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Research Article

Ethnobotanical Study of Antitussive Plants Used in Traditional Medicine by Abbey and Krobou populations, in the South of Côte d'Ivoire

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ABSTRACT

Cough is respiratory disease which becomes recidivism. Despite the development of antitussive medicines, it remains a major health problem. In the search of means of fighting, man used the medicinal properties of many plants. The ethnobotanical survey in Abbey and Krobou villages (Department of Agboville, Côte d'Ivoire), made it possible to discover that 40 traditional healers use 37 plants species for their antitussive effect. Drugs (leaf, flower, fruit, seed, root, rhizome, stem and barks) are used to develop 35 medicinal receipts. The monospecific receipts, 33 of them (94.28%), are mainly solicited. Leaves (40.54%) are more requested. The remedies are prepared by crushing, steaming, decoction, excision, expression, infusion, maceration, kneading, pounding, pulverization, softening and torrefaction. The preparation of the medicamentous receipts utilizes mainly decoction (19.04%). The majority of the remedies are employed by oral way, particularly out of drink (62.16%). *Oxyanthus unilocularis, Uapaca esculenta, Zanthoxylum gilletii, Kalanchoe crenata, Petersianthus macrocarpus, Iodes liberica, Spondias mombin, Picralima nitida* and *Triplochiton scleroxylon*, with over 75% efficacy indice, appear as the most efficient plants in cough treatment. The phytochemical screening shows that the antitussive effect would be the fact of various chemical compounds: alkaloids, catechin tannins, essential oils, flavonoids, mucilage, saponosides, polyphenols, sterols and polyterpenes.

Keywords: Agboville, Côte d'Ivoire, cough, Ethnobotany, Phytotherapy, traditional Healer

1. INTRODUCTION

Respiratory disease is a very serious problem that upset at certain times, humanity [1]. In worldwide, respiratory diseases are still among the leading causes of mortality, morbidity and consultation [2]. Cough, evidence symptom in various respiratory diseases, is treated in rural traditional areas, with plants. In Africa and in most of the developing countries, medicinal plants constitute the principal therapeutic arsenal available to healers [3]. Despite the development of various medicines, cough remains a disease which is difficult to be eradicated. It is in this context that a genuine research activity on antitussive effects of plants was developed throughout Africa and particularly in Côte d'Ivoire. In department of Divo, with Dida people, plants are used for their antitussive property [4]. Various other ethnopharmacological studies have shown that African populations use plants to treat cough. We cite the works of Aké-Assi [5], in different areas of Africa and those of Nacoulma [6], in Burkina Faso. Unfortunately, in Africa, plants' properties are empirically appreciated. Thus, the chemical composition of drugs used daily by many people for health care is non known [7]. This study is part an improvement and valorization program of traditional African medicine. To achieve an improvement of this African medicine, it is obvious

that a better knowledge of natural plant resources is required. This ethnobotanical study aims to discover more antitussive plants and provide scientific evidence of the effectiveness of their traditional effect using phytochemical and pharmacogical characteristics.

2. MATERIAL AND METHODS

2.1. Study site

Located in Southern forest of Côte d'Ivoire, Agboville department is part of the guinea field of mesophilic sector, characterized by dense moist semi-deciduous forest [8]. Currently, the original vegetation has been degraded by human activities [9]. Annual average pluviometry is about 1400 mm of water. Its climate, warm and humid, is characterized by two seasons: a dry season from December to February and a long rainy season from March to November. Agboville population is estimated at 220050 souls [10]. Nearby native populations (Abbey and Krobou), there is a community of non-natives coming from other areas of Côte d'Ivoire and also a community of foreigners for the most part coming from West African sub-region.

2.2. Collection of plant material

A prospection was conduct in some villages of Agboville department, in the aim to research, in different ecological environments, plant species cited by the traditional healers and to take samples to build up a collection of dried plants. In laboratory, from collected samples, flora, various books and specimens of the herbarium of the National Floristic Center, we identified the plants species, by their scientific name and we determined their botanical characteristics.

