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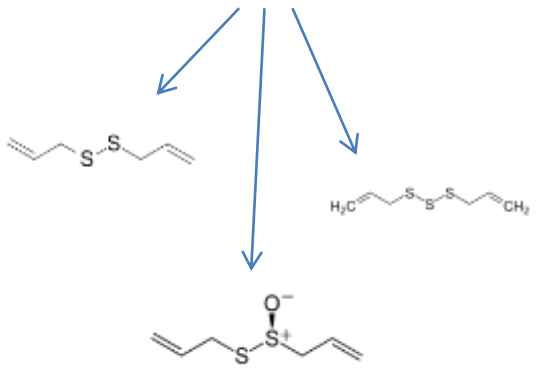
Ethnopharmacology, biological activity and chemical characterization of *Mansoa alliacea*. A review about a promising plant from Amazonian region.

Angélica Tasambay Salazar[1],*, Laura Scalvenzi[1], Andrea Stefany Piedra Lescano[1], Matteo Radice[1].
1 Universidad Estatal Amazónica, Km 2 ½ Via Napo (paso lateral), Puyo, Pastaza, Ecuador; E-Mail: atasambay@uea.edu.ec; lscalvenzi@uea.edu.ec; agi20140045@uea.edu.ec; mradice@uea.edu.ec
* Author to whom correspondence should be addressed; E-Mail: atasambay@uea.edu.ec; Tel.: +593 032-888-118 / 032-889-118112.

Graphical Abstract

Mansoa alliacea



Traditional medicine	
Magical and ritual uses	Cold, fever
Rheumatism	Food, spice
Antimalarial	Muscle pain

Biological activities	
Antioxidant	Antifungal
Antibacterial	Anti-inflammatory
Larvicidal	Antiplasmodial

Abstract.
Mansoa alliacea is a native plant from Amazonian basin and has great ancestral value for the local communities. *M. alliacea* is part of the traditional medicine for healers and shamans and has multiple uses due to the presence of several chemical constituents with important pharmacological properties. Plant derivatives are used as: antiseptic, diuretic, analgesic, antipyretic. Folk medicine is also related to the treatment of many diseases such as: reduction of blood pressure, against atherosclerosis, arthritis and rheumatism. Researches have also proven an appreciable antioxidant property, which revalue it for cosmetic purposes. Chemical composition of plant derivatives includes as main compounds: diallyl disulphide, diallyl trisulphide, alliin, allicin, propylallyl, divinyl sulfide, diallyl sulfide, dimethyl sulfide, daucosterol, beta-sitosterol, fucosterol, stigmasterol, iridoides and isothiocyanates, naphthoquinones, alkaloids, saponins, flavones. The present review includes ethnobotanical and pharmacological data that are related to the chemical composition of *M. alliacea*.

Introduction

Mansoa alliacea is a native plant to South America, exactly from the Amazonian basin, and has been recollected in Bolivia, Brazil, several Caribbean Islands, Colombia, Costa Rica, Ecuador, French Guiana, Guyana, Nicaragua, Panama, Peru, Suriname [1].

M. alliacea is a native Amazonian plant belonging to the family of Bignoniaceae, its scientific name is *Mansoa alliacea* (Lam.) A. Gentry but has been classified with several synonyms [2].

M. alliacea is well-known with several common names in different countries, in Ecuador and Peru it is denominated "ajo de monte" or "sacha ajo", in Brazil cipo-d'alho, cipo-alho, cipó-de-Alho, alho– da-mata, in Venezuela" bejuco de ajo". *M. alliacea* grows in tropical areas of primary forest with rainfalls from 1800 to 3500 mm/year, in clay or sandy soils rich in organic matter, shaded or poorly shaded areas, temperatures between 20 to 26ºC, away from puddles because it is not resistant to floods. The name "ajo sacha" means false garlic, due to the characteristic garlic smell molecules present into the leaves [3]. As many other plants cited in traditional medicine [4,5,6], *M. alliacea* has been investigated in order to identify new potential useful drugs or a source of bioactive compounds.

