

## Research Article



## Studies on *Nigella sativa* Oil for its Potential Use as Biodiesel

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Accepted on: 28-01-2015; Finalized on: 28-02-2015.

### ABSTRACT

*Nigella sativa* is an ancient food and medicinal crop. The seed has been extensively studied for its biological activities and has been shown a lot of medicinal property. The black cumin seed can heal every disease except death. It mainly prevents food allergies. The plant seed and extract are used as a food ingredient. *Nigella sativa* seeds mainly contain an important bioactive component known as thymoquinone. In this study the seeds were collected and oil was extracted by using a chemical method. The oil was subjected to various physical and chemical studies such as pH, Specific gravity Density and Viscosity. The Fire points, Flashpoint, Cloud point, Pour point, Carbon residue were also analyzed. The chemical properties such as acid value, Iodine value, and saponification value were assessed. The Physico- Chemical Properties of the oil was analyzed by blending with conventional diesel at 10% (B10) and 20% (B20) proportions. The values were compared with the ASTM standards of biodiesel. The blend B20 is found to be within the ASTM standard and it could be used as alternative energy source as biodiesel.

**Keywords:** Biodiesel, *Nigella sativa*, Pour point Carbon Residue, Thymoquinone.

### INTRODUCTION

*Nigella sativa* is an annual herbaceous flowering plant belonging to the family Ranunculaceae, native to South and Southwest Asia. It grows to a height of 20–30 cm with finely divided linear leaves. The flowers are delicate usually coloured pale blue and white with five to ten petals. The fruit is a large and inflated capsule composed of three to seven united follicles, each containing numerous seeds.<sup>1</sup> The seed is used as a spice. It originated in the Mediterranean region, but nowadays it has been cultivated in other parts of the world such as Asia, Africa, and Arabian Peninsula. In addition to this extensively cultivated in various regions of Iran. In Islamic literature it is considered as 'the seed of blessing', and also it is one of the important food additives.<sup>2,3</sup> The Greek and Romans used *Nigella* as a condiment and it is still commonly used today as a culinary herb. It is cultivated in Egypt, Middle East, Turkey, Sri Lanka, Kenya, Sweden, Afghanistan, Europe, and many other places.<sup>4</sup> The common name of the *Nigella sativa* seed is Black cumin and Fennel flower in English, *Karuñīrakam* in Tamil, *Karim jeerakamin* Malayalam, *Habbat al-barakah* in Arabic and Kalajirain Sanskrit. Seed is used in various Indigenous System of Medicine like Ayurvedha, Siddha, Unani, and Tibetan.<sup>5,6</sup> It is used primarily in confectionery and liquors. *Nigella* seed is widely used for immune stimulation, anti-inflammation, hypoglycaemia, antihypertensive, antiasthmatic, antimicrobial, antiparasitic, gilbertonics, diuretics, digestive, anti diarrheal, appetites stimulant, analgesic, skin disorders, anti diabetic, anticancer, antifertility, immunomodulatory, spasmolytic, anti inflammatory, bronchodilator, hepatoprotective, renal protective, gastroprotective, antioxidant, astringent, bitter,

stimulant, diuretic and anthelmintic.<sup>7,8</sup> This is also useful in jaundice, intermittent fever, dyspepsia, piles and paralysis. Due to its miraculous power of *Nigella sativa* has got the place among the top ranked evidence based herbal medicines. This also revealed that most of the therapeutic properties of this plant are due to the presence of thymoquinone, which is a major bioactive component of the essential oil.<sup>9</sup> *Nigella sativa* is used as a Bio energy source and it has great attention among the futurist and the world policy makers. The seeds contain more than 45% of oil on dry weight basis. The biodiesel source is renewable, biodegradable, and better quality of exhaust gas emission.<sup>10</sup> Biodiesel fuel is produced via different techniques such as direct/blends, micro emulsion, pyrolysis, and trans-esterification. In this present study the direct blending of *Nigella* oil with petro diesel at two different proportions of 10 % and 20% (B10, B20).<sup>11</sup>

### MATERIALS AND METHODS

#### Collection

The *Nigella* seeds were purchased from an Ayurvedic Medical store in Nagercoil, Kanyakumari District in Tamilnadu, India.

