Antimalarial and antianemic medicinal plants used by traditional medicine practitioners and the populations of the Korhogo 1 health district (Poro Region, Ivory Coast)

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Abstract

The purpose of this study is to identify a list of medicinal plants used by Traditional Medicine Practitioners and the populations to treat malaria and anemia in the health district of Korhogo 1. The ethnobotanical survey carried out among 251 people, including 51 practitioners of traditional medicine and 200 people from the general population identified 49 species for the treatment of malaria. Individuals cited *Azadirachta indica* 54 times, *Carica papaya* 51 times and *Nauclea latifolia*. For the treatment of anemia, 36 species have been identified, of which the most cited are: *Hibiscus sabdariffa* (38 citations), *Tectona grandis* (27 citations) and *Justicia secunda* (27 citations). The predominantly methods of preparation of remedies are decoction (63.84%), maceration (11.15%). The remedies are administered in the majority of cases orally in the form of 64.04% drink. The leaves represented 51.26% of the organs used in the preparation of herbal remedies. As part of this survey, nearly 85 plant species were listed for their antimalarial and anti-anemic properties. These species constitute potential resources that can lead to the isolation of phytocompounds of therapeutic interest. Also, given the strong use of medicinal plants by the communities, at around 90%, the ivorian government, through the Ministry of Health, has integrated into its health policy and its strategy for the development and promotion of health. Traditional medicine the research and promotion component of the traditional African pharmacopoeia. This, with the aim of making available to the populations effective Improved Traditional Medicines, of guaranteed quality and harmlessness.

Keywords: Malaria; Anemia; Traditional Healers; Korhogo; Policy; Development; National Health System

1. Introduction

Malaria is a febrile and hemolyzing erythrocytopathy due to the presence and development in the liver and then in the red blood cells of a protozoan of the genus Plasmodium transmitted to man by the bite of an infected female Anopheles [37], [44], [45]. Over 91% of malaria deaths occur in Sub-Saharan Africa, malaria is one of the leading causes of death [38]. These malaria-related deaths are mainly due to the onset of severe anemia [39], [40]. The epidemiological studies carried out in the health district of Korhogo 1 for the year 2019 made it possible to notify the most commonly encountered pathologies, in particular: malaria, anemia, acute respiratory infections (ARI), diarrheal diseases and...
Dermatoses. The Korhogo 1 health district has, in a register, all the pathologies identified and the number of cases. These data come from different public and private health establishments, at different levels. Among these pathologies, malaria and anemia remain by far those with the highest mortality rate [36], [38]. Out of a population of 141,330 people, we have 28,979 confirmed cases. Malaria, 7,022 confirmed cases in children under 5 with an incidence of 205 ‰ [12].

Faced with the extent of these pathologies in the study area, a large majority of the population uses medicinal plants for treatment for reasons of great accessibility to herbal remedies and for socio-cultural considerations [30]. The area of Korhogo is known to be an area straddling tradition as evidenced by the figures relating to the number of traditional medicine practitioners in the city with more than 166 Traditional medicine practitioners identified and trained by the National Program for the Promotion of Medicine. Traditional [11]. These traditional practices in the treatment of certain pathologies need to be documented in order to preserve the know-how of the populations in the management of recurrent pathologies in the area. Because the current sector policy of the government is to integrate traditional medicine and pharmacopoeia into the national health system in order to improve the health coverage of the health needs of the populations. The present study aims to inventory the antimalarial and antianemic plant species used in the composition of herbal remedies offered to patients from a survey of practitioners and users.

2. Material and methods

2.1. Framework

The geographic scope of the study was the Korhogo Health District 1. This District is one of two (2) health districts of the Korhogo health region in the Poro region. It brings together the city of Korhogo and the sub-prefectures of Napieolodougou, Tioro, Lataha, Karakoro, Komborodougou, Kiémou, Sohouo, Dassoungbo, Kombolokoura and Koni.

2.2. Choice of study area

Korhogo was chosen for its richness in cultural heritage and traditions. It is also full of many Traditional Medicine Practitioners (PMT) recognized and renowned for their expertise.

Figure 1 Health district map
Korhogo 1 was selected because of the high frequency of these pathologies, in particular malaria and anemia in this health district, the purpose of which is to identify the medicinal plants commonly used for the management of these endemics.

2.3. Type and duration of the study
This is a prospective cross-sectional study with a descriptive and analytical aim. It lasted three (3) months (from March 13 to June 15, 2020). The target populations consisted of 51 traditional medicine practitioners and 200 people from the population.

