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RESEARCH ARTICLE

ETHNOBOTANICAL STUDY OF MEDICINAL PLANTS USED IN TRADITIONAL PEDIATRICS IN THE CITY OF MOUNDOU (LOGONE OCCIDENTAL / CHAD)

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Abstract

Medicinal plants contribute significantly to health improvement in several countries of sub-Saharan Africa. However, despite their multiple benefits, there is very little information about their use among children. The objective of this study was to contribute to the study of medicinal plants used in traditional pediatrics in the Logone Occidental region of Chad. To achieve this objective, an ethnobotanical survey was conducted among 67 people in the city of Moundou. The results showed that the majority (95.52%) of the population in this locality has knowledge of medicinal plants used in traditional pediatrics. Women have more knowledge about medicinal plants used in traditional pediatrics than men. 33 species grouped into 32 genera and 22 families have been recorded. The most represented families are Combretaceae (10%), Poaceae (9%), and Myrtaceae (9%). The most commonly used species are: *Moringa oleifera* (11%), *Zingiber officinale* (8%), and *Euphorbia hirta* (7%). Decoction is the preferred method of preparation at 47%, as well as the oral route for administering the remedies (77%). The most common pathologies are malaria (8%), gastric disorders (7%), and cough (7%). These results could constitute a database for further studies on medicinal plants used in pediatrics in Chad.

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Introduction:-

Despite the advances in biology and medicine today, the therapeutic use of medicinal plants is very prevalent among a large portion of the population in sub-Saharan Africa. Due to their low incomes and the remoteness of health centers, these populations often turn to medicinal plants as a means of potentially improving their health. Indeed, medicinal plants are very important sources of active substances, which is why more than 80% of this population uses them to address health problems[1]. This increased use of medicinal plants affects different categories of the population, encompassing both adults and children. The interest in traditional medicine is linked to the availability and accessibility of medicinal plants, for which this population holds knowledge that has been passed down through generations[2; 3]. Consequently, their knowledge of plant identification and the methods of preparing medicinal

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recipes could provide new data on plants used in pediatric healthcare. In Africa, various studies on medicinal plants used in traditional pediatrics have been undertaken. We can mention those of [4] in Burkina Faso and [5] in Benin. In Chad, research work on medicinal plants has been conducted [6,7]. However, no study has been dedicated to medicinal plants used in traditional pediatrics in this region of the country. This is why this study was undertaken and should lead to an inventory of medicinal plants and medicinal recipes used in the treatment of childhood diseases in this city.

