THE BARU NUT

Thesis paper of herbalist course, Syntra Antwerp

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Content

Foreword

Two years ago I started the herbalist course out of interest for plants physiology and the use of plants. Every Tuesday evening I followed the courses with pleasure, I really learned new things in a pleasant casual environment. In addition, I also got involved in the non-governmental organization for sustainable agriculture, Wervel, where I learned aboutthe region of Cerrado in Brazil. This thesis project has become a combination of both activities.

I hope to make a small contribution to the awareness of the Baru nut in Belgium, so that the local population of Cerrado can create more opportunities for the marketing of their sustainable products. Baru nut oil is not yet widely known in or outside Brazil and is not easily available. Two companies who sell the oil internationally through the internet (Mundo dos Oleos and YbaNatural) turned out, after several contacts, to be unable to transport the oil to Belgium. In the end the Araujo family (Eliane, Solange, Virna and Almir) brought a package with bottles of Baru oil from Goiana to Belgium, thank you very much for that!

Also many thanks to Luc Van Krunkelsven, Hubert Gulinck and Natalia de Mello of Wervel and to Donald Sawyer, Professor at the Center for Sustainable Development (CDS) of the University of Brasilia (UnB) and my fellow students and teachers of the herbalist course for the good atmosphere during Tuesdays' classes! Thanks for translation from Dutch to English by Els Van Daele. And "last but not least" a big thank you for the support of Lili, Nynke and Amber, who eventually also learned more about plants.

I continue to follow all developments around Baru and I would also like to share any news with other interested parties. If you want information or if you have any questions please contact me at Jaapvannes@vrt.net .

Introduction

In 2015 I got involved with the Brazilian region “Cerrado” through the Belgian NGO Wervel (www.wervel.be), which is committed to sustainable agriculture. Since then I became also involved in Wervel’s projects for the conservation of the Cerrado ecosystem. In my opinion, this thesis on the Baru nut could associate well with the goal of Cerrrado’s conservation.

Figure 1 Location of the Cerrado region in Brasil. (http://thecerrado.blogspot.be)

The Cerrado is a savanna region in the central West of Brazil. The region covers an area which equals approximately 2,5 times the surface of France and has a mayor biodiversity with many unique species of flora and fauna, see figure 1. With an area of one and a half to two million square kilometers it covers about 20% of the Brazilian territory and is therefore the biggest savanna area of this kind in South America. The Cerrado covers the states Goiás, Tocantins, Mato Grosso, Mato Grosso do Sul and big parts of Minas Gerais, São Paulo, Paraná, Maranhão, Bahia, and Piauí.

Since several years the Cerrado ecosystem is under a lot of pressure because the area is deforested at a rapid rate for the intensive agriculture of monoculture crops like soya and eucalyptus.

Its unique plants and fruits made me decide to choose as a topic of this herborist thesis fora native plant of Cerrado with medical applications, which still is little known outside of Brazil. My choice became the Baru tree, because on one hand this tree is often a symbol for the Cerrado region and on the other hand because its fruit and nuts contain specific properties which could be applied economically in a sustainable wayby the local population.

In this paper I will describe the Baru tree in his different contexts (botanically speaking and socio-economically) to focus afterwards on its characteristics and some applications of the Baru nut oil.

1. Taxonomy (names, synonyms and etymology)

The Baru nut is actually the seed of the Baruzeiro tree (with his Latin name Dipteryx alata Vogel), which is native for the whole Cerrado region. A picture of the tree is displayed in Figure 2.

Figure 2 Baru tree in the Cerrado savanna (D. Conrado - Own work)

The tree produces fruit from July to October. Dipteryx alata Vogel belongs to the family of the legumes (Leguminosae or Fabaceae).

It is quite a large tree, usually referred to as "Baruzeiro" (Baru-tree) in Portugese, and its fruits and almonds are known as Baru. The tree is native in the whole Cerrado region. The fruit is eaten by cattle and wild animals and is also used by the local population. The seeds are nutritious and possess medicinal properties.

Dipteryx alata was described scientifically for the first time by the German botanist Julius Rudolph Theodor Vogel (1812-1841) and was published in the German scientific journal Linnaea (number 11: 383) in 1837. Vogel was passioned by legumes. Unfortunately he died at an early age of diphtheria in Niger.

In the Brazilian herbarium of biologist Graziela Barroso (1912-2003) of the Federal University of Piauí with more than 30.000 dried plants, Baru is described under number 22.219 (dried specimen in Figure 3).

Figure 3 Herbarium Graziela Barroso

Synonyms of the Latin name Dipteryx alata Vogel which are used for the same tree are Coumarouna alata (Vogel) Tauber, Cumaruna alata (Vogel) Kuntze, Dipteryx pteropus Mart and Dipteryx pterota Benth.

Alternative local names for Baru are: Shihuahuaco (in Peru), Congrio (in Columbia) and Bugreiro, Cumaru, Chuva-de-ouro or ComBaru in Braz (Nota Tecnica No. 149 (Spanish monograph) http://orton.catie.ac.cr/repdoc/A0009s/A0009s149.pdf). Other less used names in Brazil are: Barujo, Coco-feijão, Cumarurana, Emburena-Brava, Feijão-Coco, Pau-Cumaru and also Castanha de burro (Fonteles et al, 1988). Outside of Brazil Baru nuts are also called Tonka Beans (Sano et al, 2004).

2. Origin, site and spread of the Baru tree

The Baru tree appears in South America between southern latitude 6 to 22 in Peru, Columbia and the Brazilian Cerrado region and grows between 140 and 1200 meter above sea level. The climate in which the tree appears has an average annual rainfall between 1100 and 1900 millimeter and average temperatures between 20 and 26 °C.

The plant thrives as well in full sunlight as in shadow, typical for secondary forests. Baru grows mostly on drier and deep grounds and does not need rich soils. Baru grows best on sandy limy soils with a proper drainage. (Nota Tecnica No. 149 (Spanish monograph) http://orton.catie.ac.cr/repdoc/A0009s/A0009s149.pdf).

By the widespread deforestation of the Cerrado (Figure 4) this tree species is in danger of extinction. The Baru tree(Dipteryx alata Vogel) is often naturally occurring together with the other tree species Astronium fraxinifolium, Hymenaea sticonocarpa, Bowdichia virgilioides and Pterodon pubescens in the Cerrado (De Oliveira, 2015).

Figure 4 Clear dividing line between deforested and not deforested Cerrado(wwf.panda.org)

3. The Cerrado region in Brazil.

The Cerrado has a tropical savanna climate with periodical drought periods. In the rainy season (summer), that lasts from October to April, falls the vast majority of the annual 1100 to 1600 millimeter of rain. The rest of the year the area has a pronounced drought (winter). Many of the trees and plants have adapted themselves to the long droughts and can withstand forest fires. See FigurFigure 5.

Figure 5 Typical winding tribe of the Pequizeiro tree (Pequi-nut, Pinterest)

The Cerrado takes its name from the impenetrability of the area. Cerrado means in Portugese literally ‘closed’ as the trees and bushes in this area make it practically impenetrable. The crops are showing many twists and curves, this form of growth is created because the plants suffer by the poor, often acid soils and the many fires in the dry season.

The Cerrado can be divided in four different types depending on the kind of vegetation and its density.

1. Campo limpo: completely open grassland with some trees and bushes
2. Campo sujo: grassland with bushes and some trees
3. Campo cerrado: savanna, wilderness
4. Cerradão: wilderness or transition between savanna and jungle

Typical for the Cerrado is that these different types can merge at close range. Sometimes the border between Campo limpo and Cerradão is less than a meter. The type of vegetation is defined by the presence of water and nutrients in the soil.

The soils in the Cerrado are particularly old and weathered, therefore they have very few nutrients; they are 'poor' soils. Erosion can sometimes bring up younger, less weathered layers to the surface. In these areas, "Cerradão" can arise in historical erosion trenches. On slopes, groundwater can appear near the surface, what also can result in the creation of Cerradão. Mostly however Cerradão exists where there is an interplay between the presence of water and nutrients.

Measured per hectare the Cerrado has a very high biodiversity. Very common bird species are endemic. Mammals like the giant ant eater, the giant armadillo, the jaguar and the maned wolf live in the Cerrado. The Cerrado has been pointed out as one of the global biodiversity hotspots by Conservation International (http://www.conservation.org) because of its high level of endemism and because already a lot of nature has been lost.

Over longer distance this biodiversity is fairly constant. Within the Cerrado the biodiversity over a longer distance is determined mainly by climatic factors. There are even tree types that grow as well in the dry Cerrado as in the tropical rainforest.

Within the Cerrado there are places with microclimates which give shelter to an increased local biodiversity, like humid river valleys or karst craters where the local conditions allow a sumptuous tropical vegetation.

