Journal of
Medicinal Plant Research

Volume 10 Number 21, 3 June, 2016

ISSN 1996-0875

Academic Journals

ABOUT JMPR

The Journal of Medicinal Plant Research is published weekly (one volume per year) by Academic Journals.

The Journal of Medicinal Plants Research (JMPR) is an open access journal that provides rapid publication (weekly) of articles in all areas of Medicinal Plants research, Ethnopharmacology, Fitoterapia, Phytomedicine etc. The Journal welcomes the submission of manuscripts that meet the general criteria of significance and scientific excellence. Papers will be published shortly after acceptance. All articles published in JMPR are peer reviewed. Electronic submission of manuscripts is strongly encouraged, provided that the text, tables, and figures are included in a single Microsoft Word file (preferably in Arial font).

Contact Us

Editorial Office: jmpr@academicjournals.org

Help Desk: helpdesk@academicjournals.org

Website: http://www.academicjournals.org/journal/JMPR

Submit manuscript online http://ms.academicjournals.me/

Editors

Prof. Akah Peter Achunike
Editor-in-chief
Department of Pharmacology & Toxicology
University of Nigeria, Nsukka
Nigeria

Associate Editors

Dr. Ugur Cakilcioglu
Elazıg Directorate of National Education
Turkey.

Dr. Jianxin Chen
Information Center,
Beijing University of Chinese Medicine,
Beijing, China
100029,
China.

Dr. Hassan Sher
Department of Botany and Microbiology,
College of Science,
King Saud University, Riyadh
Kingdom of Saudi Arabia.

Dr. Jin Tao
Professor and Dong-Wu Scholar,
Department of Neurobiology,
Medical College of Soochow University,
199 Ren-Ai Road, Dushu Lake Campus,
Suzhou Industrial Park,
Suzhou 215123,
P.R.China.

Dr. Pongsak Rattanachaikunsopon
Department of Biological Science,
Faculty of Science,
Ubon Ratchathani University,
Ubon Ratchathani 34190,
Thailand.

Prof. Parveen Bansal
Department of Biochemistry
Postgraduate Institute of Medical Education and Research
Chandigarh
India.

Dr. Ravichandran Veerasamy
AIMST University
Faculty of Pharmacy, AIMST University, Semeling - 08100,
Kedah, Malaysia.

Dr. Sayeed Ahmad
Herbal Medicine Laboratory, Department of Pharmacognosy and Phytochemistry,
Faculty of Pharmacy, Jamia Hamdard (Hamdard University), Hamdard Nagar, New Delhi, 110062,
India.

Dr. Cheng Tan
Department of Dermatology, first Affiliated Hospital of Nanjing Univeristy of
Traditional Chinese Medicine.
155 Hanzhong Road, Nanjing, Jiangsu Province,
China. 210029

Dr. Naseem Ahmad
Young Scientist (DST, FAST TRACK Scheme)
Plant Biotechnology Laboratory
Department of Botany
Aligarh Muslim University
Aligarh- 202 002,(UP)
India.

Dr. Isiaka A. Ogunwande
Dept. Of Chemistry,
Lagos State University, Ojo, Lagos,
Nigeria.

Editorial Board

Prof Hatil Hashim EL-Kamali
Omdurman Islamic University, Botany Department,
Sudan.

Prof. Dr. Muradiye Nacak
Department of Pharmacology, Faculty of Medicine,
Gaziantep University,
Turkey.

Dr. Sadiq Azam
Department of Biotechnology,
Abdul Wali Khan University Mardan,
Pakistan.

Kongyun Wu
Department of Biology and Environment Engineering,
Guiyang College,
China.

Prof Swati Sen Mandi
Division of plant Biology,
Bose Institute
India.

Dr. Ujjwal Kumar De
Indian Vetreinary Research Institute,
Izatnagar, Bareilly, UP-243122
Veterinary Medicine,
India.

Dr. Arash Kheradmand
Lorestan University,
Iran.

Prof Dr Cemşit Karakurt
Pediatrics and Pediatric Cardiology
Inonu University Faculty of Medicine,
Turkey.

Samuel Adelani Babarinde
Department of Crop and Environmental Protection,
Ladoke Akintola University of Technology,
Ogbomoso
Nigeria.

Dr.Wafaa Ibrahim Rasheed
Professor of Medical Biochemistry National Research Center
Cairo
Egypt.

Journal of Medicinal Plants Research

Table of Contents: Volume 10 Number 21 3 June, 2016

ARTICLES

academicJournals

Vol. 10(21), pp. 278-285, 3 June, 2016
DOI: 10.5897/JMPR2016.6099
Article Number: ACBBBC558777
ISSN 1996-0875
Copyright © 2016
Author(s) retain the copyright of this article
http://www.academicjournals.org/JMPR

Journal of Medicinal Plants Research

Full Length Research Paper

Evaluation of acaricidal efficacy of *Synadenium glaucescens* (Euphorbiaceae) against boophilus species

Vitus Alberto Nyigo[1,2]*, Robinson Hermmerton Mdegela[1], Hamisi Massanja Malebo[2], Faith Philemon Mabiki[3] and Gerda Fouche[4]

[1]Department of Veterinary Medicine and Public Health, Sokoine University of Agriculture, P. O. Box 3021 Morogoro, Tanzania.
[2]Department of Traditional Medicine Research, National Institute for Medical Research, Barack Obama Drive, P. O. Box 9653, 11101 Dar es salaam, Tanzania.
[3]Department of Physical Sciences, Sokoine University of Agriculture, P. O. Box 3038, Morogoro, Tanzania.
[4]Council for Scientific and Industrial Research (CSIR), Biosciences, P. O. Box 395, Pretoria 0001, South Africa.

Received 15 March, 2016; Accepted 4 May, 2016

***Synadenium glaucescens* is a traditional medicinal plant used by some communities in Tanzania for the management of various diseases in animals and human including the use for control of ticks in cattle. The aim of this study was to investigate the 'acaricidal effect' of extracts from this plant *on Boophilus decoloratus and B. microplus*. The methodology involved the use of larval and adult immersion tests. Results indicated low larvicidal (corrected mortality 37.5%) and adulticidal (corrected mortality 33.33%, LC_{50} 666.91) activities respectively for methanol and ethanol extracts from leaves. Other extracts of this plant showed a non-significant activity of mortality. Thus, it is not recommended for field trials, rather additional research is needed to determine its potentials especially using fresh plant material**

Key words: *Synadenium glaucescens,* Acaricidal activity, ticks, Tanzania.

INTRODUCTION

Records indicated that the number of people relying on agriculture has gone down as from 2001 to 2010, yet still it is the only sector that provides a livelihood for the majority of the communities than any other industry in the world (Upton, 2004; World Bank, 2008; Cervantes-Godoy and Dewbre, 2010). In the agricultural sector, livestock keeping is one among important activities that is practiced by many poor communities in developing world (Randolph et al., 2007). In 2004, Upton reported that livestock keeping provided over half of the value of global agricultural output and one-third being in developing countries. Literature indicates that the number of animals is further experiencing a remarkable increase especially in developing world (Randolph et al., 2007; Thornton, 2010). Despite this amazing increase, livestock keeping is constrained by diseases transmitted by ectoparasites

*Corresponding author. E-mail: nyigoo@yahoo.com. Tel: +255 715 873558.

Author(s) agree that this article remain permanently open access under the terms of the Creative Commons Attribution License 4.0 International License

(Njoroge et al., 2006). The harmful effects of ectoparasites on the productivity of livestock are well documented (Bagavan et al., 2009, Gazim et al., 2011). Ticks and tick-borne diseases are important causes of losses to the livestock industry, in particular, the production of cattle and small ruminants in tropical and subtropical areas. The diseases are associated with a reduction in productivity, fertility and in some instances may result in the death of an animal (Bagavan et al., 2009; Gazim et al., 2011). A worldwide loss due to diseases transmitted by ticks and the costs of tick control is very high (Minjauw and McLeod, 2003). The economic importance of ticks is principally due to the ability to transmit a wide spectrum of pathogenic microorganisms, such as protozoa, rickettsiae, spirochaetes, and viruses.

In Africa, tick-borne protozoan diseases (e.g. theileriosis and babesiosis) and rickettsial diseases *e.g.* anaplasmosis and heartwater (cowdriosis) are the main health and management problems of domestic ruminants. Tick-borne diseases that are reported to affect livestock productivity in the East African Region include East Coast Fever, anaplasmosis, babesiosis and cowdriosis (McCosker et al., 1993; Kagaruki et al., 1996). In Tanzania, tick-borne diseases contribute to over 72% of the annual cattle mortality (Mtei and Msami, 1996; Kivaria, 2007). Ticks from the genus Boophilus are important due to their ability to transmit pathogens in cattle such as *Anaplasma marginale*, *Babesia bigemina*, *Brucella ovis*, *Babesia trautmanni* and *Borrelia theileri*.

Control of ticks aims at either eradication or prevention and has for a long time depended much on chemical control mainly synthetic chemicals. Main methods of applications include regular dipping of animals and sprays. Despite these novel efforts of control means, ticks control experiences many challenges, which include a rampant development of resistance against common control chemicals such as synthetic pyrethroids, organo-phosphates, and amitraz. The building and maintenance of dipping tanks or sprays and the purchasing of acaricides for tick control and therapeutic agents hike farmer's production costs.

This situation is pressing for concerted efforts to search for novel effective and eco-friendly anti-tick natural products. Natural sources especially plants are believed to be arsenals of such control agents and due to their versatile application; they are currently the main target. A study from Korea for example with a detailed analysis of ethnoveterinary plants revealed 143 medicinal plants in use for treatment of cattle diseases (Song and Kim, 2010). While some laboratory tests results report moderate toxic effects of herbal plants on adult ticks and larvae (Bagavan et al., 2009). Some plants reveal significant activity against economically important tick species including species resistant to acaricides (Borges et al., 2003; Sunil et al., 2013; Ghosh et al., 2013; Nawaz et al., 2015).

This study was therefore conceived to assess the activity of crude plant extracts from *S. glaucescens* against cattle ticks of the genus *Boophilus.* This plant has been reported to possess various pharmacological and insecticidal activities especially on its use as anti-ticks and in the post-harvest grain storage by local communities. However, there are no scientific reports regarding its acaricidal potentials against ticks. Nonetheless, other species of this genus have indicated good pesticidal activities against various ectoparasites (Bagavan et al., 2009; Hassan et al., 2012), thus building a base for investigating this plant species.

MATERIALS AND METHODS

Plant materials

Plant materials (leaves and root barks) of *S. glaucescens* Pax were harvested from Mufindi District in Tanzania during May and August 2012. The World Health Organization (WHO, 2003) guideline on Good Agricultural and Collection Practices (GACP) for medicinal plants was used. Thus, roots were dried at room temperature while some minor modifications were considered for leaves in which drying was effected in place with half day shade and half day sun because leaves of this plant contain a large amount of latex (Nyigo et al., 2015). The dried plant materials were pulverized and then subjected to extraction using solvents with different polarities sequentially in ascending order starting with hexane, dichloro-methane, ethyl acetate, methanol and ultimately water. After filtration, the extracts were dried *in vacuum* and in a freeze dryer to obtain different organic and water extracts, respectively (Table 1).

