



KAMALA SEED AND ITS OIL

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THE KAMALA TREE.

(By courtesy of Forest Research Institute, Dehra Dun and Paintindia)

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INTRODUCTION

The paint and varnish industry requires substantial amount of drying oils for the preparation of various surface coatings. These oils have a special property in that their films when applied to surfaces of metals, glass, wood, etc. eventually dry to a solid state of varying degrees of hardness. Amongst the drying oils, linseed oil is much used in paints and varnishes, to the extent of about 55-66 per cent of all the drying oils used for these purposes. India produces and also exports much linseed oil. Other drying oils used are tobacco seed, safflower seed, soyabean and dehydrated castor oils. Fish oils though used in other countries to some extent, are not employed for the manufacture of paints and varnishes in India. There is a special class of drying oils to which tung and titicaca oils belong. These are used in special types of coatings which are required to dry rapidly and at the same time to give water and solvent resistant films. They are also useful for the production of novelty effects such as wrinkle or crinkle finishes. The actual home of tung oil, the most important of this class of oils is China. Recognising the value of this oil in the paints and varnish industry, other countries have started the tung tree plantations with the result that the USA, Argentina, Brazil and South Africa are important producers of this oil. Tung tree plantations have so far not done well in India where the annual production is only about 70-80 tons. The rest of India's requirements amounting to 150 tons is met with by imports.

As a result of the work carried out at the Forest Research Institute, Dehra Dun and the National Chemical Laboratory, Poona, kamala oil, the trees of which are found in the forests of India, has been found to be a promising substitute for tung oil in paints and varnishes. Some general information on the kamala tree and its oil is being given in what follows —

Kamala seed — its availability and collection

Kamala, kamila or Rohini, botanically known as *Mallotus philippinensis* Muell. Arg., belongs to the NO Euphorbiaceae

It is a small ever green tree found throughout tropical India along the foot of the Himalayas from Kashmir eastwards and upto about 5000 ft all over the Punjab Uttar Pradesh Bengal Assam Burma Singapore and from Sind southwards through Bombay State to Ceylon It is also reported as growing in China the Malayan archipelago and in Australia

The kamala seed is not being systematically exploited even though the tree has for long been well known as a source of kamala dye powder which is obtained from the outer casing of the fruit Besides imparting a beautiful deep bright and fast orange colour to silk the dye is anthelmintic and purgative and is used as a remedy for tape worm It acts also an anti oxidant towards various oils and fats and was once an important article of export to Europe and America for colouring margarine

The seeds are black in colour, resembling somewhat those of Bhindi (lady's finger) and as mentioned by Kirtikar and Basu are reported as being used in paste form for healing of wounds and cuts According to the information received from the Indian Central Oilseeds Committee and other sources the total quantity of kamala seeds produced annually in the country is approximately 7 000 mds as per details given below —

Himachal Pradesh	200 mds
Uttar Pradesh	3 900
Orissa	1 900
West Bengal	400
Jammu and Kashmir	400
Assam	250
Punjab	28
Mysore	28
Bombay	19

The cost of collection varies from Rs 15/ to Rs 40/ per maund

Storage of kamala seeds

Kamala seeds should be collected only when they are absolutely ripe and the moisture content should not be more than 6 per cent They should be stored in a dry place free from much draught It has been found that the seeds can be store

in gunny bags or tins without undergoing appreciable deterioration for about six months. After this period the seeds stored in bags deteriorate more quickly than those stored in tins.

Extraction of kamala oil

Fresh, sound kamala seeds contain about 60 per cent of pale white kernels. The oil content of the seeds is 35-36 per cent. Kamala oil is not limp like tung oil to which it has been declared superior in drying properties but is a viscous dark brown to pale yellow oil or semi solid fat depending upon the solvent used for extraction. Ethyl ether and ethyl acetate extract from the seeds a yellowish brown viscous oil while the benzene extract is a dark brown thick viscous liquid almost similar to a fat. A low boiling petroleum fraction extracts only about 50 per cent of the total oil. The residual very thick oil can be extracted with any of the above solvents this fraction gels quickly. Chlorinated solvents have not been found suitable for extraction. A small proportion of the oil can be expressed in a hydraulic press at about 70-80 C but it gels rapidly. It is not possible to express the oil in a ghanni.

