Characterization of Agarwood Distil Water Based on Different Time Interval

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Abstract*— Agarwood distil water or known as hydrosol is obtained by using hydrodistillation method. Agarwood distil water is widely used in medicine since it contains high anti-oxidant and antibacterial properties that will improve the human health. The aim of this study is to analyze the characterization of Agarwood distil water from *Aquilaria malaccensis* at different time interval by using Fourier Transforms Infrared (FTIR) spectroscopy and Gas Chromatography-Mass Spectrometer (GC-MS) and also to make water quality test by using Inductive Couple Plasma (ICP). The functional groups has been successful identified which there were presence of same functional groups for each hydrosols samples at different time interval such as alcohol group, alkene group, alkyne group and also aromatic ring alkane group. It showed that the different time interval did not affect the functional groups. Then, there were about 48 chemical compounds of hydrosol have been successful identified and the different chemical compounds were found for the different time interval. In this work, 1,2,4,5-Tetrazine, 1,4-diethylhexahydro was the main compound found in hydrosol. Lastly, all the samples of these hydrosols did not contain any heavy metals and safe to be used as medical treatment. In conclusion, the hydrosol from hydrodistillation process contains 1,2,4,5-Tetrazine, 1,4-diethylhexahydro which is potentially used is the treatment of diarrhoea and worm infections, and also used to treat the involuntary movements (chorea) of Huntington's disease or progressive brain disorder that causes uncontrolled movements, emotional problems, and loss of thinking ability.

Keywords*— Agarwood, hydrodistillation, *Aquilaria malaccensis, agarospirol, jinkohol, jinkoh eremol, kusenol.

I. INTRODUCTION

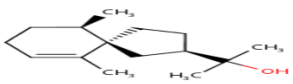
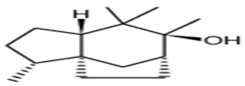
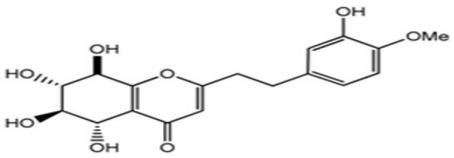
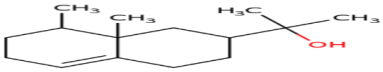
Agarwood or commonly known as gaharu, aloeswood, jinkoh, oud, agallocha and eaglewood is found in *Aquilaria* species which comes from family of *Thymelaeaceae*. *Aquilaria* is basically a woody plant which is inherent in Southeast Asia (Tetsuro Ito *et al.,* 2012). Agarwood has about 15 species and there are four species are found in Thailand which their specific names are *Aquilaria Crassna, Aquilaria Baillonil, Aquilaria Subinteqra* and *Aquilaria Malaccens* (Penpun Wetwitayaklung *et al.,* 2009). Generally, Agarwood has a few grades namely, A, B, C and D that is classified according to its physical properties, formation and unique scent. Agarwood is very highly valuable fragrant woods because it contained economically essential oil and hydrosols with its aromatic unique product (Nuttawan Yoswathana *et al.,* 2013). It is widely used in many industries including medicine, cosmetics, perfume and aromatherapy industries (Mohamed *et al*., 2013). It also plays an important role in Chinese Traditional Medicine for obvious medicinal effects as a sedative and carminative, and to relieve gastric problems, coughs, rheumatism and high fever (Yangyang Liu *et al.,,* 2013). There are three forms of Agarwood that have sold which are in form of pieces of heartwood, heartwood oil and heartwood powder. The heartwood is burned to produce the aromatic vapor in houses and also in shrines (N. Ismail *et al.,* 2016). The powder form of wood is used as incense and medicine. The figure below shows the whole plant of Agarwood, and the cutting of stem of one week, 6 months and 20 months old Agarwood.

