distillation process.

Agarwood oil can be applied directly to the skin. Pure agarwood oil has a slow release effect lasting at least 8 hours.

A small amount of agarwood oil can be added to other oils to give a rich and complex depth and to fix the aroma of middle or top notes in perfume blending.

Pure agarwood oil is also burned as incense, especially in Japan. It is used in spiritual ceremonies or holy occasions as a temple offering in the Muslim, Hindu and Buddhist traditions.

THE GLOBAL AGARWOOD MARKET

Globally, there are two major agarwood consumption regions:

- North-east Asia and the markets of Taiwan, Japan, and the Republic of Korea, and
- West Asia or the "Middle East" which centres on the countries of the Arabian Peninsula.

The uses of this resinous wood include medicinal, religious and cultural applications in various societies across Asia. No agarwood-producing species is known to grow west of India, and yet it has been a traded item within Arab-speaking commerce for over 2,000 years, being sourced from both India and further east in South-east Asia.

AGARWOOD OIL: POSSIBLE USES AND HEALTH BENEFITS

When used in aromatherapy agarwood oil (Oud oil) may help to treat anxiety, stress, depression and other nervous system disorders.

Agarwood oil is used to treat cirrhosis of the liver, kidney problems and lung and stomach tumours.

Agarwood oil is also used as an anti-rheumatic, an anti-convulsant, an anti-asthmatic, and a carminative diuretic as well as an aphrodisiac.

AQUILARIA SPECIES PRODUCES AGARWOOD

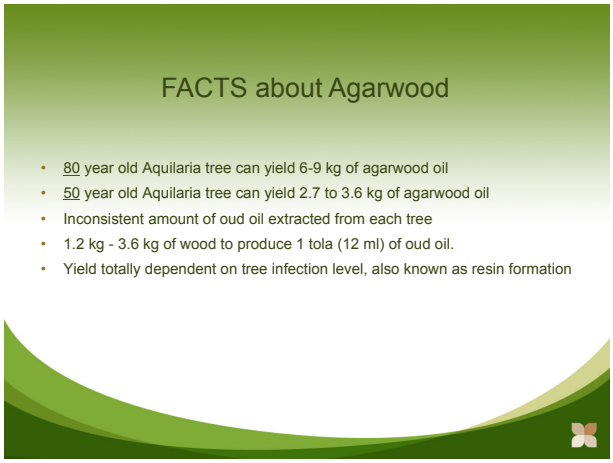
There are 17 species of *Aquilaria*, which can produce agarwood. Among them *A. agollocha*, *A. malaccensis* and *A. crassna* are the best known. One of the main reasons for the relative rarity and high cost of agarwood is the depletion of the wild resource. The endangered *A. malaccensis* has been protected worldwide under the CITES convention since 1995 while all *Aquilaria* species have received CITES protection since 2004. However, a number of countries have reservations outstanding regarding this. In Bangkok, we are doing research work in conjunction with Asia Plantations to develop the growing of *Aquilaria* trees in plantations to develop a sustainable source of Oud Oil.

Table 1 *Aquilaria species* produce agarwood

	Species	Country
1	*Aquilaria apicultina*	Philippines
2	*Aquilaria acuminata*	Papua New Guinea, Indonesia and Philippines
3	*Aquilaria baillonil*	Cambodia and Thailand
4	*Aquilaria baneonsis*	Vietnam
5	*Aquilaria beccarain*	Indonesia
6	*Aquilaria brachyantha*	Malaysia
7	*Aquilaria crassna*	Cambodia, Malaysia, Thailand and Vietnam
8	*Aquilaria cumingiana*	Indonesia and Malaysia
9	*Aquilaria filarial*	Philippines, Indonesia and Papua New Guinea
10	*Aquilaria grandiflora*	China
11	*Aquilaria hirta*	Indonesia, Malaysia and Thailand
12	*Aquilaria khasiana*	India and Pakistan
13	*Aquilaria malaccensis*	Thailand, Malaysia and India
14	*Aquilaria microcapa*	Indonesia and Malaysia
15	*Aquilaria rostrata*	Malaysia
16	*Aquilaria sinensis*	China
17	*Aquilaria subintegra*	Thailand

FACTS ABOUT AGARWOOD

- An 80-year-old *Aquilaria* tree can yield 6-9 kg of agarwood oil.
- A 50-year-old *Aquilaria* tree can yield 2.7 to 3.6 kg of agarwood oil.
- The amount of oud oil that is extracted from each tree is not constant. Amounts vary from using 1.2 kg to 3.6 kg of wood to produce 1 tola (12 ml) of oud oil.
- The yield is totally dependent on the infection level of the tree, also known as resin formation.