Ticks collection for adulticidal testing

Tests of plant extracts against adult ticks were conducted at the Faculty of Veterinary Medicine, Department of Veterinary Medicines and Public Health of the Sokoine University of Agriculture (SUA). Engorged adult ticks (*Boophilus decoloratus)* were collected from naturally infested cattle pastured on local freelance grazing from different areas of Morogoro and Coast regions in Tanzania. During collection, the researchers first enquired information on the application of acaricides to ensure that none has been applied 45 days before tick collection (Rosado-Aguilar et al., 2010, Gazim et al., 2011). Ticks were then washed with water and dried with a paper towel and were subjected into different groups for testing and control.

Adult ticks for larva production

Test of extracts against larvae was conducted at the University of Free State, South Africa. Fully engorged female ticks *B. microplus* and *B. decoloratus* were received from Clinvet International on 7 July, 2014. They were washed with tap water, dried and distributed into 5 conical flasks containing 20 females each. The flasks were incubated at 26 ±2°C at a Relative Humidity of >70% for oviposition and hatching, and the hatch date was determined to be the 26th of August 2014. Testing was performed between 17 and 25 days post hatching.

Sample preparation

Required weights of extract were prepared and dissolved using appropriate solvents. For organic extracts, the decision of solvent to

Table 1. Types of extracts of S. *glaucescens* and their codes**.**

Codes	Plant part	Extract type
RDCM	Root	Dichloromethane (DCM) extract of root prepared by extracting plant with DCM, after the plant materials extracted by Hexane
Rwater	Root	Water extract of the root after sequential extraction with Hexane, DCM, EtOAc, MeOH; and plant residue extracted with water (H_2O)
LDCM	Leaves	DCM extract of the leaves prepared by extracting plant with DCM, after the plant materials having been extracted by Hexane
LMeOH	Leaves	MeoH extract of leaves prepared after sequential extraction with DCM, EtOAc, and plant residue extracted with MeoH
Lwater	Leaves	Water extract of the leaves after sequentially extracted with hexane, DCM, ethyl acetate and MeoH
LEtoH	Leaf	Ethanol Extract; fresh ground dried leaves extracted with ethanol
REtoH	Root	Ethanol Extract; fresh ground root barks extracted with ethanol

use was reached after trials between DMSO and Tween 80. Since the solubility of extracts in DMSO was very low (Figure 1a), Tween 80 was chosen to be the dissolution solvent for organic extracts due its relatively better solubility (Figure 1b). Aqueous extracts were dissolved in distilled water while organic extracts were dissolved in 2% tween in distilled water. With aqueous extracts, the required amount of distilled water was measured and directly poured in the sample while for organic extract samples, the process involved first dissolving an extract in a known amount of tween 80 and diluted with distilled water to make the required volume of a solvent and in both cases, dissolutions were assisted by warming in a water bath. The controls composed of two solvents; 2% tween 80 in distilled water for organic extracts and 100% distilled water for aqueous extracts.

Larval immersion test (LIT)

Larvae obtained from the engorged female ticks of *B. microplus,* and *B. decoloratus* were rested unfed for 16 to 25 days after hatchability (Gazim et al., 2011). Approximately 200 larvae were placed between two round Whatman no 1 filter papers (diameter 120 mm) to form a larvae sandwich, placed in a pie plate. Ten milliliters of 1% solution from plant extracts was then poured over the larvae sandwich to expose them to the solution. Each run also included a positive control (300 ppm -Field concentration of Chlorfenvinphos- Supadip 30% m/v) and a negative control (diluent). After 30 min, excess solution was drained from the filter paper sandwich, then approximately 100 larvae were transferred to a clean filter paper (Whatman no 1, diameter 250 mm) envelop which was crimped closed as well as taped with masking tape over the crimped area to ensure that larvae cannot escape.

The envelopes were then placed in an incubator at a temperature of 26 ± 2°C and RH ≥70% for 72 h. After 72 h each envelope was opened and turned over to allow dead larvae to fall onto a clean filter paper circle (Whatman no 1, diameter 250 mm). Live larvae still clinging to the filter paper envelope were counted by squashing each larva counted onto the filter paper envelope. Then the filter paper containing dead larvae was inspected for any possible live larvae, which were also counted as live and picked up with a masking tape strip. The remaining larvae were then considered dead. Both counts were documented on a datasheet and transferred to a spreadsheet. Efficacy of extract to kill the larvae was determined against a negative control (diluent) by calculating corrected mortality Abbott's formula (Abbott, 1925).

Adulticidal tests through adult immersion test

The adult immersion tests (AIT) as described by Drummond et al. (1976) and Holdsworth et al. (2006) was adopted with some modification for acaricidal activity tests of crude extracts of plant materials from *S. glauscence* against *B. decoloratus* adult ticks. Ticks were grouped into four groups each with 12 engorged female ticks, three treated with different concentrations (triplicates) and one negative control. Both treatment and control groups were place in perforated cloth specially made to be able to hold the ticks while allowing them to be in contact with solvents (Figure 2). The ticks were then immersed for five minutes in 20 ml of the diluted crude extract with tween 80 and the control group immersed in tween with distilled water (Rosado-Aguilar et al., 2010) and distilled water alone. The ticks were then transferred into Petri dishes and observed for mortality for a maximum of three days at the condition of temperature and humidity described previously. The criteria used to diagnose dead ticks included the lack of movement of legs and change of cuticle color *(*Pirali-Kheirabadi and Teixeira da Silva, 2011). Efficacy of extract to kill the adult ticks was determined against negative controls, that is, distilled water for aqueous extracts and 2% tween 80 in distilled water for organic extracts by calculating Corrected mortalities

Definition of test scores for crude extracts

Definition of test scores was adopted from those reported by Rosado-Aguilar et al. (2010) as follows. Activity of crude plant extracts were classified in mean % of mortality of adult ticks and larvae at 24, 48 and 72 h as; high mortality (86-100%); relatively high mortality (71-85%); moderate mortality (56-70%); low mortality 31-55%; and non-significant activity of mortality (0-30%) (Rosado-Aguilar et al., 2010).

Statistical analysis

All data were recorded in an excel sheet and used it to perform descriptive statistics such as arithmetic means of triplicate tests and percentage mortalities of adult ticks and larvae in test and control groups. Efficacy of extract to kill the adult ticks and larvae for all extracts concentrations was calculated using Abbott's formula (Abbott, 1925).

Table 2. Corrected Mortalities (%) of ticks from Root extracts of *S. glaucescens*.

Extract type	Corrected %age Mortalities in different concentrations (mg/ml)								
	24 h			48 h			72 h		
	100	200	300	100	200	300	100	200	300
REtoH	2.86	8.57	9.57	3.06	8.57	12.11	9.57	13.3	16.56
RDCM	5.56	5.56	8.57	5.56	8.57	12.11	8.57	9.97	16.56
Rwater	2.78	5.56	5.56	2.78	2.78	5.56	2.78	5.56	5.56
LEtoH	9.16	9.16	16.7	16.7	16.67	25	25	33.3	33.33
LDCM	0	0	8.33	8.33	16.67	18.21	16.67	18.2	18.21
Lwater	0	0	0	0	0	0	9.05	9.05	16.67

$$\text{Corrected mortality} = \frac{(\text{Mortality in test bottles [\%]} - \text{Mortality in control bottle [\%]})}{(100\% - \text{mortality in control bottle [\%]})} \times 100$$

The corrected mortality results of adult ticks were then used to calculate lethal concentrations LC_{50} and LC_{90} for each extract using a graph pad Software version 5.0.

RESULTS

Adulticidal tests

Table 2 shows corrected percentage mortalities of adult ticks against different dried extracts of root barks and leaves of *S. glaucescens*. The minimum and highest mortalities in the last day of observation were 2.78 and 33.33%, respectively. These activities are regarded low especially when the highest mortality recorded below 50%, which appeared on the third day of the observation. However, among the extracts, the ethanol extracts from leaves was the most active (33.33%) while water extracts showed the least activity (2.78%).

Figure 3 shows the trend of mortality from day one to the third day of observation. It is evident that despite the low activity of extracts yet the tendency showed that the percentage mortality slightly increased with number of days and with increase in concentrations

Table 3 shows the lethal concentrations LC_{50} and LC_{90} of the different extracts. The high values are an indication of less effectiveness of the extracts. After 72 h, the LC_{50} of almost all of extracts are in terms of thousands except for LEtoH (666.91). This further indicates that the activities of the extracts were low including the most active amongst them.

Larvicidal activities

The larvicidal activity was tested only using two extracts. Table 4 shows the larvicidal activity of methanol and water extracts from the leaves of *S. glaucescens*. Similar results are observed in the larvicidal test as indicated in the adulticidal tests. Despite their higher susceptibility than adults (Williams et al., 2015), yet the activity of the extract against larvae was low with the highest and least mortality being 37.5 and 3.2% respectively (Table 4) with *B. decoloratus* larvae exhibiting higher resistance as compared to *B. microplus*.

DISCUSSION

Synadenium glaucescens is known for many traditional uses including use as pesticides agent in post harvests storage. Apart from traditional utilization, no any systematic study on acaricidal activity of the crude extracts from this plant had previously been reported. The existing reports are on pesticidal activities of other species in the genus (Afonso-Cardoso et al., 2011, Hassan et al., 2012). Thus, the evaluation of this plant on its effect in ticks is being reported for the first time and was based on these traditional values of the plant species and the existing pesticidal information in the genus. The study doses in this study are high and appear different from many studies that have been done on an acaricidal activity of various plant extracts (Bagavan et al., 2009; Rosado-Aguilar et al., 2010).

This is because during trials for an establishment of concentrations, the lower doses (25 and 50 mg/ml) could not perform well thus, necessitating trials of higher concentrations. Despite high test concentrations, yet extracts showed to exhibit very low activities on the adult ticks at 24, 48 and 72 h (Table 2). This is also indicated by high values of lethal concentrations (Table 3), which imply that the extracts exhibits low acaricidal effects. Therefore, most of the extracts have been grouped to bear non-significant activities while only one extract (LEtoH) exhibit low activity on adult ticks. Though only two extracts were tested for larvae efficacy, similar results have been observed where one extract exhibited low activity and the other exhibiting non-significant activity. This low activity against larvae further justifies the low effectiveness of the extracts as acaricide because larvae have relatively high susceptibility as compared to

Table 3. Lethal concentrations of Adult ticks after immersion in Root extract of *S. glaucescens.*

Extract type	LC_{50} and LC_{90} of Corrected %age Mortalities(CM) for Root and Leaf					
	24 h		48 h		72 h	
	LC_{50}	LC_{90}	LC_{50}	LC_{90}	LC_{50}	LC_{90}
REtoH	1481.67	2673.92	1130.09	2014.07	1264.26	2418.66
RDCM	3086.16	5741.96	1459.64	2681.02	1158.7	2159.95
Rwater	3463.79	6141.49	3530.46	6408.15	3463.79	6341.49
LEtoH	1220.95	2286.2	933.57	1893.93	666.91	1627.29
LDCM	-	-	920.58	1730.3	4395.24	9590.04
Lwater	-	-	-	-	1208.14	2258.01

Table 4. Corrected percentage mortalities of larvae against leaf extracts of methanol and water.

