

European Journal of Medicinal Plants (ISSN: 2231-0894)

Publisher: SCIENCEDOMAIN international

ISSN-L: 2231-0894

ISSN: 2231-0894

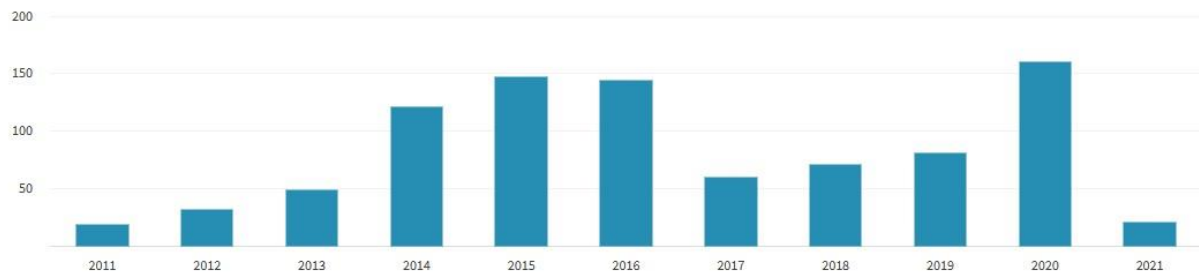
IF(Impact Factor): 2023 Evaluation Pending

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Ethnobotanical Knowledge of Jute (*Corchorus olitorius* L.) in Benin

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Authors' contributions

This work was carried out in collaboration between all authors. Author HOA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors LEA and FJBQ managed the analyses of the study. Authors HAS, DOB and CAAMC managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/EJMP/2018/43897

Editor(s):

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(3) Egu Maxwell Osaronowen, College of health sciences, university of Abuja, Nigeria.
Complete Peer review History: <http://www.sciencedomain.org/review-history/27258>

Original Research Article

Received 24 June 2018
Accepted 04 September 2018
Published 16 November 2018

ABSTRACT

Jute (*Corchorus olitorius* L.) is an indigenous leafy vegetable which leaves are very rich in amino acid and essential minerals and they form part of the meals of people of Asia, Middle East and parts of Africa. The plant is also used as a medicine and source of income for local communities. The aim of this study is to highlight the ethnobotanical importance of *Corchorus olitorius* L. in Benin. To contribute to the enhancement of *C. olitorius*, 14 localities of Benin were visited and 129 people were interviewed, during the investigation. Data were collected about social and phytomedicinal uses of jute. These investigations have led to the understanding that *C. olitorius* is cultivated in all localities of Benin by both women (53.40%) and men (46.60%). The plant has a vernacular name in each local dialect but the term " Ninuwi " in the " Fon " language is the most used (33%). On the ethnomedicinal plan, it is used in the treatment of several pathologies such as malaria, typhoid

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fever, heart disease, infantile malnutrition, etc. Various parts of the plant are used: leaves, roots, leafy stems and seeds, to prepare several drug recipes. Multiple Correspondence Analysis (MCA) followed by Ascending Hierarchical Classification (AHC) revealed that the organs of the plant that are used as medicine vary from one ethnic group to another and that it is the aerial organs of the plant that are most often exploited as a drug. Decoction (92.59%) and maceration are the only ways of preparation listed in this survey. This survey revealed the importance of the jute on ethno medicinal, culinary and social plan.

Keywords: Benin; *Corchorus olitorius*; ethnomedicine; traditional use; malaria.

