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Research Article

Thevetia Peruviana-A Potential Non-Edible Plant Source for Biodiesel Production

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Abstract

Plants are having more influence on man's life due to their applications in the areas like medicine, food and agro industry. Every plant is like a treasure and man has to explore its usefulness. Most of the plants are utilized in their natural form with minimum benefits. So the potentiality of the plant has to be analyzed for its derivatives and be adapted for the advantage of man. In this paper, *Thevetia peruviana* plant, commonly known as Yellow oleander has been taken for study and the applications of its derivatives have been discussed. In spite of the toxicity of the plant, it has been found to be useful in several spheres of life. Its derivatives are categorized into latex, stem bark, seed, seed oil and seed cake which can be used for specific applications. Seed cake can be used as an ingredient in livestock feed after detoxification. So detoxification methods have been also discussed.

Keywords: Plant; *Thevetia peruviana*; Biodiesel; Biooil; Toxicity; Detoxification.

Introduction

Man's interest in the study of plants had never diminished, as they continue to be the main source of food, medicine and many industrial applications. Many a plants are yet to be investigated for their full potential as a source for medical and industrial applications, *Thevetia peruviana* is one such plant requiring in depth study so as to bring out all its potentials. *T. peruviana* seed contains 60–65% of oil and the cake contains 30–37% protein [1-3]. Despite the fact that there is high level of oil and protein in the seed, it remains non–edible because of the presence of cardiac glycoside (toxins) [2].

The seed has nutritional value and can thus be used as an alternative protein source in animal feed formulation. It would reduce competition between man and livestock for the conventional sources of proteins if it is processed healthy. The oil could also be useful in the production of oleo chemicals such as liquid soap, shampoos, alkyd resin and biodiesel [2]. In a hectare, 3000 saplings can be planted and out of which 52.5 tons of seeds can be collected. Hence, about 1750 liters of oil can be obtained from a hectare of wasteland [4]. The plant can be grown on roadsides and road-dividers in expressways for beautification, environmental protection and at the same time for the production of biodiesel. Due to high oil and protein contents, and its availability, the plant has a potential for various uses and it may be used for biodiesel production [5].

Plant

T. peruviana plant is a shrub which grows mostly in tropical countries and we can see this ornamental plant around the lakes, schools, homes and also nearby other water resources. The plant grows as hedges around the agricultural lands and it can grow throughout the year in tropical climate. The plant has many varieties with attractive flowers. This ever green plant yields fruits all year round. Even though the native of *T. peruviana* is central and southern America [6], now we can see the plant all over the world. Though the plant has much potential, the poisonous nature of the plant limits the usage of it. The plant comes under *Aponaceae* family and it blooms thrice in a year. This perennial plant grows up to 4 meters and the greenish leaves are having sword like shape. The plant emits milky sap while the stem is injured and it is highly poisonous and gives irritation to the skin. The flower is mostly yellow in colour apart from white and orange. The flower looks like a flute which produces fruits. Each fruit consists of three to four seeds. The seed is highly poisonous in nature and the nuts can give oil by mechanical

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pressing or by solvent extraction. The toxic nature of the plant makes lack of interest about the plant even though it has several applications. The decoction of leaf and bark is used to cure intermittent fever. Corns and calluses are softened by applying the latex. Latex is also used to relieve the dental pain. The sap of leaf may be used as eye drops and nose drops for curing headaches. Skin infections can be cured by applying the seed oil externally. However care should be taken while using internally i.e., the dosage should be little higher than the therapeutic ones. The stem part is used as an insecticide. The wood is useful to make axe handle. Rezvi [7] reported that the percentage of glycosides existed in the seeds is 4.800 followed by leaf, latex and fruit of yellow oleander as 0.070, 0.045 and 0.036 respectively. Barceloux [8] reported that "The cardiac lycosides inhibit the transmembrane Na+/K+ATPase pump, and this action produces increased intercellular concentrations of Ca++and Na+.

Seeds

Each fruit contains three to four seeds. The fruit which is green in colour turns in to black as it ripens. The fruit and the seed are shown in Figure 1. The mass of the fruit varies from 2 g to 6.0 g. The plant yields the fruits year all around. The oil content of the seed is more than other plants which is nearby 64% on dry matter basis. The table 1 shows the fatty acid compositions of *thevetia* seed oils from three different locations in Nigeria [6]. Oleic, palmitic and linoleic acids were predominant fatty acids as shown in Table 1.

Figure 1. Thevetia Peruviana plant with riped fruits and seeds

Table 1. The fatty acid compositions of *thevetia* seed oils from three different locations in Nigeria

Fatty acid compositions	Location		
	North	North central	South
Myristic acid 14:0	0.247	0.306	0.407
Palmitic acid 16:0	20.173	18.123	20.212
Palmitoleic acid 16:1	0.257	0.234	0.255
Stearic acid 18:0	7.697	6.368	6.395
Oleic acid 18:1	46.097	39.908	42.207
Linoleic acid 18: 2	15.893	12.461	10.828
Linoleic acid 18: 3	0.407	0.744	0.468
Total saturated	28.303	24.97	27.113
Total unsaturated	59.900	50.971	52.932

T. peruviana seed contains good source of nutrients for livestock. But the toxic nature of the seeds deviate the interest from proper research of the oil and protein. Thevetin A and Thevetin B are the two major cardiac glycosides found in the seeds. However the long term use of oleander extract in folk medicines gave the positive effects in patients to cure prostrate or breast cancer [9]. In china, *T. peruviana* is a good source of oil for industry. The plant can grow in severe weather and degraded soil. Atteh et al. found that the *T. peruviana* cake after the fat extraction contains 48% of crude protein which need detoxification before using it as a feed to chicks [10]. It was found that the heat treatment,

fermentation, soaking in water, etc improved the Nutritive value of oil seed.