2.4. Target populations and inclusion criteria
To collect a large amount of information on medicinal plants, part of the survey was carried out among PMTs and the other among populations made up of traditional medicine practitioners and residents of the Korhogo health district 1.

- PMTs installed in the health district of Korhogo 1 and recognized by the National Program for the Promotion of Traditional Medicine (PNPMT).
- PMT members of the Association of Healers and Traditional Healers of Korhogo (AGTK);
- Adults residing in the Korhogo 1 health district and having given their consent or informed consent to participate in the survey.

51 Traditional Medicine Practitioners and 200 people from the population were surveyed (Table 1 and 2)

Table 1 Breakdown of PMT’s according to survey locations

| Workplace         | Effective | Percentage (%) |
|-------------------|-----------|----------------|
| Korhogo town      | 35        | 68.6           |
| Karakoro S/P      | 1         | 2              |
| Komborodougou S/P | 2         | 3.9            |
| Klofohakaha       | 2         | 3.9            |
| Lélékaha S/P      | 1         | 2              |
| Napié S/P         | 7         | 13.7           |
| Tioro S/P         | 3         | 5.9            |
| TOTAL             | 51        | 100            |

Table 2 Distribution of the population according to the survey sites

| Workplace          | Effective (N) | Percentage (%) |
|--------------------|---------------|----------------|
| Korhogo town       | 133           | 66.5           |
| Village of Klofohakaha | 14        | 7              |
| S/P Karakoro       | 9             | 4.5            |
| S/P Napiéolodougou | 16            | 8              |
| S/P Kiémou         | 8             | 4              |
| S/P Komborodougou  | 2             | 1              |
| S/P Lataha         | 18            | 9              |
| TOTAL              | 200           | 100            |
The average age of the people surveyed is 54.84 years with a minimum of 34 years and a maximum of 82 years and the standard deviation is 10.15. The most represented age group is [55-65] with 43.1%.

3. Method of collecting information

3.1. Ethnobotanical survey
The study was carried out using a structured method following the previously developed questionnaire. It was carried out with PMTs at their various workplaces and with the population through home and market visits in the Korhogo 1 health district, respecting criteria.

3.2. Collection of medicinal plants
Using the vernacular names given by PMTs and the people, the various medicinal plants were harvested either by gathering in the wild or by purchasing bundles of leaves at the medicinal plant supply market.

3.3. Botanical identification
Each different medicinal plant has been identified by the National Program for the Promotion of Traditional Medicine (PNPMT and confirmed at the National Floristic Center (CNF) of Felix Houphouët Boigny University in Abidjan.

3.4. Data processing
The survey data were entered using Word and Excel 2010 software. Tables and figures were produced with EXCEL 2010 software to better assess and explain the level of knowledge about malaria, anemia and the plants used for support.

4. Results

4.1. Distribution of PMTs by age
The average age is 54.84 years; the minimum age is 34 and the maximum age is 82. The most represented age group is [55-65] with 43.1%. It is followed by that of [35-45] with 21.6% of PMT (figure 2).

![Figure 2 Distribution of PMT by age](image)

4.2. Distribution of PMT's by gender
Most of the PMT's questioned are men (80.4%). The sex ratio is 4.1 (M / F).

4.3. Distribution of PMT's by place of work
The workplace of the majority of PMT surveyed is the town of Korhogo (Table 3).
Table 3 Breakdown by workplace

| Workplace            | Effective | Percentage (%) |
|----------------------|-----------|----------------|
| Korhogo town         | 35        | 68.6           |
| Karakoro S/P         | 1         | 2              |
| Komborodougou S/P    | 2         | 3.9            |
| Klofohakaha          | 2         | 3.9            |
| Lélékaha S/P         | 1         | 2              |
| Napié S/P            | 7         | 13.7           |
| Tioro S/P            | 3         | 5.9            |
| **TOTAL**            | **51**    | **100**        |

4.4. Distribution of PMTs according to level of study

Only 11.8% of PMT questioned have primary and secondary education. Also, 66.7% of them have not been to school (Table 4).

Table 4 Distribution of PMTs by level of study

| Level Of Study     | Effective | Percentage (%) |
|--------------------|-----------|----------------|
| Primary            | 6         | 11.8           |
| Secondary          | 6         | 11.8           |
| University         | 3         | 5.9            |
| Koranic school     | 2         | 3.9            |
| Illiterate         | 34        | 66.7           |
| **TOTAL**          | **51**    | **100**        |

4.5. Distribution of PMTs according to the mode of acquisition of traditional knowledge

The majority of LMPs surveyed (58.8%) acquired their traditional knowledge through apprenticeship. Only 3.9% became PMT by ambition (Figure 3).