1. INTRODUCTION

Corchorus olitorius is a leafy vegetable belonging to the family of Sparmaniaceae [1]. It is produced in all tropical regions of the world (Asia, America and Africa) [2-3]. *Corchorus olitorius* is an annual, much-branched herb (90-120 cm) tall with glabrous stems, leaves (6-10 cm long and 3.5-5 cm broad), with pale yellow flowers and black trigonous seeds [4]. In Benin, it is produced throughout the country generally for its leaves. *C. olitorius* leaves are well known as emollient, diuretic, tonic and for purifying human body [5]. Its leaves are also used to make a sticky sauce that accompanies the main dishes. *C. olitorius* leaves are very rich in proteins, β -carotene, iron, calcium, vitamin B, folic acid, amino acid and essential minerals [6,7,8]. Leaves are used as herbal pharmacopoeia against malaria or typhoid fever. They are rich in vitamins (A, C, E) and mineral nutrients like calcium and iron [9-10]. The plant stem is an important source of fiber for making clothing, bags, ropes, packaging, etc. [11]. Its fiber is environmentally friendly because of its biodegradability. The leaves of *C. olitorius* were reported to have hypoglycemic effect [12] and high antibacterial activity [13]. Consumption of Jute mallow provides indispensable antioxidants needed for good health [14,15]. Before any genetic resources collection, conservation, characterisation and evaluation, it is important that prior information and ethnobotanical study be conducted [16].

Several ethnobotanical studies have been conducted in Africa on *C. olitorius* and other species of the genus *Corchorus*. The work carried out within Ivory Coast [17] and Nigeria [18] had helped to highlight the various indigenous uses of *C. olitorius* by local people. In Benin too, *C. Olitorius* is also used for many purposes, but local knowledge about its use is few documented [10-19].

The objective of this study is to highlight the ethnobotanical uses of *C. olitorius* in Benin.

2. MATERIALS AND METHODS

2.1 Presentation of the Study Area

The ethnobotanical survey was carried out in fourteen (14) localities in Benin. Benin is a West African country located between the Equator and the Tropic of Cancer (between latitude 6 ° 30 'and 12 ° 30' north latitude and meridians 1 ° 00 'and 3 ° 40' longitude East). The country covers an area of 114.763 km² [20]. The population of the country is 10 008 749 inhabitants [20].

The choice of districts surveyed is based primarily on the prevalence of vegetable production activities in these localities. Thus, we made sure to select at least one district in each agro-ecological zone of the country. During this study, investigations were carried out according to the Table 1.

2.2 Technical equipment

The technical material for ethnobotanical investigations consists of a fact sheet for the collection of information. The questionnaire includes questions relating to:

- Socio-demographic characteristics (age, sex, education level, place of residence, religion, ethnic group);
- Knowledge of the use categories (food, traditional herbal medicine, religion) of the species by the population based on score;
- Part of plant used, methods of preparation, diseases treated and prohibited.

2.3 Collection of Ethnobotanical Data and Identification

The sample size was determined using the normal approximation of the binomial distribution proposed by Dagnelie [21]: $n = t^2 \times p \times (1 - p) / m^2$ where n is the minimum size of the sample; t = 1.96 for a confidence level of 95%; P = 0.09 for the estimated proportion of the

Table 1. Localisation of different survey area

Agroecological Zone	Study District	Coordinates
Zone 1: Cotton production zone	Kandi	11 ° 07'43"N and 2 ° 56'13"E
Zone 2: Cotton production Zone-center	Savalou	7 ° 55'50"N and 1 ° 58'31"E
Zone 3: Depression area	Adjohoun	6 ° 41'44"N and 2 ° 28'52"E
	Ketou	7 ° 21'29"N and 2 ° 36'27"E
	Pobè	6 ° 58'00"N and 2 ° 41'00"E
	Athiémé	6 ° 35'00"N and 1 ° 40'00"E
Zone 4: Fisheries area	Abomey-Calavi	6 ° 26'55"N and 2 ° 21'20"E
	Cotonou	6 ° 21'36"N and 2 ° 26'24"E
	Grand-Popo	6 ° 17'00"N and 1 ° 50'00"E
	Ouidah	6 ° 22'00"N and 2 ° 05'00"E
	Covè	7 ° 13'20"N and 2 ° 20'20"E
Zone 5: Bar land area		
Zone 6: Extreme Zone -North	Malanville	11 ° 52'00"N and 3 ° 23'00"E
Zone 7: Western Zone Atakora	Djougou	9 ° 42'00"N and 1 ° 40'00"E
Zone 8: Southern Zone Borgou	Gogounou	10 ° 50'35"N and 2 ° 49'42"E

