Holaly E. Gbekley¹, Gnatoulma Katawa¹, Simplice D. Karou¹³*, Kokou Anani¹, Tchacondo Tchadjobo¹, Yaovi Ameyapoh¹, Komlan Batawila², Jacques Simpore³

¹ Ecole Supérieure des Techniques Biologiques et Alimentaires (ESTBA-UL), Université de Lomé, Togo ² Laboratoire de Biologie et Ecologie Végétales, Faculté des Sciences, Université de Lomé ³ Centre dee cherche Biomoléculaire Pietro Annigoni (CERBA/LABIOGENE), Ouagadougou, Burkina Faso.

Corresponding Author Email: simplicekarou@hotmail.com

Abstract

Background: Asthma is one of the most common chronic diseases in modern society and it is evident that its incidence and severity are increasing, however very little is known about the plants used in the management of the disease. This study therefore aimed to document the plants usage in the Togolese traditional medicine to treat asthma.

Methodology: From January to June 2015, an ethnomedical survey was conducted using a semi-structured questionnaire with traditional healers (THs) in the southern region of Togo. The importance of the plants species was assessed by the calculated use values.

Results: In total, 121 THs (92 males and 29 females) were interviewed and 98 plants species belonging to 54 families were identified as curing asthma. The most represented families were: Leguminoseae with 7 species followed by Euphorbiaceae and Rutaceae contributing with 6 and 5 species respectively. Based on the calculated use values the most important species were Carica papaya L., Catarantus roseus L., Eucalyptus camaldulensis Dehnh., Piper guineense Thonn., Eucalyptus citriodora Hook., Eucalyptus globules Labill. and Euphorbia hirta L. The leaves and the root were the parts predominantly used to prepare the formulations, mainly decoctions, administered by oral route. Clinical manifestations such as wheezing (91.74%), difficulty as speaking or coughing (73.55%), dyspnea (66.94%), dry cough (52.89%), sweating and increased heart rate (52.07%) were used by TH to diagnose the disease.

Conclusion: This study showed initial evidence of the use of plant materials by Togolese TH to heal asthma. These results could be a starting point for laboratory screenings.

Key words: Asthma, traditional medicine, medicinal plants, survey, Togo.

Introduction

Asthma is a chronic disease characterized by variable airflow limitation and/or airway hyper-reactivity with symptoms causally related to family history, environmental influences, exposure to viruses and allergens as examples (Yunginger et al., 1992). The high economic burden linked with asthma is associated primarily with health care costs, missed work or school days (Singh et al., 2007). The treatment of asthma in the modern medicine is based on the use of beta agonists, leukotriene modifiers and inhaled corticosteroids that allowed an acceptable control of the main symptoms. However, this therapy could not suppress all the symptoms although the better use of glucocorticoids is often a cause for patient discomfort, limiting the use of glucocorticoids in asthma therapy. In addition, the current therapy is not affordable for the patients in developing countries, who rely on the traditional medicine. Therefore, there is a significant need for new medications for the treatment of asthma that are highly efficacious, with low cost, easily managed and with few adverse effects.

In the search for new medications for asthma, plants through the traditional medicine are a credible alternative. Hence, plant have been used to treat several diseases for thousands of years. And nowadays following the traditional use of plants, some pharmacological screenings have led to new drugs discovery. Indeed, plants have been the leads of about 25% of drugs introduced into the market during the last 20 years (Vuorela et al., 2004; Basso et al., 2005).

In the particular case of asthma, there is a high prevalence of usage of complementary medicine. Herbal preparations have been cited as the third most popular complementary treatment modality by British asthma sufferers (Huntley and Ernst, 2000; Urata et al., 2002). Consequently, in the recent decades, the medicinal plants used in the management of the disease have attracted the attention of some authors, through the screening for immunomodulatory activity of plant extracts. However, data on the ethnomedical of plants used in the management of asthma are scanty. The present study was undertaken to investigate the treatment of asthma by traditional practitioners in the Southern region of Togo.
Materials and methods

Study area

Togo is a western African country lying between Burkina Faso in the North, Benin in the East, Ghana in the West and the Atlantic Ocean in the South. The country is divided into five economic regions namely Savannah Region, Kara Region, Central Region, Plateau Region, and Maritime Region. The present study was carried out in the Maritime Region (figure 1). It stands between 1°20'-1°50' east and 6°10'-6°60' north of the equator and bordered to the north, West, East and the South by Plateau Region, Republic of Ghana, Republic of Benin and the Atlantic Ocean respectively. This study area is 6100 km² big and occupies approximately 10.78% of the country. The climate is sub-equatorial. The region is inhabited by 1.828.000 people (density of 50 -200 persons/km²), the main ethnic groups being Ewe, Ouatchi, Mina, Fon, Adja.

Figure 1: Map of Togo showing the Maritime Region

Data collection

Direct interviews with traditional healers (TH) were conducted between January and June 2015 using a semi-structured questionnaire.

Each TH gave a verbal consent certifying his/her agreement with the form issued to explain the importance of the information they would provide prior to interviews. Questions asked were about (i) the TH identity, i.e. name and surname, sex, age, level of education; (ii) the origin of their knowledge; (iii) the status of the TH, i.e. full-time professional TH or part-time professional TH; (iv) the disease, i.e. name of the disease in the local language; (v) the diagnosis, i.e. main symptoms; and (vi) the remedies, i.e. the number of plants in the remedy, the local names of the plants, the used parts, the remedy formulation, and the administration route.
Gbekley et al., Afr J Tradit Complement Altern Med., (2017) 14 (1): 196-212
doi:10.21010/ajtcam.v14i1.22

Plant identification

After interviews, preliminary identification of the plants was done in the field by a botanist. Afterward, voucher specimens were prepared and pictures were taken to help in the confirmation of the identity of the plants. Plant identities were confirmed by comparison with available voucher specimens in the Herbarium of the Botany Department, University of Lomé, using taxonomic keys of online databases of West African Plants – A photo Guide on the website: http://www.westafricanplants.senckenberg.de/root/index.php. Nomenclature of species was done using the online data base of IPNI website: http://www.ipni.org/ipni/plantnamesearchpage.do.

