

Availability Evaluation of Twelve Antimalarial Medicinal Plants from Western Regions of Burkina Faso

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Abstract: Major research contributions in ethnopharmacology have generated vast amount of data associated with medicinal plants in Burkina Faso. Despite the relatively abundant literature on local medicinal plants supported by an institutional environment in favor of promoting traditional medicine, any national pharmacopoeia document or monographs on antimalarial medicinal plants aren't currently available. The aim of this study is to evaluate the knowledge and perception of traditional healers on the effectiveness and availability of 12 antimalarial plants from Burkina Faso. The survey was carried out on 12 antimalarial plants from western region during January-March 2013. The informants were 100 traditional healers and herbalist from the Western region, which gathered in association affiliated to General Directorate of Pharmacy, Medicines and Laboratories. A semi-structured and open questionnaire and herbarium were used for plant identification. The data showed that *Securidaca longepedunculata* (66%) and *Zanthoxylum zanthoxyloides* (64%) was the lowest available followed by *Pavetta crassipes* (57%), *Argemone mexicana* (48%) and *Cochlospermum planchonii* (44%). The root uses of *C. planchonii* (51%), *S. longepedunculata* (24%) and *Z. zanthoxyloides* (11%) were probably their threat. *S. longepedunculata*, *Z. zanthoxyloides* and *P. crassipes* are really in endangered due to their large medicinal uses particularly in malaria treatment. It need a new policy management and integrated breeding for these plants.

Keywords: Ethnobotanical, Endangered Plants, Malaria, Traditional Medicine

1. Introduction

In the last decade, investment in malaria control strategies has contributed to a significant reduction in malaria cases and deaths worldwide [1]. Despite this situation, malaria remains a leading cause of morbidity and mortality, with an estimated 216 million cases and 445,000 deaths in 2016. The burden of

disease lies in Africa and, it is associated with poverty. Of all malaria deaths, 86% occur in children under 5 years [1]. There are four main species of malaria occurring in humans, *Plasmodium falciparum* (*P. falciparum*), *P. malariae*, *P. ovale* and *P. vivax*. They are all transmitted by mosquitoes of the genus *Anopheles*, of which exist over 400 species [2].

According to the WHO annual local statistical report (2017),

malaria was the leading cause of infantile death and constitutes a public health threat for the whole population in Burkina Faso. The geographical and financial limited accessibility of people to health services combined to the poor quality of these facilities contribute to the promotion of medicinal plants uses [3-6]. Despite the relatively abundant literature on local medicinal plants supported by an institutional environment in favor of promoting traditional medicine in Burkina Faso, any national pharmacopoeia document or monographs on antimalarial medicinal plants aren't currently available. The current research aims to evaluate the traditional healer knowledge's and perception on the effectiveness and availability of 12 antimalarial plants from Burkina Faso with well proven biological activities.

2. Methodology

2.1. Study Area

The study area is located in the West of Burkina Faso (Figure 1). It is situated between 9°21'N and 13°40'N and 2°27'W and 5°29'W and has a surface area of 94 647 km², which is about 34% of the country's area. The hottest period in this area starts from March to May with a mean temperature of 39.5°C. The mean annual rainfall of the region is between 750 mm to 1100 mm. The additional administrative and phytogeographic information were described by Zerbo et al., [4].