Fig.1: (A) Agarwood's Whole Plant, (B) One Week Agarwood, (C) 6 Months Agarwood, (D) 20 months Agarwood (Janey Alam *et al.,* 2015)

The Agarwood distil water are very expensive because the production yield during extraction are low and increasing in international demand (Mohd Farid *et al.*, 2010). Basically, the good quality Agarwood's price can achieve to RM10,000 per kg based on the resinous wood's grade. Meanwhile for other qualities of Agarwood oil are sold about RM50 to RM200 per 12 g. The common methods that have been used to extract the oils and distil water from the plants are including hydrodistillation, supercritical fluid carbon dioxide extraction (SFE), steam distillation and solvent extraction (Muhammad Hazwan *et al.,* 2013). The classical method that used to extract the Agarwood oil is by using hydrodistillation method. This method takes about 7-10 days and is guarantee safe to operate. Then, supercritical fluid carbon dioxide extraction (SFE) method is better than hydrodistillation method as it has high diffusivity, low viscosity, non-toxic, nonflammable, consume less energy, good transport properties and extraction, chemically stable and produce high yields.

Generally, the fragrance substances or aromatic of resin of Agarwood essence is belonging to the sesquiterpene and has particular chemical structure (Adi *et al.,* 2016). Sesquiterpenes can be classified as the main active constituents that have important function which is giving the scent, pleasant odor and unique aroma of agarwood (Yumi *et al.,* 2014). Sesquiterpene usually has properties of anti-allergy and anti-inflammatory. There are about 15 carbon atoms that contained in the sesquiterpenes and also have multifaceted pharmacological actions. This sesquiterpene not only found in Gaharu but also can be found in floral oils like rose and chamomile. The important chemical compounds that contained in Gaharu which contribute to the scent of Gaharu are agarospirol, jinkohol, jinkohol-eremol and khusenol.

Table 1: Chemical Compounds in Agarwood (Seri Chempaka Bt. Mohd. Yusof *et al.,* 2012)

Name of Chemical Compound	Chemical Structure
Agarospirol	
Jinkohol	
Jinkohol-eremol	
Kusenol	

The objective of the current research was to identify the characterization of hydrosols at different time interval by using Fourier Transforms Infrared (FTIR) spectroscopy, gas chromatographic-mass spectrometer (GC-MS) and Inductive Couple Plasma (ICP).

II. METHODOLOGY

A. Materials and Instruments

Agarwood of *Aquilaria malaccensis* species that used in this study were obtained from natural population of Kuala Krai, Kelantan in September 2017, distilled water, hexane, Fourier Transforms Infrared (FTIR) spectroscopy (Perkin Elmer 2000 Model), gas chromatographic-mass spectrometer (GC-MS) model Varian 240-MS completes with the 450-GC with a Combi PAL autosampler from CTC Analytics, Inductive Couple Plasma (ICP) Spectrometer (ThermoFisher Scientific) with brand or model is iCAP 6000 series, 1 Liter of separation funnel, hydrodistillation (extraction facilities), grinder, 50 ml of beakers, 50 ml of measuring cylinder, dropper, 20ml of pipette, seven unit of 500 ml plastic bottles, volumetric flask and vial cronus clear 12 x 32mm.

B. Preparation of Plant Materials

About 25 kg of dried Agarwood were ground by using grinder machine. The large trunk of Agarwood was chopped into the smaller size. This is done in order to obtain the maximum surface area for the process of extraction and also to give maximum contact time between the particle of Agarwood and the solvent.

C. Hydrodistillation Method

In this study, the type of extraction method that has been used is hydrodistillation process. The hydrosol was extracted from *Aquilaria sp* of family Thymelaeaceae. About 25 kg dried Agarwood was extracted by using extraction facilities. The experiment was run continuously for 48 hours. Before the time of extraction process was taken, the system was left for 15 minutes to equilibrium state. It is to ensure the process of extraction was conducted in stable condition.

By using hydrodistillation process, the material of plant which is Gaharu will be immersed in the water which is in heated still. This process was conducted under atmospheric pressure and a reduced pressure. The ratio of solid-to-water is usually 1:50 g/mL is applied during this process. Then, the steam of water and essential oil will be produce and will leave the hot suspension. It will then condense, collected and is separated by using decantation. It will obtain two products which are essential oil and the hydrosol or floral water. This hydrosol is actually contained the constituents of the essential oil.

