Journal of Medicinal Plants Studies
www.PlantsJournal.com

ISSN (E): 2320-3862
ISSN (P): 2394-0530
www.plantsjournal.com
JMPS 2025; 13(1): 42-45

Received: 01-11-2024
Accepted: 04-12-2024

Dr. Chandra Prabha Devi
Guest Faculty, Maharaja Chhatrasal Bundelkhand University, Chhatarpur, Madhya Pradesh, India

Corresponding Author:
Dr. Chandra Prabha Devi
Guest Faculty, Maharaja Chhatrasal Bundelkhand University, Chhatarpur, Madhya Pradesh, India

An overview of *Guizotia abyssinica* L. oil: process improvement and biodiesel synthesis

Chandra Prabha Devi

Abstract
The increasing depletion of common petroleum fossil fuel reserves and worries about pollution protection for the economy and environment have led to the necessity to develop alternative fuels. A global trend is the substitution of biodiesel for vegetable oils. As an independent source of transportation fuel and other energy requirements, Niger seed oil is being examined in this study as a possible agricultural food. The U.S.A. and European nations are testing Niger seeds, an oilseed seed primarily grown in Ethiopia, India, Myanmar, and Nepal. Linoleic and oleic acids make up the majority of its 85% polyunsaturated fatty acid content. Oil makes up 37–43% of its seeds. In addition to being utilized as a pump oil to boost water flow in rural and tribal regions, niger oil is used in food, paint, soap, perfume, and illumination. This research aims to evaluate the physicochemical characteristics of sunflower ME and soybean ME, which are commonly utilized as alternative fuels in the US and other nations, as well as to learn about the significance and development of niger in India.

Keywords: Agricultural feedstock, fatty acid, methyl ester

1. Introduction
The rapid depletion of energy resources, rising demand, and significant sources of pollution are all influenced by conventional petroleum fuels. The primary source of energy for India today is fossil petroleum. Alternative fuels must be produced from domestic food sources in order to increase energy efficiency, safeguard the environment, lessen the impact of greenhouse gases, and maintain the stability of the national economy. Since India is an agricultural nation, a variety of vegetable oils-both edible and non-edible-are produced from various oilseeds.

Bio-diesel is the oil that comes from renewable vegetable sources and is used in diesel engines. It is a long-chain acid mono alkyl ester. Known as the transesterification process, biodiesel is typically made by reacting vegetable or animal fats with methanol or ethanol in front of a catalyst to create glycerin and other esters. Many edible and inedible materials, including Jatropha, Pongamia, Neem, Mahua, castor, linseed, Kusum, coconut, palm, sunflower, mustered, soy, safflower, sunflower, niger, etc., can be used to make biodiesel.

India is the chief niger producing country in the world, with an area of 480,000 ha (Ganapathi *et al.* 1992, Marinia *et al.* 2003) [17, 18]. About 75% of the seed produced is used to extract oil, with the other portion being sold for bird food. Nigger is regarded as a rare edible oil crop in India. Presscake, a byproduct of oil extraction, is utilized as cow feed and contains 31–40% protein. For many years, rural Indian communities have been using niger oil instead of diesel. Research on the development, accessibility, and application of niger seeds and oils is the main emphasis of the current project. Additionally covered is the investigation of the physiologic and chemical characteristics of the niger seed oil and methyl esters.

2. Literature Review
The literature review demonstrated that, with minor adjustments, atypical edible oils, such as niger seed oil, could be used as biodiesel fuel in place of petroleum diesel in CI engines. However, compared to other vegetable oil biodiesel feedstocks, research on niger seed oil biodiesel was found to be quite restricted.

In his study, Demirbus noted that one possible feedstock for biodiesel edible oil is niger seeds *Guizotia abyssinica* (Demirbas, 2009) [1]. According to Mohan Kumar *et al.* (2011) [2], this crop's key characteristic is that it produces a respectable amount of seeds even in subpar marginal growing conditions.

