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Socio-economic contributions and marketing circuits of *Acacia nilotica* products in Far-North Region, Cameroon

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1. ABSTRACT

Wild fruit species, such as *Acacia nilotica*, (red gum tree) have a significant impact on the socio-economic resilience of riparian populations. In order to promote sustainable practices and valorise products from this species in the Diamaré Department, ethnobotanical and socio-economic surveys, through structured and semi-structured interviews, were carried out with 360 resource persons. It appears that *Acacia nilotica* fruits are mostly used (47.43%). Total cutting (40%) and partial cutting (60%) are the harvesting techniques used. The marketing of these products generates very significant monthly (90,000 FCFA per farmer) and annual (1, 080,000 FCFA) income. Twenty four (24) human diseases treated with all parts of *Acacia nilotica* were cited by local populations. It would be recommendable to popularize actions in favour of *A. nilotica* conservation in these Diamaré Department villages and to conduct domestication programs.

2. INTRODUCTION

Forests contribute to the well-being of billions of people worldwide by providing different timber and non-timber products. Africa is one of the richest continents in biodiversity (White, 1986). Many people in rural areas depend on it for nutrition, income. (Akinnifesi *et al.*, 2006; Dieng, 2017). In recent years, the imptovement of forest trees for non-timber forest products (fruits, nuts, resin) has been developed using high- value polyvalent trees (Tchoundjeu *et al.*, 2010). Nevertheless, trees that produce edible fruit are of particularly interest, as fruit trees can provide a safety buffer and can often serve as important sources of vitamins, minerals and phytochemicals that improve human health conditions (Leakey, 1999). Thus, in addition to the wood that is harvested to cover energy and construction needs in rural areas (Sambou, 2004), the fruit and leaves are well traded in local, national and international markets (Kouebou *et al.*, 2013; Dieng, 2017). Gathering, processing, and selling these products thus allows rural people to acquire income to purchase basic necessities and production tools. Cameroon has a rich heritage of biodiversity and biological resources (IPCC, 2007). This heritage places the country fourth in floral diversity and fifth in faunal diversity on the African continent (MINEPDED, 2016). Thus, its various ecosystems represent 92% of Africa's ecosystems, which is why it is called "Africa in miniature" (MINEP, 2008). Its rich and diverse diversity includes about 7,850 plant species with nearly 815 threatened species (Clark *et al.*, 2004). According to Van Dijk (2000), the most suitable resources for commercial extraction are those that are harvested in a sustainable manner. However, their commercial use leads to destructive harvesting practices. The manner in which fuelwood and service wood are harvested

by local residents does not promote regeneration and species survival. Thus, the collection of dead wood and the harvesting of wood after clearing is recommended (Bergonzini, 2004). In the Sahelian zone, the level of logging has exceeded the increase in woody biomass (Mvondo, 2002). People exploit young individuals of tree and/or shrub species and living individuals (Ndjidda, 2001). They can cut down almost anything that can burn without thinking about the consequences, which cause deforestation. The current rate of harvesting of forest products is becoming increasingly high and the cut species are in danger. The distance of penetration into the savannah increases every year (Tchotsoua *et al.*, 2000). The use of wild fruit trees as fuelwood is an indicator of the scarcity of woody fuels in peri-urban savannas (Mapongmetsem *et al.*, 2012). Certain wood harvesting techniques make it difficult to regenerate the species (Doua, 2010). The rate of afforestation has slowed down from 1972 (Doua, 2010). Agricultural clearing and excessive use of forests have caused biodiversity losses (Butynski, 1984). Today, given the intensity of NTFP exploitation linked to the strong demographic growth of African countries and the efforts made in their transformation, the problem of their sustainable exploitation arises. One of the solutions to this problem is the valorization of available natural resources already integrated into the culture of rural populations. Among these resources is *Acacia nilotica* L., a multi-purpose species, recognized and widely integrated by rural populations. Today the species is widely distributed outside its natural range. It is a tree of great interest and used as a source of energy. Indeed, it produces firewood and charcoal (Arbonnier, 2000; Faye *et al.*, 2007). It is also used as timber for the construction of houses because it is resistant to termites, but also for the manufacture of various household utensils and hedges. Thus, this wood is marketed and increases the financial income of the populations. The dried pods are widely used by leather craftsmen in the tanning of hides. They are traded internally between the Sahel and the Sudanian zone (Fagg & Mugedo, 2005). Extracts from green pods are also used as tannins and can also be used for dyes and ink (Kouebou *et al.*, 2013). The reddish gum that *Acacia nilotica* secretes, although of lesser value than that of *Acacia senegal*, is marketed as gum arabic. The gum is also used for making dyes (Kouebou *et al.*, 2013). It is a popular species for soil rehabilitation because of its tolerance to drought, flooding and salinity conditions (Faye *et al.*, 2007). It is also used in reforestation programs in degraded environments such as on heavy and poorly drained soils (Mapongmetsem *et al.*, 2012).Water conservation and soil protection programs against erosion (M'Baré, 2001) as well as dune fixation. *Acacia nilotica*, with its rapid growth, is commonly used as a thorny cover and windbreak species in drylands and in many parts of the world (Kawtar *et al.*, 2014) but also as a pioneer species in the reclamation of mining areas and in areas where degradation and erosion have occurred (Arbonnier, 2000; Fagg *et al.*, 2005). Based on above background, this study aims to contribute to the valorization of *Acacia nilotica* products in the Far North, Cameroon in order to fill the various gaps often observed. Thus, the aim is to determine the convergence of use of the different parts of the species; to determine the marketing circuit of the products derived from the species studied and to indicate the impact of the exploitation of woody plants and the sustainable management methods of the populations of this zone.