Extract type	Conc (%)	Total	Alive	Dead	Total	Alive	Dead	Mortality	CM
	Larva species: ***B. microplus***								
LMeOH	1	139	76	63	127	64	63	47.4	37.5
LWater	1	137	104	33	127	87	40	27.7	14.1
	Larva species: *B. decoloratus*								
LMeOH	1	54	41	13	95	86	9	14.8	5.1
LWater	1	104	92	12	119	102	17	13	3.2

Conc = Concentration; CM = Corrected mortality.

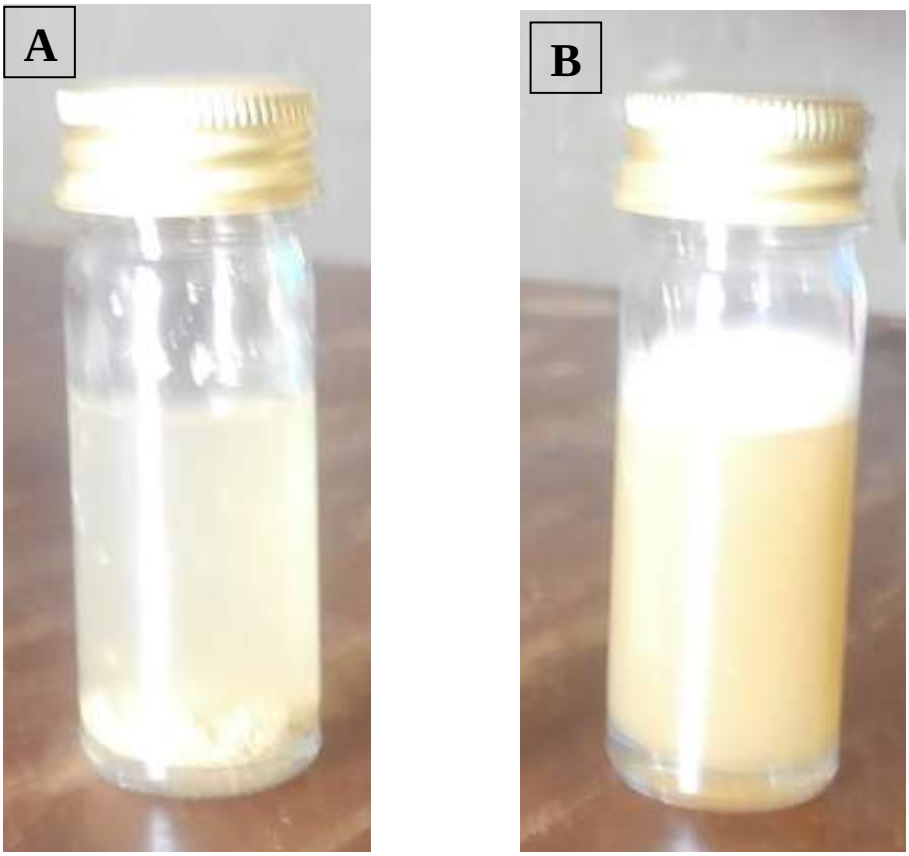


Figure 1. Extract dissolves in DMSO (a) and Tween 80 (b).

Figure 2. Adult tick immersion in a test and control solvents.

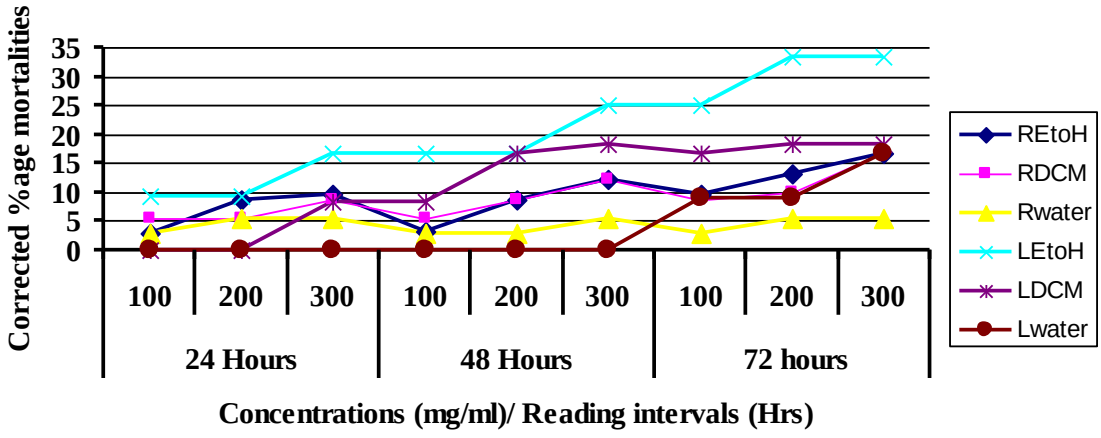


Figure 3. Mortality trends of adult ticks in the observation intervals.

adult ticks (Williams et al., 2015). These results are quite different from researchers' expectations and the claimed traditional efficacy on post-harvest storage protections. The reason for this difference is not well understood. However, it could probably be associated with conditions at which the test materials were used. In the traditional utilization, it is common that people use the fresh plant materials, but in this case, plant materials were dried for the purpose of standardization. Some changes may have happened on the constituents during processing that resulted from operational conditions such as temperature and pH (Durairaj et al., 2009). Since the current results were observed within 72 h, the duration of observation could also have affected the results especially if the

product has a slow onset of acaricidal actions (Holdsworth et al., 2006). Maybe longer time observations, which have also been the case for some studies could have a different result from the current observation (Holdsworth et al., 2006; Righi et al., 2013). None of the tested extracts could kill even 50% of the test subjects despite the high dosages used. Thus, none of the plant extracts is considered effective against tested ticks species. We, therefore, suggest further research on the plant by using fresh plant materials especially leaves as the fresh leaf latex has also shown to have activities on pest (Afonso-Cardoso et al., 2011).

Conclusion

Since the activity of extracts in adults and larvae were less than 50%, the extracts are concluded to exhibit low to non-significant activity against ticks under the conditions of the test described. Thus, it is not recommended for field trials, rather additional research is needed to determine its potential using fresh plant material especially those with latex.

Conflict of Interests

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENT

The authors acknowledge the following; Carnegie Regional Initiative in Science and Education (RISE) and African Natural Products Training Network (CR-AFNNET) for funding the study. They also acknowledge the laboratory technologists at the Faculty of Science, Sokoine University of Agriculture (SUA) for assisting in the extraction of plant materials and Mtulingala village community for their assistance in harvesting the plant materials. Authors also acknowledge Adriano Kindamba for identification of tick species, Daudi Mwangoka for assisting in the collection of ticks from the fields and Dr. Shaban Mshamu, for assisting in the identification and counting of dead ticks

REFERENCES

Abbott WS (1925). A method of computing the effectiveness of an insecticide. J. Econ. Entomol. 18(1):265-267.

Afonso-Cardoso SR, Silva CV, Ferreira MS, Souza MA (2011). Effect of the *Synadenium carinatum* latex lectin (ScLL) on Leishmania (Leishmania) amazonensis infection in murine macrophages. Exp. Parasitol. 128(1):61-67.

Bagavan A, Kamaraj C, Elango G, Zahir AA, Rahuman AA (2009). Adulticidal and larvicidal efficacy of some medicinal plant extracts against tick, fluke and mosquitoes. Vet. Parasitol. 166(3-4):286-292.

Borges LMF, Ferri PH, Silva WJ, Silva WC, Silva JG (2003). *In vitro* efficacy of extracts of *Melia azedarach* against the tick Boophilus microplus. Med. Vet. Entomol. 17(2):228-231.

Cervantes-Godoy D, Dewbre J (2010). Economic Importance of Agriculture for Poverty Reduction, OECD Food, Agriculture and Fisheries Working Papers, No. 23, OECD Publishing. https://www.oecd.org/tad/44804637.pdf

Drummond RO, Ernst, SE, Trevino, JL, Gladney, WJ, Graham OH (1976). Tests of acaricides for control of Boophilus-Annulatus (Acarina-Ixodidae) and Boophilus-Microplus (Acarina-Ixodidae). J. Econ. Entomol. 69(1):37-40.

Durairaj S, Srinivasan S, Lakshmanaperumalsamy P (2009). *In vitro* Antibacterial Activity and Stability of Garlic Extract at Different pH and Temperature. Electronic J. Biol. *5*(1):5-10.

Gazim ZC, Demarchi IG, Lonardoni MVC, Amorim ACL, Hovell AMC, Rezende CM, Ferreira GA, de Lima EL, de Cosmo FA, Cortez DAG (2011). Acaricidal activity of the essential oil from Tetradenia riparia (Lamiaceae) on the cattle tick Rhipicephalus (Boophilus) microplus (Acari; Ixodidae). Exp. Parasitol. 129(2):175-178.

Ghosh S, Tiwari SS, Srivastava S, Sharma AK, Kumar S, Ray DD, Rawat AKS (2013). Acaricidal properties of Ricinus communis leaf extracts against organophosphate and pyrethroids resistant Rhipicephalus (Boophilus) microplus. Vet. Parasitol. 192(1-3):259-267.

Hassan EM, Mohammed MMD, Mohamed SM (2012). Two New Phorbol-Type Diterpene Esters from *Synadenium grantii* Hook F. Leaves. Rec. Nat. Prod. 6(3):255-262.

Holdsworth PA, Kemp D, Green P, Peter RJ, De Bruin C, Jonsson NN, Letonja T, Rehbein S, Vercruysse J (2006). World Association for the Advancement of Veterinary Parasitology (WAAVP) guidelines for evaluating the efficacy of acaricides against ticks (Ixodidae) on ruminants. Vet. Parasitol. 136(1):29-43.

Kagaruki LK, Loretu K (1996). Ticks and tick–borne diseases of Tanzania. Tanzan. Vet. J. 16(suppl. 01):131-145.

Kivaria FM (2007). The control of east coast fever in Africa: a constant battle for impoverished dairy farmers. Vet. J. 174(2):221-222.

McCosker PJ, Musisi FK, Lawrence JA, Quiroga JC, Kamwendo SP (1993). The FAO multi – donor programme for integrated tick and tick-borne disease control in east, central and southern Africa, Proceeding of Tanzania veterinary association scientific conference, December 1993 arusha. 11th edition. pp. 340-371.

Minjauw B, McLeod A (2003). Tick-borne diseases and poverty. The impact of ticks and tick-borne diseases on the livelihood of small-scale and marginal livestock owners in India and eastern and southern Africa. Research report, DFID Animal Health Programme, Centre for Tropical Veterinary Medicine, University of Edinburgh, UK. pp. 59-73.

Mtei BJ, Msami HM (1996). Reflection on current animal health status in Tanzania. Tanzan. Vet. J. 16(1):45-64.

