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Review

A Review of Quality Assessment and Grading for Agarwood

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ABSTRACT

Agarwood is an important non-timber forest product widely used in religious and cultural activities as perfume and fragrance and as traditional medicine in Asia. The high value of agarwood and the inflated consuming market have led to constant rising of the prices. In general, the price of the agarwood is determined according to its quality, which can be divided into different grades. But up to now, there is not any standard quality grading system which could be used overwhelmingly throughout the agarwood producing, commerce and consumption. Therefore, we reviewed agarwood in diversified grading indexes, systems and methods.

Key words

agarwood; agarwood trade; grading; quality-assess

1. Introduction

Agarwood or eaglewood (also known as *chen xiang* in China; *agar* in India; *oud* in the Middle East; *gaharu* in the South East Asia, and *jinkoh* in Japan) is the resinous wood of the *Aquilaria* spp. (Thymelaeaceae), including 19 *Aquilaria* species in China, India, Burma, Laos, Vietnam, Cambodia, Malaysia, Sumatra, Borneo, Philippines, Bangladesh, and Papua-New Guinea (For a compilation, see appendix A; Rogers, 2009; Akter et al, 2013; Abdin, 2014). Only four species, i.e. *A. malaccensis* Lam., *A. crassna* Pierre ex Lecomte, *A. sinensis* (Lour.) Spreng., and *A. filaria* (Oken) Merr. are being largely used to produce agarwood (Table 1). Agarwood is absent from *Aquilaria* trees unless they are attacked by physical force (Liu et al, 2013; Li et al, 2014), insects (Kalita et al, 2015) or bacteria/fungi infection (Novriyanti et al, 1999; Mohamed, Jong, and Kamziah, 2014; Chong et al, 2015). In response to attack, agarwood is yearly embedded around the wound where amount of volatile constituents are accumulated.

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Table 1 Four major species that produce agarwood and corresponding producing and consuming areas

Species	Major producing areas	Major consumer areas	Main uses
A. malaccensis	Malaysia, India, Burma, Sumatra, Borneo, Philippines	Middle East	Pharmacy, Religion, Commodity
A. crassna	Vietnam, Cambodia, Laos, Thailand	Middle East, Japan	Pharmacy, Religion, Collection
A. sinensis	China	China, Japan	Pharmacy, Religion, Collection
A. filaria	Philippines	Middle East	Commodity

Agarwood was first used as one of traditional Chinese medicines from the 5th century. It was used in more than 1500 kinds of preparations of Chinese medical materials. Agarwood tastes in bitterness which is used as sedative, carminative, and to relieve gastric problems, coughs, rheumatism, and high fever. It can promote *qi* circulation to relieve pain, warm middle energizer to arrest vomiting, and promote inspiration to relieve asthma (Pharmacopoeia Committee of P. R. China, 2015). In *Chinese Pharmacopoeia*, there are 35 Chinese medical material preparations including agarwood such as "*Chenxiang Huazhi Wan*". Agarwood also has been used for centuries as incense in Buddhist, Hindu, and Islamic ceremonies. In traditional Ayurveda medicine, agarwood incense has been used to remove curse. In traditional Arab medicine, agarwood essential oil has been used for aromatherapy.

Nowadays more than 18 countries throughout Southeast Asia and Middle East have participated in agarwood trade. Although different countries or medical systems have different agarwood grades, several indexes such as resin, sinkage, color, and scent have been basically assessed in grading agarwood across the world. For the medical purpose, the more important parameters are the effective chemical compounds and resin content. For the religion purpose, color and scent/aroma are preferred. And for the collection purpose, shape and scent/aroma are prior to others. In addition, agarwood grades are being improved due to developing techniques. Here we reviewed agarwood in traditional and modern quality assessment for the medicinal and relevant usage.

2. Traditional systems of quality assessment grading

Agarwood is traditionally graded by physical senses. It is evaluated in resin content, sinkage in water, color, scent/aroma, agarwood-inducing method, formation time, place of origin (Table 2).

Table 2 Major items in agarwood quality assessment in trade markets

Items	Pharmacy			Religion	Collection	Commodity
	TCM	traditional Ayurveda medicine	traditional Arab medicine			
Resin content	√√	√	√	−	√	√
Sinkage	√	−	−	−	√√	−
Color	√	√	−	√√	√	√√
Secent/aroma	−	√√	√√	√	√	√√
Agarwood-inducing method	√	−	−	−	√√	√
Formation time	√	√√	−	√	√√	√
Place of origin	√√	√	√	√	√	√√

"√√": Primary item has been considered; "√": Secondary item has been considered; "−": Item has been considered scarcely.

