Sustainable utilizations of *Borassus aethiopum* Mart. fruits in the Eastern Region of Burkina Faso

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ABSTRACT

Borassus aethiopum Mart., Commonly called *Koanga* in Moore (most utilized local language in Burkina Faso), is a palmyra tree which is very widespread in India and Africa. In Burkina Faso, it is located in the Eastern region of the country, where it is used in various ways (medicinal, constructions, culinary…). Populations of Kompienga (Province of Eastern part of Burkina Faso) use mainly the hypocotyls of the young trees in their daily food rations, but also as an economical income through the trade of those hypocotyls. This study is finding out sustainable ways to avoid the destruction of the *Borassus* forest in the locality, but also, it is proposing means to add more values in the use of the fruit without touching the hypocotyls only. For the purpose we used physical, ethnobotanical and chemicals methods.

Keywords: *Borassus aethiopum* Mart, fruits, hypocotyls, ethnobotany, sustainability, conservation

INTRODUCTION

Like many Sahelian countries on the way of their development, Burkina Faso faces the rational management of its biological resources. The desert advancement and the loss of plant species are the illustration of a strong anthropic pressure. *Borassus aethiopum* Mart. is an exceptional example of a tree which has been used for diverse purposes such as food, medicine, construction and crafts (Giffard, 1967). In the eastern region of Burkina Faso, the construction of Kompienga's dam (for hydroelectricity production) in 1987 destroyed hundreds of feet of *Borassus* (Somé, C. 2008). Despite the alarming situation, the local populations, especially the ones of Kabonga I, Kabonga II, and Kompiembiga exploit highly the hypocotyls of the tree as an

economical resource by selling them to the local population, but also by exporting them to the neighborhood countries Benin and Togo where there are really appreciated as a culinary dish.

The aim of the present study is to find sustainable ways of using the *Borassus* in the study area without compromising the growth of the specie. Thus, individual and group surveys will be conducted in order to know the ethnobotanical uses of the entire tree from its roots to its fruits, some biochemical parameters will be conducted on the fruit to characterize the presence of some components such as flavor, vitamins, minerals, secondary metabolites, and reducing sugars.

Sites of the study

In Burkina Faso, the largest *Borassus aethiopum* Mart. forests are found in the provinces of Gourma, Kompienga, Koulpelogo, and Tapoa (figure 1). They are found mainly along rivers such as Kompienga's, Koulpelogo's, Pendjari's and Nouaho's. The trees are also found in some areas with big depressions (lowlands). Nevertheless, few feet or isolated *Borassus* are also found in the provinces of Boulgou and Kouritenga (Guinko and Ouedraogo, 2004).

Province of Kompienga.

The eastern Burkina Faso covers an area of 46,256 km^2 and has five provinces: Gnagna, Gourma Komandjari, Tapoa, and Kompienga. It has about one million inhabitants. The density of the population is disparate, ranging from 50 inhabitants/km^2 in parts of Gourma to 3 inhabitants/km^2 only in southern areas. The major ethnic group (the Gourmantches) own the lands' right. Other ethnic groups in the eastern region are the Fulani and Mossi who came from a relatively new immigration stream. Our study was conducted in the province of Kompienga. The province Kompienga is located in the south of the eastern region and is 355 km away from Ouagadougou (capital of Burkina Faso). It borders two countries, Benin and Togo. The weather is a Sudan type with a six-month rainy season (May to September). Agriculture is the socio-economic activity and it occupies about 80% of the population (Ministry of Economy and Finances, 2004).

Geography of the area

The province Kompienga is located in the southeastern of Burkina Faso. It is bounded in the east by the province of Tapoa, in the west by the province of Koulpelogo, in the north by the province of Gourma, and in the south by the Republics of Togo and Benin.

Climate and vegetation

As it is a Sudanese type, the climate is characterized by alternating two distinct seasons: A dry season from November to April and a rainy season from May to October. Annual rainfall varies between 800 and 1260 mm.

Hydrography

The main river is Pendjari with its tributaries that are Kompienga and Singou. The province has a large water reservoir which is the dam of Kompienga. The presence of this dam has allowed the development of socioeconomic activities such as fishing and the culture of vegetables.

