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ORIGINAL ARTICLE

The Role of *Jatropha curcas* Seed Oil in the Sustainable Development: An Overview

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ABSTRACT

Utilization of natural renewable resources has been gaining lot of attention of researchers now-a-days for the development of specialty chemicals and other useful materials. Renewable resources have ability to grow again and again, ultimately reduce the dependency on non-renewable resource petrochemicals, which is going to deplete day by day. Among numerous renewable resources vegetable oils especially those obtained from variety of seeds have received lot of attention of researchers, due to their distinctive properties and eco-friendly characteristics. Jatropha curcas seed oil (JCSO) classified as a non-edible, abundantly available in the spectrum of nature due to easy cultivation and low maintenance. In present communication effort has been made to overview the utilization of JCSO in different areas of practical utility.

Key words: *Biodiesel, Biopolymer, Jatropha curcas seed oil, sustainable development*

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INTRODUCTION

Development of eco-friendly products and energy generating sources using materials obtained from renewable natural resources have gain considerable attention now-a-days throughout the world [1-3]. Such developments not only reduce the emission of green house gasses but also provide a sustainable platform to the chemical industries as they have ability to grow again and again [4-6]. Furthermore, their productivity can be increased on demand by more cropping and plantations. Numerous agricultural wastes have been utilized to architect the numerous bio-based materials and documented in literature. Furthermore, vigorous efforts continue to utilize these raw materials in more useful way to overarching the goal of sustainability [7-8]. Among different renewable resources vegetable oils (VO) especially those obtained from seeds of different plants have largely spotted by the researchers due to their unique properties, such as ease of availabilities, functionalities for derivatizations and non-toxicity during processing [9-11]. Utilization of vegetable oils of non-edible categories in the development of useful materials is additionally significant as they are also not affecting the stock of edible materials.

Jatropha curcas is belonging to Euphoriaceae family, a shrub or small tree found in tropical and subtropical parts chiefly in America and Africa [12-15]. It can be propagated easily by seeds or cuttings. It grows wild in tropical and subtropical regions, hardy to dry weather conditions. It found to show the drought resistance properties too. It grows upto

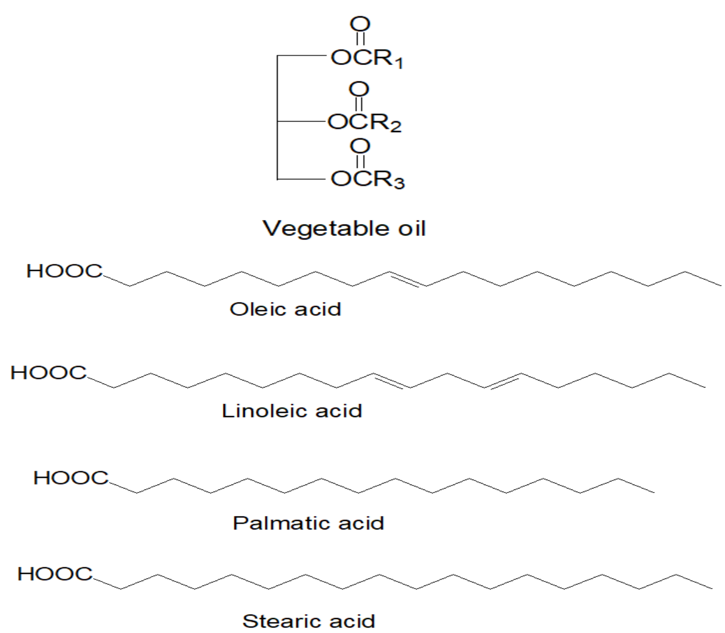
7 meter height with thick braches and also does not browsed by goat and cattle. It can be cut looped at any desired height as well as adapted by hedges. *Jatropha curcas* can grows rapidly under variable climatic conditions because of low moisture desire and tolerance to temperature, found almost throughout the India. The juice of plant reported to relief in toothache and strengthens the gum; leaves juice of *Jatropha curcas* is useful in scabies, eczema and ringworm [14,16]. Bark of the plant used for making dyes. The sap flowering from stem is used to arrest bleeding of wound. Latex has antimicrobial properties against several bacteria like *Staphylococcus aurens, Escherichia coli, Klebsiella pneumonias, Streptococcus pyogene* and *Candida albicans* and also demonstrated to coagulating effect on blood plasma [12,14]. The seeds are rich in nitrogen and phosphorous used as organic fertilizers and soil improver cake; protein may be employed as a raw material or plastic and synthetic fibers.

Jatropha curcas tree yielded non-edible seeds which contain about 48 % oil embedded with appropriate fatty acids in triglyceride structure. The bushes begin to yield oil within a year and can live upto 50 years [12]. The oil has a strong purgative action reported for treatment of skin diseases and to soothe pain such as that caused by rheumatism, herpes, pruitus. In addition to these it is largely used a as bio-fuel and as a feed stock in many industrial arena. In present communication efforts has been made to overview the usage of *Jatropha curcas* seed oil (JCSO) in biodiesel and bio-based feed stock for polymer industries.

PHYSICOCHEMICAL PROPERTIES AND COMPOSITION

The *Jatropha curcas* yielded non-edible seeds which contain about 48- wt% triglyceride oil. The physicochemical properties and fatty acid composition of the vegetable oils varies somewhat according to climatic conditions, nature of soils and purification methods [17]. Monounsaturated oleic acid is the major constituting fatty acid (about 42.0 %) of the JCSO. The iodine value provides an inside about the unsaturation of vegetable oil and analytically measured by titration is reported to ranges from 80-120 (g of I_2/100 g) for the JCSO [3, 12, 13, 18, 19]. In literature JCSO is categorized as semi-drying oil. The general structure of triglyceride oil and major fatty acid constituents of JCSO are depicted in Figure 1.