Statistical analysis

Excel spread sheet was used to make simple calculations and to determine plant frequencies. The use value (UV), a quantitative method that demonstrates the relative importance of species known locally, was calculated according to the following formula (Aburjai et al., 2007; Hudaib et al., 2008):

$$\text{UV} = \frac{\sum U}{n}$$

Where, UV is the use value of a species; ΣU the total number of citations per species; n the number of informants. The other analyses were performed using PRISM 5.02 program (GraphPad Software, Inc., La Jolla, USA). Since most of the variables did not show a normal distribution, the following tests were chosen: to compare three groups a Kruskal-Wallis-test was performed and, if significant, followed by a Mann-Whitney–U test for a further comparison of the groups. P-values of 0.05 or less were considered significant.

Results

Socio demographic profile of the traditional healers

This study included 121 traditional healers, 92 men and 29 women. Table 1 displays the socio demographic profile of the traditional healers. The THs were arbitrary divided into four age groups notably the ≥ 30 years, [30-50years], [50-70] and the <70 years accounting respectively for 15, 42, 41 and 23 THs. For the in educational level, 19.01% of the THs were illiterates while 46.28% attended at least the primary school. The rest were either secondary. We assess the descent of the knowledge for the treatment of asthma. Family heritance (47.11%) and traditional initiation (42.15%) followed the same trend and were the best means for the transmission of the knowledge compared to others (p<0.0001). In contrast, the THs who got the knowledge by divine revelation were fewer compared to those who got it by family inheritance and traditional initiation (p<0.0001). In addition, most of the healers were full time professionals (40.50%), exerting exclusively the healing as the main source of revenue. The THs in the formal sector were more represented in the asthma treatment compared to either artisans (p<0.0001) or farmers and herders (p=0.0002). This indicates that not only THs are educated but also are well organized in a formal sector.

Table 1: Sociodemographic data of the traditional healers

| Sex          | Males | Females |
|--------------|-------|---------|
| N            | 91    | 30      |
| %            | 75,21 | 24,79   |
| Age groups   |       |         |
| ≤30 years    | 15    | 42      | 41    | 23    |
| %            | 12,40 | 34,71   | 33,88 | 19,01 |
| Educational level | illiterates | Primary | Secondary | University |
| N            | 23    | 56      | 29    | 13    |
| %            | 19,01 | 46,28   | 23,97 | 10,74 |
| Origin of the knowledge | Familial inheritance | Divine revelation | Initiation with a TH | Other |
| N            | 57    | 7       | 51    | 6     |
| %            | 47,11 | 5,79    | 42,15 | 4.96  |
| Professional status | Full time | Farmer | Trader | Artisans |
| N            | 49    | 17      | 42    | 13    |
| %            | 40,50 | 14,05   | 34,71 | 10,74 |
We were then interested to know at which season of the year and at which moment of the day the plants were collected for the preparation of the recipes. Regarding the season of the year, most of the THs (36.63%) harvest plant materials in the rainy season while 3.31% of them harvest in the dry season (p<0.0001). We observed that collecting plant materials all the season of the year (60.33%) is statistically more common than both rainy and dry season (p=0.0002 and p<0.0001 respectively). Concerning the moment of the day the collect was carried, the morning hours is the most common compared to midday and the evening (p<0.0001). In addition, more TH collected plants materials all the time of the day (figure 2).

![Figure 2: Period of plant materials collection.](image)

(A): Seasons of plant materials collection. (B): Moment of the day for the plant materials collection. Bars indicate the number of THs collecting the plant materials for each season of the moment of the day.

**Symptoms used by TH for the diagnosis of asthma**

A total of 13 symptoms were identified (figure 4). In the order of importance the symptoms were ranked as follows: the wheezing, difficulty at breathing, dyspnea, chest tightness, dry cough, sweating and increased heart rate, difficulty at speaking or coughing, anxiety, confusion and agitation, disorders of consciousness, bluing and blackening of lips and nails, difficulty walking, dilated nostrils and loss of consciousness.

![Figure 3: Diagnosis of asthma by Traditional practitioners](image)

The THs were interviewed about the diagnosis of asthma. The bars represent the number of TP using the indicated clinical manifestation for the diagnosis of asthma.

**Diversity of medicinal plants and their usage in the treatment of asthma in the maritime region**

A total of 98 plants species distributed in 54 families were recorded in the present study. The plants consisted of trees, herbs, lianas and shrubs; the most frequent growth habits being the trees and shrubs, accounting for 42% and 32% respectively (figure 4). The species were diversely distributed among botanical families. Thus, some families were more represented than others. The most represented family was the Leguminosae that contributed with 7 species namely *Acacia albida* Rojas, *Acacia erythrocalyx* Brenan, *Albizia adianthifolia* W.Wight, *Desmodium gangeticum* DC.
Erythrina senegalensis DC., Parkia biglobosa Benth. and Tetrapleura tetraptera Taub. This was followed by Euphorbiaceae and Rutaceae contributing with 6 and 5 species respectively. The other families contributed with less than 5 species each.