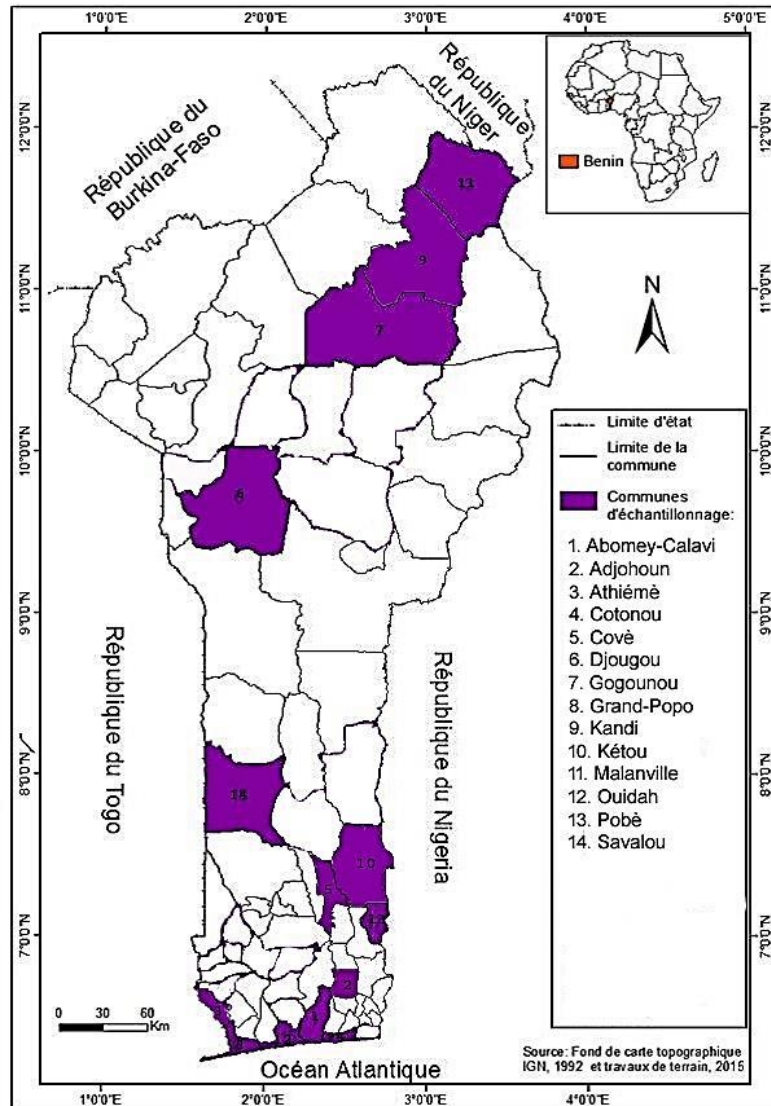


Fig. 1. Map of Benin presenting the study areas

vegetable producer population and $m = 0.05$ for the margin of error. The value of p is calculated on the basis of the following three hypotheses:

- One person is interviewed per farm household,
- The number of agricultural households is equal to 801 611 for a total of 2,693,113 households nationally [20],
- Agricultural households involved in gardening production represent less than 1/3 of agricultural assets in Benin [22].

The calculated value of n is 126. During the survey, 129 market gardeners were surveyed. The number of people surveyed varies from one locality to another according to the prevalence of gardening site.

The collection of ethnobotanical data was carried out using direct questions [17-23] in the mother tongues of the respondents. These were chosen on the gardening site. These various investigations were guided by a fact sheet. These exchanges took place from the 1st to 15th June 2017. The different localities visited were chosen according to their geographical location for a good distribution of sites throughout the territory. The market gardening sites and fields were chosen for their proximity.

2.4 Data Analysis

The data collected was analysed with Microsoft Excel.

Also, two Multiple Correspondence Analysis (MCA) followed by Ascending Hierarchical Classification (AHC) were realised with the SAS v 9.4. software. One is to determine the correlation between the organs of the plant used as endogenous medicine and the different ethnic groups encountered during the study. The second MCA aims to determine possible

correlations between the organs of the plants used and the diseases treated.