#### Extraction

The seeds were dried and the impurities were removed by hand picking. The seed were crushed by using a laboratory mixer grinder. The oil was extracted by using Soxhlet apparatus with the solvent, Petroleum ether for 48 hours.



## Blend preparation

The diesel used for the experiment was purchased at Hindustan Petroleum, Tamilnadu India. The blends were made on a volume basis and stored in glass bottles at room temperature. A blend of 20% biodiesel with 80% conventional petroleum diesel, by volume, is termed "B20" and a blend of 10% biodiesel with 90% conventional petroleum diesel, by volume, is termed "B10". The Physico Chemical studies were carried out for the blends of biodiesel.

**Table 1:** General Physical properties *Nigella sativa* oil blends B10, B20 and diesel

Parameters	<i>Nigella sativa</i> Oil Blends		Diesel
	B10	B20	
pH	6.9	7.4	6.8
Specific Gravity	0.85	0.87	0.880
Density (g/ml)	1.030	1.086	0.804g/cm <sup>3</sup>
Viscosity(Nm-2s)	5.25	8.32	3.5
Fire point	52.4°C	46.7°C	54.0°C
Flash point	44°C	37.1°C	47.2°C
Cloud point	7°C	9°C	3°C
Pour point	4°C	4°C	0°C
Smoke point	15mm	11mm	9mm
Carbon residue	0.13g	0.18g	0.2g

**Table 2:** Chemical Properties of *Nigella sativa*oil blends B10, B20 and diesel

Parameters	<i>Nigella sativa</i> Oil Blends		Diesel
	B10	B20	
Acid value (mg KOH/g)	21.9	20.3	16.31
Iodine value	10.318	10.724	6.84
Saponification value	185.16	230.05	180.41

## Physico- Chemical Analysis

*Nigella sativa* oil blends (B10 and B20) were analyzed for various physical chemical properties. The general physical parameters studied were pH, specific gravity, viscosity, fire point, flash point, smoke point, cloud point, carbon residue. The acidimetric constant chemical properties such as the Acid value, Iodine value and Saponification value were analyzed. The pH was determined by using Elico pH meter. The specific gravity and density was measured by using Brosil glass bottle method. Viscosity was measured by using calibrated Ostwald Viscometer. The fire point was analyzed by using Cleveland open cup apparatus. The flash point was determined by using Pensky- Martens closed cup tester apparatus. The cloud point was obtained by using Deep vision cloud point apparatus. The pour point was analyzed by using Deep vision pour point apparatus. The Smoke point was observed by using Seta Smoke point apparatus. Carbon residue was determined by using Conradson carbon

residue apparatus. The econometric constant namely the Iodine value was determined by Wijs method. The acidimetric namely acid value and saponification value were measured by the standard AOAC method.

## RESULTS AND DISCUSSION

The oil content of the dried seed of *Nigella sativa* is about 45% on dry weight basis. The General physical properties of the oil such as pH, Specific gravity, Density, Viscosity, fire point, flash point, Cloud point, Pour point, Smoke point, Carbon residue were measured for blends of 10% and 20% proportions. The results were given in the Table 1. The chemical properties of the oil such as Acid value, Iodine value and Saponification value were recorded in the Table 2.