2.1 Sinkage

As known, agarwood, called *Chenxiang* in Chinese, means the fragrant resin-embedded wood that can sink down in water. Agarwood pieces which sink in water are assumed to have higher resin content and higher density. Therefore, the quality of agarwood is determined by sinkage in water. In the agarwood market, the most common method of grading is to place agarwood pieces into water, and then the pieces are classified into three basic grades: sinkage, half-sinkage (or half-floating), and full-floating (Figure 1). *The Compendium of Materia Medica* (*Bencao Gangmu* in Chinese, a famous medical book on traditional Chinese medicines), records that the sinkage is agarwood, the half-sinkage is stack incense, and the full-floating is half-mature incense. Sinkage agarwood is designated to a higher grade than the others, but this test is rarely performed for the customers. Actually, not all of the high grade agarwood are sinkage. Most of the high grade Hainan agarwood (origin from Hainan island of China) and all of *tagara* (Top-grade agarwood) are half-sinkage or full-floating. Actually, sinkage related the wood texture and density of *Aquilaria* tree. Among the four major species of agarwood tree (Table 1), the wood density of *A. malaccensis* is harder than the other three, and *A. sinensis* is the loosest one.

2.2 Resin content

Resin is the main component of agarwood (Peng et al, 2014). Heartwood of *Aquilaria* trees in health has low density with a yellow-whitish color. Normally, the higher the resin content is, the higher the grade is. Therefore, people

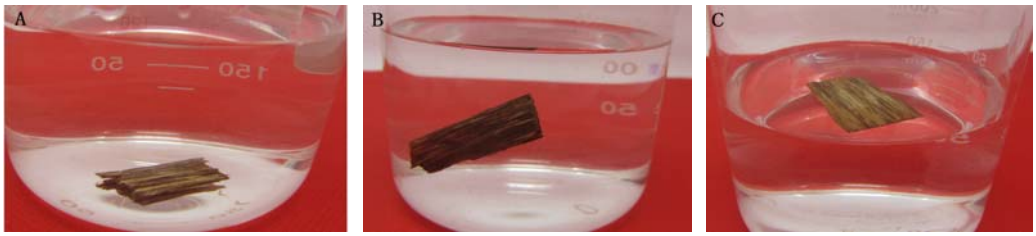


Figure 1 Agarwood sinkage in water

A: agarwood (sinkage); B: stack incense (half-sinkage); C: mature incense (full-floating)

usually estimate agarwood quality according to resin content on its surface (Azah et al, 2013). The four levels only in Chinese pharmaceutical market according to the weight ratio of resin to resinous wood were 80%, 60%, 40%, and 25%.

Moreover, burning a small sample of the agarwood is the most popular method for further determining the grade, since resin can exude something like bubbles when the agarwood is burning. Agarwood with high quality can exude more resin bubbles when burning due to containing more resin.

2.3 Agarwood color

Agarwood from different countries/regions contains distinctive resin colors, such as green, dark green, yellow, golden, red, black, brown, and white. The darker an agarwood piece is, the higher resin content is, and therefore with the higher grade (Figure 2; Barden et al, 2000; Song, 2002). But, a resin-riched agarwood may actually be very cheap if its color or texture is masked by wood or agarwood with low grade that has not yet been scraped off.

Figure 2 Agarwood of different colors

A: agarwood of first grade; B: agarwood of second grade; C: agarwood of third grade; D: unqualified agarwood

In the market of some countries, agarwood chips are usually polished, and colored to give a darker hue to attract buyers. What's more, many agarwood collectors are used to buring immature agarwood in the soil for several months to accelerate decomposition. The resulting product change into black and can be sold as higher grade agarwood (Heuveling van Beek and Phillips, 1999). Therefore, it is increasingly difficult to assess agarwood or identify fake agarwood depending on the color of "agarwood" samples.