Hydrodistillation was conducted at various time starting with 12 hours, 18 hours, 24 hours, 30 hours, 36 hours, 42 hours and 48 hours to collect the gaharu distil water in a bottle. The extraction process was started at 6pm on 14th March 2018. About 40ml of gaharu distil water was collected in a bottle every 6 hours which is until 6am of 16th March 2018. The hydrodistillation process cannot be exceeding the temperature of 120^{0}C to avoid the plant material from burning. The temperature of this extraction process is constant about 100^{0}C.

During the distillation process, the vapor that consist of volatile compounds and steam were rise to the condenser from the extractor, where two phases of immiscible liquid are formed which are known as Agarwood oil and aromatic water (hydrosol). The oil of Agarwood which is lighter than hydrosol was separated from the hydrosol and located at the top of the separation funnel, meanwhile the hydrosol is formed below the Gaharu oil. 40ml of hydrosol was collected for every 6 hours in the 250ml of plastic bottle in order to analyze their chemical profiling and evaluate the quality of hydrosol.

D. Physiochemical studies of hydrosol

The hydrosol that obtained from extraction of Agarwood (hydrodistillation) were tested in order to obtain the characterization or chemical profiling, functional groups and also to study the water quality. For the chemical profiling, it was analyzed by using gas chromatographic mass spectrometer (GC-MS), then for functional groups identification was using Fourier Transforms Infrared (FTIR) spectroscopy. Meanwhile for water quality, Inductive Couple Plasma (ICP) was used to test whether there were the presence of heavy metals or not such as Arsenic (Ar), Magnesium (Mg), Ferum (Fe), Zinc (Zn), Lead (Pb) and Cadmium (Cd) at various production temperatures.

E. Characterization of hydrosol by Fourier Transforms Infrared (FTIR)

All hydrosols were characterized by FTIR spectroscopy (Perkin Elmer 2000 Model) to identify the active functional groups that presence in hydrosol. The FTIR study was carried out by using the Perkin Elmer System 2000 FTIR instrument. First, the transparent Pellets (thin disc) were formed by mixing 5mg of the sample with 100 mg of potassium bromide (KBr) (1:20) using a mould and press, and compressed under a pressure of 7 ton. The investigation was performed within the wavelength ranging from 4000 to 400 cm-1 and the spectrum takes about three minutes to be recorded. The acquisition of the spectra and peaks assignment was performed using FTIR software Spectrum 3.02.01 (Perkin Elmer, Inc., Waltham, MA). Lastly, comparison between the resultant spectrums with the standard for entirely functional groups was conducted.

F. Preparation of Sample Hydrosol in Hexane

About 1ml of hydrosol of each seven samples of hydrosols was filled up into the seven different beakers by using pipette. Then, 10

ml of hexane was pipetted into each beaker that contained hydrosol. The solution was shaking for 2 minutes to make sure the mixture was well mixed. After that, visually observe the solution if there was any layer formation. The two layers were formed which were hexane layer and hydrosol. Then, about 1 ml of the hexane solution's layer was transferred into the vial cronus clear 12 x 32mm by using dropper. Then, the solution was analyzed using GC-MS to analyze the chemical constituents in hydrosol.

G. Study of chemical compounds by Gas Chromatography Mass Transfer (GC-MS)

Hydrosol composition was studied by GC-MS analysis using a Hewlett Packard gas chromatograph (GC 5890) coupled with a mass selective detector (5972) (Hewlett Packard, Palo Alto, USA). Separation of the analytes by gas chromatography was carried out using a silica capillary column (30 m length, 0.25 mm diameter, 0.25 mm film thickness) of HP-5MS (Hewlett Packard). Separation of the compounds involved injection of 1.0 mL of the hydrosol into the front inlet of the gas chromatograph operating at 250°C in the splitless mode. The flow rate of the carrier gas, helium, was 2.0 mL/min with a 1:50 split ratio. The oven program commenced at 80°C, where it was held for 2 min and then increased at a rate of 10°C/ min to 250°C, where it was held for 10 min. The interface temperature was 250°C. Ionization of the analytes by electron impact (EI) was obtained using an emission current of 70 eV. The ion source temperature was set at 250°C and the scan scope was set from 32 to 500 amu. The compounds were characterized by database matching and comparison of their MS spectra with existing data in the Wiley and Adams library search data.

