

Ethnobotanical study and identification of phytochemical compounds of *Waltheria indica* L. (Malvaceae), a plant traditionally used to treat infantile diarrhea in Bouaké (Côte d'Ivoire).

Abstract:

Infantile diarrhea remains a significant public health problem in Côte d'Ivoire. Populations often turn to traditional pharmacopoeia for the management of this condition. The present study aims to promote medicinal plants used against infantile diarrhea in Bouaké. It focuses in particular on *Waltheria indica* L. (Malvaceae), traditionally used in the treatment of this condition.

An ethnobotanical survey was conducted among herbalists and phytotherapists in the city of Bouaké. Its purpose was to identify the species used in the traditional treatment of infantile diarrhea. *Waltheria indica* L. was selected for this study because of its frequent use against this condition. A phytochemical characterization of its extract was then carried out in the laboratory.

Phytochemical screening revealed the presence of several groups of secondary metabolites. These include polyphenols, flavonoids, anthocyanins, alkaloids, tannins, coumarins, saponins, sterols, and polyterpenes. The presence of these different groups could contribute to the traditional uses reported for this species.

These results provide preliminary data on the ethnobotanical and phytochemical interest of *W. indica*. They also constitute a basis for further pharmacological studies. This work will notably make it possible to evaluate its therapeutic potential in the management of infantile diarrhea.

Keywords: infantile diarrhea, traditional pharmacopoeia, phytochemical characterization, secondary metabolites.

Introduction

Diarrhea remains a significant public health problem among young children. It is the third leading cause of death among children aged 1 to 59 months. Each year, it causes approximately 443,832 deaths among children under five worldwide (WHO, 2024). It also promotes dehydration and contributes to malnutrition in children.

In Africa, diarrhea remains common among children under five. A study conducted in Guinea showed a high proportion of cases among children aged 1 to 4 years. Moderate dehydration was also a frequent complication among children with acute diarrhea (Diallo et al., 2021).

In Côte d'Ivoire, several studies have also documented the importance of this condition in children. In Bouaké, Lee et al. (1995) studied children under five hospitalized for diarrhea at the Regional Hospital Center. Their study notably showed the importance of dehydration and undernutrition in severe forms of the disease.

Faced with this situation, the management of diarrhea relies mainly on prevention measures and recommended treatments. However, populations also turn to traditional medicine, particularly medicinal plants. In Côte d'Ivoire, several ethnobotanical studies have reported the use of plants in the traditional treatment of diarrhea. Ambe et al. (2015) thus identified numerous medicinal species used against this condition in the markets of Abidjan. Tuo et al. (2020) also documented the traditional use of several plants against diarrhea in different regions of the country.

Among these plants is *Waltheria indica* L. (Malvaceae), a species widely used in traditional medicine in several tropical regions. A review conducted by Zongo et al. (2013) reports, in particular, its traditional use against diarrhea and dysentery. This species contains several groups of secondary metabolites, notably flavonoids, tannins, saponins, sterols, and terpenes.

However, the ethnobotanical data available on the use of *W. indica* against infantile diarrhea remain limited in the specific context of Bouaké. Moreover, data on its phytochemical composition in this local context remain insufficient.

The present study therefore aims to document the traditional use of *Waltheria indica* L. against infantile diarrhea in Bouaké and to identify the main groups of phytochemical compounds present in its extract. This data may contribute to a better understanding of this plant and constitute a basis for future pharmacological studies.

I. MATERIALS AND METHODS

1. Material

1.1. Study area

The study was carried out in the city of Bouaké, located in the center of Côte d'Ivoire. It belongs to the Gbêkê region and the Autonomous District of the Vallée du Bandama (Figure 1). According to data from the General Population and Housing Census (RGPH) conducted by the National Institute of Statistics in 2024, the department of Bouaké has a population of 931,851 inhabitants.

The city of Bouaké, the departmental capital, is located approximately 344 km from Abidjan. Bouaké is an important commercial crossroads in the center of the country. The city is crossed by the road axis linking Abidjan to the cities of northern Côte d'Ivoire. It lies between 7°40' and 8°00' North latitude and between 4°50' and 5°20' West longitude.

The population of Bouaké is characterized by ethnic and cultural diversity. The main local languages used include Baoulé and Malinké. The city is also an important center for the marketing of medicinal plants.