Recently, more and more Malaysian agarwood have been use for artware, such as bangle and sculpture, and the wood color is considered primarily. Thus, the simplest agarwood grading system appears to be the "ABC" system: Grade A is brown/black wood, Grade B is yellow wood with flecks of brown/black, and Grade C is white wood with some flecks of yellow/brown. Agarwood in Grade A is called *kalambak*, and the lower grades are named *gaharu*. "ABC" grading method is usually determined solely on physical appearance, yet the darkness of the wood is really correlated with resin content.

The Indians have four quality grades for agarwood, which is largely used in Buddhism. "A" is the wood with black or true agar; "B" is the brown *Bantang* wood; "C" is *Butha* containing 50% of clear uninfected wood free of oleoresin; and "D" is yellow *Dhum* wood, which mostly used for the production of commercial essential oils.

2.4 Scent/Aroma

The scent or aroma of agarwood is complex and pleasing, with few or no similar natural analogues. Therefore, agarwood was used widely in *kodo*, the art of incense ceremony in China and Japan. Generally, high-quality agarwood tastes in sweet, sour, hot, salty, or bitter. In the retail market, most traders explained that scent was the major factor on which consumers make a choice. Thus, most customers who purchase raw agarwood favor its aroma. The usual method is to ignite agarwood piece and smell the scent leisurely. In general, the pieces producing the softer scent are considered as the higher grade than the intense, so they are more favorable and expensive. Particular aromas are also attributed to the origin and the resin content of the agarwood. Generally, lower resin content is at a lower quality characterized by more woody aromas. When agarwood of bad quality is burning it may irritate the nose and eyes. Moreover, agarwood of good quality burns evenly and rather slowly while releasing its aroma gradually. Its fragrance lingers at the room for a longer period. Certainly, the burning time depends on the size of the individual agarwood pieces and the resin content.

As *kodo* is very popular in Japan that has a developed and specialized traditional industry for agarwood fragrance appreciation including both use of raw agarwood and processed product which is the most common incense.

Agarwood is called *jinkoh* in Japanese. In Japan, there is a codified assessment system for agarwood grading. The fragrance of agarwood is classified by the terminology *go-mi rikkoku*, literally "six countries, five flavours", which was systematized during the Muromachi Period. This system classified scents into six categories according to their geographic sources, and further distinguished them according to five flavours or tastes. The six categories were *kyara*, *rakoku*, *manaban*, *manaka*, *sasora*, and *sumatora*, while the five flavours were sweet (the smell of honey or concentrated sugar), sour (the smell of plums or other acid foods), hot (the smell of red pepper when put in a fire), salty (the smell of a towel after wiping sweat from the brow, or the lingering smell of ocean water when seaweed is dried over a fire), and bitter (the smell of herbal medicine when it is mixed or boiled) (Morita, 1992). All six grades (see appendix B) were considered to be good quality, but *kyara* was held in particularly high esteem by agarwood connoisseurs down the centuries and was commanded the highest price in Japan. Because of its high reputation in the agarwood world, the use of "*kyara*" has been broadened to describe something with supreme character, including the admiration of female beauty.

It is said that the color of resin is the most important factor to determine agarwood scent when it is burnt. Yet, there are no systematic indicators that demonstrate the relations of color, scent, grading, and pricing.

2.5 Agarwood-inducing method and forming time

As *The Compendium of Materia Medica* records that *Aquilaria* trees could produce agarwood while there was physical lesions, artificial mechanical wound, or insect/ microbe infection, and also while the trees were withered or fell down, agarwood is the resinous wood formed slowly on wounded *Aquilaria* trees. Those four causes of resin formation have been respectively defined as aging-induced, physical wound-induced, vermiculate-induced, and fallen-induced ways. And the mechanical wound-induced agarwood has been regarded as the top quality. But in Taiwan market, aging-induced agarwood is preferred. Because raw materials isolated from dead trees buried in the ground or the swamp are generally considered more mature, which can contribute to a higher grade and higher price than those isolated from standing trees (Zhang et al, 2012; Liu et al, 2013).

In addition, quality of the agarwood was stated to be related to the age of the tree, and the time that the resin had kept accumulating. It's also linked with the different parts of one tree. When comparing agarwood taken from different parts of a tree, the root-produced is considered to be higher grade than those from other parts of the tree.

