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Phytochemical Evaluation of Plants of Western Ghats of Tamil Nadu, India

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Thirty-six species of plants collected from Courtallum RF to Srivilliputhur RF, Western Ghats of Tamil Nadu were subjected to phytochemical analysis to find out suitable alternative fuel crops. The present study reveals that *Tylophora asthmatica* of Asclepiadaceae is a prime candidate for photosynthetic hydrocarbon production (2.7%) and calorific value of hydrocarbon fraction (9378.0 cal/g) and suggested as an alternative fuel crop to fossil fuel. Hydrocarbon content is high in *Sarcostemma brevistigma* (3.6%). Calorific value of hydrocarbon fraction of 33 plants was found to be higher than coal but just nearer to or above anthacite coal. *Calotropis gigantea, Sarcostemma brevistigma* and *Aegle marmelos* also need an indepth investigation, hence their calorific values are nearer to anthracite coal as in the case of *Tylophora asthmatica.* Remarkable calorific value of whole plant sample fraction but with significantly less content (1%) is recorded for *Vateria indica, Bassia latifolia, Euphorbia tricalli and Dalbergia sissoo.* No relationship is found between the percentage of carbon and the calorific value of samples was investigated.

Key Words: Phytochemical evaluation, *Tylophora asthmatica, Dalbergia sissoo, Sarcostemma brevistigma, Euphorbia tricalli, Vateria indica, Bassia latifolia,* Renewable energy sources, Western Ghats, Tamil Nadu.

INTRODUCTION

One of the principal natural resources upon which modern society is built is an energy resource consisting of the fossilized products of ancient photosynthetic plants that had grown on the earth's surface 100 million years ago or more. The known supplies of fossil energy are very limited and, therefore, it has become a necessity of society to develop alternative fluid fuel resources. It is aptly pointed out that the best solar-converting machine available today is the green plants[1]. Recently, the collection and use of photosynthetically produced hydrocarbons from plants has been suggested as a substitute for conventional petroleum resources[2–4]. The aim of this investigation is to enlist the calorific value of plants that would enunciate to confirm alternative fuel/crops.

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EXPERIMENTAL

Thirty-six species of plants were collected from Courtallum RF to Srivilliputhur RF (Western Ghats). The plant samples were allowed to dry in a sheltered area at ambient condition. After drying, the individual samples were ground in a Wiley mill and passed through a 2 mm sieve. Milled samples (50 g) were extracted with hexane in a Soxhlet extractor for 10 h. to yield hydrocarbon fraction. The hydrocarbon fraction with hexane was distilled to separate the hexane and hydrocabon. The yield of hydrocarbon was determined by measuring the weight of the hydrocarbon obtained[5]. Whole plant samples were analyzed for total ash content[6]. Calorific value was determined by using bomb calorimetry[7]. The CH analysis of whole plant sample fraction and hydrocarbon fraction of different samples was carried out in CDRI Lucknow and RSIC Chandigarh respectively.

RESULTS AND DISCUSSION

Details of analysis carried out are tabulated (Table-1). Data for various types of biomass coal and oil products are also included for comparison (Table-2) as investigated by earlier workers[8]. The experimental yield of hydrocarbon fraction ranges from 0.5 to 3.60% (Table-1). Significantly highest yield of hydrocarbon is in *Sarcostemma brevistigma* (3.60%), while the lowest yield is in *Rauwolfia serpentina* (0.5%). Calorific value of hydrocarbon fraction from various plant samples ranges from 2877.4 to 9378.0 cal/g (Table-1). Remarkably enormous calorific value of 9378.0 cal/g was recorded in *Tylophora asthmatica* whereas *Allamanda cathartica* had shown least value 2877.4 cal/g. Calorific value of whole plant sample is from 2398.0 to 4582.3 cal/g. The highest calorific value (4582.3 cal/g) is recorded in *Vateria indica,* whereas *Cryptolepis buchanani* is showing least (2398.0 cal/g).

The maximum ash content (6.3%) was found in *Antiaris texicaria* and the minimum (0.1%) was measured in *Holarrhena antidysenterica.* Total carbon and hydrogen determinations of hydrocarbon fraction are 36.05 to 75.33% and 6.65–12.09% respectively. Similarly, total carbon and hydrogen determinations of plant sample fractions are 14.09–81.86% and 4.13–12.14% respectively (Table-1).