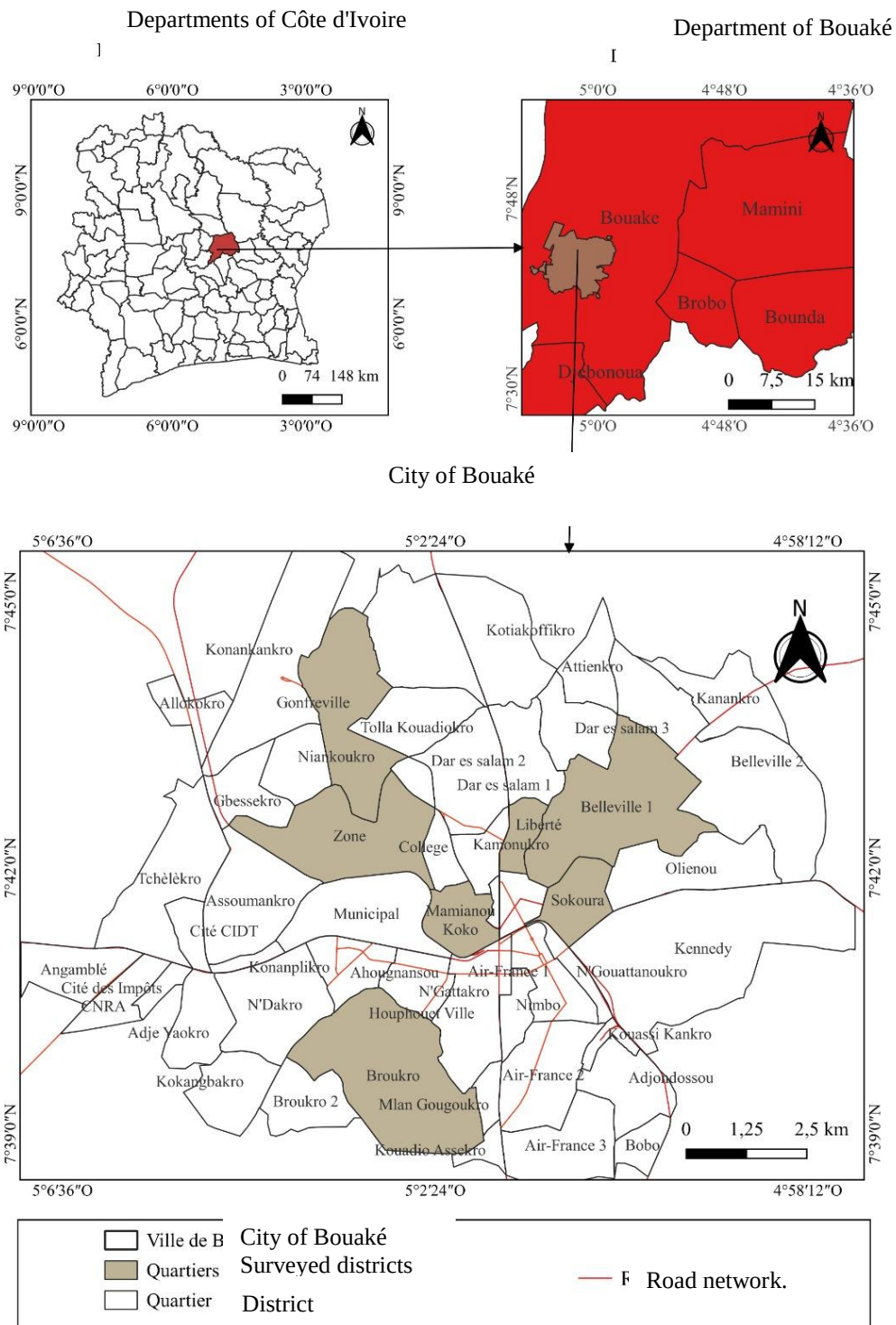


Figure 1: Mapshowing the location of the study area (Adou, 2017, modified)

1.2. Plant material

The plant material consisted of the leaves of *Waltheria indica* L. (Malvaceae). This species, selected as the study species, was the subject of an ethnobotanical survey conducted in the urban markets of Bouaké. The leaves intended for phytochemical analysis were collected as part of this study. They were subsequently used for the preparation of the aqueous extract and phytochemical screening.

1.3. Technical material

The materials used for the surveys and harvesting consisted of a digital camera, survey forms, harvesting bags, pruning shears, a pen, a notepad, and adhesive tape. The camera was used to document the plant specimens and the vendors' stalls. The survey forms were used to collect information on the plants used, the plant parts utilized, the modes of preparation, and dosage. The harvesting bags were used to store the samples and plants purchased in the markets. The pruning shears were used to collect plant samples. The adhesive tape was used to label and number the samples.

