

Antibacterial activities of some medicinal plants used for treatment of infectious diseases in the Vina and Mayo-Louti Divisions of Cameroon

Abstract

Background: In Cameroon, most peoples use traditional medicine treating infectious diseases. In order to verify the scientific bases of these locally used medicinal plants, an ethnobotanical survey was carried out in some villages of Vina and Mayo-Louti Divisions.

Materials and methods: Interviews were conducted through structured questionnaires among 31 traditional healers living in these divisions. With the medicinal plants revealed, a literature investigation on their therapeutic effects, as well as *in vitro* antimicrobial activity of these plants were conducted. The agar diffusion method was used to determine the antibacterial activities of the methanol extracts against the pathogens while the Minimum Inhibitory Concentration (MIC) was determined using the Broth dilution method.

Result: A total of 15 medicinal plants species belonging to 12 families are being used in the treatment of numerous infectious diseases in the Vina and Mayo-Louti Divisions. *Khaya senegalensis* (Meliaceae), *Terminalia glaucescens* (Combretaceae), *Flacourtia flavescens* wild (Salicaceae), *Pterocarpus erinaceus* (Fabaceae) and *Boswellia dalzielii* (Burseraceae) were mostly used plants for the treatment of infectious diseases in the study area. Maceration (43.75%) was the common mode of preparation follow by infusion (31.25%) and decoction (25.00%). Bioassay showed that crude methanol extract of *Pterocarpus erinaceus* and *Flacourtia flavescens* were the most active plant extract with MIC of 0.8 mg/ml on some tested bacteria. The antibacterial activity of *Boswellia dalzeilii* from Cameroon are reported here for the first time.

Conclusion: Many herbals remedies are used in these divisions for the treatment infectious diseases. The plants can be used as source of antibacterial drugs to treat infections caused by susceptible bacteria

Keywords: antibacterial activities, medicinal plants, infectious diseases, Cameroon

29 1- INTRODUCTION

30 Infectious diseases are one of the leading causes of morbidity and mortality worldwide,
31 especially in developing countries [1]. Indeed, human commensal bacteria could become
32 pathogenic either due to a change in their normal behavior /habitat or a failure in the immune
33 system [2]. Furthermore, enteric fever caused by *Salmonella enterica* serotypes Typhi and
34 Paratyphi A, B, and C is mainly a disease in developing countries, and it is occasionally
35 diagnosed as an imported disease in countries where the disease is not endemic [3].

36 The discovery of antibiotics has decreased the spread and severity of a wide variety of
37 infectious diseases. However, as a result of their uncontrolled use, the efficiency of many
38 antibiotics is being threatened by the emergence of microbial resistance to existing
39 chemotherapeutic agents [4] such as direct destruction of antibiotics by penicillinase
40 producing bacteria, or resistance to the wide range use of Amphotericin B and azole
41 derivatives by pathogenic fungi [5].

42 While bioactive natural compounds have been isolated mainly from cultivable microbial
43 strains, unexploited biologically active metabolites of different sources including plants
44 remains to be investigated [6] to alleviate or help respond to current health care situations.

45 Plant derived natural products therefore represent an attractive source of antimicrobial agents
46 since they are natural, have manageable side effects and available at affordable prices [7]. In
47 addition, plants derived agents may have different mechanisms of action than conventional
48 drugs [8].

49 The diversity of Cameroun flora has a dominance of plants that have been used so fare for
50 many pharmacological purposes. Although traditional medicine has played and continue to
51 play a critical role worldwide in treating infectious diseases [9]; no scientific work has been
52 carried out to the best of our knowledge, in many parts of the country in order to index
53 medicinal plants used in these localities for the treatment of infectious diseases. Thus the
54 present proposal, which aims at carrying out an activities of medicinal plants used for the
55 treatment of infectious diseases in some localities of Vina and Mayo-Louti Division (Northern
56 Region of Cameroon).

