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The Encyclopedia of Fruit & Nuts

Edited by

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Rollinia mucosa biriba.
2008 SP-S8543
CPAA-20697-1

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A catalogue record for this book is available from the British Library,
London, UK.

Library of Congress Cataloging-in-Publication Data

The Encyclopedia of fruit and nuts / edited by Jules Janick and Robert E. Paull.

p. cm.

Includes bibliographical references and index.

ISBN 0-85199-638-8 (alk. paper)

1. Tropical fruit--Varieties--Encyclopedias. 2. Tropical nuts--Varieties--
Encyclopedias. I. Janick, Jules, 1931- II. Paull, Robert E. III. Title.

SB359.E56 2006

634'.603--dc22

2006027763

ISBN 978 0 85199 638 7

Typeset by Columns Design Ltd, Reading, UK

Printed and bound in the UK by Cambridge University Press, Cambridge

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clones at 13 sites across the USA. Cultivars being tested include 'Middletown', 'Mitchell', 'NC-1', 'Overleese', 'PA-Golden 1', 'Rappahannock', 'Shenandoah', 'Sunflower', 'Susquehanna', 'Taylor', 'Taytwo', 'Wells' and 'Wilson'. The other 15 clones were selections from the PPF breeding effort. Tree survival, trunk cross-sectional area, fruit size and taste, flesh-to-seed ratio, resistance to pests and diseases, and overall productivity on a year-to-year basis are among the attributes being evaluated. The pawpaw cultivars 'PA-Golden 1', 'Overleese', 'NC-1', 'Sunflower', 'Shenandoah' and 'Susquehanna' have performed well in Kentucky, have excellent fruit size and flavour, and are recommended for planting in the south-eastern USA. Complete results from the PRVT and additional regional recommendations will be available in a few years.

Kirk W. Pomper and Desmond R. Layne

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Rollinia mucosa biriba

Biriba tree, *Rollinia mucosa* (Jacq.) Baill. (*Annonaceae*), is considered to have been cultivated in pre-Columbian times and is now widely grown throughout the Amazon region. It is also found in north-eastern Brazil, the Antilles and other parts of the Caribbean. The fruit is appropriate for the fresh fruit market, with prices varying according to size. The species is an excellent alternative to diversify fruit gardens and to supply the demand motivated mainly by originality of the native fruit. Moreover it is an important genetic resource for its natural genetic variability, which can be used in domestication studies, for selection of superior genotypes or as a source of genes for related species.

The species is most commonly known as biriba. Other names include biribazeiro, biriba-de-pernambuco or fruta-de-condessa (Brazil); anon (Peru); chirimoya (Ecuador); mulato (Colombia); sinon (Venezuela); anona babosa or zambo (Mexico); cachiman morveusc, cachiman coehon or cachiman montagne (Guadalupe); cachiman or anon cimamon (Puerto Rico); anonillo (Panama); candongo or anona (Dominican Republic); and wild sugar apple (English).

World production and yield

In Central Amazon, the fruit is sold per unit at open markets or by street vendors. The species is not commercially exploited, even considering its value as a food source and for income for small farmers. It is most often found in home gardens or urban yards and small farms. Fifteen-year-old trees can produce over 150 fruit/year (Souza *et al.*, 1997). During the first three harvests of trees evaluated at EMBRAPA Western Amazon Experimental Station, State of Amazon, the average production reported was about 45 fruit/tree, with a range from 35 to 55 (Souza, 1998).

Uses and nutritional composition

Biriba has become a popular fruit due to its delicate flavour, pulp yield and fruit size which is enough for one individual.

Fruit is consumed fresh, although some in the Amazon prefer to blend it into a juice with or without milk. Fruit is 52% pulp, 42% peel and 6% seeds (Costa and Müller, 1995). The pulp is creamy, slightly acid to sweet, with total soluble solids ranging from 10 to 20% (Sousa, 1998). The fruit is regarded as being rich in vitamin C (Table A.39). The fruit and seeds contain acetogenens and alkaloids that may be anti-tumour agents and can inhibit platelet aggregations (Liaw *et al.*, 2003). The wood is hard and heavy and is used for boats, masks and boxes.

Botany

TAXONOMY AND NOMENCLATURE There are approximately 65 species in the genus *Rollinia*, but only *R. mucosa* is cultivated for its fruit. Synonyms include *Rollinia deliciosa* Saff., *Rollinia orthopetala* A. DC., *Rollinia pulchrinervis* A. DC., *Rollinia sieberi* A. DC. and *Annona mucosa* Jacq.

DESCRIPTION The tree is leafy with a round or conic canopy, requiring sufficient space for satisfactory development. During a study carried out on 80 plants conserved in a diversified collection of Amazon indigenous species genetic resources at EMBRAPA Western Amazon Experimental Station, this species was considered to have a fast initial growth, reaching a height of 3.7 m with a trunk 6.1 cm in diameter at 50 cm in its first year (Sousa and Paiva, 2000). The leaves are alternate, simple, oblong- or elliptical-oblong-shaped, 15–25 cm long and 8–11 cm wide, coriaceous, deciduous, without stipules, with a petiole 5–10 mm long. Solitary flowers are hermaphrodite and arranged on large pedicels. The fruit is a syncarp consisting of many joined carpels of pyramidal-shaped fruitlets. The ripened fruit is yellowish coloured and varies in shape, size, consistency and pericarp. The black seeds are about 1–1.5 cm long.