Highest hydrocarbon yield was recorded in *Sarcostemma brevistigma* (3.65%) while *Jatropha multifida* (3.0%) and *Tylophora asthmatica* (2.7%) represent a slightly declining status. This clearly indicates that special attention should be focused towards the milkweeds which generally contain latex rich in oil and hydrocarbon and similar proposal was put forth[8].

Tylophora asthmatica remains as an innervate candidate for photosynthetic hydrocarbon production and due to high calorific value of hydrocarbon it can be named gasoline tree and could serve as an alternative energy crop instead of fossil fuel in the near future. Among the 36 species analyzed (Table-1), *Tylophora asthmatica* possesses the highest calorific value (9378.0 cal/g) in hydrocarbon fraction and it is comparable with that of crude oil. The magnitude of hydrocarbon yield and its calorific value are comparable with the earlier study on Calotropis species[5].

TABLE-1
CHARACTERISTICS OF HYDROCARBON FRACTION AND WHOLE PLANT FRACTIONS

Name of the Species	Hydrocarbon fraction					Whole plant fraction		
	Yield (%)	Calorific value (cal/g)	% Analysis			Calorific value (cal/g)	% Analysis	
			C	H	Total ash		C	H
Clusiaceae								
Calophyllum inophyllum	1.20	4846.0	—	—	1.00	3561.4	—	—
Clusia rosea	1.10	7944.0	42.51	9.51	4.90	3064.0	47.70	5.61
Garcinia cambogea	0.80	2911.0	37.14	7.79	0.24	4039.0	29.90	4.10
Dipterocarpaceae								
Vateria indica	1.12	4220.3	—	—	1.00	4582.3	—	—
Rutaceae								
Aegle marmelos	1.00	8344.2	36.10	8.20	0.20	3140.4	—	—
Leguminosae								
Dalbergia sissoo	1.10	5908.4	—	—	0.30	4112.0	—	—
Cornaceae								
Mastixia erborea	1.00	7183.4	—	—	0.70	3434.1	—	—
Sapotaceae								
Achras sapota	0.90	7597.0	—	—	0.20	3807.0	—	—
Bassia latifolia	0.80	5207.0	59.49	8.50	0.70	4523.0	28.52	4.20
Apocynaceae								
Allamanda cathartica	1.23	2877.4	41.79	8.53	0.70	3865.1	—	—
Holarrhena antidysenterica	0.70	6791.2	39.01	7.66	0.10	3036.0	—	—
Ichnocarpus frutescens	1.00	6252.2	—	—	0.30	3279.3	—	—
Plumeria alba	1.00	4689.2	—	—	2.00	3672.0	—	—
Plumeria rubra	1.40	5402.0	—	—	1.40	3090.0	—	—
Rauwolfia serpentina	0.50	3972.0	50.84	9.30	0.53	2844.3	—	—
Tabernaemontana divaricata	1.13	6752.4	—	—	0.30	3379.3	—	—
Asclepiadaceae								
Calotropis gigantea	1.30	8971.0	—	—	0.25	3086.1	—	—
Cryptolepis buchanani	0.59	7034.0	58.35	10.79	0.55	2398.0	37.21	5.60
Cryptostegia grandiflora	1.73	7030.1	75.33	11.54	0.18	3478.1	—	—
Hemidesmus indicus	0.95	7287.0	58.50	6.70	1.60	3185.1	—	—
Sarcostemma brevistigma	3.60	8732.0	66.40	12.00	0.04	3180.0	—	—
Tylophora asthmatica	2.70	9378.0	49.58	10.44	1.02	3641.0	43.10	5.70
Convolvulaceae								
Argyeria pomancea (white)	1.40	5665.0	48.30	9.70	0.34	3096.0	42.10	5.90
Ipomoea fistula	0.85	6665.0	43.90	8.40	0.72	3331.1	—	—

