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# OIL CONTENT VARIATION AND PHYSICO-CHEMICAL PROPERTIES OF JATROPHA CURCUS SEED OIL COLLECTED FROM KUMAUN REGION OF UTTARAKHAND, INDIA

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## ABSTRACT

*Jatropha curcas* L. is considered to have originated in Latin America, and is presently grown throughout the arid and semi-arid tropical and subtropical regions of the world. To study the oil content variation and physico-chemical properties of *Jatropha curcus* seed were collected from various districts of Kumaun. The oil contents of the seeds range from 30-44.4%. The maximum oil content was 44.4% found in seeds collected from Almora, while minimum was 30.0% in the seeds collected from Udham Singh (US) Nagar. The physico-chemical properties of the oil such as acid value, iodine value and saponification value are in the range of 5.75 to 15.53, 90.50-113.63 and 175.20-196.67, respectively. Microclimatic data of different district was also estimated which shows that soil pH ranges from 6.5-7.4, soil temperature vary from 22.2-27.5 and soil moisture vary from 21.3-33.0%. The characteristics of the seed oils studied compared favorably with other research studies.

**Key words**: Biodiesel, Jatropha curcas, Physico-chemical properties, Seed oil.

## INTRODUCTION

The use of plants and its products for treatment of diseases is as old as mankind. Likewise, other plant parts as well as seeds have been used as natural drugs for the management of several ailments as advocated by traditional healers since time immemorial. Apart from dietary (for edible oils) and industrial (mainly as lubricants) purposes, seeds serve as important herbal drugs intended for several therapeutic indications. Oil from seeds are often available as raw materials for chemical and industrial applications[1]. Due to the increasing demand for oils, improvements are being made, with crops, as well as with selected plant species, that have the ability to produce unique desirable oils. Interest in newer sources of edible oils has recently grown.

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It is well known that no oil from a single source has been found to be suitable for all purposes because oils from different sources generally differ in their composition. This necessitates the search for new sources of oils. Several plants are now grown, not only for food and fodder, but also for a striking variety of products with applications in industry, including oils and pharmaceuticals[2].

Jatropha is a genus of nearly 175 species of shrubs, low-growing plants, and trees. However, discussions of Jatropha as a biodiesel are actually talking about a particular species of the plant, *Jatropha curcas*, which is also called Barbados nut in Central America and has been known as Physic nut or *Pourghere* in parts of Africa and Asia. *Jatropha curcas* is a perennial shrub that, on average, grows approximately three to five meters in height. It has smooth grey bark. The leaves are large and usually pale green and the plant produces flowers. Fruits are produced in winter or throughout the year depending on temperature and soil moisture.

The plant can be used to prevent and/or control erosion, to reclaim land, grown as a live fence, especially to contain or exclude farm animals and be planted as a commercial crop[3]. *J. curcas* is a perennial plant, native and widely spread throughout many tropical countries. It is not grazed by animals, grows readily in poor and stony soil, is drought and disease resistant, multipurpose and yields high quality biodiesel[4].

Climate change, energy security and rural development are factors drawing much of the research and development in these areas. *Jatropha* has proven to be an inexpensive feedstock in biodiesel production that can be grown on a marginal agricultural land thus displacing much use of conventional fossil fuel. *Jatropha* diesel is a valuable renewable energy that can be used directly in any existing unmodified diesel engine. Due to above-mentioned advantages of the plant, the present investigation was therefore undertaken to explore plant seed potential as possible source for economic development by industrial application.

## EXPERIMENTAL

### Collection of plant materials

The seeds of *J. curcas* were collected from six district of Kumaon, namely : Bageshwar, Pithoragarh, Almora, Nainital, Champawat, Udham Singh Nagar. The plant species were identified by Dr. Sumer Chand, Systematic Botany Division, Forest Research Institute (FRI) Dehradun, Uttarakhand, India. The healthy seeds were collected and the damaged seeds were discarded. The seeds were cleaned, de-shelled and air dried in the shade for few days. The seeds were ground to powder using a grinder prior to oil extraction.