II. STUDY METHODS

2.1. Ethnobotanical study

2.1.1. Data collection

The ethnobotanical survey was carried out in six urban markets of Bouaké, namely Kôkô, Sokoura, Broukro, Zone, Gonfreville, and Belle Ville. These markets were selected because of their importance in the marketing of medicinal plants.

The survey was conducted over a period of two weeks among phytotherapists and herbalists. Data were collected through direct interviews. The interviews were conducted in French and supplemented, when necessary, by exchanges in Baoulé, Dioula, Senufo, or Malinké.

The information collected concerned, in particular, the use of *Waltheria indica*, the plant parts used, the modes of preparation, the routes of administration, and dosage. The people interviewed were mainly adults aged 30 to 55 years. Respondents who had practiced this activity for at least ten years were particularly targeted because of their experience in the use and marketing of medicinal plants.

Direct observations of the stalls and the plants marketed were also carried out during the surveys. The ethnobotanical information was supplemented by a literature review on medicinal plants and their traditional uses.

2.1.2. Data processing

The data collected during the surveys were entered into Microsoft Excel software. They were organized in the form of tables and figures. The citation frequency of the species was calculated from the responses of the people interviewed.

2.2. Phytochemical study of *Waltheria indica*

2.2.1. Harvesting and preparation of plant material

The leaves of *Waltheria indica* were harvested in the markets studied. They were washed with water to remove impurities present on their surface. The leaves were then dried in the shade on

the benches of the Laboratory of Plant Biology and Earth Sciences (LaBVST) of Alassane Ouattara University of Bouaké. Drying was carried out for one week. After drying, the leaves were ground into a fine powder. The powder obtained was stored away from light and humidity before use.

2.2.2. Preparation of the aqueous extract

One hundred grams (100 g) of plant powder were introduced into 1,000 mL of distilled water. The mixture was brought to a boil and maintained at boiling temperature for 15 minutes. The resulting decoction was then filtered using filter paper.

The filtrate was placed in a ventilated oven set at 40°C for 48 hours to remove the water. The dry extract obtained was collected, weighed, and stored in clean containers until the phytochemical tests were carried out. The method used was that described by Zirihi et al. (2005) (Figure 2).

2.2.3. Calculation of extraction yield

The extraction yield corresponds to the ratio between the mass of dry extract obtained and the mass of plant powder used. It was calculated according to the formula proposed by Harborne (1998):

$$R (\%) = (m/M) \times 100$$

where:

R = extraction yield as a percentage; **m** = mass of dry extract obtained; **M** = mass of plant powder used.

2.2.4. Phytochemical screening

Phytochemical screening was carried out using tube color tests. These tests were used to detect the main groups of secondary metabolites present in the *Waltheria indica* extract. The chemical groups investigated were polyphenols, flavonoids, anthocyanins, tannins, saponins, coumarins, alkaloids, sterols, and polyterpenes.

The tests were performed according to the methods described by Békro et al. (2007). The results were expressed qualitatively based on the presence (+) or absence (–) of the chemical groups investigated.

Figure 2: Flow diagram for the preparation of the aqueous extract (Zirihi et al., 2005)

II. RESULTS

2.1. Results of the ethnobotanical survey

2.1.1. Profile of the people surveyed

The ethnobotanical survey conducted in the Gbêkê region, with a particular focus on the city of Bouaké, involved phytotherapists and herbalists who sell medicinal plants in urban markets. The majority of the people surveyed were phytotherapists with extensive experience in the use of medicinal plants.

Discussions with the phytotherapists provided information on the therapeutic uses of the plants. The herbalists provided information on the plants available in the markets and their origins. Interviews with parents of children focused on the traditional use of plants in the treatment of infantile diarrhea.

These surveys made it possible to identify the plants used against infantile diarrhea, the plant parts used, as well as the modes of preparation and administration.

2.1.2. Diversity of the medicinal plants identified

The study identified seventeen (17) plant species used in the traditional treatment of infantile diarrhea. Among these species, *Waltheria indica* L. (Malvaceae) was the most commonly cited and was the subject of the present study (Figure 3). The plant parts mainly used were leaves, bark and roots (Figure 4). Their use varied depending on availability.