3. RESULTS AND DISCUSSION

3.1 General Characteristics of Respondents

Adults aged 29 to 59 accounted for 71.43% of respondents. The respondents aged 18 to 30 and 60 to 100 represents 17.58% and 10.99% respectively (Table 2). Women accounted for 53.40% of interviewees. About 48.61% of those surveyed have primary education (Table 2). These interlocutors of various ethnic groups were met mostly on gardening sites. Gardening is the main activity of 75.96% of the people surveyed. About Fifteen percent of them are primarily engaged in the vegetable trade. The remaining 9.30% includes those whose main activity is not directly related to the production or trade of vegetables such as dressmakers, masons, pupils, hunters, fishermen, motorcycle taxi drivers and hairdressers. It is important, however, to report that vegetable production is the secondary activity of the latter two categories of persons surveyed.

Despite the ethnic diversity that characterises Benin, *C. olitorius* is present and known in all the 14 localities where the study was conducted. The persons interviewed belong to 10 different ethnic groups with all the socio-cultural differences that this includes. However, all the people interviewed (regardless of gender or age) were familiar with the plant and were able to demonstrate at least one use in culinary and therapeutic areas. This shows that the plant is cultivated and exploited extensively throughout Benin [24]. Also, the large number of ethnic groups in Benin does not exclude a strong socio-cultural mix that takes into account the sharing of information related to the use of plants.

Table 2. Some characteristics of respondents

Parameters	Percentage	Parameters	Percentage
Percentage of respondents by age		Percentage of respondents by study level	
[18;30 years]	17.58%	None	25.00%
[30;60 years]	71.43%	Primary	48.61%
[60;100 years]	10.99%	Secondary	22.22%
Percentage of respondents by main activity		University	4.17%
Gardener	75.96%	Percentage of respondents by sex	
Vegetable trader	14.72%	Women	53.40%
Others	9.30%	Men	46.60%

3.2 Traditional Nomenclature

Municipalities investigation	Ethno-linguistic groups	Vernacular names <i>C. olitorius</i>
Adjohoun	Goun	Ninnuwi, Amaninnuwi
Athiémè	Mina, Adja	Ninwé, Démin, Démi
Abomey-Calavi	Fon, Aizô	Ninnuwi, Démi
Cotonou	Fon	Ninnuwi
Covè	Mahi	Ninnuwi
Djougou	Dendi	Ayôyô
Gogounou	Bariba	Yoroyorokou
Grand-Popo	Mina	Démin, Adémin
Kandi	Dendi	Ayôyô
Kétou	Nago	Ewédou, èlèkou, Obèyo,
Malanville	Dendi	Ayôyô
Ouidah	Fon	Ninnuwi
Pobè	Nago	Obèyo
Savalou	Mahi	Ninnuwi

Table 3. Vernacular names of the plant according to ethnolinguistic group and locality

Affections	Part of the plant used	Other ingredients*	Form of employment	Preparation method**	Method of administration
Malaria	Whole plant	Lemon, Leaves of Moringa	Herb tea	Decoction	Oral
	Leaves	Lemon	Herb tea	Decoction	
	Roots		Herb tea	Decoction	
	Leafy stems	Lemon	Extracts	Maceration	
Typhoid fever	Flowers	Lemon	Herb tea	Decoction	Oral
	Leafy stems	Lemon	Herb tea	Decoction	
	Flowers	Lemon	Herb tea	Decoction	
	Roots		Herb tea	Decoction	
	Leaves		Herb tea	Decoction	
	Whole plant	Lemon, Leaves of Moringa	Herb tea	Decoction	
Fever	Leafy stems	Lemon	Herb tea	Decoction	Oral
	Flowers	Lemon	Herb tea	Decoction	
	Leaves		Herb tea	Decoction	
Female fertility	Whole plant		Herb tea	Decoction	Oral
	Whole plant	Leaves of Acacia	Herb tea	Decoction	
Diarrhea	Leaves	Leaves of Moringa	Herb tea	Decoction	Oral
Ulcers, Colic	Leafy stems	-	Herb tea	Decoction	Oral
	Leaves	-	Herb tea	Decoction	
	Leaves and seeds	-	Herb tea	Decoction	
Itéra	Whole plant		Herb tea	Decoction	Oral
	Leaves	Lemon	Herb tea	Decoction	
Heart failure	Leafy stems	-	Herb tea	Decoction	Oral
	Whole plant	-	Herb tea	Decoction	
Child malnutrition	Leaves	Lemon, Leaves of Moringa	Herb tea	Decoction	Oral
Sexual weakness	Roots	Not identified	Herb tea	Decoction	Oral