## Extraction of oil

*Jatropha curcas* seeds were collected from the various districts of Kumaun region of Uttarakhand. The extractions of oil from the seeds were carried out in a Soxhlet apparatus. 100 gm of the grounded seeds were taken and were placed in the soxhlet apparatus and the oil was extracted using petroleum ether as solvent. The assembly was made to run for 8 hours. Anhydrous sodium sulphate was added to remove any trace of moisture from the extracted solution At the completion of extraction process the oil was recovered from the mixture by distillation and stored in a labeled sample bottle. This process was repeated for each sample.

The percentage of oil content is calculated as below -

$$\% \text{ of oil} = \frac{\text{Wt. of oil obtained in g}}{\text{Wt. of seed taken in g}} \times 100$$

After the oil had been obtained and its percentage of oil content was calculated the same is subjected to analyse the physio-chemical properties of oil.

## Acid value

The acid value of the sample oil was determined by dissolving about 5.0-5.5 g of the sample oil in a hot mixture of 25 mL diethyl ether and 25 mL 95% v/v ethyl alcohol. The hot solution was neutralized with 0.1 M NaOH using phenolphthalein as indicator. The acid value was calculated according to recommendation of AOAC[5].

## Iodine value

The iodine value was determined by the standard methods of AOAC[6]. About 0.23-0.26 g of each sample oil was weighed into a glass stoppered flask and dissolved in 10 mL cyclohexane. 20 mL of Wij's solution was added, the flask was stoppered and allowed to stand for 30 minutes in the dark at 25$^{o}$C after which 20 mL of 10% KI solution was added. The mixture was titrated with 0.1 M $Na_2S_2O_3$ using starch as an indicator. A blank was carried out and the iodine value was calculated.

## Saponification value

For saponification value approximately 1 g of each sample oil was weighed into a 250 mL Quickfit conical flask and 25 mL of ethanolic potassium hydroxide was added. The mixture was heated under reflux for 1 hour with constant shaking to allow uniform

temperature. Then the hot soap was titrated with 0.5 M HCl using 1 mL of phenolphthalein as an indicator. A blank was determined under the same condition and the saponification value of the oil was calculated as recommended by AOAC[6].

## RESULTS AND DISCUSSION

The oil yield of the seeds are in the range 30% to 44.4% as shown in Table 1. The seed from Almora district has the highest oil yield of 44.4% while the seed collected from Bageshwar district shows the least yield of 32.9%.

**Table 1: Physico-chemical properties of *J. curcus* seed oil grown in different districts of Kumaun region**

| S. No. | Districts | Oil yield (%) | Acid value | Iodine value | Saponification value |
|---|---|---|---|---|---|
| **1** | Udham Singh Nagar | 30.0 | 5.75 | 90.50 | 175.20 |
| **2** | Almora | 44.4 | 14.15 | 93.70 | 177.50 |
| **3** | Nainital | 36.2 | 15.53 | 113.63 | 196.67 |
| **4** | Bageshwar | 32.9 | 14.9 | 111.90 | 189.67 |
| **5** | Pithoragarh | 41.1 | 13.4 | 103.23 | 191.53 |
| **6** | Champawat | 39.5 | 12.04 | 107.63 | 183.40 |

The oil yield in the range 30- 44.4% are in agreement with the study conducted by Kumari et al.[7]. They reported that the oil content of Jatropha seed ranges from 30-50%, Pramanik[8] also reported the oil content in Jatropha seed in the range from 30-50% by weight of the seed and ranges from 45-60%weight of the kernel. Therefore the seed rich in oil yield could be exploited for economic purposes.

Acid value is an indicator for edibility of oil and suitability for industrial use. Acid value of the oil extracted from the seeds of Kumaun region are in the range of 5.75-15.53 (Table 5). The oil from Udham Singh Nagar district shows the least acid value (5.75) whereas the seed oil from Nainital district shows the highest acid value (15.53). The districts are statistically significant in respect of acid value.

