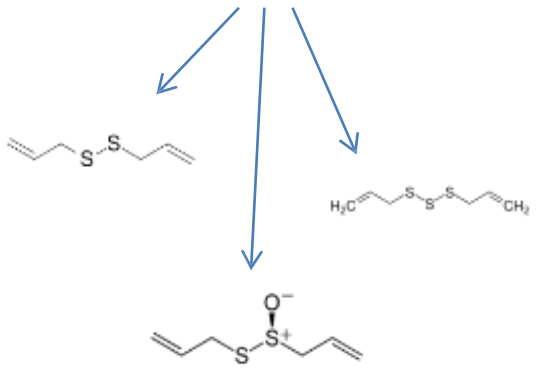
MOL2NET, International Conference Series on Multidisciplinary Sciences
http://sciforum.net/conference/mol2net-03

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

The authors gratefully acknowledge the financial support of the Amazonian State University of the Republic of Ecuador.

Author Contributions

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

Conflicts of Interest

The authors declare no conflict of interest.

References

1. www.tropicos.org. Available on line: http://www.tropicos.org/NamePage.aspx?nameid=3701394&tab=specimens (Accessed on 27/08/2017).
2. www.theplantlist.org. Available online: http://www.theplantlist.org/tpl1.1/record/kew-317544 (Accessed on 27/08/2017).
3. Zoghbi, M.; Oliveira, J.; Guilhon G.M.S.P. The genus Mansoa (Bignoniaceae): a source of organosulfur compounds. *Rev. bras. Farm*. **2009**; 19 (3) 795-804.
4. Atanasov, A.G.; Waltenberger, B.; Pferschy-Wenzig, E.M.; Linder, T.; Wawrosch, C.; Uhrin, P.; Temml, V.; Wang, L.; Schwaiger, S.; Heiss, E.H. Discovery and resupply of pharmacologically active plant-derived natural products: A review. *Biotechnology advances.* **2015**, 33, 1582-1614
5. Newman, D.J.; Cragg, G.M. Natural products as sources of new drugs over the last 25 years⊥. *Journal of natural products* .**2007**, 70, 461-477
6. Si-Yuan Pan, Shu-Feng Zhou, Si-Hua Gao, Zhi-Ling Yu, Shuo-Feng Zhang, Min-Ke Tang, Jian-Ning Sun, Dik-Lung Ma, Yi-Fan Han, Wang-Fun Fong, Kam-Ming Ko. New Perspectives on How to Discover Hindawi Publishing Corporation *Evidence-Based Complementary and Alternative Medicine*. Volume **2013**, Article ID 627375, 25 pages http://dx.doi.org/10.1155/2013/627375
7. Liogier, Alain Henri. Descriptive flora of Puerto Rico and adjacent islands. Spermatophyta. Volume IV-Melastomataceae to Lentibulariaceae. **1995**, *Ed. Universidad de Puerto Rico, Rio Piedras, Puerto Rico*. Pag. 534
8. Zoghbi, M.G.B; Ramos; Maia, J.G.S.; Miriam L. da Silva, M.L.S; Luz, A.I.R. Volatile Sulfides of the Amazonian Garlic Bush. *J. Agric. Food Chem*. **1904**, 32, 1009-1010