Niger is primarily grown for its oil (roughly 30–50%), which is used to make soap, light, lubricate, and biodiesel.
In addition to confirming that niger oil is a potential source of biodiesel feedstock in accordance with IS 1460 criteria, Rakeshsarin *et al.* (2009) [3] noted that niger oil is a non-traditional edible oil that might not be a food security risk.
In their research work, Gubitz GM *et al.* (1999) [4] noted that Niger seeds (Guizotia abyssinica) are grown in tropical nations and are somewhat costly because they are typically imported from Ethiopia and India. Because it contains 50–60% biocrude oil, which can be transformed into biodiesel through chemical or lipase-mediated esterification, Niger seed oil has also been recognized as a potential biodiesel crop. India exports about 1 million tons of high-value handpicked select (HPS) oilseeds each year, including about 300,000 tons of minor oilseeds valued at over $1 billion. These oilseeds include peanuts, sesame, niger seed, cottonseed, safflower seed, and rapeseed-mustard (USDN, 2013) [5].

3. General morphology of niger plants and seeds

An oilseed crop known as niger (*Guizotia abyssinica* (L.f.) Cass.) has been grown for over 5000 years. The two main nations that produce Niger are Ethiopia and South India, where it is extensively farmed (Ramadan, 2012) [6]. Nigerianseed, noug, guizotiaoléifère, ramtil, nigersaat, verbesina da Índia, abisin, negrillo, and ramtilla are some of the common names for Niger.
Guizotia comes in six species, with *G. abyssinica* being the only one that is grown. Niger seeds are members of the Compositae family, which also includes sunflower and safflower. Heavy clay soils with limited drainage are ideal for the crop's growth (Getinet and Teklewold, 1995) [7]. Since niger is a temperate-region plant that has evolved to a semi-tropical habitat, it is grown in both temperate and tropical regions. For growth, it prefers temperatures between around 19 °C to 30 °C.

i. Botonical Description

Niger is a dicotyledonous herb that grows every year. The tap-root in the middle and its lateral branches make up a well-developed root system. Typically, a niger's stem is spherical, hollow, smooth to slightly rough, and somewhat branching. The fruit measures just 1.5 mm in width and 3–5 mm in length. Typically, there are 15 to 30 ripe seeds per head (Fig. 2), sometimes even more, and a variable number of immature seeds or pops in the middle.
It is a dicotyledonous herb that can reach a height of 2 meters and has moderate to abundant branches (Getinet and Teklewold, 1995) [7]. First leaves are small and paired, followed by bigger leaves. The arrangement of the leaves is alternating at the top of the stem and on opposing sides of the stem. The leaves measure 3-5 cm in width and 10-20 cm in length (Fig. 1). The leaf surface is smooth, but the leaf margin morphology ranges from pointed to smooth, and the leaf color varies from light green to dark green. The niger plant is often moderately to well-branched, with a smooth to slightly rough stem. Stems of nigger are hollow and brittle. In extremely thick plant stands, fewer branches are generated, and the number of branches per plant ranges from five to twelve. The stem is roughly 1.5 cm in diameter at the base and ranges in color from dark purple to bright green. The niger blossom is yellow with a hint of green on rare occasions. The heads have ray florets that are 5–20 mm long and 15–50 mm in diameter. According to Getinet *et al.* (1996) [8], niger plants often reach a height of 1.4 meters.

