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Green Oil Extraction Technologies Part (A): An Environmental Friendly Approach

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SUMMARY

Oils and lipids are one of the most important food constituents that take a major role in body building muscles and provide energy to human as well as animals. The presence of fatty acids in the oil make oil enrich in particular compound that act as preventative agent for different diseases. Oil recovery or oil yield is the critical parameter that taken care while performing a standard research on particular oilseeds in terms of oil extraction. Each developed method of oil extraction have first approach towards maximum oil recovery followed by minimum loss of presence nutritional quality of essential bio compounds from oilseed. The utmost method of oil extraction has mentioned as solvent extraction method, which play important role in qualitative as well as quantitate assessment of extracted oil. But presence of solvent and cost of solvent for extraction listed some disadvantages of this method. To overcome these stated problem in last decade researchers has suggested alternative oil extraction methods and named as green or solvent free extraction methods including aqueous enzymatic extraction (AEE), microwave assisted extraction (MAE), ultrasound assisted (UAE) methods. They have listed in a well manner of their advantages in terms of, solvent free oil, reduction in time of extraction, well retained the nutritional quality of extracted oil, reduction in cost of operation and maintenance etc. Therefore, green oil extraction technologies nowadays focused into environmental friendly methods (absence of effluents) and stated as optimum option for industrial approach.

INTRODUCTION

From the market survey is has been concluded that, in current years the demand of edible oil will increased by 30 % due to increase in the number of population day by day. In India majorly the oil is extracted from palm kernel, soybean, rapeseed, sunflower, groundnut, coconut and olive oilseeds (Boulard *et al*., 2015). The physical methods (mechanical, screw press, hydraulic press) contribute only 70- 80 % of oil recovery hence, to recover the remaining 30- 20 % need other green technologies (AEE, MAE, UAE). The application of solvents raises health, safety and environmental concerns and therefore, regardless of their high extraction efficiency, the utilization is not only harmful but also toxic and lead harm to environment (Tiwari, 2015). Green solvents have a good potential to replace the commonly used *n*-hexane (solvent method) without losing the quality of oil and oil recovery process (Sharma *et al*., 2019). The listed effective points of green extraction such as eco-friendly, high oil recovery, cost-effective and co-products can be achieved without any deterioration in quality. The brief of green extraction technologies expressed in the following subsections with their advantages and limitations.

Aqueous enzymatic extraction (AEE)

In this method, water is used as solvent to extract the oil from oil globules materials (oilseeds). Only water is in sufficient to degrade the cells of oilseed and take longer period to extract the oi (Yusoff,Gordon, Ezeh, & Niranjan, 2016). Therefore, to enhance the rate of oil recovery and reduced the required time of degradation some food grade enzymes are also used along with water to extraction process. So AEE is a considered as novel and green extraction technique. The water media facilitating the concurrent removal of phospholipids, which eliminate the degumming process during extraction and overall production cost is get low. The method is eliminating the use of solvent or chemical load generated by organic solvent.

Popularized enzymes used in different oilseed

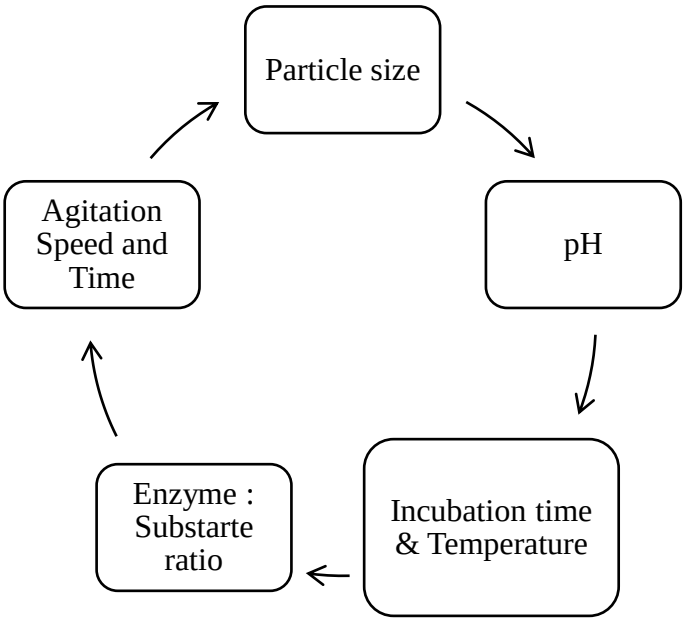
- *Neutrase 0.8 L; Cellulase and pectinase; Viscozyme L; Protex 6 L®*
- *Cellulase and neutral protease; Rohament CL®;*

Advantages of AEE:

- Minimal consumption of organic solvent
- Short extraction times
- Higher selectivity

- Higher extraction yield

Factors affecting aqueous enzymatic extraction:



Disadvantages of AEE:

- Enzymes are relatively expensive
- Sometimes enzyme cannot break plant cell completely
- Lower reaction rates compared to native enzymes

Limitations of AEE:

- Difficult to scale up to industrial scale

Microwave Assisted extraction (MAE)

MAE is high trending practical approach techniques when its compared with traditional extraction techniques. The microwave energy generated from microwave generator interact with dipoles present in the sample matrix resulted into oscillating in response to the changing electromagnetic fields (Hosni *et al*., 2013). Due to oscillated dipoles generates heat on the surface of the material and the heat is followed transferred inside of the material by conduction. Due to internal heat generation electroporation effect has been done on the cell wall of the oilseed and increased the rate of oil recovery from oilseeds. The radiations of microwaves are non-contact source of energy and therefore heating is done as per requirement.