H. Water quality test for heavy metal by using Inductive Couple Plasma (ICP)

The Agarwood distil water was undergo heavy metal test which were analyzed by using Inductive Couple Plasma (ICP) system (ThermoFisher Scientific) with brand or model is iCAP 6000 series. This test was conducted to make sure whether there was present of heavy metal or not in the Agarwood distil water. We must make sure that the results are not containing any heavy metals in this hydrosol because those elements can give a risk to human health if they use this hydrosol.

III. RESULTS AND DISCUSSION

A. Hydrodistillation Extraction

By using hydrodistillation method, the 25 kg dried Agarwood could gave about 1 litre of Agarwood distil water or known as hydrosol. This extraction process of hydrosol was run continuously about 48 hours. However, in this study, the hydrosols were collected at various time of extraction process starting with 12 hours, 18 hours, 24 hours, 30 hours, 36 hours, 42 hours and 48 hours by collecting hydrosols in the bottles. The extraction process was started at 6pm on 14th March 2018. About 40ml of hydrosol was collected in each bottle every 6 hours which is until 6am of 16th March 2018. The samples of hydrosols have been collected about 7 bottles with different time of extraction process. All samples were clear in color like normal water. All these samples were analyzed by using Fourier Transform Infrared (FTIR), Gas Chromatography-Mass Spectrophotometer (GC-MS) and Inductive Couple Plasma (ICP).

B. Characterization of hydrosol by Fourier Transforms Infrared (FTIR)

All the seven samples of hydrosols were characterized by using FTIR. By using FTIR analysis, the characteristic of the absorption peak such as scope and location of hydrosols chemical contents or the functional groups could be identified. About a few drops of each sample of hydrosols were used during FTIR analysis. The infrared spectra of all the samples of hydrosols were taken and evaluated. All the spectrums did not present major changes of peaks for Agarwood distil water at various extraction process. Figures 2 (a-g) show the IR spectrum of all the samples hydrosols that were collected respectively.

Base on the result, O-H bond of hydrogen bonded alcohol or phenol (3600-3200 cm-1) group frequency was present in all sample of hydrosols which at different time extraction process with frequency of 3309.49 cm-1, 3309.67 cm-1, 3309.02 cm-1, 3309.68 cm-1, 3309.74 cm-1, 3308.97 cm-1 and 3308.68 cm-1 respectively. A broad spectrum can be detected from the figures below that denote the availability O-H bond. This is the very important part because the presence of O-H bond indicates the existence of phenolic compound in the hydrosols. This finding was considered successful because it was same as proposed by Khalil et al., (2013) where they had identified the presence of alcohol or phenol functional group in Agarwood or hydrosol.

Then, the band of most prominent in alkynes resembles to the carbon-carbon triple bond. The alkyne C≡C-C stretch (2260-2100 cm-1) group frequency was identified in all samples of hydrosols with frequency 2101.49 cm-1, 2155.24cm-1, 2116.73cm-1, 2134.91 cm-1, 2116.25cm-1, 2067.66cm-1 and 2115.13cm-1 respectively. There was very little organic compounds show an absorption in this region. All these frequencies illustrate as a sharp and weak band at around 2100 cm-1. The band was weak because of the triple bond that was not very polar. In certain cases, such as for the highly symmetrical alkynes, it might not represent at all because of the polarity of the triple bond was low linked with those alkynes.

Next, H-O-H bond (1640-1630cm-1) group frequency was also present in all samples of hydrosols at frequency of 1636.49 cm-1, 1636.36 cm-1, 1636.44 cm-1, 1636.36 cm-1, 1636.40 cm-1, 1636.50 cm-1 and 1636.45 cm-1 respectively. All the samples contained H-O-H bond from water since the Agarwood hydrosol itself is a homogenous mixture of water and Agarwood sesquiterpenoids. From this evidence, it is expected that all these samples of hydrosols have majority of Agarwood sesquiterpenoids.

