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Chemical Constituents and Energy Content of *Cryptostegia grandiflora*: A Promising Multi-use Crop

G.D.P.S. AUGUSTUS, K. RAJARATHINAM, G.D. SHANTHAKUMARI†, D. KANAN and M. JAYABALAN*
Research Center in Botany, V.H.N.S.N. College, Virudhunagar, 626 001, India

Cryptostegia grandiflora, a member of Asclepiadaceae, was evaluated as a source of multiuse crop. The plant contained 14.0 protein, 6.5 oil, 6.9 polyphenol and 2.13% hydrocarbon. The gross heat value of the plant sample was 3878.0 cal/g; oil fraction was 7350.1 cal/g; hydrocarbon fraction was 9300.0 cal/g. The NMR spectrum of the hydrocarbon fraction reveals the presence of *cis*-polyisoprene system. The oil fraction constitutes both saturated and unsaturated fatty acids with the constituents of lauric acid (trace), myristic acid (trace), palmitic acid (5.7%), arachidic acid (6.1%), oleic acid (22.4%), linoleic acid (20.9%) and linolenic acid (30.6%). The plausible reactive oxygen species (ROS) producing compounds in the polyphenol fraction is further warranted for studying in treating cancerous tissue using laser lie photo-dynamic therapy (PDT).

Key Words: Fatty acid, Hydrocarbon, Oil, Polyphenol, Protein.

INTRODUCTION

Now-a-days there has been a renewed interest in developing alternate crops to meet the everlasting demand for fuels, chemicals and industrial feedstock. New crops evaluated for these characteristics can be grown in under-used areas that could provide us the needs of essential materials and subsequently stimulate economic growth. This has necessitated us to take up a study on identification of potential plant species with multi-use potentialities, efficacy and constraints in diesel engine and as an alternative to conventional oil.

Cryptostegia grandiflora R.Br. of Asclepiadaceae is a laticiferous woody climbing shrub. It grows profusely without any agro-management and survives well under extreme environmental conditions such as high temperature and limited water supply. During the 2nd World War, *Cryptostegia grandiflora* was used as a source of natural rubber[1].

The objective of the present study was to analyse the plant parts of *Cryptostegia grandiflora* for their botanochemicals energy-rich product useful as a substrate or complement of petrochemicals that are now called as

†Department of Physics, Fatima College, Madurai-625 018, India.

botanocontents, a term coined by USDA, Public Information Officer, Dean Mayberry as an intermediate energy source[2].

EXPERIMENTAL

Extraction: *Cryptostegia grandiflora* was clipped at ground level including leaves and flowers, allowed to dry, then ground in a Wiley mill equipped with a sieve having 1 mm diameter sieves. Extractables were removed from the plant material with acetone and then with hexane in a Soxhlet apparatus for a minimum of 24 h per solvent. Acetone extract was allowed to dry, and then partitioned between hexane and aqueous ethanol (water : ethanol, 1 : 7) to obtain fractions of oil, polyphenol and hydrocarbons. The fractions were oven dried, gravimetrically weighed for yield. The 'hydrocarbon' fraction after hexane removal was oven-dried, gravimetrically weighed for yield[3, 4].

Biochemical studies: Milled samples were analysed for ash and lignin content[5] and protein by Kjeldahl method[6]. Oil fraction was saponified by conventional procedure[7].

NMR spectrum of 'hydrocarbon' fraction was recorded with Bruker AC 300F NMR spectrometer (300 MHz) using tetramethylsilane (TMS) as the internal standard and $CDCl_3$ as the solvent.

Gross heat values of plant sample, oil fractions, and hydrocarbon fractions were determined by using bomb calorimeter (Toshniwal, Model CC.0.1)[8]. Methyl ester of fatty acids of the oil fraction was analyzed for its composition by using GLC equipped with SE 30 column and nitrogen as a carrier[9]. Fatty acid peaks of samples were identified by comparing methyl ester peaks and retention times with standards.

RESULTS AND DISCUSSION

Cryptostegia grandiflora, a stout, woody climbing shrub, is suitable for annual pollarding. It has been reported that latex of *Euphorbia* and *Calotropis procera* is an emulsion of oil and water[10] which is similar to that of natural rubber latex in terms of composition. The hydrocarbon can be a smaller molecule with low molecular weight. The plant species contain 6.5% oil, 6.9% polyphenol, 2.13% hydrocarbon and 14.0% protein. The appearance of plant oil fraction is dark and has the property of melting slightly above room temperature into a low viscosity fluid. The polyphenol fraction can be a mixture of botanochemicals including a variety of lipids, tannins and phlobaphenes[11]. It may contribute substantially in future to manufacture various adhesives, phenolic resins and antioxidants. Potential uses of oils and polyphenols have been reported[3, 12]. The saponification value of *Cryptostegia grandiflora* (285.7) is higher than that of mango seed oil (212.8), indicating the presence of low molecular weight triglycerides and hence low molecular weight acids[13].