Nawaz M, Sajid SM, Ahmed Z, Waqas M, Ahmed T, Hussain A, Mohi-ud-Din A, Shamin A, Zubair M, Khalid I (2015). Anti-Tick Activity of Leaves of Azadirachta indica, Dalbergia sisso and Morus alba against *Rhipicephalus microplus* (Acari: Ixodidae). Acta Parasitol. Glob. 6(1):60-64.

Njoroge GN, Bussmann RW (2006). Herbal usage and informant consensus in ethnoveterinary management of cattle diseases among the Kikuyus (Central Kenya). J. Ethnopharmacol. 108(3):332-339.

Nyigo VA, Mdegela R, Mabiki F, Malebo HM (2015). Assessment of Dermal Irritation and Acute Toxicity Potential of Extracts from Synadenium glaucescens on Healthy Rabbits, Wistar Albino Rats and Albino Mice. Euro. J. Med. Plants 10(4):1-11.

Pirali-Kheirabadi KH, Teixeira da Silva JA (2011). *In-Vitro* Assessment of the Acaricidal Properties of Artemisia annua and Zataria multiflora Essential Oils to Control Cattle Ticks. Parasitol. 6(1):58-65.

Randolph TF, Schelling E, Grace D, Nicholson CF, Leroy JL, Cole DC, Demment MW, Omore A, Zinsstag J, Ruel M (2007). The role of livestock in human nutrition and health for poverty reduction in developing countries. J. Anim. Sci. 85(11):2788-2800.

Righi AA, Motta LB, Klafke GM, Pohl PC, Furlan CM, Santos DYAC, Salatino MLF, Negri G, Labruna MB, Salatino A (2013). Chemical composition and efficacy of dichloromethane extract of Croton sphaerogynus Baill. (Euphorbiaceae) against the cattle tick *Rhipicephalus microplus* (Acari: Ixodidae), Vet. Parasitol. 192(1-3):292-295.

Rosado-Aguilar JA, Aguilar-Caballero A, Rodriguez-Vivas RI, Borges-Argaez R, Garcia-Vazquez Z, Mendez-Gonzalez M (2010). Acaricidal activity of extracts from *Petiveria alliacea* (Phytolaccaceae) against the cattle tick, Rhipicephalus (Boophilus) microplus (Acari: ixodidae). Vet. Parasitol. 168(3-4):299-303.

Song MJ, Kim H (2011). Analysis of ethnoveterinary treatments for cattle (Bos indicus) diseases referred in Sanrimgyeongje including twelve volumes of literature from the 7th to the 18th century. J. Ethnopharmacol. 133(2):474-479.

Sunil AR, Amithamol KK, Juliet S, Nair SN, Ajithkumar KG, Soorya VC, Divya TM, Jyothymol G, Ghosh S, Ravindran R (2013). Acaricidal effect of Cassia fistula Linn. leaf ethanolic extract against *Rhipicephlaus (Boophilus) annulatus*. Trop. Biomed. 30(2):231-237.

Thornton PK (2010). Livestock production : recent trends, future prospects. Philos. Trans. R. Soc. B 365(1554):2853-67. DOI: 10.1098/rstb.2010.0134.

Upton M (2004). Pro-poor livestock policy initiatives. The role of livestock in economic development and poverty reduction, FAO PPLPI working paper no 10. http://www.fao.org/ag/againfo/programmes/en/pplpi/docarc/wp10.pdf

Williams H, Zoller H, Roepke RKA, Zschiesche E, Heckeroth AR (2015). Fluralaner activity against life stages of ticks using Rhipicephalus sanguineus and Ornithodoros moubata in *in vitro* contact and feeding assays. Parasit. Vectors 8:90.

World Health Organization (WHO) (2003). WHO Guidelines on Good Agricultural and Collection Practices (GACP) for Medicinal Plants, World Health Organization, Geneva pp. 13-16.

World Bank (2008). Agriculture for development policy brief, World development report. pp. 1-2.

academicJournals

Vol. 10(21), pp. 286-297, 3 June, 2016
DOI: 10.5897/JMPR2016.6106
Article Number: 3D2656B58779
ISSN 1996-0875
Copyright © 2016
Author(s) retain the copyright of this article
http://www.academicjournals.org/JMPR

Journal of Medicinal Plants Research

Full Length Research Paper

Eleutherine bulbous (Mill.) Urb.: A review study

Carolyna L. L. Couto[1], Denise F.C. Moraes[2], Maria do Socorro S. Cartágenes[3], Flavia M. M. do Amaral[4]* and Rosane N. Guerra[5]

[1]Biochemistry Pharmaceutical, Master in Health Sciences, Pharmacy building, Universidade Federal do Maranhão, Campus do Bacanga, Av. dos Portugueses s/n, , 65085-580, São Luís, Maranhão, Brazil.
[2]Pharmacognosy Laboratory, Pharmacy building, Universidade Federal do Maranhão, Campus do Bacanga, Av. dos Portugueses s/n, 65085-580, São Luís, Maranhão, Brazil.
[3]Pharmacology Laboratory, Integrated building, Universidade Federal do Maranhão, Campus do Bacanga, Av. dos Portugueses s/n, 65085-580, São Luís, Maranhão, Brazil.
[4]Herbal Laboratory, Pharmacy building, Universidade Federal do Maranhão, Campus do Bacanga, Av. dos Portugueses s/n, 65085-580, São Luís, Maranhão, Brazil.
[5]Immune physiology Laboratory, Integrated building, Universidade Federal do Maranhão, Campus do Bacanga, Av. dos Portugueses s/n, 65085-580, São Luís, Maranhão, Brazil.

Received 21 March, 2016; Accepted 11 May, 2016

***Eleutherine bulbous* (Mill.) Urb, Iridaceae, is a native plant and quite common in several regions of America, commonly known as "coquinho" being widely used in the folk medicine for the treatment of giardiasis, amoebiasis and diarrhea. This paper presents a literature review of studies about *Eleutherine bulbous* including aspects of taxonomy, synonymies, geographical distribution, ethnopharmacology, chemistry and pharmacology studies from several databases (Biological Abstracts, Chemical Abstracts, Medline, Lilacs, Web of Science, Science Direct, PubMed, Food and Drugs Administration) and data bank of patents. The research was also carried on some thesis, dissertations, books and also in some whole articles covering the period from 1950 to 2015, using as key works *Eleutherine*, *Eleutherine bulbous* and its botanical synonymies. The studies indicated several works in the field of ethnopharmacology, prevailing employment in gastrointestinal disorders, especially diarrhea and giardiasis, proving the potential of the species for investments in research and development of new therapies.**

Key words: *Eleutherine bulbous* (Mill.) Urb., coquinho, review, diarrhea, giardiasis.

INTRODUCTION

Natural products with therapeutic properties are important sources of new biologically active compounds and have been used in many parts of the world for decades, attracting the interest of many researchers (Araújo, 2011). Numerous studies show that some natural products are the main source of chemical diversity while new discoveries in the pharmaceutical field are emerging (Mishra and Tiwari, 2011). The plant selection to

*Corresponding author. E-mail: carolynaleitao@yahoo.com.br. Tel: 0 +55 (98) 32728592.

Author(s) agree that this article remain permanently open access under the terms of the Creative Commons Attribution License 4.0 International License

pharmacological study is a very important step. The choice can be done by one of several ways, such as the traditional, by the chemical components, random selection or combination of more than one criterion (Albuquerque and Hanazaki, 2006). The evaluation of isolated substances, fractions or extracts obtained from the vegetable drug can occur through the characterization of their biological activity, research of the mechanisms assigned to constituents and parts of the plant, determination of their active concentration and their toxic potential (Toledo et al., 2003).

For any approach chosen, the search of new plant-derived active products must be begun with a bibliographical and documentary research (Camargo, 2003). Data obtained from literature reviews, making a list of the plant species, extracts, semi-purified fractions and chemically defined molecules with biological activity as research target, have provided important subsidies, which contribute effectively to the definition of criteria inclusion and or exclusion of plant species selected for development of the validation studies (Barbosa-Filho et al., 2006; Amaral et al., 2006).

The contribution of the review works has been found not only by the increase in publications on this subject, but also by increasing its citations in national and international journals. Thus, various approaches for selection of plant species have been presented, among which are the three most investigated: (a) Random approach, where the choice is done based on the availability of the plant; (b) Chemotaxonomic or phylogenetic approach, in which the selection is done by the interest in a given class of substances in a genus or family; (c) Ethnopharmacological approach, in which the plant is selected according to the therapeutic use evidenced by a particular ethnic group (Albuquerque and Hanazaki, 2006). In these segments, these studies contribute effectively in the selection of vegetable material to be investigated, at the collection place, experimental delineating and analysis of results among others.

Eleutherine bulbous (Mill.) Urb. an important medicinal plant belonging to Iridaceae family and distributed in Amazon region. This plant species has been included in the list of medicinal plants of interest in National Health System at Brazil (RENISUS) (Brazil, 2009). This work presents a literature review of studies showing the potential of *E. bulbous* to advance the stages of the production chain and to include it in herbal medicine to generate the products of interest for better health care.

MATERIALS AND METHODS

Surveys were done to collect information in database (Biological Abstracts, Chemical Abstracts, Medline, Lilacs, Web of Science, Science Direct, PubMed, Food and Drugs Administration) and bases of patents, employing also research to theses, dissertations and books; covering a period from 1950 to 2015; using as descriptors, Iridaceae *E. bulbous* and its botanical synonyms. The references obtained were consulted for details of the studies on the botany, ethnopharmacology, plant geography, chemistry, biology and pharmacology area.

RESULTS AND DISCUSSION

In the analysis of the works that make up this review has been shown that, in several studies, the authors employ various scientific names to designate the *E. bulbous* species (Mill.) Urb., mainly *Eleutherine american* (Aubl.) Merr. ex K.Heyne and *Eleutherine plicata* Herb. ex Klatt. The first is considered in Plant List (2015) of the Royal Botanical Garden (Kew) and the second is cited as a synonym in the two bases of the main botanical institutes (Plant List, 2015; Tropic, 2015). Thus, to keep the nomenclatures adopted by the authors in this study we chose to use the scientific names originally employed in the work referred in this review, presented in the sections and tables that make up this study. Thus, the initial citation of the accepted nomenclature was standardized, that is, bulbous Eleutherine, and in the sequence jobs with the two most commonly used synonyms.