Figure 3 Distribution of PMTs according to the mode of acquisition of traditional knowledge
4.6. Distribution of PMT according to seniority

PMTs with a seniority of 10 to 20 years are the most represented (47.06%) (Table 5).

**Table 5 Distribution of PMTs according to seniority**

| Year       | Effective | Percentage (%) |
|------------|-----------|----------------|
| [10; 20] years | 24        | 47.06          |
| [20; 40] years | 17        | 33.33          |
| ≥40 years   | 10        | 19.61          |
| TOTAL       | 51        | 100            |

4.7. Distribution of PMT according to the number of patients received per month

The majority of PMT surveyed (86.3%) receive less than 100 patients per month. Only 5.9% receive at least 200 patients per month.

4.8. Directory of medicinal plants used by PMTs

Medicinal plants used in the treatment of malaria 49 species of medicinal plants have been identified as part of the treatment of malaria. *Azadirachta indica* (54 citations) is the most cited, followed by *Carica papaya* (51 citations) and *Nauclea latifolia* (51 citations) (Table 6).

**Table 6 List of antimalarial plants identified in Korhogo health district 1**

| Nº | Latin binomials               | Families         | Vernacular names                  | NC | Parts used | Method of preparation | Fashion administration                  |
|----|-------------------------------|------------------|-----------------------------------|----|------------|-----------------------|------------------------------------------|
| 1  | *Azadirachta indica* A. Juss | Meliaceae        | Neem (French)                     | 54 | Sheets ; bark; seeds | Grinding; decoction; infusion | Oral route; bath ; steam bath            |
| 2  | *Vernonia colorata* (DC.) C.  | Arecaceae        | Kossafinin (Dioula)              | 34 | Sheets     | Grinding              | Oral route; bath                         |
| 3  | *Carica papaya* L.            | Caricaceae       | Papayer (French)                 | 51 | Sheets ; roots | Grinding ; decoction ; macération ; infusion | Oral route; bath ; steam bath           |
| 4  | *Mangifera indica* L.         | Anacardiaceae    | Manguier (French)                | 44 | Sheets ; bark; roots | Broyage ; décoction ; macération ; hydrolysat | Oral route; bath with black soap + ash  |
| 5  | *Nauclea latifolia* Sm.       | Rubiaceae        | Bati (Dioula); Zanvalm (Senoufo); Bitter yellow (French) | 51 | Sheets ; roots; bark | Decoction; maceration | Oral route; purge                        |
| 6  | *Bambusa vulgaris* Schrad. Ex | Poaceae          | Chinese bamboo (French); Bobourou (Dioula) | 26 | Sheets     | Decoction              | Oral route; purge                        |
| No. | Common Name | Family     | Local Names     | Description          | Preparation | Route       |
|-----|-------------|------------|-----------------|----------------------|-------------|-------------|
| 7   | Anogeissus leioicarpus (DC.) Guill&Perr | Combretaceae | Kérèkètè (Dioula) | Decoction; infusion | Oral route; bath |
|     |             |            | Nanganam (Senoufo) |                      |             |
|     |             |            |                 |                     |             |
| 8   | Cassia alata L. | Caesalpiniaceae | Acacia (French) | Decoction | Oral route; bath |
|     |             |            |                 |                      |             |
| 9   | Cordia myxa L. | Boraginaceae | Dolma (Senoufo) | Decoction | Oral route; bath |
|     |             |            |                 |                      |             |
| 10  | Citrus aurantifolia (Christm.) Swingle | Rutaceae | Citronnier (French) | Decoction; grinding; maceration in alcohol | Oral route; bath |
|     |             |            |                 |                      |             |
| 11  | Olax Subscorpioidea Oliv. | Olacaceae | Gangbélém (Senoufo); Ninbossi (Dioula) | Decoction | Oral route; bath |
|     |             |            |                 |                      |             |
| 12  | Flueggea virosa (Roxb. Ex Wild.) Voigt | Euphorbiaceae | Balan balan (Dioula); Galandiène (Senoufo) | Decoction | Oral route; bath |
|     |             |            |                 |                      |             |
| 13  | Moringa oleifera Lam. | Moringaceae | Moringa (French) | Decoction; infusion | Oral route |
|     |             |            |                 |                      |             |
| 14  | Tectona grandis L. f. | Lamiaceae | Teck (French) | Decoction | Oral route; bath |
|     |             |            |                 |                      |             |
| 15  | Acanthus guineensis Heine & P. Taylor | Acanthaceae | Solovoung (Senoufo) | Grinding; decoction | Oral route; bath |
|     |             |            |                 |                      |             |
| 16  | Guiera senegalensis J. F. Gmel. | Combretaceae | Ganivig (Senoufo); Koumgbè (Dioula) | Decoction | Oral route; bath |
|     |             |            |                 |                      |             |
| 17  | Musa paradisiaca L. | Musaceae | Bananier (French) | Decoction | Oral route; bath |
|     |             |            |                 |                      |             |
| 18  | Tamarindus indica L. | Caesalpiniaceae | Tamarin (French) | Decoction | Oral route |
|     |             |            |                 |                      |             |