The gross heat value of the plant sample, oil fractions and hydrocarbon fraction implies that it could serve as an intermediate energy source (Table-1). The gross heat value of the plant sample (3878.0 cal/g) is higher than that of rice straw hulls (3333.0 cal/g) (Table-2A). The very low ash content of the plant

sample (0.18%) may be attributable to it as potential as a fuel source. High ash content has a negative effect on the gross heat value[14]. The gross heat value of the oil fraction is 7350.1 cal/g.

TABLE-1
COMPOSITION (%) OF CHEMICAL CONSTITUENTS*

Protein	Oil	Polyphenol	Hydrocarbon
14.0 ± 1.1	6.5 ± 0.7	6.9 ± 0.6	2.13 ± 0.2

* Values are mean ± SE

The decrease in the gross heat value of the oil fraction might be due to the presence of high proportions of unsaturated fatty acids (Table-2). This is in conformity with the fuel properties of vegetable oils[15]. This indicates that due to few hydrogen atoms, there occurs greater unsaturation which decreases the gross heat value. The gross heat value of the hydrocarbon fraction (9300.0 cal/g) is dependent on the composition of the substances, *viz.*, rubber or gutta or wax and other low molecular weight compounds. The gross heat values of the oil fraction and hydrocarbon fraction are significantly higher in *Cryptostegia grandiflora* than that of anthracite coal (7110.0 cal/g). The gross heat value of hydrocarbon fraction is also comparable with that of crude oil (10531.0 cal/g).

TABLE-2
CHARACTERISTICS OF GROSS HEAT VALUES OF EXTRACTABLES FROM *CRYPOTOSTEGIA GRANDIFLORA* R.Br. AND COMPARED WITH THE AVAILABLE DATA OF NATURAL RESOURCES (Table-2A)

Ash (%)	Lignin (%)	Gross heat value (cal/g)		
		Plant sample	Oil	Hydrocarbon
0.18	45.2	3878.0	7350.1	9300.0
± 0.02	± 2.92	± 30.78	± 13.83	± 33.01

TABLE-2A
GROSS HEAT VALUE OF SOME NATURAL BIOMASS AND CRUDE OIL* (Ref. 17)

Rice straw hulls	3333.0
Lignite coal	3888.0
Cattle manure	4111.0
Corn cobs	5167.0
Methanol	5353.0
Anthracite coal	7111.0
Crude Oil	10531.0

The NMR spectra studied for one of the botanocontents of hydrocarbon fraction revealed the presence of natural rubber, *cis*-polyisoprene system by showing peak at 1.68 ppm[16] (Table-3). Most of the plant species produced low

molecular weight natural rubbers, which can be used as plasticizing additives (processing aid) to rubber mixes, for liquid rubber processing methods or for making adhesive cements[2].

TABLE-3
NMR SPECTROSCOPIC DATA

Chemical shift (δ ppm)				Remark
Vinylene protons	Methylene protons	Methyl protons	Others	
—	—	0.9 (Methyl 1,2 unit) 1.59 (Methyl 3,4 unit) 1.68 (*Cis*)	1.25 4.22*	The hydrocarbon may have *cis* methyl with 1,2 + 3,4 moieties

*The 4.22 ppm (δ) resonance probably indicates the presence of —OCH_2 moieties

The oil fraction of *Cryptostegia grandiflora* (Table-4) contains saturated fatty acids, *viz.*, lauric acid, myristic acid and trace amount of palmitic acid (5.7%), arachidic acid (6.1%), unsaturated fatty acids namely oleic acid (22.4%), linoleic acid (20.9%) and linolenic acid (30.6%). The fatty acid composition of plant oil is one of the key factors that determine that potentiality of an oil sample as an alternative fuel source in diesel engines instead of diesel oil[15]. The proportion of unsaturated fatty acids in *Cryptostegia grandiflora* is higher than that of saturated fatty acids. *Cryptostegia grandiflora* also contains more than 5% of oil showing promise as a potential new crop source for industrial raw material and an alternative for conventional oils.

TABLE-4
FATTY ACID COMPOSITION OF OIL FRACTION

Fatty acid	Percentage
Lauric acid (12 : 0)	Trace
Myristic acid (14 : 0)	Trace
Palmitic acid (16 : 0)	5.7
Oleic acid (18 : 0)	22.4
Linoleic acid (18 : 1)	20.9
Linolenic acid (18 : 2)	30.6
Arachidic acid (20 : 0)	6.1

It is further warranted to study polyphenols in detail in the above-investigated plants as the plant contains about 6.9% of polyphenols in its total composition. Therefore, an intense study is envisaged on extracting anti-cancer principal compounds, *i.e.*, reactive oxygen species [ROS] for use in photodynamic therapy (PDT) of cancer tissue, if any.

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