Taxonomic

E. bulbous has the following taxonomic according to Angiosperm Phylogeny Group III system (2009) (Tropics, 2015).
Kingdom: Plantae
Class: Equisetopsida
Subclass: Magnoliidae
Suborder: lilianae
Order: Asparagales
Family: Iridaceae
Genus: *Eleutherine*
Species: *Eleutherine bulbous*

Scientific and vernacular synonyms

E. bulbous (Mill.) Urb has as botanical synonyms: *Bermudiana bulbous* (Mill.) Molina; *Bermudiana congesta* (Klatt) Kuntze; *Cipura plicata* (Sw.) Griseb.; *Eleutherine american* (Aubl.) Merr. ex K. Heyne; *Eleutherine anomala* Herb.; *Eleutherine longifolia* Gagnep.; *Eleutherine plicata* (Sw.) Herb.; *Eleutherine plicata* Herb. ex Klatt; *Eleutherine subaphylla* Gagnep.; *Ferraria parviflora* Salisb.; *Galatea american* (Aubl.) Kuntze; *Galatea bulbous* (Mill.) Britton; *Galatea plicata* (Sw.) Baker; *Ixia american* Aubl.; *Sisyrinchium altissimum* Ten.; *Sisyrinchium americanum* (Aubl.) Lemée; *Sisyrinchium bulbosum* Mill.; *Sisyrinchium capitatum* Pers.; *Sisyrinchium congestum* Klatt; *Sisyrinchium elatum Seub. ex Klatt; Sisyrinchium intihuatanense (Vargas) Ravenna; Sisyrinchium latifolium Sw.; Sisyrinchium palmifolium var. Intihuatanense Vargas;*

Sisyrinchium plicatum (Sw.) Spreng.; Sisyrinchium racemosum Pers. (Kew, 2015).

E. bulbous is the currently accepted scientific name for this species, according to databases of Kew (Plant List, 2015) and the Missouri Botanic Garden (Tropicos, 2015). The vernacular names are marupari, marupazinho (Schultes and Raffaulf, 1990; Project..., 2015), marupapiranga (Schultes and Raffaulf, 1990), coquinho, lily-leaf-of-palm, marupá, marupaí, marupá-piranga, Palmeirinha (Project ..., 2015) and Rhubarb-of-field (Brasileiro et al.; 2006). In other countries it is known as Jasin huaste, pacahuasten, Pacha huaste, pachahuasten, piri-piri, yagua Piripiri, Yahuar piri piri and WA-ro (Project ..., 2015).

For synonym *Eleutherine plicata*, have been assigned the following vernacular names: marupazinho (Baraúna and Rock, 2006; Oliveira Neto et al., 2007; Lorenzi and Matos, 2008; Menezes et al., 2009; Nascimento et al., 2012), coquinho (Sousa et al., 2005; Oliveira Neto et al., 2007), marupari (Oliveira Neto et al., 2007; Nascimento et al., 2012), marupá-piranga, Palmeirinha, Marupa-ú and nambu marrow (Oliveira Neto et al., 2007).

Geographical distribution

The *E. bulbous* species is native of Americas, frequent in this area (Saralamp et al., 1996; Afanas'ev et al., 1999; Johnson, 1999; Lorenzi and Matos, 2002; Paramapojn et al., 2008; Nascimento et al., 2012). In Brazil, it occurs in the Amazon region, mainly in the state of Roraima (Revilla, 2001; 2002a).

For the *E. american* synonym, the studies indicate your origin in the tropical America, being found in plantations around the world mainly in South Africa, China, Indonesia and Thailandia (Chen et al., 1986; Hara et al., 1997).

Already by the synonymy *E. plicata* several studies indicate this species as widely found in the Amazon region (Baraúna and Rock, 2006; Oliveira Neto et al., 2007; Lorenzi and Matos, 2008).

Morphological description

The species of Eleutherine genus are herbaceous, perennial, rhizomatous and bulbous, predominantly red bulbs or wine color with scales similar to the onion, medium with 20 to 30 cm (Revilla, 2001; Lorenzi and Matos, 2002; Revilla, 2002b; Baraúna and Rocha, 2006).

Goldblatt and Le Thomas (1992) showed that the Eleutherine genus has monossulcado pollen grain with heterogeneous exine in different parts of the grain, almost perforated proximal surfaces.

Jobs reported that *E. bulbous* presents features simple leaves, whole, along pleated, with 25 cm average length; the flowers are white or pink, arranged in a large panicle at the apex of a long hard scape above the foliage, with 5 to 6 petals soldered on the base (Revilla, 2001, 2002b; Lorenzi and Matos, 2002).

Studies developed by Lorenzi and Matos (2002) and Baraúna and Rocha (2006) with *E. plicata* also identified the presence of whole leaves, pleated, simple, verticillate, linear-lanceolate, with longitudinal ribs; the inflorescence is in panicles of white flowers or roses, at the height of an escapement.

Kuntorini and Nugroho (2010) described the changes of the anatomical characteristics that occur in the leaves and the bulb of the *E. american* species during the plant growth cycle, showing that the specie leaf has homogenous mesophyll suffering change in thickness during growth of the plant. Prismatic crystals of calcium oxalate were observed in the mesophyll of this leaf. There is the presence of stomata on both sides of the leaf epidermis, with difference in number according to the development stage, however, on the average, the lower surface has a higher concentration of these. The thickness of the lower and upper epidermis layers also varied in the growth stage of the plant, and in general, the upper epidermis consists of smaller cells than the cells of the upper face. On the bulb, an increse in diameter and length with the growth of the plant was demonstrated. Anatomically, the bulb has difference in the size and number of parenchymal cells in which was observed the presence of calcium oxalate crystals of different shapes, with predominance of styloid. In the bulb was also verified increase in the vascular bundles structures.

These authors also evaluated the concentration of naphthoquinones during the growth sategs of the plant. In the bulb, there was an increase in the amount of this active ingredient, with the growth of the parenchyma; however the leaves, the concentration of naphtho-quinones remained constant evaluated in phases, despite the increase in thickness of the mesophyll (Kuntorini and Nugroho, 2010).

Use of the specie

Some studies have shown the predominance of the popular employment of leaves and *E. bulbous* bulbs for medical purposes, for gastrointestinal disorders (Table 1); being also employee as contraceptives, equimóticos healing by healers of Peru and abortive by the population of Haiti (Project ..., 2015; Weninger et al., 1982) and in indigenous communities of Guyana (Lorenzi and Matos, 2002) and Brazil (Ribeiro, 2008). Kainer and Duryea (1992) refer to representation of *E. bulbous* in extractive activities of women reservation communities in the state of Acre, Northern Brazil.

Study developed by Nascimento et al. (2012) refers potential *E. plicata* as therapeutic option in primary health care in the Amazon region.

Employment in Asian cuisine (Zhengxiong et al., 1984), in the treatment of cellulite (Revilla, 2002b) and as an

Table 1. Indications of popular therapeutic use of *E. bulbous* (Mill.) Urb. and its botanical synonyms.

Nomenclature of plant species	Use indication	References
Eleutherine american (Aubl.) Merr. ex K.Heyne *	Stroke	Ieyama et al., 2011
	Anti-inflammatory	Saptowalyono, 2007
	Antiplatelet	Saptowalyono, 2007
	Anti-Tumor	Saptowalyono, 2007
	Increase the production of milk	Ieyama et al., 2011
	Breast cancer	Saptowalyono, 2007
	Nasal congestion	Saralamp et al., 1996
	Sexual disorders	Ieyama et al., 2011
	Diuretic	Afanas'ev et al., 1999; Johnson, 1999
	Heart disease	Afanas'ev et al., 1999; Saptowalyono, 2007
	Cold diseases **	Saralamp et al., 1996
	Hypertension	Ieyama et al., 2011
	Laxative	Afanas'ev et al., 1999
	Hypoglycemic	Ieyama et al., 2011
	Intestinal disorders	Duke and Vasquez, 1994; Revilla, 2001
	Amebiasis	Duke and Vasquez, 1994; Project..., 2015
	Amenorrhea and menopause	Duke and Vasquez, 1994
	Anti carcinogenic	Brasileiro et al., 2006
	Antiparasitic	Schultes and Raffauf 1990; Revilla, 2001; Lorenzi & Matos, 2002
	Healing	Revilla, 2001; Lorenzi & Matos, 2002
	Colic;	Hodge and Taylor 1956; Revilla, 2001
	Conjunctivitis	Revilla, 2001
	Contraceptive	Weniger et al. 1982; Lorenzi and Matos, 2002
	Contractions In muscle fibers	Duke and Vasquez, 1994; Delgado et al. 1997
	Diarrhea	Schultes and Raffauf 1990; Duke and Vasquez, 1994; Delgado and Sifuentes, 1995; Revilla, 2001, Project..., 2015, Lorenzi and Matos, 2002
	Dysentery	Revilla, 2001, Project..., 2015
	Stomachache	Duke and Vasquez, 1994
	Epilepsy	Duke and Vasquez, 1994
	Spasm	Delgado and Sifuentes, 1995; Revilla, 2001
	Gastralgia	Schultes and Raffauf 1990; Lorenzi & Matos, 2002
	Bleeding	Revilla, 2001; Revilla, 2002[a]
	Irregular periods	Hodge and Taylor 1956
	Purgative	Brasileiro et al., 2006
	Treating cough	Revilla, 2001; Revilla, 2002a
	Treatment Of Cellulite	Revilla, 2002b

Table 1. Cont'd

	Treatment Of Strokes And Displacements	Revilla, 2001
	Gastric Ulcer	Revilla, 2001
Eleutherine plicata (Sw.) Herb.*	Amebiasis	Oliveira Neto et al., 2007; Baraúna and Rocha, 2006
	Antiparasitic	Sousa et al., 2005
	Dysentery	Oliveira Neto et al., 2007
	Intestinal Disorders	Sousa et al., 2005
	Diarrhea	Oliveira Neto et al., 2007; Baraúna and Rocha, 2006
	Hemorrhoids	Oliveira Neto et al., 2007
	Irregular Menstruation	Sousa et al., 2005

*Nomenclature adopted by the authors representing botanical synonyms of the species *E.bulbosa* (Mill.) Urb., official name currently defined in the databases and botanical institutes.** terminology used by the authors.

ornamental (Revilla, 2001) represent the only indications of non-medicinal popular use for the species of the genus Eleutherine.

Chemical constituents

In chemical studies of *E. bulbous* predominates analysis with bulbs, indicating the presence of secondary metabolites, proving the presence of naphthoquinones and anthraquinones, especially the eleuterina (Table 2). Chemical constituents of the aerial parts were studied by Paramapojna et al. (2008); and the underground parts were identified metabolites in study of Xijing et al. (2009).

Phytochemical screening revealed the presence of alkaloids, steroids free, hydroxybenzoic, quinones, anthraquinones, fixed coumarins, flavonoids and chalcones auronas in *E. bulbous* (Delgado et al., 1997). Studies held with *E. american* bulbs indicated the presence of anthraquinones (Komura et al., 1983).

Phytochemical screening with hydroalcoholic extracts of *E. plicata* indicated the presence of alkaloids, catechins, flavanones and coumarins in leaves and stem; Fixed acids, flavanonois, steroids and condensed tannins in the leaves and triterpenoid (Sousa et al., 2005). The presence of alkaloids was confirmed by Baraúna and Rocha (2006). Phenolic compounds, coumarin derivatives, and Depsides depsidonas, reducing sugars and organic acids were cited by Baraúna and Rocha (2006).

Pharmacological studies

Naphthoquinones (eleuterinona) isolated of dichloromethane extract *E. bulbous* bulbs demonstrated strong activity against the fungus Cladosporium sphaerospermum (Xu et al, 2006).