2.3. Nomenclature

In this study, species nomenclature does not follow the traditional classification. Phylogenetic classification, according to the work of Angiosperms Phylogeny Group, in its latest version called APG III [11], was adopted, to name the listed plants. We followed the same principle regarding families, orders, clades, subphylums and phylums. The terms used to describe biological and phytogeographic types are borrowed to Aké-Assi [12].

2.4. Ethnopharmacological survey methodology

To conduct the survey on antitussive plants, various villages in Agboville department were visited. As approach, we met the healers (men and women) and organized semi-structured interviews. Each of them was visited twice, at different moments, to answer the same questions. That helped us to confirm or no the informations we had already collected. During this ethnobotanical investigation, informations were collected relating to plants used in the treatment of cough, their therapeutic efficacy, the organs used as drugs, their methods of sampling and the modes of preparation and administration of medicamentous receipts. The informations we obtained from traditional healers, helped us to express the therapeutic efficacy of each plant species used in seeking the percentage of healed patients when 50 persons were treated. This approach has enabled us to establish therapeutic efficacy indices for listed plants species.

2.5. Phytochemical screening using experiences

To carry out the phytochemical screening, solvents (ether of oil, methanol and distilled water) and various classic reagents were used. The classical methods employed to characterize the chemical groups are described in the works of Békro *et al.* [13] and N'Guessan *et al.* [7, 14].

2.6. Non experimental validation for the medicinal activity of plants using phytochemical / pharmacogical literature

According to the literature, we performed a validation of the traditional medical practices, by looking for the chemical constituents that explain the antitussive effect for the listed plants.

2.7. Treatment of data on ethnopharmacological survey

From informations collected on healed patients when 50 persons were treated, an efficacy indice expressed as a percentage (%) of each species of plant, was assigned as follows:

- -in the range [01-05], the efficacy indice is estimated at 01-10
- -in the range [06-10], the efficacy indice is estimated at 11-20
- -in the range [11-15], the efficacy indice is estimated at 21-30
- -in the range [16-20], the efficacy indice is estimated at 31-40
- -in the range [11-25], the efficacy indice is estimated at 41-50
- -in the range [26-30], the efficacy indice is estimated at 51-60
- -in the range [31-35], the efficacy indice is estimated at 61-70.
- -in the range [36-40], the efficacy indice is estimated at 71-80.
- -in the range [41-45], the efficacy indice is estimated at 81-90.

-in the range [46-50], the efficacy indice is estimated at 91-100.

The plants, ranked according to their effectiveness, were subjected to a hierarchical classification, using STATISTICA software version 6.0, with Ward method.

3. RESULTS AND DISCUSSION

3.1. Botanical characteristics of the studied plants

The ethnobotanical investigations we conducted in Abbey and Krobou District (Department of Agboville, Côte d'Ivoire), made it possible to identify 37 species of antitussive plants, grouped in Angiosperms clade (table 1A). These species of plants belong to 37 genera and 24 families divided into 03 clades: Paleodicots (05 species), Monocots (03 species) and Eudicots (29 species), 01 subphylum (Tracheophytina) and 01 phylum (Embryophyta). The Dicots (Paleodicots and Eudicots), 34 of them, representing 91.89% of the identified species, have the highest number of plants. The predominance of Euphorbiaceae family (03 species or 8.10%), which has the largest number of medicinal plants used traditionally for their antitussive effects, can be explained by the fact that this family is part of the best represented in Ivorian flora[12]. The comparison of our results with other works shows that inventories have the same characteristics in different studies. The ligneous species of taxonomic groups as Ferns and Gymnosperms have not been listed. Spermaphytes constitute the greater part of the therapeutic arsenal of antitussive plants. Our result is in accordance with previous reports, looking at the taxonomic groups of plants. For example, populations of Dakar, in Senegal, use 57 species of plants in the treatment of cough. All the listed plants belong to Spermaphytes. The percentage of Dicots (91.89%) we obtained approximates that of the Dicots (94.73%) in study conducted by Dioune (2006[5]), in Dakar (Senegal). However, variability was observed in the number of individuals identified in one study to another. We note, in study of Ouattara [4], 09 species of plants representing 5.34% of the repertory of identified plants during ethnopharmacological study conducted in the area of Divo with Dida people, in South of Côte d'Ivoire. The Dicots have the highest number of plants. Aké-Assi [5] undertook a significant study on the medicinal plants of Africa. However, only one plant: *Abrus precatorius* (Fabaceae) was mentioned like exerting antitussive effects. This variability would be due to the variations in the methods of investigation; it could be also explained by the differences of localities and vegetation.

