Plant-oil cooking stove for developing countries

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Plant oils as cooking fuel

Plant oils are a new alternative cooking fuel resource, providing a sustainable and independent cooking energy supply. Their use as cooking fuel can bring numerous benefits to both urban and rural communities in developing countries.

A vast variety of oil plants originate in the tropics and subtropics. Many oil-bearing plants, whose oils are often toxic to human beings, grow on low grade land or in marginal locations, which are unsuitable for food crops. Some of these plants are cultivated on waste lands in order to prevent further erosion and to inhibit desertification. Use of these oils for energy provision will not compete with food production in any way. Examples of these oil plants are the Physic nut tree (*Jatropha Curcas L.*), the castor oil plant varieties (*Ricinus communis L.*) and the babassú palm (*Orbignya phalerata Mart.*), among others. Some oil plants even grow in symbiosis with food plants and are used, for example, as shade trees.

In many regions of tropical and subtropical countries, traditional methods already exist for harvesting the fruits from the oil plants and extracting the oil. This local oil production strengthens decentralized supply, providing employment and income opportunities for the local population and ensuring sustainability. The presscake, a by-product of the oil processing, can be used either as fodder or as high-quality fertilizer. Utilizing this new energy source will therefore directly increase the living standard of the population.

In general, all plant oils which are liquid at ambient temperatures can be utilized as cooking fuel. They are biodegradable and handling is both simple and free of danger. Moreover, burning of plant oils is carbon dioxide neutral.

Liquid fuel cooking stoves

Liquid fuels can be burnt in wick stoves and pressure stoves. Due to their high viscosity, plant oils can not be used in common wick stoves. Therefore, research has been focused on combustion in pressure stoves.

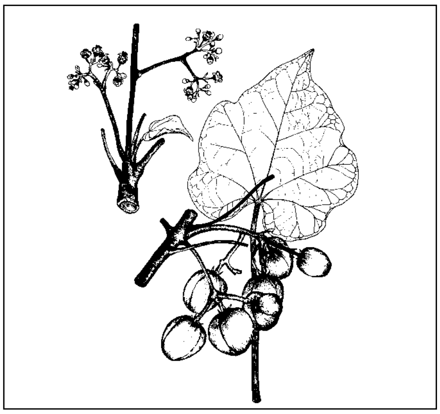

Figure 1 The Physic nut (www.raintree.com)

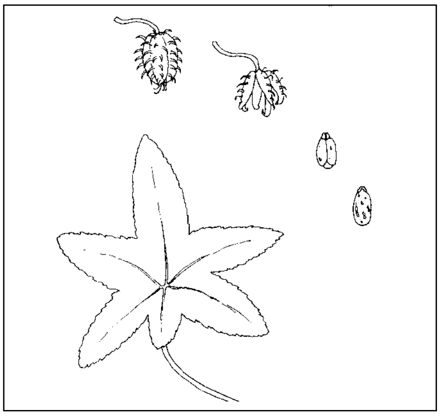

Figure 2 Castor oil palm (www.tapir.org)

Figure 3 Babassú palm

In pressure stoves, air is pumped into the fuel tank, the liquid evaporates in a vaporizer, and is emitted through a nozzle into a combustion area. Here, the jet rebounds at a rebounding plate, mixes with ambient air and burns in a blue flame. The combustion area is surrounded by a flame holder. The power output is adjusted with a valve regulating the fuel flow. For ignition, a small amount of ethanol is incinerated in a pre-heating dish beneath the vaporizer.

Kerosene is the commonly used liquid cooking fuel in developing countries today. Since the gross calorific value per volume of plant oils is only 5% lower than the corresponding value for kerosene, plant oils are suitable substitutes. Nevertheless, due to the differences in chemical structures, plant oils show very distinct physical, chemical, and combustion properties. These include elevated vaporization and flash points as well as higher ash residues.

Hohenheim plant oil stove

At the Institute for Agricultural Engineering in the Tropics and Subtropics of Hohenheim University, a plant oil pressure stove has been developed, which is believed to be the first stove so far which provides continuous operation with various pure plant oils. In addition to plant oils and plant oil mixtures, the cooking stove can also be fueled with plant oil esters, kerosene, diesel fuel and gasoline.

The new plant oil stove (Figures 4 & 5) can easily be introduced, even in rural areas of developing countries, since the operation of the plant oil cooking stove is similar to the known kerosene pressure stoves. Pre-heating is done by burning a small amount of ethanol in a dish. Likewise, the power is adjusted with a valve in the oil input tube. The power output range and efficiency of the plant oil stove is comparable to existing kerosene stoves.