Detoxification Methods

Oluwaniyi et.al [11] has done two different methods for the detoxification process. In the first method one aqueous alcohol mixture has been used for the solvent extraction of the defatted cake. Aqueous alcohol mixture of $EtOH^{-1}$ MeOH (8:2) has been used twice for the solvent extraction of defatted cake. In the first time, solvent to meal ratio of 10:1 was taken and mixture was stirred and kept overnight. In the second time, solvent to meal ratio of 5:1 was used and again left overnight. Finally the cake has been pressed and air dried. In the second one the defatted cake has been hydrolyzed prior to solvent extraction. The hydrolysis was done using 0.1M HCl with the defatted cake in the ratio of 4:1. Again the first method of solvent extraction was repeated before air drying. The reduction in 95% of toxic glycoside was observed in acid hydrolysis whereas direct solvent extraction yielded 98% toxic reduction. The proximate composition of detoxified *T. peruviana* seed meal (TSC) is shown in table 2. The table shows the significant value of the crude protein in the detoxified *T. peruviana* seed meal as discussed earlier.

Table 2. Proximate composition of detoxified *Thevetia peruviana* seed meal

Constituents	Acid Treated TSC (%)	Alcohol Treated TSC (%)
Moisture	8.40 ±0.28	8.83±0.20
Dry matter	91.60 ± 0.28	91.17±0.20
Total ash	4.90 ± 0.40	7.85±0.17
Crude protein	44.45± 0.05	53.60±0.22
Crude fat	4.68 ± 0.10	4.07±0.43
Crude fiber	3.92 ±0.20	2.55±0.30
Carbohydrate	33.65± 0.44	23.09±0.26
Calorific value (kcal 100 g^{-1} sample)	355	343

***Thevetia Peruviana* seed oil**

The seed contains about 60 – 64% oil on dry matter basis. Usually TPSO is light brown in colour. TPSO contains (30 – 45) % of saturated fats,(46-51)% of mono unsaturated fats and (1-3) % of poly unsaturated fats. Since TPSO is having reasonable calorific value, it could replace the diesel in IC engines as a fuel after the conversion in to biodiesel. *T. peruviana* seed oil is having antifungal, antibacterial and anti-termite properties which are useful for surface coating. These properties stimulate the *T. peruviana*-based oil paint in the self-preservation against microbes and thereby protecting wood from subterranean termite attack [12]. The presence of unsaturated linoleic acid in *T. peruviana* seed oil creates the drying property which is suitable for making a surface coating such as paint.

***Thevetia peruviana* biodiesel**

The increase in vehicle population and depletion of petroleum reserves urge us to find alternative fuels .The emissions of nitrogen oxide (NOx), Carbon monoxide (CO), Carbon dioxide (CO_2), Hydrocarbon emissions (HC) and particulate matter from the Internal combustion engines are also adding problem to the environment such as Global warming, ozone layer depletion, etc. In this situation alternative fuels like biodiesel, etc. are playing key role in view of their performance and emission characteristics. The performance and emission characteristics of a diesel engine using biodiesel as a fuel are closer to that of diesel fuel. Biodiesel is renewable, non-toxic, bio degradable and having comparable calorific value with petro diesel. It has higher cetane number, no aroma and contains no sulphur. It emits less quantity of unburnt hydrocarbons (HC) and carbon monoxide (CO) when compared to NOx emission which is higher due to more oxygen content.

The conversion reaction of vegetable oil in to biodiesel (Transesterification process) was carried out using sodium hydroxide as catalyst. The sodium hydroxide (catalyst) 5 g per litre of oil was mixed with 160 ml of methyl alcohol to produce methoxide. Oil was heated to 60°C and the prepared methoxide was poured into the oil. The reaction was allowed for one hour and the final products (biodiesel and glycerol) were

allowed to settle in the separating funnel overnight. The biodiesel was washed using distilled water for four or five times to remove the impurities shown in Figure 2.

Figure 2. Washing of *Thevetia peruviana* biodiesel

The comparison of properties for diesel, oil and biodiesel are listed in table 3. Biodiesel produced from *T. peruviana* seed oil has been accepted as a suitable replacement for diesel [13-15] and biodiesel production can be optimized using various techniques [16-17]. TPBD when used in diesel engines is found to produce performance and emission characteristics that are comparable with diesel fuel. Nowadays the performance and emission characteristics of the biodiesel can be improved by adding additives like, diethyl ether, water, ethanol etc [18- 20].

Table 3. Properties of diesel, *Thevetia Peruviana* seed oil and biodiesel

Properties	Diesel	Thevetia Peruviana seed oil	Biodiesel
Viscosity	3.8 Cst	32.9 Cst	6.0 Cst
Density	840 kg/ m^3	920 kg/ m^3	860 kg/ m^3
Flash point	45 °C	240 °C	160 °C
Fire point	52 °C	252 °C	172 °C
Calorific Value	42500 kJ/kg	40148 kJ/kg	41032 kJ/kg

Conclusions

Thevetia peruviana plant, commonly known as Yellow oleander, a potential plant resource, has been taken for study and the applications of its derivatives have been discussed. Biodiesel from *Thevetia peruviana* seed oil showed comparable performance and emissions with diesel fuel in internal combustion engines. These properties strongly advocate for *Thevetia peruviana* plant as a prospective and viable alternative energy source. Using the waste land the biodiesel requirement of India can be met using the seed oil of *Thevetia peruviana* plants if they are cultivated.

Conflict of interest

Authors declare there are no conflicts of interest.

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