3.2. Ethnopharmacological characterics of listed plants

3.2.1. Visited sites and interviewed respondents

During this ethnopharmacological study relating to antitussive plants, 40 traditional healers, native of 10 villages in Agboville department, were met. They are men and women, but mostly men (75%) who agreed to collaborate with us by providing informations on antitussive plants. The oldest person of these healers is a man who is about 70 years and the youngest one is a woman of 30 years old. We met a lot of traditional healers who treat cough (08, or 20%) in Aboudé-Mandéké village.

3.2.2. Preparation and administration of herbal medicines

Various organs of the plant (leaf, flower, fruit, seed, root, rhizome, stem and barks) are used as drugs for medicinal preparations (table 1B). Leaves (40.54%) are the most requested organ. According to N'Guessan *et al.* [15], the removal of 50% of plants leaves does not significantly affect the survival of this plant. Our result tallies with that of various studies conducted in other areas of Côte d'Ivoire and Africa [4, 5, 6]. Also, the massive use of leaves would be the fact of their abundance. In terms of opotherapy, honey is necessary for the preparation of syrups. In the field of mineral therapy, the salt as seasoning is used, for example, in agreement with the statements of Fleurentin *et al.* [16]; authors indicated that, to relieve his pain and injuries, human uses its immediate environment. Various utensils are employed for the preparation of medicines: mortar, flat stone, pebble, canary, saucepan and calabash [17]. We distinguish various modes of preparation: crushing, steaming, decoction, excision, expression, infusion, maceration, kneading, pounding, pulverization, softening and torrefaction. Decoction (19.04%) is the most requested technique of preparation. The drug forms are diverse: decocte, exudates, extract, infuse, macerate, paste, powder and syrup. We note that 35 medicamentous receipts of remedies are developed to treat cough. The monospecific receipts, representing 94.28%, are mainly used. This result is similar to that of Ouattara [4] who indicated that all the medicinal formulas used by Dida populations in Côte d'Ivoire, are monospecific. Considering the administration of medicines by oral routes, calabash, goblets, jugs, ladles, spoons, glasses (liqueur or beer) and cups are employed. The remedies are administered by absorption, drink, ingurgitation and oral instillations. The drink (62.16%) is the most widespread method of medicine administration. This result tallies with that of Ouattara [4]. In his study, author indicates that Dida of Divo (Côte d'Ivoire) use drink in 66.66% of cases.

3.2.3. Indices of efficacy

Indices of efficacy, determined on healed patients when 50 persons were treated, are shown in table 1B. A dendrogram (figure 1) represents the descriptive analysis. This analysis has established 04 groups of plants, when a cut is performed in the Euclidean distance 60. The first group contains plants with efficacy indice between 76 and 90%. We note 09 plants: *Iodes liberica, Kalanchoe crenata, Oxyanthus unilocularis, Petersianthus macrocarpus, Picralima nitida, Spondias mombin, Triplochiton scleroxylon, Uapaca esculenta and Zanthoxylum gilletii.* They have the best efficacy indice. These are excellent cough remedies. The second group has an efficacy indice between 61 and 75%. These plants are eleven (11): *Abelmoschus esculentus*, *Aframomum melegueta*, *Alstonia boonei*, *Annona muricata*, *Azadirachta indica*, *Boerhavia diffusa*, *Carapa procera*, *Cataranthus roseus*, *Ficus exasperata*, *Mangifera indica* and *Ocimum gratissimum.* They are good remedies against cough and are advisable in case of crisis. *Carica papaya*, *Chromolaena odorata*, *Cola nitida*, *Combretum paniculatum*, *Dissotis rotundifolia*, *Jatropha gossypiifolia* and *Monodora myristica*, rank third in terms of efficacy indice which rangs from 46 to 60%; these are pretty-good remedies. The fourth group includes 10 species: *Citrus aurantifolia*, *Nymphaea lotus, Potomorphe guineense*, *Ricinodendron heudelotii*, Sc*oparia dulcis*, *Terminalia catappa*, *Turnera ulmifolia*, *Xylopia aethiopica*, *Zea mays* and *Zingiber officinale*. They have an efficacy indice ranging from 34 to 45%. These are remedies that could be used if there is no other choice. We note that any plant is 100% effective; moreover, there is no plant with efficacy less than 34%.

