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STUDIES ON FIXED OIL OF *JATROPHA CURCAS* SEEDS

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The fixed oil (41.5%) from the seeds of *Jatropha curcas* Linn. has been characterised for its fatty acid composition, and physico-chemical properties. The oil is found to consist of palmitic acid (14.16%), stearic acid (7.68%), oleic acid (46.72%) and linoleic acid (30.31%). The physicochemical constants include: Refractive index at 30°, 1.4675; Iodine value, 102; Saponification value, 196.72; Flash point, 227° and Calorific value, 8990 K.cal/kg. The oil can be used as a mixed fuel for diesel/gasoline engines.

Key words: Jatropha curcas, Physic nut, *Euphorbiaceae.*

INTRODUCTION

Jatropha curcas Linn. (N.O. *Euphorbiaceae*) also known as "Physic nut" is an evergreen shrub as tall as 15 feet. Each nut (fruit) bears three seeds 1 x 2 cms in size with a thin blackish shell. The plant is indigenous to tropical America, Brazil and West Africa, but is grown in other countries as well including Thailand and India. It flowers in May-June and the fruits ripen after 2-3 months.

In India, the oil is employed by the poorer class for illuminating purposes. In England, the oil obtained from African seeds had a reputation of lubricant and useful in manufacture of transparent soap. The Chinese are said to produce a varnish by boiling the oil with iron oxide [1].

The seeds and fruit of *Jatropha curcas* are anthelmintic, useful in chronic dysentry, thirst, tridosha, urinary discharge, abdominal complaints, biliousness, anaemia, fistula and diseases of heart. The oil from the seeds is applied topically in Guinea for rheumatism, herpes and puritus [2].

The oil from the seeds of *Jatropha curcas* has been investigated for the first time in Pakistan. The seeds were procured from Thailand and grown in the field of these laboratories, Since the oil has been reported as a possible substitute for diesel oil, [3]. It was selected for the present studies.

EXPERIMENTAL

The seeds of *Jatropha curcas* were fractured and the shells removed. The kernels (200 gms.) were crushed in a grinder and extracted exhaustively with *n*-hexane in a Butt extractor. The extract was dried over anhydrous sodium sulphate and filtered. The solvent was removed under reduced pressure when light yellow oil (83.0 gms.) was obtained.

The physico-chemical properties of the oil (Table 1) were determined by AOCS methods [4]. and the colour was measured by Lovibond. Tintometer in a 5 1/4" cell. The U.V. was taken with Unicam SP-500 Spectrophotometer.

Table 1. Physico-chemical properties of *Jatropha curcas* seed oil.

S. No.	Property	Value	Method
1.	Appearance	Light yellow liquid	—
2.	Yield	33.2 – 41.5%	—
3.	Specific gravity at 30°/30°	0.9149	AOCS Cc 10a-25
4.	Refractive index at 30°	1.4675	AOCS Cc 7-25
5.	Acid value	1.24	AOCS Cd 3a-63
6.	Saponification value	196.72	AOCS Cd 3-25
7.	Iodine value	102.1	AOCS Cd 1-25
8.	Ester value	194.5	By difference
9.	Peroxide value (Meg/kg.)	NIL	AOCS Cd 8-53
10.	Unsaponifiable matter	0.4%	AOCS Ca 6a-40
11.	Colour	1.OR + 5.OY	Lovibond Tintometer (5 1/4" Cell)

The calorific value and sulphur content were determined on Jullius Petter (W. Germany) model by ASTM methods [5], and the flash point on Cleveland (open cup) apparatus and are recorded in Table 2.

Saponification of the oil and methylation of fatty acids: The fatty acids, obtained by usual method, were converted to their methyl esters by methanol in the presence of concentrated sulphuric acid [6]. The methyl esters were pu-

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Table 2. Comparative results of fatty acid composition of *Jatropha curcas* seed oil as reported by the previous workers and the present studies.

S. No.	Fatty acid	Steger [7] and Vanlon	Lamonica [8] *et al.*	Koley [9] *et al.*	Atchaya [10] *et al.*	Present Studies
1.	Oleic acid	35.0	42.47	50.90	41.0	46.72
2.	Linoleic acid	37.9	41.53	31.0	27.2	30.31
3.	Myristic acid	—	—	—	—	1.68
4.	Palmitic acid	16.0	9.74	11.90	21.8	14.16
5.	Stearic acid	5.4	4.55	6.20	8.2	7.68
6.	Arachidic acid	—	2.0	—	—	—
7.	Palmitoleic acid	—	1.03	—	0.8	—

rified by passing through a column of silica gel (0.2-0.5 mesh) with diethyl ether in hexane (90: 10 v/v). The absence of peak at 2.9 cm^{-1} and shifting of C = O peak from 5.9 cm^{-1} to 5.7 cm^{-1} in the I.R. spectrum indicated complete esterification which was corroborated by thin layer chromatography on silica gel using *n*-hexane: diethyl ether (90:10, v/v).

