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An Improved Microwave Extraction Method for Distillation of Essential Oil from Piper Betle L

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Abstract: Botanically called as Piper Betel, Betel vine is a member of the pepper family "Piperaceae". The heart shape green leaves of the betel vine are widely known as Paan in India. The leaves are credited with lot of medicinal values and used in therapies like treatment of bronchitis, prevention of oral diseases. Fresh betel leaves are hydro-distilled utilizing a modified microwave oven with Clevenger Apparatus for extraction of essential oil. The yield was improved by raising microwave power and elevating leaves to water ratio. The time required by MAHD method (90minutes) was less in comparison to HD method (210 minutes) for complete extraction as microwave heating involves flow of heat more efficiently. The chief components were investigated by Gas chromatography (GC) coupled with Mass spectroscopy (MS) analysis. The outcome indicated the presence of compounds which possess wide applications including as antioxidant, anti-inflammatory, anti-bacterial and antifungal agents.
Keyword: Essential oil, Piper betel leaves, MAHD, Clevenger Apparatus, Gas chromatography

I. INTRODUCTION

Essential oils are majorly concentrated hydrophobic liquids extracted from flowers, leaves, stems, roots or seeds encompassed with volatile aromatic compounds. The oil is produced in the protoplasm present in cell plant and cumulated in the form of micro droplets. This oil is often used for flavoring in food industry and in Aromatherapy, a branch of alternative medicine. It shows profound impact on the central nervous system, relieving from anxiety and depression, thereby reducing the stress [8].The genus Piper is one of the largest and the foremost aromatic and medicinal plant belonging to the pepper family Piperaceae [1]. The dioecious vine of betel is perennial root climber cultivated throughout Southeast Asia [2].It requires well drained fertile sandy soil and suitable ecological conditions. About 45 varieties of betel vine are figured out in India which is grown as a cash crop. It is cultivated in Bihar, Uttar Pradesh, West Bengal, Orissa and Southern part of the country [6]. The leaf is known as Tamalapaku, Sompatra, Vettilaietc in different parts of the country [10].The commercial varieties of leaf on the basis of the flavor characteristics of the essential oil are 'Bangla', 'Cuttack', 'Sofia', 'Deswari' etc [17]. It is best grown in wide range of soil such as sandy loam, heavy clayey loam with good organic matter resulting in higher yield. Sterilization of soil is done before plantation as the soil temperature rises in month of March to May followed by covering with polyethylene sheets to inhibit the growth of soil borne pathogens [15].

The vine is raised by vegetative propagation of stem cutting with 3 to 5 nodes under shaded and humid climate inside a hut like structure called Boroj constructed with bamboo, banana leaves etc of approximately 2m height [4]. The open system using the aid of plants and artificial rectangular structure in closed system is the two commonly used cultivation method, practiced in India. Spacing of 70 to 100 cm is required depending on the cultivation done in various states. The support plants are grown 40-45 days before the betel leaf plantation is done to provide proper shade [7]. After a month, young shoot appear and frequently tied along the support using the fiber of jute or banana. Varieties of oil cake like Castor, Neem etc, manure of nitrogen and potassium are properly homonogenized in the topsoil [11]l. Harvesting of matured leaves begins in March ended in June depending on the climatic conditions of the cultivated state followed by plucking of leaves and its petiole. Further, leaves are grouped based on the quality and size for the proper regulation of the market system. Thus providing a continuous source of income and yielding a net profit sufficient for sustaining the life of a farmer family. Medically the leaves showed carminative, digestive and stimulant properties [12, 18]. The oil present in betel leaf inhibits the growth of bacteria causing typhoid, tuberculosis etc thus possessing the antibacterial and antifungal properties[9, 13]. It also shows expectorant properties that aids in expelling accumulated phlegm present in the lungs and the respiratory passages [16].commonly used methods to obtain essential oils from the plant materials are Hydro-distillation (HD),steam distillation, steam and water distillation, maceration [3]. Among these methods HD shows the most common approach to extract the essential oils. It is the most simple and oldest method involving the immersion of plant material in water and brought to boiling attaining its boiling point. The principle of this process is based on azeotropic distillation of heterogeneous mixture at atmospheric pressure. The distillation of the oil and water is done simultaneously as a single compound. The use of Clevenger

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apparatus in this process allows the recycling of the condensate leading to the higher yield of the essential oil. Due to the easy implementation, low cost and selectivity, it is widely used on industrial scale.

One of the traditional Cold pressing methods is used to extract essential oil from the citrus fruit zest. It involves the breakage of oil sacs to release volatile oil forming a watery emulsion in oil glands followed by centrifugation for the oil recovery. The obtained vegetable essence is used as flavoring agent and in pharmaceutical industry [14].