3.2.4. Similarity with antitussive plants of other areas

Drugs sampling and preparation of herbal medicines vary according to ethnic groups, season, geographical and ecological environment of the traditional healers. Despite this variation, interesting similarities with some plants whose use is recognized in other ethnic groups were noticed. Decoction of *Mangifera indica* leaves is used by Abbey and Krobou populations in Agboville, to treat cough. This is also in agreement with the report of Jay (2014) [18], on medicinal plants of his study. The stem barks of *Carapa procera* are employed against cough in Agboville department. These results share similarity to that of Diaouné (2006)[5] who conducted ethnopharmacological investigations on antitussive plants in different markets of Dakar, in Senegal. *Carica papaya* is employed for its antitussive properties, in Agboville. This result had also been reported on ethnobotanical study in Burkina Faso by Nacoulma [6].

3.3. Phytochemistry

3.3.1. Experimental validation for antitussive effect of plants using phytochemistry

Primary validations of traditional medical practices, by looking for the chemical groups that explain the antitussive effects for some plants, were performed. Fourteen (14) plants of this study have been the subject of a phytochemical screening we have already carried out [9]. Table 2 gives the obtained results. The antitussive effect would be the fact of following chemical groups: alkaloids, catechics tannins, flavonoids, polyphenols, saponosides, sterols and polyterpenes (table 3).

3.3.2. Non experimental validation for antitussive effect of plants using phytochemical/ literature

The antitussive effect (table 4) results from several chemical elements: alkaloids, essential oils, flavonoids and mucilages. This phytochemical composition provides scientific evidence of the effectiveness of the traditional use of antitussive plants.

4. CONCLUSION

The ethnopharmacological investigations we conducted in Abbey and Krobou villages of Agboville (Côte d'Ivoire) show that 37 species of plants are used by 40 traditional healers, in various forms of medicinal preparations and administration, in the treatment of cough. Among the drugs, the leaves are mainly solicited. The preparation of the medicamentous receipts utilizes mainly decoction. The remedies are used particularly out of drink. The therapeutic effects are induced by various chemical compounds as alkaloids, catechics tannins, flavonoids, essential oils, mucilage, polyphenols, polyterpenes saponosides, sterols, which form the scientific basis of traditional therapeutic use of listed antitussive plants.

Table 1A
Taxonomic groups of plants used to treat cough in Abbey and Krobou villages