Therefore, we aimed to compile an up to date and comprehensive review about *M. alliacea* studies that matches its traditional medicine uses, phytochemistry and pharmacology.

Materials and Methods

The present research was developed adopting the following electronic databases: Pubmed, ISI-Web of Science, Google Scholar, Scielo, Scifinder and Scopus. Data was independently extracted from four reviewers and the final paper selections were completed avoiding duplication of data. Four-teen scientific name (*Mansoa alliacea* and its 13 synonyms) were selected from the web page www.theplantlist.org and used as keywords. The whole list is: *Mansoa alliacea* (Lam.) A.H.Gentry, *Adenocalymma alliaceum* (Lam.) Miers, *Adenocalymma obovatum* Urb., *Adenocalymma pachypus* (K.Schum.) Bureau & K.Schum., *Adenocalymma sagotii* Bureau & K.Schum., *Anemopaegma pachypus* K.Schum., *Bignonia alliacea* Lam., *Pachyptera alliacea* (Lam.) A.H.Gentry, *Pseudocalymma alliaceum* (Lam.) Sandwith, *Pseudocalymma alliaceum* var. *macrocalyx Sandwith*, *Pseudocalymma pachypus* (K.Schum.) Sandwith, *Pseudocalymma sagotii* (Bureau & K.Schum.) Sandwith, *Pseudocalymma sagotii* var. *macrocalyx* (Sandwith) L.O.Williams.

The reviewers selected articles in English and Spanish languages avoiding data from thesis, patents, symposiums and congress.

The above-mentioned criteria allowed selecting 42 eligible articles and 7 additionally useful papers for the introduction, discussions and conclusions. 38 papers were rejected because did not satisfy the selection methodology or due to the lack of clarity in their procedures and methodologies.

Results and Discussion

Botanical description and traditional medicine

M. alliacea is an evergreen climbing shrub with semi-woody brunches that allows attaching on larger trees, used as growing supports. The plant reaches 3m tall and its leaves are bright green, slightly coriaceous, opposite and characterized by two ovate leaflets of about 15cm long. Flowers have funnelform corolla up to 6-9 cm long, with campanulate calyx, 5-8 mm long. They are violet colored and grow in terminal or axillary raceme inflorescences. Fruits are elongate capsules up to 25-35 cm long which contain transverse-oblong seeds characterized by wings broad. Leaves of *M. alliacea* are characterized by a pungent garlic-like smell when crushed [7].

M. alliacea is an emblematic plant for many Amazonian tribes; root, stem, leaves and flowers have been described as the parts of the plant which are useful for different traditional treatment. **Table 1** summarizes several traditional medicine uses which include ritual and magical application.