Figure 4: Growth habits of medicinal plants used in the management of asthma

The importance of medicinal plant was assayed by use values (UV) that were ranged between 0.03 for the less used species and 0.09 for the most used species (table 1). Considering these UV, the following species appeared to be of great importance for the management of asthma in the surveyed region: Abruspreca torius L. (UV=0.07), Desmodium gangeticum DC (UV=0.07), Allium cepa L. (UV=0.08), Allium sativum L. (UV=0.08), Annona muricata L. (UV=0.08), Guiera senegalensis J.F.Gmel (UV=0.08), Securidaca longipedunculata Fresen (UV=0.08), Zingiber officinale Roscoe (UV=0.08), Carica papaya L. (UV=0.09) Cataranthus roseus L. (UV=0.09), Eucalyptus camaldulensis Dehn. (UV=0.09), Piper guineenseThonn. (UV=0.09), Eucalyptus citriodora Hook. (UV=0.09), Eucalyptus globules Labill. (UV=0.09) and Euphorbia hirta L. (UV=0.09).

The TH in the maritime region of Togo were found to use various parts of plant in the treatment of asthma. Figure 5 displays the trends of use of the various plants parts. No statistically difference was observed between the use of leaves (26%) and root (20%) for the treatment of asthma. Interestingly, leaves were more used compared to leafy stems (p<0.0001) and fruit (p<0.0001). In addition, bark was also less used compared to the root (p=0.0015). Almond, kernel, latex and inflorescence followed the same trend and were less used for the healing of asthma.
The parts of the plant used to prepare the recipes were investigated. Each dot shows the number of plant in relation with the part used for the preparation of recipe.

Fourteen formulations were identified. Decoction was more used by TH compared to the powder form (p=0.15). Both were predominantly used by TH compared to other galenic forms (Figure 6). More interestingly, most of the galenic forms were administrated by the oral route (57%, p<0.0001). This was followed by massage (19%). In contrast, few TH preferred bandage, oral sucker and smoking.

Figure 5: Parts of the plants used for the treatment of asthma.

Figure 6: Formulations and administration route
Fourteen formulations were identified (A). Each dot represents the number of formulations for each plant candidate. (B) Indicates the administration route of the formulations. The dots represent the number of administration route of each plant candidate.
Table 2: Diversity of medicinal plants and their uses for the treatment of asthma in the Maritime Region

| Species                  | Local name                  | Voucher N°  | UV  | Used parts | Habits | Mode of preparation | Mode of administration |
|--------------------------|-----------------------------|-------------|-----|------------|--------|---------------------|------------------------|
| ACANTHACEAE              |                             |             |     |            |        |                     |                        |
| Hygrophila spinosa Anderson | Tomeamudja              | 22FDS/UL    | 0.03 | Le, LS     | Herb   | Dec, Pow             | Oral                   |
| AMARYLLIDACEAE           |                             |             |     |            |        |                     |                        |
| Hymenocallis littoralis (Jacq.) Salisb. | Tomeyedo              | 338FDS/UL   | 0.04 | WP         | Herb   | Dec, Pow             | Oral                   |
| ANACARDIACEAE            |                             |             |     |            |        |                     |                        |
| Mangifera indica Blume   | Amangoti, yovoslatin,      | 1157FDS/UL  | 0.05 | Le         | Tree   | Dec                 | Oral, Oral             |
| ANNONACEAE               |                             |             |     |            |        |                     |                        |
| Spondias mombin L.       | Aklikon, djogbema          | 371FDS/UL   | 0.03 | Le         | Tree   | Pow                 | Oral                   |
| Annona muricata L.       | Nyigli                      | 536FDS/UL   | 0.08 | Le         | Shrub  | Dec                 | Oral                   |
| Hexalobus monopetalus Engl. &Diels | Akpado                 | 56FDS/UL   | 0.03 | TF, Ro     | Tree   | Tea                 | Massage                |
| Uvaria chamae P. Beauv.  | Agbannaagbanan             | 43FDS/UL   | 0.03 | Le, Ro     | Tree   | Pow, Tea            | Oral, bath             |
| Xylopia aethiopica A.Rich. | Eso, esokwi, kpejelekun   | 53FDS/UL   | 0.03 | Fr, Ro     | Tree   | Dec, Tea Pow        | Oral                   |
| APIACEAE                 |                             |             |     |            |        |                     |                        |
| Centella asiatica (L.) Urb. | Ewekaró                  | 287FDS/UL  | 0.04 | LS         | Shrub  | Dec, Pow            | Oral                   |
| APOCYNACEAE              |                             |             |     |            |        |                     |                        |
| Catharanthus roseus (L.) G.Don | Ganéméflava            | 95FDS/UL   | 0.09 | Le, Ro     | Shrub  | Dec, Pow            | Oral                   |
| Plumeria arborea L.      | Azuinto                    | 209FDS/UL  | 0.04 | Latex      | Tree   | Balsam              | Massage                |
| Rauwolfia vomitoria Wennberg | Adbloti, dodemakpo-we    | 1FDS/UL    | 0.03 | Ro         | Tree   | Alcohol             | Oral                   |
| Voacanga africana Stapf ex Scott Elliot | Atakpariobuko, ako dodo | 87FDS/UL   | 0.03 | Ro         | Shrub  | Tea, Alcohol        | Oral                   |
| ARALIACEAE               |                             |             |     |            |        |                     |                        |
| Cussonia arborea Hochst. ExA.Rich. | Adimniwe, yovoklo, tologunton | 356FDS/UL | 0.03 | Ba         | Tree   | Alcohol             | Oral                   |
| Cussonia barteri Seem.   | Adimniwe, yovoklo, tologunton | 299FDS/UL | 0.03 | Ba         | Tree   | Alcohol             | Oral                   |
| ARECACEAE                |                             |             |     |            |        |                     |                        |
| Cocos nucifera L.        | Neti, yovoneti            | 1188FDS/UL  | 0.04 | Fr         | Tree   | Pow                 | Oral                   |
| Common Name | Latin Name | Family | Dose (FDS/UL) | Parts Used | Form | Uses |
|-------------|------------|--------|---------------|------------|------|------|
| Elaeis guineensis A.Chev. | *Elaeis guineensis* A.Chev. | ASCLEPIADACEAE | 0.05 | Am | Tree | Pow | Massage |
| Calotropis procera W.T.Aiton | *Calotropis procera* W.T.Aiton | ASTERACEAE | 0.03 | Le | Tree | Dec, Pow | Oral |
| Ageratum conyzoides L. | *Ageratum conyzoides* L. | ASTERACEAE | 0.03 | Le | Herb | Alcohol | bandage |
| Artemisia annua L. | *Artemisia annua* L. | ASTERACEAE | 0.05 | Le | Tree | Dec | Oral, |
| Tagetes erecta L. | *Tagetes erecta* L. | COMPOSITAE | 0.05 | Le | Tree | Dec | Oral |
| Balanites aegyptiaca Delile | *Balanites aegyptiaca* Delile | BALANITACEAE | 0.03 | Ro | Tree | Dec, Pow | Massage, bandage |
| Newbouldia laevis See. | *Newbouldia laevis* See. | BIGNONIACEAE | 0.03 | Le | Tree | Tea | Massage |
| Adansonia digitata L. | *Adansonia digitata* L. | BOMBACACEAE | 0.05 | Le | Tree | Pow | Oral |
| Brassica oleracea | *Brassica oleracea* | CRUCIFERACEAE | 0.05 | Le | Shrub | Dec | poultice |
| Erythrophlaeum guineense G.Don | *Erythrophlaeum guineense* G.Don | CAESALPINIACEAE | 0.04 | St | Tree | Balsam, Alcohol | Massage, poultice |
| Caesalpinia pulcherrima (L.) Sw. | *Caesalpinia pulcherrima* (L.) Sw. | CAESALPINIACEAE/LEGUMINOSAE | 0.04 | LS | Shrub | Dec, Pow | Oral |
| Cassia absus L. | *Cassia absus* L. | CAESALPINIACEAE/LEGUMINOSAE | 0.04 | LS | Shrub | Dec, Pow | Oral |
| Senna alata (L.) Roxb. | *Senna alata* (L.) Roxb. | CAESALPINIACEAE/LEGUMINOSAE | 0.04 | LS | Shrub | Dec, Pow | Oral |
| Ritchiea reflexa (thomn.) &Gilg-Ben. | *Ritchiea reflexa* (thomn.) &Gilg-Ben. | CAPPARACEAE | 0.03 | Le, LS | Shrub | Tea | Oral |
| Carica papaya L. | *Carica papaya* L. | CARICACEAE | 0.09 | Le, Fr, Se, Ro | Tree | Dec, Pow, | Oral, smoking |
| Guiera senegalensis J.F.Gmel | *Guiera senegalensis* J.F.Gmel | COMBRETACEAE | 0.08 | Le | Tree | Dec, Pow | Oral, bath, massage |