Scientific names of plants species	Family	Clade
Abelmoschus esculentus (L.) Moench	Malvaceae	Eudicot
Aframomum melegueta K. Schum.	Zingiberaceae	Monocot
Alstonia boonei De Wild.	Apocynaceae	Eudicot
Annona muricata L.	Annonaceae	Paleodicot
Azadirachta indica A. Juss.	Meliaceae	Eudicot
Boerhavia diffusa L.	Nyctaginaceae	Eudicot
Carapa procera DC.	Meliaceae	Eudicot
Carica papaya L.	Caricaceae	Eudicot
Cataranthus roseus (L.) G. Don	Apocynaceae	Eudicot
Chromolaena odorata (L.) King et H. Robins	Asteraceae	Eudicot
Citrus aurantifolia (Christm.) Swingle	Rutaceae	Eudicot
Cola nitida (Vent.) Schott et Endl.	Malvaceae	Eudicot
Combretum paniculatum Vent.	Combretaceae	Eudicot
Dissotis rotundifolia (Sm.) Triana	Melastomataceae	Eudicot
Ficus exasperata Vahl	Moraceae	Eudicot
Iodes liberica Stapf	Icacinaceae	Eudicot
Jatropha gossypiifolia L.	Euphorbiaceae	Eudicot
Kalanchoe crenata (Andr.) Haw.	Crassulaceae	Eudicot
Mangifera indica L.	Anacardiaceae	Eudicot
Monodora myristica (Gaertn.) Dunal	Annonaceae	Paleodicot
Nymphaea lotus L.	Nymphaeaceae	Paleodicot
Ocimum gratissimum L.	Lamiaceae	Eudicot
Oxyanthus unilocularis Hiern	Rubiaceae	Eudicot
Petersianthus macrocarpus (P. Beauv.) Liben	Lecythidaceae	Eudicot
Picralima nitida (Stapf) T. Durand et H. Durand	Apocynaceae	Eudicot
Pothomorphe guineense Schum. et Thonn.	Piperaceae	Paleodicot
Ricinodendron heudelotii (Baill.) Pierre ex Pax	Euphorbiaceae	Eudicot
Scoparia dulcis L.	Plantaginaceae	Eudicot
Spondias mombin L.	Anacardiaceae	Eudicot
Terminalia catappa L.	Combretaceae	Eudicot
Triplochiton scleroxylon K. Schum.	Malvaceae	Eudicot
Turnera ulmifolia L.	Passifloraceae	Eudicot
Uapaca esculenta A. Chev. ex Aubrév. et Léandri	Euphorbiaceae	Eudicot
Xylopia aethiopica (Dunal) A. Rich.	Annonaceae	Paleodicot
Zanthoxylum gilletii (De Wild.) Wattermann	Rutaceae	Eudicot
Zea mays L.	Poaceae	Monocot
Zingiber officinale Rosc.	Zingiberaceae	Monocot
Total: Species: 37 Genera: 37	Total of Families: 24	Total of Clades: 03

Table 1B
Ethnobotanical characteristics of plants used to treat cough in Abbey and Krobou villages

Scientific names of plants species	Organs used	Technic of preparation	Mode of administration	Therapeutic efficacy (%)
Abelmoschus esculentus	Fruit, Root	Decoction: decocte	Drink	60
Aframomum melegueta	Seed	Mastication: extract	Ingurgitation	62
Alstonia boonei	Stem barks	Kneading: Paste + Palm oil	Absorption	73
Annona muricata	Flower	Infusion: Infusate	Drink	64
Azadirachta indica	Leaf	Sugary decoction: decocte	Drink	72
Boerhavia diffusa	Leaf	Kneading: Paste + Palm oil	Absorption	66
Carapa procera	Stem barks	Pounding: powder (maceration): macerate	Drink	75
Carica papaya	Root	Sugary decoction: decocte	Drink	46
Cataranthus roseus	Leaf	Sugary decoction: decocte	Drink	68
Chromolaena odorata	Leaf	Sugary decoction: decocte	Drink	54
Citrus aurantifolia	Fruit	Expression: Juice + honey (syrup)	Drink	34
Cola nitida	Seed	Crushing and maceration: macerate	Drink	48
Combretum paniculatum	Leaf	Kneading: Paste + water (mixture)	Drink	60
Dissotis rotundifolia [1*]	Leaf	Steamed	Oral instillations	56
Ficus exasperata [2*]	Stem barks	Kneading: Paste + Palm oil	Absorption	70
Iodes liberica [1*]	Leaf	Steamed	Oral instillations	80
Jatropha gossypiifolia	Leaf	Decoction: decocte	Drink	50
Kalanchoe crenata	Leaf	Expression: juice + salt (syrup)	Drink	82
Mangifera indica	Leaf (joung)	Expression: juice + salt (syrup)	Oral instillations	72
Monodora myristica	Seed	Torrefaction, pulverization: powder + water	Drink	54
Nymphaea lotus	Leaf	Kneading: Paste + Palm oil	Absorption	36
Ocimum gratissimum	Leaf	Kneading: Paste + Palm oil	Absorption	70
Oxyanthus unilocularis	Stem barks	Mastication: extract	Ingurgitation	90
Petersianthus macrocarpus	Stem barks	Mastication: extract	Ingurgitation	82
Picralima nitida	Seed	Torrefaction, pulverization: powder + water	Drink	76
Pothomorphe guineense	Stem	Excision: exudate	Drink	42
Ricinodendron heudelotii	Stem barks	Decoction: decocte	Drink	43
Scoparia dulcis	Leaf	Softening, expression: extract	Drink	44
Spondias mombin	Leaf (joung)	Expression: juice + salt (syrup)	Oral instillations	78
Terminalia catappa	Stem barks	Softening, expression: extract	Drink	42
Triplochiton scleroxylon [2*]	Stem barks	Kneading: Paste + Palm oil	Absorption	76
Turnera ulmifolia	Flower	Infusion: infusate	Drink	40
Uapaca esculenta	Stem barks	Pounding: paste + palm oil	Absorption	86
Xylopia aethiopica	Fruit	Torrefaction, pulvezisation: powder + water	Drink	41
Zanthoxylum gilletii	Leaf (joung)	Expression: juice + salt (syrup)	Oral instillations	84
Zea mays	Flower (style)	Decoction: decocte	Drink	44
Zingiber officinale	Rhizome	Mastication with salt: extract	Ingurgitation	45