Last but not least, C-C bond of aromatic ring (1500-1400 cm-1) group frequency was identified in all samples of hydrosols with frequency at 1497.69 cm-1, 1497.90 cm-1, 1497.95 cm-1, 1497.88 cm-1, 1497.90 cm-1, 1497.98 cm-1 and 1498.07 cm-1 respectively. This aromatic ring was synonym with the characteristic of hydrosol that gave out the distinctive Agarwood aroma. Table 2 shows the functional groups of hydrosols that obtained from this study.

Table 2: Functional groups of hydrosols from *Aquilaria malaccensis*

Band assignment	Functional Group	Group band (cm^{-1})
O-H	Alcohol/Phenol	3600-3200
In ring C-C stretches	Aromatic Ring Alkane	1500-1400
C≡C-C Stretch	Alkyne	2260-2110
H-O-H	Alkene	1640-1630

Figure 2 (a-g) show the plots of FTIR for Agarwood distil water that has been extracted at various time or temperature.

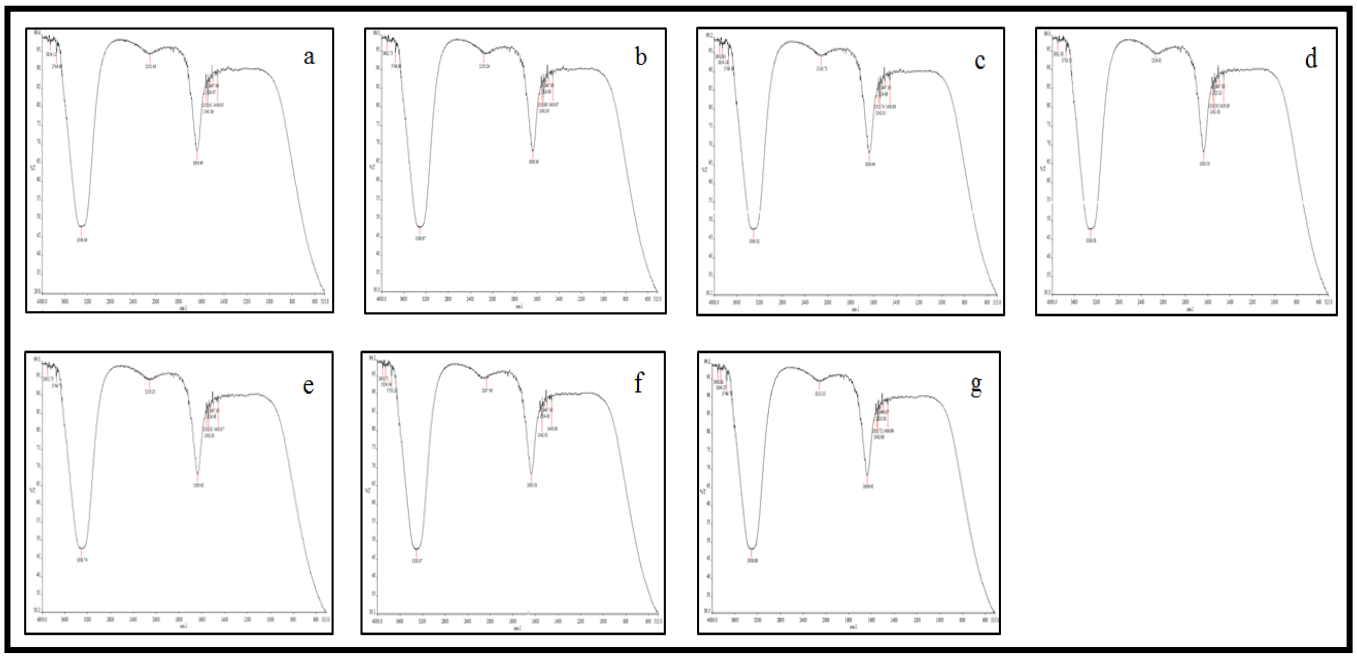


Fig.2: FTIR Spectrum for Agarwood distil water (a) For 12 hours extraction process, (b) For 18 hours extraction process, (c) For 24 hours extraction process, (d) For 30 hours extraction process, (e) For 36 hours extraction process, (f) For 42 hours extraction process, (g) For 48 hours extraction process

Table3 shows the summary of characteristic peaks bands on FTIR spectra for all the sample hydrosols at various time of extraction process.