*Note: FDS/UL = Fraction Dose (standard)/Unit of Labor; LS = Leaves, Stems; Am = Ammonia; Ro = Root; Se = Seeds; Fr = Fruits; Ul = Ultrasound.*
| Scientific Name | Common Name | FDS/UL | Dosage | Type | Dec | Oral, bath, Massage | Preparation |
|----------------|-------------|--------|--------|------|-----|---------------------|-------------|
| Pteleopsis suberosa Engl. & Diels | Kulukuli, klwi | 509FDS/UL | 0.03 | Ro | Tree | Dec, Pow | Massage, scarification |
| Commelina benghalensis L. | Awloksixengbe | 41FDS/UL | 0.03 | WP | Herb | Dec, Pow, Oral |
| Costus afer Ker Gawl. | Tetegugu | 683FDS/UL | 0.05 | Le, St | Shrub | Dec, Oral |
| Cucurbita maxima Duchesne | Kpen, ayikpen, okpe | 151FDS/UL | 0.04 | Se | Liana | Dec, Pow, Oral |
| Cucurbitapepo L. | Kpen, ayikpen, okpe | 1010FDS/UL | 0.04 | Se | Liana | Dec, Pow, Oral |
| Drosera indica L. (Droseraceae) | Amadjeye | 282FDS/UL | 0.04 | WP | Tree | Dec, Pow, Pow, Oral |
| Diospyros mespiliformis Hochst. ex A.DC. | Gubaga, kenu | 672FDS/UL | 0.03 | St, LS | Tree | Dec, Pow, Oral, Massage |
| Acalypha wilkesiana Müll. Arg. | Plante cuivre | 817FDS/UL | 0.04 | Le, Ro | Tree | Dec, Pow | Oral |
| Alchornea cordifolia (Schumach.) Müll. Arg. | Avorlo | 170FDS/UL | 0.03 | Le | Shrub | Dec | Oral |
| Bridelia ferruginea Benth. | Akamesi, hunuokokwe | 511FDS/UL | 0.05 | Le | Shrub | Dec | Oral |
| Euphorbia hirta L. | Hundihundit, anonsika, nosiwé, godota | 454FDS/UL | 0.09 | WP, Le | Shrub | Dec, Fumigation, bath |
| Hymenocardia acida Tul. | Atinjen, sogbëti | 256FDS/UL | 0.03 | Ro | Herb | Tea, Pow | Oral |
| Phyllanthus amarus Schumach. & Thomn. | Hlenwe | 421FDS/UL | 0.03 | Le | Shrub | Dec | Oral |
| Abrus precatorius L. | Vivima, jinjinkudjin, amavivi, ojuologbo | 472 FDS/UL | 0.07 | Le, LS, Ro | Liana | Dec, Pow, Oral, bath, massage |
| Canavalia ensiformis (L.) DC. | Ayivi, legbakpakun | 404FDS/UL | 0.4 | Se | Herb | Dec, Pow | Oral |
| Hygrophila auriculata K. Schum. | Hlavenka, gunu | 333FDS/UL | 0.04 | Rh | Tree | Balsam, Alcohol, Massage |
| Ocimum basilicum L. | Ahameyovoto | 04199TGC/11/AK | 0.03 | In | Shrub | Dec, alcohol | Massage, Poultice |
| Ocimum gratissimum L. | Esrou, Deveti | 1197FDS/UL / 3892 FDS/UL | 0.04 | WP | Shrub | Dec, Pow | Oral, bath, massage |
| Family             | Common names                      | Scientific name                      | Dose | Part Used | Preparation | Application     |
|--------------------|-----------------------------------|--------------------------------------|------|-----------|--------------|-----------------|
| **Lauraceae**      |                                   |                                      |      |           |              |                 |
| Persea americana   | Peayi                             | Mill.                                | 0.05 | Le        | Tree         | Dec, Oral       |
| **Leguminosae**    |                                   |                                      |      |           |              |                 |
| Albizia adianthifolia Wight | Agla                | 137FDS/UL                            | 0.03 | Le        | Herb         | Dec, Oral       |
| Desmodium gangeticum DC. | Zen'ali, eweenmo | 327FDS/UL                            | 0.07 | Ro        | Herb         | Dec, Pow, Tea   |
| Erythrina senegalensis DC. | Kpaklesi                 | 413FDS/UL                            | 0.03 | Ro        | Tea          | Oral            |
| Parkia biglobosa Benth. | Ahwati, abwatin, klwisavo (In), afiti (Gr) | 329FDS/UL                            | 0.03 | St        | Shrub        | Oral, bath      |
| Tetrapleura tetrapetra Taub. | Lelegbleati               | 395FDS/UL                            | 0.04 | St, Ro    | Liana        | Dec, Pow        |
| Acacia albida Rojas | Hlafen                           | 59FDS/UL                             | 0.05 | Ba        | Herb         | Tea             |
| Acacia erythraley Brenan | Hlafen                    | 546FDS/UL                            | 0.05 | Ba        | Herb         | Tea             |
| **Liliaceae/Alliaceae** |                             |                                      |      |           |              |                 |
| Allium cepa L.     | Sabule                           | 300FDS/UL                            | 0.08 | Rh        | Herb         | Tea             |
| Allium sativum L.  | Ail, ayo                         | 296FDS/UL                            | 0.08 | Rh        | Herb         | Tea             |
| **Loganiaceae**    |                                   |                                      |      |           |              |                 |
| Usteria guineensis | Kansuwe, akporo                  | 55FDS/UL                             | 0.03 | Ro        | Herb         | Dec, Oral       |
| **Loranthaceae**   |                                   |                                      |      |           |              |                 |
| Tapinanthus dodoneifolius (DC.) Danser | Léma                      |                                      | 0.03 | LS        | Tree         | Pow             |
| **Malvaceae**      |                                   |                                      |      |           |              |                 |
| Gossypium arboreum L. | Cotonnier              | 693FDS/UL                            | 0.04 | Se        | Shrub        | Dec, Pow        |
| Hibiscus esculentus L. | Fevi, ajatukan           | 696FDS/UL                            | 0.05 | Ro        | Herb         | Dec             |