The iodine value of oil of Kumaun region are in the range of 90.50- 113.63 (Table 1). Nainital district of Kumaun region showed the highest iodine value (113.63) and that in Udham Singh (US) Nagar the iodine was lowest (90.50). The Iodine value is a measure of

the unsaturation levels in fats and oils. A high Iodine value is an indication of the presence of high unsaturation levels of oils. The Iodine value is a measure of the unsaturation levels in fats and oils. A high Iodine value is an indication of the presence of high unsaturation levels of oils. According to Jindal[9] iodine value of Jatropha oil was 98.91 and as per Biodiesel BIS Std. it should be less than 115.

The iodine value is within the range of 115, which is at par with the BIS Std. and suitable for biodiesel. This is an agreement with Knothe et al.[10] and Mittelbach[11].

The district wise analysis in Kumaun region, saponification value ranges from 175.20-191.53 (Table 1). The highest saponification value was recorded in Nainital (196.67), while the least in Udham Singh (US) Nagar (175.20). The high saponification value indicates that the seed oil can be used industrially. Highly saponifiable oils have vast industrial applications[12]. According to Halling[13], the formation of soapy film provides adequate boundary lubrication and reduces engine wear.

**Table 2: Microclimatic data of the different study areas of Kumaun region**

| S. No. | Districts | Soil pH | Soil temperature | Soil moisture |
|---|---|---|---|---|
| **1** | Udham Singh Nagar | 6.5 | 22.2 | 21.3 |
| **2** | Almora | 6.8 | 27.5 | 25.3 |
| **3** | Nainital | 7.2 | 23.0 | 24.3 |
| **4** | Bageshwar | 6.6 | 27.0 | 33.0 |
| **5** | Pithoragarh | 7.4 | 27.0 | 23.0 |
| **6** | Champawat | 7.0 | 27.0 | 30.3 |

As shown in Table 2, soil pH of Pithoragarh was highest (7.4) as compared to the other sites while Udham Singh Nagar shows the least soil pH (6.5).

In case of soil temperature the highest was shown by the site of Almora district (27.5) whereas US Nagar shows the least soil temperature (22.2). The study site of Bageshwar shows the highest soil moisture (33.0%), while the least moisture was shown by Udham Singh (US) Nagar (21.3). Statistically all the variables i.e. soil pH, soil temperature and soil moisture shows the highly significant differences among the districts of Kumaun region as shown in Table 3, 4 and 5, respectively.

**Table 3: Statistical analysis of soil pH of study area of Kumaun region**

| ANOVA | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Source of Variation** | **SS** | **df** | **MS** | **F** | **P-value** | **F crit** | |
| Between Districts | 2.459259 | 5 | 0.491852 | 33.2*** | 1.76E-08 | 2.772853 | **CD = 0.17299** |
| Within Districts | 0.266667 | 18 | 0.014815 | | | | |
| Total | 2.725926 | 23 | | | | | |

**Table 4: Statistical analysis of soil temperature of study area Kumaun region**

| ANOVA | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Source of Variation** | **SS** | **df** | **MS** | **F** | **P-value** | **F crit** | |
| Between Districts | 110.5974 | 5 | 22.11947 | 46.13*** | 1.22E-09 | 2.772853 | **CD = 0.984** |
| Within Districts | 8.629267 | 18 | 0.479404 | | | | |
| Total | 119.2266 | 23 | | | | | |

**Table 5: Statistical analysis of soil moisture of study area Kumaun region**

| ANOVA | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Source of variation** | **SS** | **df** | **MS** | **F** | **P-value** | **F crit** | |
| Between Disttricts | 405.9259 | 5 | 81.18519 | 65.92*** | 6.14E-11 | 2.772853 | **CD = 1.577** |
| Within Districts | 22.16667 | 18 | 1.231481 | | | | |
| Total | 428.0926 | 23 | | | | | |

Microclimatic data reveals that it is good for the growth of *J. curcus*. Although the soil temperature greatly varies in between the study area but soil pH are in acceptable limit (soil pH 6-9) as per the data available in the website[14].

The study shows that the *J. curcas* seed has a good oil yield and its physico-chemical properties has a great potential for industrial use. As the *Jatropha curcas* has very good potential to be grown in Kumaun therefore it is recommended that it should be cultivated to uplift the economic condition of the rural people of this region. Therefore, it is amiable to have more research on *J. curcas* seed oil in the future to explore its potentials for future industrial oilseeds crop.

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