NATURAL RESIN FORMATION

The production of resinous compounds is a result of a plant defence mechanism associated with wounding; insects possibly assist fungal invasion.

Phaeoacremonium parasitica is an important fungus dealing with the resin formation process. Naturally, the process of resin accumulation may take many years and the longer the process, the more expensive and highly valuable the resin.

ARTIFICIAL RESIN FORMATION

First, a tree is drilled to make a hole about 5 mm in diameter, with a 25 cm space in between the holes.

Second, one ml of liquid inoculum is injected with a syringe.

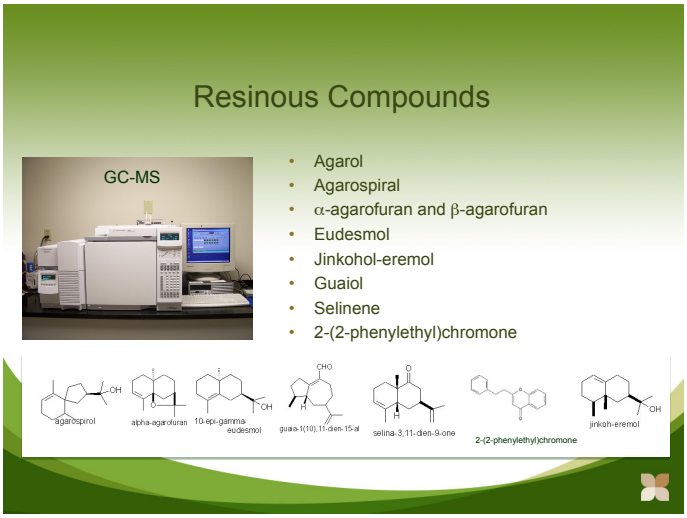
One month after inoculation, the effectiveness of the process is checked by peeling the tree bark to observe the disease symptoms.

A 7-8 year old plantation tree yields between 2-4 tolas of Oud oil.

RESINOUS COMPOUNDS

The resinous compounds in agarwood oil are detected by the Gas Chromatography-Mass Spectrometry (GC-MS) method. Many chemical compounds are found in Oud oil. Some major chemical constituents that make agarwood oils distinctive from other oils include:

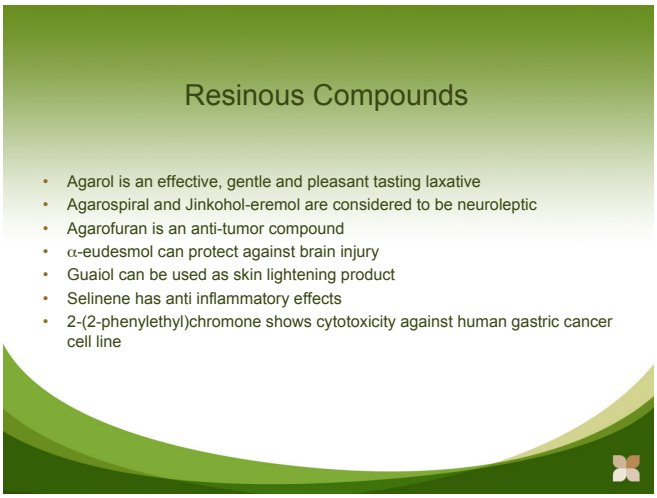
- Agarol
- Agarospiral
- α-agarofuran and β-agarofuran
- Eudesmol
- Jinkohol-eremol
- Guaiol
- Selinene
- 2-(2-phenylethyl) chromone



RESINOUS COMPOUNDS

Some of these chemical compounds were scientifically reported to have medicinal benefits.

- Agarol is an effective, gentle and pleasant tasting laxative
- Agarospiral and Jinkohol-eremol are considered to be neuroleptic
- Agarofuran is an anti-tumour compound
- α-eudesmol can protect against brain injury
- Guaiol can be used as skin lightening product
- Selinene has anti inflammatory effects
- 2-(2-phenylethyl) chromone shows cytotoxicity against the human gastric cancer cell line.



EXTRACTION PROCESS

The extraction process also affects the oil yields.

Conventional distillation plant

Water distillation methods using traditional apparatus is time consuming with high-energy consumption and low yields. The picture on the left shows the conventional distillation plant with wood fired stoves.

