



**HAL**  
open science

## Traditional uses, antimicrobial and acaricidal activities of 20 plants selected among Reunion Island's flora

Emmanuelle Dorla, Isabelle Grondin, T. Hüe, Patricia Clerc, Séverine Dumas,  
Anne Gauvin-Bialecki, Philippe Laurent

### ► To cite this version:

Emmanuelle Dorla, Isabelle Grondin, T. Hüe, Patricia Clerc, Séverine Dumas, et al.. Traditional uses, antimicrobial and acaricidal activities of 20 plants selected among Reunion Island's flora. South African Journal of Botany, 2018, 10.1016/j.sajb.2018.04.014 . hal-01865702

**HAL Id: hal-01865702**

**<https://hal.univ-reunion.fr/hal-01865702>**

Submitted on 25 Oct 2021

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial 4.0 International License

## **Traditional uses, antimicrobial and acaricidal activities of 20 plants selected among Reunion Island's flora**

---

Emmanuelle Dorla <sup>a)</sup>, Isabelle Grondin <sup>a)</sup>, Thomas Hue <sup>b)</sup>, Patricia Clerc <sup>a)</sup>, Séverine Dumas <sup>a)</sup>, Anne Gauvin-Bialecki <sup>a)</sup>, Philippe Laurent <sup>a)\*</sup>

<sup>a</sup> Laboratoire de Chimie des Substances Naturelles et des Sciences des Aliments (LCSNSA), Université de La Réunion, avenue René Cassin–CS 92003–97744 Saint-Denis Cedex 9, France.

<sup>b</sup> Laboratoire de Parasitologie, Institut Agronomique néo-Calédonien, BP 73, 98890 Païta, New Caledonia

\* Corresponding author: [philippe.laurent@univ-reunion.fr](mailto:philippe.laurent@univ-reunion.fr)  
Tel: +262 96 28 50

1 **Abstract:**

2 The aim of this study was to screen the antimicrobial and acaricidal activity of 20 endemic or  
3 indigenous plants from Reunion Island (Indian Ocean). Plants were chosen on the basis of  
4 their traditional uses and their biocidal activities found in the literature. A survey was  
5 conducted in the local population to assess and supplement knowledge about the selected  
6 plants. The collected information confirmed and/or supplemented the data obtained for nine  
7 plants. Seven plants were described for the first time for their traditional uses in medicine and  
8 ethnoveterinary practices. To evaluate their biocidal activities, leaves or bark were treated  
9 with ethyl acetate using an accelerated solvent extraction method. Six bacteria and five fungi,  
10 frequently implicated in infectious diseases, were used to assess the antimicrobial activity of  
11 these extracts. A preliminary screening using the paper disk diffusion assay showed an  
12 effective antibacterial activity of 16 extracts. The minimum inhibitory concentration (MIC) of  
13 active plant extracts was then determined using a microdilution method. The leaf extract from  
14 *Peperomia borbonensis* displayed the widest spectrum of antibacterial activity and was the  
15 only one to act as a fungicide. In parallel, acaricidal bioassays were performed on the larvae  
16 of the tick *Rhipicephalus microplus* (Ixodidae), and plant extracts from *Peperomia*  
17 *borbonensis* and *Zanthoxylum heterophyllum* were the most effective. The preliminary studies  
18 of these plant extracts exhibited biocidal activities that were not described in the literature and  
19 that are congruent with traditional uses for some of them. Investigations are currently being  
20 conducted to isolate the active compound(s) and evaluate their potential for future  
21 developments and applications.

22 **Keywords:** acaricidal, antimicrobial, La Réunion, plant extracts, traditional use, survey

23

24

## 25 **1. Introduction**

26 The resistance of microorganisms and arthropods to chemicals is becoming a major concern  
27 for agriculture and public health issues. According to several reports on antimicrobial  
28 resistance, edited by the World Health Organization, new resistance mechanisms have  
29 emerged in the last few years and have spread globally, threatening our ability to treat  
30 common infectious diseases. The non-availability and the high costs of a new generation of  
31 antibiotics have led to an increase in mortality and morbidity. In the European Union, strains  
32 of resistant bacteria are responsible for 25,000 deaths and an extra health care cost of €1.5  
33 billion each year (World Health Organization, 2015a, 2015b, 2014). Worldwide, drug-  
34 resistant infections cause 700,000 deaths every year, and a recent report has suggested that  
35 without policies to stop the spread of antimicrobial resistance, the number of deaths in 2050  
36 would rise to 10 million every year (O’Neil, 2016). Hence, there is an urgent need to react,  
37 and one option is to find effective novel molecules to circumvent this resistance phenomenon.  
38 In this context, several studies have highlighted the antimicrobial activities of plants from  
39 different regions of the world (Agyare et al., 2016; Aumeeruddy-Elalfi et al., 2015;  
40 Mgbeahuruike et al., 2017; Mickymaray et al., 2016).

41 Likewise, for several years, resistance to synthetic acaricides has been frequently reported in  
42 the literature (Abbas et al., 2014; Jongejan and Uilenberg, 2004). Among Acaria, the cattle  
43 tick *Rhipicephalus (Boophilus) microplus* is considered as the most important parasite of  
44 livestock in the world (Estrada-Peña et al., 2006). It was introduced to Reunion Island (also  
45 called La Réunion) by the importation of “Moka cattle” from Madagascar (Barré and  
46 Uilenberg, 2010). This tick causes enormous losses in cattle production, due to blood loss,  
47 stress and irritation, which affect the milk and hide. Moreover, this arthropod can transmit  
48 diseases to cattle, such as babesiosis caused by *Babesia bovis* and *Babesia bigemina* and  
49 anaplasmosis caused by *Anaplasma marginale* (Estrada-Peña et al., 2006). The main

50 treatment to control this arthropod is the use of chemical acaricides, such as organochlorines,  
51 carbamates and organophosphates, which have negative consequences in the environment and  
52 contribute to the development of resistant populations. There is therefore increasing interest  
53 by the scientific community to find new potential sources of compounds with biological  
54 activity against pests. Several recent studies have suggested the use of plants to fight cattle  
55 tick (Abbas et al., 2014; Adenubi et al., 2016; Borges et al., 2011; Hue et al., 2015).

56 Reunion Island has a great number of assets to find new molecules in the abundant plant  
57 biodiversity. Emerging from the Indian Ocean about three million years ago, La Reunion  
58 (55°3' E and 21°5'S) is a French volcanic island located about 665 km east of Madagascar in  
59 the Mascarene archipelago. The island has a rugged topography and has the highest peak in  
60 the Indian Ocean (Piton des Neiges; 3070 m), deep valleys and one of the most active  
61 volcanoes in the world (Piton de La Fournaise; 2631 m). Its tropical climate is tempered by  
62 the prevailing southeast trade winds and is occasionally unsettled by cyclones. The tropical  
63 location and the dramatic landform of the island, combined with the moist trade winds,  
64 determine strong asymmetry between the eastern windward coast subjected to daily rainfall  
65 (up to 4 to 7 m/year) and the much drier western leeward coast (0.5 to 2.5 m/year). A large  
66 variety of microclimates is observed, with radical changes in sun light, precipitation and  
67 temperature, allowing a large number of vegetal species to develop and evolve. Consequently,  
68 Reunion Island is listed among the world's top biodiversity hotspots with an endemic rate  
69 approximately of 40%. Isolated from the mainland and other islands, the biodiversity of La  
70 Reunion results from the colonization of species from Madagascar, Africa, Asia, and  
71 Australia by marine currents and birds. The evolution of indigenous species, far from their  
72 region of origin, led to the emergence of several endemic species. Almost 840 indigenous  
73 species constituted the vascular flora of La Reunion, with 236 plants species (28%) being  
74 strictly endemic to La Reunion and 153 species endemic (18%) to the archipelago of

75 Mascarene. Since the arrival of the Europeans in the 16<sup>th</sup> century, Reunion Island flora has  
76 experienced major perturbations, such as forest clearance and exotic plant introduction.  
77 Nevertheless, 25% of the original forest cover remains, and this allows unique plant  
78 communities to develop (Lavergne, 2001; Parc National de La Réunion, 2008; Strasberg et  
79 al., 2005; Thébaud et al., 2009). The human inhabitants are composed of people who  
80 originated from Europe (mainly France), Africa, Madagascar, India and China. The local  
81 traditional medicine was the result of the mixed knowledge of this cosmopolitan population  
82 (Pourchez, 2011). For instance *Ayapana triplinervis* (Vahl) R.M. King et H. Rob was  
83 introduced from India at the end of 18<sup>th</sup> century and was used by the local population for  
84 digestive problems. Additionally, numerous endemic plants from La Réunion are used in  
85 traditional medicine; for instance, Ambaville (*Hubertia ambavilla* Bory) for dermic problems,  
86 blood circulation, gastric anti-ulcer and diabetes (“Aplamedom”). The exploration of this  
87 empirical knowledge could lead to the discovery of new active molecules.

88 The screening of 20 plants from La Réunion for biocidal activities constituted the core of this  
89 study. Plants were first chosen because of their endemic or indigenous status. Then, we  
90 considered their traditional uses in medicine and ethnoveterinary practices, and if no data  
91 were available, we selected the plants on the basis of existing biocidal activities in species of  
92 the same genus. To complement the fragmentary and limited knowledge of the selected  
93 plants, a small-scale survey of the population was conducted. Plant extracts were tested for  
94 antimicrobial and acaricidal activities. To our knowledge, this is the first study to report such  
95 properties of plants from La Réunion.

## 96 **2. Material and methods**

### 97 **2.1. Plants and extracts**

#### 98 **2.1.1. Selection of plant samples**

99 Samples were chosen from our laboratory's plant collection formed during the extensive  
100 research program BIOMOL-TCN, which aimed to find new therapeutic, cosmetic and  
101 nutraceutical molecules in the marine, terrestrial and microbial biodiversity from La Réunion.

### 102 **2.1.2. Preparation of crude extracts**

103 The 20 plants chosen in this study were collected between 2009 and 2013 in different forests  
104 of Reunion Island. As described above, the selection criteria of the plants were (1) their  
105 biological status, (2) the availability of information concerning traditional practices and/or (3)  
106 data for biocidal activity of each species found in the literature or for the genus if no data  
107 were available concerning the species. This information is summarized in Table 1. The plant  
108 materials were identified by the botanists Jacques Fournel and Professor Dominique Strasberg  
109 (Faculty of Science and Technology, University of La Réunion). Voucher specimens are kept  
110 and were deposited in the Herbarium of the University.

