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DEPARTMENT OF CHEMISTRY

Topic

Oil Extraction technique using Green Solvents

Conducted by students

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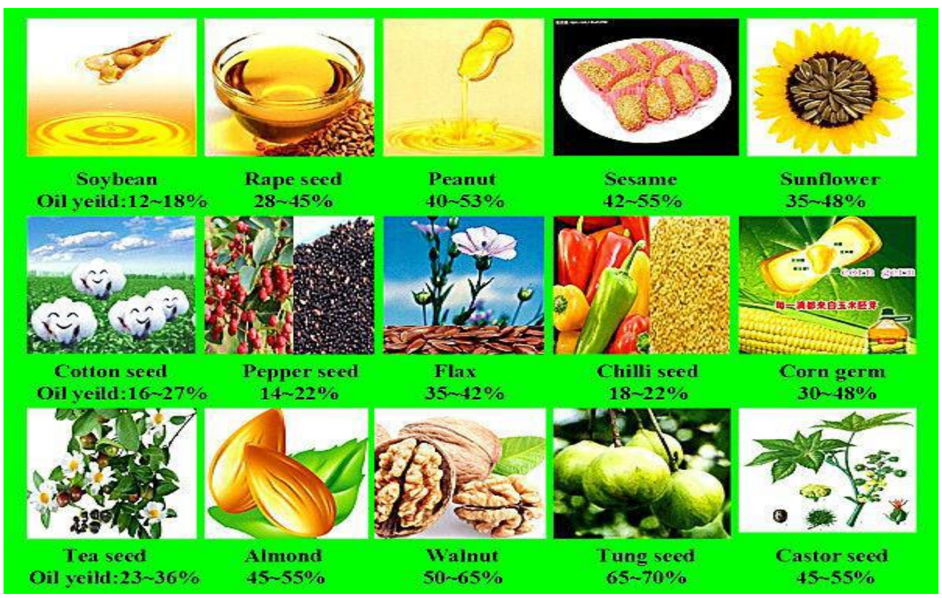
OIL EXTRACTION TECHNIQUES USING GREEN SOLVENTS

ABSTARCT :

The conventional technology used for oil extraction from oilseeds is by solvent extraction. In solvent extraction, *n*-hexane is used as a solvent for its attributes such as simple recovery, non-polar nature, low latent heat of vaporization (330 kJ/kg) and high selectivity to solvents. However, usage of hexane as a solvent has lead to several repercussions such as air pollution, toxicity and harmfulness. This study focuses on using of green solvents for the oil extraction by solvent extraction method.



1. INTRODUCTION :

1.1 STATEMENT OF THE PROBLEM :

Conventional oil extraction from oilseeds has been performed by hydraulic pressing, expeller pressing and solvent extraction (SE). Among these methods, solvent extraction has been widely adapted for economical and practical concerns. In SE process, the oilseeds are washed with hexane, thereafter the hexane is separated from oil by evaporation and distillation [2]. Hexane has been widely used for oil extraction because of easy oil recovery, narrow boiling point (63–69 °C) and excellent solubilizing ability.

In contrary, while in extraction and recovery processes, hexane is released into environment that reacts with the pollutants to form ozone and photo chemicals [4]. Moreover, several studies revealed that hexane affects neural system when inhaled by humans because of solubility in neural lipids. Toxicity has been observed in piglets fed with de-fatted meal containing residual hexane which was left over after the process [5]. Therefore, health perspective, safety and environment concerns have triggered to look for a substitute to *n*-hexane without compromising the yield of oil. Hence, green solvents coupled with technology are a viable alternative for oil extraction. Green solvents and technology are aimed to develop an environment friendly process with simultaneous reduction of pollutants [6,7] for oil extraction. Hence, green technology such as aqueous enzymatic extraction (AEE)coupled with green solvents have huge potential to replace *n*-hexane without any compromise in oil recovery from the process. In addition, the opportunities and challenges of AEE have been given comprehensively to understand the merits and demerits of the technology. Green solvents arederived either from naturally (water and CO_2) or agricultural residues (terpenes) or petroleum sources, which have good solubilizing properties like conventional solvents.

1.2 AIMS AND OBJECTIVES:

To study about the various oil extraction techniques using green solvent

2. REVIEW OF LITERATURE:

Various solvents which are employed for oil extraction discussed here. Ionic liquids are non-aqueous salt solutions that comprise both anions and cations which can be maintained in a liquid state at moderate temperatures (0–140 °C) [10,11]. Ionic liquids are considered as green solvents or green 'designer' solvents for their manifold applications in petroleum and oil industry. Ionic liquids are eco-friendly in nature as these do not have the detectable vapour pressure, as a result, no pollution. In addition, these are non-flammable,and remain in liquid state for wide range of temperatures [12]. As these solvents possess both the ions and versatile physico-chemical characteristics, these have allowed to design a suitable solvent with specific conductivity, hydrophobicity , polarity, and solubility based on the nature of solute for efficient recovery [13]. Interestingly, because of these properties about 600 molecular solvents were employed in various processes Ionic liquids were used as solvent for extraction, catalysis and synthesis of various compounds. However, studies on application of ionic liquids for oil extraction are scanty and needs to substantiate the technical and economical viability. Ma et al. studied the extraction of essential oils using ionic liquids from *Schisandra chinensis* Baill fruit and projected that the ionic liquid coupled with microwave have reduced time, energy and eco-friendly. In other study, the ionic liquid was used as a co-solvent for bio-oil extraction in a single step from microalgae. However, a meta-analysis study reported that the IL's should be chosen carefully

