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EFFECT OF SOAKING ON THE TEMPERATURE AND PH PROFILES IN AGARWOOD EXTRACTION

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Abstract - Prior to hydro distillation, pre-treatment of agarwood chips by soaking is essential to enhance the oil yield. Soaking technique used in this work is immersion technique, with water as soaking medium. During soaking, the pH fluctuates as a result of acid bleaching and minerals released from agarwood. It was found that extraction with soaked samples able to achieve stable temperature approximately 1 hour faster than unsoaked sample. Hence, soaking has play a vital role in agarwood overall extraction process.

Keywords **-** pH profile, temperature profile, soaking, agarwood

I. INTRODUCTION

Pre-treatment of agarwood as a step in overall agarwood distillation process is essential to enhance the oil recovery [8]. Soaking is the most common pre-treatment method used in agarwood oil extraction due to its simplicity. The immersion technique was used to soak the agarwood chips, while the soaking medium used was water.

The purpose of soaking in the agarwood extraction process is to open the oil glands of the agarwood, therefore enhance the oil yield. In order to open the oil gland, the soaking medium's environment need to change in order to disturb the natural surroundings of the cells. With turgor pressure, in altered condition such as acidic or alkaline, the cell structure can damage. Soaking the water makes the concentration of the minerals and essential compounds in plant cell are higher than the surrounding. Therefore, the minerals and compounds move from higher concentration to lower concentration.

On the other hand, current distillation process uses higher energy to extract agarwood oil. Since soaking process can help to enhance the oil yield, its effect on the process need to be investigate. The soaking effect toward the extraction process can be observed from the temperature profile during extraction. By damaging the plant structure before extraction process, it is expected that lower energy needed to break the oil glands.

II. MATERIAL AND METHOD

Material

The agarwood chips from the species *Aquilaria Malaccensis* were obtained from a plantation in Jengka, Pahang, Malaysia. Water was used for the soaking process. The gas supply for the stove is from the Petronas Liquified Petroleum Gas.

Material preparation

Control experiment consists of 125 kg of water added to copper pot for extraction process. For soaked wood, sufficient tap water was added to 25 kg agarwood until the wood is fully immersed into the water. The wood was left to soak for 7 and 14 days. After soaking, the wood collected and dried under the sun to remove the moisture. The moist woods were flipped over for every 2 hours to ensure even drying. The process followed by extraction process with 125 kg of water added into the distiller. Experiment repeated with unsoaked wood.

Sampling

During soaking, the pH of the soaking water was taken for every 2 days using calibrated pH probe (Mettler Toledo, FE20). The soaked wood were stirred evenly before the sample were taken. Initial temperature was recorded before the extraction process start. Temperature was measured using digital reader (FY400 PID CONTROLLER, TAIE). The temperature was recorded for every 30 minutes until 12 hours.

Extraction process

The distillation apparatus include condenser, receiving flask and digital thermometer. The experiment runs continuously for 12 hours. The distillation method used is a conventional water distillation technique. The distiller is a custom design, made of copper with the capacity of 250L. The distiller and its accessories were shown in Figure 1 below. The condenser used was fabricated by using stainless steel. Running water was used as heat exchanging medium.

The agarwood chips and water were added into the still with the ratio of 1:5 (weight/volume). It was left overnight to ensure all the agarwood chips are wet and fully immersed into the water. The initial temperature was recorded and the stove started. The temperature readings were taken for every

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30 minutes until 12 hours. The gas flow rate for heating was set at constant flow for entire experiment to ensure constant heating.

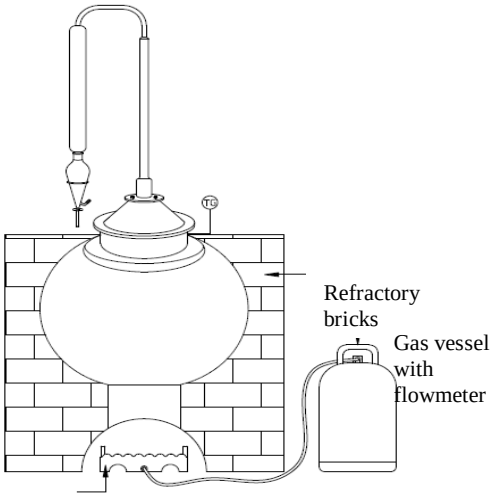

Figure 1 Costumed made distillation apparatus

III.RESULT AND DISCUSSION

Effect of soaking to temperature profile

The purpose of soaking in the agarwood extraction process is to open the oil glands of the plant cell [1], therefore enhance the oil yield. In order to open the oil gland, the soaking medium's environment need to change in order to disturb the natural surroundings of the cells. In an altered condition such as more acidic or alkaline, the environment in cells changes where content of plant cell move from higher concentration to the lower concentration

The extraction process was done for 12 hours to monitor the temperature profile. The readings were taken for every 30 minutes. It is observed from Figure 2 that Exp 2, 3 and Exp 4 able to achieved higher temperature (more than 100°C) compare to the control experiment. From the graph, control experiment cannot achieve temperature higher than 100°C. Boiling point of water at normal room temperature and atmospheric pressure is 100°C. The result suggests that addition of agarwood into the system increase the boiling points. The addition of the agarwood chips become impurities in the water and cause the changes in boiling points.