## 111 **2.2. Small scale survey**

### 112 **2.2.1. Study area**

113 La Réunion (55°3' E and 21°5'S), with Mauritius and Rodrigues, is one of three islands that  
114 composes the Mascarene archipelago located in the Indian Ocean. Discovered in 1507–1512,  
115 Reunion Island has been a French overseas department since 1946, and is divided into 24  
116 municipalities (average size: 100 km<sup>2</sup>) (Strasberg et al., 2005). According to the census of  
117 2012, the island's population was about 833,944 (403,907 males and 430,037 females). The  
118 population is mainly composed of people who originated from France, Africa, Madagascar  
119 India (Tamil Nadu and Gujarat) and China ("Insee – Département de La Réunion (974)"  
120 2012). Economic activities and around 80% of the population are located in the coastal  
121 lowlands due to the rugged topography of the island. Almost 40% of the territory belongs to  
122 the National Park, which was established to preserve and conserve the terrestrial biodiversity

123 (Figure 1). (Strasberg et al., 2005). The core zone of La Réunion National Park coincides with  
124 the area of “Pitons, cirques and remparts” in the World Heritage List of the UNESCO.

125

### 126 **2.2.2. Questionnaire design and data collection**

127 A small-scale survey of the general population was carried out in Reunion Island from  
128 October 2015 to February 2016. The questionnaire was adapted from previous studies  
129 (Grønhaug et al., 2008; Samoisy and Mahomoodally, 2015). Data were recorded via face-to-  
130 face interviews in the local language (Créole) or French, depending on the interviewee. The  
131 first section concerned general information about gender, age, and place of residence. The  
132 second section concerned the knowledge of the selected plants and their traditional uses. Non-  
133 specialist people (n = 55) were randomly chosen and interviewed in the street, at their home  
134 or in their garden. Nineteen municipalities out of 24 were covered in this study. In addition,  
135 four traditional healers, one pharmacist, two ethnobotanists and one farmer were interviewed  
136 about the medicinal usages of the 20 studied plants.

## 137 **2.3. Biological assays**

### 138 **2.3.1. Preparation of crude extracts**

139 Collected plant materials (leaves and/or bark) were air-flow dried (40°C), crushed into fine  
140 powder and kept dry at room temperature until use. Crude extracts were obtained with an  
141 accelerated solvent extractor (ASE® 300, Accelerated Solvent Extractor, France) using ethyl  
142 acetate as solvent ( $\geq 99.5\%$ , Carlo-Erba, France). Conditions were as follows: temperature,  
143 40°C; pressure, 100 bars; five cycles with static extraction time of 6 min; and flush volume,  
144 100%. The crude extracts were concentrated in a rotary vacuum and were kept at 4°C until  
145 further use.



146 **2.3.2. Evaluation of antimicrobial activity**

147 **➤ Microorganisms**

148 Antimicrobial activity was evaluated on bacteria and yeasts with sanitary relevance. Three  
149 Gram-positive bacteria, *Listeria monocytogenes* (ATCC 1914), methicillin-resistant  
150 *Staphylococcus aureus* (NCTC 12493) and *Streptococcus pyogenes* (ATCC 19615), three  
151 Gram-negative bacteria, *Escherichia coli* (ATCC 25922), *Pseudomonas aeruginosa* (ATCC  
152 10145) and *Salmonella enterica* (ATCC 13076), two filamentous fungi, *Aspergillus fumigatus*  
153 (ATCC 204305) and *Aspergillus niger* (ATCC 1688), and three yeasts, *Candida albicans*  
154 (ATCC 10231), *Candida tropicalis* (ATCC 1369) and *Cryptococcus neoformans* (ATCC  
155 76484) (Humeau Laboratory, France) were used. *E. coli*, *S. aureus*, *P. aeruginosa* and *S.*  
156 *enterica* were grown on Mueller-Hinton medium (Sigma Aldrich, France), whereas *L.*  
157 *monocytogenes* and *S. pyogenes* were grown on Brain Heart medium (bioMérieux, France).  
158 Fungi were grown on Sabouraud medium (Sigma Aldrich, France). The media were prepared  
159 according to the manufacturer's instructions.

160

161 **➤ Disc diffusion test**

162 The assay was conducted by a modified disk diffusion method of the Clinical and Laboratory  
163 Standard Institute (Cavalieri et al., 2009). Suspensions of microorganisms were made in  
164 sterile medium and adjusted spectrophotometrically between  $1 \times 10^5$  and  $1 \times 10^6$  CFU/mL for  
165 bacteria and between  $1 \times 10^3$  and  $1 \times 10^4$  spores/mL for fungi. A 150 mL volume of sterile  
166 medium was added to Petri dishes (245 × 245 × 25 mm) to a thickness of 4 mm. Once the  
167 surface of media was inoculated with 1 mL of the microbial suspension, the disks (6 mm  
168 diameter) were placed on the surface of the medium. Each extract was dissolved in  
169 dimethylsulphoxide (DMSO ≥ 99.5 %, Sigma-Aldrich, France) to have a final concentration  
170 of 10 mg/mL and was tested at 20 µL/disk. Positive controls were chloramphenicol (BDH

171 Chemicals, England) for bacteria and amphotericine B (Sigma-Aldrich, France) for fungi. The  
172 plates were left for 30 min at room temperature to allow diffusion of the extract into the agar.  
173 They were then incubated at 37°C for 24 h and 48 h for bacteria and fungi, respectively.  
174 Antimicrobial activity was determined by measuring the inhibition zone with a caliper in  
175 millimeters. The experiment was repeated three times.

176                   ➤ **Determination of minimum inhibitory concentration by the**  
177                   **microdilution method**

178 The minimal inhibition concentration (MIC) determination method was applied to extracts  
179 that had demonstrated their efficiency against microorganisms by the disk diffusion method  
180 (Kuetze et al., 2009). The extracts and antibiotics were dissolved in DMSO (max 6.2% of  
181 DMSO per well). The initial concentration of the extracts was 1000.00 µg/mL and they were  
182 serially diluted two-fold in order to obtain a concentration range from 1000.00 to 0.98 µg/mL  
183 in sterile nutrient broth. A negative control was run in parallel to study the impact of the  
184 solvent on the microorganism growth. Each well was inoculated with 50 µL of suspension  
185 containing between  $1 \times 10^5$  and  $1 \times 10^6$  CFU/mL for the bacteria and between  $1 \times 10^3$  and  $1 \times 10^4$   
186 spores/mL for the fungi. After incubation (37°C, 24 h and 48 h for bacteria and fungi,  
187 respectively), 20 µL (0.2 mg/mL) of *p*-iodonitrotetrazolium violet (INT, Sigma-Aldrich,  
188 France) was added to each well and the plates were incubated for an additional hour. MIC was  
189 determined as the lowest concentration of plant extract inhibiting microbial growth, indicated  
190 by a decrease in the intensity of the red colour of the formazan product. Positive controls were  
191 chloramphenicol (BDH Chemicals, England) for bacteria and amphotericine B (Sigma-  
192 Aldrich, France) for fungi. Three replicates were made for each extract.

193                   **2.3.3. Evaluation of acaricidal activity**

194                   ➤ **Preparation of ticks**

195 *R. microplus* engorged females were collected after detachment from cattle. The females were  
196 incubated in the laboratory of the Agronomic Institute of New Caledonia (IAC) at a  
197 temperature of 27°C and a relative humidity (RH) of 85% for one week. Eggs were then  
198 collected and placed in the same conditions until larvae were 2–3 weeks old.

#### 199 ➤ Larval packet test

200 The acaricidal activity of plant extracts was evaluated using the modified larval packet test  
201 (LPT) (Stone and Haydock, 1962) on 14–21-day-old larvae. Extracts were diluted in ethanol  
202 to a 5% solution. A 7.5 × 8.5-cm nylon paper (Anowo Ltd, Switzerland) was impregnated  
203 with the different extracts and placed in a fume hood for 1 h to allow ethanol evaporation,  
204 before being folded into packets using bulldog clips. Approximately 100 *R. microplus* larvae  
205 were placed into each treated nylon paper packet, which were then sealed with additional  
206 bulldog clips and placed in an incubator (27°C, 85% Relative Humidity) for 24 h. Two  
207 replicates for each plant extracts, a negative control (nylon paper with ethanol) and a positive  
208 control (amitraz 1 g/L) were used. After 24 h, the numbers of live and dead larvae were  
209 counted to calculate the percentage of larval mortality.

#### 210 ➤ Statistical analysis

211 Mean values of mortality and standard deviation of the mean were calculated for each plant  
212 extracts. The LC<sub>50</sub> (50% lethal concentration) was calculated using the Probit method  
213 (Finney, 1971), generated by the Probit POLOPC program (LeOra Software, 1987, Berkeley,  
214 CA, USA).

### 215 3. Results and Discussion

#### 216 3.1. Traditional use of the selected plants

217 Despite traditional plants uses being an important cultural component of Reunion Island,  
218 surprisingly, no survey had been made in the population to collect information about these  
219 plants and their uses until our work.

220 Of the people interviewed, 58.2% were male and 41.8% were female; 32.7% were aged 18–35  
221 years old, 49.1% were 36–60 years old and 18.2% were >60 years old. Finally, 65.5% of them  
222 lived in a rural area. A substantial proportion of the interviewed non-specialists (78.2%)  
223 cultivated and used plants mainly from their gardens as medicinal remedies. Among them, the  
224 proportion of women (81.8%) who used traditional remedies was slightly higher than the  
225 proportion of men (75.7%). This result is aligned with other studies around the world  
226 (Samoisy and Mahomoodally, 2015). In La Réunion, as in Mauritius and Rodrigues, people  
227 are particularly attached to traditional practices, and women are often the principal source of  
228 knowledge transmission (Pourchez, 2011). More than 85% of herbal medicine traditional uses  
229 were indeed transmitted through generations within the families. The knowledge of traditional  
230 uses of plants is indeed held by older people, and it is likely that the transfer of this  
231 information is now greatly affected by lifestyle modernization, as in many regions of the  
232 world. The preliminary literature analysis showed that only a few traditional uses were  
233 reported concerning the 20 selected plants (Table 1). During the survey, no traditional use in  
234 relation to antimicrobial or acaricidal properties was cited by the non-specialist population  
235 even though one or more of the 20 studied plants were recognized by the interviewees. For  
236 example, *Terminalia bentzoe* (L.) Pers. (benjoin) was recognized by 89% of interviewed  
237 persons, *Zanthoxylum heterophyllum* (Lam.) Sm. (bois de poivre) 50% and *Calophyllum*  
238 *tacamahaca* Willd. (takamaka) was recognized by 40%. This knowledge was observed only  
239 for some representative plants from La Réunion because the general population did not know  
240 the selected plants of this study well. For instance, the *Psiadia* species were the least known  
241 probably because of their low distribution and scarcity in the island. *Psiadia amygdalina*