The pH of biodiesel blends are slightly less than the petro diesel which also indicates the biodiesel is more acidic than the conventional diesel due to the presence of fatty acid. The specific gravity is important when considering the spray characteristic of the fuel within the engine. Higher Density and Viscosity of the liquid fuels affects the flow properties of the fuel, such as spray automation, subsequent vaporization and air-fuel mixing in the compression chamber. The change in spray can greatly alter the compression properties of the fuel mixture. The Specific gravity, Density and viscosity of vegetable oil are several times higher than that of diesel. By mixing the vegetable oil with the conventional diesel with 10% and 20% the Specific gravity, Density and Viscosity were found to slightly higher than that of diesel and it is within the range of the ASTM standard value of the biodiesel. The fire point of the blends B10 and B20 are almost equal and the B20 are slightly higher than that of petro diesel, and which falls within the range of ASTM standard. The flash point of these B10 and B20 are almost equal to the petro diesel and the values are within the range specified for petro diesel. The flash point of the biodiesel is higher than that of fossil fuel, so it clearly indicated that biodiesel is safer to handle than fossil fuel. The cloud point and pour point is slightly higher than the petro diesel, because of the fatty acids and the nature of fatty acids present in the biodiesel blends. The Smoke points of the biodiesel blend are less than the petro diesel but within the ASTM standard value. The carbon residue is slightly higher than the petro diesel. The high value of carbon residue may be due to the impurities present in the biodiesel blends.

The acid value of blends indicates that the amount of fatty acid present in the sample. The Acid value is slightly higher than that of ASTM standard because of the presence of the long chain unsaturated fatty acid in the blends. The number of double bonds present in the vegetable-oil is calculated by treating with iodine. The higher the iodine number is the amount of iodine needed to be saturate or break the double bonds in the fatty acid. Here the iodine values of biodiesel blends are lesser than the petro diesel and it is within the range of ASTM standard of the biodiesel. The Saponification value can indicate the non-fatty acid impurity and the amount of



alkali that could be required by the fat for its conversion to soap. In the biodiesel blends the Saponification values are less than that of the petro diesel. However the Saponification value is found to be within the acceptable-range of biodiesel.

## CONCLUSION

Eventhough *Nigella sativa* possess a lot of medicinal properties, other pharmacological activities are yet to be explored. *Nigella sativa*oil is analyzed for its used as the biodiesel source and it reduces the emission of toxic gases in the environment. Generally used as a food additives and also be lived to be safe for use as the biofuel to protect the environmental hazardous and enhance the natural energy sources. It is commonly cultivated in India, Westernghot, and Northeast. Domestication of *Nigella sativa* is not clearly established, but the plant was certainly under wide cultivation more than 3000 years ago, when it was placed in the tomb of Egyptian King Tutankhamun. Historical evidence also shows contemporaneous, or earlier, black seed cultivation in Jordan and Iraq. In addition, wild types of *Nigella sativa* grow in Turkey, Syria, and Iraq, suggesting domestication may have originally occurred there. In ancient times, *Nigella sativa* cultivation ranged at least from North Africa across the Middle East and into South Asia, where the plant has also been used in traditional medicine for 1000 years or more. Today, black seed is sown in its traditional range as well as in more southerly parts of Africa, in Europe, and elsewhere in the world.

The present study on *Nigella sativa* has shown that most of the physical and chemical properties evaluated for the biodiesel blends (B10 and B20) falls within the range of ASTM and EN standard values. The values are nearer to the conventional diesel properties. It could be concluded from this study the *Nigella sativa* oil blend B20 is the most potential source of biodiesel. It can be a replacement for fossil fuel. The production and effective usage of biodiesel blend at B20 will help to reduce the cost effect in the production of energy. It is eco-friendly biodegradable and protects the environment from the various environmental hazards. In order to evaluating this

present study this *Nigella* oil is used as a biodiesel potential source.

**Acknowledgements:** The authors are thankful to the Department of Science and Technology Govt. of India (DST/TSG/AF/2012/01 dated 31 December 2012) for financial assistance to carry out this investigation. The authors are indebted to the Chancellor, Vice Chancellor and the Management, Noorul Islam University Kumaracoil for their valuable guidance, constant encouragement and providing basic facilities throughout the study.

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Source of Support: Nil, Conflict of Interest: None.