*These are organs of other plants that users combine with jute to prepare their recipes, **This is the way recipes are prepared

The vernacular name of *C. Olitorius* varies regarding each locality and ethno-linguistic groups met during the investigation. These different local names are represented in Table 1 according to the localities visited. Compared with traditional nomenclature, it is common for a species to bear several local names or for several plants to bear the same name [23]. This study makes the same observation. The term " *Ninuwi* " is used in virtually every locality. This term is the most common because it is in the national language " *Fon* " which is the most spoken language in Benin. However, there are names for each ethnic group. The present study corroborates and completes the names cited by Akoègninou et al. [4].

3.3 Categories of Uses *Corchorus olitorius* Identified

Two categories of use *C. olitorius* are identified with local populations: food and traditional medicine. The respondents are unanimous on the fact that *C. Olitorius* is used in both areas and provided information to that effect.

3.3.1 Culinary uses of *Corchorus olitorius*

The leaves of *C. olitorius* are consumed in all the localities where the survey was conducted. The leaves are used fresh and dried to make sticky sauces accompanying main dishes. The leaves dried in the shade are packed in jars hermetically sealed and protected from moisture. It can be stored for up to 60 days. However, the drying of the jute sheets for storage is not common practice due to the difficulties associated with the lack of suitable drying arrangement and the black coloring of the dried leaf sauce which depreciates its organoleptic value.

The main dish that it accompanies most often is the corn dough. It accompanies other dishes that vary according to the geographical area. Thus, in the south of the country, the crunchy sauce is easily married with *Akassa*, pounded yam, *Agbéli*, pounded cassava or black paste (based on yam chips). In the northern region of the country, jute sauce also accompanies crushed yam, black paste, semolina paste, rice paste and the likes.

Due to its accessibility to all social strata, it is consumed practically by all Beninese households. It is generally present in the menus of the traders restoring traditional dishes. It is very present in the feeding of weaning children.

People (especially women) surveyed believe that the fact that the sauce is slimy facilitates the swallowing of food by weaning children.

For the kitchen, only the leaves of *C. olitorius* are used as a vegetable. These results are close to those obtained by Ta Bi et al. [17]. In Benin, leaves are usually consumed in the form of a sticky sauce. Ta Bi et al. [17] reported that it is also consumed like past in the Ivory Coast. This form does not exist in Benin.

3.3.2 Ethnic medicinal use

3.3.2.1 *Plants and diseases treated*

The affections cited by the respondents, the part of the plant used, the method of preparation of the medicament and the mode of administration are presented in Table 3. The investigations have identified 11 diseases treated by *Corchorus olitorius* Benin. These diseases include heart failure, diarrhea, typhoid fever, colic, and child malnutrition, which are also cited by Ta Bi et al. [17] as the disease treated with *C. olitorius* in Ivory Coast. The use of the plant to treat heart disease has also been reported by Denton et al. [25]. *C. olitorius* was also cited as the main element of some remedies for female fertility. Soladoye et al. [26] also obtained similar results.

Our results corroborate those of Fasinmirin and Olufayo [27] who reported the use of the plant to treat fever. In the same way, Owoyele et al. [28] have scientifically shown that the extract of *C. olitorius* root is a great anti-inflammatory that helps reduce fever significantly.

The use of *C. olitorius* for treating malaria is one of the most commonly cited in this study. In Ethiopia, the use of the plant to treat malaria has been reported by Asnake et al. [29]. This use was also reported in Cameroon by Saotoing et al. [30].

As for its use in the treatment of typhoid fever, it was reported in 2017 by Dougnon et al. [31] in Benin. This study confirms the therapeutic indications already mentioned by these authors.

