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Saba senegalensis: Key Features and Uses

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Abstract

Native of West Africa, *Saba senegalensis* belongs to the family of Apocynaceae, and is a wild plant that is mainly exploited in the diet. It grows mainly along riverbanks, in wooded savannah areas in humid areas, in gallery forests and in rocky ravines and hills. *Saba senegalensis* is a large woody liana with white latex, dark gray bark, can reach more than 40 m high and a trunk that can measure up to 47 cm in diameter. The fruit is a globose shell, 7 to 10 cm long, 6 to 8 cm wide. The leaves are opposite, elliptical, dark green in color, about 8 to 15 cm long and 4 to 6 cm wide. This fruit is characterized by its richness in antioxidant molecules especially vitamin C (480 mg/100 g) and total polyphenols (945.83 mg/100 g). The fruit contents 41.43 until 80% water with a low pH (2.24). In Senegal, the fruit is eaten as it or transformed into puree, nectar, syrup, canned etc. It is a plant that has enormous therapeutic virtues, from the fruit to the roots through the leaves, bark, and latex. Despite its high nutritional potential, its many therapeutic virtues and its economic potential, *Saba senegalensis* remains under-exploited. Further researches on the nutritional and therapeutic properties deserve to be conducted.

Keywords

Senegal, *Saba senegalensis,* Fruit, Uses, Composition

1. Introduction

Saba senegalensis (A. DC.) Pichon is a large, woody, latex vine that can grow to more than 40 m in height and has tendrils in the Apocynaceae family [1]. The dark gray bark can reach more than 40 m and a trunk up to 47 cm in diameter [2] [3] [4]. Found mainly in South Sudan and West Africa, particularly in Côte

d'Ivoire, Burkina Faso, Ghana, The Gambia, the 2 Guineas, Mali, Niger [4], *Saba senegalensis* (A. DC.) Pichon was already described and the name available on behalf of Alphonse Louis Pierre Pyramus of Candolle. It was Marcel Pichon, however, who reclassified it into to valid classification in 1953, and today he drives primarily to the edge of the river, in areas with wooded savannahs, wet areas in gallery forests [4] [5]. In Senegal, it comes largely from Casamance (Southern Senegal) and Kedougou (eastern Senegal). The interest of Saba senegalensis in feeding and treating hundreds of diseases in rural populations is widely recognized [6]. It is a fruit that is very popular with the population and can be consumed as such or can be processed into puree, nectar, jams and preserves [1] [7]. Our bibliographic study proposes a selection and a compilation of information available in the literature and research results on the botany, composition and uses of maad to better understand the nutritional and economic potential of the fruit.

2. Botanical Aspects

In Senegal, there is only one variety of *Saba Senegalensis* belonging to the Spermaphyte branch, the Magnoliophyta sub-branch, the Magnoliopsida class, the Asteridae subclass to the order of the Gentianales and the family of Apocynaceae [8]. The generic name is adapted from the name of the plant Maninka, the specific epithet senegalensis refers to Senegal in West Africa where it was collected for identification [4] [9] and (**Table 1**). In the literature it is identified by other names such as: *Vubea* or *Vabea senegalensis* A. DC.; S.

Saba senegalensis is a large woody liana with white latex [1], it has a dark gray bark, can reach more than 40 m high and a 20 cm turn [3] [4] [9]. Clinging to branches of trees with its tendrils [8], it is often anelian with a trunk that can

Table 1. Taxonomy of *Saba senegalensis* [8].

Rang	Nom scientifique
Rule	*Plantae*
Under rule	*Tracheobionta*
Super division	*Spermaphyta*
sub-branch	*Magnoliophyta*
Class	*Magnoliopsoda*
Sub-Class	*Asteridae*
Order	*Gentianales*
Family	*Apocynaceae*
Sub-Family	*Rauvolfioideae*
Tribe	*Willughbeeae*
kind	*Saba*
Specie	*Saba senegalensis*

measure up to 47 cm in diameter [3] [4] [5]. It is a climbing plant that usually seeks support from other plant species to cling and grow (**Figure 1**). But it happens that its seeds germinate in places where there is no support and therefore the plant manages to the place where it sprouted. Generally we distinguish in its range of distribution according to the nature of the support, climbing species, and the lack of support of the bush species.

