AVAILABILITY OF INDIGENOUS VEGETABLE OILS FOR INTERNAL COMBUSTION ENGINES IN INDIA*

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Summary

The report deals with the availability of oil-bearing vegetable seeds in India and indicates how far indigenous vegetable oils can replace mineral oils in the field of internal combustion engineering.

A case for the enquiry is first presented and the result of the enquiry is indicated in the form of a table. Figures of export of vegetable seed products are also given. The requirements of the country as regards fuels and lubricants in internal combustion engines are stated.

The technical aspect of the problem, purely from the view-point of availability is considered and the possibilities of mineral oils being replaced by indigenous vegetable oils are examined for the three types normally required in internal combustion engineering, namely, (*a*) Diesel fuels, (*b*) Fuels for spark ignition engines, and (*c*) Lubricants.

The economic part of the problem is discussed, and conclusions are drawn on the basis of the analysis undertaken and steps of future action are suggested.

1. Introduction

It has been the practice so far to utilise mainly mineral oils as fuels and lubricants in Internal Combustion Engines. More than 90% of these oils have to be imported into India, and in view of the economic implications and supply position of these products it is necessary that India should look to the possibilities of alternate indigenous materials for mineral oils.

Experiments, both abroad and in India, have indicated that vegetable oils can replace mineral oils both as fuels and lubricants. India holds the first position in the world for the production of vegetable oil seeds†[1] and if indigenous vegetable oils can suitably replace mineral oils in the field of Internal Combustion Engineering, it follows that the dependence on foreign supplies for these vital materials will be eliminated and the wealth of the nation will also be conserved. Accordingly the Department of Internal Combustion Engineering of the Indian Institute of Science has taken up

* The subject of this Report was initiated by Dr. H. A. Havemann, Head of the Department, in 1949, when the programme for the development of an indigenous I.C.E. Industry was considered.

† Figures refer to the list of references at the end of this report.

the problem and it was felt that, before investigating the technical implications, the first step in this direction would be to ascertain the exact availability of the vegetable seeds in the country and the probable requirements of the nation as regards fuels and lubricants in Internal Combustion Engines. The resulting information would therefore indicate how far vegetable oils can replace mineral oils in the field of Internal Combustion Engineering. This report gives a review of the progress the Department has made in answering this question.

2. Availability of Vegetable Oils in India

It was felt that as far as possible, only non-edible oils should be regarded for use in Internal Combustion Engines so that their utilisation in this way would not affect the consumers either in cost or in availability. The Agricultural Departments of all the Provinces in India have been approached regarding the availability of oil-bearing vegetable seeds in their respective provinces. A copy of the circular sent is enclosed with this report (see Appendix). The response was fairly satisfactory but the collection of figures on an all-India basis could not be done due to the following reasons: (*a*) certain provinces have not replied the questionnaire in spite of reminders and (*b*) certain provinces have pleaded their inability to quote figures for annual production. However, a consolidated statement of figures received has been prepared and is attached with this report (see Table I).

Though figures were obtained mostly for seeds yielding non-edible oils, edible oil-bearing seeds are also included in the statement since information regarding groundnut oil could be had from *Wealth of India*, Vol. I.[2]

To make the report complete, information about the proposed distribution of power alcohol production in India on a five-year target basis has also been included (see Table II).[3]

Table II

Proposed Distribution of Power Alcohol Production in India (Five-Year Target[2])

Province	Production per annum in 100,000 gallons
United Provinces ..	116·5
Bihar ..	45·0
Bengal ..	7·5
Bombay ..	12·5
Madras ..	8·0
Total ..	189·5

(Approximately equal to 19 million gallons.)

