

Sour Garcinia (GarciniaGummigutta) as a Source of Biodiesel in India

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Abstract— The Garciniagummigutta (commonly known as sour garcinia) trees are widely available and grow in tropical regions of Asia and Africa.The Garcinia trees are indigenous to India grow in deciduous and semi evergreen forests of southern Western Ghats of India. If the seeds fallen are collected and oil is extracted at village level expellers, few million tons of oil will be available for lighting lamps in rural area. In some countries, Garcinia oil is considered edible as it is used only for preparing ghee, but in our country it has been considered as non-edible oil. Growing Garcinia trees would also help in protecting the environment and benefit the farmers as well. It is the best substitute for diesel. Since these are spread over a large area, collection of seeds for Biodiesel manufacture is not viable. A compact plantation can support a Biodiesel plant. The oil has not yet found any significant commercial application as a fuel. But due to increase in awareness and growth in research in this area, the Garcinia can be developed as the alternative source of fuel by replacing diesel. In the present study attempt has been made to study the scope of Garcinia in India.

Index Terms— Garciniagummigutta, Biodiesel, Oilseed, plantation, extraction, commercial application

1 INTRODUCTION

Energy is a basic need of human kind like food and shelter. Increase in population industrial growth and living standard of people develop the impact on conventional resources. On the other hand depleting nature of fossil fuels and emissions released by fossil fuels limits the use of them. India ranks six-thin terms of consumption of energy. In other words India is consuming 3.5% of the total world's commercial energy.The current domestic production of crude oil and natural gas is less compared to the demand. The huge gap between the demand and supply is presently met by imports, resulting in heavy burden of foreign exchange on the country. Production of biodiesel from oil and ethanol from sugar based resources are considered as the best substitute of diesel and gasoline respectively in the country. The waste and degraded land after reclamation can be used to grow the resource, produce oil and its conversion to biodiesel. The biodiesel, when mixed with diesel up to 20% requires very little or no modification in internal combustion engines and brings substantial reduction in the emission of unburned hydro-carbon by 30%, carbon monoxide by 20% and particulate matters by 25% with no sulphur. The biodiesel has nearly 10% more oxygen which facilitates the complete combustion and enhances the cetane number.This indicate that with the increase of biodiesel in blends CO, HC reduces significantly whereas the fuel consumption and NOx emissions of biodiesel increases slightly compared with the diesel.

2 CULTIVATION OF OIL SEED PLANT IN INDIA

Biodiesels are mono alkyl ester of long chain fatty acids of vegetable oil or animal fats either from plant or animal meeting the standard of ASTM(American Society for Testing and Materials) D6735.Depending on climate and soil conditions. Different nations are looking for different vegetable oils as

substitute of diesel fuel: soybean oil in USA, rapeseed and sun-flower oils in Europe, palm oil in South East Asia and coconut oil in Philippines.(3). In India, the demand for biodiesel for the year 2014-2015 has been estimated as 13.38 million tonnes considering 20% blends of biodiesel with diesel. The area required for growing the Jatropha plantation alone is about 11.19 Million hectares [4]. The use of edible oil resources like mustard, soya bean, sunflower, palm oil etc. for bio-diesel production put heavy competition with food and above that, the demand of edible oils is being met by importing from other countries. The nonedible oil sources seem to be the only option for cultivation, oil extraction and biodiesel production on industrial scale for engine operation.

2.1 General Morphology of Plant and Oil Seeds

The general morphology of the oil plant and their seeds, the availability and combustion characteristics like density, viscosity, flash point and fire point, cetane number and calorific value of garcinia oil and its blends with diesel oil under test are presented. The world's rapidly dwindling petroleum supply, their raising cost and the growing danger of environmental pollution from these fuels have led to an intensive search of alternative fuels. The use of Garcinia oil as diesel substitute in compression ignition engine has now gained greater importance because of their large population and phenomenal growth rate. Garcinia oil can easily be substituted for hydrocarbons which are scarce worldwide, and save the countries crores of rupees in foreign exchange. It is therefore necessary to develop some means for improving the fuel economy of compression ignition engines and also to investigate the suitability of Garcinia oil for diesel engine operations. If the diesel engine could be fuelled on a cleaner fuel such as honge oil, Garcinia oil, it may well be the most desirable engine of the future. The present researchers considered among several

nonedible seed oils, Garcinia oil is considered because of following reasons.(5,6)