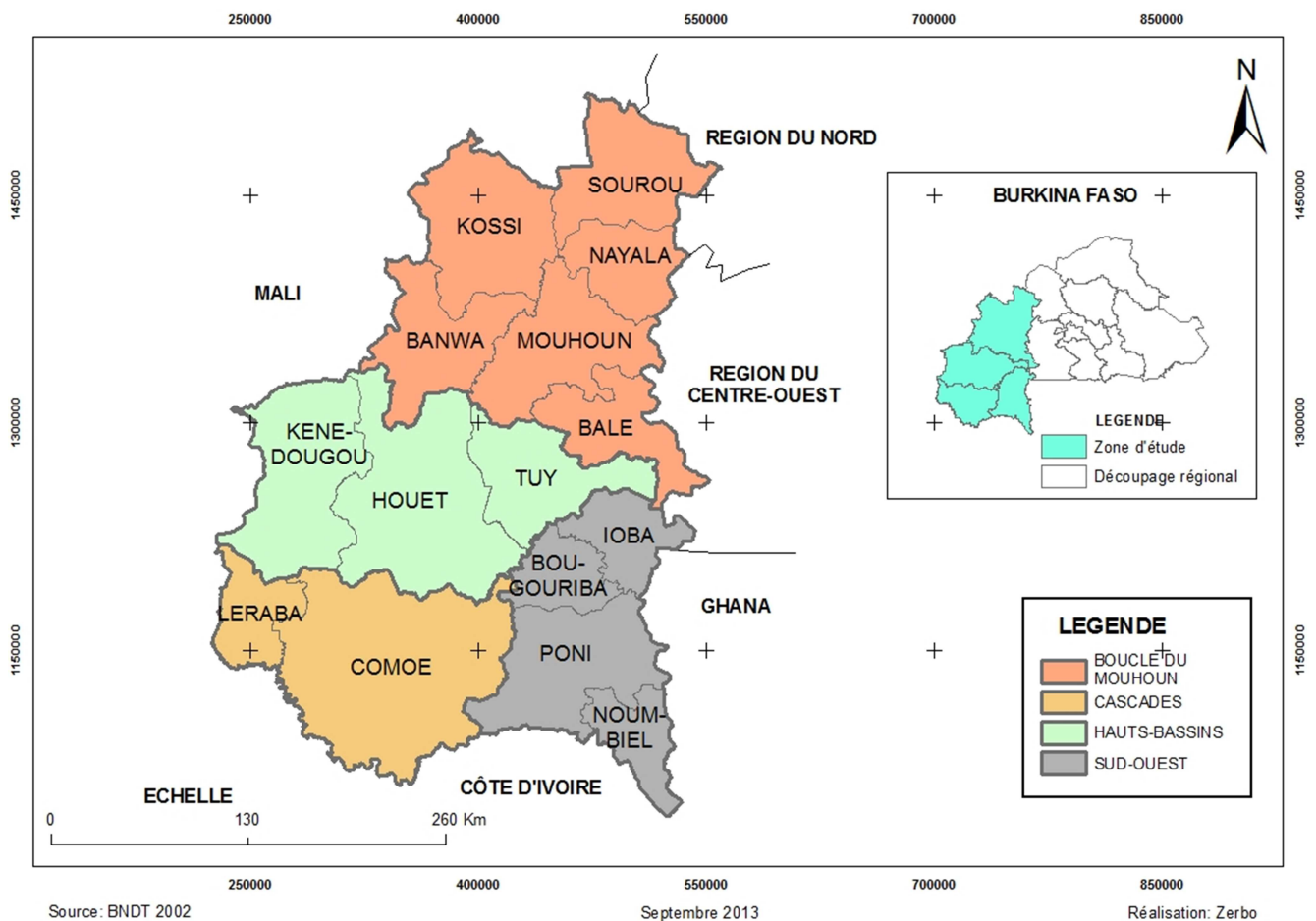


Figure 1. Localization of studied area.

2.2. Data Collection

The survey was carried out between January and March 2013. Traditional healer's organizations were approached, and the study objective was explained in the local language (Dioula) and official language (French). Our investigations were conducted with 100 herbalists and traditional healers from four regions in the western part of Burkina Faso namely Hauts-Bassins, Cascade, Boucle de Mouhoun, Sud-Ouest regions. Ethnobiological research was done by using the guideline of the ISE code of the ethics [7]. According to bibliographic survey concerning antimalarial plants from

