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RESEARCH ARTICLE

ETHNOBOTANICAL STUDY AND IDENTIFICATION OF PHYTOCHEMICAL COMPOUNDS OF *WALTHERIA INDICA* L. (MALVACEAE), A PLANT TRADITIONALLY USED TO TREAT INFANTILE DIARRHEA IN BOUAKE (COTE D'IVOIRE)

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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 Bouake. 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 Bouake. 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.

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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,

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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 Bouake, 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 Bouake. 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 Bouake 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.

Materials and Methods:-

Material:-

Study area:-

The study was carried out in the city of Bouake, located in the center of Côte d'Ivoire. It belongs to the Gbêkê region and to the Autonomous District of the Vallée du Bandama (Figure 1). According to data from the General Population and Housing Census (RGPH) carried out by the National Institute of Statistics in 2024, the department of Bouake has 931,851 inhabitants. The city of Bouake, the departmental capital, is located approximately 344 km from Abidjan. Bouake 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 Bouake is characterized by ethnic and cultural diversity. The main local languages used are notably Baoulé and Malinke. The city is also an important center for the marketing of medicinal plants.

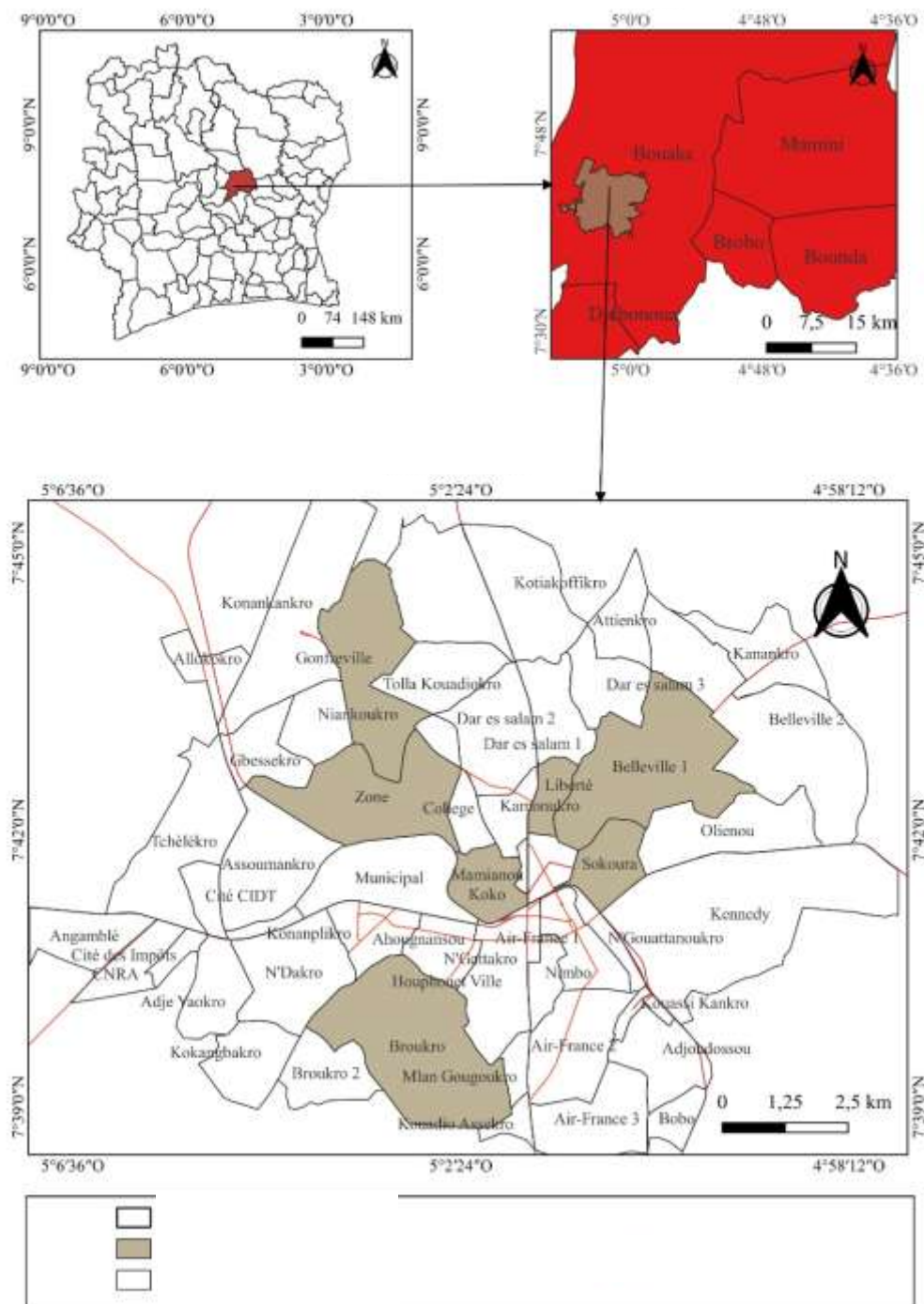


Figure 1: Map showing the location of the study area (Adou, 2017, modified)

Plant material:-

The plant material consisted of leaves of *Waltheria indica* L. (Malvaceae). This species, chosen as the study species, was the subject of an ethnobotanical survey in the urban markets of Bouake. The leaves intended for phytochemical

analysis were collected as part of this study. They were then used for the preparation of the aqueous extract and phytochemical screening.