Economic situation

Agriculture and livestock are the main economic activities in the area. The agriculture is characterized by a very large grains crop dominance to meet the nutritional needs of the population. The main speculations are millet and sorghum which cover alone nearly 2/3 acreage. The province Kompienga has enormous potential in terms of livestock, and it's handled by the Fulani.

Choice of villages

The villages selected for the study are those that produce the hypocotyls: Kompiembiga, Kabonga I and Kabonga II.

MATERIAL AND METHOD

Whole fruits of *Borassus aethiopum* Mart. were harvested in August 2009 at Kabonga II *Borassus* forest.

Ethnobotanical survey

The ethnobotanical survey concerned 126 inhabitants from Kabonga I, Kabonga II, Pama, and Kompienbiga. The survey took two weeks and it was made in Moore and French languages. It included both social and ethnic sensibilities. The questionnaires focused strictly on the use of the *Borassus* in the surveyed areas.

Biochemical analysis of the fruit

Extraction of the different chemical groups present in the fruit of *Borassus aethiopum* Mart. is made by macerating the fruit pulp in acetone (80%). A mass of 50 g of fresh pulp of the drupe is grounded and macerated for 24 hours in 500ml of hydro-acetone (80%), under shaking, away from sun and under laboratory ambient temperature (30°C). The obtained mixture is then filtered using a whatman filter paper, and concentrated. The solution is after frozen and lyophilized. The lyophilization took about 72 hours to a complete dehydration. The methods described by Ciulei (1982) were used for the determination of alkaloids, tannins, polyphenols, saponosids, coumarins, and flavonoids. Total phenolics were estimated by the method of Singleton et *al.* (1999). Total flavonoids were determined by the method of Arvouet-Grand et *al.* (1994). Carotene and lycopene are determined using the method of Nagata and Yamashita (1992). The proteins are monitored via the method described of Lowry et *al.* (1951). For the determination of minerals, the pulp of the fruit was prepared by drying 200 g in an oven at 105°C for 2 hours. The dried pulp is then calcined at 550°C for 5 hours, and the obtained ash is used for the different mineral tests. Analysis of salts such as sodium, zinc, and potassium is made using the method of Rodriguez-Otero and Paserio (1994). Iron, magnesium, phosphorus and calcium are assessed via the method described by Mouillet et *al.* (1975). All the assays are performed in triplicates for more accuracy of the results

RESULTS AND DISCUSSION

Ethnobotanical survey

The results of the ethnobotanical survey are given in Table 1. As it is shown, the *Borassus* is used in the studied area mainly for alimentation. In fact, during our investigation, the hypocotyls of the *Borassus* are eaten raw or boiled, and they are even more preferred to the cassava (*Manihot esculenta*). Construction of sheds and cages are made via the leaves and stems of the *Borassus*. The fresh ripen, boiled or roasted fruits are directly eaten like mangoes (*Mangifera indica* L.). Women in the surveyed area burn the male flowers and/or fruit shells of the *Borassus* from which they extract a potash that they use in the preparation of sauces to adjust the acidity. The treatment of malaria is done using the ripen and dried fruit according to the ethnobotanical survey results. The decoction of the *Borassus* roots is used to treat stomachaches and heart pains. In the same medical treatment way, the grilled and grinded leaves are used in the treatment

of anal mycosis (*Côtiguè*). The hypocotyls are used as aphrodisiac by men, but also for their laxative properties.

Production of "*kwoang bouli*"

The local name given to the *Borassus* hypocotyls in the study area is "*kwoang bouli*" (Moore), and it has a huge reserve in starch. They are produced traditionally in almost every household nearby the *Borassus* forest, either for family consumption or for economic incomes. In fact, the hypocotyls taste like the cassava, but they are just more bitter. They are eaten either raw (less liked), roasted or boiled (more preferred). In addition, the hypocotyls' flour is turned sometimes into a special dish called "gari" which is more and usually made with the cassava flour in other regions of the country.

