

A Review on Non-Traditional oil seeds as a new source of Biodiesel production

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Abstract- Biodiesel is gaining importance as a new renewable source of energy which can replace depleting fossil fuel resources. The population explosion and decreasing supply of fossil fuels are the most important factors to explore new alternative source of energy. Biodiesel has variety of applications in various fields like transportation, industrial power plant etc. Biodiesel refers to long chain fatty acids of lower alkyl esters. For biodiesel production various feedstocks like algae, edible oils or non-edible oils can be used. In this review the non-edible vegetable oil such as *Jatropha curcas*, *Datura stramonium*, *Annona squamosa* are explored for Biodiesel production. The oils are extracted by using soxhlet apparatus and their physio-chemical properties are examined by American oil chemical society methods. The oil is converted into biodiesel by transesterification. In this review we found *Jatropha curcas* as the most suitable oil seed for biodiesel production in comparison to *Datura stramonium* and *Annona squamosa*. Its suitability is due to high oil yield, cost effective, easy availability and sustainability for biodiesel production. The by-products formed during this process are used as cosmetics, fertilizers and as a base in soap.

Keywords- Biodiesel, *Jatropha Curcas*, transesterification.

I. Introduction

Due to the impact of environmental pollution of increasing exhaust emissions and depletion of world petroleum reserves, there is a need to develop an alternative energy resources such as biodiesel fuel. Vegetable oil is a promising alternative because it has several advantages; it is renewable, environment friendly and produced easily in rural areas, where there is an acute need for modern forms of energy. Biodiesel is monoalkyl esters of fatty acids derived from vegetable oils or animal fats, is known as a clean and renewable fuel. Biodiesel has many advantages which include: its renewability, safe for use in all conventional diesel engines, offers the same performance and engine durability as petroleum diesel fuel, non-flammable and nontoxic, noxious fumes and odors, biodegradability, and reduced exhaust emissions[1]. During the last few years the use of biodiesel has grown dramatically. Besides, biodiesel is free from sulfur or aromatic compounds and reduces air pollution like carbon monoxides, hydrocarbons and particulate matter [2,3,4]. Therefore, this makes biodiesel an ideal fuel and it is gaining attention worldwide. The first generation biodiesel production from non-edible oil has gained attention due to the high biodiesel yield and easy processing. However, edible oil based biodiesel faced the problem of fuel versus food debate and these factors have negatively affected the biodiesel production from edible oils. Therefore, non-edible vegetable oils or the second-generation feedstocks have also become more attractive for biodiesel production.

One possible alternative to fossil fuel is the use of oils of plant origin like vegetable oils and tree borne oil seeds. This alternative diesel fuel is known as biodiesel. This fuel is biodegradable, non-toxic and has low emission profiles as compared to petroleum diesel.

There are four primary ways to make biodiesel which includes direct use and blending, microemulsions, thermal cracking (pyrolysis) and transesterification. The most common method in use is transesterification of vegetable oils and animal fats. It can be produced from both edible and non-edible vegetable oils and animal fats. However, transesterification process is very reliable, less costly and easy method compared to other methods. Due to more free fatty acids content in most of the non-edible vegetable oils such as *Jatropha Curcas*, *Datura Stramonium*, *Annona Squamosa* pre-treatment is employed to convert the acids to ester, then transesterified with suitable alcohol.

More interest is leading towards the use of *Jatropha curcas* L. oil as the feedstock for biodiesel production because it is non-edible and thus does not compromise the edible oils, which are mainly used for food consumption. The oil can be combusted as fuel without being refined. Biodiesel can also be prepared from the extracts of seed oil of *Datura stramonium* by two-way process comprising of acid catalyzed esterification followed by base catalyzed transesterification. Another alternative for biodiesel production is *Annona Squamosa*. All the properties are in the range of ASTM biodiesel standards, this can be promising factor to use these seeds as one of the biodiesel sources.