Burkina, 12 plants were chosen for ethnobotanical and availability studies (Table 1). The plant selection was made according to demonstrated biological activity and medicinal plant documentations (Table 1). The origin of sample used in the antimalarial activities was mainly Burkina Faso excepted *Securidaca longepedunculata* and *Argemone mexicana* which were from Mali. Herbarium specimen of all selected plants were shown to each herbalist or traditional healer. The interviewed person was first asked to identify the herbarium plant before answering to the questions about this plant. The traditional healer and herbalist were secondly interviewed

concerning their identity, education, principal activity and the time of experience. After that, they were interviewed on the 12 plants. The herbariums used are kept in the ecological center of the life and soil department of the University Ouaga 1. The herbarium reference of plants was indicated in the table 1. The questionnaire focused on the local name, the main uses, the part(s) of the plant used, the method of preparation, the period of harvest, the harvest technique, the drying and conservation of the plant. The sites, the conservation time, any knowledge

on toxicity and efficacy, the secondary effect and the associated plants were also researched. Finally, the resource availability, the endangered species and the sustainable management mode were also collected as ecological information. During the ethnobotanical survey, all traditional healers were gathered together in the main town of each region. Ethnobotanical survey team has taken a commitment to share the data concerning monograph for five endangered medicinal plants from Burkina Faso.

Table 1. Antimalarial and toxicological previous studies of 12 plants.

Species	Herbarium reference	In vitro antimalarial Previous report origin	Previous toxicity studies
<i>Anogeissus leiocarpus</i> (DC.) Guill. & Perr. (Combretaceae)	16720	Burkina Faso [8]	Its extract DL ₅₀ was 1400mg/kg and was safely in bon-santé cleaner [9, 10].
<i>Argemone mexicana</i> L. (Papaveraceae)	16717	Mali [11]	Its extract exhibits acute toxicity in mice with LD ₅₀ of 400 mg/kg b. w. i. p and was used in reverse pharmacology for developing an anti-malarial phytomedicine in Mali clinic effectiveness of aqueous plant extract demonstrated [12-14].
<i>Boswellia dalzielii</i> Hutch (Burseraceae)	16721	Burkina Faso [15]	The aqueous extract of stem bark did not show toxicity signs or death at doses ≤2000 mg/kg p.o.[16]
<i>Cassia alata</i> L. (Caesalpinaceae)	16719	Burkina Faso [17]	Nontoxic effect of the hydroethanolic extract of leaves (DL ₅₀ : 18.5g/kg p.o.). [18]
<i>Cochlospermum planchonii</i> Hook.f. ex Planch. (Cochlospermaceae)	16712	Burkina Faso [19]	50 mg/kg b. w. of the aqueous extract of rhizome may not be completely safe as an oral remedy and aqueous root extract was clinically efficient without significant side effects [20, 21].
<i>Combretum glutinosum</i> Perr. ex DC. (Combretaceae)	16718	Burkina Faso [22]	Leave extract presented a relative cytotoxicity effect.[23]
<i>Crossopteryx febrifuga</i> (Afzel. ex G.Don) Benth. (Rubiaceae)	16716	Burkina Faso [24]	Methanolic extract of stem bark may not produce severe toxic effects at doses lower than 500mg extract/kg b. w. [25]
<i>Khaya senegalensis</i> (Desv.) A.Juss. (Meliaceae)	16715	Burkina Faso [26]	Aqueous stem bark extract may possess toxic potential.[27]
<i>Pavetta crassipes</i> K.Schum. (Rubiaceae)	16702	Burkina Faso [22]	Leave extract and alkaloids fraction presented a relative cytotoxicity effect.[23]
<i>Pterocarpus erinaceus</i> Poir (Leguminosae)	16714	Burkina Faso [26]	The ethanolic stem bark extract DL ₅₀ was 5000mg/kg, p.o. [28]
<i>Securidaca longepedunculata</i> Fresen. (Polygalaceae)	16713	Mali [29]	Root aqueous extract could be associated with tissue structural damage of some vital organs (DL ₅₀ : 37mg/kg, IP). [30]
<i>Zanthoxylum zanthoxyloides</i> (Lam.) Zepern. & Timler (Rubiaceae)	16710	Burkina Faso [8]	Methanolic root-bark (5 g/kg p.o.) could be safe.[31]

2.3. Statistical Studies

After ethnobotanical survey, 1200 sheets obtained were centralized in University Ouaga 1. They were digitized by using SPSS software V.17 with a questionnaire file allowing making some statistical analyses. GraphPad v.6 was used for graphs making.