Economic incomes of the "*kwoang bouli*"

In the markets visited (Pama, Kompienbiga, Kabonga I, and Kabonga II), the hypocotyls are boiled and sold for 25FCFA (0.04USD) each, as it is shown in figure 2. In reality there is no control on the marketing of the hypocotyls, so that it is difficult to know if their trading has or not an economic impact. Since there is no control in the harvesting of the hypocotyls either produced naturally or traditionally, it is difficult to manage the sustainability of the exploitation. This form of exploitation presents more risk to the sustainability of the *Borassus* forest in the area. The environmental law of Burkina Faso doesn't include the exploitation of the hypocotyls; thus it is difficult to penalize any ways of exploitation of the *Borassus* in the whole country. The current way which is used to save the forest is to sensitize the exploiters on the fate the palmyra if they sustain they ways of exploitation.

Production of the hypocotyls

Two different techniques are used for the hypocotyls production, the traditional which is used by 92% of the producers, and the improved technique which needs more time for the soil preparation (Coulibaly, 2007). In the traditional way, the fruits are harvested during the dry season and directly placed on the surface of the soil without any initial soil preparation, then the fruits are covered with soil in order to hide them from the animals that may destroy them. The hypocotyls are then dug up after 7-8 months. However, they can be harvested after 10-12 months of culture. After 12 months, the hypocotyls morphology change and they cannot be eaten. In the

improved hypocotyls production technique, the hole where the fruit should be buried is twice bigger than the size of the fruit (30cm). The two-third of the hole is first filled with a mixture of sand and topsoil, then the fruits are placed inside as in the previous technique and covered with soil. This technique has the advantage of having better performance and an easier harvesting. The period of harvesting remains the same (May to December). The fruit shells after the harvesting are burnt and the ash is used to produce a traditional potash that is highly appreciated in the area.

Current status of the *Borassus* forest

The forest is getting degraded every day because there is no control on its exploitation by the nearby population. The main destruction of the forest occurred between the 1980s and the 1990s during the construction of the hydro electrical dam of Kompienga which removed hundreds of *Borassus* feet. The forest is very old and the regeneration of the young trees are negligible because of the livestock that eat them (figure 3). The *Borassus* forest of Kabonga II-Wanghin is very dense, and covers several hundreds of hectares, but with old *Borassus* trees.

Species associated with the *Borassus aethiopum* Mart.

In Kabonga II, the *Borassus* forest contains many different dominant plant species such as *Mitragyna inermis* (WILLD) O Ktze (Rubiaceae), *Mimosa pigra* (Mimosaceae), *Nauclea latifolia* MS (Rubiaceae), *Calotropis procera* (AIT) AIT. F (Asclepiadaceae), *Ziziphus mucronata*, *Vetiveria nigritana* (Benth) STAPF. (Poaceae), and *Combretum nigricans* RPLS. EXGUILL. AND PERR (Combretaceae).

Chemical analysis of the fruit

The *Borassus* fruit has a very low density with a turpentine like odor (Malaise, 1997). The pulp of the fruit has 90% in water content, and a 10% in ash. In the same conditions of analysis, the *Borassus flabellifer* fruit has about 93.9% of water and 6.1% ash (Nacoulma, 1996). These two varieties are very similar in terms of water content and ashes. After analysis, the *Borassus* fruit contains many and different chemical compounds such as coumarins, saponosids, saponins as it is stipulated in table 2, and which could justify the medicinal properties of the fruit. The presence of reducing sugars determines the quality of the fruit for culinary purpose. The fruit has respectively 0.885±0.01mg EAT/100mg extract and $0.134 \pm 2\times10^{-3}$ mg EQ/100mg extract for

total polyphenols and total flavonoids. Carotene and lycopene were also present in the fruit with $5\times10^{-3} \pm 2\times10^{-4}$ mg carotene/g pulp and $3\times10^{-2} \pm 4\times10^{-4}$ mg of lycopene/g of pulp, although there are very low. Thus, there is no direct correlation between the color of the pulp (deep orange) and its content in carotene and lycopene (Ariyasena et *al.,* 2001). In terms of protein content, the fruit contains 12.61±0.25 Eq BSA/100mg of extract which is not negligible regarding the fact that it is a fruit. Following the results summarized in table 3, the fruit of the yellow *Borassus* is very rich in Na, K, and Mg. Only the iron is proportional to the one contained in *Borassus flabellifer* (Nacoulma, 1996). In addition, minerals like Ca and P are higher in the *B. flabellifer* than in the *B. aethiopum*. Also the hypocotyls are starch rich and they can replace the local meals like millet, *Sorghum*, mays during the famine season. However, the exploitation system should be deeply studied in order to reach a sustainable use of the *Borassus* products in the area.