9. Bourdy, G.; De Walt, S.J.; Chávez de Michel, L.R.; Roca, A.; Deharo, E.; Munóz, V.; Balderrama, L.; Quenevo, C.; Gimenez, A. Medicinal plants uses of the Tacana, an Amazonian Bolivian ethnic group. *Journal of Ethnopharmacology*. **2000**,70, 87–109
10. Pérez, D. Etnobotánica medicinal y biocidas para malaria en la región Ucayali. *Folia Amazónica*. **2002,**VOL. 13 (1-2)
11. De la Torre, L.; Navarrete, H.; Muriel, M. P.; Macía, M. J.; Balslev, H. (eds.) Herbario QCA & Herbario AAU. Quito & Aarhus. Enciclopedia de las Plantas Útiles del Ecuador, **2008**: 67–70
12. Shukla, R.; Kumar, A.; Prasad, C.S.; Srivastava, B.; Dubey, N.D. Antimycotic and antiaflatoxigenic potency of Adenocalymma alliaceum Miers. on fungi causing biodeterioration of food commodities and raw herbal drugs. *International Biodeterioration & Biodegradation***. 2008**, 62 348–351
13. Zoghbi, M.G.B.; Oliveira, J.; Skelding, G.M.; Guilhon, P. The genus Mansoa (Bignoniaceae): a source of organosulfur compounds. *Revista Brasileira de Farmacognosia Brazilian Journal of Pharmacognosy*. **2009,** 19(3): 795-804, Jul./Set.
14. Sanz-Biset, J.; Campos-de-la-Cruzb, J.; Epiquién-Rivera, M.A.; Cañigueral, S. A first survey on the medicinal plants of the Chazuta valley (Peruvian Amazon). *Journal of Ethnopharmacology***. 2009,** 122 333–362
15. Céline, V.; Adriana, P.; Deharo, E.; Albán–Castillo, J.; Estevez, Y.; Lores, F. A.; Rojas, R.; Gamboa, D.; Sauvain, M. Medicinal plants from the Yanesha (Peru): Evaluation of the leishmanicidal and antimalarial activity of selected extracts. *Journal of Ethnopharmacology*. **2009,**123 413–422
16. Sáez, L. and Pérez Soto, J. Fitoquímica y valor ecológico del olor a ajo en los vegetales. *Medicina Naturista*. **2010,**; Vol. 4 - N.º 1: 15-23 I.S.S.N.: 1576-3080
17. Maria Vivina Barros Monteiro, M.V.; Leal Bevilaqua, C.M.; Correia Palpha, M.d.D.; Braga, R.R.; Schwanke, K.; Tavares Rodrigues, S., Alves Lameira, O. Ethnoveterinary knowledge of the inhabitants of Marajó Island, Eastern Amazonia, Brazil. *Acta Amazónica.***2010**, vol. 41(2) 2011: 233 – 242.