242 Cordem. and *Psiadia boivinii* B.L.Rob. were recognized by 6 and 4% of interviewed people,  
243 respectively.

244 We also questioned eight specialized people (four traditional healers, one pharmacist, two  
245 ethnobotanists and one farmer) about the traditional uses of the 20 selected plants. These  
246 people acted daily for the valorization, conservation and preservation of the biodiversity of  
247 Reunion Island and the associated traditional knowledge, which is endangered by the lack of  
248 verbal transfer to new generations. As shown in Table 1, this small scale-survey allowed the  
249 collection of helpful information about the traditional use of little-known plants. This is the  
250 first time that seven plants were described for their traditional uses in medicine and  
251 ethnoveterinary practices: *Psiadia dentata* DC., *Psiadia retusa* DC., *Vernonia fimbrillifera*  
252 Less., *Antidesma madagascariense* Lam., *Stillingia lineata* (Lam.) Müll.Arg., *Indigofera*  
253 *ammoxyllum* (DC.) Polhill and *Peperomia borbonensis* Miq. Furthermore, the collected  
254 information confirmed and/or supplemented the data obtained from the literature for nine  
255 plants (*Poupartia borbonica* J.F.Gmel, *Carissa spinarum* L., *Secamone volubilis* (Lam.)  
256 Marais., *Calophyllum tacamahaca* Willd, *Terminalia bentzoe* (L.) Pers., *Croton mauritanus*  
257 Lam., *Sophora denudata* Bory, *Zanthoxylum heterophyllum* (Lam.) Sm., *Nuxia verticillata*  
258 Lam.). Finally, no traditional use was identified for *Psiadia amygdalina* Cordem, *Psiadia*  
259 *boivinii* B.L.Rob., *Psiadia laurifolia* Cordem and *Monimia rotundifolia* Thouars. These  
260 results reinforce bioprospecting of plants and herbal traditional uses to discover new  
261 substances. They should help us to direct our bioactivity tests and phytochemical studies.

### 262 **3.2. Antimicrobial activities of the selected plants**

263 Crude extracts were prepared using ethyl acetate as solvent, and were tested against the  
264 different microorganisms. Table 2 shows the results obtained for plants displaying  
265 antibacterial activity for at least one bacteria/fungi. The antimicrobial activity varied greatly

266 according to the tested species. The leaves of *Carissa spinarum*, *Indigofera amnoxylum*,  
267 *Psiadia amygdalina*, *Sophora denudata*, *Vernonia fimbriifera*, *Zanthoxylum heterophyllum*  
268 displayed no antimicrobial activity. The same result was found for the bark of *Psiadia dentata*  
269 and *P. retusa* and for the leaves and bark of *P. laurifolia*. Sixteen extracts inhibited at least  
270 one microbial species. Among these positive extracts, 12 had a zone of growth inhibition  
271 greater than 10 mm: *Antidesma madagascariense* (bark), *Callophylum tacamahaca* (leaves),  
272 *Croton mauritanus* (leaves), *Monimia rotundifolia* (leaves), *Psiadia amygdalina* (bark),  
273 *Poupartia borbonica* (leaves), *Psiadia boivinii* (leaves), *Psiadia retusa* (leaves), *Secamone*  
274 *volubilis* (leaves), *Sophora denudata* (bark), *Stillingia lineata* (leaves) and *Terminalia bentzoe*  
275 (leaves). The minimal inhibition concentration (MIC) was determined for the positive extracts  
276 following the disk diffusion test (Table 3). It is generally considered that antimicrobial  
277 activity is good for extracts with a MIC less than 100 µg/mL; from 100 to 500 µg/mL, the  
278 antimicrobial activity is moderate; from 500 to 1000 µg/mL, the antimicrobial activity is  
279 weak; and over 1000 µg/mL, the extract is considered inactive (Holetz et al., 2002). Only  
280 seven MIC values were >1000 µg/mL. The active extracts displayed a MIC ranged between  
281 1000 µg/mL and 15.62 µg/mL. Gram-positive bacteria were more sensitive than Gram-  
282 negative bacteria, as was frequently found in the literature (Ríos and Recio, 2005). This is  
283 probably due to cell-wall differences, as Gram-negative bacteria have an outer membrane  
284 known to act as a barrier to many molecules. The most susceptible bacterium was the  
285 methicillin-resistant *Staphylococcus aureus* strain, since 12 extracts were active against it.  
286 The best activities against this bacterium were observed with *Callophylum tacamahaca*  
287 (leaves) and *Psiadia dentata* (leaves) with a MIC of 62.50 µg/mL. The activity of  
288 chloramphenicol was 37.50 µg/mL on this strain. No traditional uses as an antimicrobial were  
289 reported for *Callophylum tacamahaca*. According to our survey's results, *Psiadia dentata* is  
290 traditionally used to treat dermic problems, such as mycoses in La Réunion, but the ethyl

291 acetate extract of this plant was not active against the tested fungi. Other extraction methods  
292 and a wider range of fungi should be used to evaluate the fungicide activity of this plant in the  
293 future. In Mauritius, five endemic *Psiadia* species used traditionally to treat pulmonary  
294 infections, wounds and burns were evaluated for their antimicrobial activity. They did not  
295 show any or showed moderate activity against the studied strains (Govinden-Soulange et al.,  
296 2004). The *Terminalia bentzoe* leaf extract showed a weak activity against *Staphylococcus*  
297 *aureus* and *Streptococcus pyogenes* with a MIC of 1000.00 µg/mL. Additionally, the current  
298 findings showed good antimicrobial activity of the extract of *Sophora denudata* bark against  
299 *Listeria monocytogenes* and *Streptococcus pyogenes* with a MIC value of 125.00 µg/mL and  
300 15.62 µg/mL respectively. Indeed, the antimicrobial activity of *Sophora* species has often  
301 been reported being due to flavonoids (Sohn et al., 2004; Tsuchiya et al., 1996). *Psiadia*  
302 *dentata* (leaves) and *Peperomia borbonensis* (leaves) extracts both displayed the broadest  
303 spectrum of antibacterial activities. Although MICs were not very low, *P. borbonensis* was  
304 active against four bacteria among the six tested, and was especially effective against all the  
305 Gram-negative species. Moreover, *P. borbonensis* was the only species active against fungi  
306 (one out of five, *Aspergillus fumigatus*). The traditional use of *P. borbonensis* in La Réunion  
307 as an antimicrobial is not listed. Likewise, the *Peperomia* species around the world have not  
308 been known for this traditional use, except *P. tetraphylla* (G.Forst.) Hook. & Arn., which was  
309 used to fight microbial infections in India (Nishanthi et al., 2012). Nevertheless, several  
310 studies on the antimicrobial activity of *Peperomia* species were reported in the literature  
311 (Ferreira et al., 2014; Langfield et al., 2004; Mbah et al., 2002; Saga Kitamura et al., 2006).  
312 The butanolic fraction of *Peperomia pellucida* (L.) Kunth, composed of tannins, flavonoids  
313 and saponins, showed good inhibition diameters against *E. coli* and *P. aeruginosa* (Khan and  
314 Omoloso, 2002). Patuloside A isolated from *P. pellucida* was tested on four Gram-positive  
315 bacteria and six Gram-negative bacteria and a low minimal inhibition concentration (MIC = 8

316  $\mu\text{g/mL}$ ) was obtained against *Staphylococcus aureus* and *Streptococcus  $\beta$ -haemolyticus* (Khan  
317 et al., 2010). Finally, Malquichagua Salazar et al. (2005) showed the activity of two  
318 compounds from *Peperomia villipetiola* C.D.C. against the fungus *Cladosporium*  
319 *sphaerospermum*.

320 Concerning the three indigenous species of the study, only *Antidesma madagascariense* and  
321 *Stillingia lineata* extracts showed antibacterial activity with the disk diffusion method and  
322 only against *S. aureus*. The MIC of these extracts were 125.00  $\mu\text{g/mL}$  and >1000.00  $\mu\text{g/mL}$ ,  
323 respectively. Unlike *S. lineata*, the antimicrobial activity of *A. madagascariense* was already  
324 evaluated and the methanol leaf extracts showed activity against *Enterococcus faecalis* (MIC  
325 = 60.00  $\mu\text{g/mL}$ ), *S. aureus* (MIC = 500.00  $\mu\text{g/mL}$ ), methicillin resistant *S. aureus* (MIC =  
326 250.00  $\mu\text{g/mL}$ ) and *Candida albicans* (MIC = 500.00  $\mu\text{g/mL}$ ) (Mahomoodally et al., 2015). In  
327 a study conducted by Rangasamy et al. (2007), the *A. madagascariense* crude methanol  
328 extract was active against some of the tested microorganisms of our study. Among them, *S.*  
329 *aureus* (MIC = 500.00  $\mu\text{g/mL}$ ) and *S. enteridis* (MIC = 125.00  $\mu\text{g/mL}$ ) were the most  
330 susceptible strains (Rangasamy et al., 2007). Finally, the species *Carissa spinarum* (leaves)  
331 was not active against the tested microorganisms; however, the methanolic extract of the roots  
332 of *C. spinarum* from India was active against *E. coli* (MIC = 125  $\pm$ 10  $\mu\text{g/mL}$ ), *S. aureus* (MIC  
333 = 110  $\pm$  28  $\mu\text{g/mL}$ ) and *A. niger* (MIC = 256  $\pm$ 30  $\mu\text{g/mL}$ ) in a study by Sanwal and  
334 Chaudhary (2011).

335 That being said, plant extracts with a MIC of 1000  $\mu\text{g/mL}$  should not be neglected, as they  
336 could contain interesting antimicrobial molecules. From this point of view, the leaf extracts  
337 from *Peperomia borbonensis* should be further explored, since it displayed the widest  
338 spectrum of antibacterial activity and also acted as a fungicide. Indeed, bioactive compound  
339 concentrations in plant extracts vary depending on the polarity of solvents. Ethyl acetate was  
340 used in our work to maximize the collection of a wide range of molecules in order to select



341 interesting plants for further research. Other solvents should now be gradually used to  
342 optimize active compound extraction and their isolation by bioguided-fractionation.