However, to reduce the extraction time and improve the extraction yield, innovative approaches such as Microwave-assisted extraction (MAE) [5], Supercritical fluid extraction (SCFE) and Ultrasound assisted extraction has been developed and practiced. Supercritical fluid extraction (SCFE) is based on the principle of repeatedly step of compression/depression of the fluid used. CO_2 (carbon dioxide) served as a widely used solvent due to its numerous advantages: chemically inert, non-toxic, easily attain the critical pressure, P_c: 72.9 atm and temperature, T_c: 31.2°C. Highly compressed CO_2 passed through the plant material and volatile matter followed by depression of CO_2 where extract is routed to more than one separator for the release of gas and recycling. The extract obtained from this process is of prime quality for used in biological activities differentiated from the extracts obtained by the other methods.

The present study aims at MAE method using Clevenger apparatus for the extraction of the essential oil from the 'Cuttack', cultivar variety of Piper betle.

II.EXPERIMENTALSETUP

A domestic microwave oven (Samsung, US) with maximum output power of 800W, variable in 100W and 2.45GHz with corresponding wavelength of 12.2 cm, regulated for the extraction of betel oil. Borosil round bottom flask of 1Lassembled in oven cavity with a condenser atop as shown in Fig.1 for the collection of the extracted EO. Distilled water used as an extraction solvent, obtained using double distillation unit system.

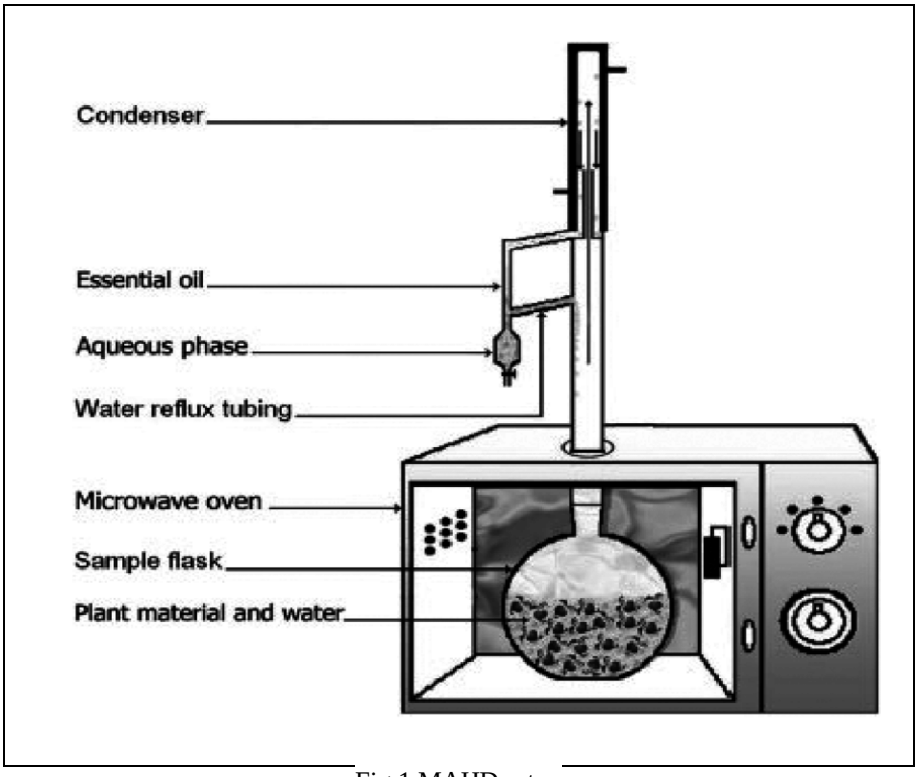


Fig.1 MAHD setup

A. Procedure

Fresh betel leaves purchased from the local market of Kanpur, washed thoroughly and cut into small pieces. For each experiment 100gm pre-treated betel leaves was placed in 1liter round bottom flask with a selected amount of distilled water (200ml,300ml and 400ml). Clevenger apparatus is mounted on the top of the microwave through the opening, connected with the round bottom flask

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placed inside the oven. The selected power levels 250W, 300W,400W and 500W initiated the extraction process for 90minutes until, further no extraction was done. For the leaves to water ratio (1:2, 1:3, 1:4), process was carried out for the above mentioned selected power. The entire sample is heated at higher rate through microwaves simultaneously. Excess water refluxed back to the extraction vessel for the restoration of water in plant material. After the collection of extracted oil, decantation of oil from the condensate is carried out. The removal of the moisture content present in the extracted essential oils was done by drying over anhydrous sodium sulfate. The oil was weighed and stored in vials until further analysis. The yield of oil is calculated by

$$\textit{Extraction yield (\%)} = \frac{volume\ of\ the\ oil\ extracted}{weight\ of\ the\ sample\ taken} * 100$$

III. RESULTS &DISCUSSION

The time required to obtain the first oil droplet in MAHD method was 15 minutes. Fig.2 shows the effect of microwave power on the volume of oil obtained in 90 minutes at different selected power levels. Initially less extraction was observed at 250W varying from 0.117 to 0.206 ml of oil due to low density of microwaves. Notably at 500W, volume of oil improved from 0.221 to 0.348 ml of oil and further increase in power leads to the degradation of the quality of essential oil.