2.3.1. Demographic Studies

Frequencies of studies level, origin of knowledge, main activity of traditional healers were calculated. The percentage of Traditional Healers and Herbalist (TH/H) who identified properly species in malaria treatment was calculated.

2.3.2. Plant Statistics

The frequencies of field and part uses, preparation and administration modes, technical, period and site harvesting, the availability and sustainable management were determined.

The traditional healers and herbalist preference number (TPN) was the total number of traditional healers or herbalists who preferred the plant for malaria treatment. The global

identification rate (GIR) was the relative number of TH/H who identified the plant as a medicinal plant. The Identification Rate as a Medicinal Plant (IRMP) and the Efficacy Rate (ER) were defined according to the equations (1) and (2) respectively.

$$\text{IRMP} = \frac{A-B}{A} * 100 \quad (1)$$

$$\text{ER} = \frac{A-C}{A} * 100 \quad (2)$$

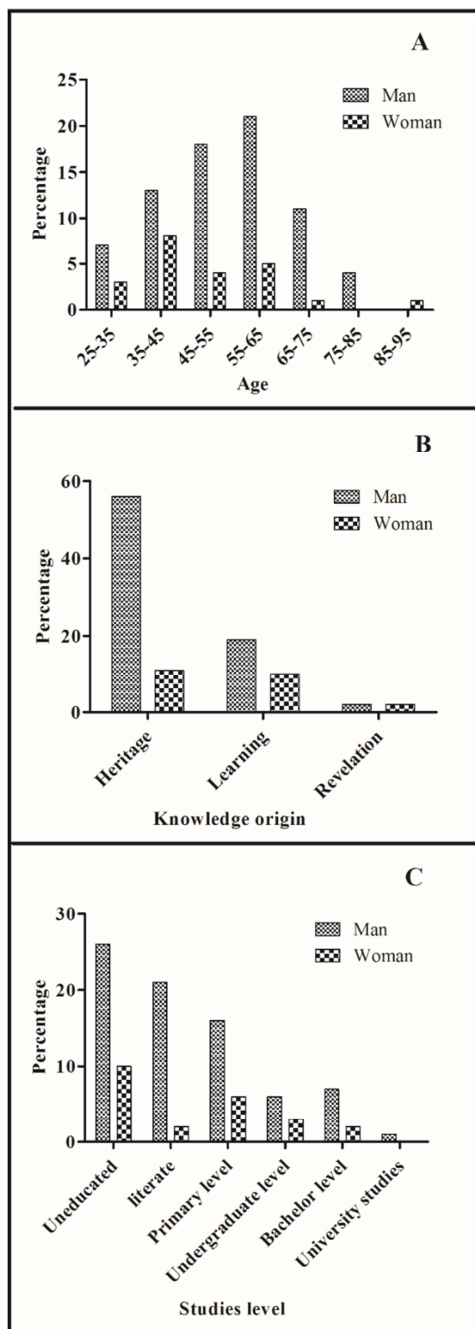
Where; A: The global identification rate, B: total number of interviewed persons who did not use the plant as medicine, C: total number of interviewed persons who confirmed the plants' antimalarial efficacy.