Fig 1: Niger plant

Fig 2: Niger seeds

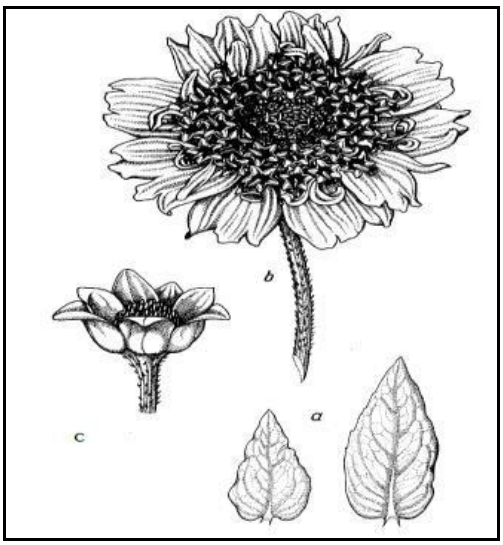

Fig 3: Niger leaves & flowers

ii. Cultivation and Harvesting

In tropical regions (June to August for rainy season crops, and September to mid-November for cold season crops in India), niger seeds are either broadcast or sown in rows. Seed can be sown in rows 40 to 50 cm apart at a rate of 5 kg/ha or broadcast at a rate of 10 kg/ha. Usually, one hand weeding is enough. A lot of farmers don't fertilize their fields. The best seed and straw yields are achieved when fertilizer is chosen carefully and in balance. In India, rows of niger and ragi should be spaced 15–30 cm apart to prevent weeds, and the ground should be tilled three–four times before planting. A useful crop to rotate with corn or wheat is niger.
Depending on the area, niger is harvested three to four months after planting. The flowers should be left to wither before moving on. Delays will result in significant seed loss from

shedding. Harvesting crops can be done by hand or by machine. In India, most threshing is done by hand. Easily separated seeds are next winnowed and sieved to remove all dirt and weed seeds.

iii. Geographical Distribution in India

With over 50% of the world's niger area and output, India is the most significant nation. The southern and central districts are primarily saturated with oil seed production. On 0.52 million hectares of land in India, niger is primarily grown during kharif. But it's a rabi crop in Orissa. Over 80% of the area and production comes from Madhya Pradesh, Maharashtra, and Orissa. According to (Ahlawat) [9] table 1, West Bengal, Karnataka, Bihar, and Andhra Pradesh are additional states where niger is grown.

Table 1: Area, production and Productivity of Niger in different states of India (2003-04).

State	Area (hectare)	Production (tonnes)	Yield (kg/hectare)
Andhra Pradesh	17.0	7.0	412
Assam	9.7	5.0	515
Chattisgarh	70.8	12.5	177
Jharkand	27.5	5.3	193
Karnataka	7.0	1.0	143
Madhya Pradesh	12.2	25.8	230
Maharashtra	54.0	17.0	315
Orissa	130.2	31.9	245
West Bengal	8.0	5.0	625
India	437.0	111.0	253

iv. Oil content of niger

Medium seed kinds from Karnataka have more oil content (e.g. up to 43%) than the ordinary niger seed, which typically contains 30% oil. Some accessions from Orissa in India have larger seeds than average. The oil content of sunflower and soybean seeds is 3850% and 18-23%, respectively.

4. Fatty Acid Composition

Saturated acids like palmitic, stearic, and arachidic, as well as monosaturated acids like palmitoleic, oleic, and erucic, and polysaturated acids like linoleic and linolenic, are typically found in fatty acid composition. Vegetable oils are thought to be a good fuel for C.I. engines since they ideally include a high concentration of mono-, low-, and poly-saturated fatty acids.

For two years in a row, Sangita Yadav et al. [10] assessed the fatty acid composition of Niger seed oil to establish its oil quality, and they contrasted the findings with those of other minor oilseed crops. They discovered that the four main fatty acids contained in Niger oil are linoleic, oleic, stearic, and palmitic acid. High diversity was observed in oleic and linoleic fatty acids, which ranged from 23.52 to 53.05% and 32.03 to 58.28%, respectively. Compared to total saturated fatty acid (14.94-18.21%), total unsaturated fatty acid (81.79-85.06%) was found to be greater. While cetane number verified its usage as biodiesel, saponification number (200.16-202.16) and iodine value (105.69-126.7 g I 2 100 g^{-1}) indicate that niger oil finds use in a variety of sectors.

Table 2: Comparison of Niger seed oil methyl ester with sunflower and soybean oil methyl esters. (Mohamed, 2012, Khunger, 2014 and Gopinath, 2010) [11-13].