- These are nonedible type oils.
- These trees are indigenous to India, grow in tropical regions and found abundantly in Western ghats of India.
- These oils can be easily substituted for petroleum based Hydro Carbon fuels that are becoming extinct.
- They have assured greater importance because of their large availability and potential growth with age

3 STUDY OF GARCINIA GUMMIGUTTA

3.1 Garcinia Trees

Amongst the many species, which can yield oil as a source of energy in the form of bio-fuel, "Garciniagummigutta" (Sour Garcinia) has been found to be one of the most suitable species in India being grown. It is tolerant to water logging, saline and alkaline soils. It is grown in high rainfall region. Garcinia seeds contain 30 to 40% oil. Garciniagummigutta belongs to the family species. The tree grows in forest and it is a preferred species for controlling soil erosion and binding soil to roots because of its dense network of lateral roots. Its root, bark, leaves, sap, and flower also have medicinal properties and traditionally used as medicinal plants. The seeds are largely exploited for extraction oil which is well known for its medicinal properties. So far there is no systematic organized collection of seeds. Mixture seeds consist of 95% kernel and are reported to contain about 27.0 to 40% oil. The yield of oil is reported to be about 35 to 40% if mechanical expellers are used for the recovery of oil from the kernels. The crude oil is brown to creamy in colour, which deepens on standing. It has a bitter taste and disagreeable odour. Hydroxycitric acid up to 50 to 60%, a toxic appetite suppressant found in rind.

3.2 Description of Garcinia Tree and Fruit

Garciniagummigutta is the scientific name of commonly known Sour Garcinia that belongs to the family of Clusiaceae. It is also known as Uppage, Muruganahuli in some local languages of India. Garciniagummigutta[9], also known as Camboge or Malabar tamarind, found commonly in the evergreen forests of Western Ghats, from Konkan south to Travancore and in the Shola forests of Nigeria upto an altitude of 6000 ft. It flowers in November-February, and fruits ripen in April-May. Fruits are in June-July. The seeds of the fruit have fat, commercially known as Kokam butter. Kokum butter is considered nutritive, demulcent, astringent and emollient. It is suitable for ointments, suppositories. [7-8].



Fig. 3.1 Photograph of Garcinia Tree



Fig. 3.2 Garcinia Fruits



Fig.3.3 Ripen Fruits



Fig.3.6 Garcinia seeds



Fig.3.7 Garcinia seeds

In Marathi villages all forest-based collection is done by men alone as a secondary source of income when they are not engaged in primary agricultural activities. This leaves Marathi women dependent on their men for their raw material. As Garcinia collection becomes more viable as a seasonal activity, men are increasingly involved, especially landless poor. Normally fruits are collected after they have fallen to the ground ripe or from their branches using long sticks with a hook on one end. Notched logs are tied to trees permanently and used as steps. As competition for Garcinia increases, new collection methods, practiced most noticeably by men, are threatening the resource base. Instead of waiting for fruits to ripen, some men lop tree branches or even fell trees to get unripe fruit before it falls naturally and is collected by someone else. Most women do not collect in this manner because custom discourages them from climbing trees. However, some wealthy women pay labourers up to 50 Rs/day to climb Garcinia trees, cut off branches and collect the green fruits. After taking out fleshy material seed is thrown out. Village women leave early in the morning for the forests, usually in groups of three or four. They carry small baskets, and wear a blanket thrown

over their heads and back to protect them from the frequent rain. The blankets also serve as additional containers for surplus fruit. Some of the women return home by noon to do other chores or work on something else for the rest of the day. The others return before nightfall. Collecting Garcinia in the forest is hard work during the monsoon, when conditions are wet and slippery, and leaches are a continual nuisance. Seeds are collected manually from freshly harvested and fully ripened fruits before they fall. Immediately after harvesting, they are washed in running water to separate the fruit rind. The seed storage behaviour is recalcitrant. Viability can be maintained for 1 to 2 months in moist storage at 20°C. Since the fruits are harvested during the monsoon season, sun drying is almost impossible. However, if the fruits are not processed quickly fungal infection takes place. Hence the only alternative is to artificially dry it using firewood. According to our estimate, approximately 22 Kg of firewood is required to get 1 kg dry Garcinia fruit rind with the traditional open fire system. The firewood for this purpose is generally collected in the forest itself as temporary processing units are situated within the forest, which is a huge hidden cost to the ecosystem.