*: Bispecific receips: [1]*Dissotis rotundifolia* and *Iodes liberica*; [2] *Ficus exasperata* and *Triplochiton scleroxylon*

Table 2
Phytochemical screening of samples from 14 plant species

Natural substances			Chemical groups								
						Tannins			Alkaloids		
Plants	Organs	Extracts	Sterols, polyterpenes	Polyphenols	Flavonoides	Gallic	Catechic	Quinones	Burchard	Dragendorff	Saponosides
Aframomum melegueta	Seed	Etheric	+	-	-	-	-	-	+	+	-
		Methanolic	+	-	-	-	-	-	+	+	-
		Aqueous	+	-	+	-	-	-	+ +	+ +	-
Boerhavia diffusa	Leaf	Etheric	+	-	-	-	-	-	+	+	-
		Methanolic	+	-	-	-	-	-	+	+	-
		Aqueous	-	+	+	-	-	-	+	+	+
Chromolaena odorata	Leaf	Etheric	-	-	+	-	-	-	+	+	-
		Methanolic	-	+	+	-	-	-	+	+	-
		Aqueous	+	+	+	-	+	-	+	+	+
Cola nitida	Stem barks	Etheric	+	-	+	-	-	-	-	-	-
		Methanolic	+	+	+	-	-	-	-	-	-
		Aqueous	+	+	+	-	-	-	-	-	+
Ficus exasperata	Leaf	Etheric	+	-	-	-	-	-	+	+	-
		Methanolic	+	-	-	-	-	-	+	+	-
		Aqueous	+	+	+	-	-	-	+	+	-
Jatropha gossypiifolia	Stem barks	Etheric	+	-	-	-	-	-	+	+	+
		Methanolic	+	-	-	-	-	-	+	+	+
		Aqueous	+	-	-	-	+	-	+	+	+
Mangifera indica	Leaf	Etheric	+	+	+	-	-	-	+	+	-
		Methanolic	+	+	+	-	+	-	+	+	-
		Aqueous	+	+	+	-	+	-	+	+	+
Monodora myristica	Seed	Etheric	+	-	-	-	-	-	-	-	-
		Methanolic	+	-	+	-	-	-	+	+	-
		Aqueous	+	-	+ +	-	-	-	+ +	+ +	-
Ocimum gratissimum	Leaf	Etheric	+	-	-	-	-	-	+	+	-
		Methanolic	+	+	-	-	-	-	+	+	-
		Aqueous	+	+	+	-	+	-	+ +	+ +	-
Petersianthus macrocarpus	Stem barks	Etheric	+	+	+	-	-	-	+	+	-
		Methanolic	+	+	+	-	-	-	+	+	-
		Aqueous	-	+	+	-	+	-	+	+	+
Potomorphe guineense	Fruit	Etheric	+	-	+	-	-	-	+	+	-
		Methanolic	+	-	+	-	-	-	+	+	-
		Aqueous	+	-	+ +	-	-	-	+ +	+ +	-
Terminalia catappa	Stem barks	Etheric	-	-	+	-	-	-	-	-	-
		Methanolic	-	+	+	-	-	-	+	+	-
		Aqueous	-	+	+	-	-	-	+	+	+
Xylopia aethiopica	Fruit	Etheric	+	-	-	-	-	-	-	-	-
		Methanolic	+	-	-	-	-	-	-	-	-
		Aqueous	+	+	+ +	-	+	-	+ +	+ +	-
Zingiber officinale	Rhizome	Etheric	+	-	-	-	-	-	+	+	-
		Methanolic	+	-	-	-	-	-	+	+ +	-
		Aqueous	+	-	+	-	+	-	+	+ +	-

