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# Babassu—A new approach for an ancient Brazilian biomass

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## ARTICLE INFO

### Article history:

Received 28 June 2007

Received in revised form

19 December 2007

Accepted 20 December 2007

Available online 8 February 2008

### Keywords:

Babassu

Biomass energy

Characterisation

Fuel

Brazil

Availability

Energy planning

## ABSTRACT

Babassu is a palm tree natural in the N and NE regions of Brazil whose fruit's kernel is used to produce palm oil, but it can also be a source of biomass for energy, which will be the focus of this article. For this purpose, the energy properties of this resource, including: higher and lower heating values; proximate, ultimate and thermogravimetric analysis of the fruit's components; together with other parameters such as density and equilibrium moisture were analysed. An availability study was also conducted considering the actual commercialised amount of kernel (only part of the fruit with commercial value), the use of an improved recovering system and the country potential. The results indicated that at least two of the fruit components do have energy-use potential, with very distinctive behaviour—epicarp (11% of the fruit, LHV of 20238 kJ kg<sup>-1</sup>) and endocarp (59%, LHV of 21179 kJ kg<sup>-1</sup>). The availability varies from 1.6 million tonnes of fruits/year on the actual baseline scenario up to 4.1 if an improved collecting system is used. The country potential was estimated at 6.8 million tonnes of fruits/year (main potential on Maranhão state—92%). More over, it is important to notice that the development of such potential must be made in line with preservation of the social structure of the local communities—the base for the collecting and segregating raw material supplying system—in order to secure the social, environmental and energy benefits of the sustainable exploitation of such biomass resource.

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## 1. Introduction

Sugarcane bagasse and eucalyptus plantations are the two main sources of biomass for energy in Brazil. However, there are other species that are currently un-exploited. One of these is the babassu palm tree fruits. This occurs naturally in the North and Northeast of the country and offers an environmentally friendly sustainable source of biomass for energy.

The fruits are collected in the woods by peasants for their kernels from which palm oil (lauric oil, similar to that produced in SE Asia) is extracted. The oil can be used to produce biodiesel, and its sustainable exploitation could bring energy, social-economic and environmental benefits to the region [1].

Exploitation of babassu palm trees is a well-established and ancient activity in Brazil. After the first oil crisis in 1973, the

Brazilian Federal government considered this palm tree, along with sugarcane and cassava, as possible energy sources to replace imported oil. Once the country decided to base its renewable fuel programme on sugarcane, few studies were done with babassu biomass.

However, there is now renewed interest in the use of babassu in Brazil.

## 2. Babassu palm tree and products

Babassu is a palm tree (up to 20 m in height), which is found naturally in Brazil and Colombia. The main products are fruits—small coconuts (a drupe) that hang from bunches, 4 per tree per season, with 15–25 coconut fruits each. The name

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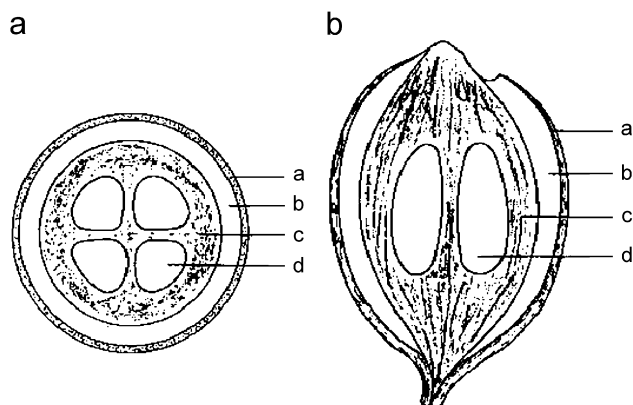
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doi:10.1016/j.biombioe.2007.12.016

babassu refers to three different species in the Palmae family: *Scheelea*, *Attalea* and *Orbigny*, where the common babassu name generally refers to *Orbignya phalerata*, and in a limited region *Orbignya oleifera* (two different species).