| Sida acuta Burm.f. | Ademesu, aflideme          | 147FDS/UL                            | 0.04 | WP        | Shrub        | Dec             |
| **Meliaceae**      |                                   |                                      |      |           |              |                 |
| Azadirachta indica A.Juss. | Kininuti            | 221FDS/UL                            | 0.04 | Se        | Tree         | Pow             |
| **Menispermaceae** |                                   |                                      |      |           |              |                 |
| Cissampelos mucronata A.Rich. | Kasaxe (mâle)  | 11FDS/UL                             | 0.03 | LS, Ro    | Shrub        | Tea             |
| Cissampelos owariensis Beauv. ex DC. | Jokoje (femelle) | 100FDS/UL                           | 0.03 | LS, Ro    | Shrub        | Tea             |
| **Mimosaceae/leguminosae** |                         |                                      |      |           |              |                 |
| Plant Name                                | Common Name(s)                  | Country Code | Effect | Part | Use     | Form | Notes                         |
|------------------------------------------|---------------------------------|--------------|--------|------|---------|------|-------------------------------|
| Acacia pennata Willd                     | Hlafen                          | 1090 FDS/UL  | 0.05   | Ba   | Herb    | Tea  | Oral                          |
| **MORACEAE**                             |                                 |              |        |      |         |      |                               |
| Ficus gnaphalocarpa Steud. ex Miq.       | Kelele, hongbwe                 | 113 FDS/UL   | 0.03   | Ro   | Shrub   | Tea  | Oral                          |
| **MORINGACEAE**                          |                                 |              |        |      |         |      |                               |
| Moringa oleifera Lam.                   | bén ailé, yovoviti, yovovigbé, yovovikpati | 398 FDS/UL  | 0.05   | Se, Fl | Tree    | Dec, Tea | Oral                      |
| **MUSACEAE**                             |                                 |              |        |      |         |      |                               |
| Musa paradisiaca L.                      | Banane                          | 1043 FDS/UL  | 0.05   | Pu   | Tree    | Dec  | Oral                          |
| **MYRTACEAE**                            |                                 |              |        |      |         |      |                               |
| Eucalyptus camaldulensis Dehn.           | Eucalyptus                      | 220 FDS/UL   | 0.09   | Le   | Tree    | Dec, Pow | Oral                      |
| Eucalyptus citriodora Hook.              | Eucalyptus                      | 235 FDS/UL   | 0.09   | Le   | Tree    | Dec, Pow | Oral                      |
| Eucalyptus globulus Labill.              | Eucalyptus                      | 121 FDS/UL   | 0.09   | Le   | Tree    | Dec, Pow | Oral                      |
| Psidium guajava L.                       | Goyavier                        | 470 FDS/UL   | 0.05   | Le   | Tree    | Tea  | Oral                          |
| **NYCTAGINACEAE**                        |                                 |              |        |      |         |      |                               |
| Boerhavia diffusa Engelm. &A.Gray       | Herbecochon, ahozemeklo,handoukpo, afokpadin-wa | 259 FDS/UL  | 0.04   | Ro   | Shrub   | Dec  | Oral                          |
| Boerhavia erecta Elliott                | Herbecochon, ahozemeklo,handoukpo, afokpadin-wa | 41 FDS/UL   | 0.04   | Ro   | Shrub   | Dec  | Oral                          |
| **NYMPHAEACEAE**                         |                                 |              |        |      |         |      |                               |
| Nymphaea lotus L.                        | Tobolo                          | 511 FDS/UL   | 0.04   | Rh   | Herb    | Dec, Pow | Oral                      |
| **OXALIDACEAE**                          |                                 |              |        |      |         |      |                               |
| Biophytum petersianum Klotzsch           | Patonmo                         | 81 FDS/UL    | 0.03   | WP   | Shrub   | Tea  | Oral                          |
| **PAPAVERACEAE**                         |                                 |              |        |      |         |      |                               |
| Argemone mexicana L.                     | Ahunja                          | 508 FDS/UL   | 0.04   | LS   | Shrub   | Dec, Pow | Oral                      |
| **PASSIFLORACEAE**                       |                                 |              |        |      |         |      |                               |
| Passiflora incarnata L.                  | Dagura                          | 959 FDS/UL   | 0.05   | Le   | Shrub   | Dec  | Oral                          |
| **PEDALIACEAE**                          |                                 |              |        |      |         |      |                               |
| Harpagophyllum procumbens DC.            | Bedja                           | 257 FDS/UL   | 0.05   | Ro   | Tree    | Dec  | Oral                          |
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doi:10.21010/ajtcam.v14i1.22