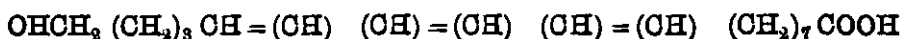
Properties and storage of kamala oil

The total kamala oil extractable with ethyl ether, ethyl acetate or benzene polymerises and gels rapidly and is about four times as active as tung oil in this respect. The petroleum ether (40-60 C) extracted fraction of the oil however, resembles tung oil. The characteristics of the total kamala oil and petroleum ether extracts are set out below. The figures for tung oil are also given for comparison—

Characteristics	Ethyl ether extracted kamala oil	Petroleum ether extracted kamala oil	Tung oil
(1)	(2)	(3)	(4)
Specific gravity 30 C 30 C	0.9444	0.9409	0.926-0.936
Refractive index 30 C	1.5233— 1.5260	1.5084— 1.5170	1.5130— 1.5181

(1)	(2)	(3)	(4)
Acid value	52 - 113	57 64	1-8
Saponification value	195 - 198	192 - 195	189 - 195
Iodine value (W ₁ s)	160 - 163	129 140	155 - 175
Unsaponifiable matter%	2.8 - 4.0	3.18 - 3.42	maximum 1
Brown's heat test (Min)	2.0 - 2½	9 - 9½	9 - 12

A new acid, kamlolenic acid, has been isolated from the constituent fatty acids of kamala oil. Its constitution has now been established as 18 hydroxy 9,11,13-octadecatrienoic acid



Kamlolenic acid

Consecutive extraction of kamala seeds with petroleum ether and ethyl ether yields two fractions of the oil containing about 40 per cent and 80 per cent of kamlolenic acid. The total kamala oil extractable from the seeds with ethyl ether, benzene or ethyl acetate contain 57.5 to 64.0 per cent of this acid.

The various fatty acids of the kamala oil obtained by extraction of the seeds with ethyl ether usually vary between the following limits

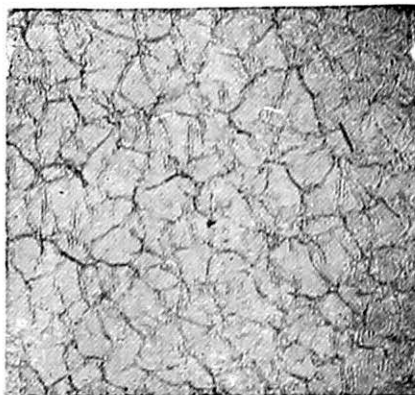
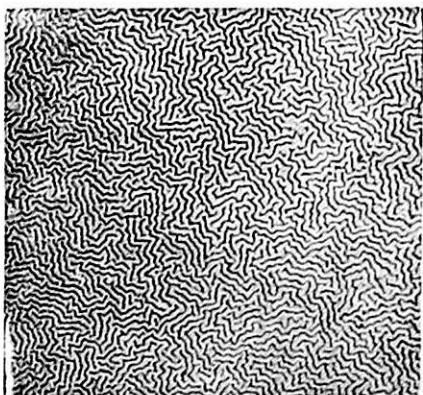
Kamlolenic acid	57.5 to 58.5 per cent
Conjugated diene acid	2.0 - 4.5
Linoleic acid	11.7
Oleic acid	13.3 - 19.6
Lauric acid	0.1
Myristic acid	2.1 - 2.5
Palmitic acid	7.4 - 8.7
Stearic acid	0.6 - 0.7