Table 1. Traditional medicine, magical and ritual uses of *M. alliacea*

Year	Country	Ethnic group	Traditional medicine, magical and ritual uses	Ref.
1984	Brazil	n.r.	Colds, fevers	[8]
2000	Bolivia	Tacana	Abdominal pain, fever, intestinal parasites, rheumatic pain, ritual uses	[9]
2002	Perú	Shipibo – Conibo y Ashaninka y mestizo	Anti-malarial	[10]
2008	Ecuador	Kichwa	Food, spice	[11]
	n.r.	n.r.	Analgesic, anti-arthritic, anti-inflammatory, antipyretic, anti-rheumatic, antitussive, depurative, purgative, vermifuge	[12]
2008	Surinam Brazil Guianas	n.r.	Analgesic, anti-rheumatic, anti-arthritic, antipyretic, colds, constipation, cough, epilepsy, fevers, food, headache, insecticidal, malaria, mystical and magical rituals, nausea, pneumonia, rheumatic pains, treatment of pains and muscular fatigue, tonic, useful for healthy pregnancy, vermifuge	[13]
2009	Peru	San Martin Quechuas or Lamas Quechuas	Rheumatism	[14]
	Peru	Yanesha	Fever, flu, rheumatic pain	[15]
2010	Panama	Téribe	Aggressive dementia	[16]
2011	Brazil	n.r.	Fly repellant (ethnoveterinary reports)	[17]
2012	Brazil	n.r.	Magical and ritual uses (evil eye)	[18]
2014	Brasil	Riverine communities	*Amoeba*, bath, cough, flu, pain of head	[19]
2014	South America (Brazil, Peru)	n.r.	Analgesic, antiarthritic, anti-inflammatory, antipyretic, antirheumatic, colds, constipation, depurative, nausea, pneumonia and respiratory disorders, purgative, vermifuge,	[20]
2015	Ecuador	Achuar	Cold	[21]
	Ecuador	Waorani	Magic rituals, Topical anesthetic	[22]
	n.r.	n.r.	Analgesic, anti-inflammatory, antirheumatic, body aches and pain, muscle aches, rheumatism, treatment for arthritis, injuries and pain	[23]
2016	Ecuador	Kichwa	Infections, muscular system disorders, respiratory diseases	[24]
	Ecuador	Kichwa and Mestizo	Anesthetic, cold, muscle pain, ritual use	[25,26]
	Brazil	Caruaru	Magical and ritual use “Limpeza do corpo” (Body cleaning); “Proteção” (Protection)	[27]
2017	Brazil	Riverine inhabitants	Magical and ritual use “Doença-do-ar” (air diseases); “espante” (fright); “vento caído” (fallen wind); “derrame” (leakage)	[28]
	Brazil	n.r.	Antifungal, antiviral, antimicrobial, anti-inflammatory, fever, rheumatism	[29]

n.r. – not reported

2.2 Phytochemistry and biological activity

Several authors focused their researches on the phytochemistry of *M. alliacea*, also adding some interesting study regarding the biological activity of its phytocomplex. Results are respectively reported in **Table 2** and **Table 3**.

Table 2 – Phytochemistry of *M. alliacea*

Plant part(s) used	Plant extract(s)	Main compound(s)	Ref.
Leaves	Essential oil	allyl methyl trisulfide, allyl propyl trisulfide, dithiacyclopentene, allyl propyl disulfide, allyl methyl trisulfide, allyl isobutyl sulfide, allyl isobutyl disulfide, diallyl monosulfide, diallyl disulfide, diallyl sulfide, diallyl trisulfide, diallyl tetrasulfide, 3-vinyl-1,2-dithi-4-en, allyl tri-sulfite, tetrasulfite, di-2-propinil, trisulfide, di-2-propenyl, 1-Octen-3-ol, 1-octen-3-ol, , allyl methyl disulfide, allyl methyl tetrasulfide, propenyl propyl trisulfide, , 3-vinyl-1,2-dithi-4-ene, 3-vinyl-1,2-dithi-5-ene, trithiacyclohexene, 2-methyl-2-pentenal, cis-dipropenyl disulfide, trans-dipropenyl disulfide, methyl salicylate, 3,4-dimethyl-2,3-dihydrothiophen-2-one, nonanethiol, diisoamyl disulfide	[8] [13] [20] [30]
	Petrol extract	n-alkanes C25-C35, n-alkanols, 24-ethylcholest-7-ene-3β-ol, fucosterol, 3β-hydroxyurs-18-en-27-oic acid, 32-hydroxyhexatriacontan- 4-one, 19-hydroxyhexatriacontan-18-one, 34-hydroxy-8-methylheptatriacontan-5-one, pentatriacont-1-en-17-ol, β-sitosterol, stigmasterol	[13] [31]
Flowers	Essential oil	diallyl disulfide, diallyl tetrasufide, diallyl trisulfide, 1-octen-3-ol	[8] [13]
	Methanol extract	Alliin, β-amyrin, apigenin, apigenin-7-glucoside, apigenin-7-glucuronide scutellarein-7-glucuronide, apigenin-7-glucuronyl glucuronide , apigenin-7-O-methylglucuronide, cyanidin-3-rutinoside, β-sitosterol, β-sitosteryld-glucoside, luteolin, 7-O-methylscutellarein , ursolic acid	[13]
Inflorescences	n.r.	benzaldehyde (54.8%), benzyl thiol (20.3%) dibenzyl disulphide (18.0%).	[30]
Wood (bark)	Dichloromethane phase of the methanol extract	9-methoxy-α-lapachone, 4-hydroxy-9-methoxy-α-lapachone	[13]
Plant	Ethyl acetate extract, Aqueous Infusion	*p*-coumaric acid, ferulic acid and resveratrol	[32]
	Dry extract	Betulinic acid	[33]
n.r.	n.r.	9-methoxy-*α*-lapachone	[34]
n.r.	n.r.	alliin, allicin, allylsulfoxide, diallyl sulfide, divinyl sulfide, propyl allyl disulfide, stigmasterol	[35]
n.r.	n.r.	alkaloid, ferulic acid, flavonoids, cumarin, p-coumaric acid saponin, resveratrol, sulfur compounds tannin, terpenes, caffeic acid	[36, 37]