On the for agriculture exploited Cerrado a lot of rice is cultivated by "correcting" the natural soil through liming. Large-scale deforestations because of the start-up of soya plantations are a serious threat for the ecology in the Cerrado (https://nl.wikipedia.org/wiki/Cerrado).

Besides the destroying of the biodiversity and decreased evapotranspiration other side-effects for the soil are for example related to the run-off of the fertile top layer of the soil, densification of the soil surface and the decrease of humus content and its fragile natural soil fertility. For an optimal return in the production of monoculture, irrigation, plant protection products, industrial nutrients and often genetically engineered crops are being used. The scarce water resources are often excessively exploited. On the one hand risks of run-off of plant protection products, nitrate and phosphate to the groundwater and surface water do occur and on the other hand there are risks of salinization.

The Brazilian soya is mainly grown for the export. Soya is frequently used as animal feed in the EU or the US. Net, this export of soya contributes to a decrease of nutrients in Brazil and a net increase of nutrients in Europe. The nutrient surplus in the European agriculture has led to regional increased levels of nitrates and phosphates in groundwater and surface water.

Several studies and modelling have shown that large-scale deforestations have an effect on the climate (Arantes et al, 2016). At regional level the deforestations contribute to extreme climate impacts like "heat islands" (De Ridder et al, 2016), drought sensitivity, extreme heat, floods, erosion by storm drain or wind and increase of dust in atmosphere.

Traditionally the Cerrado has been seen as useless barren land. The revolutionary exploitation and fertilization for intensive agriculture was for short the only thing that the government thought of as a positive development. But recently (October 2016) the Brazilian environment minister Sarney Filho has called for the protection of the Cerrado against further intensive cultivation of soya like it was done 10 years before for the Amazon (Mail Elly Peters, World Wildlife Fund Belgium, 2016).

Full rehabilitation of land to the original Cerrado ecosystems after intensive agriculture has taken place is not realistic and probably also not desirable because it needs a lot of time to

fully recover soils and vegetation in the difficult climate conditions and also because of the economic need of large-scale food production. Changeover to more sustainable forms of agriculture and the application of buffer zones for example can however contribute positively to combating soil erosion, superficial run-off of rainwater and allow the partially return of regional flora and fauna. Non-intensive farming zones can be corridors between still untouched “islands” with an original habitat.

On the other hand sustainable applications of the original Cerrado habitat could contribute to increasing the (economic) value of the natural Cerrado ecosystem and therefore stimulate its protection. Examples of sustainable initiatives which already take place are eco-tourism and the collection of medicinale plants and fruit. In the Cerrado, protected reserves already exist, from where the local population can collect plants/fruits for sale in a responsible way.

The large-scale cultivation of soya in the Cerrado is in the hands of a few large land owners. The local rural population could economically profit more from the sustainable extraction and commercialization of the naturally occurring plants-products of the Cerrado-ecosystem. The variety of useful herbs, plants and fruits in the Cerrado is considerable. Often their traditional uses are only known by the local population. However, before traditional or new products from Cerrado could be presented at the national or international markets potential clients shall first be made more familiar with these plant products. The Baru-fruit is an example of a natural resource with a potential for being developed into several commercial products. Of course, the application of sustainable production, harvesting and treatment methods are crucial to prevent the Baru tree and the other flora and fauna from being put under extra pressure.

4. Description of the Baru plant

The Baru tree occurs as well as an evergreen as a deciduous variant, depending on the local climate conditions. The tree is a slow grower. The height of an adult Baru tree ranges from 5 until 25 meter with a diameter of 15 to 70 cm. Exceptionally heights until 50 meter and diameter until 170 cm are mentioned. The crown of the tree is dense and shapely. The tree bark has a grey color with spots and has an external raw structure, sometimes with thorns, see Figure 6. The bark has an average thickness of 15 mm. The trunk often has bumps and points.

Figure 6 Bark of the Barutree (http://arvoresdaufmt.wixsite.com)

The leaves are compound, see also Figure 7. Each individual leaf is approximately 8 cm long and 4 cm wide.

Figure 7 compound Baru leaf (Silva Jr., M.C. 100 Árvores do Cerrado, 2005)

The inflorescence (see Figure8) has a length until 20 cm. The individual flowers are hermaphrodite with a purple or yellow color and with an individual length of about 2 cm. The number of chromosomes is 2n=16, which is usual for the Faboideae (Legumes) (Sano et al, 2004)

Figure 8 Flowers of the Barutree (unopened and opened, http://arvoresdaufmt.wixsite.com)


The plant flourishes between November and May. After six years the tree starts to bear fruit. The fruits are formed between May and October. The pollination is done by bees.

A tree produces normally 1000 to 3000 fruits varying from 5 to 7 cm length and 3 to 5 cm diameter, and a weight between 26 and 40 gram (De Oliveira, 2015). The tree produces around 100 kilo fruits per harvest. The baru tree produces as one of the few trees fruits in the dry season and is therefore an important source of food for the fauna in that period. The natural spreading of the fruit and seeds happens amongst others by bats and the blue Ara (Anodorhynchus hyacinthinus), which eat the fruit pulp. Rodents as Agouti's and monkeys consume mainly the seed. Cows, termites, ants and bugs eat the fruits that fall on the ground.

The Baru fruit has an oval-elliptical shape with a length of about 6 cm, see Figure 9. The pericarp of the fruit is fleshy with a thickness of 1 cm.

Figure 9 Baru-fruit (reference-boxes of 1 cm x 1cm)

The endocarp is a paved pit in which the actual seed is located; this seed (Figure 10) is the part that is called the Baru nut.

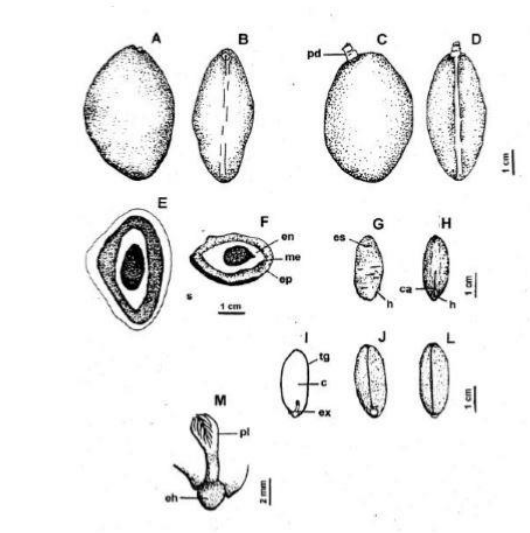
De fruit consists of about 30% flesh (pulp), 65% is woody endocarp and 5% is seed.

The fruit has been described in detail by Ferreira et al (1998). The fruit is of the type drupoid or stone fruit (fruit whose inside wall, the endocarp, consists of a stony wall) and has a smooth internal texture. The fruit is egg-shaped and high-fiber, with a color between dark red and beige brown. The stick is woody.

Figure 10 Opened Baru fruit with seed

In the pit (the “stone”) lies the actual seed. When the fruit is opened, the pericarp appears to be good defined; the epicarp (the skin of the fruit) has a thin, smooth and brittle consistency; the mesocarp (flesh or pulp) is brown with a smooth thick consistency. The endocarp (shell of the “almond”) is woody, greenyellow or brown with a foamed layer on the inside. This is shown schematically in Figure 11.

Figure 11 Figure of Baru fruit and seed (Ferreira et al, 1998)



A-D - fruto; E - seção longitudinal do fruto; F - seção transversal do fruto; G-H- semente com tegumento; I - seção longitudinal da semente mostrando o eixo embrionário; J-L - embrião fechado; M - detalhe do eixo-embrionário.

Legenda: ; c-cotilédone; ca-calaza; eh-eixo hipocótilo-radícula; en-endocarpo; ep-epicarpo; es-estria; ex-eixo-embrionário; h-hilo; me-mesocarpo; pd-pedúnculo; pl-plúmula; s-semente; tg-tegumentos.

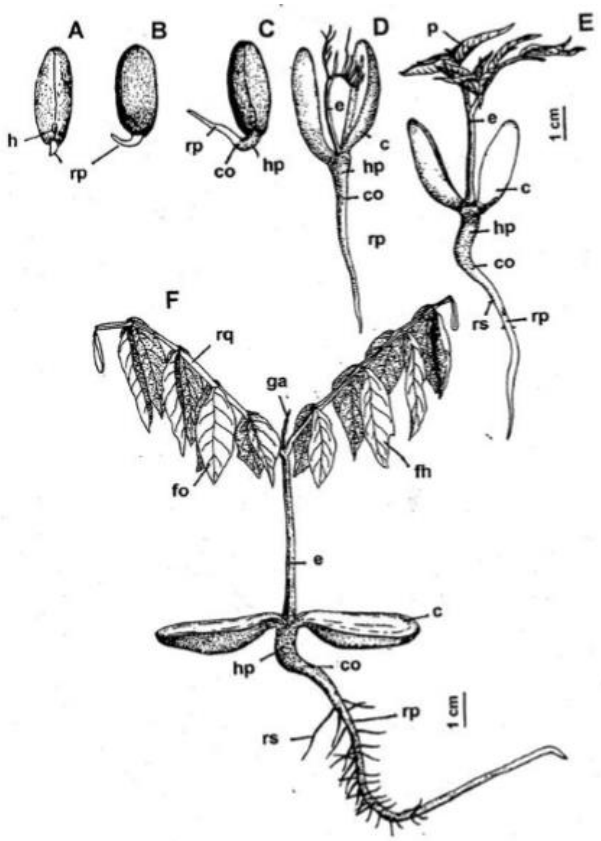
FIGURA 1: Aspectos externos e internos do fruto e da semente de *Dipteryx alata* Vogel.