Explanation of symbols: + +: Abundantly present; +: Presence; -: Absence

Table 3
Experimental validation for antitussive effect of plants using phytochemistry

Plants species	Phytochemical screening (N'Guessan, 2008)[9]	Antitussive effect of plants using pharmacology	Literature
Aframomum melegueta	Polyphenols	Immunostimulants providing resistance to aggression	(Betty, 2003) [19]
Boerhavia diffusa	Saponosides	Thinners, expectorant mucolytic action	(N'Guessan *et al*., 2009) [7]
Chromolaena odorata	Polyphenols	Immunostimulants providing resistance to aggression	(Zirihi, 2006)[20]
Cola nitida	Saponosides	Thinners, expectorant mucolytic action	(Fleurentin *et al*., 2008) [21]
Ficus exasperata	Flavonoids	Bronchodilator, muscular relaxants	(Jay, 2014) [18]
Jatropha curcas	Saponosides	Thinners, expectorant mucolytic action	(Ahyi, 2001)[22]
Jatropha gossypiifolia	Sterols and Polyterpenes	Antiseptic, disinfectant properties	(Fleurentin *et al*., 2008) [21]
Mangifera indica	Flavonoids	Muscular relaxants	(Jay, 2014) [18]
Monodora myristica	Flavonoids	Muscular relaxants	(Ahyi, 2001) [22]
Ocimum gratissimum	Polysaccharides	Immunostimulants providing resistance to aggression	(Saraswathy, 2014) [2]
Petersianthus macrocarpus	Tannins (catechics)	Bactericidal properties	(N'Guessan *et al*., 2006) [23]
Potomorphe guineense	Flavonoids	Muscular relaxants	(Jay, 2014) [18]
Terminalia catappa	Alkaloids	Vasodilators, they breake alveolar secretions	(Anonyme, 2015a) [24]
Xylopia aethiopica	Flavonoids	Muscular relaxants	(Diaouné, 2006)[5]
Zingiber officinale	Flavonoids	Muscular relaxants	(Anonyme, 2015b) [25]

Table 4
Non experimental validation for antitussive effect of plants using phytochemical/ pharmacological literature

Plants species	Phytochemistry	Pharmacology	Literature
Abelmoschus esculentus	Mucilages	Emollient, protecting the pharyngeal mucosa from irritation	(Anonyme, 2015a) [24]
Alstonia boonei	Alkaloids	Anti-cancer (tumors)	(Zirihi, 2006) [20]
Annona muricata	Alkaloids	Respiratory stimulant	(Zirihi, 2006)[20]
Azadirachta indica	Essential oils	Expectorant, bronchodilator, reduce phlegm	(Jay, 2014) [18]
Carapa procera	Flavonoids	Muscular relaxants	(Diaouné, 2006) [5]
Carica papaya	Alkaloids	Vasodilators, they brake alveolar secretions	(Diaouné, 2006) [5]
Cataranthus roseus	Alkaloids	Vasodilators, they brake alveolar secretions	(Anonyme, 2015a) [24]
Citrus aurantifolia	Flavonoids	Muscular relaxants	(Diaouné, 2006) [5]
Combretum paniculatum	Alkaloids	Vasodilators, they brake alveolar secretions	(Osuagwu and Nwoko, 2014) [26]
Dissotis rotundifolia	Alkaloids	Vasodilators, they brake alveolar secretions	(Tavs *et al*., 2010) [27]
Iodes liberica	Alkaloids	Vasodilators, they brake alveolar secretions	(Fleurentin *et al*., 2007) [16]
Kalanchoe crenata	Mucilages	Emollient, protecting the pharyngeal mucosa from irritation	(Jay, 2014) [18]
Nymphaea lotus	Alkaloids	excito-respiratory activity	(Tavs *et al*., 2010) [27]
Picralima nitida	Alkaloids	Vasodilators, they brake alveolar secretions	(Tavs *et al*., 2010) [27]
Triplochiton scleroxylon	Mucilages	Emollient, protecting the pharyngeal mucosa from irritation	(Fleurentin *et al*., 2007) [16]
Turnera ulmifolia	Essential oils	Expectorant, bronchodilator, reduce phlegm	(Jay, 2014) [18]
Zanthoxylum gilletii	Alkaloids	Vasodilators, they brak alveolar secretions	(Zirihi, 2006) [20]
Zea mays	Essential oils	Expectorant, bronchodilator, reduce phlegm	(Fleurentin *et al*., 2008) [21]