3. MATERIALS AND METHODS

3.1 Study area: The Far-North Region is located between 10°00' and 13°00' north latitude and 13°30' and 15°30' east longitude (figure 1). It extends 325 km to the shore of Lake Chad (Iyébi-Mandjek and Seignobos, 2000). Diamare Division is one of the six Divisions that constitute this Region. It is bordered to the north and north-east by the Logone and Chari Division, to the east and south-sast by the Mayo-Danay Division, and to the west and north-west by the Mayo-Tsanaga Division. The study was carried out in the Far-North Region of

Cameroon, in three Subdivision of the Diamaré Division (Maroua 1: Ngassa, Maroua 2: Gayak and Maroua 3: Kodek). The type of climate is Sudano-Sahelian, who has a short rainy season from June to October and a long dry season from late October to May (PCD, 2016). It rains on average 700 mm per year. Temperatures vary from 25°C in the cool season, 30°C in the rainy season and peak at 45°C in the hot season. The ecological fragility of the area increases the aridification of the environment and the mortality of woody species leading to a decrease in biodiversity (Lienou *et al.*, 2003). The vegetation is made up of shrub and tree savannahs with thorny plant species. The villages are composed of a diversity of ethnic groups. Economic activities in this area are: agriculture, livestock, trade and handicrafts. The exploitation of firewood and other NTFP is an important income-generating activity for these populations (PCD, 2016).