Materials:-

Presentation of the study area:-

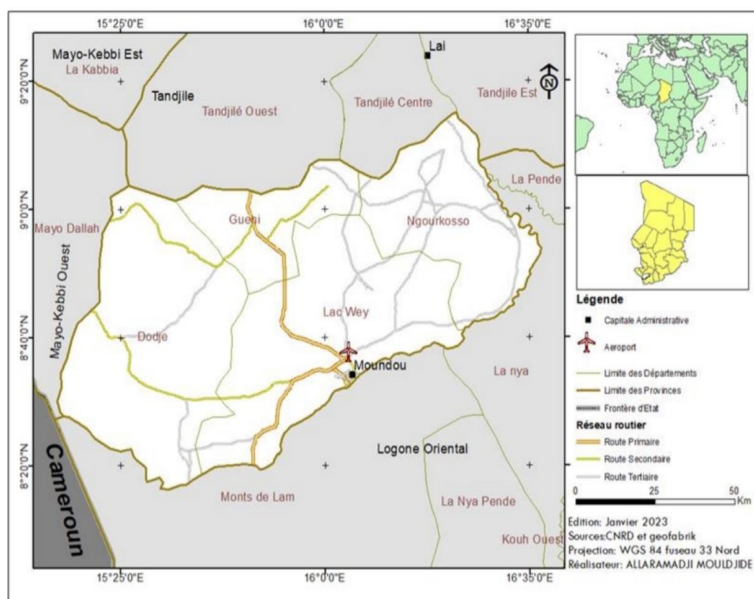


Figure 01: Geographic map of the study area

The work took place in the Logone Occidental region, in southern Chad. It is one of the 23 provinces of the country, with its capital Moundou, located between 8.5° and 11° North and 14° and 17° East. Its area is 8916 km² and its population is estimated at 865,000. Its climate is tropical Sudano-Guinean, with 2 seasons: the rainy season begins in April and ends in October, and the dry season extends from November to March. The average temperature is 30°C. The region contains all the floristic strata: forest galleries around rivers and ponds on clay-sandy soils, wooded and shrubby savannas amidst different exposed areas on tropical soils where ferruginous soils dominate on the lower plateaus and ferralitic soils in the lowlands. The vegetation formation consists of wooded, tree, shrub, and grass savannas. The main woody species in the province are *Isoberrlinia doka*, *Prosopis africana*, *Daniella oliveri*, *Pterocarpus lucens*, *Parkia biglobosa*, *Vitellaria paradoxa*, and *Lophira lanceolata*. [11]

Methodology:-

Ethnobotanical survey:-

The surveys were conducted in various locations in the city of Moundou, particularly at the Djarabé market, the grand market, and the Moua-Rome market. The choice of these locations was guided by the high female attendance. Door-to-door surveys were also conducted with individuals believed to possess knowledge on the subject. These include herbalists, stay-at-home mothers, and elderly individuals. The collection of information was made possible through a pre-established survey form, consisting of open-ended and closed questions inspired by the works of [12]. The questions were posed directly in French or translated into Gambia (a dialect spoken by the locals) in local Arabic. These surveys lasted for three (3) months.

Inclusion criteria:-

Any parent over 20 years old; Any parent with knowledge of medicinal plants and using them in the treatment of illnesses in their child; Any parent who declares themselves willing to participate in the survey and respond honestly.

Exclusion criteria:-

Any parent under the age of 20; Any parent who does not use medicinal plants; Any parent who does not agree to participate in the survey.

Data analysis:-

The survey data was processed using Microsoft Office Excel 2013. This software was used to determine the citation frequencies using the following formula:

$FC = (NC/NTR) \times 100$ (with FC: citation frequency; NC: number of citations and NTR: total number of respondents)

Results:-**Sex, age, and education level of the respondents:-**

67 people were interviewed, including 43 women, representing 64%, and 24 men, representing 36%. The distribution by age is as heterogeneous as that by gender. The age of the informants ranges from 23 to 75 years. The most represented age groups are those from 40 to 49 and 50 to 59, with a cumulative percentage of 37.5%. On the other hand, this rate is low in the first age bracket of 20 to 29 years; indeed, during the survey, few young people participated, likely due to their lack of experience. The results of the survey show that the population interested in phytotherapy is predominantly those with a secondary education level, with a rate of 46%. Illiterates are very minimally represented, likely due to the study environment. The number of children per informant varies from 4 to 5.