### 343 **3.3. Acaricidal activities of the selected plants**

344 Five extracts showed acaricidal activity on the tick *Rhipicephalus microplus* larvae (Figure 2).  
345 At a concentration of 5 %, the most active samples, with a mortality rate of 100%, were  
346 extracted from the leaves of *Peperomia borbonensis* (Piperaceae) and the bark of  
347 *Zanthoxylum heterophyllum* (Rutaceae). The extracts obtained from *Zanthoxylum*  
348 *heterophyllum* leaves showed weaker activity (63.8%) than those obtained from the bark  
349 (100%). Medium activity was also observed for *Monimia rotundifolia* (65.7% of mortality).  
350 Finally, *Psiadia amygdalina* leaf extract had weak acaricidal activity with 31.8% of mortality.

351 No previous study has reported acaricidal activity of these four plants. However, several  
352 studies have reported this property in plants belonging to the Piperaceae and Rutaceae  
353 families. Solvent extracts and essential oils from *Piper* (Piperaceae) species have been widely  
354 studied for their acaricidal properties (de Souza Chagas et al., 2012; Ferraz et al., 2010; Lima  
355 et al., 2014; Silva et al., 2009). Likewise, several species of the genus *Zanthoxylum* were  
356 studied for their biocidal activity against arthropods (Moussavi et al., 2015; Prieto et al.,  
357 2011). The essential oil of *Zanthoxylum caribaeum* Lam. was assessed for its acaricidal  
358 activity against cattle tick. This volatile extract acted on engorged females and inhibited  
359 oviposition and egg eclosion (Nogueira et al., 2014). Before this work, no reports about  
360 biocidal activity (*in vitro* or traditional) against arthropods was recovered for *Peperomia* spp.,  
361 *Psiadia* spp. and *Monimia* spp. As previously said, other solvents should now be gradually  
362 used to optimize active compound extraction and their isolation by bioguided-fractionation.  
363 Furthermore, these efforts should be complemented by the use of other extraction methods  
364 and the implementation of tests on a wide spectrum of biological targets. This is best

365 illustrated by another work conducted in parallel on *Peperomia borbonensis* in our laboratory,  
366 which led to demonstrating insecticidal activity of the leaf essential oil of *Peperomia*  
367 *borbonensis* and of its isolated major components against the melon fly *Bactrocera*  
368 *cucurbitae* (Dorla et al., 2017).

#### 369 **4. Conclusion**

370 To conclude, this *in vitro* study corroborated the acaricidal activity of *Peperomia borbonensis*  
371 traditionally used by a few farmers on the island to protect their cattle from ticks. The crude  
372 extract could possess one or several bioactive molecules acting in combination. Further  
373 research is currently being conducted to isolate the active component(s) by bioguided-  
374 fractionation. Furthermore, this study also demonstrated, for the first time, the acaricidal  
375 activity of *Zanthoxylum heteropyllum* and the antimicrobial activity of *Psiadia dentata* (MIC  
376 of 62.50 µg/mL against *S. aureus*) and *Sophora denudata* (MIC of 15.62 µg/mL against *S.*  
377 *pyogenes*). These results will further be used in bioguided phytochemical studies.

378 Lastly, a large-scale survey should be carried out to collect more information throughout the  
379 territory from older people. It could be especially interesting to dedicate a part of this future  
380 survey to the three mountain cirques Mafate, Cilaos and Salazie (Figure 1), and more  
381 particularly Mafate, which is accessible only by a pedestrian path network. In this landlocked  
382 area, the traditional lifestyle is more preserved than in coastal areas.

383 Many potential bioactive plants remain unexplored among the Reunion Island biodiversity.

384 Our multi-criteria approach would also allow the discovery of many other plants with  
385 interesting properties. Moreover, several plants selected in this study are endangered and  
386 protected in La Réunion. Raising the awareness and knowledge about such plants and  
387 improving their valorization by researching biological properties could allow their  
388 preservation.

389

390 **Conflict of interest**

391 The authors declare no conflict of interest.

392 **Acknowledgements**

393 The authors are very grateful to D. Strasberg and J. Fournel (UMR C\_53 PVBMT), H.  
394 Thomas (Parc National de La Réunion) and G. Begue for their contributions to species  
395 collection and plant material identification. Thanks to the following students for their  
396 technical contributions: L. Rivière, A. Fabre, M. Marchand and E. Grondin. The authors  
397 would like also to thank Anowo Ltd. for providing nylon paper.

398 **Funding**

399 This work was supported by the European Commission and the Regional Council of Reunion  
400 Island through the BIOMOL-TCN programme and ERDF (European Regional Development  
401 Fund, Grant No. 2012–326).

402       **References**

- 403       Abbas, R.Z., Zaman, M.A., Colwell, D.D., Gilleard, J., Iqbal, Z., 2014. Acaricide resistance in cattle  
404       ticks and approaches to its management: The state of play. *Veterinary Parasitology* 203, 6–20.
- 405       Ademola, I.O., Ibrinke, A.A., Aghanu, N.V., Chris, C.O., 2014. Evaluation of acaricidal activity of  
406       different seed oils on *Psoroptes cuniculi* (Delafond, 1859) (Cheyletidae) in rabbits. *Journal of*  
407       *Pharmacy and Biological. Sciences* 9, 94–97.
- 408       Adenubi, O.T., Fasina, F.O., McGaw, L.J., Eloff, J.N., Naidoo, V., 2016. Plant extracts to control  
409       ticks of veterinary and medical importance: A review. *South African Journal of Botany* 105,  
410       178–193.
- 411       Adesina, J.M., Ofuya, T.I., Afolabi, L.A., 2012. Insecticidal activity of *Secamone afzelii* (Schult) K.  
412       *schum* powder in the control of *Stiphilous zeamais* (Mots) (Coleoptera: Curculionidae).  
413       *International Research Journal of Pharmacy* 8, 117-124.
- 414       Agrawal, I.L., Mall, S.B., 1988. Studies on the insecticidal and antifeedant activity of some plant  
415       extracts on Bihar hairy caterpillar, *Diacrisia obliqua* Walker (Lep., Arctiidae). *Journal of*  
416       *Applied Entomology* 105, 529–532.
- 417       Agyare, C., Boakye, Y.D., Bekoe, E.O., Hensel, A., Dapaah, S.O., Appiah, T., 2016. Review:  
418       African medicinal plants with wound healing properties. *Journal of Ethnopharmacology* 177, 85–  
419       100.
- 420       Akinnibosun, H.A., Akinnibosun, F.I., German, B.E., 2008. Antibacterial activity of aqueous and  
421       ethanolic leaf extracts of *Peperomia pellucida* (L.) HB & K. (Piperaceae) on three Gram-  
422       negative bacteria isolates. *Science World Journal* 3, 33–36.
- 423       Alexander, I.C., Pascoe, K.O., Manchard, P., Williams, L.A.D., 1991. An insecticidal diterpene from  
424       *Croton linearis*. *Phytochemistry* 30, 1801–1803.

425 Alkhamaiseh, S.I., Taher, M., Ahmad, F., Qaralleh, H., Althunibat, O.Y., Susanti, D., Ichwan, S.-  
426 J.A., 2012. The phytochemical content and antimicrobial activities of Malaysian *Calophyllum*  
427 *canum* (stem bark). *Pakistan Journal of Pharmaceutical Sciences* 25, 555–563.

428 Aplamedom. Association des Plantes Aromatiques et Médicinales de La Réunion.  
429 <http://www.aplamedom.org/4.html> (accessed 4.14.16).

430 Aumeeruddy-Elalfi, Z., Gurib-Fakim, A., Mahomoodally, F., 2015. Antimicrobial, antibiotic  
431 potentiating activity and phytochemical profile of essential oils from exotic and endemic  
432 medicinal plants of Mauritius. *Industrial Crops and Products* 71, 197–204.

433 Barré, N., Uilenberg, G., 2010. Spread of parasites transported with their hosts: Case study of two  
434 species of cattle tick. *Revue scientifique et technique (International Office of Epizootics)* 29,  
435 135–147.

436 Belmi, R.M., Giron, J., Tansengo, M.L., 2014. *Antidesma bunius* (bignay) fruit extract as an organic  
437 pesticide against *Epilachna* spp. *Journal of Asian Scientific Research* 4, 320–327.

438 Borges, L.M.F., Sousa, L.A.D. de, Barbosa, C. da S., 2011. Perspectives for the use of plant extracts  
439 to control the cattle tick *Rhipicephalus (Boophilus) microplus*. *Revista Brasileira de*  
440 *Parasitologia Veterinária* 20, 89–96.

441 Cavalieri, S.J., Harbeck, R.J., McCarter, Y.S., Ortez, J.H., Rankin, I.D., Sharp, S.E., Spiegel, C.A.,  
442 2009. *Manual of antimicrobial susceptibility testing*. American Society for Microbiology,  
443 Washington, DC.

444 Cota, B.B., Johann, S., Oliveira, D.M., Siqueira, E.P., Souza-Fagundes, E.M., Cisalpino, P.S., Alves,  
445 T.M.A., Zani, C.L., 2011. Biological potential of *Stillingia oppositifolia*. *Revista Brasileira de*  
446 *Farmacognosia* 21, 70–77.

447 Cuesta-Rubio, O., Oubada, A., Bello, A., Maes, L., Cos, P., Monzote, L., 2015. Antimicrobial  
448 assessment of resins from *Calophyllum antillanum* and *Calophyllum inophyllum*. *Phytotherapy*  
449 *Research* 29, 1991–1994.

450 Dahot, M.U., 1999. Antibacterial and antifungal activity of small protein of *Indigofera oblongifolia*  
451 leaves. *Journal of Ethnopharmacology* 64, 277–282.

452 de Souza Chagas, A.C., de Barros, L.D., Cotinguiba, F., Furlan, M., Giglioti, R., de Sena Oliveira,  
453 M.C., Bizzo, H.R., 2012. In vitro efficacy of plant extracts and synthesized substances on  
454 *Rhipicephalus (Boophilus) Microplus* (Acari: Ixodidae). *Parasitology Research* 110, 295–303.

455 Dechayont, B., Hansakul, P., Itharat, A., 2012. Comparison of antimicrobial, antioxidant activities  
456 and total phenolic content of *Antidesma thwaitesianum* fruit extracts by different methods.  
457 *Journal of the Medical Association of Thailand* 95 Suppl 1, S147–S153.

458 Dharmaratne, H.R.W., Wijesinghe, W.M.N.M., Thevanasem, V., 1999. Antimicrobial activity of  
459 xanthenes from *Calophyllum* species, against methicillin-resistant *Staphylococcus aureus*  
460 (MRSA). *Journal of Ethnopharmacology* 66, 339–342.