| 19  | Combretum micranthum G. Don | Combretaceae | Kinkeliba (Dioula) | Grining; decoction | Oral route; purge |
|     |             |            |                 |                      |             |
| 20  | Khaya senegalensis (Desr.) A. Juss. | Meliaceae | Djalà (Dioula); Cailcedra (French) | Decoction | Oral route; bath |
|     |             |            |                 |                      |             |
| 21  | Alchornea cordifolia (Schumach. &Thonn.) Müll. Arg. | Euphorbiaceae | Djéka (Baoulé) | Decoction; maceration | Oral route; purge |
|     |             |            |                 |                      |             |
| 22  | Acacia nilotica subsp. adstringens | Mimosaceae | Bagana (Dioula) | Decoction | Oral route; bath |
| No. | Plant Name               | Family       | Common Names                          | Parts Used | Preparation | Route       |
|-----|--------------------------|--------------|---------------------------------------|------------|-------------|-------------|
| 23  | Aloe vera (L.) Burm.f.   | Liliaceae    | Aloes (French)                        | Sheets     | Decoction;  | Oral route  |
|     |                          |              |                                       |            | maceration   |             |
|     |                          |              |                                       |            |             |             |
| 24  | Ananas comosus (L.) Merr. | Bromeliaceae | Ananas (French)                       | Peeling of fruit | Decoction   | Oral route  |
| 25  | Cymbopogon citratus (DC) Stapf | Poaceae     | Citronnelle (French)                  | Sheets     | Decoction;  | Oral route  |
|     |                          |              |                                       |            | infusion     |             |
| 26  | Leptadenia lanceolata (Poir.) Goyder | Apocynaceae | Djrime (Senoufo)                      | Sheets     | Decoction   | Oral route; bath |
|     |                          |              |                                       |            |             |             |
| 27  | Piliostigma thonningii (Schumach.) Milne-Redh. | Fabaceae    | Gnanman (Dioula) ; Tchanhanm (Senoufo) | Sheets ; fruit; roots | Decoction   | Oral route; bath |
|     |                          |              |                                       |            |             |             |
| 28  | Pericopsis laxiflora (Benth.) Meeuwen | Fabaceae    | KoloKolo (Dioula)                     | Sheets ; roots | Decoction   | Oral route; bath; steam bath |
|     |                          |              |                                       |            |             |             |
| 29  | Zizyphus mauritiana Lam. | Rhamnaceae   | Tomonon (Dioula) ; Jujubier (French)  | Sheets ; roots | Decoction   | Oral route; bath |
|     |                          |              |                                       |            |             |             |
| 30  | Spondias mombin L.       | Anacardiaceae | Trowan (Agni)                        | Sheets; bark | Grinding ; maceration | Bath |
|     |                          |              |                                       |            |             |             |
| 31  | Ocimum basilicum L.      | Lamiaceae    | Basilic (French)                      | Sheets     | Decoction   | Steam bath  |
|     |                          |              |                                       |            |             |             |
| 32  | Psidium guajava L.       | Myrtaceae    | Goyavier (French)                     | Sheets     | Decoction   | Oral route; bath |
|     |                          |              |                                       |            |             |             |
| 33  | Prunus domestica L.      | Rosaceae     | Mirabelle (French)                    | Sheets     | Decoction   | Steam bath  |
|     |                          |              |                                       |            |             |             |
| 34  | Parkia biglobosa (Jacq.) R. Br. Ex G. Don | Mimosaceae  | Néré (French)                         | Bark       | Decoction; maceration | Oral route |
|     |                          |              |                                       |            |             |             |
| 35  | Garcinia kola Heckel     | Clusiaceae   | Small cola (French)                   | Fruit      | To chew     | Oral route  |
|     |                          |              |                                       |            |             |             |
| 36  | Alstonia boonei De Wild. | Apocynaceae  | Aimian (Agni)                         | Bark       | Maceration   | Oral route; bath; purge |
|     |                          |              |                                       |            |             |             |
| 37  | Annona senegalensis Pers. | Annonaceae  | Damourou (Senoufo) ; Madessoussou (Dioula) | Buds       | Maceration   | Oral route  |
|     |                          |              |                                       |            |             |             |
| 38  | Entada africana Guill.&Perr. | Fabaceae    | Samanérè (Dioula)                     | Roots      | Decoction   | Oral route; bath |
|     |                          |              |                                       |            |             |             |
| 39  | Cassia sieberiana DC.    | Fabaceae     | Sidjani (Dioula) ; Zangob (Senoufo)  | Roots; sheets ; bark | Decoction; maceration | Oral route; bath |
### Table