TABLE I

Availability of Oilbearing Seeds in India

ANNUAL PRODUCTION

Serial No	Name of seed	Name of the Provinces (Figures are given in 1,000 lbs) Madras	Mysore	Bombay	West Bengal	Uttar Pradesh	East Punjab	Madhya Pradesh	Bihar	Orissa	Assam	Hyderabad	Cochin & Travancore	Gwalior	Navanagar	Rajastan	Other Places	Total	Oil Production Possible approx	Remarks
1	*Pongamia glabra* (Karanj) ..	37,620						97·4										37,717·4	15,086·5	Exact figures for Bombay not available
2	*Azadirachta indica* (Neem) .	12,100				360,000		367 6										372,467·6	166,990	Production in E. Punjab, heavy; exact figs. not available, same for Bombay
3	*Bassia longifolia* (Mowra) ..	14,100				100,000			40 to 60									114,440	45,680	Exact figures for Bombay not available
4	Agrimone ..					4,000												4,000	1,800	
5	Wild Safflower ..					4,000												4,900	1,800	
6	Poppy ..					1,909												1 909	850	
7	Coconut ..																			Production heavy in Travancore Edible oil
8	Groundnut* ..	643,104	35,840			8,960	71,680	13,440	11,200		35,840					13,440	255,360	1088,864 7400,000*	1088,864	Edible oil *Production of oil seeds approx.
9	Sesamum (Gingelly) .								400 to 800									400 to 800	240	Edible oil Exact figures in S India not available
10	Tobacco ..	200																200		
11	Marotti ..																			
12	Hongay ..																			
13	*Emblica officinalis* ..							92·4										92·4		
14	*Madhuka latifolia* ..							3,285										3,284·7	1,314	
15	*Shorea robusta* .							674										674·4	270	
16	*Strychnos nuxvomica* ..																			
17	*Schleichera oleosa* ..							327										326·7	120	
18	Castor ..											80,640						80,640	3,226	
19	Linseed ..					324,000						60,270						384,270	153,708	
20	Cotton ..																			
21	Mustard ..								240 to 800											
22	Nigar ..																			
23																				
	Total ..																	3404,622	1479,949	

* [illegible] (Ref. *Wealth of India*, Vol. I) Oil production assumed to be about 45% of oil seeds

3. Export Trade of India in Vegetable Seed Products

After satisfying local requirements, India is able to export large quantities of vegetable seed products in the form of oil-seeds. oils and oil-cakes. The figures of export both in quantity and value for the years 1947–48, 1948–49 and 1949–50 have been entered in Table III.[3]

Table III

Export Figures of Vegetable Seed Products[3]

Particulars	Quantity (per annum) in tons			Cost (per annum) in rupees		
	1947–48	1948–49	1949–50	1947–48	1948–49	1949–50
A. OIL-SEEDS—						
Castor ..	4,951	..	5,245	27,72,838	..	27,56,842
Coconut .. (Kernel)	85	101	..	63,354	90,759	..
Cotton ..	..	1	..	..	360	..
Groundnuts ..	55,610	38,272	125,706	3,75,20,792	3,13,22.049	9,01,19,937
Linseed ..	66,861	25,024	71,566	3,80,88,337	1,39,04,275	4,55.14,695
Mowa ..	516	728	..	2,69,315	3,68,035	..
Mustard ..	..	137	1	250	74,075	40,200
Poppy ..	25	25	18	31,605	42,702	31,338
Sesamum ..	886	33	..	8,71,215	24,749	13,30,254
Other Sorts ..	1,681	1,080	1,159	12,41,883	11,66,391	17,59.129
Total ..	2,196	4,039	2,359	2.58,314	5.19,111	5,92,725
B. OIL-CAKES— (Includes castor, coconut, cotton, groundnut, linseed, rape, sesamum and other oils)						
C. OIL—						
Coconut ..	1,340	161.717	48	6,550	10,90,928	591
Groundnut ..	7,252,330	8,950,705	6,176,103	4,62,75,918	6,45,56 391	4,53,35,333
Linseed ..	3,321,768	2,280 683	1,773,371	2,71,07,975	1,47,96.931	1,28,38,258
Mustard or rape	26,651	222,479	60,503	1,70,080	18,49,107	5,43,866
Sesamum ..	876	3	586	6,125	25	5,690
Other sorts ..	484,900	858,793	872,453	14,44,051	44,98,645	37,76,596
Total ..	18,727,900	1 5,483,486	10,009,016	11,49,88,237	10,85,72,825	6,93,32,875