2.6 Place of origin

Agarwood from different countries/regionsmay may have different prices even at the same grade. Ng et al (1997) reported that the highest quality agarwood was from *A. baillonii* (Cambodia), *A. crassna* (Thailand), *A. sinensis* (China) and *A. malaccensis* (Myanmar and India). But consumers and traders in Taiwan believed that the agarwood with highest qualities is from Sumatra, Borneo, and some other islands in Malay Archipelago (CITES, 2000). In the United Arab Emirates market, the origin countries/regions as "brand names" or with particular quality are in the following order: India, Cambodia, Malaysia, Laos, Myanmar, and Indonesia. One large dealer in Singapore, for example, usually offers pieces or chips that from five or six countries (Heuveling van Beek and Phillips, 1999).

The agarwood producing region is rough broken into two zones (Hoi-An Zone and Sin-Chew Zone) by the agarwood collectors. In their opinion, the agarwood from China, Vietnam, Cambodia, India, Thailand, Laos, and Myanmar all belong to Hoi-An Zone, agarwood from Malaysia, Indonesia, and Brunei belong to Sin-Chew Zone. Agarwood in Sin-Chew Zone has harder wood texture and density, but agarwood in Hoi-An Zone presents better pleasant scent. Nowadays, agarwood from some origins is known to have decreasing supplies, such as those from Vietnam and China (especially from Hainan island), are sold at much higher price than other agarwood of similar quality, because of their scarceness.

3. Modern systems of quality assessment grading

The traditional systems are replaced by modern systems of quality assessment grading gradually with the new indexes from qualitative analysis to quantitative analysis.

3.1 Color

The traditional color method for agarwood quality assessment usually counts on eyes. This has led to several problems such as the inconsistent results and the process of grading depends on individual opinion. Amin et al (2012) has developed a prototype of agarwood grade determination system using image processing technique. It involved four phases: image acquisition, pre-processing, segmentation, and feature analysis. Color images of agarwood are obtained and converted into grey scale level, continued with categorized each grey scale value into five ranges as it refers to the grade of agarwood. Percentage of grey scale value range will be calculated during the feature analysis phase. The higher percentage of grey scale value range has, the better the agarwood is. The results demonstrate that the precision is close to 80%. This technique detects different grades of agarwood by applying fast and effective image processing and is to advance the understanding of agarwood, but it cannot identify shoddy and counterfeit agarwood.

3.2 Scent/Aroma

Formerly, the quality assessment of agarwood by its individual scent or aroma is classified based on human

sensation. Recently, an intelligent grading technique for the agarwood classification was developed based on advanced signal processing of E-nose measurements (Figure 3). This proposed technique, employing feed forward artificial neural network defined by "32-8-1 architecture" and trained via Levenberg-Marquardt back propagation (LMBP) algorithm, can successfully grade agarwood with a 100% classification rate (Sharfi et al, 2011). It could be perspective that in the future, such a technique can be further utilized on other characteristic such as the origin, color, and resin content of agarwood, and finally substitute the human experience.

Figure 3 Electronic Nose (Hidayat et al, 2010)

Hung et al (2014) utilized non-targeted headspace solid-phase microextraction (HS-SPME) combined with gas chromatography/mass spectrometry (GC/MS) and multivariate analysis to analyze aromatic characteristics. The principle component analysis results show that the agarwood are classified successfully and 17 markers were confirmed by GC/MS, indicating that the method is useful for grading of agarwood.

3.3 Chemical analysis

Currently agarwood has been intensively studied in chemical constituents by several research teams (Mei et al, 2013; Tajuddin et al, 2013; Gao et al, 2014; Yang et al, 2014). Sesquiterpenoids and 2-(2-phenylethyl) chromone derivates are the two predominant constituents in agarwood (Naef, 2011; Chen, 2012; Subasinghe and Hettiarachchi, 2015). The main compounds in agarwood essential oil have been revealed to be sesquiterpenoids.

Sixty-six different sesquiterpenoids have been identified in various agarwood, most of which were essential ingredients for luxury perfume. Pasaribu et al (2013) analyzed different grades of agarwood (*kemedangan C*, *teri C*, *kacangan C*, and *super AB*) by GC-MS to determine its chemical composition. The results showed that aromadendrene (Figure 4) could be found in all of the agarwood, indicating that aromadendrene was an effective characteristic compound for agarwood. The agarwood grade is in accordance with aromadendrene content. In addition, agarospirol and guaiol exist in kinds of agarwood in different grads or from different *Aquilaria* trees. But γ-eudesmol and baimuxinal are only found in agarwood from *A. sinensis* and *A. crassna*. *epi*-γ-Eudesmol, Jinkoh-eremol, and β-agarofuran cannot always be founded in all agarwood but which is from *A. malaccencis* (Naef, 2011; Chen et al, 2012; Hashim et al, 2016; Figure 4).