| Genus/Monographs | Species | Family | Preparation | Part Used | Medicinal Use |
|------------------|---------|--------|-------------|-----------|--------------|
| *Piliostigma thonningii* (Schumach.) Milne-Redh. | Klon | 0.05 | Le | Shrub | Dec | Poultice |
| *Piper guineense* Thonn. | Poivrier | 19 FDS/UL | 0.09 | Fr, Se, WP | Shrub | Dec, Pow, Pow, Balsam | Oral, massage |
| *Cymbopogon citratus* Stapf | Tigbe | 357 FDS/UL | 0.05 | Le | Shrub | Dec | Oral |
| *Securidaca longepedunculata* Fresen. | Kpata, atakpa, kpeta | 275 FDS/UL | 0.08 | Le, Ro, Ba | Tree | Dec, Pow | Oral, nasal, poultice, massage |
| *Fadogia agrestis* Schweinf. ex Hiern | Dusu mante | 154 FDS/UL | 0.03 | Ro | Shrub | Dec, Pow | Massage, scarification |
| *Citrus aurantium* L. | N'ti, n'tisi, bodo n'tisi | 782 FDS/UL | 0.04 | Fr, Ze | Tree | Jus | Oral |
| *Citrus grandis* Hassk. | Azongbo | 44 FDS/UL | 0.03 | Ze | Tree | Dec | Oral |
| *Citrus limon* (L.) Burm.f. | N'tisi | 173 FDS/UL | 0.05 | Le, Fr, Ze | Tree | Dec, Jus | Oral |
| *Citrus sinensis* Pers. | N'titi | 74 FDS/UL | 0.05 | Le | Tree | Dec | Oral |
| *Zanthoxylum zanthoxyloides* (Lam.) B.Zepernick & Timler | Ganhopovi, xetin, druba, xeti | 0.03 | St | Tree | Pow | Massage |
| *Vitellaria paradoxa* C.F.Gaertn | Yokumiti | 205 FDS/UL | 0.03 | Ro, St | Tree | Tea | Oral, bath |
| *Capsicum frutescens* L. | Pilipili, wuli-wuli, yebesevi, yebesi | 189 FDS/UL | 0.05 | Fr | Herb | Pow | Massage |
| *Aframomum melegueta* K.Schum. | Atakun, oburo | 204 FDS/UL | 0.03 | Se | Herb | Dec, Tea | Oral |
| *Curcuma longa* L. | Curcuma, dote djin | 2 FDS/UL | 0.05 | Rh | Shrub | Pow | Oral |
| *Zingiber officinale* Roscoe | Dotè, atalè, gbatakwi, ataribo | 348 FDS/UL | 0.08 | Rh | Shrub | Dec, Tea, Alcohol | Oral |

