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Niger seeds (*Guizotia abyssinica* Cass.) as a biodiesel source in India

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Abstract
The need to produce alternative fuels is a rapid decline in the common reserves of petroleum fossils and concerns about economic and environmental protection from pollution. The use of biodiesel in vegetable oils as an alternative is a worldwide phenomenon. The current study is to consider Niger seed oil as a potential agricultural food as a separate source of transport fuel and other energy needs. Niger seeds are an oilseed seed produced mainly in Ethiopia, India, Myanmar and Nepal and are being tested in the U.S.A. and European countries. It contains 85% poly unsaturated fatty acid mainly comprising linoleic and oleic acid. Its seeds contain 37 to 43% oil. Niger oil is used in food, paint, soap, perfume, and lighting and as a pump oil to raise water flowing in rural and tribal areas. The purpose of this paper is to learn about the importance and growth of Niger in India and to compare the physicochemical properties of Soybean ME and Sunflower ME which are widely used as other fuels in the US and other countries.

Keywords: Agricultural feedstock, fatty acid, methyl ester

1. Introduction
Conventional petroleum fuels play an important role in the rapid depletion of energy resources and the growing demand and major sources of pollution. Today's energy demand in India is met mainly by fossil petroleum. In order to improve energy, environmental protection, reduce the impact of the greenhouse and the stability of the country's economy, the need to produce alternative fuels from domestic food sources of food. As India is an agricultural country, there is a wide range of vegetable oil production (both edible and non-edible) from different oilseeds.
The oil found in renewable vegetable sources for use in diesel engines is known as bio-diesel. It is a mono alkyl esters of long-chain acids. Biodiesel is usually produced by the reaction of vegetable oils or animal fats containing methanol or ethanol in front of the catalyst to produce glycerin and various esters and is commonly referred to as the transesterification process. Biodiesel can be produced from a variety of edible and inedible sources such as Jatropha, Pongamia, Neem, Mahua, castor, linseed, Kusum, coconut, palm, sunflower, mustered, -soya, safflower, sunflower, niger, etc.
India is the chief Niger producing country in the world, with an area of 480,000 ha (Ganapathi *et al.* 1992 [17], Marinia *et al.* 2003) [18]. In India Niger is considered a rare edible oil crop and about 75 percent of the seed produced is used to extract oil while the rest is exported for bird food. The byproduct presscake after extracting oil contains 31 to 40 percent protein and is used as a beef feed. Niger oil has been used as an alternative to diesel communities in remote India for many years. The current work focuses on research on the growth, availability and use of Niger seeds / oils. Also the study of the physiological and chemical properties of the oil / methyl esters of Niger seeds is discussed.

2. Literature review
The review of literature revealed the potential of nontraditional edible oil like Niger seed oil as biodiesel fuel instead of petroleum diesel used in CI engines with or without small modifications. But research work on Niger seed oil biodiesel was found to be very limited compared to other vegetable oil biodiesel feedstock.
Geetha Vaidyanathan *et al*. Revealed in their study that a small tribal kinchiligi village of population 75 in Odisha state used 450 litres of 100% neat biodiesel in regular pumpsets to lift drinking water over a period of 3 years.

The village level production unit produces 10 litres per day using a pedal driven machine. The local harvested Niger seeds were used as raw material for the production of biodiesel. Demirbus mentioned in his research paper that the Niger seed (*Guizotia abyssinica*) is one of the potential biodiesel edible oil feedstock (Demirbas, 2009) [1]. Mohan Kumar *et al.* (2011) [2] described the important feature of this crop is that it gives reasonable seed yield even under poor marginal growing conditions and Niger is mainly cultivated for extraction (about 30-50%) of oil which is used for soap making, lighting, lubrication and also used as a biodiesel. Rakeshsarin *et al.* (2009) [3] has confirmed the niger oil as a source of potential biodiesel feed stock as per IS 1460 specifications and also mentioned that the niger oil is a non-traditional edible oil which may not come under the food security concern.