3. Results

3.1. Socio-economic and Demographic Profile of the Informants

Ninety seven percent (97%) of informants were from the different traditional and herbalist associations. The age

informants were from 25 to 95 years, with the majority age of men between 55 to 65 years and the women majority age was between 35 to 45 years (Figure 2 A). The different ages were saved according to the information from Burkinabè national identity card. According to the ethnobotanical survey, more than 88% of the interviewed persons have an experience of over ten years. This population obtained their knowledge by heritage (67%), through learning (29%) and revelation (4%) (Figure 2 B). Remarkably, 56% of this people cannot read and write in French, the official language of Burkina Faso (Figure 2 C). In addition, 99% of interviewed were believe in God for curing their patients. Most informants (96%) have patient care as main profession.



A: age, B: knowledge origin, C: studies level

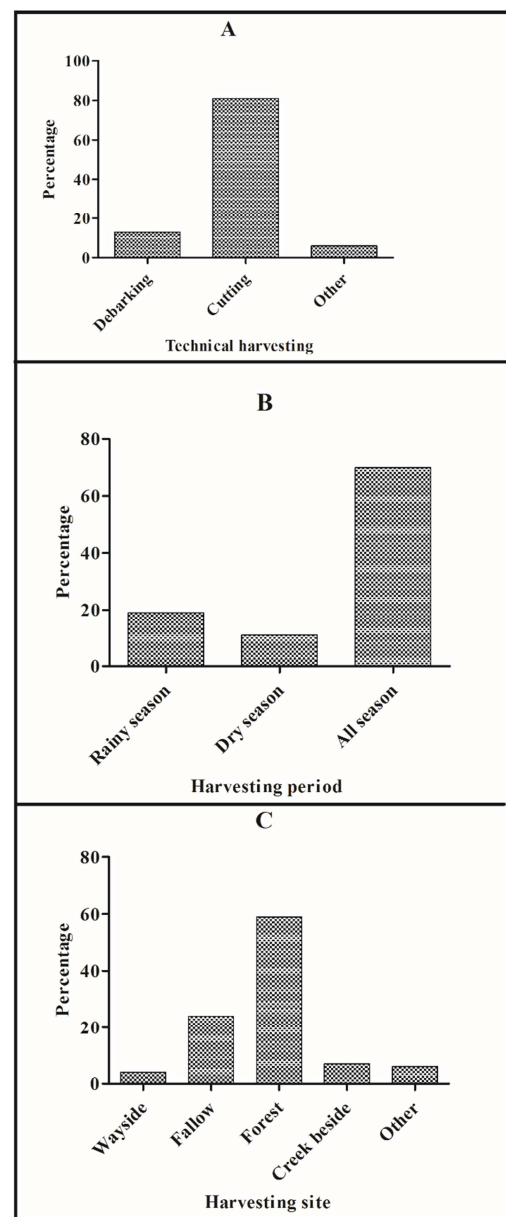
Figure 2. Traditional healers and herbalist demographic profile.

3.2. Traditional Healer Challenges

During the ethnobotanical survey, the current problems indexed by the traditional healers and herbalists (100%) were the storage, the administration and the dosage modes. The different TH/H associations were affiliated to the Department of health Ministry named Direction Générale de la Pharmacie, du Médicament et des Laboratoires (DGPML). The lack of adequate documentation, of packing and proper training hinders traditional medicine development. The TH/H (97%) have indicated that they don't only treat their patients, but they also give them an advice on the prevention ways of malaria i.e. the use of mosquito, clearing bushes, avoiding stagnant water.

3.3. Ethnobotanical Characteristics and Ecology

3.3.1. Conservation Level



A: technical harvesting, B: harvesting period, C: harvesting site

Figure 3. Plant sampling.

Different parts of the plant were used by traditional healers and herbalists. The leaves (47%) and the root (17%) were mostly used in malaria treatment. Particularly, the rate of root uses of *C. planchonii*, *S. longepedunculata* and *Z. zanthoxyloides* were 51%, 24% and 11% respectively. The decoction represented 87% of preparation mode and was used by the majority by drinking. The part used were obtained by cutting in majority (70%), but there is no specific period for cutting (Figure 3, A, B). In general, plants were stored in sachet (88%) after drying in shadow (82%) or in the sun (16%). Notably, there is no limited period for plant storing.