ECOLOGY AND CLIMATIC REQUIREMENTS The biriba tree is typically found growing in hot and humid climates. In the

Municipality of Manaus, State of Amazonas, Brazil, where the species is under study, the climate is characterized by a short dry season, with an average rainfall above 60 mm during the driest months (July and August) and above 300 mm during the rainy season (January–March), annual rainfall averaging around 2700 mm. The annual average temperature for the last 10 years has been around 26°C, with temperatures during the coldest month never being below 18°C.

The tree grows better in deep soil with a high content of organic matter and good drainage, even though it tolerates poor, acid and heavy-textured soils. In the Brazilian Amazon, the tree has been planted in upland xanthic ferralsols (yellow oxisols) that have a clay texture, high acidity and high content of exchangeable aluminum. In that region, the tree also grows in lowlands subject to periodic flooding.

REPRODUCTIVE DEVELOPMENT The juvenile period from seed is about 3 years. The biriba tree is among the most tropical species and flowers just once a year after leaf fall, which occurs in the Central Amazon during the low rainfall season, between June and September. In Costa Rica, flowers are observed between February and July.

FRUIT DEVELOPMENT In the state of Amazonas, fruit usually mature between October and May, and between June and November in Costa Rica. The fruit mature about 55 days from anthesis (Falcão, 1993). Fruit may be spherical to oblong-shaped, attaining 10–20 cm in length, 7–20 cm in diameter and an average weight from 200 to 1000 g. Special care must be taken in harvesting and handling to avoid fruit darkening due to mechanical injury (Fig. A.8).

Horticulture

PROPAGATION Trees are propagated either vegetatively or by seeds. Seeds should be sown as soon as they are collected from



Fig. A.8. Biriba, *Rollinia mucosa*, is a syncarp of many joined pyramidal-shaped fruitlets with soft spines that are easily damaged during harvesting and handling.

Table A.39. Composition of edible flesh of biriba per 100 g (Source: Morton, 1987).^a

Proximate	%
Water	77.2
Energy (kcal)	80
Protein	2.8
Lipid (fat)	0.2
Carbohydrate	19.1
Fibre	1.3
Ash	0.7
Minerals	mg
Calcium	24
Iron	1.2
Phosphorus	26
Vitamins	mg
Ascorbic acid	33
Niacin	0.5

^aThe pulp is 52% of the total fruit weight and the total soluble solids/acidity ratio is 28.

the fruit, preferably from high-yielding plants with high-quality fruit. Germination takes about 30 days with about 80% germination. The most common vegetative method is grafting. Rooted plantlets can be produced *in vitro* (Figueiredo *et al.*, 2000).

DISEASES AND PESTS *Cerconota anonnella* (Lepidoptere) larvae attack maturing fruit and cause considerable damage. A borer (*Cratosomus bombina*) burrows into the bark and trunk leading to secondary infections and branch death. White flies (*Aleurodicus cocois*) and mealy bugs (*Pseudococcus brevipes* and *Aspidiotus destructor*) are common on the leaves. Cercospora leaf spot occurs and *Glomerella cingulata* causes stem dieback and fruit rot.

MAIN CULTIVARS AND BREEDING No breeding programmes have been described. The existing variation in the trees planted from seeds offer excellent opportunities for selection for yield, size, weight, consistency and total soluble solids content. Some selections may have been made by Indians in the Upper Solimões River region, where fruit weighing above 4 kg with a smooth pericarp are found (Clement *et al.*, 1982; Lima and Costa, 1997). These selections have been known as *biriba do Alto Solimões*.

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APOCYNACEAE

Carissa congesta karanda

The English names of *Carissa congesta* Wight. (*Apocynaceae*), in addition to karanda, include Bengal currant and karaunda. It is known as karandan and senggaritan in Indonesia; kerenda, kerandang and berenda in Malaysia; caramba and pekunkila in the Philippines; naam daeng, manaa ho and naam khee haet in Thailand; and cay siro in Vietnam. The species is common throughout its native range of India, Sri Lanka, Myanmar and Malacca and it grows often in Thailand, Cambodia, South Vietnam and East Africa. Introduced as a hedge, it is now wild around Djakarta. The synonym is *Carissa carandas* Auct.

Uses and nutrient composition

The sourish-sweet fruit is consumed fresh when ripe and the more acid fruit is stewed with sugar (see Table A.40 for proximate fruit composition). It is also used to make beverages, pickles, curries, tarts, jellies and chutneys. The fruit exudes a gummy latex when cooked, but the red juice is clear and consumed as a cold beverage. Green fruit can be pickled.

The fruit can be used for tanning and dyeing while a paste of the pounded root serves as a fly repellent. The white or yellow wood is hard, smooth, and useful for handicrafts and utensils.

Unripe fruit are used medicinally as an astringent and ripe fruit as an antiscorbutic, and as a traditional remedy for biliousness. A leaf decoction is used in cases of intermittent fever, diarrhoea, oral inflammation and earache. The bitter root is a stomachic and vermifuge, and contains salicylic acid and cardiac glycosides. Bark, leaves and fruit contain an unnamed alkaloid.

Table A.40. Proximate fruit composition of karanda per 100 g (Source: Morton, 1987).

Proximate	g
Water	83
Energy (kcal)	75
Protein	0.39–0.66
Lipid	2.57–4.63
Carbohydrate	7.9–12.5
Fibre	0.62–1.8
Ash	0.66–0.78
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Vitamins	mg
Ascorbic acid	9–11