According to Pornpunyapat, J. et al (2011) [2], the temperature of distillation should not reach beyond 120°C because it may burn out the plant material. As observed from Figure 2, Exp 2, 3 and 4 does not exceeding 120°C and meeting the condition criteria. Sesquiterpenes were detected in the range of its boiling points from 250°C to 280°C [3][4]. Therefore when mixed with water, the mixture boiling point is higher compare to the blank experiment.

Figure 2 shows that Exp 2, 3 and 4 have similar temperature profile patterns. However, Exp 3 and 4 has achieved its temperature stability at least 1 hour faster than Exp 2, which explain that more heat were absorbed in the unsoaked wood in order to rupture the parenchyma cells and its oil glands [2]. Similar to previous work [5], it suggested that the compounds were hard to be extracted from the unsoaked agarwood. Hence, breakage of cell walls is an essential step for the essential oil extraction. This work shows that soaking activity speed up the extraction process. The heat supplied for the extraction process was less consumed at breaking the cell wall. Energy used more on vaporizing the volatile compounds. The compounds were carried by the steam along the condenser and finally collected as distillate.

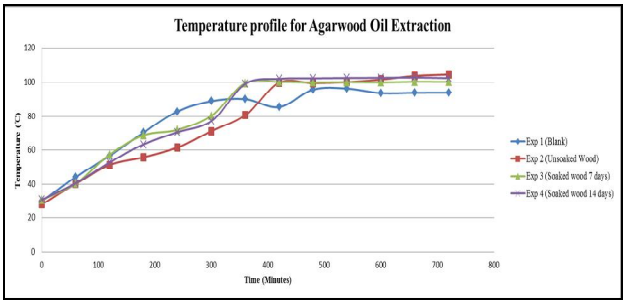

Figure 2 Temperature Profile of agarwood extraction process

Control experiment was able to become stable after approximately 4.5 hours and continue to maintain for the rest of the time. For Exp 2,3 and 4, the temperature is significantly increased at 5.5 to 6.5 hours

Effect of soaking to pH profile

From the experimental result, the soaking water becomes more acidic from Day 0 to Day 14 of soaking. Within this period, the acidic compounds leached from the plant material into the water. This has changed the water properties to be more acidic [6]. From Figure 3 show the comparison of lab scale and pilot scale soaking. However, the ratio of agarwood chips and soaking water for both lab and pilot scale were same. For lab scale experiment, 100 g of agarwood chips were added to 500 g water, while for pilot scale, the quantity was 25 kg agarwood chips and 125 kg of water. The pH profile pattern for both experiment are same.

The pH profile decreased approximately to pH 6.4 after 14 days while the initial pH was pH 7.0. Some compounds content in agarwood plant cells are acidic. The acidic solution results in soaking might suggest that there are acidic compounds leached out during the soaking time. The pilot experiment show slower pH changes compare to lab experiment. This is due to the larger volume compare to the lab experiment.

The fluctuation of the pH can be observed from Figure 3. The significant drops of pH at Day 12 shows that cells wall burst out and letting more acidic compounds to the soaking water. The increment in pH at Day 14 suggests that not only acidic compounds, but alkaline compounds releases from the cells too.

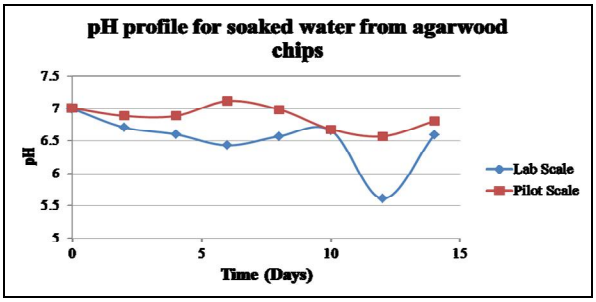

Figure 3 pH profile for soaked water from agarwood chips

Alkalinity from plant material could be come from the minerals present in the plant cell. Minerals such as potassium (K) and sodium (Na) needed for the plant growth. Previous studies on medicinal plant shows that minerals and heavy metals are present in these plants [7]. Na and mangan (Mn) is commonly present in medicinal plant including agarwood, therefore this explain the fluctuation of the pH during soaking. Readily available –OH group from water combines with Na ions from Na metals in the plant. After bleached out together with other compounds, these Na ions react with –OH group from water and form NaOH. The acidic environment of the soaking water become near to neutral due to NaOH formed. The process of acid bleaching and formation of alkaline compound keeps on occurring because it is coexist. Therefore, explain the fluctuation in the pH profile.

IV. CONCLUSIONS

It is concluded that soaking process help to speed up the extraction process. Indirectly, soaking process help to reduce the energy usage during extraction process due to cell ruptured before extraction. It is also concluded that soaking of agarwood chips in water by immersion technique affect the pH of soaking medium, where acidic compounds and minerals were leached out from the agarwood samples. It is hoped that the findings will benefits the agarwood oil producers across the world.

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