Antimicrobial properties and coronary dilating action, potentially useful in treating heart disease have been attributed to species rhizomes extract (Lorenzi and Matos, 2002). Zhengxiong et al. (1984) indicate that eleuterol and eleuterina isoeleuterina isolated of rhizomes extracts of the specie have antifungal activity and enhances the flow of the bloodstream, including coronary artery.

Eleuterina, isoeleuterina, elecanacina and isolated isoeleuterol bulbs of bulbous Eleutherine showed inhibitory activity against HIV replication (Hara et al., 1997).

Voravuthikunchai et al. (2007) showed anti-bacterial activity of *E. bulbous* on Streptococcus pyogenes. Ifesan and Voravuthikunchai (2009) demonstrate that the extract ethanolic species bulbs can be used as an additive in the pork meat; indicating mild anti-bacterial effect and significant antioxidant activity.

In vitro assays performed with Eleutherine leaf extracts bulbous giardicidal showing activity against Giardia lamblia (Amaral, 2007) and amebicide against Entamoeba histolytica / Entamoeba dispar (Nascimento et al., 2012) represent the only biological studies to validate the ethno-pharmacological use.

Oliveira Neto et al. (2007) in biomonitored study indicate a steroidal sapogenin with peripheral analgesic properties and anti-dematogênica, as active ingredient in *E. plicata* bulbs extract.

E. plicata crude lyophilized extract has shown anti-edema and peripheral analgesic activity, but not central (Baraúna and Rock, 2006); and

Table 2. Chemical constituents isolated from *Eleutherine bulbous* (Mill.) Urb. And its botanical synonyms.

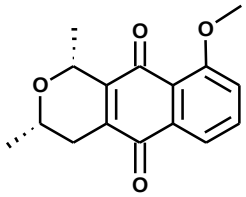
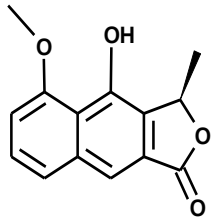
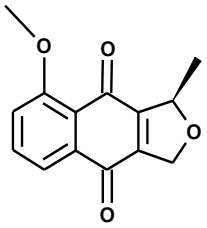
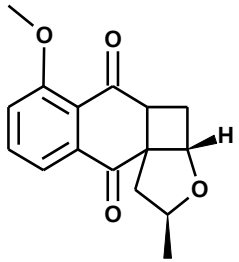
Nomenclature of plant species	Chemical compound	Chemical nomenclature**	Structure **	Reference(s)
Eleutherine american (Aubl.) Merr. ex K.Heyne *	Eleuterina	1*H*-Naphtho[2,3-*c*]pyran-5,10-dione,3,4 dihydro-9-methoxy-1,3-dimethyl-,(1*R*,3*S*)- 1H-Naphtho[2,3-c]pyran-5,10-dione, 3,4-dihydro-9-methoxy-1,3-dimethyl-, (1R-cis)-; 1HNaphtho[2,3-c]pyran-5,10-dione,3,4-dihydro-9-methoxy-1β,3β-dimethyl- (8CI)	 1	Hara et al., 1997; Paramapojna et al., 2008; Xijing et al., 2009; Phoem & Voravuthikunchai, 2012
	Eleuterol	Naphtho[2,3-*c*]furan-1(3*H*)-one, 4-hydroxy-5-methoxy-3-methyl-, (3*R*)- Naphtho[2,3-c]furan-1(3H)-one,4-hydroxy-5-methoxy-3-methyl- (8CI); Naphtho[2,3-c]furan-1(3H)-one, 4-hydroxy-5-methoxy-3-methyl-, (R)-	 2	Weniger et al., 1982; Hara et al., 1997; Jinzhong et al., 2006; Paramapojna et al., 2008; Cavalcante et al., 2009
Eleutherine american (Aubl.) Merr. ex K.Heyne *	Eleuterinona	Naphtho[2,3-*c*]furan-4,9-dione, 1,3-dihydro-8-methoxy-1-methyl-, (1*S*)- (+)-	 3	Xijing et al., 2009
	Elecanacina	10*H*Naphtho[2',3':2,3]cyclobuta[1,2-*b*]furan-5,10(3a*H*)-dione, 1,2,4,4a-tetrahydro-6-methoxy-2-methyl-, (2*S*,3a*S*,4a*S*,10a*S*)-(+)	 4	Hara et al., 1997

Table 2. Cont'd.

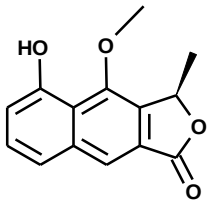
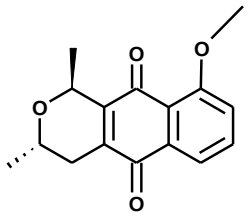
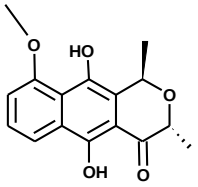
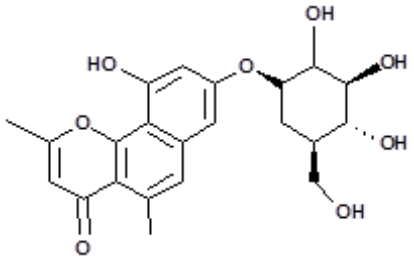
	Isoeleuterol	Naphtho[2,3-*c*]furan-1(3*H*)-one, 5-hydroxy-4-methoxy-3-methyl-, (3*R*)-Naphtho[2,3-c]furan-1(3H)-one,5-hydroxy-4-methoxy-3-methyl-, (R)-	 5	Hara et al., 1997 ; Jinzhong et al., 2006; Xijing et al., 2009
Eleutherine american (Aubl.) Merr. ex K.Heyne *	Isoeleuterina	1*H*-Naphtho[2,3-*c*]pyran-5,10-dione, 3,4-dihydro-9-methoxy-1,3-dimethyl-, (1*R*,3*R*)-1H-Naphtho[2,3-c]pyran-5,10-dione, 3,4-dihydro-9-methoxy-1,3-dimethyl-, (1R-trans)-; 1H-Naphtho[2,3-c]pyran-5,10-dione,3,4-dihydro-9-methoxy-1β,3α-dimethyl- (8CI)	 6	Hara et al., 1997 ; Paramapojna et al 2008 ; Xijing et al., 2009 ; Nascimento et al., 2012 ; Phoem & Voravuthikunchai, 2012
	Hongconina	1*H*-Naphtho[2,3-*c*]pyran-4(3*H*)-one, 5,10-dihydroxy-9-methoxy-1,3-dimethyl-,(1*R*,3*R*)-1H-Naphtho[2,3-c]pyran-4(3H)-one, 5,10-dihydroxy-9-methoxy-1,3-dimethyl-,(1R-trans)-	 7	Zhengxiong et al., 1981; Xijing et al 2009
Eleutherine american (Aubl.) Merr. ex K.Heyne *	Isoeleuterol	Naphtho[2,3-*c*]furan-1(3*H*)-one, 5-hydroxy-4-methoxy-3-methyl-, (3*R*)-Naphtho[2,3-c]furan-1(3H)-one,5-hydroxy-4-methoxy-3-methyl-, (R)-	5	Hara et al., 1997 ; Jinzhong et al., 2006; Xijing et al., 2009
	Eleutherinoside A	4H-Naphtho[1,2-b]pyran-4-one, 8-(β-D-glucopyranosyloxy)-10-hydroxy-2,5-dimethyl-	 8	Ganzera et al., 2009

Table 2. Cont'd.

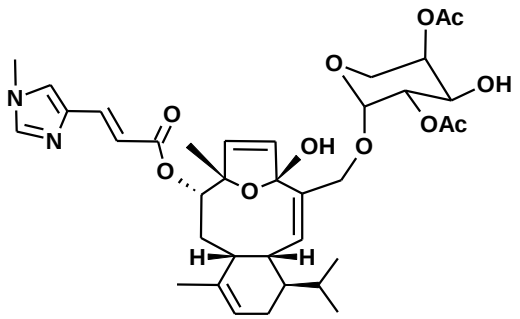
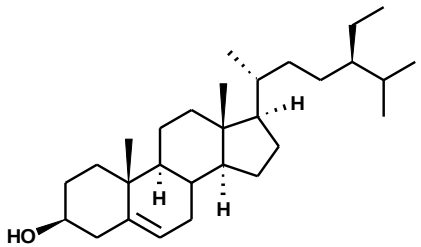
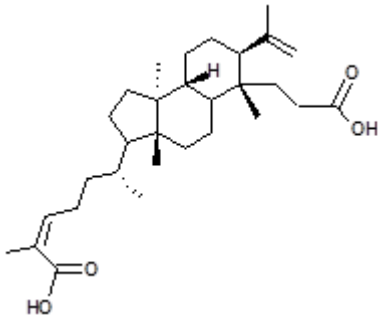
	Eleuthoside B	Naphtho[2,3-*c*]furan-1(3*H*)-one, 4-[(6-*O*-β-D-glucopyranosyl-β-D-glucopyranosyl)oxy]-5-methoxy-3-methyl-, (3*R*)-	 9	Ganzera et al., 2009
Eleutherine american (Aubl.) Merr. ex K.Heyne *	Beta-Sitosterol	Nimbosterol (6CI); Stigmast-5-en-3β-ol (8CI); (-)-β-Sitosterol;(24R)-Ethylcholest-5-en-3β-ol; (24R)-Stigmast-5-en-3β-ol; 22,23-Dihydrostigmasterol; 24α-Ethylcholestero	 10	Xijing et al., 2009
	Ni	8-hydroxy-3, 4-Dimethoxy-1-methyl-anthra-9, l0-quinone-2-carboxylic acid methyl ester	NI	Xijing et al., 2009
	Ni	4,8-Dihydroxy-3-Methoxy-1-methyl-anthra-9,10-quinone-2-carboxylic acid methyl ester	NI	Xijing et al., 2009
	Kadsuric Acid	1H-Benz[e]indene-6-propanoic acid, 3-[(1R,4Z)-5-carboxy-1-methyl-4-hexenyl]-2,3,3a,4,6,7,8,9,9a,9b-decahydro-3a,6,9b-trimethyl-7-(1-methylethenyl)-,(3R,3aR, 6S,7S, 9aR,9bS)-(9CI);3,4-Secolanosta-4(28),9(11),24-triene-3,26-dioic acid, (24Z)-;1H-Benz[e]indene-6-propanoic acid, 3-(5-carboxy-1-methyl-4-hexenyl)-2,3,3a,4,6,7, 8,9,9a,9b-decahydro-3a,6,9b-trimethyl-7-(1methyle thenyl)-,[3R-[3α(1R*,4Z), 3aα,6β,7α,9aα,9bβ]]-	 11	Xijing et al., 2009

Table 2. Cont'd.