Figure 3: Bundle of *Waltheria indica* L. (Malvaceae) leaves, known as "dabada" in Malinké

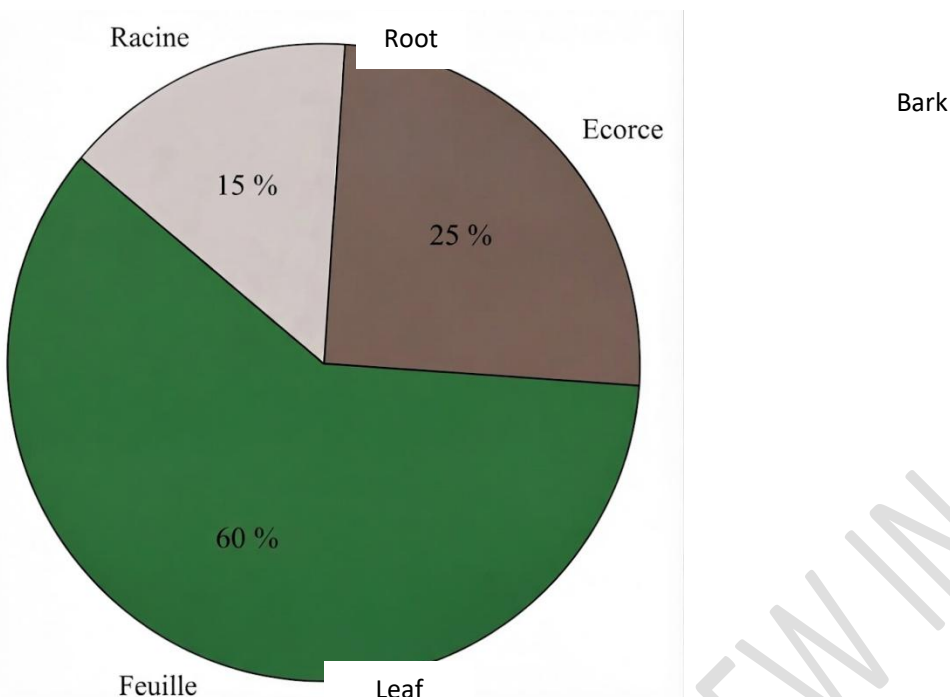


Figure 4: Pattern of use of medicinal plants according to the parts used.

2.2. Yield of the aqueousextract

The aqueous extraction wascarried out from one hundred (100) grams of *Waltheria indica* L. leafpowder. It yielded an average dry extract mass of 1.745 g. The averageyield of the total aqueousextractwas 17.45% (Table 1).

Table 1: Yield of the total aqueousextract of *Waltheria indica* L.

Total aqueousextract	Mass of plant materialtreated M (g)	Mass of extractafter drying (mg)	Yield (m/M) × 100 = η
<i>Waltheria indica</i> L.	100	1,745	17.45

M = mass of plant powdertaken; m = mass of extractafter drying.

2.3. Phytochemical screening

The qualitative phytochemical analysis of the total aqueousextract of *Waltheria indica* L. revealedseveral groups of phytochemical compounds (Table 2). The tests were positive for flavonoids, polyphenols, anthocyanins, sterols and polyterpenes, catechin tannins and coumarins. The resultsobtained for gallic tannins, alkaloids and saponins are presented in **Table 2**.

Table 2: Results of the phytochemical screening of the total aqueous extract of *Waltheria indica* L.

Extract	Fla	Poly	Ant	Ste-pol	Ta G	Ta C	Cou	Al	Sa
<i>Waltheria indica</i> L.	+	+	+	+	—	+	+	+	—

+ = positive; — = negative.

Fla = flavonoids; Poly = polyphenols; Ant = anthocyanins; Ste-pol = sterols and polyterpenes; Ta G = gallic tannins; Ta C = catechin tannins; Cou = coumarins; Al = alkaloids; Sa = saponins.

III. Discussion

The ethnobotanical survey conducted in the Gbêkê region was based on a multi-criteria approach, with sampling structured around two target groups: phytotherapists and herbalists who use traditional pharmacopoeia, as reported by Sidio et al. (2019). The cohort of respondents was predominantly composed of highly experienced phytotherapists. A similar study conducted by Doh (2015) in the District of Abidjan showed that the traditional healers surveyed had between 4 and 18 years of professional experience.

This extensive experience and the knowledge of traditional practitioners may be based on historical, empirical, and cultural foundations, as noted by Jaffré et al. (2003). Traditional medicine can also be defined, according to Jaffré et al. (2003), as the sum of knowledge, uses of substances, measures, and practices based on the sociocultural and religious foundations of a given community, as well as on lived experiences and observations, transmitted from generation to generation, orally or in writing, and used to diagnose, prevent, or eliminate imbalances in physical, mental, social, or spiritual well-being.