The following listed oil source has been used to extract respective oil with good retention quality by MAE. (Yusoff *et al*., 2015).

- Pumpking seeds (65%); Yellow horn seed (60.7 %); Moringa *oleifera(94.21 %)*
- Sandbox seed (72.25 %); Lavender (75 %); Fructus *forsythia (45.3 %)*

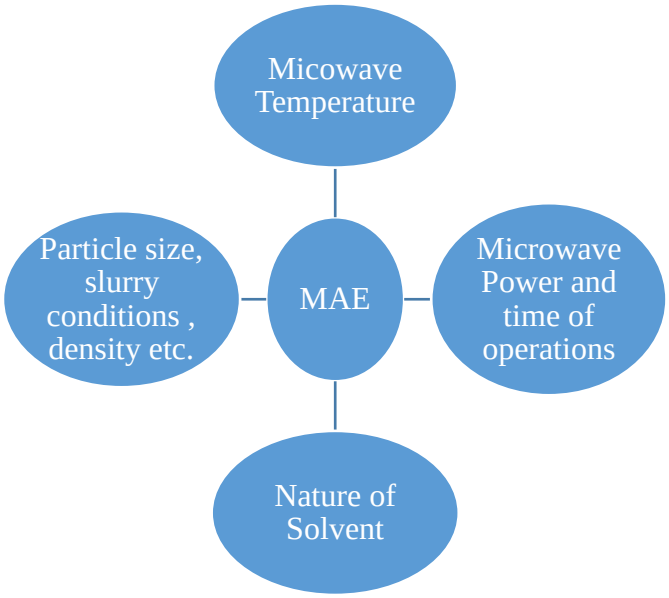
Applications:

- Closed vessel techniques of MAE are used for the extraction of terpenes.
- Extraction of imidazolinone herbicides and sulphonylurea herbicides has been reported.
- Extraction of fungicides i.e hexaconzole via MAE from weathered soil can also be done.

Advantages of AEE:

- In MAE, extract multiple samples simultaneously using a minimal organic solvent.
- Reduction in extraction time.
- Improved yield.
- Better accuracy

Factors affecting Microwave Assisted extraction



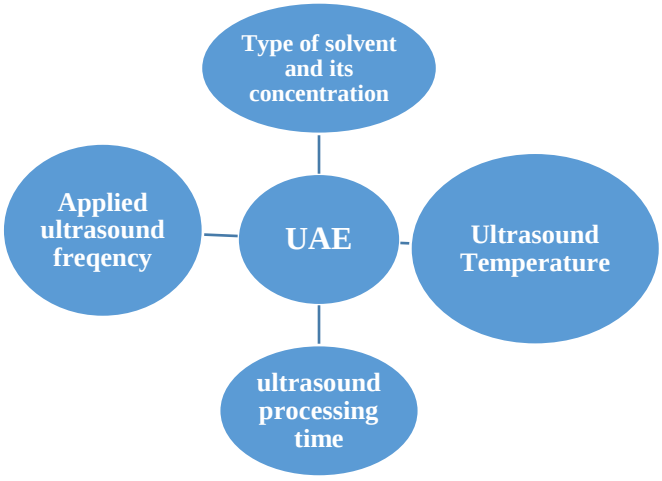
Ultrasound Assisted Extraction (UAE)

Recently in the year ultrasound energy came into exist in application of different food industry. The ultrasound energy (UE) play an important role in oil extraction techniques in terms of their oil recovery with maximum retention of quality parameters (bioactive compounds). The main mechanism involved in the UE are cavitation bubbles, vibration, mixing and pulverization of mechanical effects (Wen *et al*., 2018). The techniques collectively break the cell wall, increase the permeability of the cell wall and enhanced the rate of mass transfer. The emmitation of ultrasound waves produced the cavitation inside the oil globules and due to formation of alternative expansion and compression cycles and immediately blasting of respective cycles causes mechanical stress effect on the cell wall of oilseed. This mechanical effect responsible for formation of electroporation effect and enhanced the permeability of cell wall and hence increased the rate of oil transfer from oil globules to solvent media.

The following listed examples have proven that, successful applications of ultrasound on oil bearing oilseeds in term of their oil recovery and quality produced oil (Pico, 2013).

- Pomegranate seeds (85 %)
- Flax Seed (78 %)
- Perilla Seeds (82 %)
- Moringa oleifera (81 %)

Factors affecting Ultrasound Assisted extraction



Advantages of AEE:

- Simple and inexpensive
- can be applied to industrial and commercial production on a large scale.
- Can improve mass transfer, thereby shortening the time of extraction
- Reducing the solvent consumption and temperature, and lowering energy input

Disadvantages of AEE:

- Limited testing distance,
- Inaccurate readings
- Inflexible scanning methods.

CONCLUSIONS:

The novel and green extraction technologies will help in maximum recovery of oil from oil bearing seed. The number of listed advantages and benefits of green extraction techniques made it in significant contribution in term of saving cost of extraction, reducing time of operation, maximum retention of nutritional quality of oil and minimum producing of effluents. So overall we called as green extraction technologies is an environmental friendly approach to extract edible oil from different oilseeds.

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