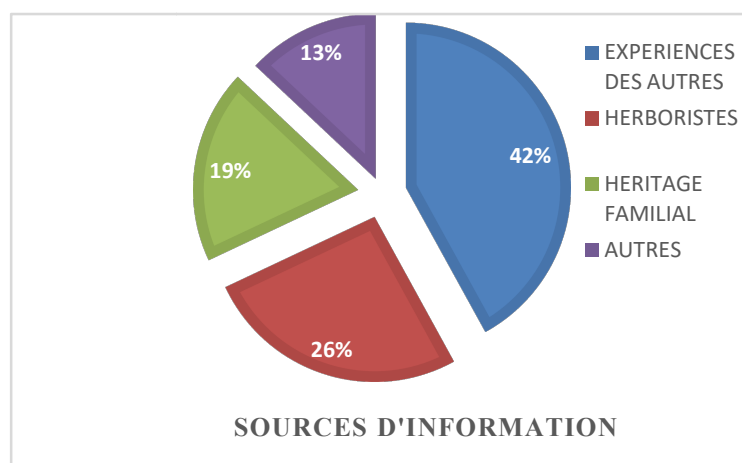
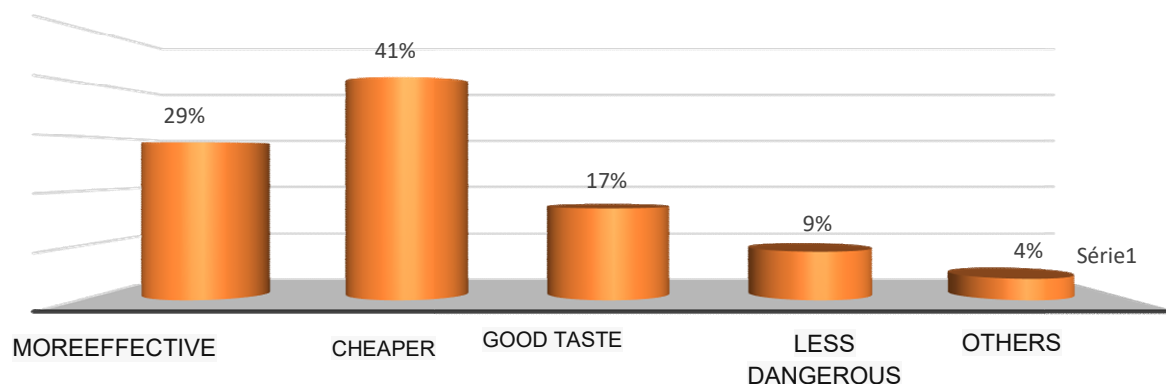
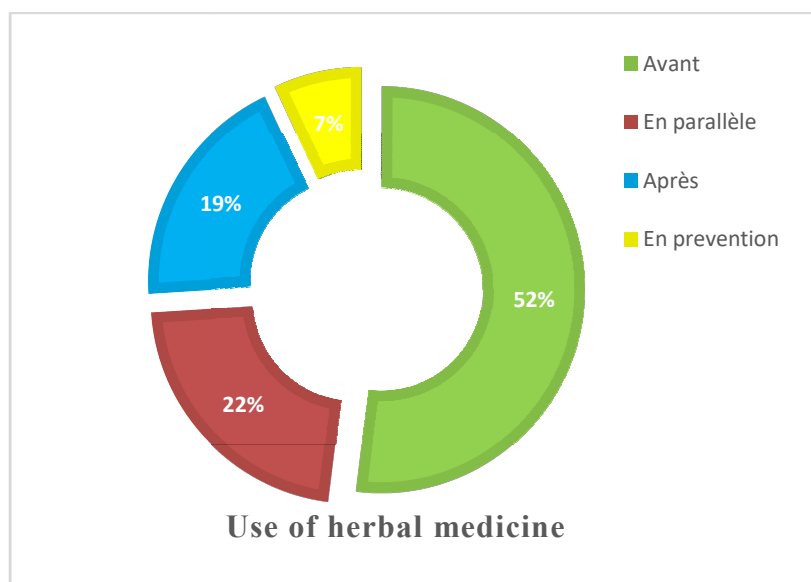
Sources of information:-

Figure 2: Distribution of informants based on the sources of information used

Figure 7 below shows that 42% of the information on medicinal plants used by the Moundoulaise population comes from the experiences of others, 26% from the advice of herbalists, 19% from family heritage, and 8% from media and the internet. Furthermore, more than half of our informants (61%) use plants based on advice given by a neighbor, a friend, an uncle, an aunt, a grandmother or grandfather, a father, or a mother.

Reasons for using medicinal plants among the:-**Figure 3: Distribution of respondents according to the reasons for using medicinal plants**

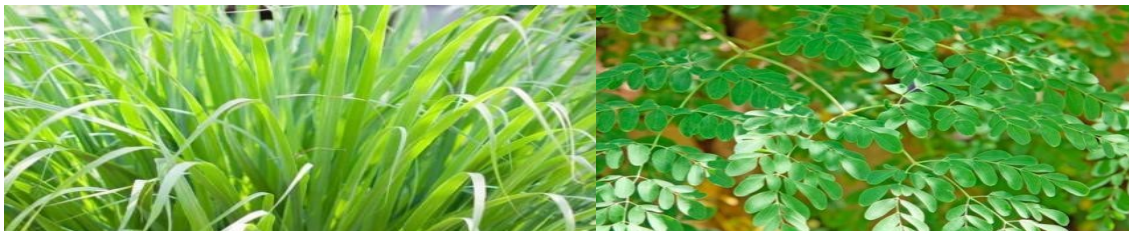
According to the results, 41%, or the majority of the respondents, use medicinal plants for reasons related to their purchasing power incapacity. 29% believe that medicinal plants are more effective than modern medicine, while 4% have diverse reasons such as: valuing African customs, accessibility.