II. MATERIALS AND METHOD

2.1 Materials and reagents

Jatropha Curcas, *Datura Stramonium*, *Annona Squamosa*. Methanol (99.9% purity), toluene (99.9% purity), H₂SO₄ (purity 95–97%), phosphoric acid (H₃PO₄ 20%), NaOH pellet, CaCl₂ anhydrous (purity 99%), Na₂SO₄ anhydrous (purity 99%) and qualitative filter paper (filter fiori, France). All reagents were used without purification.

2.2 Oil Extraction

For the extraction of oil many researchers used soxhlet extraction method. It is a time consuming method as it requires 3-6 hours but still widely used. Using RSM (response surface methodology) the parameter of soxhlet extraction were utilized earlier. The parameter obtained were used in determining the sufficient condition for the extraction of oil from seeds.

2.3 Biodiesel Production

Number of methods are currently available that have been well established for the production of biodiesel fuel. Crude oils are worthwhile to be modified in order to reduce their viscosities so that the product obtained has suitable properties to be used as engine fuels. There are many procedures available for this but we are going to use *Transesterification* method.

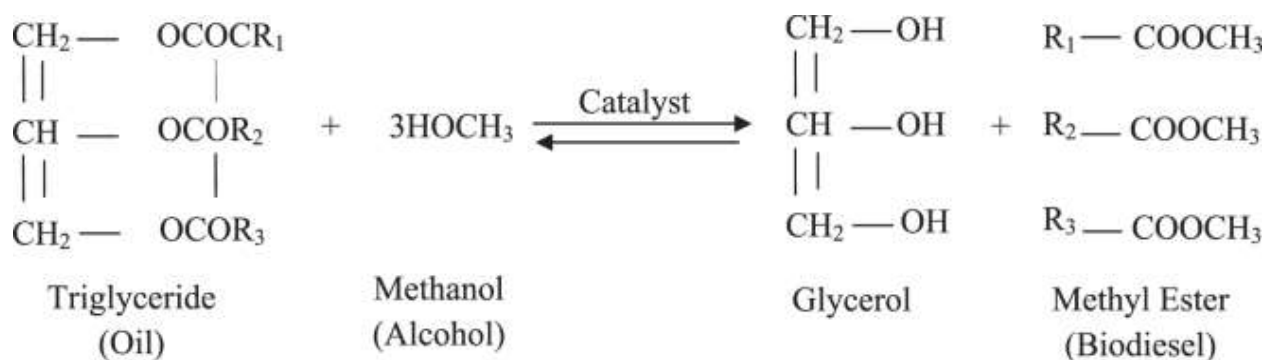
fig 1. soxhlet apparatus



2.4 Transesterification

In transesterification process esters and glycols are formed by the chemical reaction of alcohol with triglycerides in the presence of catalyst. Three consecutive reversible reaction occurs in transesterification :a) conversion of triglycerides to diglycerides. b) diglycerides to monoglycerides c) glycerides are then converted to glycerol. Catalyst is used to improve the reaction rate so that the reaction is completed in a shorter period of time. The catalyst used are acids, alkali or enzymes [7]. Favourable catalysts are basic catalyst over acid ones due to their milder process conditions (lower temperature) and higher reactivity [5]. In this reaction ester and crude glycerol is produced. The by-product glycerol is also important in this reaction as it has numerous applications in various fields. [6]. In the overall transesterification reaction three consecutive and reversible equations occurs as shown below.

fig 2. transesterification reaction



III. Result And Discussion

3.1. Fatty acid composition

The major components of biodiesel are straight fatty acid chain and the common fatty acids are palmitic (C16:0) acid, stearic (C18:0) acid, oleic (C18:1) acid, linoleic (C18:2) acid and linolenic (C18:3) acid [8]. It is reported that biodiesel with a high level of methyl oleate (monounsaturated fatty acid) may have excellent characteristics in ignition quality, fuel stability and flow properties at low temperature [9]. The saturated chain (capric acid) is suitable for cold flow properties and possess higher oxidative stability [14,9] due to long saturated chain and the absence of double bonds [10]. Fatty acid composition will affect the iodine value whereas the higher iodine value leads to rapid deterioration of lubricant oil [14,11]. Generally, non-edible oil contains high degree of unsaturated fatty acid as it is made up of high number of polyunsaturated in comparison to saturated oil [12].