4. Requirements of the Country as Regards Fuels and Lubricants in Internal Combustion Engines

The requirements of fuels and lubricants depend on the number of Internal Combustion Engines that are operating in the country and thus to properly assess the required quantity of fuels and lubricants, the number must be known of Internal Combustion Engines required to cater the demands of the industry in various fields. Unfortunately an exact figure of the

latter item cannot be had as industries are fast developing in India and the exact future expansion of the industrial development of the country cannot be foretold correctly. Thus recourse was taken to the present position of the country and figures of requirements of fuels and lubricants were based on the data published by the Government of India[3] (see Table IV).

TABLE IV

Import Figures of Mineral Oils[3]

Particulars	Quantity (per annum) in gallons			Cost (per annum) in rupees		
	1947-48	1948-49	1949-50	1947-48	1948-49	1949-50
Diesel oils ..	86 092,063	75,875,625	136 585,698	2,48,45,739	2,91,53,712	6,83,93,744
Lubricating oils	39,116 355	42,837,824	39,539,182	95,79 893	46,59,222	1.18,74,418
Petroleum including petrol benzoine and benzol	150,488,688	119,004,164	177,047,163	8,56,66,025	10,87,20,304	16,32.55,114

5. TECHNICAL CONSIDERATIONS OF THE PROBLEM

5.1. *Diesel Fuels*

At the outset, for a comparison of the products available with the required quantities, it should be mentioned that the figures of production of vegetable seeds represented in the consolidated statement (see Table I) does not include the possibilities of the production and they only represent the present state of production. The total annual production of all types of vegetable seeds amounts to about 3,400 million lb. and the amount of oil that can be extracted is about 170 million gallons. It is interesting to note that groundnut oil constitutes about 72% of the production.

The mineral Diesel fuel oil required per annum, according to Table IV, is about 140 million gallons, and if on the other hand, all the oil extracted out of vegetable seeds could be utilised in the existing Diesel Engines no mineral Diesel Oil need be imported. This comparison does not take into account the technical possibilities of the vegetable oils as Diesel fuels but only indicates the quantities available. Furthermore, it is probable that the comparison is not quite up to reality as it might not be possible to use all the oils mentioned in the statement as fuels. At the same time, one has to remember that vegetable oils are at present also used for other purposes such as soap making, medicines, enamels, paints, etc., and in fact the total yield is used mainly for these purposes, partly for internal consumption and

partly for export. From Table III, it can be seen that about 10% of the production of vegetable seed products is exported. The export of seeds is considered by many to constitute a great economic loss to the country.[4] The figures, however, indicate, that if the technical possibilities of utilising vegetable oils as Diesel fuels are bright;—an assumption which has still to be proved,—the vegetable oils can successfully replace mineral Diesel oils to a large extent, if their production is sufficiently expanded.

The important seeds produced in considerable quantities are:

(*a*) Groundnut seeds,
(*b*) *Pongamia glabra* (Karanj),
(*c*) *Azadirach idica* (Neem),
(*d*) Linseed and
(*e*) *Bassia longifolia* (Mohwa or Illippai).

Out of these, groundnut oil, however, belongs to the group of edible oils. The other edible oils which could be successfully employed in Diesel Engines are coconut oil and gingelly oil; though they are available in large quantities they are not considered here further, since they are mostly used for edible purposes.

Experiments have been conducted under the auspices of the Directorate of Scientific and Industrial Research[4] about the possibilities of utilising groundnut seed, karanj, cotton seeds and rape (mustard) seed oils as Diesel fuels. No other oils have been tried so far. The availability of cotton seeds and rape seeds could not be worked out as figures regarding their production were not available.