Moments of resorting to traditional herbal medicine in children:-**Figure 4: Distribution of respondents based on the timing of the use of herbal medicine**

The results show that 52% of the study population first resort to medicinal plants before considering modern medicine. 22% continue herbal treatment even when the patient is undergoing modern therapy. This poses a real problem, as beyond the potential issues of drug interactions, there is also the problem related to dosage, which has a significant negative impact, especially in an immature body such as the pediatric population.

Floristic analysis:-

A total of 33 species distributed across 32 genera and 22 botanical families were recorded during the surveys. The most represented families are Combretaceae (9%), Myrtaceae (9%), and Poaceae (9%). Nearly 70% of the species used in the treatment of childhood pathologies are woody plants. The survey allowed us to list 129 recipes, consisting of 33 species of medicinal plants used in the treatment of diseases in children. The most frequently mentioned species are: *Moringa oleifera* (11%), *Combretum micranthum* (8%), *Euphorbia hirta* (7%).



Cymbopogon citratus*, *Moringa oleifera*, *Euphorbia hirta

Figure 5: Some medicinal plants used in the province

Table I: frequency of citations of medicinal species

Species	FC(%)	Genres	Families	FC(%)
<i>Allium cepa</i> L.	2	Allium	Amaryllidaceae	4
<i>Aliumsativum</i> L.	2			
<i>Mangifera indica</i> L.	1	Mangifera	Anacardiaceae	3
<i>Calotropis procera</i> (Ait.) Ait. f.	1	Colotropis	Apocynanaceae	3
<i>Vernonia crinita</i> ‘Mammuth’	2	Vernonia	Asteraceae	6
<i>Ageratum conizoides</i> (L.) L. (L.) (L.)	2	Ageratum		
<i>Adansonia digitata</i> L.	2	Adansonia	Bombacaceae	3
<i>Combretum micranthum</i> G. Don	8	Combretum	Combretaceae	10
<i>Guiera senegalensis</i> J. F. Gmel	3	Guiera		
<i>Terminalia macroptera</i> Guill. &Perr.	2	Terminalia		
<i>Carica papaya</i> L.	4	Carica	Caricaceae	3
<i>Balanites aegyptiaca</i> Lam.	2	Balanites	Caryophyllaceae	3
<i>Taranindus indica</i> L.	1	Taranindus	Cesalpiniaceae	6
<i>Pilostigma reticulatum</i> (DC.) Hochst.	5	Pilostigma		
<i>Momordica charantia</i> L.	2	Momordica	Cucurbitaceae	3
<i>Mitragyna inermis</i> (Willd.) Kuntze	2	Mitragyna	Rubiaceae	2
<i>Manihot esculenta</i> Cranz.	2	Manihot	Euphorbiaceae	5
<i>Euphorbia hirta</i> L.	7	Euphorbia		
<i>Diospyros mespiliformis</i> Hochst. exA.Rich.	2	Diospyros	Ebenaceae	3
<i>Senna alata</i> L.	1	Senna	Fabaceae	3
<i>Gossypium</i> spp	5	Gossypium	Malvaceae	3
<i>Moringa oleifera</i> Lam.	11	Moringa	Moringaceae	3
<i>Psidium guajava</i> L.	3	Psidium	Myrtaceae	9
<i>Syzygium aromaticum</i> (L.) Merr. & Perry	1	Syzygium		
<i>Eucalyptus camadulensis</i> Dehnh.	2	Eucalyptus		
<i>Acacia nilotica</i> (L.) Willd. ex A. Rich.	5	Acacia	Mimosaceae	3

