Banswara (Patel et al., 2011). Believed to be a "sacred tree," its flowers, seeds, and wood are integral to the local economy.

Botanical Characteristics and Ecological Adaptation

The Mahua tree is characterized by a dense, spreading canopy and can reach heights of 15 to 20 meters. It is highly adaptable to varied soil conditions, including stony and degraded lands, and displays remarkable drought resistance. The tree produces fleshy, cream-colored flowers that are exceptionally rich in sugars (up to 41.6g total sugars), and ovoid fruits containing elongate, shining brown seeds.

Biochemical Composition of Mahua Butter

The seeds of *M. longifolia* are the source of "Mowrah butter," a high-quantity lipid product with an oil yield ranging from 35% to 61%. The fat is a semi-solid substance at ambient temperatures, with a fatty acid profile that mirrors that of palm oil and cocoa butter.

Table 4: Fatty Acid Profile of *Madhuca longifolia* (Mahua) Butter (Ramadan et al., 201

Fatty Acid Component	Percentage (%)
Oleic Acid ($C_{18:1}$)	37.0% – 45.0%
Stearic Acid ($C_{18:0}$)	22.7% – 25.9%
Palmitic Acid ($C_{16:0}$)	19.6% – 24.5%
Linoleic Acid ($C_{18:2}$)	9.4% – 15.8%

The physicochemical properties of Mahua fat make it ideal for the chocolate and confectionery industries as a cocoa butter substitute. It has a slip melting point of approximately 35.5°C ensuring the desired "melt-in-the-mouth" characteristic.

Traditional and Industrial Use

Traditionally, Mahua seed oil (mahua butter) is used by tribal communities for cooking (after processing), body massage, skin care, and lamp lighting. It is also used in traditional medicine for treating skin disorders and rheumatism. The oilcake is applied as manure and in pest control. Industrially, mahua oil is used in soap and detergent manufacture, oleochemicals, candles, and increasingly explored for biodiesel production due to favorable fatty acid composition (Patel & Naik, 2010; Dubey, 2023).

Fig 3: Fruits and Seeds of *Madhuca longifolia*

Ratanjot (*Jatropha curcas*)

Jatropha curcas, known as Ratanjot, is a perennial shrub that has become a focal point of India's non-edible oilseed research, particularly in the arid districts of Rajasthan. Its ability to grow on marginal wastelands and its toxicity to livestock make it an ideal "live fence" for protecting agricultural fields (Kumar et al., 2004).

Botanical Characteristics and Ecological Adaptation

Jatropha is an incredibly hardy species, capable of surviving on poor, rocky, and shallow soils with minimal cultural interventions. The plant is monoecious and starts bearing fruits within one to two years of planting. A critical factor in its productivity is the timing of harvest; research demonstrates that harvesting fruits at the yellow stage yields peak oil content compared to brown, dry fruits, as the latter stage involves the beta-oxidation of unsaturated fatty acids.

Lipid Profile

The seed kernels of Jatropha contain between 30% and 57% oil, which is categorized as non-edible due to the presence of phorbol esters and curcin. The oil is predominantly unsaturated, making it highly suitable for conversion into biodiesel (Salimon& Abdullah, 2013).

Fatty Acid Component	Percentage (%)
Oleic Acid ($C_{18:1}$)	31.3% – 48.8%
Linoleic Acid ($C_{18:2}$)	32.3% – 38.0%
Palmitic Acid ($C_{16:0}$)	13.0% – 16.6%
Stearic Acid ($C_{18:0}$)	2.5% – 11.8%

Jatropha biodiesel is noted for its high cetane number (approx. 51-56), which results in superior engine performance and a significant reduction in emissions of carbon monoxide and sulfates.

Traditional and Industrial Use

Traditionally, Jatropha seeds and oil have been used in rural areas for lamp fuel, soap making, and as a topical application for certain skin ailments; however, the oil is non-edible due to toxic phorbol esters. Folk practices also report its use as a purgative and in external medicinal preparations. Industrially, Jatropha oil is widely studied and utilized as a biodiesel feedstock because of its high oil content and suitability for marginal lands. It is also used in biolubricants, candles, and specialty soaps (Achten et al., 2008; Kumar & Sharma, 2008).