These practitioners are primary holders of ancestral knowledge, often transmitted orally and consolidated from generation to generation, as noted by Rwangabo (1993). This historical depth of knowledge provides an important basis for understanding the therapeutic uses identified. At the same time, the involvement of medicinal plant sellers made it possible to identify the commercial availability and origins of plant species used against diarrhea, while interviews with parents of children highlighted the sociocultural context and acceptability of these treatments as a first-line approach to pediatric care.

This approach is similar to the work carried out by Yao et al. (2024), who conducted an ethnobotanical survey of medicinal plants used in the treatment of COVID-19 symptoms among traditional medicine practitioners from different specialties. Their study aimed to document and contribute practitioners' knowledge and ancestral expertise to the search for effective remedies for COVID-19 symptoms.

The plant organs most frequently used were, in order of importance, leaves (60%), trunk bark (25%), and roots (15%). Lutoti et al. (2023) also reported that leaves were the most commonly used plant parts for the preparation of traditional remedies. The preferential use of leaves by traditional healers may be related to their role as sites of synthesis and accumulation of

secondary metabolites responsible for various biological properties of plants. Moreover, harvesting leaves extensively does not generally significantly affect the survival of trees (Ouattara et al., 2021; Béné et al., 2016).

This observation is supported by Doh (2015), citing Chamouleau (1979), who also noted that leaves are among the most frequently used plant parts because they are sites of photosynthetic reactions and reservoirs of organic matter derived from these processes.

The phytochemical study was carried out using the leaves of *Waltheria indica* L. to identify the groups of secondary metabolites potentially responsible for its biological activities. The biological activities of plants are closely related to their chemical composition. The qualitative phytochemical analysis conducted to identify the groups of secondary metabolites potentially associated with the biological activities of the leaves showed that the extract contained polyphenols, flavonoids, tannins, anthocyanins, coumarins, saponins, sterols, and polyterpenes.

These natural phytocompounds possess various biological activities, including antioxidant activity. Flavonoids, in particular, are recognized for their antioxidant properties (Torel et al., 1987). The work conducted by Ngene et al. (2015) on the importance of flavonoid-rich plants in traditional pharmacopoeia and their sale in the markets of Douala also reported that such plants are widely sought after for the treatment of numerous conditions. In addition to their antioxidant properties, flavonoids have been reported to exhibit anti-ulcer, antitumor, antispasmodic, antisecretory, and antidiarrheal activities (Di Carlo, 1999), as well as antiallergic, anti-inflammatory, and hypotensive effects. They have also been associated with protective effects against certain diseases, including cancer and cataracts (Bruneton et al., 2007).

According to Theis and Lerda (2003), terpenes may contribute to the prevention and treatment of various diseases, including cancer. Tannins have astringent properties and have also been associated with vitamin P activity. They may contribute to the strengthening of blood vessels and to the accumulation of vitamin C in the body (Lazurevskii et al., 1966).

Polyphenols and flavonoids exhibit multifaceted antioxidant activity through several mechanisms, including free-radical scavenging, chelation of transition-metal ions, prevention of the initiation of chain reactions that produce reactive oxygen species (ROS), and decomposition of peroxides. These compounds may also have chemopreventive effects against degenerative diseases (Ozen, 2009).

The extraction yield obtained from the leaves was 17.45%. Extraction yield may vary considerably among plant species depending on the nature of the plant material, the organ used—particularly leaves, bark, or roots—and the solvent employed according to its polarity. According to WAHO (2013), these factors can significantly influence the extraction yield. The relatively high yield obtained from *Waltheria indica* leaves may therefore indicate the presence of water-soluble phytocompounds, as suggested by Dembélé et al. (2023).

CONCLUSION

This study identified seventeen plant species used in the traditional treatment of infantile diarrhea in the markets of Bouaké. Among these species, *Waltheria indica* L. was the most frequently cited. The leaves, bark, and roots were the main plant organs used, with leaves being the predominant plant part.

The aqueous extraction of *Waltheria indica* leaves yielded an average extraction yield of 17.45%. Phytochemical screening revealed several groups of secondary metabolites, notably flavonoids, polyphenols, anthocyanins, sterols, polyterpenes, catechin tannins, coumarins, and alkaloids.

These findings highlight the ethnobotanical and phytochemical interest of *Waltheria indica* in traditional practices for the treatment of infantile diarrhea in Bouaké. They provide an initial basis for further research into the chemical constituents of this plant and its potential antidiarrheal properties through more detailed phytochemical analyses and biological studies.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest related to this article.

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