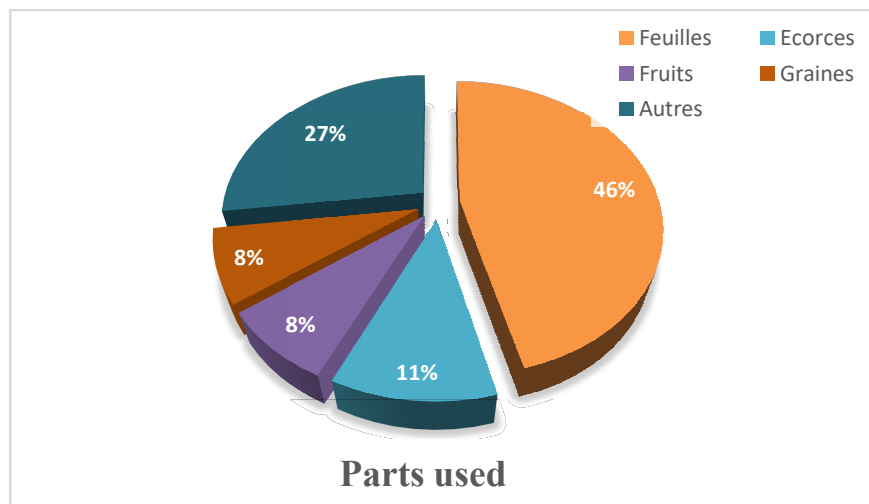
Azadirachta indica A. Juss.	2	Azadirachta	Meliaceae	6
Khayasenegalensis (Desr.) A. Juss.	1	Khaya		
Cympogon citratus (DC.) Stapf.	2	Cympogon	Poaceae	9
Sorghum bicolor (L.) Moench.	2	Sorghum		
Bambusa vulgaris Schrad ex J.C. Wendl.	1	Bambusa		
Vitellaria paradoxa Gaertn. f.	2	Vitellaria	Sapotaceae	3
Zingiber officinale Rosc.	2	Zingiber	Zingiberaceae	3

Table II: General description of the characteristics of each recipe

Species	Used parties	Preparation methods	Modes of administration	Treated diseases
Adansonia digitata	Leaves, bark, flowers	Decoction, infusion	Oral, nasal	Malaria, cough, toothache
Ageratum conyzoides	Leaves	Decoction	Oral	Fever, inflammation, toothaches
Allium sativum	Clove + honey	Maceration	Oral, rectal	Cough, fever
Allium cepa	Bulb + honey	Maceration	Oral	Cough, anorexia, digestive ulceration,
Azadirachta indica	Leaves, bark, seeds (powder), oil	Decoction, maceration	Oral, massages	Malaria, cough, fever, vomiting
Balanites aegyptiaca	Bark, root	Maceration,	Oral, dermic	Measles, asthma, dry cough
Bambusa vulgaris	Leaves	Decoction	Oral	Typhoid
Carica papaya	Leaves jaunes, racines	Infusion, decoction	Oral, inhalation	Malaria, asthma, typhoid
Carica papaya + moringa oleifera	Bourgeons	Broyage	Oral	Vomitive
Combretum micranthum	Leaves	Grinding and macerate	Oral	Fever, malaria, urinary retention, gastric disturbance
Coltropis procera	Leaves, stems	Decoction, poultice	Bath, dermal application	Asthma, protection against infections of the navel
Coltropis procera	Dry bark powder	Maceration	Oral	Stomach pains
Cympogon citratus	Leaves fresh	Decoction, infusion	Oral, inhalation	Cold, bronchitis, headaches, throat infection, malaria
Eucalyptus camadulensis + Cympogon citratus	Leaves	Decoction	Oral and nasal	Cold
Eucalyptus camadulensis	Leaves	Decoction	Inhalation, lavage, oral	Flu, cold, malaria
Euphorbia hirta	Whole plant	Infusion	Oral	Asthma, fièvre, dysenterie, bronchite, diarrhée
E. hirta + T. macroptera + G. senegalensis + P. reticulatum	Leaves and rameaux	Decoction	Bath	Fortifying for the newborn
Gossypium spp	Leaves	Decoction,	Oral	Anemia, malaria