| No. | Species                                      | Family               | Common Names            | Part Used | Preparation | Route      |
|-----|---------------------------------------------|----------------------|-------------------------|-----------|-------------|------------|
| 40  | *Scoparia dulcis* L.                         | Scrophariaceae       | Timitimini (Dioula)     | Sheets    | Decoction   | Oral route |
| 41  | *Cochlospermum tinctorium* Perr. Ex A. Rich. | Bixaceae             | Touroughba (Dioula)     | Roots     | Decoction   | Oral route; bath |
| 42  | *Argemone mexicana* L.                       | Papaveraceae         | Wénigbè (Dioula)        | Sheets    | Decoction   | Oral route |
| 43  | *Ficus umbellata* Vahl                      | Moraceae             | Feraladèbè (Dioula)     | Roots     | Decoction; maceration | Oral route; bath |
| 44  | *Anacardium occidentale* L.                  | Anacardiaceae        | Cashew (French); Sonmon (Dioula) | Sheets ; bark | Decoction   | Oral route |
| 45  | *Alternanthera purgens* Kunth                | Amaranthaceae        | Kaméléssamara (Dioula)  | Sheets    | Decoction   | Oral route |
| 46  | *Lannea nigritiana* (Scott-Elliot) Keay     | Anacardiaceae        | Bembé (Dioula)          | Bark      | Decoction   | Oral route |
| 47  | *Saba senegalensis* (A.DC.) Pichon           | Apocynaceae          | Maad (Wolof) ; N’zaba (Dioula) | Sheets    | Decoction   | Oral route; bath |
| 48  | *Detarium microcarpum* Guill. & Perr.        | Fabaceae             | N’tabacoumba (Dioula)   | Sheets    | Decoction   | Oral route |
| 49  | *Terminalia macroptera* Guill. & Perr.      | Combretaceae         | Wolo (Dioula)           | Bark      | Decoction   | Oral route |

The parts of plants most used in the treatment of malaria are the leaves, bark and roots

![Figure 4](attachment:image.png)

**Figure 4** Parts of plants most used in the treatment of malaria

**4.9. Distribution of drugs used in the treatment of malaria**

The decoction is the most used method of preparation in the treatment of malaria.
The most widely used route of administration in the treatment of malaria is by mouth.

For the treatment of anemia, 36 species of medicinal plants have been identified. Among them, Hibiscus sabdariffa (38 citations) is the most cited, followed by Tectona grandis (27 citations) and Justicia secunda (27 citations). (Table 7).