461 Dorla, E., Gauvin-Bialecki, A., Deuscher, Z., Allibert, A., Grondin, I., Deguine, J.-P., Laurent, P.,  
462 2017. Insecticidal activity of the leaf essential oil of *Peperomia borbonensis* Miq. (Piperaceae)  
463 and its major components against the melon fly *Bactrocera cucurbitae* (Diptera: Tephritidae).  
464 *Chemistry and Biodiversity* 14, 1–9.

465 Erasto, P., Grierson, D.S., Afolayan, A.J., 2006. Bioactive sesquiterpene lactones from the leaves of  
466 *Vernonia amygdalina*. *Journal of Ethnopharmacology* 106, 117–120.

467 Estrada-Peña, A., García, Z., Sánchez, H.F., 2006. The distribution and ecological preferences of  
468 *Boophilus microplus* (Acari: Ixodidae) in Mexico. *Experimental & Applied Acarology* 38, 307–  
469 316.

470 de B.F. Ferraz, A., Balbino, J.M., Zini, C.A., Ribeiro, V.L.S., Bordignon, S.A.L., von Poser, G.,  
471 2010. Acaricidal activity and chemical composition of the essential oil from three *Piper* species.  
472 *Parasitology Research* 107, 243–248.

473 Ferreira, E.A., Juliana B., R., Correia, M.V., Young, M.C.M., Guimarães, E.F., Franchi, G.C.,  
474 Nowill, A.E., Lago, J.H.G., Yamaguchi, L.F., Kato, M.J., 2014. Antifungal and cytotoxic 2-

475 Acylcyclohexane-1,3-diones from *Peperomia alata* and *P. trineura*. *Journal of Natural Products*  
476 27, 1377–1382.

477 Finney D. J., 1971. *Probit Analysis*, 3rd ed. Cambridge University Press, Cambridge. *Journal of*  
478 *Pharmaceutical Sciences* 60, 1432–1432.

479 Gemedda, N., Mokonnen, W., Lemma, H., Tadele, A., Urga, K., Addis, G., Debella, A., Getachew,  
480 M., Teka, F., Yirsaw, K., Mudie, K., Gebre, S., 2014. Insecticidal activity of some traditionally  
481 used ethiopian medicinal plants against sheep ked *Melophagus ovinus*. *Journal of Parasitology*  
482 *Research* 2014, 1–7.

483 Govinden-Soulange, J., Magan, N., Gurib-Fakim, A., Gauvin, A., Smadja, J., Kodja, H., 2004.  
484 Chemical composition and in vitro antimicrobial activities of the essential oils from endemic  
485 *Psiadia* species growing in Mauritius. *Biological & Pharmaceutical Bulletin* 27, 1814–1818.

486 Grønhaug, T.E., Gläserud, S., Skogsrud, M., Ballo, N., Bah, S., Diallo, D., Paulsen, B.S., 2008.  
487 Ethnopharmacological survey of six medicinal plants from Mali, West-Africa. *Journal of*  
488 *Ethnobiology and Ethnomedicine* 4, 1–11.

489 Holetz, F.B., Pessini, G.L., Sanches, N.R., Cortez, D.A.G., Nakamura, C.V., Filho, D., Prado, B.,  
490 2002. Screening of some plants used in the Brazilian folk medicine for the treatment of  
491 infectious diseases. *Memórias do Instituto Oswaldo Cruz* 97, 1027–1031.

492 Hüe, T., Cauquil, L., Fokou, J.B.H., Dongmo, P.M.J., Bakarnga-Via, I., Menut, C., 2015. Acaricidal  
493 activity of five essential oils of *Ocimum* species on *Rhipicephalus (Boophilus) microplus* larvae.  
494 *Parasitology Research* 114, 91–99.

495 Insee – Département de La Réunion (974). 2012.  
496 [http://www.insee.fr/fr/themes/dossier\\_complet.asp?codgeo=DEP-974](http://www.insee.fr/fr/themes/dossier_complet.asp?codgeo=DEP-974) (accessed 4.11.16).

497 Islam, A., Sayeed, A., Bhuiyan, M.S.A., Mosaddik, M.A., Islam, M.A.U., Astaq Mondal Khan,  
498 G.R.M., 2001. Antimicrobial activity and cytotoxicity of *Zanthoxylum budrunga*. *Fitoterapia* 72,  
499 428–430.

500 Jongejan, F., Uilenberg, G., 2004. The global importance of ticks. *Parasitology* 129, S3–S14.

501 Jonville, M.C., Kodja, H., Strasberg, D., Pichette, A., Ollivier, E., Frédérick, M., Angenot, L.,  
502 Legault, J., 2011. Antiplasmodial, anti-inflammatory and cytotoxic activities of various plant  
503 extracts from the Mascarene Archipelago. *Journal of Ethnopharmacology* 136, 525–531.

504 Kadir, R., Awang, K., Khamaruddin, Z., Soit, Z., 2015. Chemical compositions and termiticidal  
505 activities of the heartwood from *Calophyllum inophyllum* L. *Annals of the Brazilian Academy of*  
506 *Sciences* 87, 743–751.

507 Kamal, R., Mangla, M., 1993. In vivo and in vitro investigations on rotenoids from *Indigofera*  
508 *tinctoria* and their bioefficacy against the larvae of *Anopheles stephensi* and adults of  
509 *Callosobruchus chinensis*. *Journal of biosciences* 18, 93–101.

510 Khan, A., Rahman, M., Islam, M.S., 2010. Isolation and bioactivity of a xanthone glycoside from  
511 *Peperomia pellucida*. *Life Sciences and Medicine Research* 2010, 1–10.

512 Khan, M.R., Omoloso, A.D., 2002. Antibacterial activity of *Hygrophila stricta* and *Peperomia*  
513 *pellucida*. *Fitoterapia* 73, 251–254.

514 Kitonde, C.K., Fidahusein, D.S., Lukhoba, C.W., Jumba, M.M., 2012. Antimicrobial activity and  
515 phytochemical study of *Vernonia glabra* (Steetz) Oliv. & Hiern. in Kenya. *African Journal of*  
516 *Traditional, Complementary, and Alternative Medicines* 10, 149–157.

517 Krishna, P.M., KNV, R., S, S., Banji, D., 2012. A review on phytochemical, ethnomedical and  
518 pharmacological studies on genus *Sophora*, Fabaceae. *Revista Brasileira de Farmacognosia* 22,  
519 1145–1154.

520 Küçükboyacı, N., Özkan, S., Adigüzel, N., Tosun, F., 2011. Characterisation and antimicrobial  
521 activity of *Sophora alopecuroides* L. var. *alopecuroides* alkaloid extracts. *Turkish Journal of*  
522 *Biology* 35, 379–385.



- 523 Kuete, V., Nana, F., Ngameni, B., Mbaveng, A.T., Keumedjio, F., Ngadjui, B.T., 2009.  
524 Antimicrobial activity of the crude extract, fractions and compounds from stem bark of *Ficus*  
525 *ovata* (Moraceae). *Journal of Ethnopharmacology* 124, 556–561.
- 526 Langfield, R.D., Scarano, F.J., Heitzman, M.E., Kondo, M., Hammond, G.B., Neto, C.C., 2004. Use  
527 of a modified microplate bioassay method to investigate antibacterial activity in the Peruvian  
528 medicinal plant *Peperomia galioides*. *Journal of Ethnopharmacology* 94, 279–281.
- 529 Lavergne, R., 2001. *Le grand livre des tisaneurs et plantes médicinales indigènes de La Réunion*,  
530 Orphie. ed. France.
- 531 Leite, S.P., Vieira, J.R.C., de Medeiros, P.L., Leite, R.M.P., de Menezes Lima, V.L., Xavier, H.S., de  
532 Oliveira Lima, E., 2006. Antimicrobial activity of *Indigofera suffruticosa*. *Evidence-based*  
533 *Complementary and Alternative Medicine* 3, 261–265.
- 534 Lima, A. da S., Filho, J.G. do N.S., Pereira, S.G., Guillon, G.M.S.P., Santos, L. da S., Júnior, L.M.C.,  
535 2014. Acaricide activity of different extracts from *Piper tuberculatum* fruits against  
536 *Rhipicephalus microplus*. *Parasitology Research* 113, 107–112.
- 537 Lima, G.P.G. de, Souza, T.M. de, Freire, G. de P., Farias, D.F., Cunha, A.P., Ricardo, N.M.P.S.,  
538 Morais, S.M. de, Carvalho, A.F.U., 2013. Further insecticidal activities of essential oils from  
539 *Lippia sidoides* and *Croton* species against *Aedes aegypti* L. *Parasitology Research* 112, 1953–  
540 1958.
- 541 Lindsay, E.A., Berry, Y., Jamie, J.F., Bremner, J.B., 2000. Antibacterial compounds from *Carissa*  
542 *lanceolata* R.Br. *Phytochemistry* 55, 403–406.
- 543 Mahomoodally, M.F., Korumtollee, H.N., Chady, Z.Z.B.K., 2015. Ethnopharmacological uses of  
544 *Antidesma madagascariense* Lam. (Euphorbiaceae). *Journal of Intercultural Ethnopharmacology*  
545 4, 86–89.
- 546 Malquichagua Salazar, K.J., Delgado Paredes, G.E., Lluncor, L.R., Young, M.C.M., Kato, M.J.,  
547 2005. Chromenes of polyketide origin from *Peperomia villipetiola*. *Phytochemistry* 66, 573–579.