Le (Leaves), WP (Whole plant), Ro (Roots), St (Stem), Ba (Bark), Rh (Rhizome), Fr (Fruit), LS (leafy Stem), Jus (Juice), Dec (decoction), Pow (Powder).
Table 3: Literatures reporting on relevant ethnomedicinal uses, toxicity and immunomodulatory studies on the most important plants used to treat asthma in Maritime region of Togo.

| Species                  | Relevant ethnobotanical citations                                                                                                                                                                                                 | Toxic effects                                                                                                                                                                                                 | Relevant pharmacological reference to immunomodulatory citations                                                                                                                                                                                                 |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Abrus precatorius        | Asthma (Sonibare and Gbile, 2008; Olowokudejo, Kadir and Travih, 2008; Emmanuel noumi, 2009; Makinde et al., 2015). Chloroform and ethanol extracts of leaves tested for in vitro cytotoxic activity by MTT assay on human cancer cell lines, (A549) lung cancer, (hepG2) liver cancer, (HCT116) colon cancer, (HeLa) cervical cancer (Scudiero et al., 1988). The ethanol extract showed better cytotoxic effect than chloroform extracts against the above mentioned cancer cell lines (Manoharan et al., 2011). | The ethanol extract of leaves showed marked effect on milk-induced leukocytosis and eosinophilia in the management of asthma (Choi et al., 1989; Anant Solanki and Maitreyi Zaveri, 2012). The ethanol extract of leaves significantly decreased milk-induced leukocytosis and eosinophilia in mice in a dose dependent manner when compared with control group (Yadava and Reddy, 2002; Taur and Patil, 2011; Solanki and Zaveri, 2012). Evaluation of the methanol extract of the leaves for bronchodilator activity by using various in vivo and in vitro models in guinea pigs (Mensah et al., 2011; Solanki and Zaveri, 2012). The extract offered a maximum degree of protection comparable to that of salbutamol (Wingard et al., 1991). The methanol extract produced dose-dependent bronchodilator activity (Wambebe and Amosun, 1984). |
| Allium cepa L. (Liliaceae/Alliaceae) | -                                                                                                                                                                                                                                       | -                                                                                                                                                                                                         | Reduction in the production of inflammatory cytokines, a relaxation of tracheal rings, and a reduction in total number of cells in broncho-alveolar lavage and eosinophil peroxidase in lungs by treatment (Oliveira et al., 2015). |
| Allium sativum L. (Liliaceae/Alliaceae) | Asthma (Sonibare and Gbile, 2008; Olowokudejo et al., 2008; Noumi, 2009).                                                                                                                                                           | -                                                                                                                                                                                                         | -                                                                                                                                                                                                                                                                   |
| Annona muricata L. (Annonaceae) | Asthma (Noumi, 2009; Makinde et al., 2015)                                                                                                                                                                                               | -                                                                                                                                                                                                         | -                                                                                                                                                                                                                                                                   |
| Carica papaya             | -                                                                                                                                                                                                                                       | Not toxicity effect (Afzan et al., 2012). No significant toxic effect of the oral administration of the aqueous extract of leaves (Ismail et al., 2014)                                                                 | -                                                                                                                                                                                                                                                                   |
| Catharanthus roseus       | -                                                                                                                                                                                                                                       | -                                                                                                                                                                                                         | -                                                                                                                                                                                                                                                                   |
| Desmodium gangeticum     | Asthma (Mainen et al., 2006; Towns et al., 2014)                                                                                                                                                                                          | Toxicity against brine shrimp larvae, with LC50 values equal to 33.1 μg/ml (Mainen et al., 2006)                                                                                                               | -                                                                                                                                                                                                                                                                   |
| Species                          | Condition                               | Effects                                                                                                                                  | Additional Information                                                                 |
|---------------------------------|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| Eucalyptus camaldulensis        | Asthma (Noumi, 2009)                    | -                                                                                                                                       | -                                                                                       |
| Eucalyptus citriodora           | Asthma (Noumi, 2009)                    | -                                                                                                                                       | -                                                                                       |
| Eucalyptus globulus             | Asthma (Noumi, 2009)                    | -                                                                                                                                       | -                                                                                       |
| Euphorbia hirta                 | Asthma (Sonibare and Gbile, 2008; Noumi, 2009; Mohammed et al., 2014) | Effects of extracts on the ultrastructure of the murine liver (Wong et al., 2013); acute and subchronic toxicity of methanol extract in rats (Yuet Ping et al., 2013); Cytotoxicity (Kwan et al., 2015); leukocytosis, dullness, anorexia, stairyharcoat and 20% mortality in rat (Adedapo et al., 2004; Tangjitman et al., 2015) | Ethanol extract of whole aerial part of the plant at doses (100-1000 mg/kg) shows antihistaminic and antiallergic activity by inhibiting inhibited the passive cutaneous anaphylaxis and paw anaphylaxis reaction; protection of mast cell from degranulation (Youssouf et al., 2007). |
| Guiera senegalensis             | Asthma (Fatou et al., 2010)             | -                                                                                                                                       | Effect of in vitro exposure of the leaves of Guiera senegalensis, at 0.01 mg/ml or 0.1 mg/ml for 30 min on acetylcholine-induced contraction of isolated rat trachea (Fatou et al., 2010). |
| Piper guineense                 | Asthma (Towns et al., 2014)             | -                                                                                                                                       | Ethanol and aqueous extract of leaves at doses 100 and 200mg/kg possesses antiasthmatic activity on histamine induced bronchoconstriction in guinea pig and histamine induced dose dependent contraction of guinea pig tracheal chain and isolated guinea pig ileum preparation (Jawale et al., 2009). |
| Securidaca longepedunculata     | Asthma (Sonibare and Gbile, 2008; Towns et al., 2014) | -                                                                                                                                       | -                                                                                       |
| Zingiber officinale             | Asthma (Sonibare and Gbile, 2008; Olowokudejo, Kadiri and Travih, 2008; Emmanuel noumi, 2009). | Embryo toxic to pregnant rats (Weidner and Sigwart, 2001; Tangjitman et al., 2015).                                                    | -                                                                                       |

- Non available data
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doi:10.21010/ajtcam.v14i1.22

Discussion

The present survey was undertaken to identify medicinal plants used in the south of Togo for the treatment of asthma. Asthma is a chronic disease involving the airways in the lungs (Holgate et al., 2010). Asthma symptoms include coughing, wheezing, and chest tightness, and the diagnosis is based on several factors such as a detailed medical history, a physical exam and symptoms (Yunginger et al., 1992). Southern Togolese medicine practitioners diagnose asthma on the basis of clinical manifestations. We observed that wheezing, difficulty of breathing, coughing, chest tightness and dyspnea were commonly used by TH to diagnose the disease before the treatment. Different plants species were used by Togolese TH to heal asthma attack. There were 98 species of plants such as Eucalyptus camaldulensis Dehn., Eucalyptus citriodora Hook., Eucalyptus globulus Labill., Bridelia ferruginea Benth., Carica papaya L., Catharanthus roseus (L.) G. Don, Piper guineense Thom., Zingiber officinalis Roscoe, Securidaca longipedunculata Fresen, Guiera senegalensis J.F. Gmel, Annona muricata L., Allium sativum L. and Allium cepa L. that were more cited by TH for the treatment of asthma.