The shape of the Baru seed is slightly oval with slightly rounded edges. The color varies in different shades of brown (light, medium and dark, dark, almost black). The average length, width and thickness are respectively 1,8, 1,0 and 0,8 cm. The smooth outer casing is shiny.

Baru belongs to the legumes and is dicotyl. The seed has two cotyledons, a navel (hilum) and a germ opening (micropyle) through which the little root can grow to the outside by germination (Ferreira et al., 1998).

The germination process is displayed in Figure 12.

Figure 12 Germination process of a little Baru plant (Ferreira et al, 1998)



As a legume the Baru tree can fixate nitrogen out of the air and store it in little yams (Ferreira et al, 1998). The wood is very hard with a specific gravity of 0,9 to 1,2 g/cm^3. The sapwood is white-yellowish and the sago is brown yellow in color. The wood is very resistant to damage by organisms (Nota Tecnica No. 149 (Spanish monograph) http://orton.catie.ac.cr/repdoc/A0009s/A0009s149.pdf).

5. Traditional use, history and folklore

Because of the large scale deforestation of the Cerrado for transposition into areas for intensive agriculture, the exploitation of the Baru tree for its hard wood, but also through the harvesting of its seed in a non-sustainable way, the species is nowadays classified as vulnerable on the IUCN Red List of Threatened Species (http://www.iucnredlist.org) (Carazza et al, 2010). Below the function of the Baru treewithin the ecosystem and the traditional use of the tree and its fruit by the local population of the Cerrado are being described.

Tree

The Baru has an important function in the savanna ecosystem for the recovery of the soil and vegetation (both through its tree crown that provides shadow and through the enrichment of the soil by fixation of nitrogen (Ferreira et al, 1998). The tree also protects cattle and wild animals against the direct sun. The fruits are a food source for animals in the dry season (De Oliveira, 2015). Its flowers spread a strong smell of honey and attract a lot of bees (Gomes Pereira dos Santos et al, 2008). The local people of the Cerrado therefore use the tree for honey production. The local population uses the seed ("almond" or "chestnut" for consumption (which taste is similar to almonds).

The hardwood is used in furniture and construction, as parquet floor and for train sleepers, as firewood of a good quality and for the production of charcoal. Furthermore the tree is exploited for ornamental planting/shadowing planting along streets. (Nota Tecnica No. 149 (Spanish monograph) http://orton.catie.ac.cr/repdoc/A0009s/A0009s149.pdf).

Bark

The bark is traditionally used against snake bites and back pain (Puebla et al, 2010).

Fruit

The Baru-fruits are an important food source for the fauna during the dry months. The flesh of the fruit and the almonds are also used by the local population as an ingredient for sweet pastries and cookies. With the wood pulp coal, firewood, tar and volatile acids can be produced. (Carazza et al, 2010).

The oil of the Baru seeds is traditionally used by the inhabitants of the Cerrado as a remedy for rheumatism, and to regulate transpiration and menstruation period. The oil is extracted by means of cold mechanical pressing or hot extraction. It is seen as a "tonic" (a reinforcement product that stimulates and strengthens the whole body or particular parts of it. (Sano et al., 2004). The seed is used as a cure for cramps (Nota Tecnica No. 149 (Spanish monograph) and Togashi, 1993).

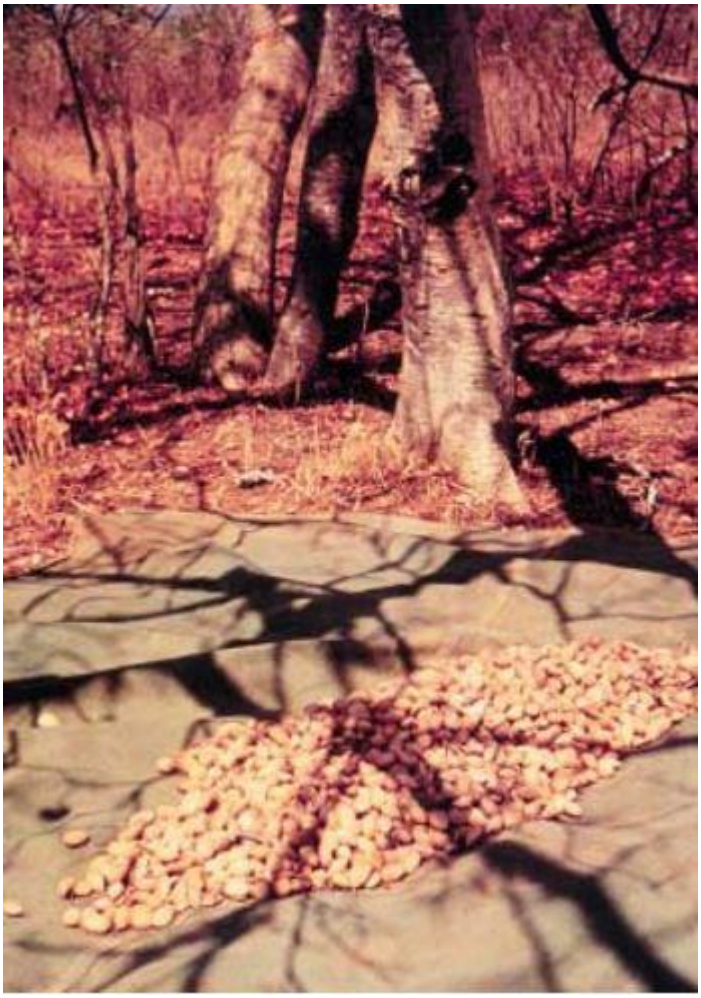
Root

I did not find any documentation about possible qualities of the root.

6. Harvest and process of the Baru nut.

Baru nuts are not specifically cultivated in orchards, but collected in nature. As soon as the fruit is colored, it can be collected. It is directly harvested from the tree (with ladders) or tarps are being laid down around the tree and after that the fruits are shaken out of the tree (similar to olive harvesting), see FigurFigure 13.

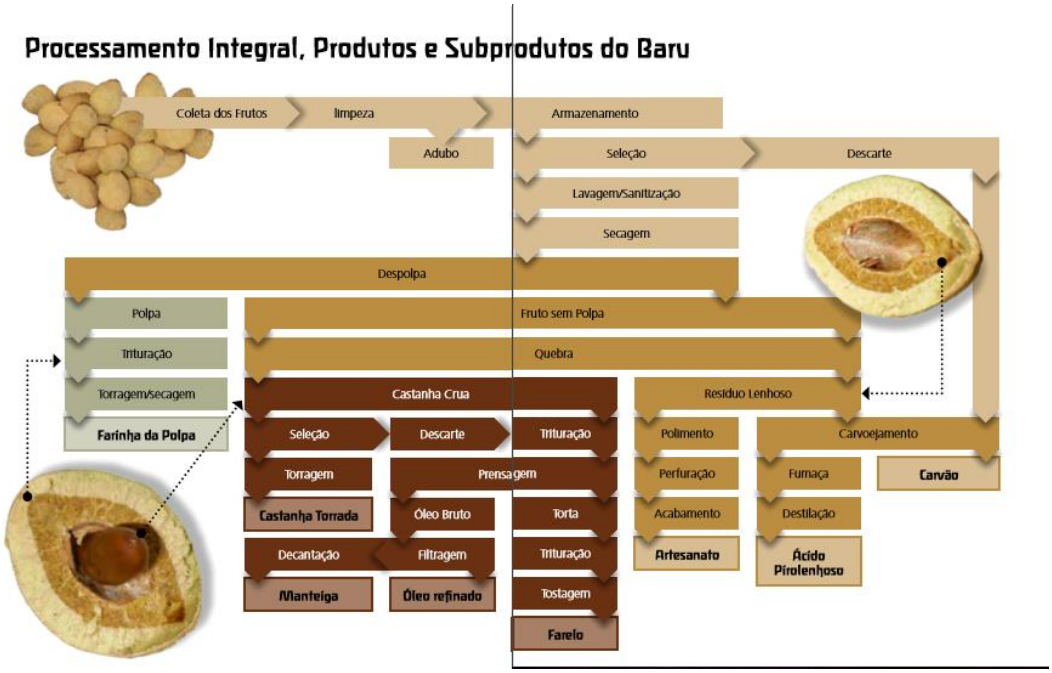
Figure 13 Tarp under Baru tree for collecting the fruits (Sano et al, 2004).