- 548 Mao, L., Henderson, G., 2007. Antifeedant activity and acute and residual toxicity of alkaloids from  
549 *Sophora flavescens* (leguminosae) against formosan subterranean termites (Isoptera:  
550 Rhinotermitidae). *Journal of Economic Entomology* 100, 866–870.
- 551 Masoko, P., Picard, J., Eloff, J.N., 2005. Antifungal activities of six South African *Terminalia*  
552 species (Combretaceae). *Journal of Ethnopharmacology* 99, 301–308.
- 553 Mbah, J.A., Ngemenya, M.N., Abawah, A.L., Babiaka, S.B., Nubed, L.N., Nyongbela, K.D., Lemuh,  
554 N.D., Efange, S.M., 2012. Bioassay-guided discovery of antibacterial agents: in vitro screening  
555 of *Peperomia vulcanica*, *Peperomia fernandopoioana* and *Scleria striatinux*. *Annals of Clinical*  
556 *Microbiology and Antimicrobials* 11, 1–10.
- 557 Mbah, J.A., Tchuendem, M.H., Tane, P., Sterner, O., 2002. Two chromones from *Peperomia*  
558 *vulcanica*. *Phytochemistry* 60, 799–801.
- 559 Mgbeahuruike, E.E., Yrjönen, T., Vuorela, H., Holm, Y., 2017. Bioactive compounds from medicinal  
560 plants: Focus on *Piper* species. *South African Journal of Botany* 112, 54–69.
- 561 Mickymaray, S., Al Aboody, M.S., Rath, P.K., Annamalai, P., Nooruddin, T., 2016. Screening and  
562 antibacterial efficacy of selected Indian medicinal plants. *Asian Pacific Journal of Tropical*  
563 *Biomedicine* 6, 185-191.
- 564 Misra, L.N., Wouatsa, N.A.V., Kumar, S., Venkatesh Kumar, R., Tchoumboungang, F., 2013.  
565 Antibacterial, cytotoxic activities and chemical composition of fruits of two Cameroonian  
566 *Zanthoxylum* species. *Journal of Ethnopharmacology* 148, 74–80.
- 567 Moussavi, N., Malterud, K.E., Mikolo, B., Dawes, D., Chandre, F., Corbel, V., Massamba, D.,  
568 Overgaard, H.J., Wangensteen, H., 2015. Identification of chemical constituents of *Zanthoxylum*  
569 *heitzii* stem bark and their insecticidal activity against the malaria mosquito *Anopheles gambiae*.  
570 *Parasites and Vectors* 8, 1-8.
- 571 Mwanauta, R.W., Mtei, K.A., Ndakidemi, P.A., 2014. Prospective bioactive compounds from  
572 *Vernonia amygdalina*, *Lippia javanica*, *Dysphania ambrosioides* and *Tithonia diversifolia* in  
573 controlling legume insect pests. *Agricultural Sciences* 5, 1129–1139.

574 Mwangomo, D.T., Moshi, M.J., Magadula, J.J., 2012. Antimicrobial activity and phytochemical  
575 screening of *Antidesma venosum* root and stem bark ethanolic extracts. International Journal of  
576 Research in Phytochemistry and Pharmacology 2, 90–95.

577 Ngemenya, M.N., Mbah, J.A., Tane, P., Titanji, V.P., 2006. Antibacterial effects of some  
578 Cameroonian medicinal plants against common pathogenic bacteria. African Journal of  
579 Traditional, Complementary and Alternative medicines 3, 84–93.

580 Nishanthi, M., Mohanambal, E., Narendiran, S., Shankar, M., Aanandhi, M.V., Vijayakumar, B.,  
581 2012. Extraction and preliminary phytochemical investigation on whole plant of *Peperomia*  
582 *tetraphylla* (G. Forst. Hook & Arn). International Journal of Novel Trends in Pharmaceutical  
583 Sciences 2, 35–38.

584 Nogueira, J., Vinturelle, R., Mattos, C., Tietbohl, L.A.C., Santos, M.G., Junior, I.S.V., Mourão, S.C.,  
585 Rocha, L., Folly, E., 2014. Acaricidal properties of the essential oil from *Zanthoxylum*  
586 *caribaeum* against *Rhipicephalus microplus*. Journal of Medical Entomology 51, 971–975.

587 Nyahangare, E.T., Mvumi, B.M., Mutibvu, T., 2015. Ethnoveterinary plants and practices used for  
588 ecto-parasite control in semi-arid smallholder farming areas of Zimbabwe. Journal of  
589 Ethnobiology and Ethnomedicine 11, 1–16.

590 Obey, J.K., von Wright, A., Orjala, J., Kauhanen, J., Tikkanen-Kaukanen, C., Obey, J.K., von  
591 Wright, A., Orjala, J., Kauhanen, J., Tikkanen-Kaukanen, C., 2016. Antimicrobial activity of  
592 *Croton macrostachyus* stem bark extracts against several human pathogenic bacteria,  
593 antimicrobial activity of *Croton macrostachyus* stem bark extracts against several human  
594 pathogenic bacteria. Journal of Pathogens 2016, 1–5.

595 Olila, D., Olwa-Odyek, Opuda-Asibo, J., 2001. Antibacterial and antifungal activities of extracts of  
596 *Zanthoxylum chalybeum* and *Warburgia ugandensis*, Ugandan medicinal plants. African Health  
597 Sciences 1, 66–72.

598 Oloyede, G.K., Onocha, P.A., Olaniran, B.B., 2011. Phytochemical, toxicity, antimicrobial and  
599 antioxidant screening of leaf extracts of *Peperomia pellucida* from Nigeria. *Advances in*  
600 *Environmental Biology* 5, 3700–3709.

601 O’Neil, J., 2016. Infection prevention, control and surveillance: Limiting the development and spread  
602 of drug resistance.

603 Parc National de La Réunion, 2008. Dossier de candidature au Patrimoine Mondial de l'UNESCO  
604 Pitons, Cirques et Remparts de l’île de La Réunion, France.

605 Peres, M.T.L., Monache, F.D., Cruz, A.B., Pizzolatti, M.G., Yunes, R.A., 1997. Chemical  
606 composition and antimicrobial activity of *Croton urucurana* Baillon (Euphorbiaceae). *Journal of*  
607 *Ethnopharmacology* 56, 223–226.

608 Poullain, C., Girard-Valenciennes, E., Smadja, J., 2004. Plants from Reunion Island: Evaluation of  
609 their free radical scavenging and antioxidant activities. *Journal of Ethnopharmacology* 95, 19–  
610 26.

611 Pourchez, L., 2011. *Savoirs des femmes : médecine traditionnelle et nature: Maurice, Réunion,*  
612 *Rodrigues. UNESCO, Paris.*

613 Prieto, J.A., Patiño, O.J., Delgado, W.A., Moreno, J.P., Cuca, L.E., 2011. Chemical composition,  
614 insecticidal, and antifungal activities of fruit essential oils of three Colombian *Zanthoxylum*  
615 species. *Chilean Journal of Agricultural Research* 71, 73–82.

616 Rabe, T., Mullholland, D., van Staden, J., 2002. Isolation and identification of antibacterial  
617 compounds from *Vernonia colorata* leaves. *Journal of Ethnopharmacology* 80, 91–94.

618 Rangasamy, O., Raelison, G., Rakotoniriana, F.E., Cheuk, K., Urverg-Ratsimamanga, S., Quetin-  
619 Leclercq, J., Gurib-Fakim, A., Subratty, A.H., 2007. Screening for anti-infective properties of  
620 several medicinal plants of the Mauritian flora. *Journal of Ethnopharmacology* 109, 331–337.

621 Rani, P.U., Venkateshwaramma, T., Devanand, P., 2011. Bioactivities of *Cocos nucifera* L.  
622 (Arecales: Arecaceae) and *Terminalia catappa* L. (Myrtales: Combretaceae) leaf extracts as

623 post-harvest grain protectants against four major stored product pests. *Journal of Pest Science* 84,  
624 235–247.

625 Ríos, J.L., Recio, M.C., 2005. Medicinal plants and antimicrobial activity. *Journal of*  
626 *Ethnopharmacology* 100th Volume Special Section: Perspectives of Ethnopharmacology 100,  
627 80–84.

628 Saga Kitamura, R.O., Romoff, P., Young, M.C.M., Kato, M.J., Lago, J.H.G., 2006. Chromenes from  
629 *Peperomia serpens* (Sw.) Loudon (Piperaceae). *Phytochemistry* 67, 2398–2402.

630 Samoisy, A.K., Mahomoodally, M.F., 2015. Ethnopharmacological analysis of medicinal plants used  
631 against non-communicable diseases in Rodrigues Island, Indian Ocean. *Journal of*  
632 *Ethnopharmacology* 173, 20–38.

633 Sanwal, R., Chaudhary, A.K., 2011. Wound healing and antimicrobial potential of *Carissa spinarum*  
634 Linn. in albino mice. *Journal of Ethnopharmacology* 135, 792–796.

635 Selowa, S.C., Shai, L.J., Masoko, P., Mokgotho, M.P., Magano, S.R., 2010. Antibacterial activity of  
636 extracts of three *Croton* species collected in Mpumalanga region in South Africa. *African*  
637 *Journal of Traditional, Complementary, and Alternative Medicines* 7, 98–103.

638 Silva, W.C., de Souza Martins, J.R., de Souza, H.E.M., Heinzen, H., Cesio, M.V., Mato, M.,  
639 Albrecht, F., de Azevedo, J.L., de Barros, N.M., 2009. Toxicity of *Piper aduncum* L. (Piperales:  
640 Piperaceae) from the Amazon forest for the cattle tick *Rhipicephalus (Boophilus) microplus*  
641 (Acari: Ixodidae). *Veterinary Parasitology* 164, 267–274.

642 Smadja, J., Vera, 1991. Essais préliminaires sur quelques plantes de La Réunion. *Plantes médicinales*  
643 *et phytothérapie* 25, 212–241.

644 Sohn, H.-Y., Son, K.H., Kwon, C.-S., Kwon, G.-S., Kang, S.S., 2004. Antimicrobial and cytotoxic  
645 activity of 18 prenylated flavonoids isolated from medicinal plants: *Morus alba* L., *Morus*  
646 *mongolica* Schneider, *Broussonetia papyrifera* (L.) Vent, *Sophora flavescens* Ait and  
647 *Echinosophora koreensis* Nakai. *Phytomedicine* 11, 666–672.

648 Stone, B.F., Haydock, K.P., 1962. A method for measuring the acaricide-susceptibility of the cattle  
649 tick *Boophilus microplus* (Can.). Bulletin of Entomological Research 53, 563–578.

650 Strasberg, D., Rouget, M., Richardson, D.M., Baret, S., Dupont, J., Cowling, R.M., 2005. An  
651 assessment of habitat diversity and transformation on La Reunion Island (Mascarene Islands,  
652 Indian Ocean) as a basis for identifying broad-scale conservation priorities. Biodiversity and  
653 Conservation 14, 3015–3032.

654 Thébaud, C., Warren, B., Strasberg, D., Cheke, A., 2009. Mascarene islands, biology, in: Gillespie,  
655 R.G. and Clague, D.A., (eds.), The Encyclopedia of Islands. University of California Press, 612-  
656 619.

657 Toyang, N.J., Ateh, E.N., Keiser, J., Vargas, M., Bach, H., Tane, P., Sondengam, L.B., Davis, H.,  
658 Bryant, J., Verpoorte, R., 2012. Toxicity, antimicrobial and anthelmintic activities of *Vernonia*  
659 *guineensis* Benth. (Asteraceae) crude extracts. Journal of Ethnopharmacology 144, 700–704.