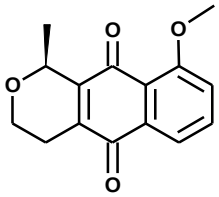
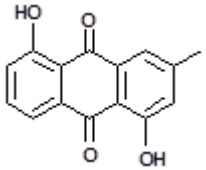
Eleutherine american (Aubl.) Merr. ex K.Heyne *	Ni	(_)-3-[2-(acetyloxy)propyl]-2-hydroxy-8-methoxy-1,4-naphthoquinone	NI	Malheiros, 2008
	Ni	2,5-Dimethyl-10-hydroxynaphtho pyrone 8-*O*-_-d-glucopyranoside	NI	Paramapojna et al., 2008
	Ni	3-methoxy-1-methylan-thraquinone-2-carboxylic acid methyl ester	NI	Phoem and Voravuthikunchai, 2012
	Ni	methyl ethers of 3,4,8-trihydroxy-1-methyl-anthra-9,10-quinone-2-carboxylic acid methyl ester 4-6	NI	Komura et al., 1983
Eleutherine bulbous (Mill.) Urb.	Ni	anthracene-9,10-dione-1,5-diol-4-methoxy-3-methyl-2-carboxylic acid methyl ester	NI	Weniger et al.,1982
	Eleutheriona	Naphtho[2,3-*c*]furan-4,9-dione, 1,3-dihydro-8-methoxy-1-methyl-, (1*S*)-(+)	 12	Xijing et al., 2009
Eleutherine bulbous (Mill.) Urb.	Eleuterina	1*H*-Naphtho[2,3-*c*]pyran-5,10-dione, 3,4-dihydro-9-methoxy-1,3-dimethyl-, (1*R*,3*S*)-1H-Naphtho[2,3-c]pyran-5,10-dione, 3,4-dihydro-9-methoxy-1,3-dimethyl-, (1R-cis)-; 1H-Naphtho[2,3-c]pyran-5,10-dione,3,4-dihydro-9-methoxy-1β,3β-dimethyl- (8CI)	1	Hara et al., 1997; Paramapojna et al., 2008; Xijing et al., 2009; Phoem & Voravuthikunchai, 2012
	Isoeleuterina	1*H*-Naphtho[2,3-*c*]pyran-5,10-dione, 3,4-dihydro-9-methoxy-1,3-dimethyl-, (1*R*,3*R*)-1H-Naphtho[2,3-c]pyran-5,10-dione, 3,4-dihydro-9-methoxy-1,3-dimethyl-, (1R trans)-; 1H-Naphtho[2,3-c]pyran-5,10-dione,3,4-dihydro-9-methoxy-1β,3α-dimethyl- (8CI)	6	Hara et al., 1997 ; Paramapojna et al 2008 ; Xijing et al., 2009 ; Nascimento et al., 2012 ; Phoem & Voravuthikunchai, 2012
	Eleuterol	Naphtho[2,3-*c*]furan-1(3*H*)-one, 4-hydroxy-5-methoxy-3-methyl-, (3*R*)-Naphtho[2,3-c]furan-1(3H)-one,4-hydroxy-5-methoxy-3-methyl- (8CI); Naphtho[2,3-c]furan-1(3H)-one, 4-hydroxy-5-methoxy-3-methyl-, (R)-	2	Weniger et al., 1982; Hara et al., 1997; Jinzhong et al., 2006; Paramapojna et al., 2008; Cavalcante et al., 2009

Table 2. Cont'd.

Eleutherine bulbous (Mill.) Urb.	Isoeleuterol	Naphtho[2,3-*c*]furan-1(3*H*)-one, 5-hydroxy-4-methoxy-3-methyl-, (3*R*)-Naphtho[2,3-c]furan-1(3H)-one,5-hydroxy-4-methoxy-3-methyl-, (R)-	5	Hara et al., 1997 ; Jinzhong et al., 2006; Xijing et al., 2009
	Elecanacina	10*H*Naphtho[2',3':2,3]cyclobuta[1,2-*b*]furan-5,10(3a*H*)-dione, 1,2,4,4a-tetrahydro-6-methoxy-2-methyl-, (2*S*,3a*S*,4a*S*,10a*S*)-(+)	4	Hara et al., 1997; Nielsen e Wege 2006
	Hongconina	1*H*-Naphtho[2,3-*c*]pyran-4(3*H*)-one, 5,10-dihydroxy-9-methoxy-1,3-dimethyl-, (1*R*,3*R*)-1H-Naphtho[2,3-c]pyran-4(3H)-one, 5,10-dihydroxy-9-methoxy-1,3-dimethyl- (1R-trans)-	7	Zhengxiong et al., 1981; Chen, et al., 1986; Xijing et al 2009
	Crisofanol	9,10-Anthracenedione,1,8-dihydroxy-3-methyl-Anthraquinone, 1,8-dihydroxy-3-methyl- (8CI); 1,8-Dihydroxy-3-methyl-9,10-anthracenedione; 1,8-Dihydroxy-3-methyl-9,10-anthraquinone; 1,8-Dihydroxy-3 methylanthraquinone; 2-Methyl-4,5dihydroxyanthraquinone; 3-Methyl-1,8-dihydroxyanthraquinone; 3-Methylchrysazin; 4,5-Dihydroxy-2-methylanthraquinon	 13	Weniger et al., 1982; Lorenzi & Matos, 2002
Eleutherine plicata (Sw.) Herb. * *Eleutherine plicata* Herb. ex Klatt *	Eleuterol	Naphtho[2,3-*c*]furan-1(3*H*)-one, 4-hydroxy-5-methoxy-3-methyl-, (3*R*)-Naphtho[2,3-c]furan-1(3H)-one,4-hydroxy-5-methoxy-3-methyl- (8CI); Naphtho[2,3-c]furan-1(3H)-one, 4-hydroxy-5-methoxy-3-methyl-, (R)-	2	Weniger et al., 1982; Hara et al., 1997 ; Jinzhong et al., 2006; Paramapojna et al., 2008; Cavalcante et al., 2009
	Isoeleuterina	1*H*-Naphtho[2,3-*c*]pyran-5,10-dione, 3,4-dihydro-9-methoxy-1,3-dimethyl-,(1*R*,3*R*)-1H- Naphtho[2,3-c]pyran-5,10-dione, 3,4-dihydro-9-methoxy-1,3-dimethyl-,(1Rtrans)- ; 1H-Naphtho[2,3-c]pyran-5,10-dione,3,4-dihydro-9-methoxy-1β,3α-dimethyl- (8CI)	6	Hara et al., 1997 ; Paramapojna et al 2008 ; Xijing et al., 2009 ; Nascimento et al., 2012 ; Phoem & Voravuthikunchai, 2012

*Nomenclature adopted by the authors representing botanical synonyms of the species *E. bulbous* (Mill.) Urb, official name currently defined in the databases and botanical institutes; ** Chemical nomenclature and structure of the Chemical Abstract; NI: no information.

moderate anti-fungal activity (Menezes et al., 2009). Study of hydroalcoholic extract of your bulbs has shown anticholinesterase action (Cavalcante et al., 2009).

Crude extract *E. american* bulbs inhibit protease and lipase enzymes and may be used in the food industry as an additive, aiming to combat the growth of *Staphylococcus aureus* (Ifesan and Voravuthikunchai, 2009).

Study Mahabusarakam et al. (2010) with *E. american* bulbs has shown antibacterial activity against *S. aureus* (ATCC25923 and ATCC27664). Study of ethanol extract of kind of bulbs has shown antibacterial activity against *Campylobacter spp* (Sirirak and Voravuthikunchai, 2011).

In a study of bioprospecting, Brazilian et al. (2006) showed that the ethanol extracts of the aerial parts of *E. bulbous* have toxicity to larvae of Artemia salina (LD50 <1000 ppm) without evidence of antimicrobial activity assay with *Escherichia coli,* but showing activity against *S. aureus*, which is the only evaluation job of toxicity developed with the species under study.

Patents

In databases it was found patent deposit, predominating registration based in the *E. plicata* terminology, where the evaluated patent corresponds to the process for obtaining of an extract and a vegetable fraction, pharmaceutical compositions and their use for the treatment of malaria (WO 2013166576 A1); use of *E. plicata* to decreased levels of blood cholesterol triglicerideose (CN103127319-A); use of *E. bulbous* for the treatment of neuro-degenerative disease, heart disease and diabetes (VN31660-A); use of *E. plicata* for cure of diseases rheumatoid arthritis, arthralgia and myalgia (CN1813986-A), use of leaves of *E. bulbous* (Mill.) Urb. giardicidal for therapeutic use as (BR 1020150161930).

Conclusion

E. bulbous (Mill.) Urb., which is native and of high occurrence in various regions of the Americas, is a vegetable specie with potential for investments in research and development of herbal products, given the broad therapeutic use in popular practice. The analysis of botanical institutions databases have demonstrated a high number of scientific synonyms for this species and, further, various publications employing scientific names *E. plicata* and us Eleutherine, which do not represent the official name for the species currently accepted. In this review we noted that the ethnopharmacological studies indicate broad popular job *E. bulbous* in the gastro-intestinal disorders, but there are few validation studies of popular use; noting the need for more study of plant anatomy, for the determination of authenticity parameters. Thus, research in these areas, as well as evaluation of toxicity, should be encouraged aiming at setting security parameters.

Conflict of Interests

The authors have not declared any conflict of interests.

ACKNOWLEDGMENTS

The authors thank the National Council for Scientific and Technological Development (CNPq) for financial support and scholarships and the Maranhão Foundation for the Protection of Research and Scientific and Technological Development (FAPEMA) for financial support.

REFERENCES

Afanas'ev SA, Lasukova TV, Cherniavskii AM, Vecherskii I, Ponomarenko IV (1999). The effect of histochrome on the lipid peroxidation indices during the surgical treatment of patients with ischemic heart disease of different functional classes. Eksp. Klin. Farmakol. 62(6):32-34.

Albuquerque UP, Hanazaki N (2006). As pesquisas etnodirigidas na descoberta de novos fármacos de interesse médico e farmacêutico: fragilidades e pespectivas. Rev. Bras. Farmacogn. 16:678-689.

Amaral FMM, Ribeiro MNS, Barbosa-Filho JM, Reis AS, Nascimento FRF, Macêdo RO (2006) Plants and chemical constituents with giardicidal activity. Rev. Bras. Farmacogn. 16:696-720.

Amaral FMM (2007). Potencial giardicida de espécies vegetais: aspectos da etnofarmacologia e bioprospecção. João Pessoa. Tese de Doutorado, Pós-Graduação em Produtos Naturais e Sintéticos Bioativos, Universidade Federal da Paraíba. 346 p.

Baraúna RA, Rocha JCS (2006). Avaliação fitoquímica e farmacológica do extrato aquoso de Eleutherine plicata. XVII Seminário de Iniciação Científica – *UFPA*. Belém, Brasil.

Barbosa-Filho JM, Medeiros KCP, Diniz MFFM, Batista LM, Athayde-Filho PF, Silva SM, Cunha EVL, Almeida JRGS, Quintas-Júnior LJ (2006). Natural products inhibitors of the enzyme acetylcholinesterase. Rev. Bras. Farmacogn. 16:258-285.