3.3.2. Perception of the Quality of Harvested Samples

All plants were identified as medicinal plant according to the IRMP with index superior at 79.6% (Table 2). According to the different global rates of plant identification (Table 2), *C. alata* (87%) was the best known followed by *C. planchonii* (82%) and *K. senegalensis* (81%) by using the herbarium,

while *B. dalzielii* was hardly known (33%). According to TH/H, there is no doubt about the effectiveness of these plants in malaria treatment. *C. alata* was regarded as the most effective followed by *C. planchonii* and *A. leiocarpus*, while this last plant did not have a good preference rate in contrast to the two first plants (Table 1). The TH/H (98%) considered that there were no side effects and toxicity for all plants such as there is no contraindication. TH/H information could be partially justified by previous clinical and toxicological studies (Table 2). More than 95% of the people have harvested the different plants without considering the plant age. The savannah forest is the best place to harvest (64%) even if the plant harvested is in fallow (21%) (Figure 3 C). In considering the traditional healers and herbalist preference number and the efficacy rate the three best antimalarial plants were *C. planchonii*, *C. alata*, and *P. crassipes* that the activities were demonstrated (Table 1).

Table 2. Perception of medicinal plants availability and statistics.

Species	Local name	Relative availability (%)			Plants statistics			Major mode of preparation
		Low	Medium	Abundant	TPN	GIR (IRMP)	N (EF)	
<i>S. longepedunculata</i>	Djoro	66	9	25	22	60(98.4)	35(58%)	Decoction of root and root bark
<i>Z. zanthoxyloides</i>	Wouho	64	11	24	9	55(98.2)	31(56%)	Decoction of root and root bark
<i>P. crassipes</i>	Too fla, Koumou yiri	57	19	24	35	55(91.7)	41(74%)	Decoction of leaves and stem leaves
<i>A. mexicana</i>	Bagan gwè, Baakoro yiri	48	15	38	23	44(100)	36(82%)	Decoction of leaves and stem leaves
<i>C. planchonii</i>	N'dribala, Kongo, kòride	44	20	37	69	82(100)	70(85%)	Decoction of root and root bark
<i>B. dalzielii</i>	Kongo, nimou Fadougani	41	7	52	5	33(100)	19(57%)	Decoction of stem leaves and stem bark
<i>C. alata</i>	Kouwo; taaba Kankaliba	23	19	58	48	87(100)	78(90%)	Decoction of leaves and stem leaves
<i>P. erinaceus</i>	Sihindjan gwè, Goni yiri	22	17	61	12	43(79.6)	33(76%)	Decoction of stem leaves and stem bark
<i>C. febrifuga</i>	Babouwo ni, Kènèma, djoun	22	15	63	12	57 (98.3)	44(77%)	Decoction of leaves and stem leaves
<i>A. leiocarpus</i>	N'galama, Kèrèkètè	18	10	72	28	68 (100)	62(91%)	Decoction of stem and leaves
<i>K. senegalensis</i>	Djalan yiri	7	11	82	14	81(98.8)	52(64%)	Decoction of stem bark
<i>C. glutinosum</i>	Wagara, Kambeleba	4	18	78	13	57(100)	34(60%)	Decoction of leaves and stem leaves

TPN: traditional healers and herbalist preference number,

GIR: Global Identification rate,

IRMP: Identification rate as a medicinal plant,

N(ER): number and efficacy rate

3.3.3. Availability of Species

The perception of the 12 medicinal plants availability of the traditional healer and herbalist is shown in Table 2. *S. longepedunculata* and *Z. zanthoxyloides* were the lowest available followed by *P. crassipes*, *A. mexicana* and *C. planchonii*. The roots use of *C. planchonii* (51%), *S. longepedunculata* (24%) and *Z. zanthoxyloides* (11%) were probably their threat. While the most abundant plants were *C. glutinosum* (96%), *K. senegalensis* (93%) and *A. leiocarpus* (82%). For a sustainable management of medicinal plants, 32% TH/H proposed to realize some grove, 20% to protect the forest and 14% to grow. Thirty four percent did not have a solution.