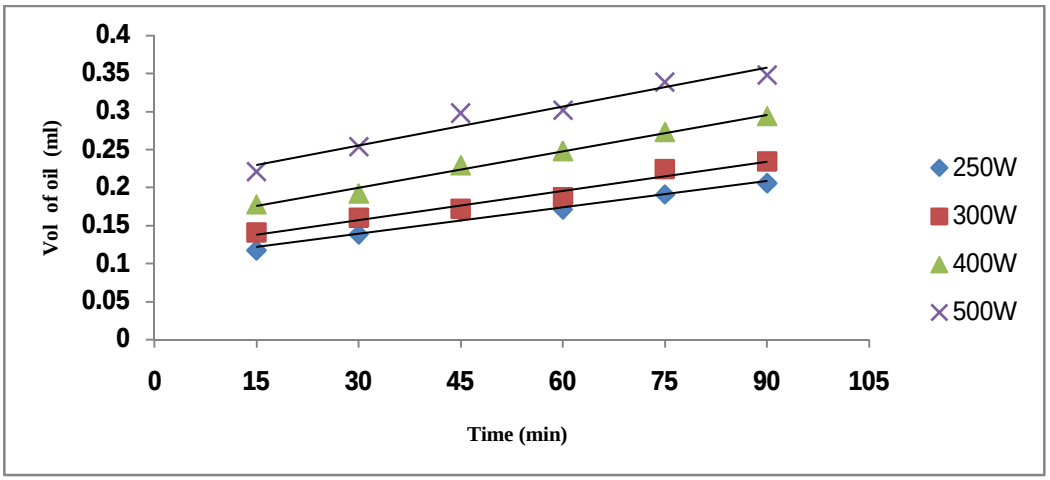


Fig.2 Volume of oil as a function of time for the selected power levels

From Fig.3 it is concluded that lowest oil yield 0.206% at 250W was obtained but gradual increase in power level yield of oil was maximum at 500W i.e. 0.348%.Extraction yield was less at 250W resulted due to low density of microwaves. Elevating the power from 250W to 500W showed the increment in extraction yield.

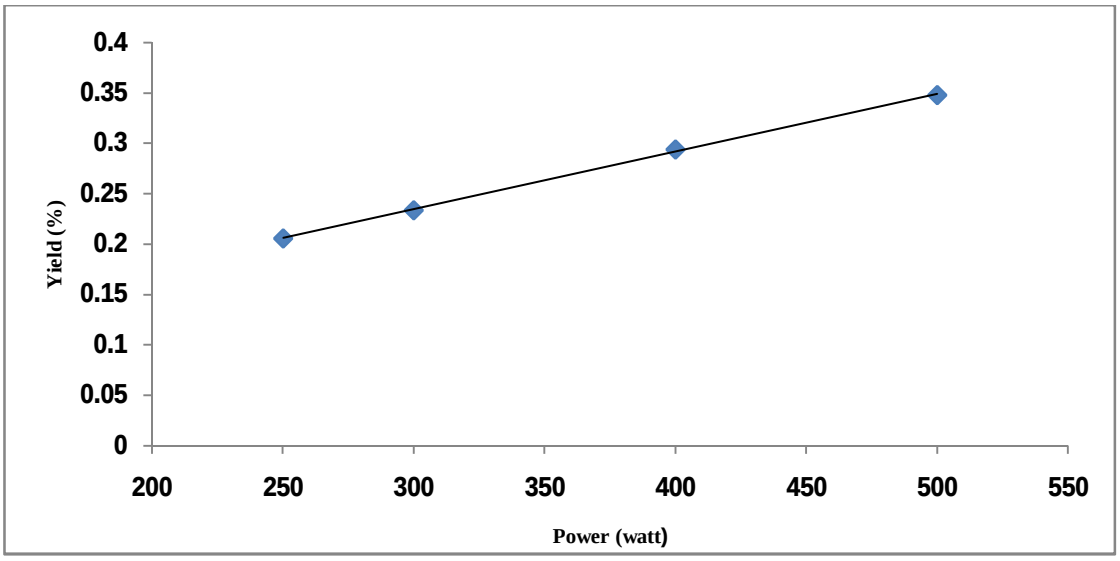


Fig.3Effect of power on extraction yield

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The oil sample undergoes GC-MS analysis for the identification of the compounds present in it. The chemical profile showed the major compounds occurred in first 60 minutes and plays a vital role in manufacture of perfumes. The compounds of betel oil are used as odorant in perfumery belonging to the derivative class of phenylpropene.