The fruit is a large ovoid, bumpy, globose berry, 7 to 10 cm long, 6 to 8 cm wide that contains seeds coated with slightly translucent yellow and fibrous pulps [10] [11]. The interior of the berry contains a fine fibrous superficial skin that includes fruit [12]. Very soft and juicy, the pulp is sweet and tart and the skin of the fruit has a green color before maturity [13], but at its physiological maturity, its color becomes orange (**Figure 2**). Leaves are opposite, dark green, elliptical, lanceolate and petiolate with entire margins. Brilliant on upper surface, an elliptical or oval limber glabrous barely acuminate and shiny above, about 8 to 15 cm long and 4 to 6 cm wide [14] with a rounded or rounded base and apex short obtuse tip, 8 to 14 pairs of lateral veins, translucent fresh, and a network of fine nerves (**Figure 2**). The plant has a rough or scaly bark of dark gray color with a pale red slice [1]. The flowers are white, greenish or yellowish very fragrant, in terminal corymbs, they have a corolla wide of 3 to 4 cm with a yellowish tube, 10 to 15 mm long, 5 - 9 times longer than the calyx [1] [4] [10], with 5 white, oblong lobes, 3 to 6 mm wide, thickened towards the base, 1.5 mm wide at the apex, finely pubescent. The sepals are 1 - 1.5 times longer than broad, the stamens are inserted 3.5 - 6 mm above the base of the corolla. Petals 1 - 1.5 cm long, more or less translucent fresh, with prominent midrib on top, 8 - 14 pairs of lateral veins. Branchlets glabrous, lenticel, purple brown with the presence of a small bead on the branch between the base of each pair of leaves. Flowering is spread over the whole year and the peak of flowering is between April and May, some plans may be in flower and fruit [1] [15] (**Figure 2**).

3. Distribution Area and Vernacular Names

Saba senegalensis is mainly found in South Sudan and West Africa, particularly in Côte d'Ivoire, Burkina Faso, Nigeria, Ghana, Gambia, Guineas, Mali, Niger, Senegal and Tanzania [4] [5] (**Figure 3**). It grows mainly along riverbanks [4]

Figure 1. *Saba senegalensis* [10].

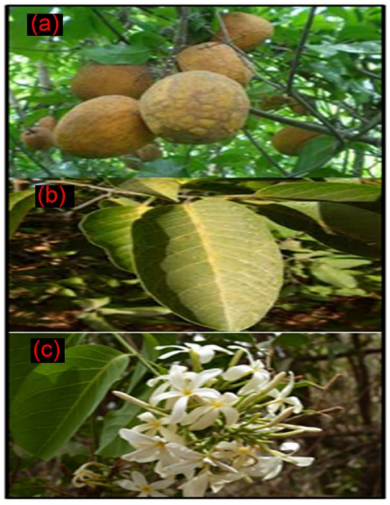


Figure 2. (a) Fruit, (b) Leaf and (c) Flower of *Saba senegalensis* [10].

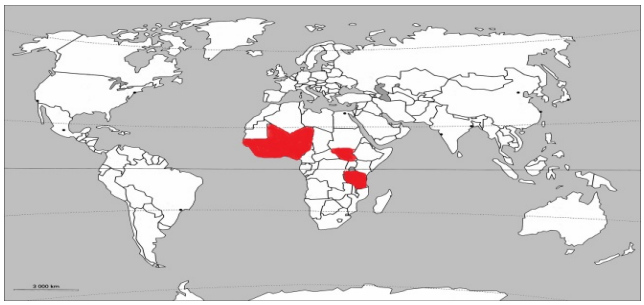


Figure 3. Approximate Range of *Saba senegalensis* [4].