Possible utilizations of the fruit

The dye of the fruit can be extracted by solvents which are slightly polar such as acetone-hexane system. The dye is stable, and the color which is a deep orange can be used as a food coloring agent. The essential oil of the fruit is a turpentine like (Malaise, 1997). However, the aroma is still like a melon (Nacoulma, 1996). Since 2004, the national center for agricultural research of Save located in the Republic of Benin, uses the pulp of the *Borassus* fruit to make fruits jam and syrup. However, the population does not well appreciate the bitterness of the products due to the nature of the fruit itself because it contains a bitter principle called flabelliferin (Jansz et *al.,* 1994).

Socio-economic benefits of the study: The current study is showing to the population of the Eastern Burkina Faso how they could use their *Borassus* forest in a sustainable way, but also to let them know the consequences on the disappearance due to their exploitation ways of the forest. The population has already its own ways to use the *Borassus*, thus the study is improving those ways but also, the study is a kind of sensitization to stop the bad methods of exploitation. The installation of small factories for the valorization of the *Borassus* via its fruits mainly (syrups and jams) can give economic incomes to the local population and can help in using sustainably the forest through young *Borassus* forest growth cooperatives.

Management of the *Borassus* forest: According to the National Forest Policy of Burkina Faso (MEE, 1998), the conservation and management of forest resources are regulated by the law 006/ADP/97 of 31 January 1997' Forest Code of Burkina Faso. When the exploitation of forest products becomes commercial, it is subject to authorization and taxation. However, except the exploitation of forest wood products which are regulated by decree No. 98-306/PRES/PM/MEE/MEF/CEC of 15 July 1998, there is no regulation on the other products such as the hypocotyls. Meanwhile the National Program for Forest Resource Management (PNGRF) has adopted in 2007 new texts related to the protection of high socio-economic forest products including the *Borassus*. Thus, in local areas bags of 100Kg of hypocotyls are taxed for 0.51USD (referring to article 60 and 70 of the above decree), but still the amount varies from one locality to another. Thus, clear texts should be developed in order to sustain the exploitation of the *Borassus* in the country.

CONCLUSION

Our study aimed to find ways to valorize in a sustainable way the *Borassus aethiopum* in the watershed of Kompienga in Burkina Faso. From, the ethnobotanical surveys, the hypocotyls of the *Borassus* are very used as an economic income by the local population, but also as food during the dry season. The chemical analysis of the fruit, which is a sustainable way for the *Borassus* exploitation showed that it has many nutritional and medicinal compounds such as proteins, carotenes, lycopenes, polyphenols, and minerals. In west Africa region, the center of Save in the Republic of Benin is doing a lot to come up with new technologies to exploit sufficiently the fruits of *Borassus* as fruit jams, syrups, …This study is encouraging the establishment of *Borassus* gardens which will help for the renewal of the natural *Borassus* forests which are very old.

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Table 1 : Ethnobotanical survey

Scientific name	**Local name (Moore)**	**Parts the tree which are used**	**Utilizations**	**Percentage of the purpose**
***Borassus aethiopum* Mart.**	***Koanga***	Leaves	Fabrication of mats, baskets, hand fans, poultry cages, beds	100%
		Grilled and grinded Leaves	Children "Côtiguè" (anal mycosis)	40%
		Stem	House construction, sheds, chairs	100%
		Inner of the young stem	Heal heart pains	20%
		Male flowers	Heal dermatosis	50%
		Roasted male flowers	Used as potash for food.	80%
		Ripen fruits (boiled, raw or roasted)	Eaten, green fertilizer Antimalarial (dried fruits)	100% 50%
		Non ripen fruit's nuts	Eaten	50%
		Whole fruit (shell)	To wash clothes Potash	5% 30%
		Hypocotyls (boiled or roasted) Hypocotyls (raw)	Eaten Aphrodisiac, Used by singers against voice extinction, angina, bronchitis, throat pain	100% 100 % 50% 60% 50%
		Roots decoction	Stomachache, heart pain	100 %