The right hand picture is a modified distillation plant with gas fired stoves and agitation systems. Energy and mass transfers have been improved on the later model. However, the distillation system still requires on-going research and modification.

Modified conventional distillation plant

Solvent extraction can be used in combination with distillation. A hydrocarbon solvent is put in with the wood dust and dissolves the essential oil. The resulting solution is then filtered and put through a distillation process that concentrates the oil to produce a resin. The remaining substance is a combination of wax and essential oil called "concrete".

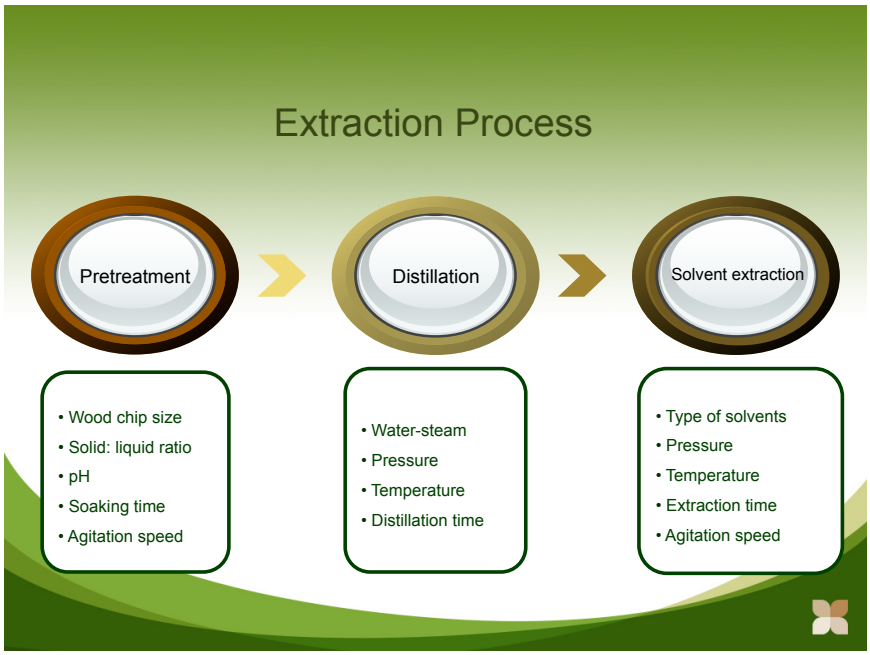
Solvent extraction unit

Supercritical fluid extraction unit

The supercritical fluid extraction method is non-flammable, non-toxic, and chemically stable and consumes less energy. It provides some advantages over the classical method, since supercritical carbon dioxide has low viscosity, high diffusivity, and good transport properties and gives faster extraction and high yields.

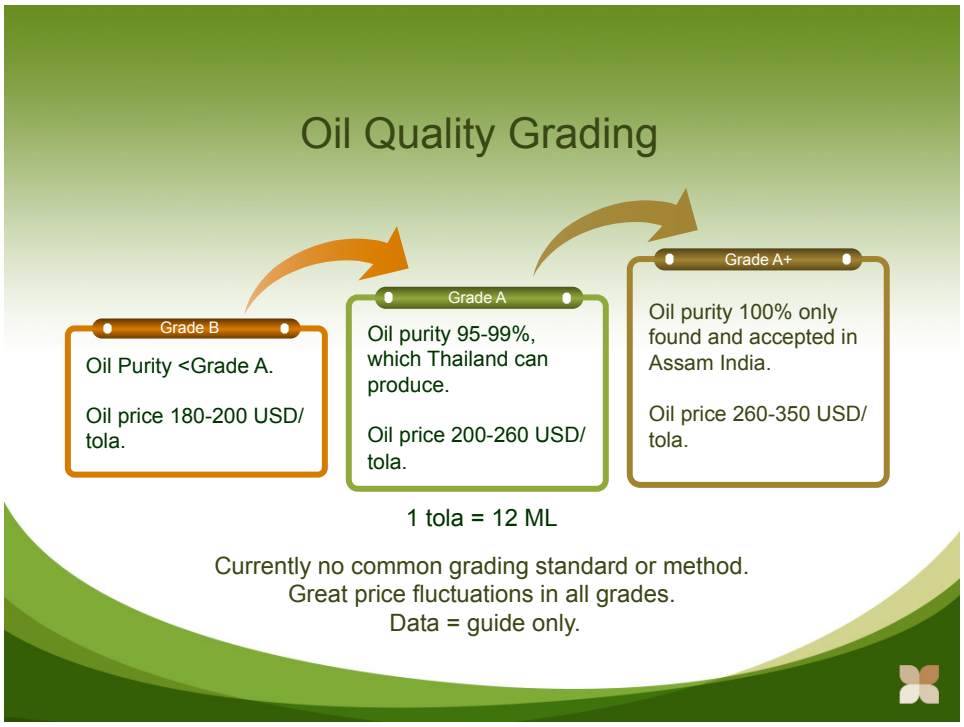
The extraction process can be further enhanced by a pre-treatment process that is affected by many parameters including wood chip size, solid to liquid ratio, pH, soaking time and agitation speed. For the distillation process more study and research is still required. There are questions such as whether water or steam distillation is better. The impacts of pressure, temperature and distillation time should be further investigated.

