

## Appendix I

### Karanja

Karanja is a medium sized tree that generally attains a height of about 8 meters and a trunk diameter of more than 50 cm. The trunk is generally short with thick branches spreading into a dense hemispherical crown of dark green leaves. The bark is thin gray to grayish-brown, and yellow on the inside. The tap root is thick and long, lateral roots are numerous and well developed.

Karanja tree grows mainly in Western India and near Mumbai. The tree is occasionally seen on roadsides in Peninsular India. It is indigenous species and available throughout India from the foothills of the Himalayas down to the south of the Peninsula, especially not far from the seacoasts. Native to the Asian subcontinent, this species has been introduced to humid tropical lowlands in Malaysia, Australia, the Seychelles, the United States and Indonesia. Karanja trees are green during summer and they add to natural beauty. They also provide shelter and cool air. Karanja trees are normally planted along the highways, roads and canals to stop soil erosion. If the seeds fallen along road side are collected, and oil is extracted at village level expellers, tons of oil will be available for lighting the lamps in rural area. It is the best oil for lighting.

Karanja is called as Koroch in Bangladesh. In Bangladesh, it is a fresh water flooded tree. The seedlings of Koroch can survive in 1.5 meters deep water submergence for five to six months duration at a stretch. There are nearly 30,000 square km of water reservoirs in India. This tree can be cultivated in such water storage reservoirs up to 1.5 meters depth and reap additional economic value from unused reservoir lands.

The leaves of Karanja tree are alternate, compound pinnate type consisting of 5 or 7 leaflets which are arranged in 2 or 3 pairs, and a single terminal leaflet (Refer Plate I.1). Leaflets are 5-10 cm long, 4-6 cm wide, and pointed at the tip. The flowers borne by these trees are pink, light purple, or white. Pods are elliptical in shape. They are 3-6 cm long and 2-3 cm wide, thick walled, and usually contains a single seed. Seeds are 10-20 cm long, oblong, and light brown in color.



**Plate I.1 Leaves and Seeds of Karanja Tree**

Karanja is one of the few nitrogen fixing trees to produce seeds containing 30-32% oil. Native to humid and subtropical environments, Karanja grows in areas having an annual rainfall ranging from 500 to 2500 mm. In its natural habitat, the maximum temperature ranges from 27 °C to 38 °C and the minimum 1 °C to 16 °C. Mature trees can withstand water logging and slight frost.

Karanja trees can grow on most of the soil types ranging from stony to sandy to clay. It does not grow well on dry sands. It is highly tolerant of salinity and drought. Hence, it is commonly grown along waterways or seashores, with its roots in fresh or salt water. The growth rates are found to be fastest on well drained soils with assured moisture.

There are various uses of Karanja tree. Some of them are listed below

**Wood:** Karanja is commonly used as fuel wood. Its wood is medium or sometimes coarse textured. However, it is not durable and is susceptible to insect attack. Thus the wood is not considered a quality timber. The wood is used for cabinet making, cart wheels, agricultural implements, tool handles and combs.

**Oil:** A thick yellow-orange to brown oil is extracted from seeds. The oil is extracted from the seeds using mechanical expellers and crushers. The oil has a bitter taste and a disagreeable aroma, thus it is not considered edible. In India, the oil is used as a fuel for cooking and lighting lamps. The oil is also used as a lubricant, water-paint binder, pesticide etc. The oil is known to have value in folk medicine for the treatment of

rheumatism, as well as human and animal skin diseases. It is effective in enhancing the pigmentation of skin affected by leucoderma or scabies.

**Fodder and feed:** The leaves of karanja trees are eaten by cattle and readily consumed by goats. However, in many areas it is not commonly eaten by farm animals. Its fodder value is greatest in arid regions. The oil cake, remaining when oil is extracted from the seeds, is used as poultry feed.

**Other uses:** Dried leaves are used as an insect repellent in stored grains. The oil cake, when applied to the soil adds pesticidal value to the soil, particularly against nematodes and also improves soil fertility.

The Karanja biodiesel used to conduct the experiments is commercially procured from MINT BIOFUELS, Pune. The process used by MINT BIOFUELS to produce Karanja biodiesel is shown in Figure I.1. The seeds of Karanja are crushed through an oil expeller, which separates the oil and cake. The oil is filtered and passed through a chemical reactor for mixing it with methanol in the presence of a catalyst. Here fatty acids are separated, and esterification process takes place. The end product is bio-diesel. By-product glycerin is separated and excess methanol is recovered. The by-products of esterification have got commercial utility.

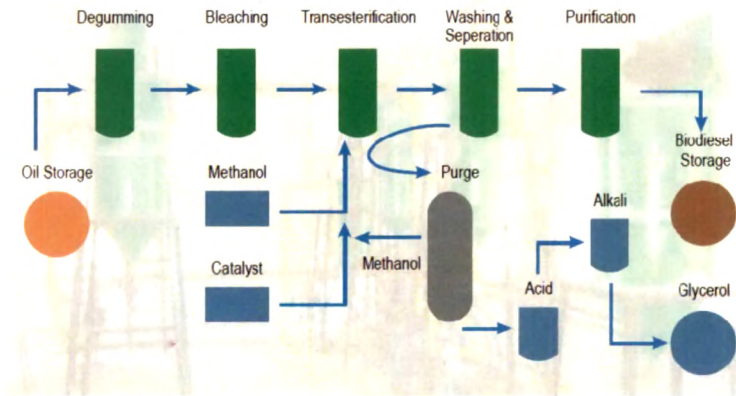


Figure I.1 Biodiesel Production Process

Figure I.2 shows the reaction of esterification process. During the esterification process, the vegetable oil is reacted with methyl alcohol in the presence of a catalyst,

usually a strong alkaline like sodium hydroxide. The alcohol reacts with the fatty acids to form biodiesel (methyl ester) and crude glycerol.

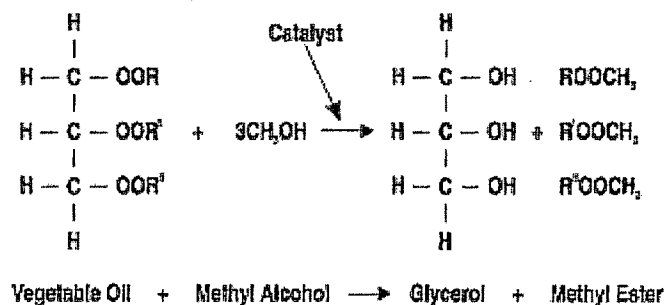


Figure I.2 Esterification of Vegetable Oil