Name of the Species	Hydrocarbon fraction					Whole plant fraction		
	Yield (%)	Calorific value (cal/g)	% Analysis			Calorific value (cal/g)	% Analysis	
			C	H	Total ash		C	H
Moraceae								
Antiaris toxicaria	1.03	6286.0	—	—	6.30	3654.1	—	—
Ficus bengalensis	1.03	5024.1	—	—	1.00	3876.1	—	—
F. glomerata	1.07	3670.0	42.70	8.80	1.25	3768.1	77.20	2.10
Morus alba	0.07	6353.1	56.70	10.40	0.60	3460.0	—	—
Euphorbiaceae								
Bischofia javanica	0.70	7673.2	39.20	8.16	0.60	3976.3	42.00	5.00
Croton sparsiflorus	1.10	7162.0	—	—	0.30	3850.1	—	—
Euphorbia antisyphylitica	1.90	7448.0	59.70	11.80	2.60	3873.0	14.10	1.70
E. heterophylla	1.70	6565.0	54.50	10.80	0.56	2886.0	64.70	9.19
E. tirucalli	2.63	7831.4	63.90	12.09	0.12	4213.3	81.80	10.00
Jatropha multifida	3.00	5821.0	59.90	11.20	2.80	3169.0	37.70	5.20
Pedilanthus tithymaloides	1.30	7167.0	—	—	0.30	3683.1	—	—
Synadenium gigantii	0.80	5411.0	42.20	8.90	0.99	3647.2	—	—

In *Tylophora asthmatica*, the calorific value of hydrocarbon fraction is eloquently very high (9378.0 cal/g) with lower carbon content (49.58%) than in *Cryptostegia grandiflora* hydrocarbon fraction where it has lower calorific value (7300.1 cal/g) with higher carbon content (75.33%), There exists no linear relationship between percentage of carbon and calorific value. Therefore, this observation deviates from the earlier work[9].

The calorific value of whole plant sample fraction in *Vateria indica* (4582.3 cal/g), *Bassia latifolia* (4523.0 cal/g), *Euphorbia tirucalli* (4213.3 cal/g) and *Dalbergia sissoo* (4112.0 cal/g) is recorded above 4000 cal/g with significantly less ash content (1%, Table-1). Calorific value above 4000 cal/g with less content is a positive attribution obtained for a potential fuel/energy plant, as high ash content has a negative effect on the calorific value. This is inconsonance and conformity with the conclusions of previous workers[9].

TABLE-2
COMPARATIVE FUEL VALUES OF REPRESENTATION BIOMASS AND FOSSIL FUELS[10]

Fuel source	Cal/g (dry)
Rice straw hulls	3333
Lignite coal	3888
Cattle manure	4111
Corn cobs	5167
Municipal refuse	5278
Methanol	5353
Anthracite coal	7111
Fuel oil (Mexico)	10308
Crude oil	10531

An average heat content of 4781 and 5010 cal/g is assigned to hardwood and softwood respectively[9]. The higher heat content of softwood is due to high lignin content. The calorific values of whole plant sample in *Vateria indica* and *Bassia latifolia* lie within this range (Table-1), connoting that the above species could be a supplement to wood for fuel, if the density is increased mechanically and comparable fuel content of group A (Table-2).

Calotropis gigantea yields 1.3% of hydrocarbon and its calorific value is 8971.0 cal/g. The calorific value of whole plant is 3086.1 cal/g. This result is in contrivance to the observations of other workers[5], where, in another species *Calotropis procera,* the same genus yielded more quantity of hydrocarbon, as well as having higher calorific value for both hydrocarbon and whole plant sample. It clearly suggests the importance and dependency of species growing on different agro-climatic conditions, which ultimately determine the difference in their phyto-composition.

The calorific value of hydrocarbon in some investigated plants is greater than the calorific value of anthracite coal (Table-1). This comparison clearly reveals that the above plants, in future, could be an alternative source to fossil fuel coal.

Terpenoid hydrocarbon or resin with low oxygen content has heat content of 8124 and 9027 cal/g[9]. The calorific values of hydrocarbon in *Calotropis gigantea* (8971.0 cal/g), *Sarcostemma brevistigma* (8732.0 cal/g) and *Aegle marmelos* (8344.2 cal/g) are comparable to those of terpenoid hydrocarbon or resin and hence considered to have immense importance for future consideration.

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