and need to understand their adverse effects. Although, this method is promising but it needs more studies to substantiate the hypothesis of oil extraction from ionic liquids. Another

promising green solvent such as switchable solvent has showed potential for oil extraction from soy bean flakes. In addition, super critical fluid, deep eutectic solvents, natural deep eutectic solvents and supramolecular solvents are gaining wide interest and there is a need to study their applicability in oil extraction.
Recent advances on 'green' approaches have great impetus in oil industry because ofgreen solvents i.e., terpenes (D-limonene, *p*-cymene and α-pinene). Terpenes are isoprene units (CH) derived chiefly from agriculture sources. For example, D-limonene isderived from citrus peels and employed in many applications. Similarly, *p*-cymene and α-pinene are derived from tree oils and pine forests respectively. Interestingly, these solvents have good Hansen solubility properties (HSP) to dissolve the like molecules. To determine the behaviour of given solvent, Hansen has proposed three properties which is also called Hansen properties based on the energy of dispersive (δ), dipolar (δ) and hydrogen bond forces (δh), between the molecules [8]. In a study, the terpenes were found to possess the characteristics of *n*-hexane that substantiate the capability to dissolve the like molecules. Moreover, terpenes are not only safer due to higher flash point, but also have slightly higher dissociating power due to slight differences in the dielectric constant in comparison with *n*-hexane [9].

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and need to understand their adverse effects. Although, this method is promising but it needs more studies to substantiate the hypothesis of oil extraction from ionic liquids. Another promising green solvent such as switchable solvent has showed potential for oil extraction from soy bean flakes. In addition, super critical fluid, deep eutectic solvents, natural deep eutectic solvents and supra molecular solvents are gaining wide interest and there is a need to study their applicability in oil extraction.

Recent advances on 'green' approaches have great impetus in oil industry because of green solvents i.e., terpenes (D-limonene, *p*-cymene and α-pinene). Terpenes are isoprene units (C_5H_8) derived chiefly from agriculture sources. For example, D-limonene is derived from citrus peels and employed in many applications. Similarly, *p*-cymene and α-pinene are derived from tree oils and pine forests respectively. Interestingly, these solvents have good Hansen solubility properties (HSP) to dissolve the like molecules. To determine the behaviour of given solvent, Hansen has proposed three properties which is also called Hansen properties based on the energy of dispersive (δ) dipolar (δ) and hydrogen bond forces (δh), between the molecules [8]. In a study, the terpenes were found to possess the Characteristics of *n*-hexane that substantiate the capability to dissolve the like molecules. Moreover, terpenes are not only safer due to higher flash point, but also have slightly higher dissociating power due to slight differences in the dielectric constant in comparison with *n*-hexane [9].

3. RESEARCH METHODLOGY:

Before, oil extraction it is necessary to reduce the size of oleaginous materials (seeds/fruits) either by grinding or flaking to gain much access by enzymes. Grinding ruptures the cell constituents and releases the oil. In case of grinding, factors such as structural and chemical constituents of oilseed, initial moisture content are to be determined to make judicious choice either for wet or dry grinding. Generally, oleaginous material with high moisture content can ground in wet condition, whereas for low moisture content oilseeds like rapeseed, peanut and soybean, drying is necessary. For example, grinding of coconut (high moisture content) in wet condition not only resulted higher oil yield but also alleviated drying step.

Several factors are essential for the maximum recovery of oil from oilseeds. Application of enzymes either alone or in concoction can be determined based on the structure of oilseed,

enzyme composition, type of enzyme, experimental conditions. For instance, heat treated soy bean flour separately treated with cellulase, pectinase, hemicellulase and protease (Alcalase 2.4 L from Bacillus licheniformis) enzymes, respectively. Among them, protease resulted higher yield (Alcalase 2.4 L) than rest of the enzymes. Similarly, in extruded soybean flakes, protease treatment resulted higher yield of oil (96.0%) than phospholipase (73.4%) treatment. Furthermore, when extruded soybean oil was treated with cellulase alone and with a mixture of cellulase and protease, no significant augmentation of soybean oil yields (68%) was observed. Aqueous extraction involves water as a medium to extract the oil from oilseeds. It is well known that the lipid molecules are amphipathic in nature and the water soluble components diffuse into water which culminates into emulsion formation. The emulsified oil in water can be de-emulsified by changing the temperature or deploying enzymes. Hence, in the process of AEE, enzymes are involved which segregate the desired extracted constituents without any damage. Recent investigations have unraveled the tremendous potential of AEE .
Moreover, this process is environmental-friendly, safer, healthier, simultaneous oil and protein extraction can be done without compromising the quality. In addition, it is cost effective as consumption of solvent is reduced and is effective in removal of anti-nutritional factors, toxins and avoids degumming process. These several merits make AEE a promising green technique not only for oilseed processing but also to extract the desired compound.

4. FINDINGS:

Best results achieved with aqueous enzymatic extraction (AEE) method from various oil seeds.

5. CONCLUSIONS AND SUGGESTIONS:

Green solvents are effective in consumption of solvent, reduction of downstream processing steps (reclamation of solvent) without causing any effect to other desired products. AEE coupled with green solvents could be economical, eco-friendly and safer.

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