

MUSTARD OLEORESIN: EXTRACTION TECHNOLOGY AND ITS BIOLOGICAL SIGNIFICANCE

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Introduction

Oleoresins have become very popular as effective flavouring and bioactive agents as more and more people want natural and plant-based products. Oleoresins are concentrated extracts from herbs and spices that keep their true flavour. They have both volatile and non-volatile chemicals in them, such as pigments, resins, and strong-smelling substances. Oleoresins are much stronger than raw spices, often 5 to 20 times stronger. The oleoresin is composed of natural antioxidants, phenolic compounds, and essential oils. Mustard oleoresin shows robust antimicrobial properties against pathogenic bacteria, like *Staphylococcus aureus*, *Escherichia coli*, and *Salmonella typhi*. Isothiocyanates (ITCs) are the main compounds responsible for this property. It shows good antioxidant properties because of compounds like sinapic acid, quercetin, and kaempferol that protect cells from damage caused by free radicals. In addition to its health benefits, mustard oleoresin can be used as a natural food preservative, insect repellent, and bio-fumigant.

Oleoresins are concentrated, viscous extracts derived from various plant parts, including seeds, fruits, rhizomes, and roots, using organic solvents such as acetone, ethanol, ethyl acetate, or ethylene dichloride. Unlike essential oils, which contain only volatile compounds, oleoresins comprise both volatile and non-volatile constituents, making them more complex and complete extracts that capture the true flavour and aroma of the source spice. They are 5 to 20 times more potent than raw spices, with yields ranging from 7 to 15% depending on the variety. Their key advantages over raw spices include stronger aroma, longer shelf life, more hygienic and economical storage, lighter weight for transport, and freedom from mildew risk. Extraction is

carried out using the cold percolation method, where finely ground, shade-dried plant material is soaked in hexane for seven days in a dark environment, followed by filtration and solvent evaporation under vacuum using a rotary evaporator, with the final oleoresin stored at 4°C for further use.

Extraction of Oleoresin:

Oleoresin extraction employs several techniques including supercritical fluid extraction, ultrasound-assisted extraction, enzyme-assisted extraction, microwave-assisted extraction, and solvent extraction or cold percolation. The solvent used in plant extraction, commonly referred to as the menstruum, is selected based on the plant part being extracted, the nature of the target bioactive compounds, and solvent polarity. Polar solvents such as methanol and ethanol are used to extract polar compounds, while non-polar solvents like hexane and dichloromethane are preferred for non-polar compounds. In sequential fractionation, solvents are added in order of increasing polarity — beginning with n-hexane for non-polar compounds, followed by acetone for moderately polar compounds, and finally methanol for highly polar compounds — ensuring comprehensive and systematic recovery of the full spectrum of bioactive constituents present in the plant material (Fig. 1).



Fig.: Steps involved in Oleoresin extraction

Mustard oleoresins are prepared using the cold percolation method, where finely ground, shade-dried plant material is soaked in a suitable solvent for seven days with daily shaking, followed by filtration and solvent evaporation under vacuum using a rotary evaporator, with the final extract stored at 4°C. The effectiveness of bioactive compound extraction is heavily dependent on solvent polarity, as plant secondary metabolites range widely from lipophilic fatty acids to highly polar phenolic acids. Non-polar solvents like hexane are used in the initial defatting stage to recover lipids, carotenoids, and tocopherols. Intermediate polarity solvents like acetone are employed in sequential extraction to isolate specific flavonoids and moderately polar antioxidants. Polar solvents like methanol are most effective for recovering phenolic compounds such as sinapic acid and sinapine, typically yielding the highest total phenolic content, strongest DPPH radical scavenging activity, and superior metal-chelating capacity. Thus, solvent selection

acts as a selective filter, directly determining the phytochemical composition and biological potential of the resulting oleoresin extract.

Mustard oleoresin:

Mustard, one of the oldest oilseed crops cultivated in tropical regions, is valued as a spice, condiment, fodder, and medicinal source due to its rich phytochemical profile. Mustard oleoresin contains diverse bioactive compounds across several chemical classes. Glucosinolates, sulfur-rich secondary metabolites, are hydrolyzed by myrosinase enzymes to produce isothiocyanates — primarily allyl isothiocyanate (AITC) — which are responsible for mustard's characteristic pungency and potent antimicrobial and cytotoxic activities, with alternative hydrolysis also yielding nitriles, epithionitriles, and thiocyanates. The phenolic fraction includes sinapic acid and its esters, along with flavonoids kaempferol and quercetin, collectively contributing antioxidant, anti-inflammatory, and neuroprotective properties. The lipophilic fraction is enriched in alpha and gamma-tocopherols, which protect polyunsaturated fatty acids from oxidative damage, alongside phytosterols such as beta-sitosterol, campesterol, and brassicasterol. The fatty acid profile is dominated by erucic acid, which can constitute up to 45% of total fatty acids in high-erucic *B. juncea* varieties, along with oleic, linolenic, and linoleic acids.

Other Applications of Oleoresins:

1. **Repellent Activity:** The high amount of pungent volatile compounds found in mustard oleoresin acts as a potent deterrent that repels various insect species.
2. **Bio-Fumigant:** The primary compound, allyl isothiocyanate (AITC), is found to be as effective as commercial turpentine mixtures that are widely used against aphids like *Myzus persicae*.
3. **Targeted toxicity:** The isothiocyanates present in mustard oleoresin interfere with the respiratory and nervous systems of insects, leading to deaths in the larval stage itself.
4. **Biodegradability:** Mustard oleoresins have minimal residual effects on the environment. They rapidly break down in soil and water, mitigating bioaccumulation, a problem often encountered with synthetic pesticides.
5. **Human Safety:** Owing to their low toxicity, mustard oleoresins are generally considered safe for handlers as well as consumers when applied to stored food products.

6. **Sustainability:** Using mustard oleoresin as a "bio-pesticide" supports a sustainable production and consumption model, replacing the conventional model by refurbishing and recycling the agricultural by-products to protect the harvests from pest infestation.

Conclusion

As the demand for natural products increases, oleoresins have become a topic of interest for the researchers because of their various biological activities. Oleoresin is basically a concentrated extract packed with the strong flavour, aroma, and key active compounds of the seeds.

References

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