Sl. No	Fatty Acid	Niger oil ME (%FA)	Sunflower oil ME (%FA)	Soybean oil ME (%FA)
1	Palmitic acid (C16:0)	8.0-9.7	5.35	10.2
2	Stearic acid (C18:0)	5.6-8.1	3.41	3.7
3	Oleic acid (C18:1)	5.9-11.0	19.58	22.8
4	Linoleic acid (C18:2)	70.7-79.2	46.87	53.7

5. Physical and Chemical Properties

When choosing an effective biodiesel, factors like as viscosity, cetane number, and fatty acid makeup are crucial. The ME characteristics of niger seed oil are nearly identical to those of soybean and sunflower oil.

Table 3: Properties of niger oil methyl esters are compared with soybean and sunflower oil methyl esters (Sarin *et al.* 2009) [3] and Singh and Singh (2010) [14].

Sl. No	Property	Niger ME	Soybean ME	Sunflower ME
1	Calorific value (MJ/kg)	34	33.5	33.5
2	Cetane number	57	45	49
3	Density(kg/m^3)	901	885	860
4	Kinematic viscosity (mm^2/ sec)	4.30 (40 °C)	4.5 (37.8 °C)	4.6 (37.8 °C)
5	Flash point(^{0}C)	157	178	183
6	Cloud point(^{0}C)	4	1	1

6. Uses and byproducts of niger

Niger is grown for its oil seeds, which produce around 30% of a clear, high-quality, slow-drying edible oil that can be utilized in paints, culinary products, fragrances, lighting, and other industrial settings. It can be combined with linseed oil, used as an adulterant for rape oil, sesame oil, and other oils, and substituted for olive oil. Additionally, seeds can be used as a seasoning or fried. Birds frequently consume seeds as food. Glycerin, a byproduct of the chemical conversion of Niger seed oil into Niger biodiesel, is used to make soap. The leftover plant material during threshing could be applied to the soil as green manure.

7. Yield

One of the oil seeds covered by the government's Minimum Support Prices (MSP) is niger seed, which is distributed by state governments through public, cooperative, and other agencies [15].

There are wide variations in the statistical data on niger seed production. Ethiopia and India, which together produced over 350,000 t annually in the 1990s, are the main producers. The amount of niger seed produced in India is decreasing; it was projected to be 200,000 t in 1990 and 120,000 t in 2000. The report makes this quite plain, as shown below.

Table 4: Production of oil seeds/oils in India [16].

Quantity in Lakh tons

Oil seeds/oils	2019-20		2020-21	
	Oil seeds	Oils	Oil seeds	Oils
Niger seed	0.98	0.29	0.96	0.29

8. Limitations

The crop's fertilizer appears to be encouraging vegetative growth rather than seed output, as seen by the low harvest index (the ratio of harvested product to total plant weight) (Getinet and Sharma 1996) [8]. Farmers in the area have little knowledge of or desire for Niger seed oil. The infrastructure and facilities required for the conversion of biodiesel are outdated. It was unknown whether illnesses and pests would pose a hazard to the niger. Compared to other oilseeds, Niger seed has a lower oil recovery rate because of its thicker hull, which contributes to its higher fibrous component. The growth, yield, and application of niger seed oil and various vegetable oil feedstocks for biodiesel conversion in India need further investigation.

9. Conclusions

The cetane number and other fatty acid compositions of niger seed methyl ester were analyzed in this study, and it appears to have good potential for usage as a future energy biodiesel source.

Even though *G. abyssinica* is a nutritionally rich, medicinal, and commercially significant crop for small and marginal farmers in the country's arid and semi-arid regions, it is still considered a neglected underutilized crop. These days, farmers understand the value of net income and niger. The country's varied agro-ecological characteristics are ideal for niger cultivation. Increasing the use of niger requires a number of significant elements, including feedstock production, harvesting, and storage, conversion technology, project funding, and regulatory direction. The government has started a number of initiatives to raise yields through improved varieties, which will benefit farmers and the nation as a whole by increasing the amount of seed that can be exported.