		maceration		
G. senegalensis	Leaves and stems	Decoction	Oral, Bath	Fortifying newborns, cough
K. senegalensis	Bark, almond	Decoction, oil	Oral	Gastro-intestinal troubles
Mangifera indica	Bark	Decoction	Oral	Diarrhea
Manihot esculenta	Leaves	Maceration after crushing	Oral	Anemia
Mentha piperata + citrus limon	Leaves	Infusion	Oral	Flu
Mentha piperata	Leaves and flowers	Decoction	Oral	Vomiting, digestive pain
Mitragyna inermis	Leaves	Decoction	Oral, Bath	Stomach troubles, Strengthening
Momordica charantia	Leaves and fruits	Decoction	Oral	Malaria, fever, intestinal worms
Moringa oleifera	Leaves	Decoction, jus naturel	Oral, ocular, forehead rubbing	Anemia, asthenia, conjunctivitis, headache
Nocloa platifolia	Powdered bark of the root	Maceration, infusion	Oral	Gastric troubles, constipation
Pilostigma reticulatum	Leaves	Decoction	Oral, bath	Diarrhea, Malaria, tonic
Psidium guajava	Leaves, bourgeon	Decoction	Oral, rectal	Diarrhea, constipation, enterobiasis,
Senna alata	Leaves	Decoction	Oral, washing	Ringworm, eczema, taeniasis, constipation
Sorghum bicolor	grain, Leaves	Braised + water and sugar, decoction	Dermic, oral	Measles, bronchitis
Syzygium aromaticum	Flowers	Maceration	Oral	Flu, cough
Tamarindus indica	bark, fruits Leaves	Decoction, maceration	Oral, bain	Dysenteric, rougeole, constipation
Terminalia macroptera	Leaves	Decoction	Oral, bain	Diarrhée, lavage des plaies, fortifiant
Vitellaria paradoxa	Eraser	Decoction	Oral	typhoid
Vernonia crinita	Leaves	Décoction,	Oral	Malaria
Zingiber officinalis + citrus lemon	Rhizome	Maceration, sirop	Oral	Anorexie, toux, troubles gastriques, grippe, rhume, vomissement
Zingiber officinalis + Citrus lemon	Rhizome + law	Maceration	Oral	Anorexia
Zingiber officinalis + Citrus lemon + Allium sativum	Jus + clove + rhizome	Herbaltea	Oral	Tonifiant, désinfectant

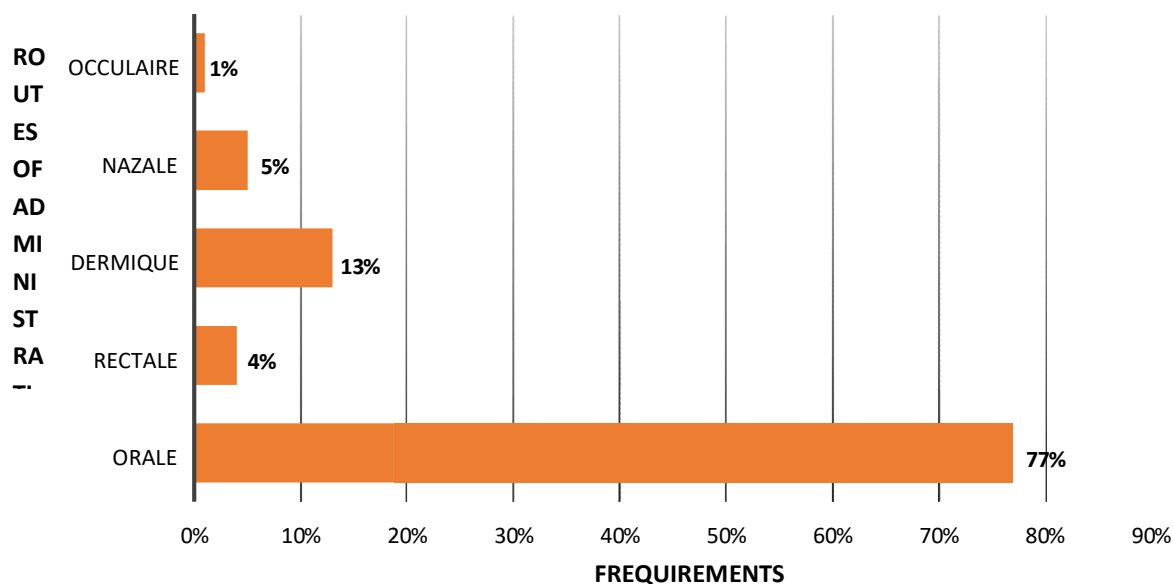
A total of 28 conditions that can be treated with traditional herbal medicine in children were cited. Most of the plants listed are used to treat malaria (8%), followed by coughs (7%), stomach problems (7%), and anemia (7%). Other diseases include constipation (5%), diarrhea (5%), typhoid (5%), fever (5%) and also for strengthening newborns (5%).