660 Tsuchiya, H., Sato, M., Miyazaki, T., Fujiwara, S., Tanigaki, S., Ohyama, M., Tanaka, T., Iinuma,  
661 M., 1996. Comparative study on the antibacterial activity of phytochemical flavanones against  
662 methicillin-resistant *Staphylococcus aureus*. Journal of Ethnopharmacology 50, 27–34.

663 Valente, P.P., Amorim, J.M., Castilho, R.O., Leite, R.C., Ribeiro, M.F.B., 2013. In vitro acaricidal  
664 efficacy of plant extracts from Brazilian flora and isolated substances against *Rhipicephalus*  
665 *microplus* (Acari: Ixodidae). Parasitology Research 113, 417–423.

666 Vera, R., Smadja, J., Conan, J., 1990. Preliminary studies on some alkaloid plants in the Reunion  
667 Island. French. Plantes Medicinales et Phytotherapie 24, 50-65.

668 Wang, C.-F., Yang, K., You, C.-X., Zhang, W.-J., Guo, S.-S., Geng, Z.-F., Du, S.-S., Wang, Y.-Y.,  
669 2015. Chemical composition and insecticidal activity of essential oils from *Zanthoxylum*  
670 *dissitum* leaves and roots against three species of storage pests. Molecules 20, 7990–7999.

671 Wang, Y., Hamburger, M., Gueho, J., Hostettmann, K., 1989. Antimicrobial flavonoids from *Psiadia*  
672 *trinervia* and their methylated and acetylated derivatives. Phytochemistry 28, 2323–2327.

673 Wei, L.S., Wee, W., Siong, J.Y.F., Syamsumir, D.F., 2011. Characterization of anticancer,  
674 antimicrobial, antioxidant properties and chemical compositions of *Peperomia pellucida* leaf  
675 extract. *Acta Medica Iranica* 49, 670–674.

676 World Health Organization, 2015a. Global action plan on antimicrobial resistance.

677 World Health Organization, 2015b. Worldwide country situation analysis: Response to antimicrobial  
678 resistance.

679 World Health Organization (Ed.), 2014. Antimicrobial resistance: global report on surveillance.  
680 World Health Organization, Geneva, Switzerland.

681 Yimdjo, M.C., Azebaze, A.G., Nkengfack, A.E., Meyer, A.M., Bodo, B., Fomum, Z.T., 2004.  
682 Antimicrobial and cytotoxic agents from *Calophyllum inophyllum*. *Phytochemistry* 65, 2789–  
683 2795.

684 Zhang, Y., Luo, Z., Wang, D., He, F., Li, D., 2014. Phytochemical profiles and antioxidant and  
685 antimicrobial activities of the leaves of *Zanthoxylum bungeanum*. *Scientific World Journal* 2014,  
686 1–13.

688 **Table 1.** The studied plants: type, habitat, traditional uses and biocidal activity for the genus.

Family	Traditional uses in medicine and ethnoveterinary practices			Biocidal activities known in the genus		
	Botanical name Vernacular Créole name Plant type/habitat	Status	Found in literature	Collected in this study	Against arthropods	Against microbes
<b>Anacardiaceae</b>						
<i>Poupartia borbonica</i> J.F.Gmel. Bois de poupart, Zévi marron Shrub/semi-dry forests	End. R. M. P.	contraceptive, furuncle, nephritis (Lavergne, 2001; Smadja and Vera, 1991)	menopause, blood circulation disorders, fungi, insects	nd	nd	
<b>Apocynaceae</b>						
<i>Carissa spinarum</i> L. Bois amer Shrub/semi-dry forests	Ind. P.	skin disorders, wounds, gonorrhoea, stomach disorders, tonic, nephritis. (Poullain et al., 2004; Vera et al., 1990)	typhoid fever, fever	<i>C. edulis</i> (Nyahangare et al., 2015)	<i>C. lanceolata</i> (Lindsay et al., 2000) <i>C. spinarum</i> (Sanwal and Chaudhary, 2011).	
<i>Secamone volubilis</i> (Lam.) Marais Liane bois d'olive Liana/semi-dry forests	End. R. M.	hernia, diarrhoea, fever, diabetes, hypertension. (Poullain et al., 2004; Smadja and Vera, 1991)	cancer	<i>S. afzelli</i> (Adesina et al., 2012)	nd	
<b>Asteraceae</b>						
<i>Psiadia amygdalina</i> Cordem. Bois collant, Ti mangue Shrub/cloud forests	End. R	nd	nd	nd	} <i>P. trinervia</i> (Wang et al., 1989) <i>P. arguta</i> , <i>P. lithospermifolia</i> , <i>P. penninervia</i> , <i>P. terebinthina</i> , <i>P. viscosa</i> (Govinden-Soulange et al., 2004) nd	
<i>Psiadia boivinii</i> B.L.Rob. Bouillon blanc Shrub/dense cloud forests	End. R	nd	nd	nd		
<i>Psiadia dentata</i> DC. Bois collant, Ti mangue Shrub/dense cloud forests	End. R	nd	skin disorders (mycoses), insects	nd		
<i>Psiadia laurifolia</i> Cordem. Bois de tabac, Bois de chenille Tree/dense cloud forests	End. R.	nd	nd	nd		
<i>Psiadia retusa</i> DC. Saliette Shrub/rocky coastal areas	End. R. P.	nd	source of mineral salts	nd		

End: endemic, Ind.: Indigenous, R: Reunion Island, M: Mauritius Island, Mas: Mascarenes, P: Protected species, nd: no data



<i>Vernonia fimbrillifera</i> Less. Bois de source Shrub/rainforests	End. R.	nd	blood circulation, cancer, wound healing	<i>V. phosphorea</i> (Valente et al., 2013) <i>V. amygdalina</i> (Mwanauta et al., 2014) <i>V. auriculifera</i> (Gemedo et al., 2014)	<i>V. colorata</i> (Rabe et al., 2002) <i>V. amygdalina</i> (Erasto et al., 2006) <i>V. glabra</i> (Kitonde et al., 2012) <i>V. guineensis</i> (Toyang et al., 2012)
<b>Clusiaceae</b>					
<i>Calophyllum tacamahaca</i> Willd. Takamaka Tree/lowland rainforests	End. R. M.	eye diseases, rheumatism, headache, gout, arthritis, dermic problems (Lavergne, 2001)	skin disorders, memory troubles, rheumatism, blood circulation	<i>C. inophyllum</i> (Ademola et al., 2014; Agrawal and Mall, 1988; Kadir et al., 2015)	<i>C. moonii</i> , <i>C. thwaitesii</i> (Dharmaratne et al., 1999) <i>C. inophyllum</i> (Yimdjo et al., 2004) <i>C. canum</i> (Alkhamaiseh et al., 2012)  <i>C. antillanum</i> (Cuesta-Rubio et al., 2015)
<b>Combretaceae</b>					
<i>Terminalia bentzoe</i> (L.) Pers. Faux benjoin Tree/dry lowland forests	End. Mas.	fever, cold, cough, influenza, asthma, dysmenorrhoea, pleuritis paludism. (Lavergne, 2001; Poullain et al., 2004; Smadja and Vera, 1991)	reproductive disorders (spermatozoids), flu, bronchitis, cold	<i>T. catappa</i> (Rani et al., 2011)	<i>T. brachystemma</i> , <i>T. gazensis</i> , <i>T.</i> <i>mollis</i> , <i>T. prunioides</i> , <i>T. sambesiaca</i> , <i>T. sericea</i> , (Masoko et al., 2005)
<b>Euphorbiaceae</b>					
<i>Antidesma madagascariense</i> Lam. Bois de cabri Shrub/medium altitude forests	Ind.	nd	skin disorders, urine secretion	<i>A. bunius</i> (Belmi et al., 2014)	<i>A. thwaitesianum</i> (Dechayont et al., 2012) <i>A. venosum</i> (Mwangomo et al., 2012)
<i>Croton mauritanus</i> Lam. Ti bois de senteur Shrub/coastal areas	End. R. P.	fever (Poullain et al., 2004; Vera et al., 1990)	fever, cold, muscle pains	<i>C. linearis</i> (Alexander et al., 1991) <i>C. argyrophyloides</i> <i>C.</i> <i>nepetaefolius</i> , <i>C. sonderianus</i> <i>zehntneri</i> (Lima et al., 2013)	<i>C. urucurana</i> (Peres et al., 1997) <i>C. megalobotrys</i> (Selowa et al., 2010). <i>C. macrostachyus</i> (Obey et al., 2016)
<i>Stillingia lineata</i> (Lam.) Müll.Arg. Bois de lait Tanguin de pays Tree/lowland dry forests	Ind. P.	nd	chikungunya virus, furuncles	nd	nd
<b>Fabaceae</b>					
<i>Indigofera amnoxylum</i> (DC.) Polhill Bois de sable, Bois de rose Tree/steep gorges	End. R. P.	nd	hypercholesterolemia, diabetes	<i>I. tinctoria</i> (Kamal and Mangla, 1993)	<i>I. oblongifolia</i> (Dahot, 1999) <i>I. suffruticosa</i> (Leite et al., 2006)

End: endemic, Ind.: Indigenous, R: Reunion Island, M: Mauritius Island, Mas: Mascarenes, P: Protected species, nd: no data.

<i>Sophora denudata</i> Bory Petit tamarin des hauts Tree/high-altitude forests	End. R. M.	skin cancer (Poullain et al., 2004; Vera et al., 1990)	skin disorders (psoriasis, eczema)	<i>S. flavescens</i> (Mao and Henderson, 2007)	<i>S. alopecuroides</i> (Küçükboyacı et al., 2011) <i>S. oppositifolia</i> (Cota et al., 2011) <i>S. exigua</i> , <i>S. flavescens</i> (Krishna et al., 2012)
<b>Monimiaceae</b>					
<i>Monimia rotundifolia</i> Thouars Mapou Tree/lowland rainforests	End. R.	nd	nd	nd	nd
<b>Piperaceae</b>					
<i>Peperomia borbonensis</i> Miq. Pourpier Epiphyte succulent/highland rainforests	End. R.	nd	ticks	nd	<i>P. villipetiola</i> (Malquichagua Salazar et al., 2005) <i>P. fernandopoina</i> (Mbah et al., 2012; Ngemenya et al., 2006) <i>P. Pellucida</i> (Akinnibosun et al., 2008; Khan and Omoloso, 2002; Oloyede et al., 2011; Wei et al., 2011)
<b>Rutaceae</b>					
<i>Zanthoxylum heterophyllum</i> (Lam.) Sm. Poivrier des hauts Tree/rain/semi-dry forests	End. Mas. P.	back pain, toxins, fever (Lavergne, 2001; Poullain et al., 2004)	tooth lesion, local anaesthetic (mooth)	<i>Z. caribaeum</i> (Nogueira et al., 2014) <i>Z. dissitum</i> (Wang et al., 2015) <i>Z. heitzii</i> (Moussavi et al., 2015)	<i>Z. budrunga</i> (Islam et al., 2001) <i>Z. chalybeum</i> (Olila et al., 2001) <i>Z. zanthoxyloides</i> , <i>Z. leprieurii</i> (Misra et al., 2013) <i>Z. bungeanum</i> (Zhang et al., 2014)
<b>Stillbaceae</b>					
<i>Nuxia verticillata</i> Lam. Bois maigre Tree/medium altitude forests	End. R. M.	toxins, albuminuria, venereal diseases, intestinal transit disorders.  (Jonville et al., 2011; Lavergne, 2001; Poullain et al., 2004; Smadja and Vera, 1991)	hypercholesterolemia, stomach problems, malaria, urine secretion, albuminuria	nd	nd

End: endemic, Ind.: Indigenous, R: Reunion Island, M: Mauritius Island, Mas: Mascarenes, P: Protected species, nd: no data.