Gubitz GM *et al.* 1999) [4] mentioned in their research paper that Niger seeds (*Guizotia abyssinica*) is cultivated in tropical countries and is quite expensive as it is imported usually from Ethiopia and India. Also the Niger seed oil has been identified as a potential biodiesel crop because of the presence of 50–60% the oil called biocrude, which can be converted into biodiesel by chemical or lipase mediated esterification. USDN Gain: in its reports mentioned that India annually exports of volume around 1 million tons, including approximately 300,000 tons of minor oilseeds worth of more than $1 billion high value handpicked select (HPS) oilseeds include peanuts, sesame, niger seed, cottonseed, safflower seed and rapeseed-mustard (USDN, 2013) [5].

3. General morphology of Niger plants and seeds

Niger (*Guizotia abyssinica* (L.f.) Cass.) is an oilseed crop cultivated for more than 5000 years. It is widely grown in South India and Ethiopia, which are the two major countries producing Niger (Ramadan, 2012) [6]. The Common names of Niger are nigerseed, noug, guizotiaoléifère, ramtil, nigersaat, verbesina da Índia, abisin, negrillo, ramtilla.

There are six species of Guizotia with *G. abyssinica* being the only cultivated species. Niger seed belongs to the same botanical family as sunflower and safflower (Compositae). The crop grows best on poorly drained, heavy clay soils (Getinet and Teklewold, 1995)[7]. Niger is cultivated in both temperate and tropical climates, being considered a temperate-region plant that has adapted to a semi-tropical environment. It prefers moderate temperatures for growth, from about 19 °C to 30 °C.

A. Botonical description

Niger is an annual dicotyledonous herb. The root system is well developed, with a central tap-root and its lateral branching. The stem of Niger is usually round, smooth to slightly rough, hollow and moderately branched. The fruit is small 3-5 mm in length and 1.5mm in width. There are usually between 15 and 30 mature seeds/head; (Fig.2) occasionally more, and a varying number of immature seeds or pops at the centre.

Fig 1: Niger plant

Fig 2: Niger seeds

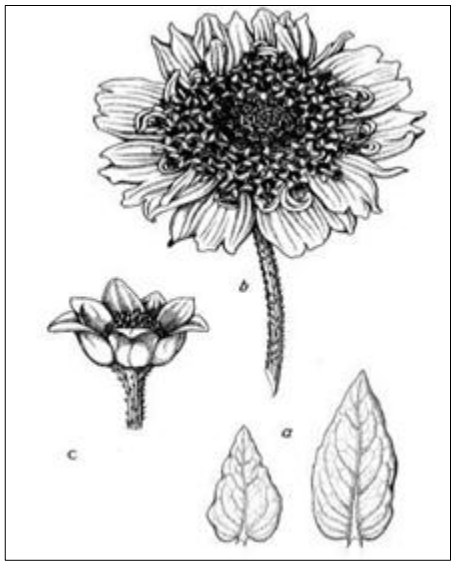

Fig 3: Niger leaves & flowers

It is a dicotyledonous herb, moderately to well branched, growing up to 2 m in height (Getinet and Teklewold, 1995) [7]. The first leaf is paired and small and successive leaves are larger. The leaves are arranged on opposite sides of the stem; at the top of the stem leaves are arranged in an alternate fashion. Leaves are 10-20 cm long and 3-5 cm wide (Fig. 1). The leaf margin morphology varies from pointed to smooth and leaf colour varies from light green to dark green, the leaf surface is smooth. The stem of Niger is smooth to slightly rough and the plant is usually moderately to well branched. Niger stems are hollow and break easily. The number of branches per plant varies from five to twelve and in very dense plant stands fewer branches are formed. The colour of the stem varies from dark purple to light green and the stem is about 1.5 cm in diameter at the base. The Niger flower is yellow and, rarely, slightly green. The heads are 15-50 mm in diameter with 5-20 mm long ray florets. The plant height of Niger is an average of 1.4 m (Getinet *et al.* 1996) [8].