Table 2 : Secondary metabollites of *Borassus aethiopum* Mart. fruit

Secondary metabollites	**Hydro acetone macerate of *Borassus aethiopum* Mart.the fruit**
Flavonoids	-
Tanins and polyphenols	-
Saponosids	+
Coumarins	+
Alcaloids	-
Reducing sugars	+

- **negative** **+ positive**

Table 3 : Minerals of *Borassus aethiopum* Mart. fruit

Minerals and trace elements	Mg	Ca	Fe	P	Na	K	Zn
As a mg/100g of calcined fruit	3.42	≤0.05	1	1.13	101.7	1450.8	0.14

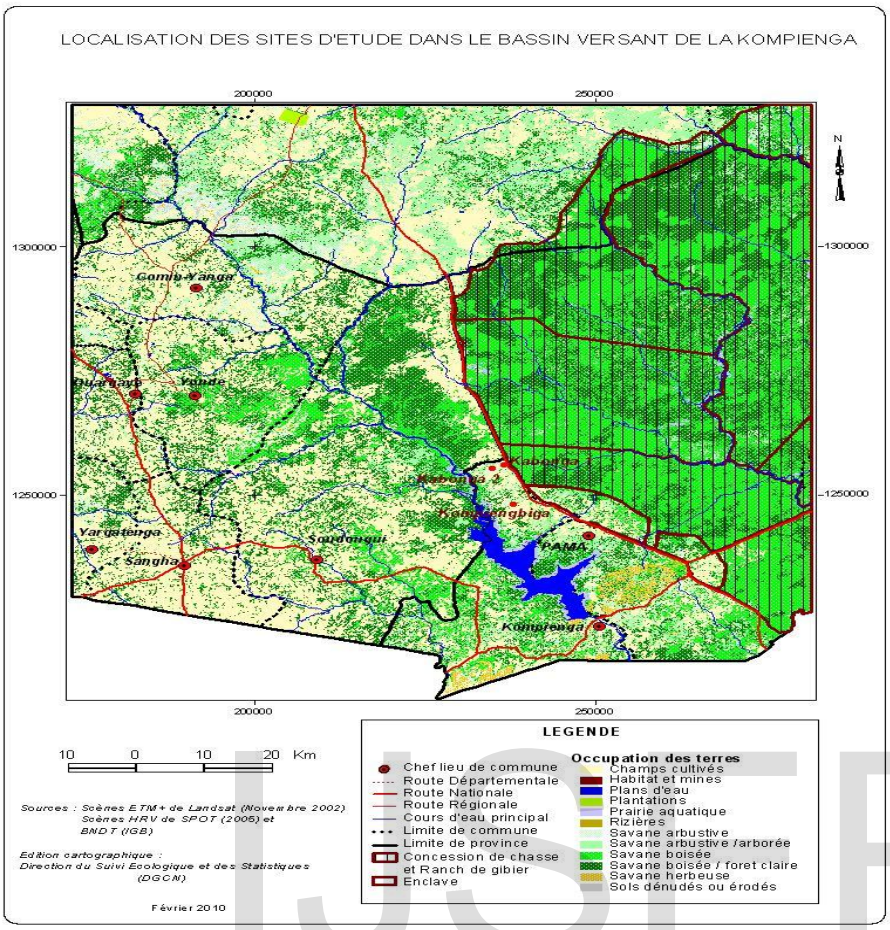

Figure 1: Localization of the study sites

Figure 2: Boiled and sold *Borassus* hypocotyls at the market of Kabonga II

Figure 3: Old *Borassus* forest at Kabonga II and livestock preventing the growth of young feet