57

58

59 2- Materials and Methods

60 2-1 Ethnobotanical survey and plant collection



61 This study took place in northern Cameroon, and more specifically in the Vina Division (6° 37'
62 60" latitude North and 13° 24' 0" longitude East) and the Mayo-Louti Division (9° 37' 60"
63 latitude North and 13° 55' 60" longitude East). In order to identify some plants used for the
64 treatment of infectious diseases such as malaria, typhoid, diarrhea and dysentery in these
65 regions, an ethnobotanical survey was carried out from April 2013 to November 2013
66 involving thirty-one traditional healers aged between 20 and 50 years. A questionnaire was
67 used for the survey and it comprised: types of medication (medicinal plants or pharmaceutical
68 products) used when sick; and for each medicinal plant used, its vernacular name, parts of the
69 plant used, methods of preparation and administration, diseases used for, the solvent used.

70 The interviews were conducted in the local language (foufouldé) in order to facilitate
71 communication. Fresh samples of plants were harvested and their identification confirmed at
72 the Cameroon National Herbarium (CNH), where their full scientific names and voucher
73 number were obtained. Further literature investigations were also conducted relative to their
74 therapeutic and/or pharmacological effects and their phytochemical composition. The plants
75 of interest in this study should be traditionally used for the treatment of infectious diseases in
76 the Department of Vina and the Department of Mayo-louti and should have been cited by at
77 least five traditional healers in both divisions. After ethnobotanical survey, *Khaya*
78 *senegalensis* (Meliaceae), *Terminalia glaucescens* (Combretaceae), *Flacourtia flavescens*
79 wild (Salicaceae), *Pterocarpus erinaceus* (Fabaceae) and *Boswellia dalzielii* (Burseraceae)
80 were selected for antimicrobial analyses.

81 2-2 Preparation of extracts

82 The bark and / or roots of four of the above plants were harvested in the Vina Division while
83 roots and bark of *Boswellia dalzielii* were harvested in the Mayo-Louti Division, shade-dried,
84 and ground. 500 grams of each powder were macerated in 2000 mL of methanol in an
85 Erlenmeyer flask. The mixture was filtered and the residue returned to the methanol after
86 every 24 hours. The operation was repeated twice. At the end of the 72 hours the filtrate was
87 concentrated using a Rotary evaporator at 45°C. The resulting extract was weight (196.34 g),
88 stored in sterile, clean and dry flasks prior to usage

89 **2-3 Microorganisms**

90 Microorganisms were obtained from the Laboratory of Microbiology and Antimicrobial
91 Substances of the University of Dschang. All the ten microorganisms investigated, were
92 associated with numerous cases of human infections. The microorganisms were two Gram-
93 positive bacteria (*Bacillus cereus* and *Staphylococcus aureus*), while eight Gram-negative
94 bacteria (*Escherichia coli*, *Klebsiella pneumoniae*, *Proteus mirabilis*, *Pseudomonas*
95 *aeruginosa*, *Salmonella typhi*, *Salmonella typhimurium*, *Salmonella paratyphi A*, *Salmonella*
96 *paratyphi B*). All the microorganisms were maintained at 4 °C on Muller Hinton Agar.

97 **2-4 Phytochemical screening of plants extracts**

98 Phytochemical screening aim to estimate the nature of secondary metabolites responsible for
99 the biological activity of plant extracts. Phytochemical Screening was carried out, according
100 to the methods described by Prashant et al. [10] and Shaheen et al. [11].

101 **2-5 Antibacterial test**

102 Microbiological screening of the crude extracts was evaluated by the agar diffusion method
103 (agar well diffusion method) as described by Abubakar [12] and Titilope et al. [13]. The Petri
104 dish were incubated overnight at 37°C and microbial growth was determined by measuring
105 the inhibition zone diameter. The extracts were considered active when the inhibition zone
106 diameter was greater than or equal to 14 mm. For each bacterial strain, controls were done
107 and pure solvents were used instead of the extract. The experiment was done three times and
108 the mean values are presented.

109 **2-6 Determination of Minimal Inhibitory Concentration (MIC) and Minimal** 110 **Bactericidal Concentration (CMB)**

111 The MIC and CMB were determined by the method of micro dilution in a liquid medium [9].
112 In the 96-well microplates, 100 µL of double concentrated culture broth (MHB) were added to
113 each well. These wells were then supplemented with the various extracts (100 µL) and
114 reference antibiotic (ceftriaxone) concentrations ranging from 12000 to 93.75 µg / mL and
115 from 50 to 0.39 µg / mL respectively. Finally, 10 µL of bacteria inoculum 1.5×10^6 CFU/mL
116 were introduced into each well. Control wells containing only the broth and those containing
117 the inoculum without extract or antibiotics were made.