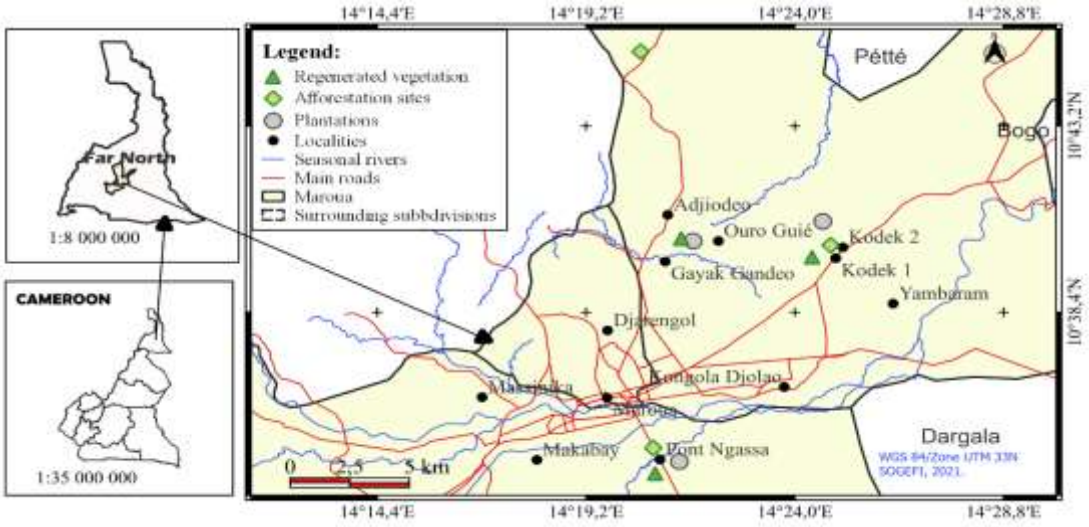


Figure 1: Location map

3.2 Description of the studied species: *Acacia nilotica* belongs to the subgenus *Acacia*, which encompasses all African Acacia species with straight spiny stipules (Brenan, 1983). There are 09 subspecies, all of which differ in pod and twig characteristics and tree form (Nassima 2015). It is a 5-20 m tall plant with a thick spherical crown, generally sinister to black stems and branches, pinkish gray cup, cracked bark exuding a poor quality reddish gum. The plant has straight, light, thin, gray spines in axillary pairs, usually 3 to 12 pairs, 5 to 7.5 cm long in young trees, mature trees are usually spineless. Leaves are bipinnate, with 3 to 6 pairs of pinnae and 10 to 30 pairs of leaflets each (Champion and Seth, 1968). Pinnae are elliptic or narrowly oblong, 1.5-7 mm x 0.5-2 mm, rounded and oblique at the base. They are somewhat glaucous and very thin, with obtuse apex, glabrous to pubescent. The flowers form balls of a bright golden yellow with peduncles of 2 to 3 cm, axillary or verticillate at the end of the branches. The fruits are pods that vary greatly according to subspecies; they are indehiscent, oblong to linear, straight or curved, glabrous or velvety, 4-22 cm x 0.9-2.2 cm, dark brown to gray. The edges of the pod are scalloped. The pod is formed by a succession of bulging, slightly constricted articles. The position of each seed is clearly marked by a protrusion on the pod valves (figure 2). The seeds are brown in colour and ovoid in shape. Their dimensions are on average 10×8×7mm for length, width and thickness respectively. They number 6-17 per pod and have areoles of 5-7 x 4-7 mm (Nassima, 2015: Poda, 1989).

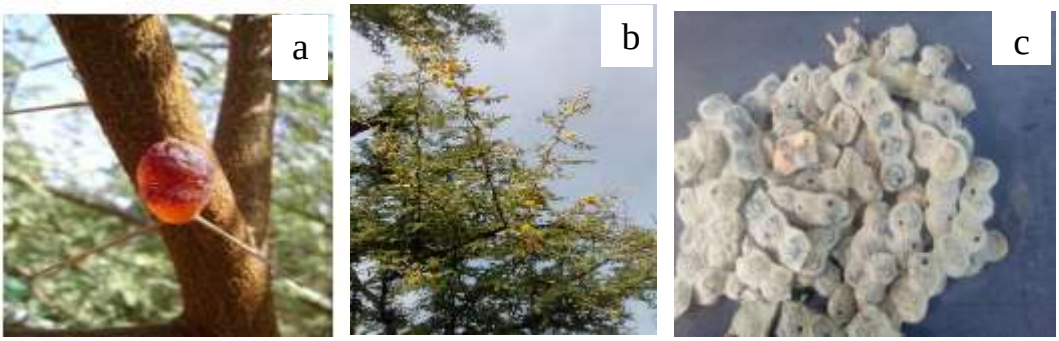


Figure 2: Different parts of *Acacia nilotica* (a: Mature gum exuding trunk, b: Flowers, c: Pods)

3.3 Ethnobotanical survey: Using a structured and semi-structured questionnaire, 360 people, regardless of gender and aged between 15 and 65, were surveyed, with 330 in the three villages (Ngassa, Gayak, Kodek) and 30 traders in the markets, with a sampling rate of 10%. The exchanges were conducted in Foufouldé, the language common to all the inhabitants of these villages. The survey approach made it possible to gather information on the categories of use, the socio-economic impact of *Acacia nilotica* and the mode of management of woody plants in the area. To assess the products collected from this species, the product assessment and quantification method was used (Froumsia, 2005). It consists of keeping a register of traders who have agreed to collaborate in order to evaluate the quantity of products collected and marketed, as well as the market sales prices and profits generated. Three categories of traders were identified: collectors in the villages, wholesalers who sell in bags and retailers. This enabled the social and economic value of the products exploited to be determined.