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Important Wild Oil-Seed Species of Rajasthan and Their Uses

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Introduction

The arid and semi-arid ecosystems of Rajasthan, India, represent one of the most challenging environments for vegetative growth globally. Characterized by extreme temperature fluctuations, sparse and erratic precipitation, and soil profiles often dominated by salinity and nutrient deficiency, the region has necessitated the evolution of specialized plant species. Among these, the wild tree-borne oilseeds (TBOs) play a pivotal role in maintaining the ecological balance while supporting the socio-economic fabric of rural and tribal populations. The strategic importance of these species has grown in recent decades as global energy demands shift toward renewable feedstocks and the pharmaceutical industry seeks novel bioactive compounds from extremophiles. The utilization of non-edible oilseeds from the wild provides a mechanism for energy independence and industrial raw material supply without competing with traditional food crops for fertile land or water resources (Tripathi et al., 1997).

In the context of the National Biofuel Policy of India, which targets significant displacement of fossil fuels, the screening and systematic documentation of Rajasthan's indigenous oilseed species are essential.

Some Important wild tree-borne oilseeds of Rajasthan

Pilu (*Salvadora oleoides*)

Salvadora oleoides, known locally as Pilu, Khara Jal, or the Toothbrush Tree, is a facultative halophyte that serves as a cornerstone of the arboreal flora in western Rajasthan. This species is uniquely adapted to thrive in soils where high salinity and water scarcity render other vegetation unviable. Its distribution across the Barmer, Jalore, Jodhpur, and Pali districts under scores its role as a resilient biological barrier against desertification (Bhansali, 2011).

Botanical Characteristics and Ecological Adaptation

The botanical structure of *S. oleoides* reflects its extreme environmental adaptation. It typically presents as a small evergreen tree or a sprawling shrub with a short, often twisted trunk and a dense canopy of drooping branches. Under favorable moisture conditions, it can attain a height of 6 to 9 meters, with a trunk diameter reaching 2 meters in ancient specimens. The bark is light gray, providing a reflective surface that likely aids in thermal regulation during the intense summer heat. The leaves are fleshy, linear-lanceolate, and exude a pungent odor, a characteristic attributed to secondary metabolites that function as herbivore deterrents.

Ecologically, the species is categorized as a mesomorphic xerophyte. It possesses a dual-purpose root system that facilitates both deep-water access and surface sand binding. In regions like the Dudhwakhara spans of Rajasthan, *S. oleoides* is found clustered around traditional community water bodies (johads) and along field boundaries, where it acts as a windbreak and soil stabilizer (Singh et al., 2013). Research indicates that its presence significantly contributes to the restoration of gypsum-mined surfaces and saline-alkali wastelands.

Fig 1: *Salvadora oleoides* Fruits

Lipid Chemistry and Industrial Viability

The seeds of *S. oleoides* are a significant reservoir of industrial-grade lipids, commonly referred to as Khakan fat or Pilu oil. The oil content in the seeds is reported between 32% and 45%, with the kernel alone accounting for over 40% of the dried seed mass. One of the most distinctive features of Pilu oil is its high saturation level, which renders it solid at room temperature with a melting point of approximately 31.10C.

Table 1: Physicochemical Properties of *Salvadora oleoides* Seed Oil (Varshney et al., 2025)

Physicochemical Property	Value / Range
Oil Content (Seed)	32.0% – 45.0%
Specific Gravity (35.5^{0}C)	0.9246
Refractive Index (40^{0}C)	1.4465
Saponification Value	242 – 251 mg KOH/g
Iodine Value	10 – 16 g I_2 /100g
Melting Point	31^{0}C – 32^{0}C

The fatty acid profile of *S. oleoides* is predominantly characterized by medium-chain saturated fatty acids (MCFAs), specifically lauric and myristic acids (Prakash & Arya, 2021). This chemical signature is remarkably similar to that of coconut and palm kernel oils, positioning Pilu oil as a high-value substitute in the soap and detergent industries.