18. Kawa, N. Magic Plants of Amazonia and Their Contribution to Agrobiodiversity. *Human Organization.* **2012**, 71 (3); 225-233.
19. Flores Vásquez, S.P.; De Mendonça, M.S.; Do Nascimento Noda, S. Etnobotânica de plantas medicinais em comunidades ribeirinhas do Município de Manacapuru, Amazonas. Brasil. *Acta Amazónica*. **2014**, VOL. 44(4): 457 - 472
20. Granados-Echegoyen, C.; Pérez-Pacheco, R.; Soto-Hernández, M.; Ruiz-Vega, J.; Lagunez-Rivera, L.; Alonso-Hernandez, N.; Gato-Armas, R. *Inhibition of the growth and development of mosquito larvae of Culex quinquefasciatus (Diptera: Culicidae) treated with extract from leaves of Pseudocalymma alliaceum (Bignonaceae).* **2014**, Asian Pacific Journal of Tropical Medicine, 594-601
21. Giovannini, P. Medicinal plants of the Achuar (Jivaro) of Amazonian Ecuador: Ethnobotanical survey and comparison with otherAmazonian pharmacopoeias. *Journal of Ethnopharmacology.* **2015**, 164 78–88
22. Towne, C.M.; Dudt, J.F.; Ray, D.B. Effect of *Mansoa alliacea* (Bignonaceae) leaf extract on embryonic and tumorigenic mouse cell lines. *Journal of Medicinal Plants Research***. 2015**, Vol. 9(29), pp. 799-805, 3 August
23. Ankita, S., Chandra, S.S.; Arti, T. Free radical scavenging activity of leaves of *Adenocalymma alliaceum. Ejbps***. 2015**, Volume 2, Issue 3, 1035-1038.
24. Lalama Aguirre, M.; Montes Cruz, S.B.; Zaldumbide Verdezoto, M.A. Etnobotánica de plantas medicinales en el cantón Tena, para contribuir al conocimiento, conservación y valoración de la diversidad vegetal de la región amazónica. *Dom. Cien***. 2016**, ISSN: 2477-8818 Vol. 2, núm. esp.,ago. pp. 26-48
25. Abril, R.V.; Ruiz, T.E.; Alonso, J.; Verena Torres, V.; Cabrera, G. Prospecting of plant species in Pastaza province, Ecuador. Prospección de especies vegetales en la provincia de Pastaza, Ecuador. *Cuban Journal of Agricultural Science.* **2016**, Volume 50, Number 4. 50th Anniversary
26. Abril, R.V.; Vásquez, T.E.; Lazo, J.A.; Banguera, D.V.; Guayasamín, P.D.R.; Vargas, J.K.A; Peñas, I.V. The use of medicinal plants by rural populations of the Pastaza province in the Ecuadorian Amazon. *Acta Amazónica***. 2016**, VOL. 46(4) 2016: 355 – 366.
27. Ferreira Lanalice, R.; Tavares-Martins, A.C. Chemical and ethnopharmacology mystical plants in an Amazonian community. *Revista Fitos***. 2016**, Rio de Janeiro, Vol, 10(3), 220-372, Jul-Set e-ISSN: 2446-4775 | www.revistafitos.far.fiocruz.br
28. Pagani, E.; Pagania, Santos, J.F.L.; Rodrigues, E. *Culture-Bound Syndromes of a Brazilian Amazon Riverine population: Tentative correspondence between traditional and conventional medicine terms and possible ethnopharmacological implications.* **2017**, Journal of Ethnopharmacology 203 (2017) 80–89
29. Faccin, H.; Loose, R.F.; Viana, C.; Alves Lameira, O.; Carvalho, L. M.. Determination of phenolic compounds 1 in extracts of Amazonian medicinal plants by liquid chromatography electrospray tandem mass spectrometry. *Anal. Methods*. **2017** 2017,DOI:10.1039/C6AY02937J.
30. Zoghbi, M.dG.B.; Andrade, E.H.A.; Maia, J.G.S. Volatile constituents from *Adenocalymma alliaceum* Miers and *Petiveria alliacea* L., two medicinal herbs of the Amazon. **2009,** Flavour Fragr. J. 2002; 17: 133–135. DOI: 10.1002/ffj.1051
31. Misra, T.N.; Singh, R.S.; Pandey, H.S.; Prasad, C. A Novel Pentacyclic triterpene acid from Adenocalymma alliaceum leaves. *Journal of Natural P&J.* **I995**, Vol. 58, No. 7, pp. 1056-1 058, July
32. Domingos da Silveira, G.; Jung Motta, M.; Sabo Müller, L.; Lameira, O.; Athayde, M.L.; Piana, M.; Barcelos Da Rosa, M.; Viana, C.; Machado De Carvalho, L. Determination of Phenolic Antioxidants in Amazonian Medicinal Plants by HPLC with Pulsed Amperometric Detection. *Journal of Liquid Chromatography & Related Technologies***. 2015**, 0: 1–8. ISSN: 1082-6076 print/1520-572X online. DOI: 10.1080/10826076.2015.1037450
33. Assis Gobo, L.; Viana, C.; Alves Lameira, O.; Machado de Carvalho, L. A liquid chromatography-atmospheric pressure photoionization tandem mass spectrometric (LC-APPI-