3.4 Data analysis

3.4.1 Survey data analysis: The non-quantitative data determined the marketing channel and diseases treated with *Acacia nilotica*, as well as the parts used, harvesting methods, associated plants, preparation methods, administration methods and dosage. For the quantitative data, several parameters were considered. Initially, the parts used, the uses, the periods and modes of organ harvesting, the selling price of the products (seeds, roots, leaves, fruits, wood bark), the quantities of the products marketed, and then the proportions were calculated. This made it possible to determine the importance of this plant for the population and the income generated by the sale of its products.

4 RESULTS AND DISCUSSION

4.1 Socio-economic importance of *Acacia nilotica*

4.1.1 Use categories by populations: *Acacia nilotica* is used in several areas by local people. Handicrafts is the most solicited category with a value of 30.21% (table 1). Handicrafts, a very profitable activity, places the Far-North among the leading handicraft regions in Cameroon, leading to overexploitation of *Acacia nilotica* fruits which are used in the transformation of animal skins into leather. Products from *Acacia nilotica* are also used for the construction of traditional houses (the wood is used as a stake) and the manufacture of traditional medicines. Thus, according to Adjanohoun *et al.* (1989), *Acacia nilotica* is used to treat many diseases in Cameroon.

Table 1: Product use categories.

Uses	Ngassa	Gayak	Kodek	Average (%)
Fodder	13.04	14.05	8.87	11.99
Pharmacopoeia	25.22	20.66	22.58	22.82
Handicrafts	27.83	29.75	33.06	30.21
Construction	19.13	19.83	16.94	18.63
Energy	14.78	15.70	18.55	16.34

4.1.2 Parts used by operators: The results show that all parts of *Acacia nilotica* are used. The fruits, the most cited part, with an average of 47.43% (28.70% in Ngassa, 28.93% in Gayak and 84.68% in Kodek), are used for handicrafts (leather tanning) and pharmacopoeia; the wood, 38.69% (25.22% in Ngassa, 21.49% in Gayak and 69.35% in Kodek), is used for building huts, sheds and for energy the leaves, 24.94% (14.78% in Ngassa, 14.88% in Gayak and 45.16% in Kodek), are used for pharmacopoeia and fodder; the bark, 21.94% (13.91% in Ngassa, 12.40% in Gayak and 39.52% in Kodek), is used for pharmacopoeia; the roots, 17.54% (9.57% in Ngassa, 13.22% in Gayak and 29.84% in Kodek), are used for the construction of huts, sheds and energy. 84% in Kodek), are used for pharmacopoeia and flowers, 12.90% (7.83% in Ngassa, 9.00% in Gayak and 21.77% in Kodek), are used for pharmacopoeia and forage (figure 3). These results are in line with Mapongmetsem *et al.* (2012) who showed that the diversity of plant forest products exploited in the savannahs contributes to satisfying basic needs and represents a substancial source of income to ensure the well-being of rural populations. In addition, they provide rural populations with the elements essential for their survival (Ambé, 2001; Mapongmetsem *et al.*, 2008).