[16], in wooded savanna areas in humid areas, in gallery forests and in ravines and rocky hills [1] [9]. In Senegal, it comes largely from Casamance (southern Senegal) and Kedougou (eastern Senegal) (**Figure 4**) and is also present in widely dispersed individuals Niayes [10] [11]. These areas are characterized by maritime trade winds with an average annual temperature of 26˚C - 31˚C, a dry climate with considerable variations in humidity. The rainy season lasts from 2 to 4 months with a maximum of precipitation during the month of August for an annual average of 400 to 1200 mm [17]. The species can live in various ecological conditions with an average annual rainfall ranging from 100 mm to 1300 mm and in altitudes of 0 - 800 m [4] [18], it is resistant to bush fire. The Saba fruit of Senegal has different vernacular names which vary according to the dialect spoken by the local populations. In Senegal, the Wolof call it *maad* while Manding say *Saba*.

4. The Fruit

4.1. Presentation

The fruit of Saba is a large ovoid berry, of yellow-orange color at maturity [4] containing seven to twenty nuclei depending on the size covered, of a juicy acidulous pulp. The section of the fruit shows a hard, thick and bumpy skin, which

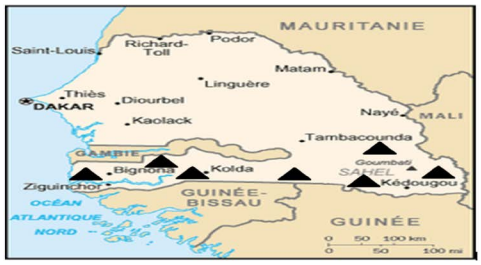
covers a fibrous membrane adhered to the skin surrounding all the nuclei (**Figure 5**) [12].

4.2. Harvest Stage and Conservation

Generally, Saba creeper returns to fruiting in less than two years [19]. *S. senegalensis* fruits begin to ripen as early as the beginning of the rainy season, starting in June and the harvest can be until September. As it matures, it goes from green, its initial color, to light orange [13]. It's the best time to taste it, but it will not wait, because this moment is also expected by other animals, particularly the monkey that feeds heavily on this fruit. Many losses are recorded in fruit production and conservation poses serious problems for loggers [7]. To avoid these losses, it is good to respect the collect procedures, pick unhooked fruits without injury on the envelope that can serve as entry doors to contamination, put in an appropriate packaging, respect the principles of hygiene. It should also avoid a maad harvested in the rainy season during this period; the fruit becomes a flower [20]. There are even some forest harvesters who harvest only green fruits in order to lengthen the conservation and reduce losses, but the disadvantage of this method is that the quality of the fruit is mainly due to the early harvest, that is to say the fruit has not yet reached maturity.

4.3. Nutritional Composition

The nutritional composition of the pulp (**Table 2**) is subject to very large



The main areas in Senegal

Figure 4. Main production areas of Maad in the south and the eastern part of Senegal.

Figure 5. Cross section of the fruit of *S. senegalensis*.

Table 2. Nutritional composition of *Saba senegalensis* pulp [8] [20]-[27].

Components	Fresh Pulp	Components	Fresh Pulp
Energy (kJ)	296 - 379.32	Riboflavin mg/100 g	0.03
Water g/100 g	41.43 - 80	Niacin mg/100 g	0.5
Proteins g/100 g	0.53 - 0.8	Vitamin B6 mg/100 g	0.02
Lipids g/100 g	0.2	Vitamin K mg/100 g	0.889
Carbohydrates g/100 g	11 - 17.2 - 18.5 - 26.71 - 31.87 - 50 - 74.23	Total Polyphenols mg/100 g	945.83
Fibers g/100 g	1.3 - 12 - 13.52	Flavonoïds mg/100 g	5.30
pH	2.24	Ash g/100 g	2.8
Brix (Soluble Dry Extract) (g/100 g)	14.1	Iron	0.26 - 1.0
Titratable acidity meq/100 g	30.30 - 30.44 - 56 - 78.5	Phosphorus mg/kg	28 - 97.75 - 215.9 - 357.5
Malic acid mg/100 g	47.2	Calcium mg/kg	30.2 - 51
Vitamine C mg/100 g	16.41 - 18 - 48 - 34.8 - 67.8 - 167 - 187 - 317 - 480	Potassium mg/kg	152
β-caroténe mg/100 g	1.55	Magnesium mg/kg	32.6 - 47.5
Thiamin mg/100 g	0.2	Sodium mg/kg	<5