3.3.2.2 *Use of the plant as phytomedicines*

Several parts of the plant are used in the preparation of phytomedicines: Leafy stems, leaves, seeds, flowers and roots. The leaves and the whole plant are mainly solicited (respectively 28% and 24%). Leafy stems are used in 20% of

cases. The leaves are thus stressed in 72% of the recipes medicines. These results are quite similar to those of Ta Bi et al. [17] which reported the use of leaves in 53.57% of cases. The results of Doh [23] indicate that the leaves were mainly used in 56.89% of the cases. Roots, flowers and

leaf-seed combination are used in drug recipes respectively in 12%, 12% and 4% of cases. These different values are indicated in Fig. 2. The use of these organs was reported by Owoyele et al. [28] and Ta Bi et al. [17].

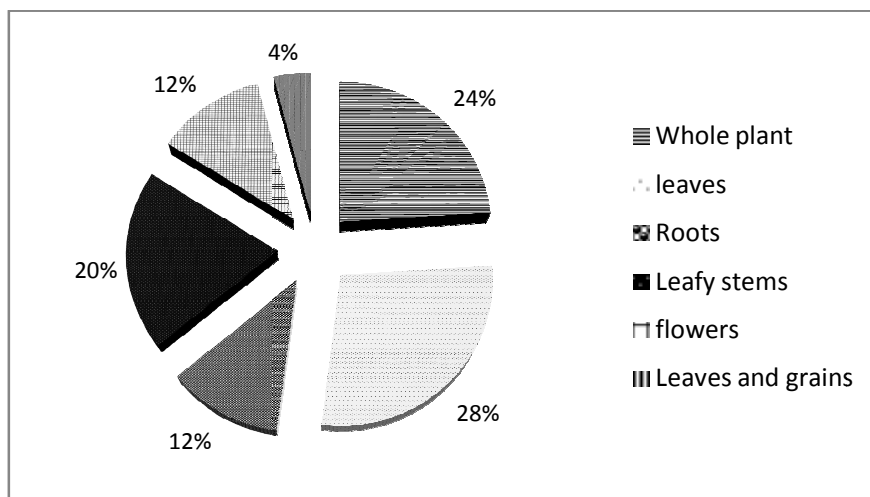


Fig. 2. Spectrum of distribution of the plant parts used as plant protection products

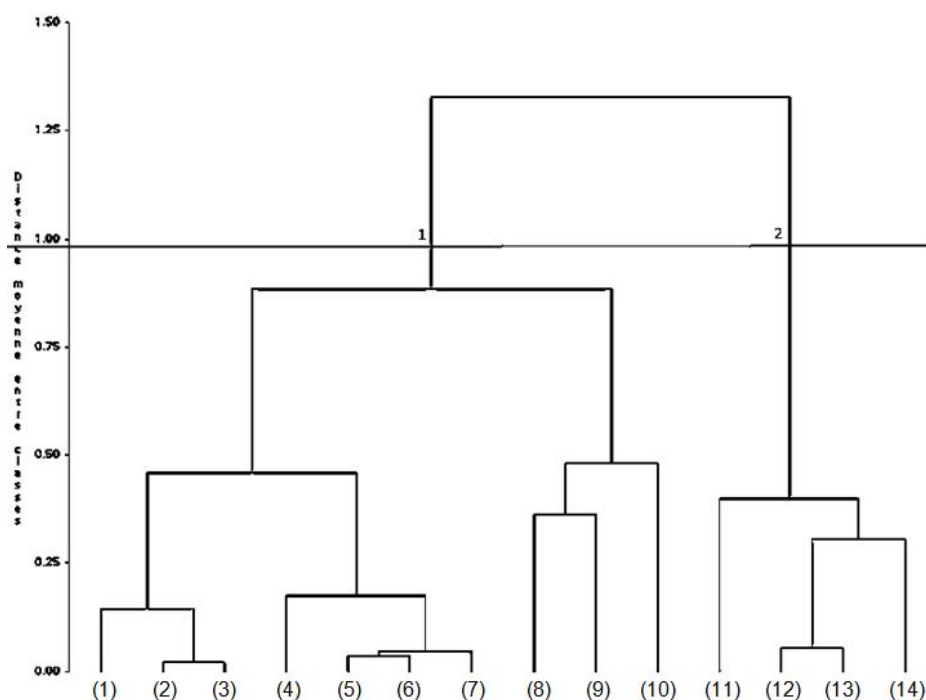


Fig. 3. Dendrogram showing correlations between parts of the plant used as a drug and the different ethnic groups encountered