Fig. 1: General Structure of vegetable oil and common fatty acids present in *Jatropha curcas* seed oil



BIODIESEL

The search for alternative and sustainable resource for petrochemical has become significant now-a-days, due to fast depletion of petrochemical stock and negative effect on environment [12, 20]. Vegetable oils obtained from seeds of different plants have emerged as the prospects to develop an alternative fuel. These are reasonably due to some unique properties, such as easy availability, renewability and friendly to the environment [21].

Among the different plants species *Jatropha curcas* is the main commodity for the biodiesel and has immense potential for producing oil. The JCSO categorized as non-edible oil and directly used by the farmers as fuel to run the water pumps for irrigation of their field [22]. However, like other triglyceride oils, there are limitations in the use of this non-edible oil as fuel, like as its high viscosity, excessive engine deposit and engine contaminations, low thermal efficiency, higher smoke emission. Products obtained after transesterificaion of vegetable oils commonly known as a biodiesel, known for the improved performances in terms of fuel over the normal vegetable oil. Biodiesel fuel can be defined as medium chain length mono alkyl fatty acid ester [23]. Such transformation of JCSO, improves its fuel characteristics remarkably. The transestrification can be performed by the reaction of triglyceride oil with an excess of alcohol (mainly methanol) in presence of acid or base as a catalyst [24]. Base catalyzed transesterification generally preferred due to faster rate of conversion. Common catalysts used for transesterification are NaOH, KOH or alkoxides. Among them utilization of KOH is more fruitful as neutralization of reaction mixture with phosphoric acid on completion of reaction, yielded potassium phosphate, a well known fertilizer. Transesterification reactions are reversible in nature and hence it is required to use either a large excess of alcohol or remove the one of the product to shift the equilibrium towards forward direction. A molar ratio of 6:1 is normally used for industrial processes to obtain methyl ester [24]. The viscosity and flash point of the JCSO decreased notably after transesterification. It has been reported that an average cetane value of biodiesel derived from JCSO is 53.0 [19].

BIO-BASED FEED STOCK FOR POLYMER INDUSTRIES

The worldwide interest in the development of bio-based polymer has geared at present due to the desire and need to find out polymers from renewable ones [25]. The use of vegetable oils especially those are categorized as non-edible in the development of useful materials has received significant importance as they reduced the dependency on petrochemical as well as minimizes the environmental problems [8,26,27]. The syntheses of oleochemical and polymeric materials from seed oils have introduced a renewable alternative to feed stock. JCSO reported to use a precursor of natural renewable resource for the syntheses of many polymeric materials of practicable utilities. JCSO chemically triglyceride reported to used for the synthesis of alkyd resins. Alkyd resins are chemically polyester of long chain fatty acids, a dibasic acid and a polyol and extensively used as a binder for paint and coating industries. Alkyd resin derived from JCSO, glycerol, phthalic and maleic anhydride, reported suitable for making varnishes for electrical insulation applications [28]. The aluminium modified poly(ester-amide) of JCSO reported for improved physic-mechanical performances as well as significant reduction in curing temperature [29]. JCSO and its derivatives (epoxide and its metal soap like barium, cadmium, lead and zinc) has reported for stabilization of poly(vinyl chloride) against thermal degradation. The results showed that derivatives of JCSO are effective in suppressing the rate of dehydrochlorination and in reducing the extent of degradation of the polymer [30]. Urethane modified polyesteramide (UPEA) resin from JCSO through microwave technique has been reported. In this JCSO converted to bifuntional fatty amide diol followed by poly(condensation) reaction with itaconic acid to obtained polyesteamide. The resulting polymer further react with toluylene diisocyanate (TDI) in variable amount to obtained UPEA. They claimed that the final product is thermally safe upto 230^oC and also show the good chemical resistance performance in organic solvents, acidic, alkaline and saline environments [31]. JCSO based polyurethane using aromatic and aliphatic isocyanate was reported for paint and coating materials. JCSO was epoxidised with H_2O_2 followed by treatment with acrylic acid to obtained polyol through ring opening reaction. The polyol then treated with aromatic and aliphatic isocyanate to obtained respective polyurethane. The resulting JCSOU based films were investigated for gloss, hardness and adhesion quality. The reported results demonstrate that JCSO has potential to develop as a polyurethane coating raw material [32]. Hydroxylation of JCSO with formic acid in presence of excess of hydrogen peroxide and their urethanation with toluylene diisocyanate in variable ratios to obtained urethanated oil was reported. The resulting products were characterized by FT-IR, ^1H-NMR and ^{13}C-NMR spectroscopies. Various physicochemical properties like iodine value, saponification value, and hydroxyl value were carried out titrimetrically to envisage the progress of reaction and formation of final products. The authors also investigate the thermal stabilities using differential scanning calorimeter (DSC) [33].

CONCLUSION AND PROSPECTS

In present communication efforts have been made overview the physicochemical properties and utilization of JCSO as a source of energy production as well as a renewable feed-stock for many environment friendly useful resources. The article enlightens the JCSO as a potential candidate for the development of environment friendly valuable recipes materials. It yielded value added materials by simple chemical transformations, which find copious applications in day to day of life. The exploitation of JCSO in different value added materials with less hazardous impact on environment, not only reduced the demand of petrochemicals but also reduce the pressure on the other edible triglyceride oils. Thus the use of JCSO categorized as non edible abundantly available, due to easy cultivation in most of climatic conditions, heaping up the feed stocks, a way towards overarching goal of sustainable development.

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