Brasil (2009). Ministério da Saúde. Plantas de interesse ao SUS. Portal da saúde, Brasília, DF, 2009. Disponível em: http://portalsaude.saude.gov.br/index.php/cidadao/principal/agencia-saude/noticias-anteriores-agencia-saude/3487

Brasileiro BG, Pizziolo VR, Raslan DS, Jamal CM, Silveira D (2006). Antimicrobial and cytotoxic activities screening of some Brazilian medicinal plants used in Governador Valadares district. Braz. J. Pharm. Sci. 42(2):195-202.

Camargo MTLA (2003). Etnofarmacobotânica: conceituação e metodologia de pesquisa. São Paulo: Humanitas/FFLCH/USP: Terceira Margem.

Cavalcante PO, Cunha NR, Moreira LEL, Paula AC, Costa SMO, Cavalcanti ESB, Morais SM, Alencar JES (2009). Atividade Anticolinesterásica de Eleuterol isolado de *Eleutherine plicata* Herb. *32º Reunião Anual da Sociedade Brasileira de Quimica*. Fortaleza, Brasil.

Chen Z, Huang H, Wang C, Li Y, Ding J, Ushio S (1986). Honconin, a new naphthalene derivative fromHong-Cong, the rhizome of *Eleutherine Americana* Merr. Heyne (Iridaceae). Chem. Pharm. Bull. 34:2743-2746.

Delgado HS, Sifuentes TC (1995). *Plantas medicinales del Jardin Botânico IMETIPSS.* Iquitos: Instituto Peruano de Seguridad Social/Instituto de Medicina Tradicional. 85 p. http://bases.bireme.br/cgibin/wxislind.exe/iah/online/?IsisScript=iah/iah.xis&src=google&base=LILACS&lang=p&nextAction=lnk&exprSearch=253837&indexSearch=ID.

Delgado HS, Herrera JEH, Sifuentes TC, Ruíz JG, Dávila MM, Isern FR

(1997). Plantas medicinales de la Amazonia peruana utilizadas por curanderos y chamanes com fines anticonceptivos. Iquitos: Instituto Peruano de Seguridad Social/Instituto de Medicina Tradicional. http://www.sidalc.net/cgibin/wxis.exe/?IsisScript=INPERUPE.xis&method=post&formato=2&cantidad=1&expresion=mfn=010791

Duke JA, Vasquez R (1994). Amazonian ethnobotanical dictionary. London: Boca Raton/Ann Arbor/ CRC. https://books.google.com.ng/books?hl=en&lr=&id=6g59ppE8ixEC&oi=fnd&pg=PA1&dq=Amazonian+ethnobotanical+dictionary&ots=6Q5fa4cl9_&sig=ALCUyLO_7fvw9SkFwUAV2z89osY&redir_esc=y#v=onepage&q=Amazonian%20ethnobotanical%20dictionary&f=false.

Ganzera M, Nischang I, Siegl C, Senzenberger B, Svec F, Stuppner H (2009). Application of MEKC and monolithic CEC for the analysis of bioactive naphthoquinones in *Eleutherine americana*. Electrophoresis 30(21):3757-63.

Goldblatt P, Le Thomas A (1992). Pollen apertures, exine sculpturing and phylogeny in Iridaceae subfamily Iridaceae. Rev. Palaeobot. Palynol. 75(3):301-315.

Hara H, Maruyama N, Yamashita S, Hayashi Y, Lee KH, Bastow KF, Chairul, Marumoto R, Imakura Y (1997). Elecanacin, a novel new naphthoquinon from the bulb of *Eleutherine americana*. Chem. Pharm. Bull. 45:1714-1716.

Hodge WH, Taylor D (1956). The ethnobotany of the island Caribs of Dominica. Webbia 12(2):513-644.

Ieyama T, Gunawan-Puteri MDPT, Kawabata J (2011). a-Glucosidase inhibitors from the bulb of *Eleutherine Americana.* Food Chem. 128(2):308-11.

Ifesan BOT, Voravuthikunchai SP (2009). Effect of *Eleutherine americana* Merr. extract on enzymatic activity and enterotoxin production of *Staphylococcus aureus* in broth and cooked pork. Foodborne Pathog. Dis. 6(6):699-704.

Xu J, Qiu F, Duan W, Qu G, Wang N, Yao X (2006). New bioactive constituents from Eleutherine americana. Front. Chem. China 1(3):320-323.

Kainer AK, Duryea ML (1992). Tapping Women"s Knowledge: plant resource use in extractive reserves, Acre, Brazil. Econ. Bot. 46(4):408-425.

Royal Botanic Gardens (2015). Royal Botanic Gardens, Kew: calendar of events 2015. http://www.kew.org/about/press-media/pressreleases/royal-botanic-gardens-kew-calendar-events-2015

Kuntorini EM, Nugroho LH (2010). Structural development and bioactive content of red bulb plant (*Eleutherine americana*); a traditional medicines for local Kalimantan people. Biodiversitas 11(2):102-106.

Lorenzi H, Matos FJA (2002). Plantas medicinais no Brasil: nativas e exóticas. Nova Odessa: Plantarum.

Lorenzi H, Matos FJA (2008). Plantas Medicinais no Brasil: nativas e exóticas. 2. ed. São Paulo: Instituto Plantarum de Estudos da Flora.

Mahabusarakam W, Hemtasin C, Chakthong S, Voravuthikunchai SP, Olawumi IB (2010). Naphthoquinones, Anthraquinones and Naphthalene Derivatives from the Bulbs of *Eleutherine Americana.* Planta Med. 76:345-349.

Malheiros LCS (2008). *Isoeleuterol e Isoeleuterina: Potenciais marcadores químicos da tintura de Eleutherine plicata Herb (Iridaceae) e atividades microbiológica e antioxidante*. Belém. Dissertação de mestrado, Faculdade de Ciências Farmacêuticas, Universidade Federal do Pará.

Menezes TOA, Alves ACBA, Vieira JMS, Menezes SAF, Alves BP, Mendonça LCV (2009). Avaliação *in vitro* da atividade antifúngica de óleos essenciais e extratos de plantas da região amazônica sobre cepa de *Candida albicans.* Rev. Odontol UNESP 38(3):184-191.

Mishra BB, Tiwari VK (2011). Natural products: An evolving role in future drug discovery. Eur. J. Med. Chem. 46(10):4769-807.

Nascimento MS, Vieira JMS, Malheiros LCS, Júnior JOCS, Rodrigues LCS, Barbosa WLR (2012). Characterisation of isoeleutherine in aqueous extract of *Eleutherine plicata* Herb., iridaceae, active against *entamoeba hystolitica/ entamoeba dispar in-vitro.* Int. J. Pharm. Sci. Res. 3(4):1096-1100.

Oliveira Neto AR, Pinto MA, Silva IR, Moraes SC, Gomes ML (2007). O uso de *Eleutherine plicata* no tratamento de doenças gastrointestinais na Amazônia paraense. *VIII Congresso de Ecologia do Brasil*. Caxambu, Brasil. http://seb-ecologia.org.br/viiiceb/pdf/633.pdf

Paramapojna S, Ganzerab M, Gritsanapana W, Stuppnerb H (2008) Analysis of naphthoquinone derivatives in the Asian medicinal plant *Eleutherine americana* by RP-HPLC and LC–MS. J. Pharm. Biomed 47:990-993.

Plant list (2015). A working list of all plants species. http://www.theplantlist.org/tpl1.1/search?q=eleutherineacbril

Phoem AN, Voravuthikunchai SP (2012). Growth stimulation/inhibition effect of medicinal plants on human intestinal microbiota. Food Sci. Biotechnol. 21(3):739-745.

Project (2015). ITTO Organização Internacional de Madeiras Tropicais Universidade de Brasília - UnB Instituto de Química. Laboratório de Tecnologia Química – LATEQ. Fundação de Estudos e Pesquisas em Administração e. Desenvolvimento – FEPAD, uma fundação de apoio da UnB. Projeto ITTO PD 31/99 Rev.3 (I) "Produção não-madeireira e desenvolvimento Sustentável na Amazônia". http://www.itto.int/files/itto_project_db_input/2202/Technical/2.1%20Flora%20Amaz%C3%B4nica%20%20433%20esp%C3%A9cies%20para%20o%20extrativismo%20n%C3%A3o-madeireiro.pdf

Revilla J (2001). Plantas da Amazônia: oportunidades econômicas e sustentáveis. Manaus: SEBRAE-AM/INPA.

Revilla J (2002a). Plantas úteis da Bacia Amazônica. Manaus: INPA/SEBRAE. V.1.

Revilla J (2002b). Apontamentos para a cosmética amazônica. Manaus: SEBRAEAM/ INPA.

Ribeiro CM (2008). *Avaliação da atividade antimicrobiana de plantas utilizadas na medicina popular da Amazônia.* Belém, 70 p. Dissertação de Mestrado, Pós-Graduação em Ciências Farmacêuticas, Universidade Federal do Pará.

Saptowalyono CA (2007). Bawang dayak, tanaman obat kanker yang belum tergarap. www.kompas.com.

Saralamp P, Chuakul W, Temsiririrkkul R, Clayton T (1996). Medicinal plants in Thailand (Vol. 1). bangkok: Faculty of Pharmacy, Mahidol University. 218 p.

Schultes RE, Raffauf RF (1990). The healing forest. Medicinal and toxic plants of the northwest amazonia. Dioscorides Press. pp. 218-219.

Sririrak T, Voravuthikunchai SP (2011). *Eleutherine americana*: A candidate for the control of *Campylobacter* species. Poult. Sci. 90:791-796.

Sousa SM, Farias JC, Costa GC, Carvalho Junior OS, Silva LA, Goncalves JRS, Prado MAS (2005). Análise fitoquímica de folhas e caule de Eleutherine plicata Herb. *XX Reunião Anual da Federação de Sociedades de Biologia Experimental-FeSBE*. Águas de Lindóias, Brasil.

Toledo ACO, Hirata LL, Buffon MCM, Miguel MD, Miguel OG (2003). Fitoterápicos: uma abordagem farmacotécnica. LectaUSF 21:7-13.

Tropicos (2015). Missouri Botanical Garden. 50151134. http://www.tropicos.org/Name/

Voravuthikunchai SP, Lmsuwan S, Chusri S (2007). New perspectives on herbal medicines for bacterial infections. Nat. Prod. II 18:41-101.

Xijing L, Nai-Li W, Li Rong-Xian L (2009). Effect of Eleutherine Americana Extracts on Rats' Vascular Ring of Aorta ex Vivo. China Pharm. 18:1376-1378.

Zhengxiong C, Huizhu H, Chengruui W, Yuhui L, Jianmi D, Sankawa U, Noguchi H, Iitaka Y (1984). Hongconin, a new naphthalene derivative from the rhizome of *Eleutherine americana* (Hong-Cong). Heterocycles 22:691-694.

Journal of Medicinal Plant Research

Related Journals Published by Academic Journals

- *African Journal of Pharmacy and Pharmacology*
- *Journal of Dentistry and Oral Hygiene*
- *International Journal of Nursing and Midwifery*
- *Journal of Parasitology and Vector Biology*
- *Journal of Pharmacognosy and Phytotherapy*
- *Journal of Toxicology and Environmental Health Sciences*

academicJournals