10. Acknowledgement

The author is thankful to authorities of Agriculture department of Rewa district who helps in ways more than one.

11. References

1. Demirbas A. Progress and recent trends in biodiesel fuels. Energy Conversion and Management. 2009;50(1):14-34.
2. Gubitz GM, Mittelbach M, Trabi M. Exploitation of the tropical oil seed plant *Jatropha curcas* L. Bioresource Technology. 1999;67:73-82.
3. Mohan Kumar BN, Basavegowda, Vyakaranahal BS, Deshpande VK, Kenchanagoudar PV. Influence of sowing dates on production of seed yield in niger (*Guizotia abyssinica* Cass.). Karnataka Journal of Agricultural Sciences. 2011;24(3):289-293.
4. Sarin R, Sharma M, Khan AA. Studies on *Guizotia abyssinica* L. oil: biodiesel synthesis and process optimization. Indian Oil Corporation Ltd, R&D Centre, Sector-13, Faridabad 121 007, India. Elsevier. 2009;100:4189-4192.
5. USDA Foreign Agricultural Service. India oilseeds and products. 2013.
6. Ramadan MF. Functional properties, nutritional value, and industrial applications of niger oilseeds (*Guizotia abyssinica* Cass.). Critical Reviews in Food Science and Nutrition. 2012;52:1-8.
7. Getinet A, Teklewold A. An agronomic and seed-quality evaluation of niger (*Guizotia abyssinica* Cass.) germplasm grown in Ethiopia. Plant Breeding. 1995;114:375-376.
8. Getinet A, Sharma SM. Niger *Guizotia abyssinica* (L.f.) Cass: Promoting the conservation and use of underutilized and neglected crops. Institute of Plant Genetics and Crop Plant Research, Gatersleben, International Plant Genetic Resources Institute, Rome. 1996;5:1-10.
9. Ahlawat IPS. Agronomy – Rabi Crops, Niger. Head, Division of Agronomy, Indian Agricultural Research Institute, New Delhi – 110 012.
10. Yadav S, Kumar S, Hussain Z, Suneja P, Yadav SK, Nizar MA, Dutta M. *Guizotia abyssinica* (L.f.) Cass.: An untapped oilseed resource for the future.
11. Ramadan MF. Functional properties, nutritional value, and industrial applications of niger oilseeds (*Guizotia abyssinica* Cass.). Critical Reviews in Food Science and Nutrition. 2012;52:1-8.
12. Khunger I, Berwal P. Performance evaluation of four stroke C.I. engine with methyl ester of sunflower oil. International Journal of Aerospace and Mechanical Engineering. 2014;1(2):67-72.
13. Gopinath A, Puhan S, Nagarajan G. Effect of biodiesel structural configuration on its ignition quality. International Journal of Energy and Environment. 2010;1(2):295-306.
14. Singh SP, Singh D. Biodiesel production through the use of different sources and characterization of oils and their esters as substitutes for diesel: A review. Renewable and Sustainable Energy Reviews. 2010;14:200-216.
15. Department of Agriculture and Cooperation. Annual report 2010-2011. Ministry of Agriculture, Government of India.
16. The National Food Security Mission. Quarterly agricultural outlook report April–June 2013. Under the project commissioned by Ministry of Agriculture, June 2013.
17. Ganapathi RN, Shaw SS, Ganguli J. Effect of auxins and cytokinins on plant regeneration from hypocotyls and cotyledons in niger (*Guizotia abyssinica* Cass.). Biologia Plantarum. 1992;35:209-215.
18. Marinia F, Magria AL, Marinib D, Balestrieric F. Characterization of the lipid fraction of niger seeds (*Guizotia abyssinica* Cass.) from different regions of Ethiopia and India and chemometric authentication of their geographical origin. European Journal of Lipid Science and Technology. 2003;105:697-704.