Table 2: Fatty Acid Composition of *Salvadora oleoides* (Pilu) Oil(Garg et al., 2013)

Fatty Acid Component	Percentage (%)
Capric Acid ($C_{10:0}$)	1.0% – 1.5%
Lauric Acid ($C_{12:0}$)	19.6% – 50.3%
Myristic Acid ($C_{14:0}$)	16.8% – 54.5%
Palmitic Acid ($C_{16:0}$)	7.7% – 29.5%
Oleic Acid ($C_{18:1}$)	5.5% – 12.0%
Linoleic Acid ($C_{18:2}$)	0.0% – 2.1%

Traditional and Industrial Uses

Traditionally, *Salvadora oleoides* seeds yield a non-edible oil used for lighting, soap making, and as a lubricant in rural communities. Various plant parts are used in ethnomedicine for digestive and skin disorders, and the twigs are used as natural toothbrushes. Industrially, the seed oil has potential in soap, detergent, and biofuel sectors, and the species is valued for arid-zone agroforestry and wasteland rehabilitation (Arora & Pandey, 2014; Orwa et al., 2009).

Tumba (*Citrullus colocynthis*)

Citrullus colocynthis, colloquially known as Tumba or Indrayan, is a perennial herbaceous creeper that thrives in the hyper-arid sand dunes and open plains of western Rajasthan. Belonging to the Cucurbitaceae family, it is recognized for its extreme drought tolerance and its potential as a secondary-generation biofuel feedstock.

Botanical Characteristics and Ecological Adaptation

Tumba is characterized by a deep, fleshy taproot that enables it to survive in regions with annual precipitation as low as 50 mm. Its prostrate stems bear deeply lobed, scabrid leaves and yellow-green globose fruits that reach the size of a small orange. The fruits contain a white spongy pulp that is intensely bitter due to high concentrations of cucurbitacins, which protect the plant from herbivory.

In the context of Rajasthan's agricultural landscape, *C. colocynthis* is often found growing wild in the fallow fields of the Thar, requiring no irrigation or chemical inputs. Research conducted by the Arid Forest Research Institute (AFRI) has evaluated its antifungal properties against common desert pathogens, suggesting its role in maintaining soil health.

Fig 2: Fruits and Seeds of *Citrullus colocynthis*

Lipid Profile

The seeds of *C. colocynthis* are exceptionally rich in oil, typically ranging from 17% to 25% of the total seed weight (Mahla et al., 2018). Unlike the saturated fats of *Salvadora*, *Tumba* seed oil is highly unsaturated, dominated by omega-6 linoleic acid.

Table 3: Fatty Acid Distribution in *Citrullus colocynthis* (Tumba) Seed Oil(Menon et al., 2016)

Fatty Acid Fraction	Percentage (%)
Linoleic Acid ($C_{18:2n6}$)	50.3% – 74.8%
Oleic Acid ($C_{18:1n9}$)	10.0% – 18.8%
Palmitic Acid ($C_{16:0}$)	8.4% – 12.4%
Stearic Acid ($C_{18:0}$)	5.0% – 15.2%
Unsaturated Fatty Acids (Total)	70.0% – 85.0%

The oil yield can reach up to 3 tons per hectare, making it a highly attractive non-food biodiesel feedstock (Menon et al., 2016). The fuel properties of Tumba-derived biodiesel, including its flash point and viscosity, are comparable to petroleum diesel, and its high polyunsaturated content ensures excellent cold-flow properties.

Traditional and Industrial Uses

Traditionally, seeds of *Citrullus colocynthis* are used in desert regions as a minor oil source after detoxification, and in folk medicine for anti-inflammatory and antimicrobial purposes. Seed oil has been used locally for massage and therapeutic applications. Industrially, colocynth seed oil is investigated for biodiesel potential and as a source of nutritionally valuable fatty acids and bioactive compounds for pharmaceutical formulations (Marzouk et al., 2010; Giwa et al., 2010).

Mahua (*Madhuca longifolia*)

Madhuca longifolia, widely known as Mahua, is a multi-purpose deciduous tree that holds immense cultural and economic significance for the tribal populations of southern Rajasthan, including the Bhils of Udaipur and