In terms of agricultural characteristics, the areas where this palm tree grows have a minimum insulation of 2400 annual hours (or monthly total radiation  $360 \text{ cal m}^{-2}$ ), evapotranspiration during dry trimester not higher than 280 mm (corresponding to September–November, but if above parallel  $3^\circ$  south, goes to June–July–August—In the central area of Brazil, concentrates along July–August–September), annual precipitation no less than 1700 mm, moisture condition in root area (during dry season), no higher than 400 mm and wind speed below  $3 \text{ m s}^{-1}$  [2]. In terms of suitable soil texture, babassu occurrence is associated with red-yellow latosol, clay medium texture and low slope to flat areas, also red-yellow podzolics medium clay texture soils, in low-slope landscape [3].

The fruits are ellipsoidal weighing 90–280 g. The fruit has a particular “anatomy”, which makes it different from the ordinary coconut and from the palm cultivated in Asia. Externally, it has a thin peel (the epicarp) that involves a starchy secondary layer (the mesocarp), and as a core of the coconut there is a hard wooden endocarp, with 3–4 kernels from which the palm oil is extracted (Fig. 1).



**Fig. 1** – Transversal (a) and longitudinal (b) cuts of the babassu coconut. Components from external to internal: epicarp—*a*; mesocarp—*b*; endocarp—*c* and kernel—*d*.

The percentage of each fruit component varies from location to location. Values obtained from the literature are given in Table 1 [4–8].

In this study the values from Vivacqua Filho [6] were used: epicarp 11%, Mesocarp 23%, endocarp 59% and kernel 7%. Calorific values for the fruit have been reported but it is unclear whether they refer to the higher or lower heating value.

One key aspect in the exploitation of the babassu is the collecting and gathering system. There are no plantations of these palm trees (as for palm oil production in Malaysia and Indonesia), so the fruits have to be collected from natural woodlands by the indigenous population. In the case of Brazil, women are mainly responsible for collecting the fruits and they break the hard wooden endocarp using an axe and a strong piece of wood to hit the fruit over the blade to retrieve the kernels. These are sold to small dealers who sell them to the oil-extraction industries.

This activity is a significant part of the financial income for the peasants’ families, and also a source of social and economical tension in Brazil (mainly Maranhão State, where the women have an organised movement) between the land owners and the access to the palm trees [9–11].

The sector plays a significant part of the annual income for more than 450,000 of peasant families. These figures vary with region and level of organisation between the women. For example in the Médio Mearim (area in Maranhão state) where the Babassu women have developed an association to secure their rights to access the palms and continue with their activity [10].

The external epicarp and the wooden endocarp can be used as fuel and the starchy Mesocarp is used as food but it is the kernel that holds the commercial value of the fruit. In some cases, the entire fruit is carbonised to produce charcoal for the pig iron industry in the Carajás region in North Brazil. This has led to even more stress between the women seeking to sell the kernel in the market and the rights to exploit the resource.

### 3. The raw material-collection system

The use of biomass as a fuel is normally observed in association with the industrial processing of agricultural raw materials (e.g. sugarcane bagasse and sugar), for what Babassu was investigated from the perspective of its already established oil-extracting productive system.

**Table 1** – Percentage in weight of fruit components

Comp.	Abreu, 1940 [4]	Gonsalves, 1955 [5]	Vivacqua Filho, 1968 [6]		Vivacqua Filho, 1881 [7]	Amaral Filho, 1990 [8]	
			Normal	More prod.			
Epicarp	11	12.6	±0.5	11.0	13.6	12	11
Mesocarp	23	22.3	±1.14	23.0	21.2	20	23
Endocarp	57	57.3	±5.4	59.0	56.5	63	59
Kernel	9	7.6	±0.3	7.0	8.7	7	7
Oil	–	0.05	–	–	–	–	–
Total	100	–	–	100	100	102	100

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