Therefore, this structural fatty acid composition will influence the physicochemical properties of biodiesel such as cetane number, cold properties, heat of combustion and viscosity [14,15,9]. On the other hand, the freezing point and viscosity of biodiesel increases with the increase of carbon chain length and decreases with the increase of double bonds [14].

3.2. Determination Of Acid Value And The Free Fatty Acid values

Acid value and the free fatty acid percentage of crude oil and degummed oil were measured following AOCS Cd 3d-63 method [16]. Free fatty acid percentage is the number of gram for fatty acid in 100 ml of oil. Moreover, acid value is the number of milligrams of potassium hydroxide needed to neutralize the free fatty acid in 1 g of oil sample. KOH solution with normality 0.10 was used as titrated solution to measure acid value and free fatty acid. The first step was to measure oil sample about $1.0-2.0 \pm 0.1$ g and put into conical flask. Then, along with the few drops of KOH solutions and end point appears as a pink colour. The acid value was expressed as mg KOH per g of oil by Eq. (2) and % free fatty acid as shown by following equations [16,17].

$$\text{Acid value (AV)} = (V \times N \times MW_{\text{KOH}} / W) \quad (\text{Expressed in mg KOH per g}) \quad (1)$$

$$\% \text{FFA} = (V \times N \times MW_{\text{C18:1}} / W \times 1000) \times 100\% \quad (\text{Expressed as Oleic acid}) \quad (2)$$

$$\% \text{FFA} = (V \times N \times MW_{\text{C18:2}} / W \times 1000) \times 100\% \quad (\text{Expressed as Linoleic acid}) \quad (3)$$

$$\% \text{FFA} = (V \times N \times MW_{\text{C16:0}} / W \times 1000) \times 100\% \quad (\text{Expressed as Palmitic acid}) \quad (4)$$

where V is the amount of KOH solution consumed in the reaction (mL); N is the normality of the KOH solution; W the weight of sample taken (g); MW the molecular weight (g/mol); MW of KOH is 56.1 g/mol; MW of C18:1 is 282.5 g/mol; MW of C18:2 the 280.4 g/mol; and MW of C16:0 is 256.4 g/mol.

table 1: composition of free fatty acid

	<i>Jatropha curcas</i>	<i>Datura stramonium</i>	<i>Annona squamosa</i>
Palmitic acid (C16:0)	12.12	8.5	19.99
Stearic acid (C18:0)	5.56	8.19	4.16
Oleic acid (C18:1)	43.52	17.5	38.58
Linoleic acid (C18:2)	36.0	61.3	35.97
Linolenic acid (C18:3)	0.46	3.1	1.31
Iodine value (mg/g)	103.62 ± 0.07	121.05	110
Saponification value	193.55 ± 0.61	113.2	90

3.3. Free Fatty Acid Profile

The fatty acid composition is shown in above table 1. The fatty acid profile showed that the primarily composition were oleic acid (44.5%), and linoleic acid (39.7%) for the CJCO, CSFO and CCPO respectively. Moreover, the fatty acid profile of CSFO shows that it consists 25% of saturated, 15.3% of unsaturated, 1.7% of malvaloyl acid and 35.1% of sterculoyl acid [18]. However, C. pentandra contains a pair of unique cyclopropene fatty acids (malvalic acid) which are more reactive than the double bond carbon (polyunsaturated) in the reaction with radical formation by atmospheric oxygen. Thus, this hydrocarbon chain reduces oxidation stability in vegetable oil.

IV. CONCLUSION

Jatropha curcas seed oil have very good yield in comparison to *Datura stramonium* and *Annona squamosa* which show that they are very good and viable food stock for biodiesel production. The other oils though low in yields could be exploited for biodiesel production since they are derived from non common food sources. The major limitations of all the oils were mostly high FFA values.

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Figure reference

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