4. Discussion

In this work, it was presented the current traditional healer and herbalist knowledge on 12 medicinal plants with antimalarial properties well-demonstrated (Table 1). It was found that older people (middle age, 53.55) with little formal or institutional education have a lot of knowledge about the uses of 12 medicinal plants despite that the younger with age between 15-29 years represented 51% of population. It is a profession dominated by the elderly and uneducated men like indicated by Balamurugan et al. study [32]. The average practice experience was 23 years. It was confirmed that traditional medicine was a current activity for TH/H in western of Burkina. This information demonstrates that the

traditional medicine practice was not properly accepted by the young people, and therefore a breakdown in spreading of knowledge might be the cause of rapid loss of valuable information regarding the use of medicinal plants in this area. This situation is similar to that reported by Muthee et al. and Gakuya et al. studies [33, 34]. In addition, the identification rate variability reflects the study level of TH and herbalists or the influence of the herbarium used in plant identification. It is the first time they were interviewed by using herbarium according to them.

The majority uses of stem and leaves in this study could be explained by their easy accessibility in contrast to the roots, fruits and flower [5, 35, 36]. In addition, leaves uses could be a best ways to protect the plants as digging out roots might be the cause of death of the plant and putting the species in a vulnerable condition [5]. The traditional healer had a variety of opinions concerning the availability of useful plants, but the majority found that these plants are not available. Previous investigation have notified that *S. longepedunculata*, *Z. zanthoxyloides*, *P. crassipes*, *B. dalzielii*, *P. erinoceus*, *C. febrifuga*, *A. leiocarpus*, *K. senegalensis* were endangered in Burkina Faso [37]. Tapsoba and Deschamps (2006) studies have found that *S. longepedunculata* and *B. dalzielii* are endangered antimalarial medicinal plant in Plateau central area in Burkina Faso [38]. The causes of medicinal plants disappearance were manifold such as anthropogenic factors, rainfall decrease, fire management, deforestation and poor protection of forests. For example *C. planchonii* and *C. alata* were used in antimalarial phytomedicinal by Phytofla at Banfora [39]. This ethnobotanical survey site was the main agro-pastoral area with a significant number of protected forests (national parks, game reserve, state forests), but it was demonstrated that this area was submit yearly to bush fires [40]. In previous study, the fallow have been suggested to be a sustainable management of medicinal plants in this area [41].

Concerning the effectiveness of different plant found in informant, it could be supported by the previous antimalarial investigations (Table 1), particularly the three most preference plants namely *C. planchonii*, *C. alata* and *P. crassipes* biological proprieties evaluated by searcher Burkinabè [17, 39, 42]. Although traditional healer and herbalists were convinced of non-toxicity of these plants, it is found that in previous studies that plant extract could present some toxicity (Table 1).

5. Conclusion

In this study it was found that *C. planchonii*, *C. alata* and *P. crassipes* were presented a general consent, which claims for subsequent clinical investigations. According to importance medicinal uses in malaria treatment in Burkina Faso, it would be desirable to realize a prioritization study of plants. The endangered plant that is *S. longepedunculata*, *Z. zanthoxyloides*, *P. crassipes*, *A. mexicana*, and *C. planchonii* will be used in monograph redaction and quality control.

List of Abbreviations

ER: Efficacy rate
GIR: Global identification rate
IRMP: Identification rate as a medicinal plant
TH/H: Traditional Healers and Herbalist
TPN: Traditional healers and herbalist preference number

Ethics Approval and Consent to Participate

The investigation was carried out according to DGPML (General Direction of Pharmacy, Medicine and Laboratories) procedures through its Traditional Medicine and Pharmacopoeia Direction. The different Traditional healer's organizations were approached, and the study objective was explained in the local language (Dioula, Moore) and official language (French) for getting their consent. Each participant was explained clearly, about the benefit of this study. A verbal consent was obtained before administering the questions. The cost of travel, the restoration and the time spent were modestly payed.