Technical material:-

The material 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 specimens and the vendors' stalls. The survey forms were used to collect information on the plants used, the parts used, 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 the plant samples. The adhesive tape was used to number the samples.

Study Methods:-**Ethnobotanical study:-****Data collection:-**

The ethnobotanical survey was carried out in six urban markets of Bouake, 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 two weeks among phytotherapists and herbalists. Data were collected by direct interview by means of interviews. The interviews were conducted in French and supplemented, when necessary, by exchanges in Baoule, Dioula, Senufo or Malinke. The information collected concerned in particular the use of *Waltheria indica*, the 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 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.

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.

Phytochemical study of *Waltheria indica*:-**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 Bouake. 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.

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 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 then stored in clean containers until the phytochemical tests were carried out. The method used is the one described by Zirihi et al. (2005) (Figure 2).

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.

Phytochemical screening:-

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

out according to the methods described by Bekro et al. (2007). The results were expressed qualitatively by the presence (+) or absence (–) of the chemical groups sought.

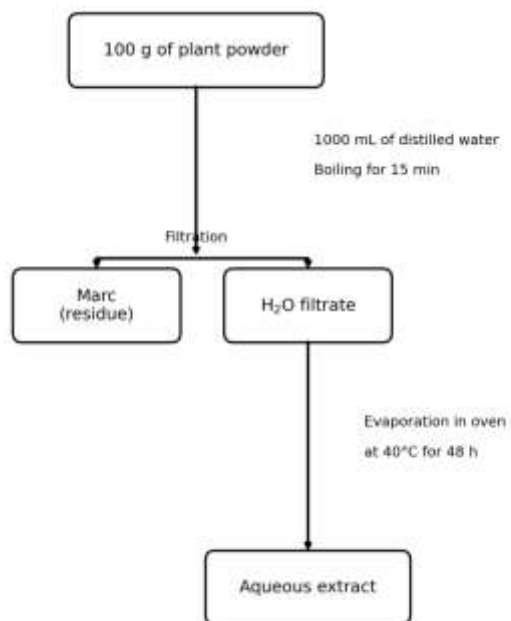


Figure 2: Flow diagram for the preparation of the aqueous extract (Zirihi et al., 2005)

Results:-

Results of the ethnobotanical survey:-

Profile of the people surveyed:-

The ethnobotanical survey conducted in the Gbêkê region, with a particular focus on the city of Bouake, involved phytotherapists and herbalists, sellers of 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 origin. 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 use.

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 Malinke

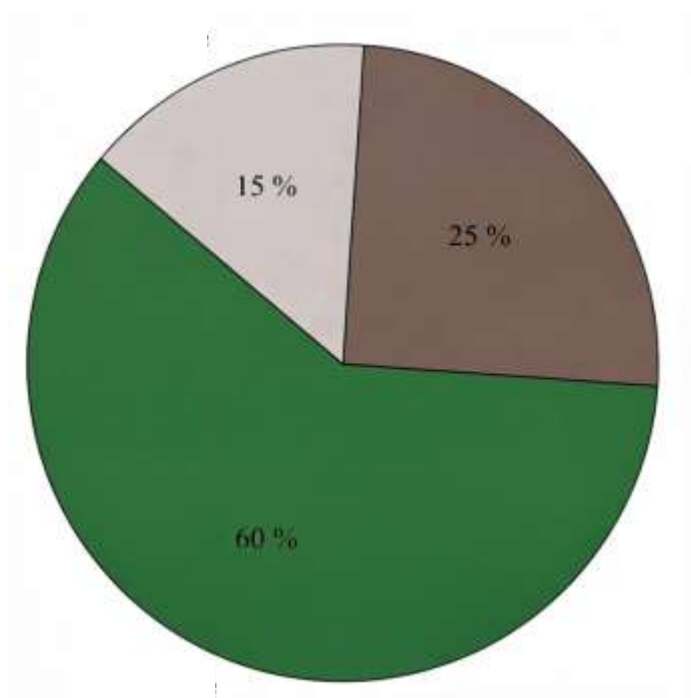


Figure 4: Pattern of use of medicinal plants according to the parts used.

Yield of the aqueous extract: -

The aqueous extraction was carried out from one hundred (100) grams of *Waltheria indica* L. leaf powder. It yielded an average dry extract mass of 1.745 g. The average yield of the total aqueous extract was 17.45% (Table 1).

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

Total aqueous extract	Mass of plant material treated M (g)	Mass of extract after drying (mg)	Yield (m/M) × 100 = η
<i>Waltheria indica</i> L.	100	1,745	17.45

M = mass of plant powder taken; m = mass of extract after drying.

Phytochemical screening: -

The qualitative phytochemical analysis of the total aqueous extract of *Waltheria indica* L. revealed several groups of phytochemical compounds (Table 2). The tests were positive for flavonoids, polyphenols, anthocyanins, sterols and polyterpenes, catechin tannins and coumarins. The results obtained 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.