Besides sesquiterpenes, another key "marker" constituent in agarwood is 2-(2-phenylethyl) chromone derivate, which can be only extracted by solvents or supercritical CO_2 and never found in hydrodistillates (Yagura et al, 2005; Naef, 2011; Yoswathana, 2013; Jong et al, 2014). Substituted chromones are peculiar compounds in agarwood, because they have been obtained from only a few plant species, such as *Cucumis melo* L. var. *reticulatus* Naud. (Cucurbitaceae) (Ibrahim et al, 2010) *Imperata cylindrical* L. (Gramineae) (Yoon et al, 2006), and *Bothriochloa ischaemum* (L.) Keng (Gramineae) (Wang et al, 2010), and *Aquilaria* spp.

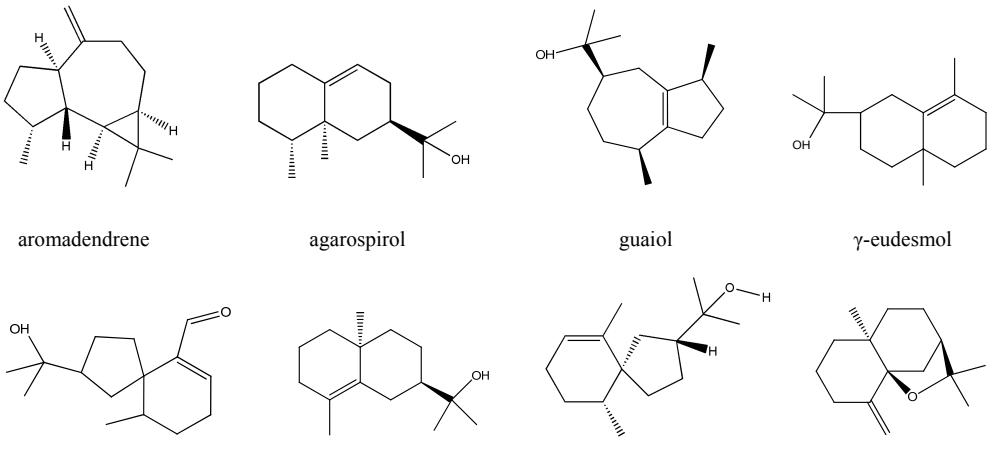
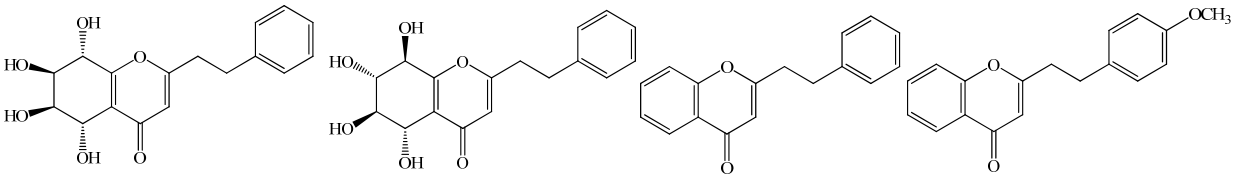


Figure 4 Chemical structures of main sesquiterpenoids

(Thymelaeaceae). So far, 39 different 2-(2-phenylethyl) chromones have been identified in various agarwood (Naef, 2011; Lancaster and Espinoza, 2012; Espinoza et al, 2014), responsible in a great part for the warm, sweet, balsamic, long lasting odor when agarwood is burnt or heated. Those specific compounds may be used as markers for the authenticity and quality of agarwood. The substituted chromones within agarwood of different grades have also been studied. Thin-layer chromatography techniques have been used to analyze agarotetrol and isoagarotetrol (Figure 5) to related with the agarwood market grading specifically on middle-grade agarwood from Kalimantan (Shimada et al, 1982) and high-grade agarwood from Hong Kong, Singapore, and Vietnam traders (Shimada et al, 1985). High-grade samples (n = 100) classified by *kyara* were tested in chromone content, and it was discovered that chromone content could be used to distinguish *kyara* from low quality agarwood (Ng et al, 1997; Yoneda, 1998). Yagura et al (2005) and Dai et al (2009) isolated chromones from agarwood resin using column chromatography techniques. Such chromones, detectable through thin-layer chromatography, may be useful for the identification of agarwood. Lancaster and Espinoza (2012) utilized direct analysis in real time time-of-flight mass spectrometry (DART-TOFMS) to detect 2-(2-phenylethyl)chromones. The methods provide reproducible mass spectra that are useful for inferring the genus of suspected agarwood samples. The contents of 2-(2-phenylethyl)chromone and 2-[2-4-methoxy-phenylethyl]chromone are over 66.47% in high-quality agarwood, and outstanding higher than low-quality agarwood (Yang et al, 2014; Figure 5). The high-quality agarwood can be distinguished. But there is no significant regularity between different agarwood, even though which is from different origins or different species.