Competing Interests

The authors declare that they have no competing interests

Author Contributions

M.C.: Contribution: ethnobotanical survey, redaction of paper, data analysis

R.N-T M.: Main contribution: Ethnobotanical survey, article correction,

P. Z.: Main contribution: Ethnobotanical survey, article correction,

I. K.: Main contribution: Data collection by SPSS

O.T.: Main contribution: Data collection by SPSS

A. LM.: Main contribution: Data analysis, article correction

M. K.: Main contribution: Article correction, data analysis

J. N.: Main contribution: Data analysis control, article correction

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Appendix

APPEAR / Interviewer number..... Date

Herbalist information

Full name

Age.....Sex

Region.....Province.....

Village.....Tel:

Ethnic group:

Level of education: ☐ Literate ☐ Primary level ☐ Undergraduate level ☐ bachelor level ☐ University level

Main activity: ☐ Cultivator ☐ Farmer ☐ TPS ☐ Other.....

Duration of activity.....

Herbalist: ☐ Non ☐ Yes

Mode of learning: ☐ Heritage ☐ Learning ☐ Revelation ☐ Other...

Association membership ☐ Non ☐ Yes

If Yes, Which?

Does He carry other traditional medicinal practice? ☐ Non ☐ Yes

If Yes, Which?

Best 3 plants antimalarial (about 12).....

The three most endangered or rare plants (About 12).....

Malaria Knowledge.....

APPEAR / Informant number:APPEAR / Plant number:

1. Ethnobotanical characteristics

Local Name.....

Current Name:

Species.....

Uses domain: ☐ Medicinal ☐ Food ☐ Fodder ☐ Aromatic.

Other uses ☐ Crafts ☐ Firewood, ☐ Coal, ☐ Construction

Main diseases treated by the plant

.....

Part used in malaria treatment: ☐ Root ☐ Root bark ☐ Stem leaves ☐ Leaves ☐ Stem bark ☐ Fruits ☐ flower ☐ whole plant ☐

Other.....

The age of harvested plant ☐ Seedling ☐ Tree,

Number of patients treated during the season

Technical harvesting: ☐ Debarking ☐ Cutting ☐ Other

Harvesting period ☐ Rainy season (end/beginning) ☐ Dry season end/beginning)

Harvesting moment: ☐ Sunrise ☐ Morning ☐ noon ☐ Evening ☐ Night

Drying technique: ☐ Sun ☐ Shadow ☐ Fumigation ☐ Other

Préservation technique: ☐ Sachet ☐ cardboard ☐ Barrel ☐ Other

Shelf life:(year).

Harvesting site: ☐ Roadside ☐ Cultivated field ☐ Young fallow ☐ Forest ☐ Backwaters (bank) ☐ Other.....

Administration mode: ☐ Mastication ☐ Compress ☐ Macerated ☐ Tea ☐ Decoction ☐ Syrup ☐ Ointment (cream) ☐ Vaporization

☐ Inhalation ☐ Porridge ☐ Cauterization ☐ Powder ☐ suppository ☐ Lotion

Perceived effectiveness ☐ High ☐ Means ☐ Low

Plant toxicity ☐ High ☐ Means ☐ Low

Side effects.....

Associated plant.....

Prohibition: ☐ Child ☐ Expectant mother ☐ Hypertension ☐ Diabetes

2. Ecology

Availability of the species in the region: ☐ Absent ☐ Rare ☐ Means ☐ Abundant

Age of disappearance observation

Proposal for sustainable management: ☐ Wild harvest ☐ Grown ☐ Protected (fields) ☐ Groves ☐ Other:

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