Gas chromatography of methyl esters: The gas chromatographic analysis was carried out on a Pye Unicam 204 Unit using a glass column (1.5m x 4mm) packed with DEGS (20%) on diatomite (80-100 mesh) maintaining the column temperature at 200°. Nitrogen was used as the carrier gas. Standard fatty acid methyl esters were used to identify the peaks. No correction factors were applied.

RESULTS AND DISCUSSION

The physico-chemical characteristics of *Jatropha curcas* seed oil are given in Table 1. Since the seeds used for extraction of the oil were fresh, it showed low activity (1.24) and no peroxide value.

The chemical constants of the oil viz. iodine value, unsaponifiables, saponification value and acid value, are almost indentical with those reported by previous workers [6-9]. However, there is a slight variation in the fatty acid composition as shown in Table 2 which is possible due to soil and climatic conditions. The results show that the oil is composed of mainly unsaturated fatty acids (oleic acid 46.72% and linoleic acid 30.3%).

The present studies show the presence of myristic acid (1.68%) which has not been reported by earlier workers. However, no arachidic or palmitoleic acids were found in the oil.

The U.V. spectrum of the oil does not indicate the presence of conjugated double bonds which is an exception from the seed oils of the *Euphorbiaceae* family which generally contain conjugated and linolenic acids.

Jatropha curcas oil is easily soluble in gasoline and diesel oil and no separation occurs even on long time storage. Its calorific value (8990 K. cal/kg.) and other properties (Table 3) suggest that it can be utilized as a mixed fuel for gasoline/diesel engines. The following figures show the calorific value of conventional fuels:

1. Diesel oil 10,170 K. cal/kg.
2. Gasoline 10,600 "
3. Ethyl alcohol 6,400 "

The oil could be used for edible purposes but due to the presence of a toxic substance "Curcin" it has developed strong purgative properties and disagreeable taste. It can however, be used as mixed fuel for diesel engines, in soap manufacture and other non-food applications. More work (practical) is required to establish its utility as a substitute for diesel engine oil.

Table 3. Analysis of *Jatropha curcas* oil compared with diesel.

S. No.	Test	Diesel oil [3]	Jatropha oil	Method
1.	Flash point (C°)	290	227	ASTM-D-92-52
2.	Calorific value (K. cal/kg)	10,170	8,990	ASTM-D-271-58
3.	Sulpher %	1.2	0.13	ASTM-D-271-58
4.	Distillation point (C°)	350	284-85	—
5.	Specific gravity	d^{15}_{4} 0.82-0.84	d^{30}_{30} 0.9149	—

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REFERENCES

1. G. Watt. *Dictionary of Economics Products of India* (Govt. of India Printing Press, Calcutta, 1890), Vol. **IV**, p. 546.
2. K. R. Kirtikar and B. D. Basu, *Indian Medi...*

Plants (Lalit Mohan Basu, 49-Leader Road Allahbad, India, 19), Vol. III, 2nd ed., 2244-45.

3. Yoshifumi Takeda, Interim Report,*Development-Study on Jatropha curcas (Sabu Dum) Oil as a Substitute for Diesel Engine Oil in Thailand,* Agricultural Engineering Division, Ministry of Agriculture, Thailand (1982).
4. *Official and Tentative Methods of the American Oil Chemists Society,* (AOCS, Chicago, USA, 1964), Vol.1, 2nd ed.
5. American Society for Testing Materials, Part 8, pp. 1009, 1023, (1958).
6. J. L. Sebedio, J. Prevost and a. Grandgirard, J. Am. Oil Chem. Soc., **64,** 1027 (1987).
7. A. Steger and J. Vanloon, Fette U Seifen, **49,** 770 (1942).
8. G. Lamonica, G. Dugo and N. Uccella, Boll. Inform. Ind. Olearia Sapon. **10,** 27 (1967).
9. S.N. Koley, D. Bhattacharya and A. Saha, Ind. Chem. Belge, **34,** 301 (1969).
10. A. T. Atchaya *et. al.*, J. O. T.A. I., **5:**1, 8 (1973)
11. R.D. Silva and A. Schwab, *Rev. quim. ind.* (Rio de janeiro), **11** No. **126,** 18-19, 23 (46-7, 351): No. **128,** 20-1, 23 (420-1, 423) (1942).