IV. CONCLUSION

Highest yield of oil 0.348% obtained at microwave power of 500W and 0.33 L/W ratio in less extraction time. The extracted oil is colorless and lighter than water. It is substantially energy saving process and shows a promising future due to the significant reduction of time. Thus, proposing an alternative method without affecting the composition of the oil obtained.

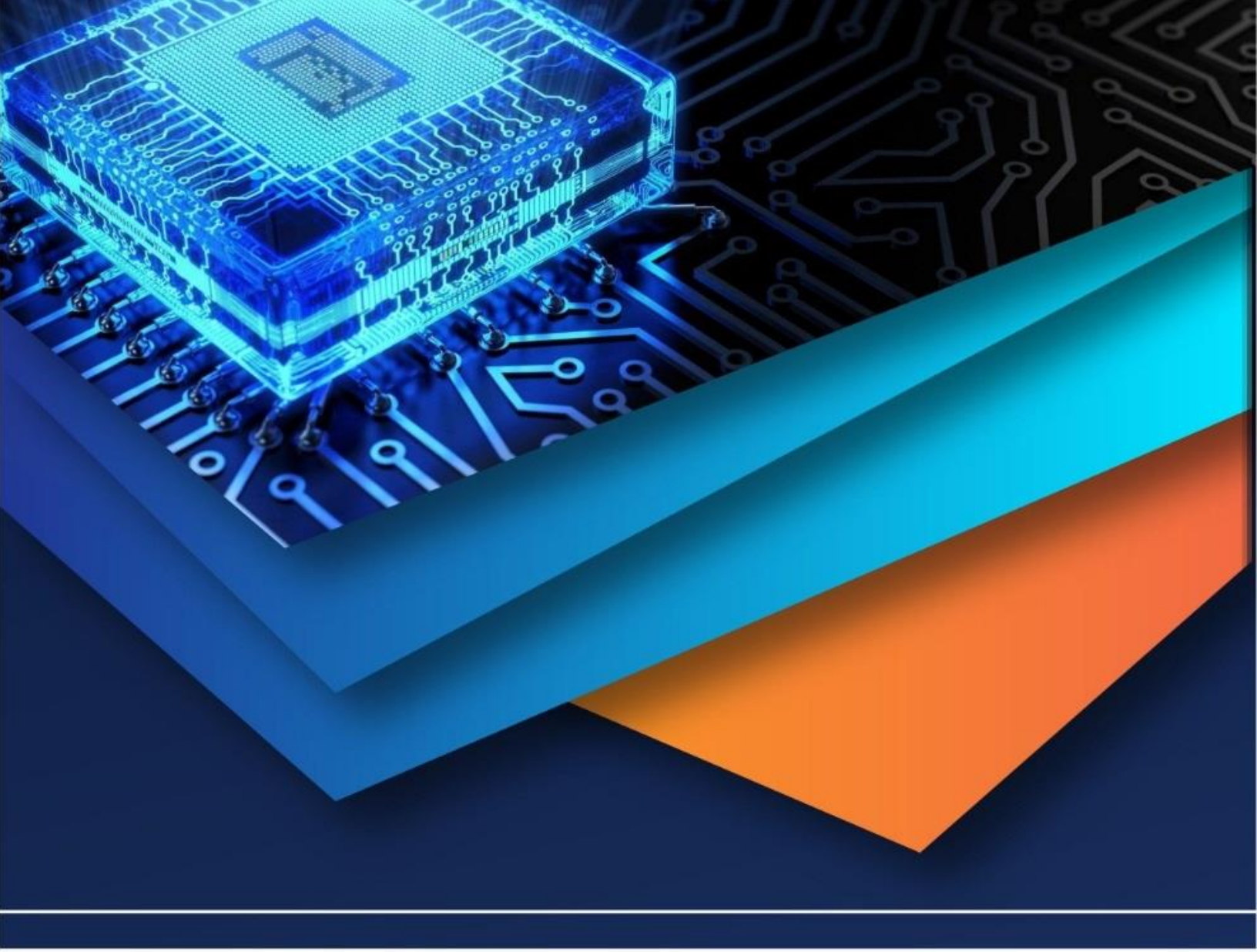
V. ACKNOWLEDGEMENT

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