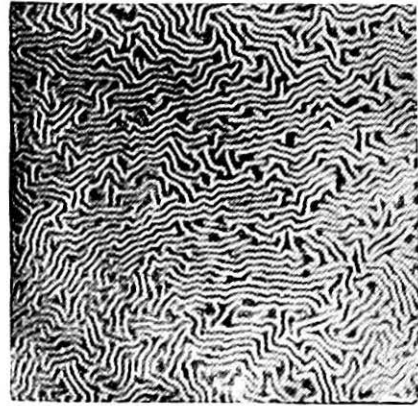
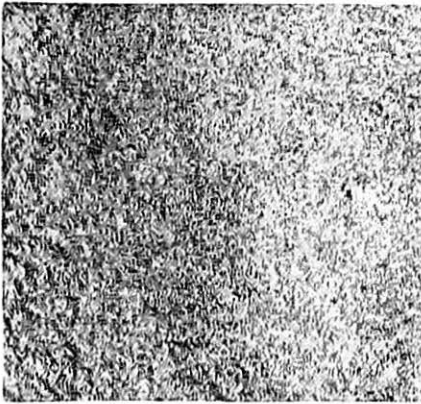
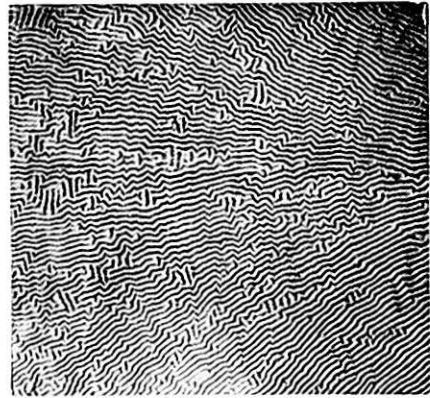
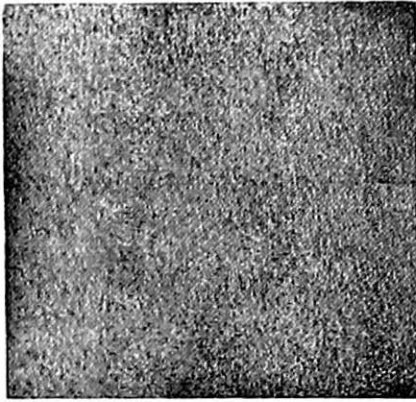
Preliminary work on the molecular constitution of kamala oil has indicated that the oil does not consist entirely of the usual triglycerides of the constituent fatty acids but appears to be a partly condensed polyester of kamlolenic acid. As kamala oil polymerises and gels quickly it used to be stored at the National Chemical Laboratory, Poona in presence of about 5 per cent petroleum ether or benzene in order to inhibit gelation. It has now been found that addition of hydroquinone or naphthylamine at 0.5 to 1.0 per cent levels effectively stabilizes

the oil obtained by petroleum ether extraction. Benzene extracted oil is stabilized by the addition of 1.0 per cent hydroquinone. The oils stabilized with these antioxidants maintain their original coating characteristics.

Comparison of kamala oil with other oils when used for Paints and Varnishes:

As mentioned above the total kamala seed oil extracted with ethyl ether, ethyl acetate or benzene polymerises and gels quickly. No other animal or vegetable oil can compare with kamala oil in this respect. The petroleum ether (40-60°C) fraction is rather similar to tung oil, although it polymerises much more readily than dehydrated castor or linseed oils. This portion of the kamala oil has been used in the National Chemical Laboratory, Poona for the preparation of air-drying wrinkle-finish varnishes and paints. As the films of these varnishes and paints dry in ambient air to give wrinkle patterns of various designs, these compositions can be applied to large surfaces which cannot conveniently be baked in ovens, such as walls of houses, metallic or wooden doors, window panes, furniture, fabrics, leather, and attachments which cannot be easily removed from their surroundings. Also, smaller objects such as scientific instruments, photographic equipment, typewriters, toys, novelty goods, beads of various kinds and such-like articles can be treated by these finishes. The type of wrinkle finish obtained depends upon the film thickness of the paint or varnish applied. Thus finishes ranging from a frosted glass appearance on ordinary window panes to very heavy wrinkles can be obtained.





Alkyd resins modified with kamala oil have also been prepared recently. On baking, these films also set to wrinkled patterns.

Preliminary work has also been done on the preparation of smooth coatings and spar varnishes from the petroleum ether extracted kamala oil.

The Forest Research Institute, Dehra Dun has produced 'Friol' a new paint oil from kamala oil. They have also worked out a process for the extraction of kamala oil with other drying oils.