689

690

691

692 **Table 2.** Antimicrobial activity of ethyl acetate extracts of 16 plants from Reunion Island.

693

Plants	Parts used <sup>a</sup>	Gram-negative bacteria			Gram-positive bacteria			Fungi
		<i>Salmonella enterica</i>	<i>Pseudomonas aeruginosa</i>	<i>Escherichia coli</i>	<i>Streptococcus pyogenes</i>	<i>Listeria monocytogenes</i>	<i>Staphylococcus aureus</i>	<i>Aspergillus fumigatus</i>
<i>Antidesma madagascariense</i>	B	-	-	-	-	-	13.15 ± 0.21	-
<i>Calophyllum tacamahaca</i>	L	-	-	-	-	-	10.20 ± 0.28	-
<i>Croton mauritianus</i>	L	-	-	-	-	-	10.25 ± 1.18	-
<i>Monimia rotundifolia</i>	L	-	-	-	-	-	10.70 ± 0.23	-
<i>Nuxia verticillata</i>	L	-	-	-	-	9.67 ± 0.58	-	-
<i>Peperomia borbonensis</i>	L	8.77 ± 0.49	8.77 ± 0.40	9.87 ± 0.81	-	9.20 ± 1.11	-	7.97 ± 0.67
<i>Poupartia borbonica</i>	L	-	-	-	-	-	15.00 ± 0.60	-
<i>Psiadia amygdalina</i>	B	-	-	10.33 ± 0.58	-	-	-	-
<i>Psiadia boivinii</i>	L	-	-	-	-	-	10.67 ± 0.83	-
<i>Psiadia dentata</i>	L	-	9.87 ± 0.23	9.60 ± 0.40	-	9.70 ± 0.52	9.15 ± 1.20	-
<i>Psiadia retusa</i>	L	-	-	-	-	9.77 ± 0.38	10.50 ± 0.71	-
<i>Secamone volubilis</i>	L	-	-	-	-	-	11.70 ± 2.01	-
<i>Sophora denudata</i>	B	-	-	-	8.00 ± 0.00	10.27 ± 0.46	-	-
<i>Stillingia lineata</i>	L	-	-	-	-	-	10.15 ± 0.21	-
<i>Terminalia bentzoe</i>	L	-	-	-	11.70 ± 0.42	9.23 ± 0.06	8.80 ± 0.28	-
<i>Zanthoxylum heterophyllum</i>	B	-	-	-	-	-	9.70 ± 0.42	-
<b>Chloramphenicol</b>		31.30 ± 2.70	8.40 ± 0.53	21.60 ± 2.27	29.20 ± 0.81	29.57 ± 3.19	25.50 ± 0.81	-
<b>Amphotericine B</b>		-	-	-				10.67 ± 0.61

694

695 The growth inhibition was determined by paper disk diffusion. Inhibition diameters were given in mm ± standard deviation obtained in three  
696 replicates, ‘-’ means not active. Chloramphenicol was used as standard for bacteria, amphotericine B was the standard used for fungi.

697 <sup>a</sup>L = leaves, B = bark.

698

699

700

701

702 **Table 3.** Minimal inhibitory concentration (MIC, µg/mL) of 16 plants extracts from Reunion Island.  
 703

Plants	Parts used <sup>a</sup>	Gram-negative bacteria			Gram-positive bacteria			Fungi
		<i>Salmonella enterica</i>	<i>Pseudomonas aeruginosa</i>	<i>Escherichia coli</i>	<i>Streptococcus pyogenes</i>	<i>Listeria monocytogenes</i>	<i>Staphylococcus aureus</i>	<i>Aspergillus fumigatus</i>
<i>Antidesma madagascariense</i>	<b>B</b>	-	-	-	-	-	125.00	-
<i>Calophyllum tacamahaca</i>	<b>L</b>	-	-	-	-	-	62.50	-
<i>Croton mauritianus</i>	<b>L</b>	-	-	-	-	-	>1000.00	-
<i>Monimia rotundifolia</i>	<b>L</b>	-	-	-	-	-	1000.00	-
<i>Nuxia verticillata</i>	<b>L</b>	-	-	-	-	1000.00	-	-
<i>Peperomia borbonensis</i>	<b>L</b>	1000.00	1000.00	1000.00	-	1000.00	-	500.00
<i>Poupartia borbonica</i>	<b>L</b>	-	-	-	-	-	125	-
<i>Psiadia amygdalina</i>	<b>B</b>	-	-	>1000.00	-	-	-	-
<i>Psiadia boivinii</i>	<b>L</b>	-	-	-	-	-	>1000.00	-
<i>Psiadia dentata</i>	<b>L</b>	-	1000.00	1000.00	-	500.00	62.50	-
<i>Psiadia retusa</i>	<b>L</b>	-	-	-	-	500.00	125.00	-
<i>Secamone volubilis</i>	<b>L</b>	-	-	-	-	-	>1000.00	-
<i>Sophora denudata</i>	<b>B</b>	-	-	-	15.62	125.00	-	-
<i>Stillingia lineata</i>	<b>L</b>	-	-	-	-	-	>1000.00	-
<i>Terminalia bentzoe</i>	<b>L</b>	-	-	-	1000.00	>1000	1000.00	-
<i>Zanthoxylum heterophyllum</i>	<b>B</b>	-	-	-	-	-	>1000.00	-
Chloramphenicol		18.75	150.00	37.50	4.68	nt <sup>b</sup>	37.50	-
Amphotericine B		-	-	-	-	-	-	0.50

704

705 The minimum inhibitory concentration (MIC) expressed in µg/mL was determined by broth dilution. Chloramphenicol was used as standard for  
 706 bacteria, amphotericine B was the standard used for fungi. Three replicates were made for all extracts tested. ‘-’ means not active.

707 <sup>a</sup> L = leaves, B = bark.

708 <sup>b</sup> nt = not tested

709 **Figure captions**

710

711 **Figure 1. a) Map of the south-west Indian Ocean. b) The National Park and the repartition of the**  
712 **Reunion Island population.**

713 The 24 municipalities are represented as circles. The three mountains cirques appear in italic font.

714

715 **Figure 2. Percentage mortality for *Rhipicephalus microplus* larvae exposed to plant extracts**  
716 **(dilution 5%).** The Standard Deviation of the mean values are represented by error bars.

717 **Table captions**

718

719 **Table 1. The studied plants: type, habitat, traditional uses and biocidal activity for the genus.**

720

721 **Table 2. Antimicrobial activity of ethyl acetate extracts of 16 plants from Reunion Island.**

722 The growth inhibition was determined by paper disk diffusion. Inhibition diameters were given in mm ±

723 standard deviation obtained in three replicates, ‘-’ means not active. Chloramphenicol was used as

724 standard for bacteria, amphotericine B was the standard used for fungi.

725 <sup>a</sup>L = leaves, B = bark.

726

727 **Table 3. Minimal inhibitory concentration (MIC, µg/mL) of 16 plant extracts from Reunion Island.**

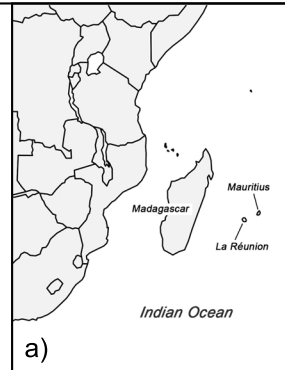
728 The minimum inhibitory concentration (MIC) expressed in µg/mL was determined by broth dilution.

729 Chloramphenicol was used as standard for bacteria, amphotericine B was the standard used for fungi.

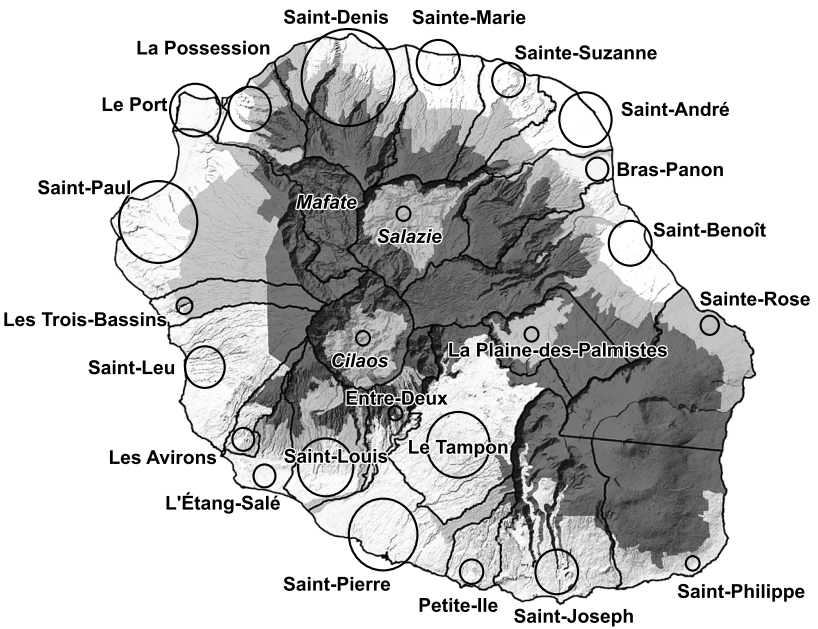
730 Three replicates were made for all extracts tested. ‘-’ means not active.

731 <sup>a</sup>L = leaves, B = bark.

732 <sup>b</sup> nt = not tested



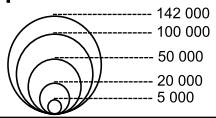
a)



**Réunion National Park**



**Population**



b)