(1)=Adja; (2)=Aizô; (3)=Mahi; (4)=Dendi; (5)=Mina; (6)=Root; (7)=Nago; (8)=Bariba; (9)=Leaves; (10)=Leafy stem; (11)=Fon; (12)=Goun; (13)=whole plant; (14)=Flower

The correlation between the parts of the plant used as a drug and the different ethnic groups encountered is explained by a MCA followed by AHC. It reveals two levels of correlation (Fig. 3). The first level concerns the whole plant and the flowers which are the most used as drug by the peoples Fon and Goun. The second level concerns the leafy stem, leaves and roots which are more used by peoples *Adja, Aïzo, Mahi, Bariba, Dendi, Mina* and *Nago*. This is quite close to the results of Lougbegnon et al. [32] who estimate to 72.36% the use of leafy stem in the ethnobotanical practices in Aïzo and Fon. Furthermore, Kouchadé et al. [19] identified leafy branches as the most used part of the plant in southern Benin, where the ethnic groups *Fon, Aïzo, Adja, Mina Nago* and *Mahi* are found.

The second MCA and AHC (Fig. 4.) explain the correlations between the organs of the plant used and the diseases. It should be noted on the one hand that the use of leafy stem and leaves is strongly linked to the treatment of jaundice, ulcer, children malnutrition and colic. On the other hand, it is the whole plant and the flowers that are most often used for the treatment of typhoid fever, fever and malaria (the most frequently cited by the interviewees). This information corroborates those of Kouchadé et al. [19] which report the use of leafy shoots in the treatment of jaundice and typhoid fever. The use of the whole plant in the treatment of typhoid fever is also reported by Ta Bi et al. [17]. Asnake et al. [29] also report the use of leafy stem in the treatment of malaria and diarrhea in Ethiopia. Unlike the realities of Cameroon [30], seeds are not used in Benin in the treatment of malaria. Also, for the treatment of sexual weakness, roots are the most commonly used. This analysis also reveals that

there is no real correlation between the organs of the plant used and the treatment of female fertility and heart disease. However, the whole plant can be used in the treatment of female fertility and heart disease.

3.3.2.3 Modes of drug preparation

The investigations reveal two ways of preparing phytomedicines: Decoction and maceration. The decoction is the most important method of preparation with 92.59% of the cases. Maceration is used only in 7.41% of cases. This result is very similar to that of Kouchadé et al. [19] who indicated that the decoction is used mainly in 93.87% of cases, in its study on medicinal plants used in the treatment of infantile diseases and sold in markets in southern Benin. This would certainly be due to the fact that on the one hand the species is not woody and on the other hand most of the recipes are prepared from leaves whose extracts are quite soluble in hot water. The decoction, which is the most popular method of preparation, would allow the collection of the most active ingredients, but would also mitigate or cancel the toxic effect of certain recipes [33] because heating would disinfect plant organs and cancel thus the toxic effect of the recipe. But this process could destroy certain active ingredients of the species used [34].

3.3.2.4 Drug forms

In relation to drug forms, three cases are obtained: herbal tea, extract and powder. Herbal tea is the most used (92.59% of the cases). The powder and the extract are each used in 3.70% of the cases.