118 After 24 hours of incubation at 37°C, 20 µL of 2% MTT (Methylthiazolyl-diphenyl
119 tetrazolium bromide) solution were added in one test wells of each repeated concentration.

120 This compound is instantly metabolized (reduced) by the active living cell mitochondrial
 121 succinate dehydrogenase to formazan to form a purple precipitate whose intensity is
 122 proportional to the amount of living cells and the metabolic activity of each cell. The lowest
 123 concentration at which no visible color change was observed was considered as the MIC. For
 124 wells that did not receive a developer, 20 µl of solution of the wells corresponding to the
 125 concentrations that did not display the blue-violet color were removed and streaked on the
 126 surface of the MHA previously poured into Petri dishes. After 24 hours of incubation at 37°
 127 C, the concentrations of wells having less than three bacterial colonies were considered
 128 bactericidal and the smallest of these, noted as CMB.

129 **2-7 Data analyses**

130 Descriptive statistic was principally used in this study. Initially, information on the popular
 131 uses of the species collected, along with botanical information, was compiled into a database.
 132 The species were listed in alphabetical order by scientific name, popular name in the region
 133 (vernacular name), voucher number and frequency of use. The frequency of citation (FC) of
 134 the used plant species was evaluated using the following formula:

$$FC = \frac{\text{Number of times a particular species was mentioned}}{\text{Total number of times that all species were mentioned}}$$

135 Quantitative data were subjected to one-way analysis of variance, and differences between
 136 samples at $P \leq 0.05$ were determined by Duncan Multiple Range Test using the Statistical
 137 Package for the Social Sciences (SPSS) program. The experimental results were expressed
 138 (where appropriate) as mean \pm standard deviation of three replicates.

139 **3. Results**

140 **3-1 Ethno-pharmacological survey and phytochemical screening of extracts**

141 The set of plants recorded during the ethnobotanical survey and their frequency of citation are
 142 grouped in Table 1. A total of 15 plants belonging to 12 botanical families were identified.
 143 The leaves were the most used parts followed by the bark. The 05 (five) most common plants
 144 (cited 5 times and more) were: *Boswellia dalzielii*, *Pterocarpus erinaceus*, *Khaya*
 145 *senegalensis*, *Flacourtia flaveces* and *Terminalia glaucescens*.

146 About three of the plants obtained are used to treat at least three others diseases. This is the
 147 case of *Khaya senegalensis* (Rheumatoid arthritis, Syphilis, leprosy); *Jatropha curcas*
 148 (Hypertension, rheumatism, diabetes); *Euphobia hirta* (Skin diseases, bronchitis and asthma).

149 Three of these plants (*Boswellia dalzielii*, *Flacourtia flavescens* and *Terminalia glaucescens*)
150 presented higher frequencies of citation.

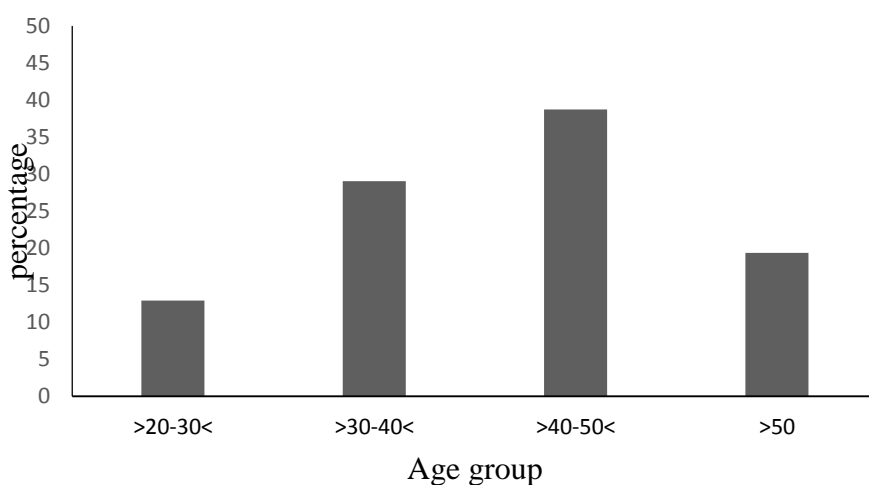
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Table 1: Keck-list of medicinal plants species inventoried during the survey