The quick drying and gelation properties of the total kamala oil extractable with ethyl ether, ethyl acetate or benzene enable a good drying oil for paints and varnishes to be produced, which is similar to tung oil. Further work on these lines is going on at the National Chemical Laboratory, Poona.

With more work and co-operative effort there is every possibility that India becomes independent of tung oil imports for kamala oil from the seeds of *Mallotus Philippinensis* might well be able to satisfy the requirements of the protective coatings industry in this country

Other prospective uses of kamala oil

Kamala seed oil has been found to contain a new fatty acid called kamalolenic acid. Besides containing three double bonds in conjugated positions, this acid is unique in having a hydroxyl group at the carbon atom terminal to the carboxyl group. This acid and its hydrogenated derivatives are promising materials for use in the preparation of products of industrial value such as waxy materials, additives in lubricating oils, perfumery compounds, high polymeric substances like poly- and super polyesters and amides of nylon type, detergents and wetting agents. Work on these lines is in progress at the National Chemical Laboratory, Poona.

Propagation of kamala trees

The present annual consumption of tung oil in India is about 200 tons and this is likely to increase. The yield of kamala seed oil which is superior to tung oil in its polymerising properties, from the seeds of existing trees in India should be about 90-100 tons annually. In order to cope with the entire demands of the quick drying oils of the country and to create an export market, plantations of kamala trees should be started at suitable places in India at an early date as has been done in the case of the tung tree in the USA, Argentina, Brazil and South Africa. There is an apprehension that as the kamala tree takes six to seven years to bear fruit, the importance of kamala oil may by then have diminished as a result of the possible discovery of still better materials. However, the example of the establishment of tung plantations in USA should point the way. According to the bulletin entitled 'Tung oil: A new American Industry' by Edmung C. Wood and issued by the US Department of Commerce in 1949, the first attempt to cultivate the tung tree in that country was made in 1902. At first many failures occurred owing to improper location of the groves, poor soil conditions and lack of care of the trees. In 1932 the first commercial crop of tung nuts was obtained from groves in Florida. The phenomenal increase since then in the number of tung trees in USA can be seen by the following figures:

Year	Number of tung trees in U S A.
1930	350,793
1935	2,632 356
1945	9,583,087

The steady increase in the production of tung oil may be seen from the data for the 8 year period (1940-47) given below

Year	Production of tung oil in U S A in lbs
1940	62 000
1941	3,533,000
1942	2 300 000
1943	5 310,000
1944	2 020 000
1945	8 766,000
1946	8 722 000
1947	12 680,000

The tung trees in the U S A are sometimes planted along rail way highways and the edges of fields where they are used for stringing wire fencing in addition to yielding nut crops The U S A now do not import tung oil from China

From the above figures it may be seen that the production of tung oil has increased tremendously during the last fifty years in America Synthetic coating materials have also been developed but have not affected the demand for this oil It is therefore unlikely that kamala seed oil which promises to be even more useful than tung oil will be replaced by other coating materials in the near future Further the cultivation of kamala trees should not be difficult as they are indigenous to this country and even now grow well in our forests

As has proved to be the case with tung tree the kamala tree when properly cultivated may bear fruit in less than 6 to 7 years and give better yields of the seeds both in quantity and quality Once the kamala tree groves are established the cost of collection of the seeds will be much less than at present from the forest trees which lie scattered in practically inaccessible regions Until the kamala trees start giving fruits work on the development for the methods for employment of kamala seed oil for paints and varnishes and for the preparation of other useful products can be completed A preliminary

idea regarding the method of plantations of kamala tree can be had from the following information kindly supplied by Mr I M Qureshi Silviculturist Bombay State —

Kamala is a small, much branched evergreen and low grown tree. Its artificial regeneration in completely dry open spaces without any side shade is not advisable. Shade and moisture are necessary in its early stages as it is sensitive to drought. This observation is confirmed by the results obtained at Dehra Dun where the seed failed to germinate in all the plots situated in sunny localities. Kamala plantation succeeded only in partially shaded plots. Line sowings with the aid of field crops have proved successful at Dehra Dun the field crop giving the required side shade during the early growth.