n.r. – not reported

Table 3 - Biological activities of several *M. alliacea* extracts**.**

Plant part(s) used	**Biological activities**	**Ref.**
Leaves	Allosteric dose-depend effect on the muscarinic acetylcholine receptor M2 subtype	[34]
	Antimycotic effect against *Aspergillus flavus* and *Aspergillus niger*, antiaflatoxigenic effect. Non-phytotoxic effect.	[38]
	Antifungal activity against *Colletotricum gloeosporioides* Penz and *Botryodiplodia theobromae* Pat.	[39]
	Antifungal activity against *Microsporum gypseum*	[40]
	Antibacterial activity against *Staphylococcus aureus, Bacillus subtilis*	[41]
	Larvicidal activity	[20]
	Partial insecticidal activity on *Bemisia tabaci* eggs, nymphs, and adults	[42]
	Inhibition effect of T3-HA cancer cells (tertiary liver metastatic tumor) at low concentrations and cytotoxic effect at higher concentrations.	[22]
	Antioxidant activity	[23]
	Antifungal activity against: *Alterniaria brassicae, Colletotrichum capsici, Curvularia lunata, Alternaria alternata, Alternaria brassicola, Alternaria carthami, Fusarium oxysporum, Fusarium udum* Antiviral activity against virus-mild mosaic. Antioxidant activity. Prostaglandin synthesis inhibition. Biocide activity against *Hipsiphyla Grandella* and *Anofeles*	[13]
Dried flowers	Blood cholesterol lowering effect in rats	[13]
Root and stem	Anti-inflammatory activity	[13]
Plant	Antiplasmodial activity	[43]
	Inhibition of the normal growth and development of the insect due to a prolonged and delayed larval and pupal duration	[20]
	Larvicidal activity against mosquito larvae (*Culex quinquefasciatus*).	[44]
	Sinergic larvicidal activity against *Anopheles stephensi* and *Culex quinquefasciatus* if used with using the synthetic insecticide temephos	[45]
n.r.	Antiallergic, antibacterial, antifungal, anti-inflammatory, antioxidant, antiviral, suppression of tumor growth	[36]

n.r. – not reported

Conclusions

Despite a big number of ethnobotanical data, the phytochemistry and biological activities of *M. alliacea* have been partially investigated and the main results have been obtained only in the last ten years. The presence of orgasulfur compounds in other species motivated a wide cluster of studies mainly focused on health promoting effects [46, 47, 48, 49]. These findings and the results presented in the present conference paper justify more pharmaceutical and nutraceutical researches as a new trend of investigation for *M. alliacea*. Finally, interesting preliminary results have been achieved also regarding the larvicidal activity and phytopathogen control.

Acknowledgments

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Author Contributions

All authors contributed extensively to the work presented in this paper.

Conflicts of Interest

The authors declare no conflict of interest.

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