N°	Botanical/ Scientific name	family	Local name (foufoulde)	Parts used	Methods of Preparation	Frequency	Others uses/effects
1	<i>Khaya senegalensis</i>	Meliaceae	Dalehi	Barks, roots	Maceration	6/59	Rheumatoid arthritis, Syphilis, leprosy [14,15]
2	<i>Pterocarpus erinaceus</i>	Fabaceae	Banohi	barks	Maceration	7/59	Febrifuge [16]
3	<i>Eucalyptus sp</i>	Myrtaceae		Leaves	Decoction	3/59	Antidiabetic, anticancer [17,18]
4	<i>Boswellia dalzielii</i>	Burseraceae	Andakedje	Barks, roots	Maceration	8/59	Venereal diseases, rheumatism [19]
5	<i>Flacourtia flavescens</i>	Flacourtiaceae		Barks	Decoction	5/59	Jaundice, stomach pain [20]
6	<i>Terminalia glaucescens</i>	Combretaceae	Koulahi	Barks, roots	Maceration	5/59	Hemorrhoids [21]
7	<i>Jatropha curcas</i>	Euphorbiaceae	Kolkoladjé/ Magalehi	Leaves	Infusion	2/59	Hypertension, rheumatism, diabetes [22]
8	<i>Euphobia hirta</i>	euphorbiaceae	Kosam-yel	Whole plant	Maceration	3/59	Skin diseases, bronchitis and asthma [23]
9	<i>Psorospermum febrifugum</i>	Hypericaceae	Cawayki	Leaves, barks	Maceration /Infusion	4/59	Epilepsy disease [24]
10	<i>Harungana madagascarensis</i>	Hypericaceae	Bourgal	Leaves	Infusion	4/59	Anti-haemorrhage, skin diseases[25, 26]
11	<i>Vitellaria paradoxa</i>	Sapotaceae	Karehi	Leaves, barks	Infusion	3/59	Cutaneous infection, stomach ailments [27]
12	<i>Aloes buettneri</i>	Liliaceae		Leaves	Maceration	4/59	Dysmenorrhea, general stomach aches [28]
13	<i>Citrus limonum</i>	RutaceaeMyrtaceae	Lemou	Leaves, Fruit	Infusion	1/59	Arthritis [29]
14	<i>Carica papaya</i>	Caricaceae	Dukudjee	Leaves, roots	Decoction	3/59	Colon cancer, heart attacks [18]
15	<i>Ocimum gratissimum</i>	lamiaceae	kacuke	Leaves	Decoction	1/59	respiratory tract infections, skin diseases, and conjunctivitis [30]

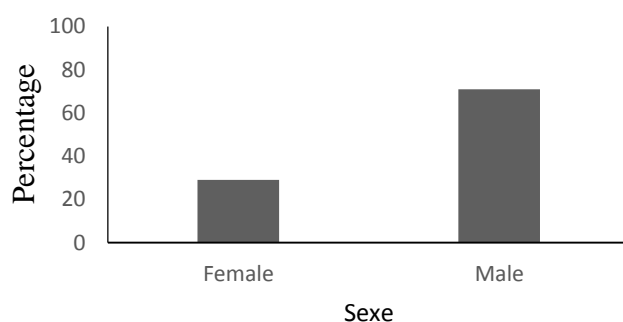
153 3-2 Demography/Personal Information on Respondents

154 The characteristics of population are presented in figure 1 to 4. From figure 1 it is noted that
 155 thirty-one (31) traditional healers were interviewed. The informants were between 20 and 50
 156 years old (figure 3), and the modal class was 39 to 49 years old. The age distribution of
 157 informants showed that most of the traditional healer encountered during the survey are
 158 within the age range 29-49. Among these informants, there were 9 women and 22 men (figure
 159 2).