variations which are obviously related to the variability of climatic conditions, to the nature of the soil, but also to the various methods of analysis used. The Saba's fruit is very rich in vitamin C. Nafan *et al.* (2013) indicate rates ranging from 34.8 to 67.5 mg/100 g [27]; this value can even go up to 480 mg/100 g [20]. The fruit is also characterized by water content which is most often closed to 80% [23]. The titratable acidity is from 30 up to 78.5 meq/100 ml; this high content explains the acid taste of the fruit with a malic acid concentration of 47.2 mg/100 g [24]. One of the characteristics of *Saba senegalensis* is the level of β-carotene (vitamin A) which is estimated at 1.55 mg/100 g [8]. Like such others fruits, Saba is very rich in carbohydrates but values vary widely from author to author in the range of 11 - 74.23 g/100 g [20] [22] [23] [24] [26] [27]. The lipid content is 0.2 g/100 g [23] and the protein content varies from 0.8 to 0.3 g/100 g [23] [24]. Minerals are also revealed in Saba's fruit such us calcium, phosphorus, magnesium and potassium respectively 51 ppm, 357.5 ppm, 47.5 ppm and 152 ppm [24], the fruit is poor in sodium (<5 ppm). It's also content thiamine, riboflavin, niacin, and vitamin B6. Maad contents an appreciate level of 945.83 mg/100 g polyphenols [21], mainly composed of flavonoids and anthocyanins. There is also the presence of anthraquinones and triterpenes [25]. However it does not contain tannins or alkaloids [27]. The fruits of the maad also contain an essential oil whose major compounds terpineol (29.8%), linalool (18%) and benzoic acid (9.2%) [28]. All these components contribute to suppose that Saba's fruits may really have nutritional and healthy impact to consumers.

4.4. Uses

4.4.1. Food Uses

The fruit of *Saba senegalensis* is consumed in different forms. It can be eaten as is or seasoned with sugar, salt and/or chilly [1] [7] [9]. The fruit pulp is tart and pleasant [3]. In rural areas, maad is used to enhance the taste of cereal porridge [2] [29]. It can also be processed into mashed potatoes, nectar, jams, preserves and maad jellies [30]. The inside of the shell is also covered with superficial skin that can be consumed. The leaves are prepared in sauces and condiments as an aperitif with a salty or sweet taste [2] [31]. In High Guinea, the nuclei surrounded by their pulp are sun-dried and used to replace lemon and tamarin [12]. In Senegal, the maad can be transformed using a mechanical extractor and this primary transformation the maad makes it possible to obtain a refined puree (**Figure 6(a)**) which can subsequently be converted into several finished products such as nectars (**Figure 6(c)** and **Figure 7**), syrups, concentrated bases and marmalades. It can also be added in other food diets such as yoghurt.

4.4.2. Medicinal Uses

Saba senegalensis has a long and rich history in herbal medicine with noted native use. The effects of *Saba senegalensis* in local traditional medicine are varied. Green fruits fight against sterility, galactagogic, colic [2] [32]. The ripe fruits are anorexic, antiscorbutic, stimulating, tonic [33]. The Fulani consider the fruits still green and cooked with salt as an effective diuretic drug and fast acting [31]. The maad is also used to cure constipation for this, it is just enough to constantly drink fruit juice. The leaves are used in cases of migraine or food poisoning [1] [2], but also in the treatment of injuries when they are pounded [1]. Inhalation of the vapor emitted during the boiling of the leaves in the water would calm headaches and coughing [31]. The macerate leaves help fight against vomiting and stomachaches [32]. They are hemostatic, anti-gonorrheal, antiseptic, anti-emetic and healing [1] [2]. Latex can treat pulmonary problems. It also helps to fight against cough and tuberculosis [34]. It is haemostatic and coagulant [2] [9]. Dry root bark powder is applied to wounds as healing [9] [32]. It helps to fight against vomiting, stomach pain and anemia [2] [9]. The roots of this species are used in the care of female infertility and treat skin burns. Root

Figure 6. (a) Maad puree, (b) Raw pulp, (c) Maad nectar, (d) Maad preserve.