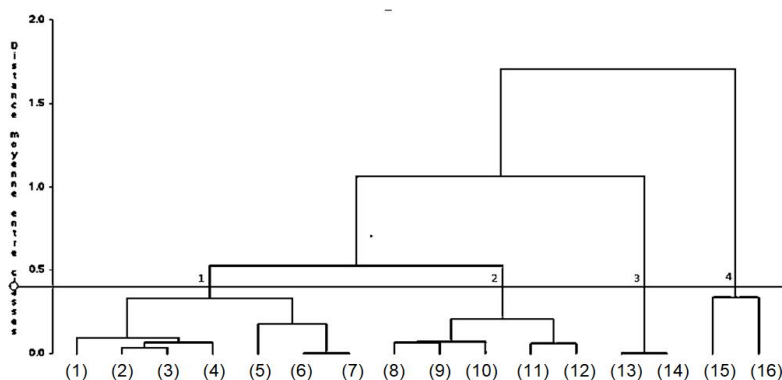


Fig. 4. Correlations between parts of the plant used as a drug and the conditions treated
 (1)=Leaves; (2)=Leafy stem; (3)=Ulcer; (4)=Jaundice; (5)=Colic; (6)=Diarrhea; (7)=Children malnutrition;
 (8)=Flower; (9)=Fever; (10)=whole plant; (11)=Typhoid fever; (12)=Malaria; (13)=heart disease; (14)=female
 fertility; (15)=Root; (16)= sexual weakness

Investigations reveal drug recipes prepared only from plant organs. 13 recipes are shown for the treatment of 11 affections. Among them, only five were prepared based on *C. olitorius*. The medicinal preparations of *C. olitorius* usually do not only with the organs of the plant. The integration of other ingredients like lemon or moringa leaves (*Moringa oleifera*) is quite frequent (61.53% of cases). The lemon (*Citrus limon* fruit) is most often used. According to our own observations, the use of lemon aims to prevent the solution obtained is sticky like sauce made from leaves of *C. olitorius*. As for the use of *Moringa oleifera*, it would aim to enrich the nutritional value of decoction.

3.3.2.5 Methods of administration

Oral administration is the only one administered by the respondents. In their work on the plants of the genus *Corchorus* in Ivory Coast, Ta Bi et al. [17] have listed several other modes of administration such as the dermal route or inhalation. The absence of these practices in Benin is due to the fact that decoction is the most common method of preparation (92.59% of cases). These results are very close to those of Kouhadé et al. [19] which show that oral administration is the most common in Benin (91.46%).

3.4 Social Taboos Related to *Corchorus olitorius*

This study allowed us to evidence some prohibitions related to the production and use of *C. olitorius* in the visited locations. The consumption of jute can be prohibited for several reasons:

- Members of certain traditional *vaudou* communities may be prohibited from consuming the leaves of *C. olitorius* permanently or periodically (during periods of the year when important rituals are practiced),
- Some people and their families may be banned from eating jute by the *fâ* (the traditional oracle). In these cases, the plant becomes a totem for these families.

In Benin, the cradle of *Vaudoun* culture, plants play a fundamental role in religious practices [35]. As a result, it is heavily impregnated in certain social practices. The cultural social prohibitions listed in this study bear witness to this fact. In the locality of Covè (locality with strong production of Jute), in *Mahi* environment,

the prohibitions linked to the production are much anchored in the daily life of the producers. Thus, it is prohibited to enter in a field of *C. olitorius* being shod. The use of metal containers is prohibited for harvesting. Only vegetal material baskets are authorised to enter in a field of *C. olitorius*. Our results corroborate those of Dansi et al. [9] who report that the consumption of *Corchorus tridens* is forbidden to the followers of the divinity *Heviosso* in Benin.

4. CONCLUSION

Ethnobotanical investigations, in 14 localities of Benin, have identified the different uses of *Corchorus olitorius*. They are consumed and used in traditional medicine. The leaves of these plants commonly called *Ninuwi* are consumed throughout the territory in sauce accompanying several dishes. In ethno-medicinal plan *C. olitorius* involved in the treatment of several diseases. Various parts of these plants: leaves, roots, leafy stems, and seeds are used to prepare medicated recipes. The realisation of a first MCA followed by AHC made it possible to understand that plant organ are used as medicine vary from one ethnic group to another. A second MCA followed by AHC revealed that it is the aerial organs of the plant that are most often exploited as a drug. There are also socio-cultural prohibitions related production and consumption of *C. olitorius*. For these many contributions, cultivation of *C. olitorius* should be encouraged and popularised in Benin.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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