Table 3: Summary of characteristic peaks bands on FTIR spectra

Functional groups (bands)	**Wavenumber (cm^{-1})**						
Time of extraction process	**12 hours**	**18 hours**	**24 hours**	**30 hours**	**36 hours**	**42 hours**	**48 hours**
-OH stretch	3309.49	3309.67	3309.02	3309.68	3309.74	3308.97	3308.68
C≡C-C stretch	2101.49	2155.24	2116.73	2134.91	2116.25	2067.66	2115.13
H-O-H water	1636.49	1636.36	1636.44	1636.36	1636.40	1636.50	1636.45
C-C aromatic stretching	1497.69	1497.90	1497.95	1497.88	1497.90	1497.98	1498.07

As a conclusion, it was found that all samples of hydrosols from various extraction time consists the alcohol or phenols functional groups that were very useful in order to prove the presence of phenolic compounds inside the hydrosols. Then, the presence of H-O-H bond from water since the Agarwood hydrosol itself was a homogenous mixture of water and Agarwood sesquiterpenoids. Next, the presence of C-C bond of aromatic ring was very important because that aromatic ring gave the pleasant smell of hydrosol. Besides, the patterns of FTIR spectrum for all the samples were quite similar in which the entire spectrum did not show significance change of peaks. So, it means that the different time of extraction process or different production temperature did not affect the pattern of FTIR spectrum because all of the samples hydrosols had almost same functional groups. The spectrum of all samples of Agarwood hydrosols were recorded at range of 4000 – 400 cm-1 (mid infrared spectroscopy) at 4 cm-1 resolution (FTIR model: Nicolet Avatar 370 DTGS).

C. Characterization of hydrosol by Gas Chromatography Mass Transfer (GC-MS)

GCMS was used to detect the chemical contents in hydrosol. Basically, all of the Agarwood were complex mixtures of sesquiterpene hydrocarbons, sesquiterpene alcohols, aromatic compounds, and aliphatic hydrocarbons that very difficult to be identified based on MS alone where the chemical compounds of Agarwood should be identified by comparing the mass spectral data with the existing Wiley library and reference library spectral data (Nor Azah M.A et al., 2008).

In this study, seven hydrosols samples of different time process extraction were identified by GC-MS analysis. The chemical compounds that were detected in this hydrosol by GC-MS instruments were 48 in total as listed in table 4.3. According to the result, it was found that the chemical component that was present in almost samples was 1,2,4,5-Tetrazine, 1,4-diethylhexahydro. This showed that 1,2,4,5-Tetrazine, 1,4-diethylhexahydro was the main compounds found in hydrosol at different time interval. 1,2,4,5-Tetrazine, 1,4-diethylhexahydro formula was $C_6H_{16}N_4$ with molecular weight of 144.21804 g/mol. This compound is used in the treatment of diarrhea and worm infections, and also used to treat the involuntary movements (chorea) of Huntington's disease or progressive brain disorder that causes uncontrolled movements, emotional problems, and loss of thinking ability.

From the results, it indicates that there were some differences and variations in the chemical composition of hydrosol at different time. According to Jutarut Pornpunyapat *et al.,* (2011), the different extraction process time will effect on the chemical compounds of hydrosol. The higher number of chemical components should be result at longer extraction time. So, this study was similar to the findings by Jutarut Pornpunyapat *et al.,* (2011) because the results showed the differences of chemical contents in all samples at different production time. Meanwhile, for the number of chemical components, the result showed that the

number of chemical component in hydrosol was increased from hour 12 until hour 36 which were from 8 to 15 of chemical components. Then it was decreased at hour 42 and hour 48. The decreasing in number of chemical components means that there was something wrong because it should be the higher number of chemical compounds when the production time was longer.