After that the fruits are being transported in big bags to the place of processing. The pulp is being removed for use in various purposes. Then the wooden shell (“nut”) will be cracked so that the seed (“almond”) can be pulled out. Both the seed as the wooden shell are used (Nota tecnica 149 (Spanish monograph)).

All this is happening by hand and is therefore very labor intensive. One kilogram contains about 600 to 700 Baru seeds. The fruit weighs about 25 g, of which 30% pulp, 65% is woody endocarp and 5% is seed. The steps from harvest to process are shown schematically in FigurFigure 14 (in Portuguese) and are briefly discussed below.

Figure 14 Steps in manufacturing process of the Baru fruit (Carrazza et al, 2010)



1. Collecting the fruits
2. Selection of the fruits
3. Washing
4. Desinfection in a bath of chlorinated water (100 ml sodium hypochlorite in 100 liters of water)
5. Drying
6. Dried flesh (pulp) is removed manually or mechanically with or without water
7. The pulp will be further processed into various finished products (like flour or cookies). What's left is the nut with woody shell.
8. The nut (woody endocarp) is cracked in such a way (Figurfigure 15) that the Baru-almund does not break.

Figure 15 Baru nut cracker (Sano et al, 2004)

1. Selection of the Baru-almonds
1. Depending on its consistency and size, the almond can be either used entirely or broken, crushed into flour, or used for oil extraction. The almonds are roasted to inactivate the phytic acid that is a natural ingredient of the almond. Phytic acid inhibits the hormone trypsin that degrades proteins in human's small intestine.
2. Packaging of the almonds (vacuum) and Baru-flour
1. Oil is extracted from non-roasted almonds, by means of cold pressing. The oil is filtered and bottled after.

2. The remaining mass after the processing is roasted and is further processed in animal foods or human food.

7. Ingredients fruit and bark

Research institutes and universities in Brazil are doing and have done research on the ingredients and properties of the Baru fruit. Scientific sources of information in English about the Baru are unfortunately only very limited.

Unfortunately iformation on the ingredients and properties of the root and the wood of the Baru tree is unknown. Hereafter I describe only the most important ingredients of the fruit (pulp and seed) and the bark. The described ingredients and their concentrations are indicative because the concentrations depend on the local climate conditions in which the tree is located and the ways in which sampling and analyses have been done. The harsh local conditions because of the warm dry climate and the poor soils of the Cerrado have caused that the baru plants adapted themselfes for better survival. One of the strategies of plants is to produce certain chemical and biological components as protection against being eaten by animals. Also the plant adapted its wood and seeds in order to better resistitself against drought and forest fires.

The properties of some ingredients (terpenes) and related chemical are being mentioned as structural chemical formulas in Annex 2.

7.1 Fruit

7.1.1 Pulp

The fruit flesh is high in energy but has a somewhat bad taste. However the taste is improved by drying and during conservation of the fruit flesh it gets sweeter during ripening, probably because the concentration of the tannins decreases when stored. The principal ingredients of the Baru flesh are sugars, amino acids, fatty acids, minerals and dietary fibers (Medeiros Alves et al, 1983). In Table 1 and 2 the nutritional values and most important amino acids, which are found in the fruit flesh, are displayed.

Table 1 Nutritional information of the pulp (per 100 g dry weight), Carrazza et al, 2010

Calories	300 kcal	Carbs	58,4 g
Proteins	5,59 g	Total sugars	20,4 g
Total fats	3,4 g	Starch	38,0 g
Total fibers	29,5 g	Shaft (size minerals)	2,99 g

Table 2 Amino acids in pulp (% of protein total), Carrazza et al, 2010			
Valine	3,25	Lysine	4,84
Isoleucine	2,46	Tryptophan	0,53
Leucine	4,38	Aspartic acid	10,06
Threonine	2,35	Serine	2,67
½ Cystine	0,00	Glutamic acid	8,11
Methionine	0,41	Proline	17,91
Tyrosine	0,87	Glycine	2,98
Phenylalanine	2,37	Alanine	3,84
Histidine	1,47	Arginine	3,50

Minerals

The four essential macronutrients Ca, Mg, P and K appear in significant amounts in the pulp (De Oliveira, 2015) of Baru.

Anti-nutritional factors

The Baru pulp contains high levels of Tannin (3,11 g/100 g pulp) and the anti-nutritional ingredient phytic acid (0,27%), source: Carrazza et al, 2010.

7.1.2 Seed (“almond”)

The principal ingredients of the Baru nut or “almond” are tannins, flavonoids, vitamins, amino acids, fibers, unsaturated fatty acids (i.a. omega 6 and 9), minerals, phytosterols, tocopherols and phytic acid (Siqueira et al, 2015).

Nutritional values

In Table 3 the nutritional values of the Baru almond are displayed. Baru almond has elevated levels of unsaturated fat and is a source of energy.

Table 3 Nutritional values Baru almond in g/100 g (Carrazza et al, 2010)			
Proteins	23,9	Total fibres	13,4
Total fats	38,2	Carbs	15,8
Trans fats	7,2	Calories (kcal/100 g)	502

Unsaturated fats	31,0		

Proteins

The eight essential amino acids (which are not being produced by the human body): leucine, isoleucine, valine, methionine, threonine, lysine, phenylalanine and tryptophan all appear in the Baru nut, see also Table 4. In the table distinction is made between raw baru seed and roasted seed (the roasting process eliminates the trypsin inhibitor phytic acid).

Table 4 Amino acids of Baru almond (g/100 g protein) with the essential fatty acids marked in red (Carrazza et al, 2010)

	raw	roasted		raw	roasted
Valine	4,49	4,53	Lysine	5,65	4,17
Isoleucine	3	2,79	Tryptofaan	1,26	0,92
Leucine	7,15	7,04	Aspartic acid	7,47	7,56
Threonine	3,04	2,95	Serine	3,03	2,91
½ Cystine	0	0	Glutamic acid	19,18	19,3
Methionine	0,74	0,84	Proline	4,17	4,2
Tyrosine	2,34	2,1	Glycine	3,79	3,8
Phenylalanine	4,2	4,2	Alanine	3,64	3,67
Histidine	2,1	1,95	Arginine	7,26	6,99

Table 4 shows no significant difference between the protein content in raw or roasted Baru almonds.

Fatty acids

The oil of the Baru almond contains over 75% (good) unsaturated fatty acids such as oleic acid (omega 9), linoleic acid (omega 6), linolenic acid (omega 3), gadoleïne acid and erucic acid (Cardoso Bailao et al, 2015), see also two certificates of analysis of Baru oil in Annex 3. The unsaturated fatty acids are part of a healthy diet.

Minerals

The Baru nut contains high values of Ca, P, K, Mg, Cu, Fe and Zn (observed levels were higher than in the pulp). In Table 5 the minerals in the almond are displayed, which were detected (Carrazza et al, 2010) during analyses. The seed also contains high levels of Sulphur (De Oliveira, 2015). For Selenium and Sulphur no values in Baru were found in literature.

Table 5 Minerals in Baru almond in mg/100 g (Carrazza, 2010)			
Ca	140	Cu	1,45
K	827	Fe	4,24
P	358	Mn	4,9
Mg	178	Zn	4,1

Phosphor is a nutrient that is important for energy storage and structural integrity (phosphate components sugars, nucleic acids, nucleotids, co-enzyms, phospholipides, phytic acid, and plays a central role in connection with ATP). Potassium plays an important role as a co-factor of more than 40 enzymes, especially related to the cell-turgor and ion balance. Calcium is an important component of the membranes and cofactor of some enzymes. Magnesium is for example important for the transfer of phosphate as a substance of the chlorophyl molecules . The micronutrient Zinc is in turn involved in several basic redox reactions (De Oliveira, 2015).

Polyphenols

Nuts are generally rich in polyphenols. Polyphenols are divided into tannins, flavonoids and phenyl propanoids. Polyphenols are anti-inflammatories and anti-carcinogenics. Free radicals are eliminated by polyphenols. Therefore polyphenols fall under the antioxidants. They also provide a decrease of the risk to obtain Alzheimer disease. Baru contains a significant level of phenolic components (568,9 mg/100 g) according to Marques et al, 2015.

A high level of tannin of 563 mg/100 g Baru almond was published by Siquiera et al, 2015.

No information was found in literature about the specific flavonoids in Baru almond, but only information of a total amount of flavonoids of 9,6 mg/100 g in raw almond and 1,6 mg/100 g in roasted almond (Fraguas et al, 2014).

Information on the presence of phenyl propanoids in the Baru almond was not specifically found in the literature.