B. Cultivation and Harvesting

Niger seed are broadcast or sown in rows in tropical areas (during June to August for a rainy season crop, and September to mid-November for a winter season crop in India). Seed may be broadcast at rate of 10 kg/ha or sown in rows 40 to 50 cm apart at rate of 5 kg/ha. One hand-weeding is usually sufficient. Many cultivators do not manure the land. Best yields of seed and straw obtained with a balanced and good selection of fertilizer. In India, when Niger is mixed with ragi, rows should be 15-30 cm apart to allow weed control, the land being harrowed 3-4 times before planting. Niger is a good crop for rotation with corn or wheat.

Niger is harvested 3-4.5 months after planting, depending on the region. It should be allowed to stand until flowers have withered. Further delay will cause heavy loss of seed through shedding. Crop can be harvested by hand or machine. Threshing is mostly done by hand in India. Seeds are easily separated then they are cleaned of all earth and weed seed by winnowing and sieving.

C. Geographical Distribution in India

India is the most important country accounting for more than 50% of world Niger area and production. The oil seed production is mostly saturated in southern and central districts. In India, Niger is grown on an area of 0.52 million ha mainly during kharif. However, in Orissa it is a rabi crop. Madhya Pradesh, Maharashtra and Orissa contribute more than 80% of area and production. Other states where niger is grown are Andhra Pradesh, Bihar, Karnataka and West Bengal as mentioned in the (Ahlawat) [9] table 1.

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
Chhattisgarh	70.8	12.5	177
Jharkhand	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

D. Oil content of Niger

The niger seed usually contains 30% oil, in some accessions from Orissa in India have larger seeds than average, and medium seed types from Karnataka have higher oil content (e.g. up to 43%). The soybean and Sunflower seeds contain 18-23% oil and 3850% of oil.

4. Fatty acid composition

Fatty acid composition generally includes saturated acids like palmitic, stearic, arachidic, monosaturated acids like palmitoleic, oleic, erucic and polysaturated acids like linoleic, linolenic. Vegetable oils ideally have high mono saturated, low saturated and polysaturated fatty acids are considered to be a suitable fuel for C.I. Engines.

Sangita Yadav *et al*. Determined that the oil quality in the fatty acid composition of niger seed oil for two consecutive years and compared the results with other minor oilseed crops. And found that Niger oil has four major fatty acids namely palmitic, stearic, oleic and linoleic acid. Oleic and linoleic fatty acids showed high variability ranging from 23.52 to 53.05% and 32.03–58.28%, respectively. Total unsaturated fatty acid (81.79-85.06%) was found to be higher than total saturated fatty acid (14.94-18.21%). Based on saponification number (200.16-202.16) and Iodine value (105.69-126.7 g I 2 100 g $^{-1}$) the Niger oil finds its application in various industries while Cetane number confirmed the use of it as biodiesel (Yadav) [10].

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

The fatty acid composition and other properties like cetane number, viscosity etc. plays important role in selecting the efficient biodiesel. The comparison of Niger seed oil ME properties are almost falls in line with the soybean and sunflower oil ME.

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 cultivated as an oil seed crop, the seeds yielding about 30% of a clear, excellent, edible oil which is slow drying, used in foods, paints, and perfumes and as an illuminant and also in industrial purposes. It is used as a substitute for olive oil, can be mixed with linseed oil, and is used as an adulterant for rape oil, sesame oil, *et al*. Seeds can also be used fried or as a condiment. Seed is commonly used as food for birds. After the chemical conversion of Niger seed oil into Niger biodiesel, glycerin is obtained as byproduct and used in the soap production. The plant remains after threshing could be used as green manure for the soil.

7. Yield

Niger seed is one of the oil seed which covered under the Minimum Support Prices (MSP) given by the government through public, cooperative and other agencies designated by the state governments [15].

Statistical data on the production of Niger seed vary greatly. The production is concentrated in Ethiopia and India, which had a combined annual production of about 350,000 t in the 1990s. Niger seed production in India is declining; in 1990 it was estimated at 200,000 t, in 2000 at 120,000 t. This is clearly evident from the report as 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 harvest index (ratio of harvested product to total plant weight) is low; fertilizer used for the crop seems to be promoting the vegetative growth rather than seed yield (Getinet and Sharma 1996) [8]. Local awareness and demand for Niger seed oil in the farmers is low. The facilities and infrastructure needed for the biodiesel conversion is obsolete. Potential threats from pests and diseases to the Niger were not known. Because of the hull thickness, its fibrous composition is more; hence Niger seed has a lower oil recovery rate compared to other oilseeds. More research work requires on growth, yield, usage of Niger seed oil and multiple vegetable oil feedstock biodiesel conversion in India.