This failure may cause by the incorrect preparation of sample hydrosol in hexane. In this study, the solvent extraction had been conducted before the analysis of GC-MS was done. The reason of conducting this solvent extraction was because of the sample of this hydrosol was water based solution, so that it should undergo the solvent extraction which was by using the hexane as a solvent in order to give a better sensitivity for the GC-MS test. It is because GC-MS instrument could not handle the sample from the water base solution and it also had a potential to cause the damage of column. It should inject the extracted sample in the GC-MS because it could not detect the chemical component from the water based. However, this step of solvent extraction also did not give the best result. It might cause of the ratio of sample to hexane were not suitable. The ratio of sample to hexane that was used in this study was 1:10. It might be the solvent could not extract the ion in sample properly because the content of sample was too little. Hence, another step should be done in order to get the most accurate results. Table 4 shows the chemical compounds of the all samples.

Table 4: Compounds Identified From GC-MS Analysis of Hydrosol

No	Compounds	Chromatogram Area (%)						
	Time of extraction process	**12 hours**	**18 hours**	**24 hours**	**30 hours**	**36 hours**	**42 hours**	**48 hours**
1	Pentane, 3-ethyl-2,2-dimethyl	0.2120	-	-	0.3690	-	-	-
2	2-Octanol, 8,8-dimethoxy-2,6-dimethyl	0.0466	-	-	-	-	-	-
3	1,2,4,5-Tetrazine, 1,4-diethylhexahydro	0.0459	-	0.0612	0.0967	0.0665	-	0.1140
4	Allyldimethyl(vinyl)silane	0.0057	0.0352	0.0284	-	-	-	-
-5	2,2-Dimethylpropanoic anhydride	0.0046	-	-	-	-	-	-
6	3H-1,2,4-Triazol-3-one, 1,2-dihydro	0.0056	0.0058	-	0.0102	-	-	-
7	Oxalic acid, cyclohexyl propyl ester	0.1760	-	-	-	-	-	-
8	Oxalic acid, butyl cyclobutyl ester	0.0213	-	-	-	-	-	-
9	2-Isopropyl-3-vinyloxirane	-	0.6600	0.2570	-	-	-	0.6870
10	4-Methoxypyrrolo[2,3-d]pyrimidine	-	0.0056	-	-	-	-	-
11	Thiazole	-	0.0040	-	-	-	-	-
12	1H-Tetrazole, 1-methyl	-	0.0094	-	-	-	-	-
13	2-Methyl-1,5-hexadiene-3-ol	-	0.0029	-	-	-	-	-
14	Acetamide, N-(2-hydroxyethyl	-	0.0490	-	-	-	-	-
15	Silicon tetrafluoride	-	0.0019	-	-	-	-	-
16	Oxalic acid, cyclohexyl hexyl ester	-	-	-	-	-	-	0.2520
17	Nonane, 2,2,3-trimethyl	-	-	1.1600	-	-	-	-
18	2-Propynal	-	-	0.0159	-	-	-	-
19	1-Pentanol, 4-methyl	-	-	0.0161	-	-	-	-
20	Cyclobutanecarboxylic acid, 2-propenyl ester	-	-	0.3480	0.1580	-	0.3900	-
21	Butane, 1-chloro	-	-	0.0187	-	-	-	-
22	(Trimethylsilyl)acetylene	-	-	0.0138	-	-	-	-
23	1-Hexene, 4-methyl	-	-	-	0.6060	0.6240	0.2250	-
24	Trimethylaluminum	-	-	-	0.0003	-	-	-
25	Thiopivalic acid	-	-	-	0.0527	-	-	0.0640
26	6-Heptene-2,4-diol	-	-	-	0.0361	-	-	-
27	Hexanoic acid, 2-oxo-, methyl ester	-	-	-	0.0085	0.0182	-	0.0090
28	2-Pentanone, 5,5'-oxybis	-	-	-	0.0606	-	-	-
29	Cyclopropane, 2-bromo-1,1,3-trimethyl	-	-	-	0.3430	0.3860	-	-
30	5-Nonanone	-	-	-	0.0181	-	-	-
31	Decane, 2,2,3-trimethyl	-	-	-	-	0.3130	-	-
32	4,8-Dioxatricyclo[5.1.0.0(3,5)]octane, 1-methyl-5-(1-methylethyl)	-	-	-	-	0.0008	-	-
33	Cyclopropanecarboxylic acid, but-3-yn-2-yl ester	-	-	-	-	0.0048	-	-
34	2-Pentanol, 5-methoxy-2-methyl	-	-	-	-	0.0805	-	-
35	S-Methyl 3-methylbutanethioate	-	-	-	-	0.0408	-	-
36	Hexane, 1-(3-butenyloxy)	-	-	-	-	0.0461	-	-
37	1-Penten-3-ol	-	-	-	-	0.0107	-	-
38	Butyric acid, 2,2-dimethyl-, vinyl ester	-	-	-	-	0.0247	-	-
39	2,6-Octadiene, 2,4-dimethyl	-	-	-	-	0.6360	-	-
40	6,6-Dimethyl-1,3-heptadien-5-ol	-	-	-	-	0.0943	-	-
41	Ethanone, 1-cyclobutyl	-	-	-	-	0.0283	-	-
42	Vinyldimethyl(hydroxymethyl)silane	-	-	-	-	-	0.0172	-
43	Pentanal, 2,2-dimethyl	-	-	-	-	-	0.0215	-
44	1-Propen-2-ol, formate	-	-	-	-	-	0.0059	-
45	2-Methylheptanoic acid	-	-	-	-	-	0.0035	-
46	Propane, 2-methyl-2-nitro-	-	-	-	-	-	-	0.0404
47	Azetidine	-	-	-	-	-	-	0.0458
48	1-Heptene, 3-methoxy	-	-	-	-	-	-	0.0042