Parts used in the treatment of diseases:-**Figure 6: Frequency of citation of the parts used.**

The results in Figure 10 show that a total of 11 parts of the plant are used in the treatment of diseases in children. Leaves predominate over other parts, accounting for 46% of the total. This is justified by their availability in all seasons. In addition, they contain a large amount of active substances, as they are the site of synthesis and storage of a large part of the plant's organic matter.

Recipe preparation methods:-

With the aim of extracting and utilizing the active ingredients of plants in the treatment of their children's illnesses, the respondents use preparation methods such as decoction, maceration, and infusion. The results show that decoction is the main method of preparation, accounting for 47% of mentions, followed by maceration and infusion with 21% and 15% respectively. Decoction is considered to be the most reliable method of preparation because heating more or less guarantees the destruction of certain microorganisms.

Route of administration of traditional preparations:-**Figure 7: Frequency of routes of administration for phytotherapeutic products.**

According to the majority of respondents, most of the preparations are administered orally (77%). The remaining 23% are divided among other routes of administration such as: dermal (13%), nasal (5%), rectal (4%), and ocular (1%).

Discussion:-

Sociodemographic characteristics of respondents:-

The survey results showed that of the 67 people interviewed, 43 (64%) were women and 24 (36%) were men. The majority of respondents primarily use herbal medicine (52%). The use of medicinal plants is quite common in Africa and is often the first resort for vulnerable populations who turn to modern healthcare only at a late stage. According to [13], the use of traditional medicine by poor households to meet their primary healthcare needs is linked to poverty and lack of access to modern medicines. The high number of women shows that they use medicinal plants much more than men to treat childhood illnesses, no doubt because of their experience and closeness to children. These results are similar to those obtained by [14] among populations living near the Amsittène forest in Morocco. The most represented age groups are those aged 40 to 49 and 50 to 59, with a cumulative percentage of 37.5%. However, this rate declines among younger people (aged 20 to 29). In fact, few young people participated in the survey due to their limited experience. The predominance of older people can be explained by the experience they have acquired over many years. The current population of Chad consists mainly of young people who have little or no knowledge of medicinal plants, and as a result, this local knowledge, which is passed down from generation to generation, is being called into question [3]. According to [15], knowledge about local plants and their uses is currently incomplete and scattered. It is therefore urgent to draw on the experience and knowledge of these populations with a view to establishing a policy for the management and promotion of medicinal plants.

Species Diversity and Uses:-

The study identified 34 species used in traditional pediatric medicine in the city of Moundou. Previous research conducted in the same area by [6] identified 58 medicinal species used in the treatment of cardiovascular diseases. Other studies conducted in the Mao Department in western Chad identified 29 medicinal species [7]. These results demonstrate the importance of Chad's flora to the Chadian people. Photochemical, pharmacological, and chemical studies are needed to develop these plants and establish a comprehensive program for the production of medicines based on local knowledge. An analysis of biological types reveals a predominance in the use of woody species (60.6%). According to [16], the knowledge and use of woody plants are linked to their biology. Indeed, due to their longevity and size, woody species are more visible, and their parts are readily available. The Combretaceae, Myrtaceae, and Poaceae are the most commonly represented families. These results differ from those reported for medicinal plants traditionally used for children in Algeria [12]. According to those authors, the most frequently cited families are the Lamiaceae, Rosaceae, Apiaceae, and Asteraceae. Comparing these two sets of results provides insight into the dynamism of local knowledge. According to [17], African peoples possess a wealth of traditional ethnobotanical knowledge due to the cultural and ecological diversity of the environment in which they live.