160

161 Figure 1: Distribution of 31 traditional healers surveyed by a sex



162

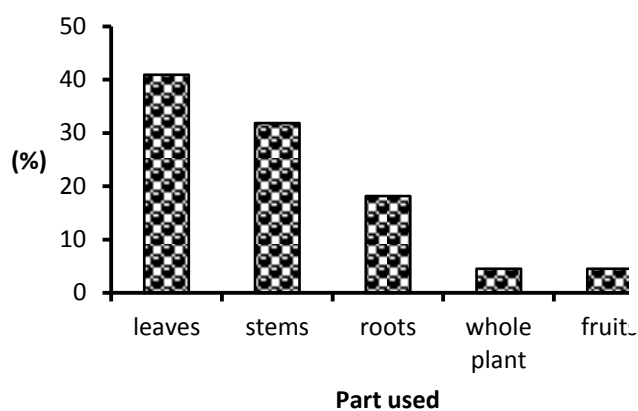
163 Figure 2: Distribution of informant's sex

164 3-3 Parts of plant used, mode of preparation

165 Leaves, roots, stems, whole plant, fruits, seeds and barks were used for numerous
 166 preparations. Amount these, the most commonly used plant parts (Fig. 3). were the leaves
 167 (40.91%), followed by stems (31.81%), roots (18.18%), fruits (4.55%) and whole plant

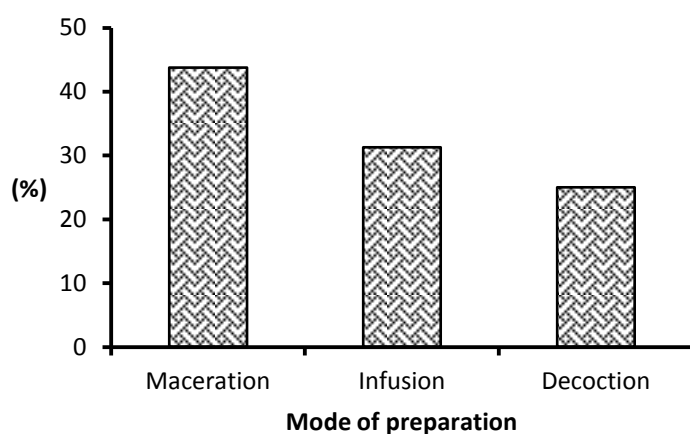
168 (4.55%). Water was the only solvent used for different preparations that included maceration
 169 (43.75%), infusion (25.25%) and decoction (25.00%) (Figure 4).

170



171

172 Figure 3: Percentage distribution of medicinal plant parts used



173

174 Figure 4: Methods of preparation of plants

175 After investigation, five most used plants caught our attention. They were latter collected and
 176 used for biological tests.

177 3-4 Phytochemical screening

178 Plants samples were screened for the following classes of compounds: polyphenols, tannins,
 179 terpenes steroids, flavonoids, alkaloids, anthraquinone and saponins. This test revealed the
 180 presence of different classes of chemical compounds in each of these extracts. (Table 2).

181

182

183 Table 2: Phytochemical profile of methanolic crude extracts

Samples	Polyphenols	Tannins	flavono ids	Sterols and tri terpenes	glycosides	alkaloids	Anthraquinones	saponins
Bde	+	+	-	+	+	-	+	+
Bdr	+	+	+	+	+	+	+	-
Pe	+	+	+	+	+	+	+	-
Ff	+	+	+	+	-	-	+	-
Ks	-	-	+	+	-	+	-	-
Tge	+	+	-	+	-	+	-	+
Tgr	+	+	+	-	-	+	+	+

184 Key: + = Present; - = Absent; Tge: *Terminalia glaucescens* stem; Tgr: *Terminalia glaucescens* root; Ks:
 185 *Khaya senegalensis*; Pe : *Pterocarpus erinaceus*; Bde: *Boswellia dalzielii* stem; Bdr: *Boswellia dalzielii* root; Ff:
 186 *Flacourtia flavescens*

187 3-5 Sensitivity of bacteria to methanolic crude extracts

188 Table 3 below summarizes the behavior of different germs vis-à-vis the tested extracts.

189 Except for *Flacourtia flavescens* extract, *Bacillus cereus* was the most sensitive bacterium.

190 On the other hand, *Pseudomonas aeruginosa* is resistant to 4 extracts (Tgr, Ks, Bde and Bdr)

191 followed by *Salmonella para typhi* A which is resistant to Tge, Tgr, Bde and Bdr.