A literature review was made for the most important species (UV>0.08) to assess the previous relevant ethnobotanical citations related to asthma, the toxicity data and the screening reports for immunomodulatory activities. The recorded data are displayed in table 2. According to the data in the table, there was no available relevant ethnobotanical citation related to asthma for Allium cepa, Catharanthus roseus and Carica papaya, although these plants recorded respective use values of 0.08, 0.09 and 0.09. The other plants were cited at least once as curing asthma in ethnobotanical reports. Among these plants, Abrus precatorius is the plant with a great number of citations, thus there are four available ethnobotanical reports referring to the use of the plant in the traditional medicine for the management of asthma (Olowokudejo et al., 2008; Sonibare and Gbile, 2008; Noumi, 2009). Allium sativum and Zingiber officinalis recorded three reports (Olowokudejo et al., 2008; Sonibare and Gbile, 2008; Noumi, 2009). These findings demonstrate that the traditional healers in the southern Togo share some similarities with others in the management of asthma. For the toxicity data, were available for the Abrus precatorius, Carica papaya, euphorbia hirta, Desmodium gangeticum and Zingiber officinalis. Most of the tests were made on cell lines with crude extracts. Only Carica papaya was demonstrated to be nontoxic in vivo (Añaz et al., 2012; Ismail et al., 2014). Five of the abovementioned plants were tested for their possible anti asthmatic potentials. These are Abrus precatorius, Allium cepa, euphorbia hirta, Guiera senegalensis and Piper guineense. Of these plants, Abrus precatorius received more attention through several laboratory screenings for immunomodulatory activity (table 2), however any antiasthmatic molecule was not yet isolated or identified from the plant.

The use of herbal-derived medicines is increasing in therapies of immune disorders such as allergy and chronic inflammatory and asthma (Huntley and Ernst 2000). Herbal medicines have the advantage of being cheap and are associated with fewer incidences of adverse reactions when compared to current pharmaceutical treatment. Therefore ongoing research tries to identify new molecules that either treat or provide benefit for individuals with such illnesses. Plants are an important source of these molecules and about 50% of drugs introduced into the market during the last 20 years have been derived directly or indirectly from small biogenic molecules (Vuorela et al., 2004; Basso et al., 2005). The anti-inflammatory, anti-allergic and immunomodulatory properties of plant extracts have been widely shown in several studies (Kim et al., 2004; Jeon et al., 2014). For instance, the use of herbal products, coffee or black tea, and over-the-counter medications as self-treatments among adults with asthma was shown (Blanc et al., 1997). Xui-Min Lu et al. have demonstrated the efficacy and the mechanism of action of traditional Chinese medicines for the treatment of asthma (Li and Brown, 2009). In our study, Bridelia ferruginea Benth. was also used for the healing of asthma. Interestingly, Bridelia ferruginea produces antineuroinflammatory activity through the inhibition of nuclear factor-kappa B and p38 MAPK signaling (Olajide et al., 2012). This inhibition of MAP-kinases signaling may contribute in the dampening of asthmatic reactions. Knowledge of toxicity is crucial to decrease the risk/benefit ratio. This defines appropriate conditions for use and strategies for development of safer products. In contrast of being cheap and widely use in treatment of various disease, medicinal plant were observed to be toxic (Bateman et al., 1998; Sheehan et al., 1998). In murine model, acetate fraction from Bridelia ferruginea Leaves were shown to be cytotoxic (Fabiyi et al., 2012). Essential oil from Eucalyptus camaldulensis Dehn. was observed to be toxic for insect. In the present study we observed that oral administration of decoction was more used for the treatment of asthma. The oral administration of Japanese herbal complex Saiboku-to (TJ-96) significantly decrease asthma symptoms, blood eosinophils and serum eosinophilic cationic protein (Urata et al., 2002). In addition, herb decoction could improve airway hyper-responsiveness in stabilized asthmatic children (Chan et al., 2006). More interestingly, we highlighted that herbal leaves and root were more utilized for the healing of asthma. This makes sense some researcher argued that Luteolin from Perilla frutescens L. leaves also significantly reduced the histamine release from rat peritoneal mast cells stimulated (Jeon et al., 2014) Antihistamine role in the management of asthma is widely documented (Wilson et al., 2006). In addition Lim et al demonstrated the inhibition of airways inflammation by the root of Angelica decurciva (Lim et al., 2014). It was shown that seasonal variation has an
impact on the composition of plant extract (Jerkovic et al., 2001; Hess et al., 2007). Regarding this aspect Togolese TP mostly collect their plant material all season but we noticed that the collection during morning time and rainy season were preferred compared to midday, evening and dry season.

This survey provides initial evidence of the ability of Togolese traditional medicine practitioners to heal asthma and this by family inheritance in traditional initiation manner. This raises the question of the ignorance of the exact bioactive molecules, the side effect and the dosage. It is therefore necessary for scientist to go further in characterization of this biomolecules. To that end our group is currently investigation the ability of plants-derived molecules to modulate the immune response.

Acknowledgement

The authors are grateful to all the practitioners who accepted to participate to the study

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