The importance of the Combretaceae family in the treatment of childhood illnesses has been demonstrated by several authors, including [18]. In the city of Moundou, Combretaceae are used either alone or in combination with species from other families as tonics for newborns, to treat diarrhea and urinary retention, or to clean wounds. The three reported species of Myrtaceae are used in the treatment of childhood illnesses such as malaria, the common cold, coughs, diarrhea, the flu, pinworm infection, and constipation. As for the Poaceae, the extent of their use is explained by the greater species richness of this family in Chad [19]. The most frequently cited species are: *Moringaoleifera*, *Combretummicranthum*, and *Euphorbia hirta*. *M. oleifera* is recognized for its therapeutic properties and is used in traditional medicine to treat metabolic, inflammatory, infectious, and parasitic diseases [20, 21]. The antibacterial, diuretic, and antifungal activities of extracts from various parts of *Combretummicranthum* have been demonstrated in several recent studies. Extracts from this species exhibit inhibitory activity against various pathogenic bacteria as well as significant antifungal activity [22; 23]. Furthermore, pharmacological studies have confirmed its diuretic properties through its effects on water and electrolyte metabolism, renal tubular function, and blood pressure regulation [24]. These results corroborate the plant's numerous traditional uses in African medicine [25]. As for *E. hirta*, previous studies have shown that an aqueous decoction of the whole plant exhibits antibacterial, analgesic, and anti-inflammatory properties [26].

Plant Parts Used:-

All parts of the plant are used in traditional pediatrics. A total of 10 plant parts are used to treat children in this city. The most commonly used parts are, in order, leaves (46%), bark (11%), and seeds and fruits (8% each). These results are similar to those reported in [27], which found that leaves are the most commonly used part in traditional

pediatrics. The prevalence of leaf use among this population is due to the ease of access to this part of the plant. Indeed, leaves are the most commonly used parts in medicinal preparations because they are available year-round [25]. The use of leaves contributes to plant conservation. Results from studies conducted in the same city of Moundou on plants used to treat cardiovascular diseases showed that leaves are highly sought after by traditional healers because of their high content of active substances [6; 25]. Indeed, leaves are the site of organic substance synthesis. In this study, bark is the second most commonly used plant part for treating children. Harvesting these parts using inappropriate techniques could threaten the plant's survival [28]. It is not so much the amount harvested that determines the impact of harvesting on the plant resource, but rather the way in which the harvest is carried out. In fact, inappropriate harvesting practices such as uprooting individual plants, complete debarking, or excessive pruning of branches compromise the plants' survival and their ability to regenerate [29; 30]. Conversely, the use of appropriate harvesting techniques helps preserve plant populations while ensuring the sustainable use of resources [31]. Therefore, for the sustainable management of these plant species, it is essential to raise awareness and train local communities in proper harvesting practices in order to balance the needs of communities with biodiversity conservation [30; 31].

Methods of preparation and routes of administration of recipes:-

There are many different ways of preparing recipes. The survey results showed that the most common method of preparation is aqueous decoction (47%). These results are similar to those obtained in the commune of Tèssékéré in northern Senegal among Fulani herders [25]. The same observation was made in Uganda regarding the use of medicinal plants for the treatment of pediatric conditions [26]. The predominance of decoction highlights this population's belief in this method of preparation, which they find suitable for treating childhood illnesses [27].

Decoction is indeed the easiest method of preparation. It also allows for complete extraction of the active ingredients from medicinal plants when the mixture is boiled [28]. The herbal tea produced from this preparation is often easy to consume. In most of the preparation methods listed, water is the main solvent, thus facilitating administration. In this study, the oral route was the main route of administration for the recipes (77%). These results corroborate those of [12] in Algeria on medicinal plants traditionally used in children (oral route: 77.6%). Southern Chad, and more particularly western Logone, has a large number of herbal medicine recipes that are neither registered nor controlled. It is therefore urgent to implement regulations governing the various aspects of traditional medicine.

Conclusion:-

The results of this study reveal that herbal medicine remains a practice widely used by the population of western Logone to treat several childhood diseases. Women have more knowledge about medicinal plants used in traditional pediatrics. The study identified around 30 species used to treat 28 childhood diseases in 129 recipes. Leaves are the most commonly used parts of plants for treating children. Decoctions and oral administration are the most popular methods of preparation and administration, respectively. The contribution of these species to improving children's health in the region is well established. Although in high demand, these essences are now in sharp decline in the region. The data from this study call for the implementation of a genuine policy for the sustainable management and promotion of medicinal plants used in traditional pediatrics. Phytochemical, pharmacological, and chemical studies based on local knowledge are necessary for the manufacture of medicines.

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