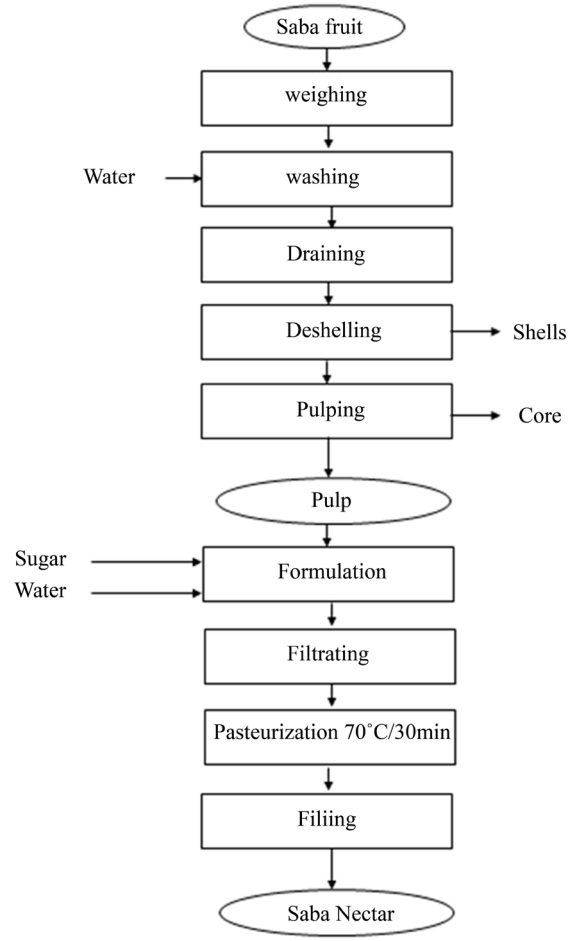


Figure 7. Production chart of nectar maad standardized by the Institute of Food Technology (ITA) of Dakar.

maceration, as a drink, is considered to be anti-blennorrhagic or with other plants [1].

5. Production in Senegal

The statistics available on the exploitation of maad do not make it possible to differentiate between the quantity exploited and the quantity marketed. According to the Department of Water and Forests, maad accounts for 15% of the total amount of picking fruits in Senegal [35]. Meanwhile, the important of these products in the life of populations allows, without quantitative data, to say that the quantity exploited is largely underestimated because of the local consumption not taken into account. The evolution of maad production recorded in Senegal has undergone a very wide variation from 1997 to 2015 (**Figure 8**). With a peak of 2370 tons in 2004 [36], the total national maad production in Senegal cannot be accurately advanced for the moment as it ignores the quantity consumed and sold in the villages or used by chimpanzees or other animals. These results therefore only concern products that have been declared at the water and forest management level and taxed at CFAF 15 per kg in the various control

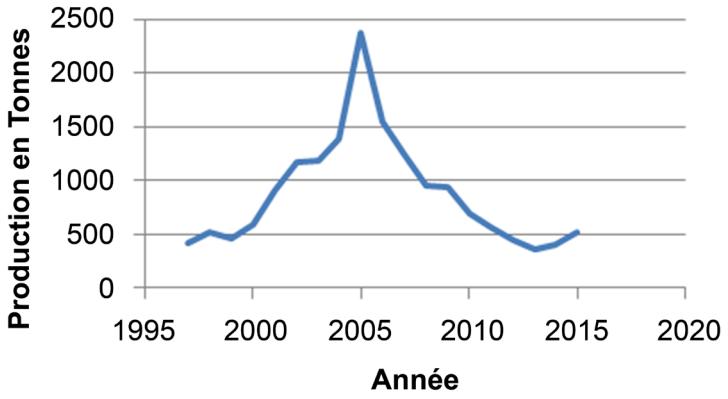


Figure 8. Evolution of *S. senegalensis* recorded production in Senegal from 1997 to 2015 [36].

zones. In Senegal, the maad comes largely from Casamance and Kédougou. However markets are also flooded by the same products from Guinea Bissau, Guinea Conakry or sometimes even Mali, maad was controlled and registered on the national territory, between 2014 and 2015 respectively 1132 to 1427 tons maad [36]. In Dakar, the maad found on the market comes largely from the sub region Casamance, comes second and then Kédougou and Kolda region. **Table 3** presents the quantity of maad consumed in Dakar from 2013 to 2015. Comparing the national production consumed in Dakar and the maad import market arriving in Dakar. Domestic production arriving in the capital is much lower than imports, with as an example for 2015, of the 1427 t of maad registered, only 521.24 t come from Senegal or 36.5% of annual consumption. On average during the 2013-2015 periods, 1103.55 t of maad were consumed in Dakar.