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 did Sidio et al. (2019). The cohort of respondents is predominantly made up of highly experienced phytotherapists. A similar study conducted by Doh (2015) in the District of Abidjan shows that the traditional healers surveyed had between 4 and 18 years of experience in the profession. This long experience and the know-how of traditional practitioners could rest on precise historical, empirical and cultural foundations, as noted by Jaffreet al. (2003). Traditional medicine can also be defined synthetically as "the sum total of all knowledge, uses of substances, measures and practices, whether explicable or not, based on the sociocultural and religious foundations of a given community, as well as on lived experiences and observations, handed down from generation to generation, orally or in writing, and used to diagnose, prevent or eliminate an imbalance in physical, mental, social or spiritual well-being", according to Jaffre et al. (2003). These practitioners are the primary holders of ancestral knowledge, most often derived from rigorous oral transmission, consolidated from generation to generation, as noted by Rwangabo (1993). This historical depth of knowledge guarantees the reliability of the therapeutic uses identified. At the same time, the involvement of medicinal plant sellers made it possible to identify the commercial availability and origin of anti-diarrheal species, while interviews with parents of children highlighted the sociocultural realities and acceptability of these treatments as a first line of pediatric care. This is similar to the work carried out by Yao et al. (2024), on an ethnobotanical survey of medicinal plants used in the treatment of COVID-19 symptoms with practitioners of traditional medicine of different specialties, in order to contribute their know-how and ancestral knowledge to the search for effective remedies to combat COVID-19 symptoms.

The most used organs are, in order of importance, leaves (60%), trunk bark (25%) and roots (15%). Lutoti et al. (2023) also indicated that leaves were the most used for the preparation of traditional remedies. The use of leaves by traditional healers is due to the fact that they are the storage site for the secondary metabolites responsible for the plant's biological properties. Moreover, extensive harvesting of this organ does not significantly affect the survival of a tree (Ouattara et al., 2021; Beneet al., 2016). This idea is supported by Doh (2015, citing Chamouleau, 1979), who also noted that leaves are the most used because they are simultaneously the site of photochemical reactions and the reservoir of the organic matter derived from them.

The phytochemical study carried out consisted of using the leaves of *Waltheria indica* L. in order to reveal the groups of secondary metabolites potentially responsible for its biological activities. These activities of the plant are related to its chemical composition. Thus, the qualitative phytochemical analysis carried out in order to identify the groups of secondary metabolites likely to be responsible for the biological activities of its leaves showed that the extract contains polyphenols, flavonoids, tannins, anthocyanins, coumarins, saponins, sterols and polyterpenes. These natural phytochemicals have various biological activities such as antioxidant activity. Indeed, flavonoids are renowned antioxidants par excellence (Torel et al., 1987). The work carried out on the importance in traditional

pharmacopoeia of flavonoid-rich plants sold in the markets of Douala by Ngene et al. (2015) confirms that flavonoid-rich plants are much more sought after in the treatment of numerous conditions. In addition to their antioxidant power, they are anti-ulcer, antitumor, antispasmodic, antisecretory and antidiarrheal (Di Carlo, 1999), anti-allergic, anti-inflammatory, hypotensive, and protect against cancer and cataracts (Bruneton et al., 2007).

According to Theis and Lerda (2003), terpenes would be beneficial in the prevention and treatment of various diseases such as cancer. Tannins have an astringent effect and exhibit properties of vitamin P. They strengthen blood vessels and contribute to the accumulation of vitamin C in the body (Lazurevskii et al., 1966). Polyphenols and flavonoids exhibit multifaceted antioxidant activity attributed to different mechanisms such as free radical scavenging, chelation of transition metal ions, prevention of the initiation of a chain of reactions producing ROS, decomposition of peroxides, and their chemopreventive effect against degenerative diseases (Ozen, 2009).

The extraction yield obtained from the leaves is 17.45%. This extraction yield shows that it can vary from one plant species used to another. According to WAHO (2013), it varies considerably depending on the nature of the drug, the organ used, notably leaves, bark and roots, and the solvent used depending on its polarity. The leaves of *Waltheria indica* would therefore contain more water-soluble phytochemicals, as noted by Dembele et al. (2023).

Conclusion:-

This study identified seventeen plant species used in the traditional treatment of infantile diarrhea in the markets of Bouake. Among these species, *Waltheria indica* L. is the most commonly cited. Leaves, bark and roots are the main organs used, with a predominance of leaves. Aqueous extraction carried out from the leaves of *Waltheria indica* gave an average yield of 17.45%. Phytochemical screening identified several groups of chemical compounds, notably flavonoids, polyphenols, anthocyanins, sterols and polyterpenes, catechin tannins, coumarins and alkaloids. These results show the ethnobotanical and phytochemical interest of *Waltheria indica* in traditional practices for the treatment of infantile diarrhea in Bouake. They constitute an initial basis for continued research on the chemical compounds of this plant and on its antidiarrheal properties through more in-depth phytochemical analyses and biological trials.

Conflict of Interest:-

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

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