agarotetrol isoagarotetrol 2-(2-phenylethyl)chromone 2-[2-4-methoxyphenylethyl]chromone

Figure 5 Typical 2-(2-phenylethyl) chromone compounds

Generally, pharmacologically active compounds are absolutely necessary index on the quality control for medicinal materials. Though agarwood is a traditional medicinal product, few studies have been focused on seeking for pharmacologically active compounds. According to previous studies, Jinkoh-eremol (Yoshii et al, 1978; Figure 4) and agarospirol (Wetwitayaklung et al, 2009; Figure 5) showed antimicrobial activity on the central nervous system of mice. Thus, the content of pharmacologically active compound may be acceptable in assessing and grading agarwood quality. Actually, agarospirol quantitative determination is used for agarwood quality control firstly in legal be regulated in *Chinese Pharmacopoeia* 2015, but there is no report to prove that the ararospirol content is positive correlation with agarwood quality.

Moreover, China has paid more attention to the origin of agarwood, and the Hainan agarwood from Wanning, China, has been recommended as the top-quality one. Agarwood as a very important ingredient in traditional Chinese medicines is recorded and standardized in the early edition of *Chinese Pharmacopoeia*. But only agarwood from *A. sinensis* and *A. malaccensis* can be used as officinal medicine officially. The ethanol soluble extract was first used to assess the quality of agarwood from the 1977 edition of *Chinese Pharmacopoeia*. Generally, agarwood of high quality has a higher yield (Liu et al, 2013). But, in the 2005 edition of *Chinese Pharmacopoeia*, the yield of alcohol soluble extract of agarwood should be less than 10%, the yield value is reduced from 15%.

4. Agarwood trade relations of the world

Agarwood-producing species are found only in areas covering India eastwards throughout the Southeast Asia, as well as southern of China. Indonesia and Malaysia are the major countries in origin of agarwood, form the Sin-Chew Zone. Also China, Cambodia, India, Lao PDR, Myanmar, Vietnam, and Thailand are reported as country origins of agarwood, form the Hoi-An Zone.

The United Arab Emirates is an important importing, re-exporting and consuming country within the "Middle East" agarwood market, and is connected to other agarwood-consuming countries in this region including Saudi Arabia, Kuwait, Bahrain, and Qatar. Japan is not an origin country for any agarwood-producing species. But in the agarwood global trade, Japan ranks behind the United Arab Emirates and Saudi Arabia as the most important end-destination markets. As we known, Arabs love perfume. Thus, United Arab Republic is the largest consumptive area for agarwood essential oil. Consequently, the scent and essential oils content are taken into account for the agarwood essential oil manufacturer (Hidayat et al, 2010; Jayachandran et al, 2014).

Hong Kong, Singapore, and Bangkok also play important roles as entrepots to supply agarwood with consuming countries. In all markets, agarwood grading standard usually becomes more sophisticated while the supplying chain is moving down, different countries/regions have different classification systems according to their usage mode or purpose, and even different-level traders/retailers

have their own grading methods.

5. Discussion

Agarwood is the precious and most expensive resinous wood used as incense in *kodo* or religious ceremonies, as crude medicine, or as raw material of essential oil that highly appreciated in perfumery. In the traditional systems of quality assessment grading, agarwood was simply divided into different grades in trade fair based on the organoleptic descriptions with their subjective experiences. Meanwhile, in the modern systems of quality assessment grading, agarwood grading was taken into account only from the simplex aspect, leading to the confusion of agarwood assessment. Indeed, there is not any standard grading system for agarwood throughout the whole industry and commerce. This puzzle hinders the production and trade for agarwood in the globe all the time.