Kamala trees can be propagated both by direct sowing and transplanting. Direct sowing is easy and economical if germination and further development thereof is satisfactory. Since the seed is oily germination is rather uncertain and low. It is therefore of utmost importance to collect mature sound viable and fresh seeds and test their germinative capacity in small plots before actual sowing.

Direct sowing

The seeds should be removed from the capsule. In case of dibbling four seeds should be sown by the end of May at each stake (space $2 \times 2'$) after loosening the soil at each dibble. They should be covered well with about $\frac{3}{4}$ layer of the soil to protect from rats and insects. Germination begins in about three weeks and continues for some time. Regular weeding and loosening of the soil should be carried out during the first two years and as often as may be necessary afterwards. Kamala plant is not readily browsed by goats and cattle so protection against trampling is only necessary.

Transplanting

For getting seedlings for transplantation in rains fresh and sound seeds should be sown in April in nurseries and lightly covers with earth. Nurseries should be kept shaded watered and weeded regularly. The more stout seedlings should be transplanted in the beginning of the rains in June while the smaller ones may be retained in the nursery for transplanting next year. As *Mallotus philippinensis* is a dioecious plant (male and female flowers on separate plants) it is

necessary to have the maximum number of fruit bearing female seedlings. An initial spacing of $2' \times 2'$ is therefore, recommended for planting of about 6 months old nursery raised seedlings. A close spacing is also advisable as the growth of this species is comparatively slow.

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**UTILIZATION OF KAMALA SEED OIL IN PAINTS
AND VARNISHES**

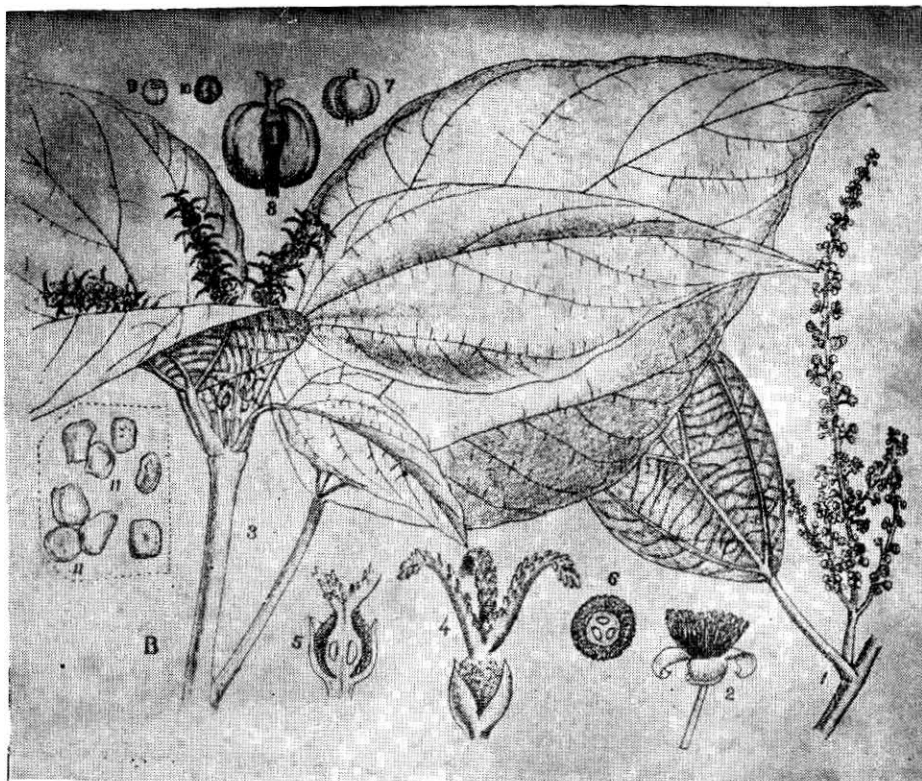
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Parts of the Kamala tree showing a branch with leaves, flowers, fruits and seeds
(From: Indian Medicinal Plants by K. R. Kirtikar and B. D. Basu)



CLOSE UP OF A KAMALA TREE BRANCH
WITH CLUSTER OF FRUITS.

(By courtesy of Forest Research Institute, Dehra Dun and Paintindia)

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