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Although most erucic acid for oleochemical use is derived from high erucic acid rapeseed (HEAR), crambe is another potential source for this fatty acid *Dr G Nagaraj*

Sourcing erucic acid from crambe

Crambe abyssinica is a non-food oilseed crop mainly grown for its high erucic acid content.

The plant is native to Ethiopia, eastern Africa, western Asia and the Mediterranean region, and is a fast growing short season crop which can be easily included in common crop rotations. It is cultivated in spring in Europe and as a winter crop in Mediterranean climates.

Crambe grows between sea level and 2,000-2,500m in areas with rainfall in the range of 350-1,200mm and does not require irrigation. The crop grows where annual average temperatures range between 5-16°C and the oilseed is moderately tolerant to saline soils during germination.

The crop was first cultivated in the former USSR in 1933 before being introduced in the USA in the 1940s,

according to an *Agronomy* journal article in 2020.

It was produced on about 10,000ha of land in the USA by 1992, reaching 16,000ha in North Dakota by 1996.

"However, production declined thereafter in North Dakota and Montana to less than 8,500ha by 2002," the '*Crambe: A Non-Food Oilseed Crop with Great Potential*' report said.

It was reported that global cultivation of crambe declined to less than 810ha by 2016 with "premature commercialisation, higher prices for other crops, establishment difficulties and decreasing governmental support for research the main reasons contributing to the decline", the *Agronomy* report said.

Brazil introduced crambe cultivation in the 1990s, with the '*FMS Brillhante*' cultivar developed for local conditions. However, yields were relatively low at between 1,000-1,500kg/ha, according to

the State University of Maringá.

Today, crambe is cultivated in parts of the USA and Europe, with yield levels varying widely between 450-2,500kg/ha.

Erucic acid

Crambe has a 30-35% oil content, comprising 40-60% erucic acid.

This monounsaturated omega-9 fatty acid is an oleochemical used to produce plastics, printing inks, cosmetics and personal care products.

Erucic acid (cis-13-docosenoic acid - C22:1) cannot be produced from fossil fuels and is only found in seed oil from plants belonging to *Brassicaceae* and *Tropaeolaceae* families.

Based on the grade, erucic acid sources are divided into two categories: erucic acid content of 43-50% and erucic acid content >50%. Currently, erucic acid is mainly sourced from high erucic acid rapeseed (HEAR), a specific rapeseed

- ▶ variety containing up to 50% erucic acid. This is in contrast to canola, a rapeseed variety containing less than 2% erucic acid in its oil to make it suitable for human consumption and a low glucosinolate content in its meal to make it safe for animal feed.

Crambe has some advantages over HEAR including:

- The plant and seed morphology are distinctively different from rapeseed, minimising the risk of contamination with food-grade rapeseed.
- Crambe does not cross with HEAR or canola.
- Crambe can have a higher erucic acid content than HEAR.
- The cultivation of HEAR involves higher amounts of agronomic inputs such as fertilisers and crop protection chemicals, which have a negative environmental impact.

One of the key advantages of crambe is its ability to tolerate pests and diseases, according to the *Agronomy* report.

Crambe is more resistant to flea beetles compared with rapeseed, perhaps due to its high levels of glucosinolates.

However, it is highly susceptible to turnip yellow mosaic virus and is not very competitive against weeds due to its slow initial growth.

The oilseed matures rapidly after flowering, usually within two to five weeks, and the crop has a low bulk density, which is small and lightweight to transport and store.

Industrial applications

The growing focus on biodegradability and renewability has placed more emphasis on producing chemical compounds utilising plant-based feedstocks.

As such, crambe oil has several special traits, such as a high smoke point, good wettability of different materials and high viscosity.

The oil can be used as industrial lubricant, an inhibitor of the corrosion and as an ingredient to manufacture synthetic rubber. It can also be used to produce plastic films, plasticisers, nylon, adhesives and electrical isolation products.

Erucic acid has attracted wide interest as a raw material for hydraulic fluids, oleochemicals, lubricants, additives, and as a starting material for new fibres, resins, plastics, lacquers, and other products.

Erucic acid-derived compounds are used as additives in the plastic industry; in high temperature hydraulic fluids; and

Crambe oil contains 40-60% erucic acid, which can be used to produce plastics, printing inks, hydraulic fluids, lubricants, cosmetics and personal care products

as a base for paints and coatings, .

Erucic acid is also the starting material for the manufacture of synthetic fibres like nylon13 and nylon 13,13.

Erucic acid is valued as a superior lubricant. When used in the manufacture of plastic films in the form of erucamide, it migrates to the surface, resisting the sticking of each film to its neighbour.

Being a hydrocarbon of high calorific value with a very low flash point and high cetane rating, erucic acid can also be a valuable component of biodiesel.

The oxidative stability of crambe oil-derived biodiesel is higher than soyabean oil-derived biodiesel, opening another potential use for crambe.

When converted into behenyl alcohol $\text{CH}_3(\text{CH}_2)_{21}\text{OH}$, erucic acid has many further uses, such as a pour point depressant – enabling liquids to flow at a lower temperature – and silver behenate for use in photography.

Cosmetics, hair and skin care

Crambe oil has a market as an ingredient in specific personal care products, with erucic acid widely used to produce emollients, especially for skin and healthcare products.

The oil has a light skin feel, colour and scent and can be used in hair and skin care products as a silicone replacement.

It is used in cosmetics in amounts ranging from 0.1–20%.

Applied topically, the seed oil forms a protective layer over the skin which helps it retain moisture. This promotes hydration, giving skin a soft, smooth and plump appearance.

Due to its hydrating and conditioning qualities, crambe oil can also be used in hair care formulations for shine,

hydration and hair protection.

Monounsaturated long chain fatty acids such as erucic acid can disrupt the skin barrier in the same way as oleic acid. This allows for the use of crambe oil as a penetration enhancer for hard-to-absorb cosmetic ingredients, as well as other compounds present in the plant oils.

However, the combined total of erucic and oleic acids in crambe oil can be as high as 90% and, because of this, using the oil at 100% may have a negative effect on the skin barrier and would be unsuitable for people with a compromised skin barrier (such as dermatitis) or in newborn babies.

Crambe meal

Crambe meal is a by-product of oil production and an important resource.

According to the *Agronomy* report, dehulled crambe meal can contain up to 50% crude protein, with a digestibility level similar to soyabean meal but at a third of the cost.

However, the oilseed contains anti-nutritional elements such as tannins, inositol phosphate and glucosinolates, which induces thyroid problems in monogastric animals such as swine and poultry.

For cattle, new technologies for glucosinolate detoxification, such as chemical and physical treatments, could allow crambe to substitute soyabean meal in ruminant diets.

Crambe meal has also been reported to have insecticidal activity against house flies, and can be potentially used as a soil amendment to minimise soil pathogens due to its phytotoxic chemical compound, 1-cyano-2-hydroxy-3-butane, according to the *Agronomy* report.

Conclusion

Although the cultivation of crambe is niche compared to other oilseeds, its high erucic content offers potential for the oilseed to partially replace HEAR.

“However, crambe’s low seed yield, the need for dehulling, the high glucosinolates and fibre in the meal, and the lower seed oil content than HEAR limit its development as a competitive cash crop,” the *Agronomy* report says.

For crambe to compete in the high erucic acid crop space, there must be greater efforts in plant breeding to increase seed yield and erucic acid content in the oil, and to reduce glucosinolates in the meal.

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