D. Water quality test by using Inductive Couple Plasma (ICP)

By using Inductive Couple Plasma (ICP), the result was obtained as shown in table 5:

Table 5: Concentration Values of The Metals

Elements	Amount (mg/L)
Arsenic (As)	ND
Magnesium (Mg)	ND
Ferum (Fe)	ND
Zinc (zn)	ND
Lead (Pb)	ND
Cadmium (Cd)	ND

Base on the results in table above, the concentration values of the metals (As, Mg, Fe, Zn, Pb and Cd) for all samples could not be detected. Hence, it can be concluded that there were no presence of heavy metals in the hydrosols. So, the hydrosols were safe to be use in daily life and also as medical treatment.

IV. CONCLUSION

As a conclusion, the aim of this work which was the characterization of Agarwood distil water had been successful achieved at different time interval by using three analysis which were Fourier Transforms Infrared (FTIR) analysis, gas chromatographic-mass spectrometer (GC-MS) and Inductive Couple Plasma (ICP) . From FTIR analysis, the active functional groups of hydrosol that were found in this study were including O-H bond of hydrogen bonded alcohol or phenol, alkyne C≡C-C stretch, C-C bond of aromatic ring and also the presence of H-O-H bond from water. This work has revealed that the hydrosols from *Aquilaria malaccensis* consist of phenolic compounds. This was according to the presence of alcohol or phenols group in the Fourier Transforms Infrared (FTIR) analysis. The different extraction process time did not affect the pattern of FTIR spectrum. Next, by using gas chromatographic-mass spectrometer (GC-MS), we had successful identified about 48 total of chemical components in all samples of Agarwood distil water and the main compound that was found was 1,2,4,5-Tetrazine, 1,4-diethylhexahydro because it contained in almost samples. This compound is used in the treatment of diarrhoea and worm infections, and also used to treat the involuntary movements (chorea) of Huntington's disease or progressive brain disorder that causes uncontrolled movements, emotional problems, and loss of thinking ability. The longer the time of extraction process, the higher the number of chemical components. Lastly, by using Inductive Couple Plasma (ICP), the concentration values of the metals (As, Mg, Fe, Zn, Pb and Cd) for all samples could not be detected. Hence, it can be concluded that there were no presence of heavy metals in the hydrosols. So, the hydrosols were safe to be use in daily life and also as medical treatment.

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