4 TRADITIONAL PROCESSING OF THE FRUIT

The ripe fruit is halved or sectioned and spread in thin layers, dried in the sun for three to seven days to moisture level of about 15 to 20 percent and smoked. Rind which is available commercially is loaded with considerable amounts of common salt, which is added during drying. The thick rind is cut into sections, dried in the sun and preserved for future use in Sri Lanka. This dried material along with salt is used for curing of fish. The fruit rind and extracts of Garcinia species are used in many traditional recipes especially for fish curries. In the Indian Ayurvedic system these types of fruits having sour taste are said to promote digestion. Apart from these uses in food preparations and preservation, the fruit juice possesses anti-scorbutic, anthelmintic and cardiotoxic properties. Hence it finds application in the treatment of piles, dysentery, tumours, pains and heart complaints. The decoction of the fruit rind is given in rheumatism and bowel complaints. It is also employed in veterinary medicine as a rinse for diseases of the mouth in cattle. The dried rind is also used for polishing gold and silver and as a substitute for acetic and formic acids in the coagulation of rubber latex. The yellow resin obtained from the fruit is soluble in turpentine and used as varnish.

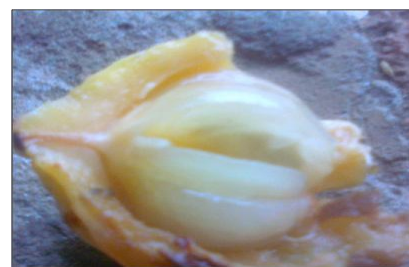


Fig.4.1 Split Garcinia fruit.

5 GARCINIA OIL EXTRACTION

Garcinia oil can be extracted from seed mainly by three methods. They are as follows

- Boiling method
- Expeller method
- Solvent extraction method

5.1 Extraction of Oil by Boiling Conventional Method

The finely dried and crushed seeds are then put in boiling water, heated at 70°C to 80°C and the mixture is stirred till the ghee floats on upper layer on hot water whereas the heavier residual waste at the bottom. The liquid fraction contains oil and water, which are further separated by heating so that water content evaporates from the oil. And the oil is separated. From this process 5 to 10% of oil can be extracted from one kg of Garcinia seeds

5.2 Extraction of Oil by Expeller Method

Sour Garcinia oil is extracted from the Sour Garcinia seeds through a mechanical expeller process. By this process 40% of oil could be extracted from one kg of Sour Garcinia seeds from this process

5.3 Extraction of Oil by Solvent Extraction Method

Here the oil is extracted from seeds by using solvent, generally hexane, methanol, etc. From this process 25 to 30% of oil as to be extracted from one kg of Sour Garcinia seeds.

5.4 Suitability and Problems of Garcinia Oil as Fuel

The Garcinia (vegetable) oil has some properties, which makes replacement of diesel fuel. Cetane number of garcinia oil is generally in the higher range of diesel fuel. Heat content of vegetable oils are nearly 90 % that of diesel fuel. Long chain saturated, un-branched hydrocarbons are especially suitable for conventional diesel fuel. The long, un-branched hydrocarbon chains in the fatty acids meet this requirement.

6. CONCLUSIONS

From above study the following conclusions are drawn.

1. The production of these oil seeds can be increased by necessary development in high yielding, high-breed variety of these plants so that their yield may be accelerated to meet the higher demand.
2. Traditionally people of high rainfall tracks of Karnataka and Kerala use the dried fruit rind in culinary preparations as flavoring agent while preparing fish and beef curries in lieu of tamarind or lime.
3. The rinds of the ripe fruits are processed and used as a condiment in fish and prawn preparations to impart flavor and taste and to improve the keeping quality.
4. The rinds are also used for the preparation of vinegar (FAO 1989). Seeds are the rich source (30%) of an edible butter.

The butter is used as an edible ghee (fat) as well as in the preparation of confectionaries.

5. The decoction of the fruit rind is administered to reduce rheumatism and cure improper bowel complaints.
6. It is also employed as a rinse for disease of the mouth in cattle. Along with all this the fruit rinds have got many other medical values.
7. Garcinia extract is believed to reduce fat accumulation when consumed. So it is extracted from the dried fruit rind and used in the preparation of medicine.
8. Presently due to its global market emerging faster than envisaged, over and unsustainable harvesting of Garcinia have set in the areas.
9. Antifungal effect of methanolic extracts of leaves of Garcinia gummitutta plays an important role as a plant derived pesticide in crop protection strategy which poses little or no threat to environment compare to chemical based pesticides.
10. Lot of scope is available to study Garcinia oil as an alternative fuel.

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