5.2. Fuels for Spark Ignition Engines

Regarding spark ignition engines, power alcohol seems to be the only vegetable oil that can replace petrol as a fuel. The production of the same, on a five-year target basis, has been represented in Table II.[2]

It will be noted that the contemplated power alcohol production of nearly 19 million gallons forms only a minor percentage of the requirements of fuels in spark ignition engines which nearly amounts to 177 million gallons per year. Thus the chances of vegetable oils replacing petrol as a fuel in Internal Combustion Engines are rather remote.

The other alternative fuels for petrol are producer gas, methane gas, town gas, and natural gas. Producer gas can be manufactured in almost every part of India but the application of the other types of fuel is limited to the places of their production. Since India has large resources of low

grade solid fuels, the production of producer gas can be enormous if suitable means of gasification of low grade solid fuels can be devised.

Thus the problem of fuel for spark ignition engines can be approached as follows: (*a*) the use of spark ignition engines can be reduced to the bare minimum and as far as possible utilisation of Diesel Engines for all purposes could be encouraged: (*b*) since a mixture of about 10 to 15% of power alcohol with petrol gives no trouble to the engine without altering its performance at the same time, this process of blending could be adopted to reduce the requirements of petrol; (*c*) utilisation of producer gas, town gas, methane gas, etc., wherever possible, could be resorted to.

5·3. *Lubricants*

The vegetable oils which can be successfully employed in Internal Combustion Engines as lubricants are: (*a*) castor oil, (*b*) groundnut oil and (*c*) rape oil. Experiments with these oils in different blends have been carried out under the auspices of the Directorate of Scientific and Industrial Research.[5,6] Unfortunately the information regarding the availability of these oils except groundnut oil is lacking and hence it is rather difficult to state to what extent vegetable oils can replace mineral oils as lubricants. Since the export figures of castor seed and castor oil are considerable, the possibilities of the availability of castor oil for lubricating purposes in Internal Combustion Engines are bright with an increased production. Technical difficulties which may be involved may be overcome with the help of further researches.

6. ECONOMIC CONSIDERATIONS OF THE PROBLEMS

A serious objection to the utilisation of vegetable oils is their high cost. The remarks of the authors of the Bulletin No. 19 of Indian Industrial Research,[4] will not be out of place, here.

"At present the market prices of vegetable oils, in general, are higher than those of mineral Diesel oils, but it may be anticipated that in due course, the cost will be reduced as a result of systematic and scientific agricultural developments combined with the development of more efficient oil extraction methods. Even now it is possible in certain localities to purchase a number of the non-edible oils at fairly cheaper rates, which goes to show that it may become possible to reduce the cost of such oils as to compete with mineral Diesel oil. On the other hand, mineral oil prices may rise above the limit of those of vegetable oils, as the supply of former becomes more restricted with time. Furthermore, the utilisation of some of these oils

may mean the utilisation of a fairly large quantity of what are now regarded as forest wastes."

7. Conclusions

The present figures of production of vegetable oils indicate that they can successfully replace mineral Diesel oils and lubricants in Internal Combustion Engines if steps are taken to increase their production and reduce their cost. The possibility of petrol being replaced by the only possible vegetable fuel, namely power alcohol, is dim; but technical methods can be developed to become self-sufficient in regard to this fuel too. Experiments on the utilisation of vegetable oils as fuels and lubricants have been conducted to a certain extent by the Directorate of Scientific and Industrial Research and the authors of the reports have clearly stated that further work should be continued so as to gain more knowledge about the technical aspects of the problem. The utilisation of indigenous fuels and lubricants in Internal Combustion Engines can only be solved by technical development and systematic planning and it is urged that the Government of India should approach the problems involved at an early date.

8. Acknowledgements

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9. References

1. "Vegetable Oils in Mechanical Engineering Practice," by Lal C. Verman, *Science and Culture*, 1941, 7, 155–59.
2. *Wealth of India*, published by Council of Scientific and Industrial Research, Vol. I.
3. *Accounts Relating to the Sea-borne Trade and Navigation of India*, March 1950.
4. *Bulletin of Indian Industrial Research*, No. 19.
5. *Ibid.*, No. 18, Part I.
6. *Ibid.*, No. 18, Part II.