9. Conclusions

In this study the Niger seed methyl ester properties were compared and it seems to have a good potential to be used as a future energy biodiesel source due to its Cetane number and other fatty acid compositions.

The plant *G. abyssinica* is treated as neglected underutilized crop despite being nutritionally rich, medicinally and economically important for the livelihood of small and marginal farmers in arid and semi-arid areas of the country. The farmers are realizing importance of Niger and net income nowadays. The diverse agro-ecological conditions in the country are favorable for growing the Niger. The feedstock cultivation, harvest and storage to conversion technology, project finance and regulatory guidance are important considerable factors to increase the usage of Niger. The Government has initiated several programmes to improve yields through better varieties, with consequent benefits to farmers and to the country through increased supply of seed available for export.

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11. References

1. Demirbas A. Progress and recent trends in biodiesel fuels. Energy Convers. Manage, 2009;50(1):14-34.
2. Gubitz GM, Mittelbach M, Trabi M. Exploitation of the tropical oil seed plant *Jatropha curcas* L. Bioresour Technol. 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 J Agric Sci. 2011;24(3):289-93.
4. Sarin Rakesh, Meeta Sharma, Arif Ali Khan. Studies on *Guizotia abyssinica* L. Oil: Biodiesel synthesis and process optimization," Indian oil corporation Ltd, R&D centre, Sector-13, Faridabad 121 007, India. Elseveir. 2009;100:4189-4192.
5. USDN. Gain: India oil seeds and products, 2013.
6. Ramadan MF. Functional properties, nutritional value, and industrial applications of niger oilseeds (*Guizotia abyssinica* Cass.)., Crit Rev Food Sci Nutr. 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 Breed. 1995;114:375-76.
8. Getinet A, Sharma SM. Niger *Guizotia abyssinica* (L.f.) Cass, Promoting the conservation and use of underutilized and neglected crop, 5; Institute of Plant Genetics and Crop Plant Research, Gatersleben, International Plant Genetic Resources Institute, Rome, 1996.
9. Dr. IPS Ahlawat. Agronomy Rabi Crops, Niger, Head, Division of Agronomy, Indian Agricultural Research Institute, New Delhi, 110012.

10. Yadav Sangita, Sandeep Kumar, Zakir Hussain, Poonam Suneja, Shiv K. Yadav MA, *et al*. Guizotia abyssinica (L.f.) cass.: An untapped oilseed resource for the future.
11. Mohamed Fawzy Ramadan. Functional Properties, Nutritional Value, and Industrial Applications of Niger Oilseeds (Guizotia abyssinica Cass) Critical Reviews in Food Science and Nutrition. 2012;52:1-8. ISSN: 1040-8398 Biochemistry Department, Faculty of Agriculture, Zagazig University, Zagazig, Egypt.
12. Khunger Ishaan, Pragya Berwal. Performance Evaluation of Four Stroke C.I. Engine with Methyl Ester of Sunflower Oil, International Journal of Aerospace and Mechanical Engineering. 2014 Nov;1(2). ISSN (O): 2393-8609
13. Gopinath A, Sukumar Puhan G Nagarajan. Effect of biodiesel structural configuration on its ignition quality, International Journal of Energy and Environment. 2010;1(2):295-306.
14. Singh SP, Singh Dipti. Biodiesel production through the use of different sources and characterization of oils and their esters as the substitute of diesel: A review, Renewable and Sustainable Energy Reviews Devi Ahilya University, Khandwa Road, Takshila Campus, Indore 452011, Madhya Pradesh, India. 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, 2013 Jun.
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 Plant. 1992;35:209-215.
18. Marinia Federico, Magria Antonio L, Marinib, Domenico, Balestrieric Fabrizio. 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. Eur. J Lipid Sci. Technol. 2003;105:697-704.