**Table 7** List of anti-anemic plants identified in Korhogo health district 1

| Nº  | Latin binomials          | Families          | Vernacular names         | NC  | Parts used | Method of preparation | Route of administration |
|-----|--------------------------|-------------------|--------------------------|-----|------------|-----------------------|-------------------------|
| 1   | *Hibiscus sabdariffa* L. | (Malvaceae)       | Guinea Sorrel (French); Dah (Dioula) | 38  | Sheets; flowers | Decoction              | Oral route              |
| 2   | *Tectona grandis* L. f. | (Lamiaceae)       | Teck (French)            | 27  | Buds; sheets | Decoction              | Oral route; bath        |
| 3   | *Sorghum bicolor* (L.) Moench | (Poaceae) | Bimbiri (Dioula)       | 24  | Rods        | Decoction; maceration | Oral route              |
| 4   | *Justicia secunda* Vahl. | (Acanthaceae)     | Bassifla (Dioula)       | 27  | Sheets      | Decoction              | Oral route              |
| No. | Latin Name                          | Family       | Common Names                      | No. of Sheets | Preparation       | Route          |
|-----|------------------------------------|--------------|-----------------------------------|---------------|-------------------|----------------|
| 5   | *Bambusa vulgaris* Schrad. Ex J. C. Wendl. | Poaceae      | Chinese bamboo (French); Bobourou (Dioula) | 7             | Sheets, Decoction | Oral route; bath |
| 6   | *Lawsonia inermis* L.               | Lythraceae   | Hénné (French)                     | 7             | Sheets, Decoction | Oral route     |
| 7   | *Carica papaya* L.                 | Caricaceae   | Papayer (French)                   | 7             | Sheets, Grinding ; decoction; maceration | Oral route |
| 8   | *Sorghum halepense* (L.) Pers.     | Poaceae      | Red sorghum (French)               | 4             | Rods, Decoction   | Oral route     |
| 9   | *Anacardium occidentale* L.        | Anacardiaceae| Anacardier (French); Sonmon (Dioula) | 2             | Sheets; bark, Decoction | Oral route |
| 10  | *Adansonia digitata* L.            | Bombacaceae  | Baobab (French)                    | 2             | Sheets; bark, Decoction; sauce | Oral route; bath |
| 11  | *Antidesma venosum* E M. Mey. Ex Tul.           | Euphorbiaceae| Djelikonan (Dioula)                | 2             | Sheets, Decoction | Oral route; bath |
| 12  | *Pterocarpus erinaceus* Poir.      | Fabaceae     | Goni (Dioula); Modjawaka (Baoulé)  | 2             | Sheets; bark, Decoction | Oral route |
| 13  | *Lannea nigritiana* (Scott-Eliot) Keay | Anacardiaceae| Bembé (Dioula)                     | 2             | Bark, Decoction   | Oral route     |
| 14  | *Manihot esculenta* Crantz         | Euphorbiaceae| Cassava (French)                   | 2             | Sheets, Decoction | Oral route     |
| 15  | *Ipomoea batatas* (L.) Lam         | Convolvulaceae| Potato (French)                    | 2             | Sheets, Decoction | Oral route     |
| 16  | *Ceiba pentandra* (L.) Gaertn.     | Bombacaceae  | Cheese maker (French)              | 1             | Sheets, Sauce     | Oral route     |
| 17  | *Opilia amentacea* Roxb.           | Opiliaceae   | Kagbo (Senoufo); Korogbé (Dioula)  | 1             | Bark; roots, Decoction | Oral route |
| 18  | *Guiera senegalensis* J. F. Gmel.  | Combretaceae | Koumgbè (Dioula); Ganivig (Senoufo) | 1             | Sheets, Decoction | Oral route; bath |
| 19  | *Alchornea cordifolia* (Schumach. &Thonn.) Müll. Arg. | Euphorbiaceae| Koyiran (Dioula); Fém (Senoufo)    | 1             | Sheets, Decoction | Oral route     |
| No. | Scientific Name | Family | Common Name | Part Used | Preparations | Route |
|-----|----------------|--------|-------------|----------|--------------|-------|
| 20  | *Terminalia schimperiana* Hochst. | Combretaceae | Kpandji (Baoulé) | Bark | Decoction | Oral route |
| 21  | *Ximenia americana* L. | Olacaceae | N’ tonguè (Malinké) | Bark; roots | Decoction | Oral route |
| 22  | *Anogeissus leiocarpus* (DC.) Guill. & Perr. | Combretaceae | Nanganam (Senoufo); Kérékété (Dioula) | Sheets; bark; roots | Grinding; decoction | Oral route; bath |
| 23  | *Ficus sur* Forssk. | Moraceae | Sérétoro (Dioula) | Sheets | Decoction | Oral route |
| 24  | *Daniellia oliveri* (Rolfe) Hutch. & Dalziel | Fabaceae | Sourouchiqué (Senoufo) | Bark | Maceration | Oral route |
| 25  | *Colocasia esculenta* (L.) Schott | Araceae | Taro (French) | Sheets | Decoction | Oral route |
| 26  | *Cola cordifolia* (Cav.) R. Br. | Malvaceae | Wam (Senoufo) | Sheets | Decoction | Oral route |
| 27  | *Piliostigma thonningii* (Schumach.) Milne-Redh. | Fabaceae | Gnanman (Dioula); Tchanhanm (Senoufo) | Roots | Decoction | Oral route |
| 28  | *Phoenix dactylifera* L. | Areaceae | Date palm (French); Tamaro (Dioula) | Fruits | Maceration | Oral route |
| 29  | *Flueggea virosa* (Roxb. ex Wild.) Voigt | Euphorbiaceae | Balan balan (Dioula); Galandiène (Senoufo) | Sheets | Decoction; maceration | Oral route |
| 30  | *Alternanthera purgens* Kunth | Amaranthaceae | Kaméléssamara (Dioula) | Sheets | Decoction | Oral route |
| 31  | *Moringa oleifera* Lam. | Moringaceae | Moringa (French) | Sheets | Spraying + infusion | Oral route |
| 32  | *Annona senegalensis* Pers. | Annonaceae | Damourou (Senoufo); Madéssoussou (Dioula) | Sheets; bark; roots | Decoction | Oral route |
| 33  | *Sesamum indicum* L. | Pedaliaceae | Sesame (French) | Seeds | Spraying + maceration | Oral route |
| 34  | *Tamarindus indica* L. | Caesalpiniae | Tamarind (French) | Fruits | Decoction | Oral route |
| 35  | *Bridelia ferruginea* Benth. | Phyllanthaceae | Sagba (Dioula) | Sheets; bark | Maceration | Oral route |
| 36  | *Nauclea latifolia* Sm. | Rubiaceae | Bati (Dioula); Zanvalm (Senoufo) | Roots | Spraying + infusion | Oral route |
The parts most used in the treatment of anemia are the leaves.