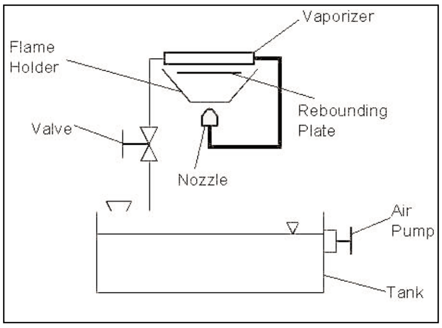

Figure 4 Schematic diagram of Hohenheim plant oil stove

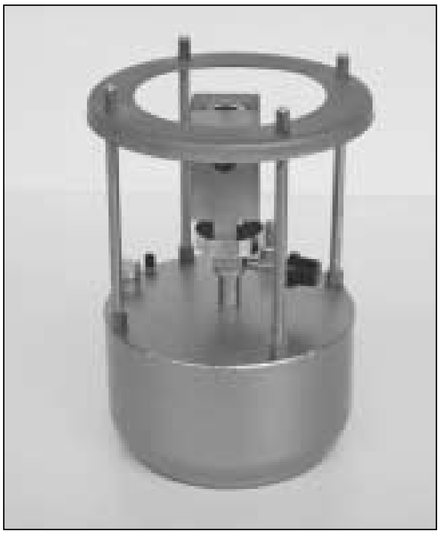

Figure 5 Hohenheim plant oil stove

A further benefit of plant oils as fuel is that they reduce the severe operating risks related to highly inflammable kerosene. The emissions of the plant oil stove are very much lower than the ones for open fires and are similar to the emissions of pressure kerosene stoves. For example, hydrocarbon emissions of the plant oil stove were measured to be 370 times lower than the emissions of an open fire with comparable power output. Likewise, the carbon monoxide and the nitrogen oxides emissions of the open fire are 120 times and 15 times higher than the emissions of the plant oil stove, respectively.

For the development of the plant oil stove, a completely new design of burner was required to maintain continuous vaporization as well as combustion. The vaporizer was redesigned to increase the retention time of the plant oils in the cooker flame sufficiently to reflect the high flash points of those liquids.

Because plant oil molecules start to dissociate at temperatures around boiling point, leaving cracking products at the vaporizer walls, the vaporizer can be released from the cooker frame and cleaned manually if necessary. For cleaning, a wire rope is pulled through the entire vaporizer tube. Nevertheless, the burner of the prototype already runs for more than 30 hours continuously on the test bench without cleaning.

In general, the new plant oil burner can be used independently of the stove's tank design and pot support. Nevertheless, common tank designs were analyzed and a new cooking stove prototype was designed. The stove can be manufactured using simple methods and materials at a very competitive price. The whole design is very robust and ensures that pots (Figure 6) or woks are seated securely during cooking.

The prototype has been developed as a one-flame cooker. However, the burner of the plant oils stove can be also used in cooking stoves with multiple flames. Depending on the required cooking task, the burner can be built in different sizes with distinct power outputs.

Current research is being carried out on the optimization of stove parameters, such as power range and efficiency. A first practical test of the cooking stove is planned in Guatemala. Later on, a field test of the plant oil cooking stove within a tropical or subtropical country will prepare the dissemination of this new technology.

Conclusions

A pressure cooking stove was developed which can be fueled by pure plant oils. Only a small amount of ethanol is needed for start-up. In addition, a new stove prototype was designed which can be built locally at competitive prices in developing countries.

Utilization of the plant oil cooking stove has numerous ecological, economical, and sociological benefits. Plant oils are a sustainable energy source ensuring a sustainable supply of cooking energy. Introduction of the new plant oil cooking stove can be readily acceptable to people in tropical and subtropical countries since its operation is similar to the familiar kerosene stoves.

Figure 6 Hohenheim stove with pot

Acknowledgement

The authors acknowledge their indebtedness to the Bellagio Forum for Sustainable Development, Osnabrück (Germany), especially their member associations German Federal Foundation for the Environment, Osnabrück (Germany), The Rockefeller Foundation, New York (USA), and The Toyota Foundation, Tokyo (Japan), for their financial assistance of this project. They would like also to express their deep gratitude to the European Natural Heritage Fund (Euronatur), Radolfzell (Germany) for their continuous support.

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