Terpenes

Baru oil contains according to Marques et al, 2015 the following mono (C10)- and sesqui (C15)-terpens: β-Sitosterol, Stigmasterol, α and ϒ-Tocopherol (vitamin E), Campesterol, Cycloartenol, β and α-Caryophyllene, ϒ- and β-Elemene and Limonene. Of these terpens β-Sitosterol is the most prominent. Tabel 6 shows the relative levels of these terpenes.

Table 6 Relative levels (%) of terpenes in Baru oil (hydraulic cold pressing), Marques et al, 2015			
β-Sitosterol	63,9 %	β - Caryophyllene	0,3 %
Stigmasterol	14,2 %	α - Caryophyllene	0,1 %

α -Tocopherol	7,4 %	ϒ - Elemene	0,1 %
ϒ -Tocopherol	3,6 %	β - Elemene	0,1 %
Campesterol	5,5 %	Limonene	0,03 %
Cycloartenol	4,6 %		

β-Sitosterol, Stigmasterol, Cycloartenol and Campesterol are being called phytosterols. The basis skeleton of a phytosterol consists of a steroid structure, comparable to cholesterol, which is an important component of the cell membrane. There are more than 200 different types of phytosterols. They are featured by one of two unsaturated binding carbons.

The terpens β and α-Caryophyllene, ϒ- and β-Elemene and Limonene out of the Baru almond are typical components of essential oil. In Annex 2 you find a more detailed description of these EO terpenes.

Essential oil

Essential oil are (semi)volatile ingredients (often with a specific odor) and mainly consist of terpenes or aromatics with a benzene ring (phenyl propanoids). Some essential oils can also contain fatty acids and their esters. They are rarely colored, soluble in organic solvents and insoluble in water.

Essential oils can be found in various plant organs (flowers, fruit, seeds, leaves, stems and roots) which are produced and stored in separate secretory structures which are different in morphology, structure, function and distribution. These specialized structures minimize the risk of auto toxicity and can be found on the surface of the plant organs or in the plant tissue, respectively as external or internal separation structures. In nature essential oils play an important role in plant defense and signaling.

Essential oils are for example involved in plant defense processes against micro-organisms, insects and herbivores, attraction processes for insects that spread pollen and animals that spread fruit and in processes for water management.

They are valuable natural products which are used as resources in many fields, such as pharmaceutical, agronomic industries, food industries, sanitary industries, cosmetic and perfume industries (Zuzarte et al, 2015). The method of oil pressing has an immediate effect on the concentration of essential oils in Baru oil. With extraction techniques where heat is used or where heat is released through friction (temperatures up to 60° C were observed with warm pressing of Baru oil) the volatile parties of the essential oils will evaporate (Savoire et al., 2013). Therefore one should use cold pressing techniques to obtain best quality oil (Marques et al, 2015).

Vitamins and Tocopherol

The Baru almond contains Vitamins A, B and E (tocopherols), (Carrazza, 2010). According Da Costa (2015) the vitamin E concentration is iqual to 13,62 mg/100 g. Marques et al find for the sum of tocopherols (alfa and bèta) 2 mg/100 g Baru almond. De Oliveira, 2015 mentions 5 mg/100 g Baru for Tocopherol. Siquiera et al, 2015 find levels of a total amount of Tocopherol that equal 12 mg/100 g and total Carotenoide equal to 12 mg/100 g. Most carotenoids serve as antioxidant and can be converted into Vitamine A in the human body. Tocopherols are of interest as important anti-oxidants.

For Vitamins A and B no specific amounts in Baru were found in litterature.

Anti-nutritional factors: Phytic-acid

Phytic acid is the most important storage form of phosphor in a lot of plant tissue, especially in the tough outer shell around the grain and other seeds. It is a natural antioxidant that protects the seed. It contains the mineral phosphor that is bound compact in a molecule in the shape of a snowflake. For humans and animals with one stomach the phosphor is not directly available for the body. Subsequent to this availability of phosphor for the body the “arms” of the phytic acid molecule bind easily with other minerals like calcium, magnesium, iron and zinc, making them also no longer available.

Phytic acid attaches itself not only to important minerals or removes them, but inhibits enzymes which we need to digest our food, such as pepsin that is required for the distribution of proteins in the stomach, and amylase that is required for the distribution of starch in sugar. Trypsin, required for the digestion of proteins in the small intestine, is also inhibited by phytates (Source: http://www.leefbewust.com/themas/fytinezuur_granen.html)

In Baru almond for phytate a level of 313 mg/100 g was observed (Siquiera et al, 2015). In Table 7 differences of Phytic acid between raw and roasted almonds are displayed.

Tabele 7 Anti-nutritional factors Baru nut (Carrazza et al, 2010)

	Raw	roasted
Phytic acid (%)	0,16	0,06
Trypsin inhibitor (UTI/mg)	38,60	0,63

7.2 Bark

Terpenes

Out of the bark of the Baru tree various active terpenes, flavonoids and polyphenols were extracted, which are responsible for the positive effects against snakebites (see also paragraph 8.1).

8. Properties and applications

In this chapter the scientifically based properties of Baru's bark and fruits are described. A subdivision has been made between pulp and seed.

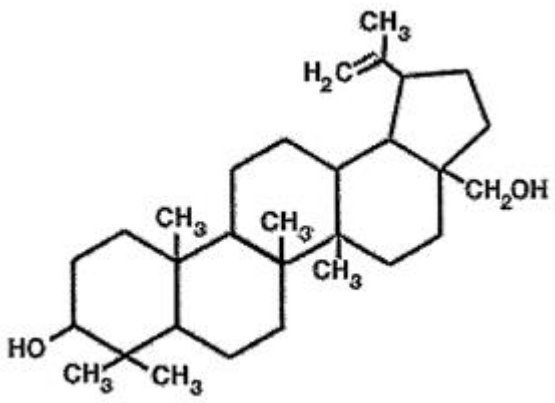
8.1 Application of bark

Experiments have shown that the bark can be used against poisonous bites (neurotoxins) of the snake species Bothrops jararacussu with the local name "Bjssu" (Puebla et al, 2010).

During scientific research, three pentacyclic tri-terpens were extracted out of the bark: Lupeol, Lupen-3-on and Betulin (Sano et al, 2004).

Plants use Betulin to defend themselves against being eaten by insects or animals and also appears for instance in birch juice. Investigation has shown that Betulin has an inhibitory effect on different types of tumors. Betulin contributes to processes whereby some tumors will destroy themselves ("apoptosis") and can inhibit certain tumor growths (Alakurtti et al, 2016). Betulin has further many positive aspects that are often applied in dermatology. Betulin is an anti-inflammatory, supports the differentiation of skin cells (keratinocytes) and it supports the healing of wounds (www.chagapower.nl/chaga-informatie/betuline-berkenblast-extract). The structural formula of Betulin is displayed in Figure 16.

Figure 16 structural formula triterpenoid Betulin



There is evidence that Betuline that is injected can reduce neuromuscular effects of Bothrops jararacussu poison by mechanisms that need further investigation. This neutralising capacity has the potential to be useful for the treatment of Bothrops-bites in veterinary medicine and possibly also for humans, as an additional measure on the use of antitoxin (Ferraz et al, 2015).

In another study by Puebla four triterpenoids, nine isoflavonoids, a chalcone, an aurone and three fenolic compounds were isolated. As a result was found that probably the fenolic compound vanillin acid, the isoflavone (3',7,8-trihydroxy-4'-methoxyisoflavon) and the aurone (3', 4', 6-trihydroxyauron) would be the most important substances responsible for the observed protection against the neurotoxical effects of this same type of snake venom (Puebla et al, 2010).

8.2 Application of fruit

The pulp and the seed of Baru are used as ingredient in pastry and cookies, but is also more often processed in energy-food ("energy bars"). The oil of the seed is so far mainly used in food supplements for the prevention of cardiovascular disease, as massage oil and in cosmetics. Also other therapeutic applications are known, which are scientifically tested on a limited scale or on which no public information is available (for instance because of ongoing patents of Baru applications).

8.2.1 Pulp

The pulp gets after ripening a sweet taste and is therefore traditionally used in jams, pastry, cookies and liqueur. In the Cerrado region there are various organizations which plan to commercialize these products on a larger scale outside the region as a gourmet article.

The Baru fruit contains besides the sugars also calcium, iron, zins, phytic acid and tannin. The tannins are important because of their properties as antioxidants (Cardoso Bailao et al, 2015).

8.2.2 Seed

<u>Food supplement: healthy diet against cardiovascular diseases</u>

The Baru almonds are tasteful and are before consumption mostly roasted to deactivate the phytic acid, which inhibits the functioning of the enzyme trypsin.

The almonds are used as an ingredient of cookies (see Figure 17), butter, bread, cakes, candies, cereal bars, pesto and ice cream. The oil is used as culinary oil, comparable with olive oil.