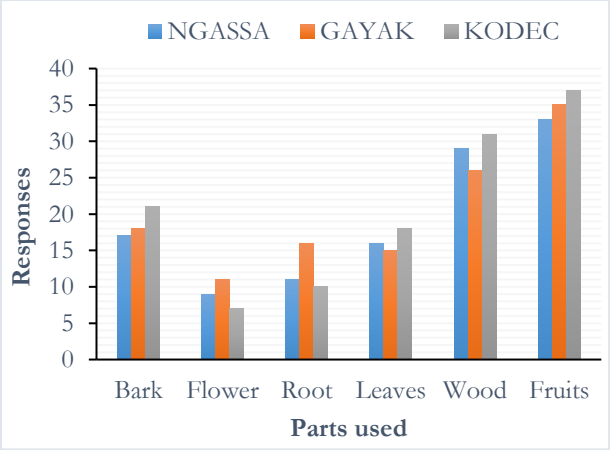


Figure 3: Parts used

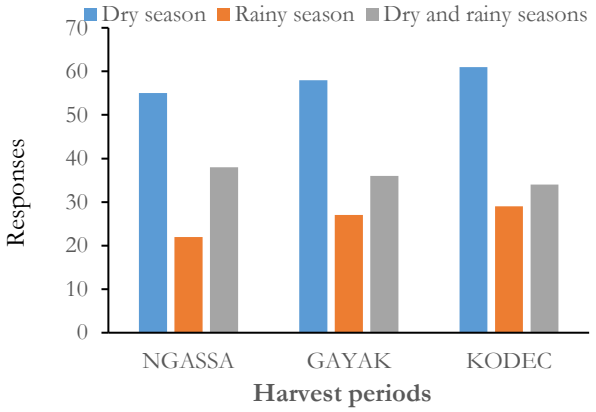


Figure 4. Harvest periods.

4.1.3 Period and method of collection of products: The collection of organs (wood, stems, roots, leaves and bark) takes place throughout the year and the quantity of products collected varies with the seasons. Fruits produce more during the dry season in all three villages (figure 4). Due to irrational exploitation of forest products, the population is beginning to perceive the disappearance of woody vegetation cover. The cutting of wood for energy, the intensification of agriculture, traditional pharmacopoeia, the construction of traditional houses and the marketing of wood are responsible for the loss of species in the plant formations. Thus, overexploited species are threatened with extinction. The analysis of variance reveals that there is a significant difference ($P<0.05$) between logging periods and

not between localities (P>0.05). These results are in agreement with those of Ntoupka (1994) who showed that the low production of phytomass in the dry season in North Cameroon is due to the depressive effects of logging, bushfires and dry season grazing on the vegetation. Several techniques are used to harvest organs: felling of trees, removal of leaves, fruits, stems, bark and roots. The tools used for cutting and removing these organs are: knives, machetes, axes, chainsaws and hooks (table 2). There are two types of cutting: total cutting, which accounts for 40% of harvesting techniques, leads to the elimination of plants, thus reducing the number of species; partial cutting, which accounts for 60%, is not destructive but is harmful because it produces a dwarfed appearance noted on individuals that have been maintained in the seedling state for several years. Operations such as picking (20%) are used to exploit the fruit. On the other hand, collection (45%) allows the collection of fruits, leaves and inflorescences that have fallen to the ground following ripening and/or drying under the effect of gravity. Similar method of NTFP harvesting are described by Tchatat *et al.* (1999) and Shanley and Pierce (2002). The impact of this harvesting on forest structure and composition is closely linked not only to this harvesting intensity, but also to the plant organ harvested (Froumsia, 2013).

Table 2: Product collection tools

Techniques or methods	Tools used
Partial cutting	knives, Machetes
Full cut	Axes, Chainsaws, Machetes
Picking	Manual, Hooks

4.1.4 Commercialisation of products in markets: The selling price of the products varies according to season, availability and the different markets (table 3). The fruit is the most traded part and also has the highest commercial value. These fruits are used for processing animal skins into leather and in the manufacture of traditional medicines. The sale of these products contributes to the development of families and helps finance health, education, nutrition and recreation.

Table 3: Sales prices of products in markets.