For the absence of a standard grading system, the grade of agarwood products is always flexible and subjective. Because the nonstandard classification has often been misapplied, there are amounts of fake or adulterated agarwood currently available in China, and it is the same in the other agarwood-consuming countries (Anon, 2004).

The commercial value of agarwood depends on many factors including resin content, texture, scent, shape, and color. Retrospect to the discussion above all, we attempt to provide the following two principles for the agarwood grading.

5.1 Emphasize on origin or species

The grades of agarwood classification based on origin used within different country/region may vary widely. The particular quality of agarwood from different countries of origin has regarded as "brand names". What's more, even all species in the genus *Aquilaria* Lam. are believed to producing agarwood, but the qualities are varied. Therefore, traders should establish a standard that classified primarily by the original country/region or tree species (that list on Appendix A), then by other characters of agarwood quality.

5.2 Emphasize on use

Consumers in different countries have different priorities for assessing the agarwood quality, which is related to their aims of use.

As a consequence, customers from the Middle East consider scent to be the most important quality and in India a significant quantity of agarwood oil is used for perfumery, hence the scent is of prime importance. For essential oil manufacturers, the essential oil content of agarwood is the other important index that should be considered in the bulk purchase.

Chinese consumers buy substantial agarwood for medicinal purposes and in such cases it is not the scent or color, but the active constituents and safety that are appreciated most. Actually, more strict and scientific quality standard has been published in the *Chinese Pharmacopoeia* 2015.

For incense or *kodo*, the resin content, color or shape of agarwood has not be considered. But the scent and its fragrant constituents are the major element in the ceremony to appreciate the agarwood. Therefore, the fragrant constituents may be detected and determined quantitatively, and further used to assess the quality of agarwood for incense or *kodo* usage.

For agarwood artware, resin content, texture, color, or shape of agarwood are the bases of an excellent work. Thus, an agarwood with unique form and beautiful resin usually is traded as a high price. Obviously the originality and post production are keys to promote agarwood value.

Appendix A

The 19 accepted species of *Aquilaria* Lam. in alphabetical order (areas of growth in brackets) are *Aquilaria apiculata* Merr. (Philippines), *A. baillonii* Pierre ex Lecomte (Cambodia), *A. banaensis* P. H. Hô (Vietnam), *A. beccariana* Tiegh (Borneo, Brunei, Sarawak, and Sumatra), *A. citrinicarpa* Hallier f. (Philippines), *A. crassna* Pierre ex Lecomte (Cambodia, Laos, Thailand, and Vietnam), *A. cumingiana* Ridl. (Philippines), *A. filaria* Merr. (Philippines), *A. hirta* Riedl. (Malaysia), *A. khasiana* Hallier f. (India), *A. malaccensis* Lam. (northeastern India, Burma, Malaysia, Sumatra, Borneo, and Philippines, synonym: *A. agallocha*), *A. microcarpa* Baill. (Borneo, Sarawak, and Sumatra), *A. parvifolia* Ding Hon (Philippines), *A. rostrata* Ridl. (Malaysia), *A. rugosa* Kiet & Kessler (Vietnam), *A. sinensis* (China), *A. subintegra* (Thailand), *A. urdanetensis* (Philippines), and *A. yunnanensis* S.C. Huang (China).

Appendix B

Kyara: sourced from Vietnam, originating from the Sanskrit *kara*, meaning "black". It is the highest quality in variety of agarwood and possessing all five component flavours. *Kyara* is prized for its noble and elegant scent as an aristocrat in its elegance and gracefulness.

Rakoku: sourced from Thailand, possessing a sharp and pungent smell similar as sandalwood, and possessing bitter, salty, and hot flavours.

Manaban: sourced from the east coast of India, with a great variety of scents and rich in resin ingredients, and possessing mostly sweet flavours but coarse and unrefined, like a peasant.

Manaka: sourced from Malacca of Malaysia. Among the scented woods, this type has a rather shallow scent and is not strongly related to any of the five flavours, which is light and changeable like a woman's feelings.

Sasora: sourced from western India and other countries/ regions, possessing a quiet scent with a light and faint flavour.

Sumatora: sourced from Sumatra of Indonesia, rich in resin ingredients and sour at the beginning and end.

Conflict of interest statement

The authors declare no conflict of interest.

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