Figure 17 Organic cookies in which among other Baru nut is processed

The Baru almond has a high nutritional value and a high content of proteins. The fat contents and protein contents and the amino acid profile is representative for edible seeds and comparable to other nuts. Baru can be used as an additional source of proteins and fits in a healthy diet (Fernandes et al, 2015).

The association of the present phytosterols β-Sitosterol, Stigmasterol, Cycloartenol and Campesterol with the high unsaturated content of fatty acid is an indicator that the Baru oil could have a hypocholesterolemic effect (reducing cholesterol).

This theory is supported by the fact that the consumption of Baru nuts lead to a decrease of cholesterol peroxidation, triacylglyceride peroxidation and lipid peroxidation in rats (Fernandes et al., 2012). This suggests that Baru oil can be both used as functional food as for medical purposes (Marques et al, 2015).

Intake of Baru almonds by persons decreased the total cholesterol, low-density lipoprotein cholesterol, and non–high-density lipoprotein cholesterol with persons which took 20 g / day over a period of 12 weeks (Cardoso et al, 2015).

Intake of Baru almond improves the lipid profile and protects against oxidative stress by dyslipidemia in animals. The high content of mono-unsaturated fatty acids in the Baru almond could be related to the anti dyslipidemic effect (Dyslipidemia is a collective term for different disturbances in the lipid metabolism) that was observed in a study of Fernandes et al, 2015. The Baru almond is therefore potentially suitable for diet use for prevention and control of dyslipidemia (Fernandes et al, 2015). Dyslipidemia is characterized by increased levels in the blood of total-cholesterol, LDL-cholesterol, triglycerids and a reduced HDL-cholesterol. As a result artificial calcification increases (atherosclerosis). Also by Gromadzka et al, 2011 Baru is mentioned as suitable food supplement for prevention against atherosclerosis or artificial calcification, a special form of atherosclerosis (Marques et al, 2015).

Investigation showed that the consumption of aqueous extracts and ethyl acetate extracts of the Baru nut by rats, which were supplemented orally with iron, caused tissue protection against oxidative stress. This effect was attributed to the phytic acid, but it is also possible that phenolic connections may be involved in this effect (Siqueira et al, 2011).

The current use of the almond as food supplement focuses by these properties mainly on the internal application for the benefit of lowering cholesterol, prevention of cardiovascular diseases and weight reduction.

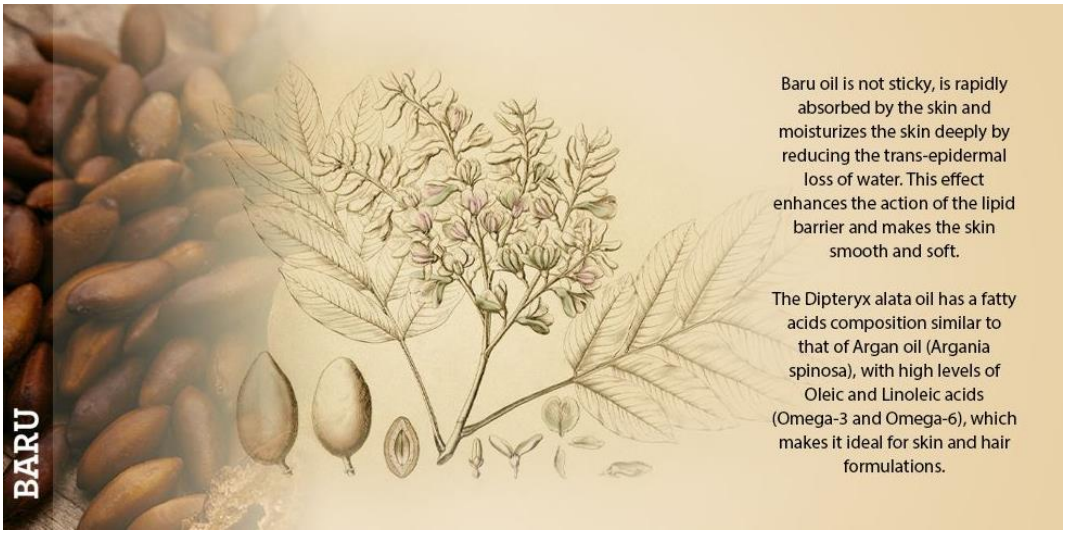
Skin, hair, nails

Vitamin E, minerals and proteins from Baru nuts or oil have, when taken as food supplement, a positive effect on the ageing process of the skin. Hair and nails become thereby also stronger.

Baru oil is not only used as food but is also applied externally on the skin because of the moisturizing capacity. Because of its anti-oxidative ingredients Baru can contribute to protect the skin against free radicals and against premature ageing. The oil improves the elasticity of the skin and is applied to reduce the effects of wrinkles or elongated skin (after pregnancy or weight reduction). It is an excellent massage oil, because it is thin and is easily absorbed through the skin. The oil protects the skin against sunlight and regenerates skin burns by the presence of vitamin E and fatty acids (http://ybanatural.com.br/).

An example of a producer of Baru oil through cold pressing as a resource for pharmaceuticals is the Brazilian company Atina, see Figure 18. According to the website of Atina the composition of Baru oil is comparable to Argan oil.

Figure 18 Product description Brazilian producer of cosmetic resources Atina



Baru oil is besides used as resource in shampoo, see Figure 19.

Figure 19 Shampoo Baru oil with D-Pantenol addition (www.metamorfosecosmeticos.com.br)

Energy (high-calorie energy source)

The Baru endocarp (woody shell) can be converted into coal for industrial use (Sawyer et al, 2015). The residues of the fruit and the seed can be used for the extraction of volatile (tar)acids and as firewood (Carvalhaes, 2015).

Baru oil has been studied as an alternative source for the production of biofuels because of its physical and chemical properties. After an analysis of the peroxide value, iodine number, kinematic viscosity, water content, relative density, saponification and refractive index the high quality of the Baru oil was confirmed to be usable as resource for biodiesel production (Silva et al, 2015).

For the production of biodiesel big efficient (monoculture) plantations are needed. It is currently under investigation which plant varieties are best suited. Of course, as a footnote,

we can say that the sustainability of biodiesel production should be revisedcritically. Plantations with monocultures of Baru trees (comparable to intensive palm oil plantations) are by definition not sustainable.

Restoration of the natural environment

Traditionally the Baru tree is used for revegetation on degraded soils and as ornamental street tree. The plantation of the native tree can be used for protection against erosion and can capture secondary CO2. The Baru tree can thrive in difficult climate conditions. Research is currently carried out by Brazilian universities to select those species with the right genetic characteristics, which will quickly bear fruits and with the greatest resistance to diseases. The pharmaceutical industry is of course following this research with interest. With large-scale planting so-called carbon credits can be obtained, an example is the Oreades project (Oreades, 2016). For large-scale planting the similar remark on sustainability should be made as above.

Other applications: anti-rheumatism, menstrual cycle, aphrodisiac, gastrointestinal disorder, melanin-inhibitor

Anti-rheumatism and regulation of menstruation

The phytosterols β-Sitosterol, Stigmasterol, Cycloartenol and Campesterol which are found in Baru oil have anti-oxidative, hypocholesterolemic, anti-carcinogenic, anti-inflammatory and oestrogenic workings (Marques et al, 2015).

The traditional use of Baru oil as a menstruation regulator and an anti-rheumatism drug (Sano et al., 2004) can be associated with the estrogenic effect of these phytosterols and the anti-inflammatory effects of caryophyllene and phytosterols (Marques et al, 2015).

Gastrointestinal disorders

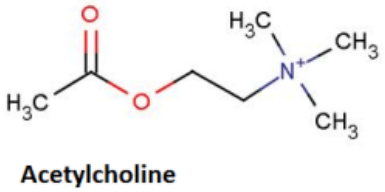
Baru is also considered as a tonic (analeptica), it regulates sweating physiology and is effective for the treatment of gastrointestinal disorders (Correa et al., 2000). In pharmaceutical testing on animals by Fonteles et al, 1988, delaying effects on muscles were demonstrated after the provision of an extract of the Baru almond: the heart of a frog went slower, the duodenum of a rabbit slowed down, and the activity of the rectus muscle of a frog and contractions of the uterus of a rat were slowed down.

Matos et al, 1988 isolated out of the Baru almond betafarneseno with an inhibitory effect (antagonist) on the functioning of acetylcholine in animals (Sano et al, 2004). Antagonists are substances who inhibit or prevent the functioning of acetylcholine. Examples of this are atropine and muscle relaxants such as curare. Acetylcholine (see structural formula in FigureFigure20) is a neurotransmitter, effective in momentum transfer between nerve cells and other cells, like with the contraction of stomach and intestines. In many parts of the body acetylcholine transfers incentives, whereby for example stomach and intestines contract (regulation of the peristalsis) fluids are excreted by the digestive glands, mucus in the bronchi

is produced, the pupil narrows or certain blood vessels get wider (causing blood pressure's dropping) (Wikipedia).