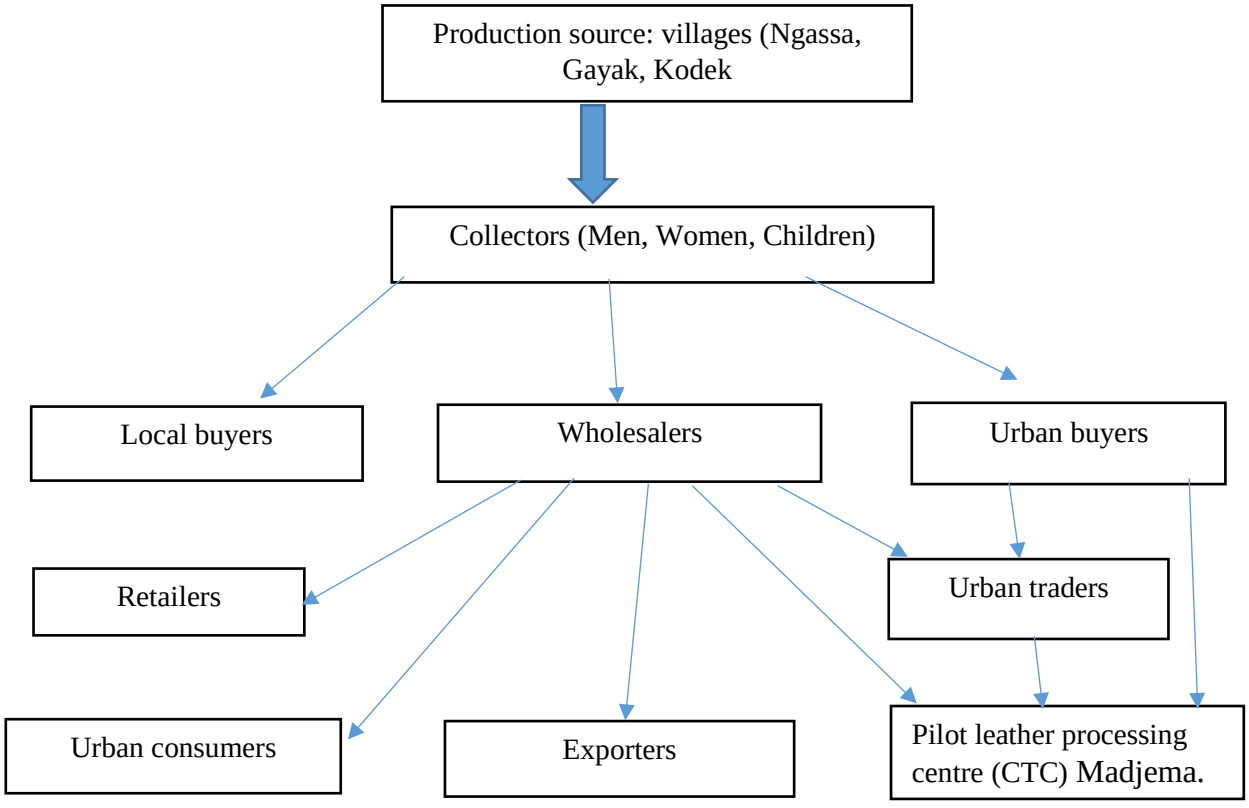
Products	Quantity	Selling price in FCFA (USD)
Leaves	100 grs	100 to 200 (0.15 to 0.33)
Roots	200 grs	200 to 500 (0.33 to 0.79)
Wood	1 bundle	200 to 1000 (0.33 to 1.67)
	1 stake	1500 to 5000 (2.46 to 7.98)
Fruits	300 grs	250 to 500 (0.39 to 0.79)
	1 bag/50 Kgs	3000 to 8000 (5.01 to 13.36)
Bark	200 grs	300 to 1000 (0.5 to 1.67)
Gum	300 grs	500 to 1000 (0.79 to 1.67)

4.1.5 Quantities of products marketed and income generated: The total quantity of organs marketed is 127,200 kg and fruits contribute 62.5%, leaves and flowers 15.6%, bark 12.89% and roots 10.01%. These results differ from those of Awono and Ngono (2002) who show that the quantities of *Ricinodendron heudelotii* (djansang) organs traded in the New-bell market are 121t. The annual income generated from the sale of *Acacia nilotica* products in the study area is estimated at CFA francs 7, 632, 000, (12, 745 USD) or a monthly income of CFA francs

90,000 (150.3 USD) per farmer and an annual income of CFA francs 1, 080, 000 (1, 803.6 USD). These results differ from those of Louanga (2005) who estimates the annual income from the commercialisation of *Gnetum africanum* at 2,245,928,000 CFA francs (3, 750, 706.5 USD), and wild mangoes at 1,152,000 CFA francs (1, 923.84 USD). The profits from these products are of considerable importance because they contribute to increasing farmers' incomes. However, the exploitation and commercialisation of NTFPs as it takes place in Central Africa remains for some a strategy to increase their income and not a guarantee of sustainable NTFP management or promotion of agroforestry practices (Mbolo, 2006). The price of different products varies according to the time and place of sale, and there is no regulation of price setting. The price of NTFPs depends on the general market situation, which in turn depends on the free play between supply and demand (Mapongmetsem *et al.*, 2012). At the end of the production season, product quantities decrease and prices increase (Ndoye, 1995).