6. Collection and Distribution Circuits

Maad picking in the production areas is very organized; the start date of picking is still fixed and is reserved only for local populations. The gathering is carried out essentially by the women and the children who resell basins or baskets of fruits in the weekly markets of the production areas to itinerant traders or to the itinerant traders known as "Banas Banas". After having conditioned the fruits of maad or in bags that were previously used for the conditioning of the rice or the onion, these Banas Banas will declare these products at the level of the agents of waters and forests by paying 15 francs CFA kg to be able to take them out and sell them on the market. The packaging bag weighs on average 65 kg [29]. The products are either packed in very large baskets called "Damba" transported in trucks for those coming from Kedougou and part of Casamance or transported by boat to the other part of Casamance for supplies in the rest of the country. This marketing on long journeys is facilitated by the long shelf life of the fruit which can be kept in good condition for (8 to 10) days if it enjoys good transport and storage conditions [12]. The main destinations are the country's major markets: Kolda, Diaobe, Bignona, Touba, Dinguiraye and Dakar which is the

Table 3. Quantity of *S. senegalensis* distributed in Dakar from 2013 to 2015 [36].

Origin	2013	2014	2015
Senegal	185,010 kg	206,379 kg	521,540 kg
Mali	-	569,398 kg	418,410 kg
Guinée Bissau	-	44,230 kg	22,570 kg
Guinée Conakry	-	311,800 kg	432,750 kg
Gambia	-	900 kg	31,970 kg
Total Importation	565,684 kg	926,328 kg	905,700 kg
Total Quantity of maad on Dakar	750,694 kg	1,132,707 kg	1,427,240 kg

main place of disembarkation and distribution of maad especially in the "Syndicat, Tilene or Port" markets where wholesalers, semi-wholesalers and retailers are responsible for resale. Although at the "Syndicat" market, the marketing of maad occupies more than 100 half-wholesalers and about sixty wholesalers. A wholesaler sells about 10 bags of 70 kg on average a day, where a half-wholesaler sells 1 bag and makes a margin of 5000 FCFA/day. After the wholesalers, the resellers will repackage the products in large baskets; 50 or 60 kg, or average baskets weighing 35 or 40 kg. There are also small baskets of 25 or 20 kg. The chain of distribution of this fruit extends on the secondary markets of Dakar and the interior as well as in the districts. Women buy, for example, the basket at 25,000 FCFA and sell retail in lots of 500 - 1000 FCFA and sometimes even 250 FCFA. Retailers, who occupy the last link in the chain, sell the product per unit ranging from 50 to 250 CFA depending on the size.

7. Conclusions

Saba senegalensis is a plant that grows in most countries in West Africa. It grows in all types of soil. It has economic potential given the enthusiasm of the various actors of the distribution and marketing exploitation circuit. Its fruit is characterized by its wealth of antioxidant molecules including polyphenols, carotenoids and vitamin C, but especially because of its high acidity. It is a plant that according to the local pharmacopoeia has therapeutic properties, from the fruit to the roots through the leaves, bark, and latex. It fights against several types of diseases. Its fruit is very popular with the population. It is tasted as such or transformed into puree, nectar, jam, and jelly or even used as a food matrix in yogurt.

Despite its high nutritional potential, its many therapeutic virtues and its economic potential, *Saba senegalensis* is still under-exploited.

The evaluation of the nutritional and aromatic potential of the pulp is very incomplete, particularly as regards the profile of polyphenols, carotenoids and aroma compounds. Further research on the antioxidant and therapeutic properties of maad should be carried out as well as the study of thermal degradation of antioxidant molecules.

Thus, the study of the stability of the products resulting from the transformation must be envisaged in order to reduce the post-harvest losses and to ensure a good conservation of these products but especially in a general way to contribute to the valorization of this fruit very appreciated by the population.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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