MS/MS) method for the determination of triterpenoids in medicinal plant extracts. *J. Mass Spectrom.* **2016**, 51, 558–565.

34. Zheng Dong, G.; Haga, T.; Itokawa, H.; Mizobe, F. Allosteric Binding of 9-methoxy-alpha-lapachone and alcuronium, to the muscarinic acetylcholine receptor m2 subtype. *Biomedical Research.* **1995**, 16 (5) 327—335
35. López Sáez, A. and Pérez Soto, J. Fitoquímica y valor ecológico del olor a ajo en los vegetales. *Medicina Naturísta*. **2010**, Vol. 4 - N.º 1: 15-23 I.S.S.N.: 1576-3080
36. Pires, F.B.; Dolwitsch, C.B.; Dal Prá, V.; Monego, D.L.; Schneider, V.M.; Loose, R.F.; Petra Schmidt, M.E.; Bressan, L.P.; Mazutti, M.A.; Barcellos da Rosa, M. An Overview about the chemical composition and Biological Activity of Medicinal species found in the Brazilian Amazon. *Journal of Applied Pharmaceutical Science*. **2016**, Vol. 6 (12), pp. 233-238, December.
37. Pires, F.B.; Dolwitsch, C.B.; Dal Prá, V.; Faccin, H.; Monego, D.L.; M. de Carvalho, L.; Viana, C.; Lameira, O.; Lima, F.O.; Bressan, L.; Barcelos da Rosa, M. Qualitative and quantitative analysis of the phenolic content of *Connarus* var. angustifolius, *Cecropia obtusa*, *Cecropia palmata* and *Mansoa alliacea* based on HPLC-DAD and UHPLC-ESI-MS/MS. *Revista Brasileira de Farmacognosia***. 2017**, 27, 426–433
38. Shukla, R.; Kumar, A.; Shekhar Prasad, C,; Srivastava, B.; Kishore Dubey, N. Antimycotic and antiaflatoxigenic potency of *Adenocalymma alliaceum* Miers. on fungi causing biodeterioration of food commodities and raw herbal drugs. *International Biodeterioration & Biodegradation***. 2008**, 62, 348–351
39. Aswini, D.; Prabakar, K.; Rajendran, L.; Karthikeyan, G.; Raguchander, T. Efficacy of new EC formulation derived from garlic creeper (*Adenocalymma alliaceum* Miers.) against anthracnose and stem end rot diseases of mango. *World J Microbiol Biotechnol*. **2010**, 26:1107–1116
40. Freixa, B.; Vila, R.; Vargas, L.; Lozano, N.; Adzet, T.; Cañigueral, S. Screening for Antifungal Activity of Nineteen Latin American Plants. *Phytotherapia Research***. 1998**, VOL. 12, 427–430
41. Olivera-Condori, M.; Flores-Arizaca, J.; Vásquez-Zavaleta, T.; Ocsa-Borda, E. Physicochemical properties and bioactividades in vitro of essential oils *Mansoa alliacea* (Lam.) Gentry. *El Ceprosimad***. 2013**, 2(1): 96-102
42. Baldin, E.L.L.; Fanela, T.L.M.; Pannuti, L.E.R.; Kato, M.J.; Takeara, R.; Crotti, A.E.M. Botanical extracts: alternative control for silverleaf whitefly management in tomato *Hortic. bras.* **2015**, v. 33, n. 1, jan. - mar.
43. Ruiz, L.; Ruiz, L.; Maco, M.; Cobosa, M.; Andréa-Luz Gutierrez-Choquevilca, A.L.G.; Roumy, V. Plants used by native Amazonian groups from the Nanay River (Peru) for the treatment of malaria. *Journal of Ethnopharmacology***. 2011**, 133 917–921
44. Rathy, M. C., Mathai, A.; Aravind, U.K. and 3 Thomas, A.P. Mosquito larvicidal activity of indigeneous plant extracts against *Culex quinquuefasciatus* (Diptera: culicidae). *International Journal of Current Research***. 2015,** Vol. 7, Issue, 06, pp. 16768-16772, June
45. Shrankhla, L.M.; Srivastana, C.N. Synergistic, activity of temephos and *Pseudocalymma alliaceum* leaves against *Anopheles stephensi* and *Culex quinquefasciatus* larvae. **IJPRBS**. **2015**, Volume 4(3): 69-82
46. Hall, A.; Troupin, A.; Londono-Renteria, B. and Colpitts, T.M. Garlic organosulfur compounds reduce inflammation and oxidative stress during denguevirus infection. *Viruses.* **2017**, 9, 159; doi:10.3390/v9070159
47. Ko, J.W.; Park, S.H.; Shin, N.R.; Shin, J.Y.; Kim, J.W.; Shin, I.S.; Moon, C.; Heo, J.D.; Kim, J.C.; Lee, I.C. Protective effect and mechanism of action of diallyl disulfide against acetaminophen-induced acute hepatotoxicity. *Food and Chemical Toxicology*. **2017**, 109, 28-37
48. Martins, N.; Petropoulos, S.; Ferreira, I.C.F.R. Chemical composition and bioactive compounds of garlic (*Allium sativum* L.) as affected by pre- and post-harvest conditions: A review. *Food Chemistry* **.2016**, 211, 41–50
49. Wang, Y.I.; Guo, X.Y.; He, W.; Chen, R.J.; Zhuang, R. Effects of alliin on LPS-induced acute lung injury by activating PPARγ. *Microbial Pathogenesis.* **2017**, 110, 375-379