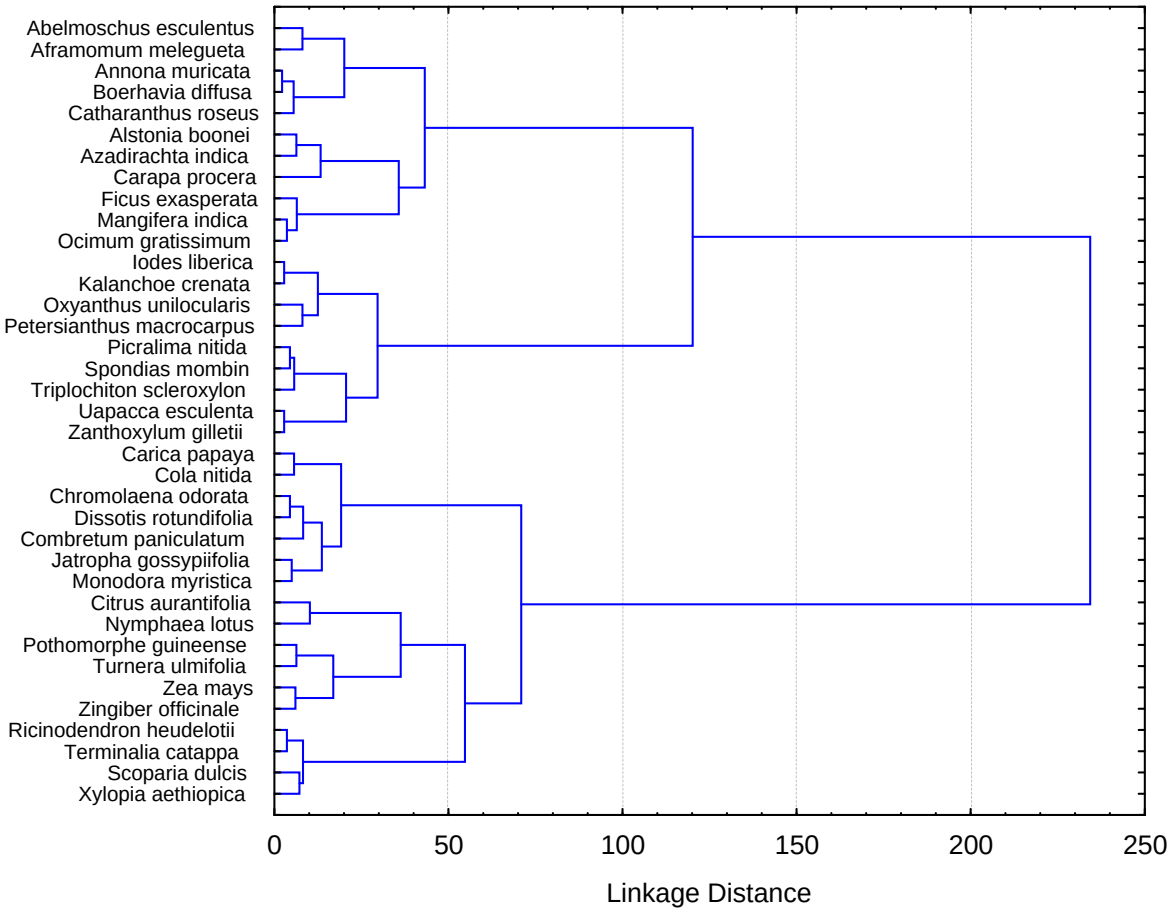

Figure 1
Dendrogram of efficacy indice for plants used in the preparation of cough remedies.

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