**4.11. Distribution of drugs used in the treatment of anemia**

![Graph showing distribution of drugs used in the treatment of anemia]

*Figure 7* Drugs used in the treatment of anemia

The most popular form of preparation in the treatment of anemia is a decoction.

![Graph showing method of preparation most used in the treatment of anemia]

*Figure 8* Method of preparation most used in the treatment of anemia

The most common route of administration for the treatment of anemia is by mouth; 84% of users use it against 16% for baths.

**4.12. Distribution of medicinal plants identified according to the method of preparation of remedies for malaria and anemia**

We note that the decoction is the method of preparation par excellence (63.84%)
Different ways of preparing remedies

4.13. Distribution of medicinal plants identified according to the route of administration of the remedies

The majority of remedies are administered orally (64.04%)

5. Discussion

5.1. Diseases treated with medicinal plants (Malaria and anemia)

Our study concerned the most frequent pathologies in the Korhogo health district 1. For this, malaria and anemia were chosen on the basis of statistics provided by the Korhogo regional health directorate.

During the survey, we identified 86 species of medicinal plants, divided into 46 botanical families. Some plants are involved in the treatment of both pathologies at the same time.

- For malaria, we have identified 49 species, among which the most cited are: Azadirachta indica (54 citations), Carica papaya (51 citations) and Nauclea latifolia (51 citations).

The effectiveness of Azadirachta indica has been confirmed by several laboratory studies. The chemical constituents responsible for its antimalarial activity are limonoids: nimbolide and guedunine [2]. The leaves and stems of Nauclea latifolia contain glucoalkaloids, which have antipyretic activity; also, the leaves contain an active ingredient against Plasmodium falciparum [15].

In the south of Côte d'Ivoire, more precisely in the Autonomous District of Abidjan, people are turning to these same plants for the traditional treatment of malaria [2]. In Burkina Faso, populations who use traditional medicine for the treatment of malaria also use Azadirachta indica and Carica papaya, according to a study carried out by [13].
For anemia, we have identified 36 species, among which the most cited are: *Hibiscus sabdariffa* (38 citations), *Tectona grandis* (27 citations) and *Justicia secunda* (27 citations).

[49] determined that one of the characteristics of *Hibiscus sabdariffa* is its richness in anthocyanins (red calyxes). They have an antioxidant power that promotes tissue regeneration, decreases the permeability of blood capillaries and strengthens their resistance to hemolysis [27]. This could explain their traditional use in the treatment of anemia. *Tectona grandis* leaves are known to be diuretic, depurative, stimulating, anti-dysenteric and deworming and are used in traditional medicine to treat anemia [2].