For solvent extraction, the effects of the different types of solvents, pressure, temperature, extraction time and agitation speed should be studied.



OIL QUALITY GRADING

Currently, there is no common grading standard or method for agarwood oil. The oil is sometimes classified into three grades. Grade B is for the oil with purity less than Grade A. This oil's price is approximately 180-200 USD/tola. 1 tola is 12 ml. Grade A is for the oil with 95-99% purity. Oils produced in Thailand usually fall within this grade with a price of 200-260 USD/tola. Grade A+ is the oil with 100% purity, which is only found in Assam India. Its price is 260-350 USD/tola. Price fluctuates within all grades. These data are for guidance only.



CURRENT GLOBAL VALUE OF AGARWOOD TRADE

The current estimated global value of the agarwood trade is 6-12 billion USD.

This estimate on the current global value of agarwood trade is based on information as per CITIES Traffic report and Asia Plantation Capital's research. Most of the trade is still on the black market and technically illegal as highlighted in CITES reports for Taiwan, United Arab Emirates and Japan. Because most of the trade is on the black market, there is no official documented market information for Oud available in any country.

CHALLENGES FOR THE AGARWOOD OIL INDUSTRY

There are many challenges facing the agarwood oil industry.

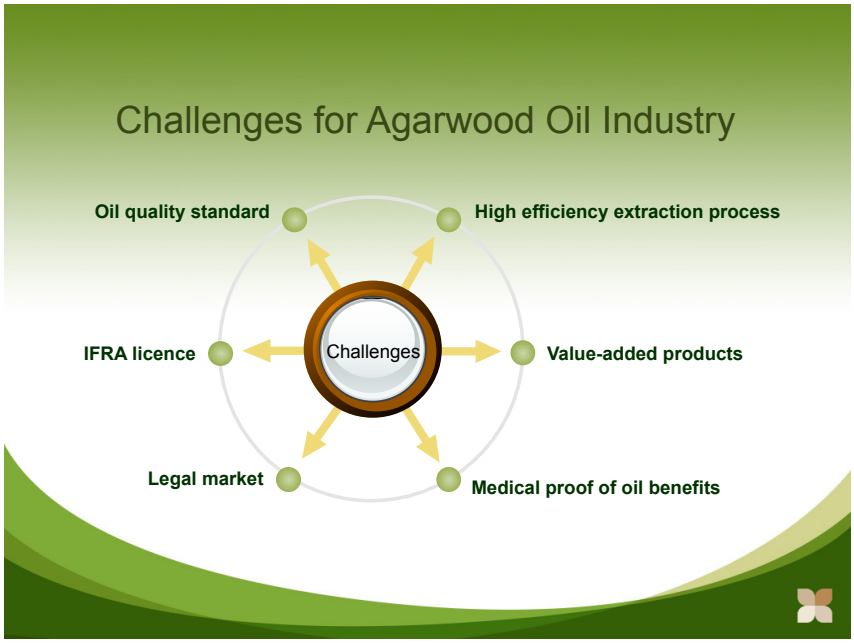
The trade on the black market needs to be more highly regulated and banned. With a legally traded market, oil quality standardisation can move forward.

Global demand for 100% natural organic oils for fragrance production has increased dramatically over the last few years. One of the goals of an agarwood oil manufacturing company is to obtain an International Fragrance Organisation (IFRA) license.

A high efficiency extraction process is required to obtain a high oil yield with savings in energy and time consumption.

To make the industry more profitable, agarwood oil itself can be utilised to produce other products for other industries, such as cosmetics and food. In addition, all parts of agarwood have value. The leaves can be used to produce tea. Agarwood dust after distillation can be made into incense sticks. Agarwood distilled water can be used as an ingredient in soap production.

Finally, more investigation into the medicinal benefits of agarwood is required.



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