4.1.6 Product marketing circuits: The villages studied do not have local markets where products from *Acacia nilotica* are sold. The products collected are sold either on site (collection sites and house) or in urban markets. The markets are supplied by the population who transport the products from their village to the markets, but also by traders who come to buy the products on site. The most popular customers are the wholesalers who enter the villages with their cars (trucks, tricycles), to buy products in large quantities to be sold in the big markets and even outside the city and the country. The most commercialised product is fruit, more than half of which is sold at the Madjema Leather Processing Centre (CTC) (figure 5).

Figure 5 : Product marketing circuits



4.1.7 Phytomedicinal study of *Acacia nilotica* : Plants withmedicinal properties are valuable resources for the vast majority of rural populations in Africa, where over 80% of the population use them for heaith care (Dibong *et al.*, 2011). Still called Nep-Nep in West Africa, *Acacia nilotica* has proven therapeutic virtues. In the study area, 24 diseases were cited by local populations (table 4).

Table 4: Diseases treated with *Acacia nilotica* and method of preparation of products.

Diseases	Parts used	Harvesting Method	Associated plants	Method of preparation	Mode of administration	Dosage
Dysentery	Root	Peeling	None	Infusion	Oral route	1GM and 1GE /3d
Injury	Fruit	Picking	None	Powder	Cataplasm	M and E /5d
Hypertension	Root	Cutting	None	Infusion	Oral route	1GM and 1GE /14d
Heart failure	Root	Cutting	None	Infusion	Oral route	1GM and 1GE /14d
Wounds Syphilitic	Fruit	Collection	None	Powder	Cataplasm	M and E /7d
Sore throat	Bark	Cutting	None	Powder	Oral route	M and E /5d
Injury to the Mouth	Fruit	Collection	None	Powder	Friction	M and E /3d
Bronchitis	Leaves	Cutting	None	Infusion	Oral route	1GM and 1GE /4d
Digestive disorder	Root	Cutting	None	Infusion	Oral route	1VM and 1GE /3d
Cough	Bark	Cutting	None	Infusion	Oral route	1GM and 1VS /3d
Itching vaginal	Seed	Collection	None	Infusion	Sitz bath	M /5d
Vaginal white discharge	Seed	Collection	None	Infusion	Sitz bath	M /5d
Unpleasant smells	Seed	Collection	None	Infusion	Sitz bath	M /5d
Stomach ache	Fruit	Collection	None	Infusion	Oral route	1GM and 1GE /3d
Eye pain	Leaves	Cutting	None	Infusion	Bath	M and E /4d
Cold	Fruit	Collection	*Citrus limon* *Allium cepa* *Tamarindus indica*	Infusion	Oral route	1GM and 1GE /5d
Malaria	Bark Leaves Fruit	Peeling Cutting Collection	*Psidium guayava* *Mangifera Indica* *Azadirachta indica*	Infusion	Oral route	1GM and 1GE /7d
Gastritis	Seed	Collection	None	Powder	Oral route	M and G /5d
Intestinal worm	Bark	Peeling	None	Decoction	Oral route	1GM and 1GE /3d
Meningitis	Bark	Peeling	None	Infusion	Oral route	1GM and 1GE /7d
Hemorrhoid	Bark Leaves Fruit	Peeling Cutting Collection	None	Infusion	Oral route Sitz bath	1GM and 1GE /7d
Toothache	Fruit	Collection	None	Powder	Friction	M and E/3d
Jaundice	Bark	Peeling	None	Infusion	Oral route	1GM and 1GE /7d
Itching of the skin	Leaves	Cutting	None	Infusion	Bath	M and E/3d

M=morning, E=evening, d=day, GM=glass morning, GE=glass evening.

5 CONCLUSION

The present study shows that *Acacia nilotica* is a highly valued species by the population and is used in several areas: handicrafts, pharmacopoeia, construction, energy and fodder. All organs are used, but the fruits are more exploited. Total cutting represents 40% of harvesting techniques. Its high economic value has enabled the establishment of a marketing circuit forming an exploitation chain in which the farmers are upstream and the traders-wholesalers downstream. This allows all stakeholders to make a substantial profit that can satisfy the primary needs of the family. The population uses this species to satisfy their daily needs for energy, food, health, handicrafts. For a sustainable management approach of natural resources, it would be wise to promote the popularisation of actions in favour of the conservation of *Acacia nilotica* in these villages and to conduct domestication programmes in order to favour a cultural wealth worthy of the name.

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