In the Moyen-Comoé region, the population of the town of Abengourou uses *Hibiscus sabdariffa* and *Tectona grandis* to treat anemia by plants according to the survey carried out by [24]. Also, the study by [2] revealed that the populations of Abidjan who resort to traditional medicine, also use *Hibiscus sabdariffa*, *Justicia secunda* and *Tectona grandis* to treat anemia.

Also, *Solanum lycopersicum* is said to be used as an antianemic in Côte d’Ivoire, in the town of Abengourou [24].

### 5.2. Parts of plants used

The leaves are the most used parts in the preparation of remedies with 51.26%. [3], during his ethnobotanical study in the Zuénoula region, also recorded that the leaves were mainly used in the preparation of traditional remedies at 64.7%. Our results also agree with those of [30], which found from its study on the treatment of malaria in the district of Abidjan, that the leaves are 68.89% used in the preparation of traditional medicines.

[5] asserts that the leaves, bark and roots are the site par excellence of the biosynthesis and even of the storage of secondary metabolites responsible for the biological properties of the plant. Also, the choice of leaves could be explained by the ease and speed of their harvest [47]. These results agree with those of [48] with 64.49%, [18] with 73.28%, [4] with 64%, [22] with 43% and Yapo [31] with 44%.

In addition, the intense removal of the leaves does not present any danger for the plant [28]. According to this author, removing 50% of the leaves from a tree does not significantly affect the survival of the tree.

### 5.3. Method of preparation

The method of preparation of traditional remedies the most used during our study is a decoction with 63.84%, followed by maceration (11.15%). Our results agree with those of [29], who carried out an ethnobotanical survey on Euphorbiaceae in the district of Yamoussoukro, from which it emerged that a decoction, with 34%, is the most frequently used method of preparation for the majority of drug recipes. In Senegal, more precisely in the region of Matam, [50], during his ethnobotanical study on antimalarials, revealed that the decoction was the most used method of preparation with a percentage of 61.11%.

This is explained by the fact that the decoction collects the most active ingredients and attenuates or cancels the toxic effect of certain recipes [4].

### 5.4. Administration mode

The oral route with 64.04% is the most common method of administration in our study. In the study by [30], 84.09% of preparations are administered orally. The latter was also the most used to administer the remedies, in the study by [29], at 44%.

[6], indicate that the decocted containing bioactive ingredients ingested orally, requires a much faster and more efficient process than other techniques.

### 6. Conclusion

According to the WHO, more than 80% of the population uses traditional medicine for treatment, especially in Africa. Indeed, in developing countries, faced with a lack of health infrastructure, populations tend to turn to the Traditional Medicine Practitioner, who in addition to being closer to them, is financially accessible. Having realized this reality and the strong potential of traditional medicine, the Ivorian health authorities deemed it necessary to integrate the latter into the National Health Development Plan (PNDS) in 1995.
Since then, studies and research by eminent botanists have identified and identified several species of medicinal plants present in our flora.

However, it should be noted that very few studies have been carried out in the northern part of the country, which also has a rich variety of flora. It is in this context that we tried to make our contribution to the knowledge of the traditional Ivorian pharmacopoeia through a study in the Poro region, located in the north of the Ivory Coast.

To carry out this study, we carried out an ethnobotanical survey in the department of Korhogo, among the populations on the one hand and traditional medicine practitioners on the other.

200 people in the population and 51 traditional medicine practitioners were questioned about pathologies commonly encountered in the Korhogo 1 health district: malaria, anemia.

At the end of the survey, 49 species of medicinal plants were listed against malaria, among the population and PMT. The most cited were *Azadirachta indica*, *Carica papaya* and *Nauclea latifolia*; which are also used by other peoples, in other West African countries where malaria is rife, for its traditional treatment.

Regarding anemia, 36 species of medicinal plants have been identified in total. Among them, the most cited in our two samples are: *Hibiscus sabdariffa*, *Tectona grandis*, and *Justicia secunda*.

At the end of our study, it emerges that traditional medicine occupies a very important place in the department of Korhogo, as evidenced by the high level of satisfaction of practitioners of this medicine. Also, all the species of medicinal plants inventoried among the population and PMTs constitute real solutions to the health problems facing African populations in general. The results of this study will serve as the basis for the development of approved improved traditional medicines.

This has led the Ivorian government to integrate medicine and traditional pharmacopoeia into the national health system in order to improve the health coverage of the health needs of the populations.

**Compliance with ethical standards**

**Disclosure of conflict of interest**

No conflict of interest related to the publication of the article.

**Statement of informed consent**

Informed consent was obtained from all individual participants included in the study.

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