This could explain why the seed is traditionally used as anticonvulsant.

Figure 20 structural formula Acetylcholine (https://www.smartdrugsforthought.com)



Acetylcholine

Aphrodisiac

Baru is also considered as a tonic (analéptica), (Correa et al., 2000).

Because of the richness of high calorie nutrients (vitamins, minerals and fats) the Baru nuts are associated (as tonic) with sexuality as a natural aphrodisiacs food (http://www.projetobaru.com.br/en/about.html). Although no scientific sources on the Baru as aphrodisiac are found the Baru nut has probably an effect as adaptogen.

Melanin inhibitor (aimed at a whiter skin)

Another isolated substance out of Baru is a substance that inhibits the forming of melanin pigments in the skin (Fraguas et al, 2014). Baru possesses specific phenols that can inhibit the melanogenic activity of the enzyme tyrosine (Silverio et al, 2013). The Japanese pharmaceutical company Ichimaru Pharcos Inc. has applied for a patent in 2002 for a substance (no public information available about the name or properties of this substance), which inhibits the forming of melanin and was obtained by an ethanolic extract (Sano et al, 2004).

Phytic acid is also used as "whitener" in the skin care industry, because of the inhibition of the forming of melanin. Phytic acid has also proven to be very effective in the treatment of epidermal melasma's (skin patches) when it is associated with glycolic acid or retinoic acid. (https://www.rhondaallison.com/Phytic_Acid.html).

Phytic acid is further used as antioxidant in the food industry and is applied in odontology to increase the resistance of odonatological fillings and to strengthen teeth.

9. Indications and recommended doses

Extracts of Baru bark can be used at snake bites of Bothrops jararacussu. There has no further information been found in literature on the appropriate preparation, administration and dosing.

Daily oral intake of the oil of the Baru-almond fits in a diet for the prevention of cardiovascular disease and arteriosclerosis.

Daily intake of Baru oil contributes to balance an irregular menstrual cycle.

Stomach and intestinal disorders (cramps) can be relieved by intake of oil (optionally with a bit of honey) .

External administration on the skin by massage of the oil might lighten the effects of rheumatism, and is effective against premature ageing skin and against sunburn.

External administration at melanin spots. The dose is not knows. Probably the most effective form of administration is in the form of an unguent.

There is no information available on doses. It would be useful to know the traditional method of production and its doses that is/were used by the local population.

10. Warnings, side effects, contra-indications, interaction with other substances

When cattle eats the whole Baru fruit the wall of the rumen can be damaged (De Oliveira, 2015). This probably is causedby the hard shell of the almond (endocarp) that scrapes against the wall of the rumen, after the pulp has been aborted.

The almond of raw Baru has a high level of the “inhibitor” of the trypsin phytic acid, which can hinder the breakdown of proteins in the small intestine and therefore it would not be suitable for consumption. Phytic acid also reduces the intake of minerals. An excess of phytic acid can cause osteoporosis because the vitamin acid absorbs vitamin D. Roasting inactivates the phytic acid. Therefore Baru almonds are sold roasted. However, with a healthy and varied diet (with enough intake of fruit and vegetables) phytic acid is not harmful.

The roasting increases the levels of fats, P, Ca, Mg, Cu, Zn, Fe, but lowers inter alia the levels of phenols and flavonoids. Phenols are linked to properties as: natural anti-oxidant, anti-allergy, anti-inflammation, antibacterial, antithrombosis and protection of heart and blood vessels (Fraguas et al, 2014).

In general saturated fats can be heated well without changing the structure. Monounsaturated fatty acids can be heated quiet well without changing the structure too much. Polyunsaturated fatty acid cannot be heated well. The structure changes quickly, the taste and quality is deteriorating. Baru oil contains a large part of unsaturated fatty acids. When using Baru oil in food it is recommended not to use Baru oil to fry or bake (180 °C), but to only use it for cold applications.

Persons who suffer from the Herpes simplex virus (cold sores) should best avoid products rich on arginine during an upsurge of herpes (Source: course nutrition herbalist training, page 26). Arginine is also found in Baru.

When in doubt before using a product on the skin it is better to test first on a little surface of the skin to see of any allergic reactions occur.

Because of the phytosterols it is probably better not to use Baru oil during pregnancy.

11 Economic value

Many local communities in the Cerrado have ancestral knowledge about the use and management of native species. However only recently some of these groups have started harvesting and managing of these species on a larger scale, especially Pequi (Caryocar Brasiliense), Babaçu (Orbignia phalerata), Buriti (Mauritius palm) and also Baru (Dipteryx alata).

Baru products were until recently only regionally brought on the market, but via Brazilian governmental organizations and international NGO's local farmers are stimulated to harvest products like Baru and to process it into full products. Because of this sustainable strategies are being developed to improve the livesof the local inhabitants of the Cerrado and to preserve its ecosystems. Small farmers, also in the Cerrado, face enormous challenges to gain access to markets for their natural products, as a result of logistical constraints, legal barriers and a lack of marketing capacity.

Baru is today also sold outside of the Cerrado region as roasted almond, as oil, and processed in products like pesto, energy bars, ice cream, bonbons and liqueur, see Figure 21.

Figure 21 Some Baru products which are marketed internationally

The pharmaceutical industry is interested in the medicinal properties of Baru. Investigation take place to isolate its active compounds and also agronomic research is done to find the most suitable varieties of the Baru tree for production on a larger scale. Examples with an economical potential are medical applications of Baru against rheumatism, snake bites and as a regulator of menstruation.

There needs to be more research on Baru's functioning, dose and effects. Also the existing knowledge about traditional methods of production and administrations has to be well

cataloged. The challenge is to involve the local population in research and in sustainable products of extraction and production.

Some examples of commercial websites that sell Baru products:

1. http://www.mundodosoleos.com/ sell Baru nut oil
2. https://www.baru nuts.com/faq sell Baru nuts
3. http://ybanatural.com.br/ sell Baru nut oil
4. http://www.atina.com.br sell oil as a resource for the cosmetical industry

12 Conclusion

The research into traditional and medical applications of Bare are still rather unexplored. Especially in Europe the Baru nut is practically unknown.

There is market potential and there is interest for the development of Baru-applications from the food and the pharmaceutical industry and from organizations which want to promote sustainable alternatives for the intensive cultivation of soya that takes place in the Cerrado region.

The only right way toward such a development is trough sustainable harvest and production methods without damaging the Baru population. The goal should on the contrary be to expand the Baru population in the natural ecology of the Cerrado.

For me the elaboration of this thesis was an interesting path of learning. The story around Baru is certainly not written completely and therefore I will maintain connected to know the new developments and applications.

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Annexes

Annex 1: C trial

For some practical herbalist applications of Baru oil I have been focusing on its use in cosmetics and therefore I prepared a skin cream. Besides the cream, I have tested the oil as tastemaker in salads and its direct application on the skin as massage oil.

Salad

Baru oil as part of a dressing on a salad of cucumber, olive, tomato with lemon juice (tablespoon), salt, pepper and Baru oil (tablespoon). The salad gets a tasteful light nutty flavor.

The oil itself is odorless, pale yellow in color, easily liquid with a nice subtle nutty flavor.

Direct dosing on the skin as after sun lotion

When directly dosed on the skin as an after sun lotion the oil seems to be well absorbed by all skin types.

Production of moisturizer of Baru oil and hydrolate of roses for dry/normal skin

My plan for the preparation of the daily skin moisturizer was to use the hydrolate of Muscat Rose (rosa mosqueta), but this was unfortunately only available as oil. I have therefore in the end used a hydrolate of roses of the Rosa *Damascena* blossom.

Baru serves as base oil because of its cold pressing. A base oil may not adversely affect the application of essential oil that is added if appropriate and has to have a mitigating effect of itself and stimulate the natural skin functions.

Ingredients Fat component (base) :

25 gram emulsifier Tegomuls (provider Herbacos - Gent Belgium)

60 gram cold pressed Baru oil (provider Absoluto Oleos - Brasil)

20 gram Sheabutter (Herbacos)

In a measuring cup I let these ingredients slowly melt au bain-marie on a low flame (to about 35 °C) constantly stirring. Then I tooak it away from the fire, it was one more time well stirred and poured into a sterile jar. This base fat component is kept in the fridge with a label.

Ingredients Moisturizer:

10 gram base fat component

30 gram Hydrolate of roses (provider Sjankara)

20 drops of Vitamin E-acetate (provider Herbacos)

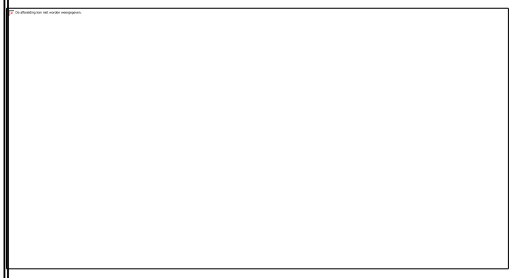
Simultaneously the fat component and the hydrolate are heated au bain-marie in separate measuring cups. This happens again slowly on a low flame until 50 °C has been reached. After that the heating source is turned off the hydrolate is slowly dripped into the fat component stirring continuously. Finally vitamin E is added (stirring). The moisturizer is also kept in the fridge with a label.

Observation: The cream has a bright white color, a good consistency and is well and quickly absorbed by the skin by test subjects with a dry and normal skin type.

Label Baru nut-Rosecream:

Functioning: cream has a soothing factor and moisturizing effect, generates an anti-inflammatory action and has a fresh rosy smell.

Composition: Tegomuls emulgator (hydrogenated Palm glyceride), Sheabutter (Bortyrosmermn Parkil), Baru nutoil of cold pressing (Dipteryx alata Vogel), Vitamin E (Tocopheryl acetate), Rosehydrolate (Rosa Damascena).



Storage: cool, in a dry place , not in the sun (in fridge).

Administration: take out of the jar with a spatula and administor daily on skin, rubbing in lightly.

*Best before:*12 months after opening.

Not yet analysed

1. I still want to test the preparation of a macerate of Baru oil by drying in the sun a couple of weeks leaves of marigold, chamomile or violets.
2. I also still want to examine the possibility to apply oil of Rosa Mosqueta in a Baru cream
3. And I will also use Baru nut as ingredient in Shampoo, for example:

   60 ml coconut milk, 80 ml neutral liquid soap, 1 teaspoon Baru oil, 20 drops of essential oils at the choice, 5 drops of vitamin E.

Annex 2: Most important terpenes in Baru seed

Baru contains according to Marques et al, 2015 the mono- and sesqui-terpenes β-Sitosterol, Stigmasterol, α and ϒ-Tocopherol, Campesterol, Cycloartenol (phytosterols), and

β and α-Caryophyllene, ϒ- and β-Elemeen and Limonene (components of essential oil). Of which the terpenes β-Sitosterol has the highest levels. The latter are further described below.

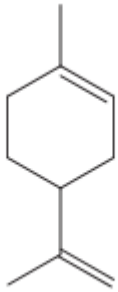
Limonene

Limonene: C10 H16, Boiling point 176 °C. Melting point –95 °C. Flashpoint 50 °C. Varieties consist of A-limonene, D-limonene, L-limonene and R-(+)-limonene. Synonym: Dipentene. Limonene is a hydrocarbon classified as terpene, insoluble in water and miscible with alcohol. It is a colorless liquid with a very strong orange odor. The name comes from the lemon peel. The peel of other citrus fruit also contains a lot of limonene and a lot of monoterpenes in general.

The citrus oils are therefore very valuable oils: sedative (calming), antispasmodic, weak hypnotic (sedative), anti-inflammaticum (anti-inflammatory), bactericidal, digestive (stimulates digestion), vermifugum hypotensor (blood pressure lowering), lowering the heartbeat, antidepressant, tonic, general, fungicide (antifungal), regenerating effect, inhibiting wrinkles, generally reinforcing the immune system, anticancer, antiseptic, viricide, expectorant. Possible applications: nervousness, hart conditions/palpitations, bronchitis, respiratory infections, cold, flew, sinusitis, all kinds of cough, constipation, spasm.

Limonene is sensitive to light, air, heat, alkali, acids and is auto-oxidized to carvone and carveol. Oxidation with sulphur gives p-cymeen.
Limonene with oxidants are skin irritating by prolonged industrial exposure to the pure product. There is no evidence for carcinogenicity or genotoxicity in humans, but the pure substance is classified as irritating and dangerous for the environment. The R-(+)-limonene inhibits by induction of phase I enzymes and stimulation of phase II enzymes not only the initiation but also the promotion and progression of the development of cancer. In animal studies: by cancer in rats and mice (stomach and lungs) limonene inhibits the tumor growth (Gielen aroma and Marques et al, 2015)

Structural picture Limonene (Zuzarte et al, 2015):



Alfa-Caryophyllene

The terpene Alfa-Caryophyllene is soothing - relaxing. It can irritate the skin (Gielen aroma).

Beta-Caryophyllene

Beta-Caryophylleen is anti-inflammatory, solving cramps, can irritate the skin, insecticide, spasmolytic.

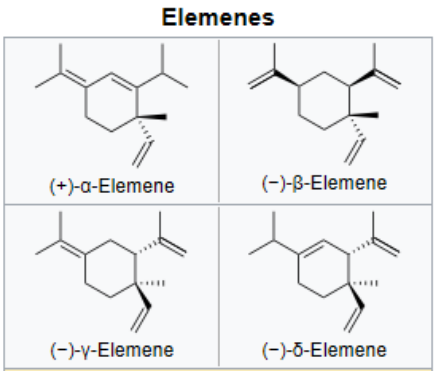
B-Caryophyllene (sesqui-terpene) might further inhibit the functioning of cancer cells (Gielen Aroma en Marques et al, 2015).

Structural pictures of Alfa- and Beta-Caryophyllene (www.cibiday.nl):

Elemene

Elemene is a Sesqui-terpene. Characteristic for this group is that they are calming, blood pressure lowering, stomachic, antispasmodic and disinfecting. They harmonize and stabilize the psyche, by a direct functioning on the limbic system of our brains. They are skin regenerating and anti-inflammatory, antiseptic, antibacterial, anti-tumor (Marques et al, 2015), analgesic and antispasmodic (Gielen aroma).

Structural formulas of Elemene varieties (Wikipedia):



Annex 3: Fatty acids according to Mundo dos Oleos en Franco et al

MUNDO DOS ÓLEOS

Óleo de BARU
(Baru Seed Oil)

CARACTERÍSTICAS FÍSICO-QUÍMICAS

CAS:	8046-22-8	
INCI:	Dipterix Alata (Baru) Seed Oil	
Outros óleos:	Ausentes	
Procedência:	Nacional	
	Especificação	**Resultado**
Aparência	Líquido Transparente	De acordo
Cor	Amarelado	De acordo
Odor	Característico	De acordo
Densidade (25°C)	0,910 - 0,915	0,915
Índice Refração	1,4620 – 1,4680	***
Índice de Iodo (mgI/lOOg)	90 - 113	91
Índice de Saponificação	178 - 192	190,13 (mgKOH/g)
Índice de Peróxido (mEq/kg)	Max. 4	0,9
Índice de Acidez	Max. 4,0	0,09 (g/100g)

(C16:0) Palmítico	7,4 - 7,9
(C18:0) Esteárico	3,1 - 5,7
(C18:1) Oleico (ômega 9	50,2 - 51
(C18:2) Linoleico (ômega 6)	28,9 - 30,7
(C20:0) Araquídico	0,8 - 1,1
(C22:0) Behênico	2,1 - 2,7

Fabricação:	10/01/2015
Validade:	24 meses (embalagem lacrada)
Lote:	BA005/15
Quantidade:	5,000 L
Invoice:	000
Armazenagem:	Recipientes cheios e bem vedados

OBS: O produto acima especificado apresenta suas características e propriedades conforme especificações técnicas e padrão de qualidade previamente estipulado. Certificado relativo ao produto após sua fabricação, devidamente identificado e lacrado, e não exime de responsabilidade do usuário em realizar sua própria análise a fim de verificar se as características do produto atendem a aplicação pretendida. Os dados contidos nesta especificação são provenientes do fabricante, não nos responsabilizamos por perdas e danos decorrentes destes.
Produto para uso exclusivamente industrial e cosmético. Proibido o manuseio por pessoas não habilitadas. Armazenar em local seco e fresco. Manter embalagem fechada.

(*) Nunca consuma insumos vegetais sem orientação e acompanhamento de profissional qualificado. (**) Produto para uso exclusivamente industrial e cosmético.

(cópia do original - dispensa assinatura)

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TABELA 2. Valor nutricional do baru e do coco da Bahia.

Baru (amêndoas) (g/100 g)		Baru (amêndoas) (%)							
Proteína	Ext. etéreo	I*	II*	III*	IV*	V*	VI*	VII*	VIII*
26,29	45,24	5,70	5,45	44,9	32,39	2,16	2,02	3,32	4,84

Coco da Bahia ralado seco (100g)						
Calorias	Proteína (g)	Lipídios (g)	Glicídios (g)	Cálcio (mg)	Ferro (mg)	Fósforo (mg)
619,2	9,70	57,20	16,42	108,0	4,80	209,0

Fonte: Franco (1982).

*Ácidos graxos
I - palmítico
II - esteárico
III - oléico
IV - linoléico
V - linolênico
VI - araquídico
VII - behênico
VIII - não identificado