192

193 3-6 MIC and CMB of the crude methanolic extracts

194 It can be seen from table 4 that *Terminalia glaucescens* bark extracts as well as root extract of

195 *Pterocarpus erinaceus* and *Flacourtia flavescens* showed a good activity with regard to Gram-

196 positive bacteria with MICs varying between 0.75 mg/mL and 1.5 mg/mL. In contrast,

197 *Boswellia dalzielii* bark extract had the smallest activity with an MIC of 12 mg/mL and

198 CMB> 12mg/mL

200 Table 3: Diameter of inhibition zones of methanolic crude extracts on bacteria at 25 mg/mL

Extrait souche	Tge	Tgr	Ks	Pe	Bde	Bdr	Ff	Cef
Ec	17.5 ± 0.5 ^{de}	17.5 ± 0.5 ^{bc}	19.5 ± 0.5 ^e	16.5 ± 0.5 ^d	18.5 ± 1.5 ^d	5.0 ± 0.5 ^{ab}	19.5 ± 0.5 ^e	26.8 ± 0.3
Kp	18.5 ± 0.5 ^e	20.0 ± 0.0 ^c	22.0 ± 0.0 ^f	11.5 ± 0.5 ^a	16.5 ± 0.5 ^{cd}	10.5 ± 0.5 ^{bc}	10.5 ± 0.5 ^b	24.3 ± 0.8
PM	16.5 ± 0.5 ^d	18.0 ± 1.0 ^c	20.5 ± 0.5 ^{ef}	10.5 ± 0.5 ^a	13.5 ± 0.5 ^{ab}	11.5 ± 0.5 ^c	0 ± 0.0 ^a	27.5 ± 0.5
Pa	15.0 ± 0.0 ^c	15.5 ± 0.5 ^{ab}	15.5 ± 0.5 ^b	14.5 ± 0.5 ^{bc}	13.5 ± 0.5 ^{ab}	0.0 ± 0.0 ^a	10.5 ± 0.5 ^b	26.0 ± 0.5
St	14.5 ± 0.5 ^c	18.0 ± 2.0 ^{bc}	20.5 ± 0.5 ^{ef}	15.5 ± 0.5 ^{cd}	16.0 ± 1.0 ^{cd}	10.5 ± 0.5 ^{bc}	20.5 ± 0.5 ^e	28.0 ± 1.0
Stm	14.5 ± 0.5 ^c	18.5 ± 0.5 ^{bc}	12.0 ± 0.0 ^a	18.5 ± 0.5 ^e	17.5 ± 0.5 ^d	9.5 ± 0.5 ^{bc}	19.5 ± 0.5 ^e	22.5 ± 1.0
Spa	10.5 ± 0.5 ^a	14.5 ± 0.5 ^a	17.5 ± 0.5 ^{cd}	13.5 ± 0.5 ^b	13.0 ± 1.0 ^{ab}	0.0 ± 0.0 ^a	19.5 ± 0.5 ^e	29.3 ± 0.8
SPb	14.5 ± 0.5 ^c	17.5 ± 0.5 ^{bc}	19.0 ± 1.0 ^{de}	15.5 ± 0.5 ^{cd}	18.5 ± 1.5 ^d	10.0 ± 0.0 ^{bc}	20.5 ± 0.5 ^e	26.0 ± 0.0
Sa	12.5 ± 0.5 ^b	17.5 ± 0.5 ^{bc}	16.5 ± 0.5 ^{bc}	10.5 ± 0.5 ^a	11.5 ± 0.5 ^a	11.5 ± 0.5 ^c	13.5 ± 0.5 ^c	29.8 ± 0.3
BC	20.5 ± 0.5 ^f	27.0 ± 1.0 ^d	22.0 ± 0.0 ^f	19.0 ± 1.0 ^e	18.5 ± 1.5 ^d	13.5 ± 0.5 ^c	17.5 ± 0.5 ^d	29.5 ± 0.5

201 The values are the mean of the inhibition diameter ± standard error of the mean of 3 repetitions. a, b, c, d, and f: in the same column, the assigned values of the same letters
202 are not significantly different (p < 0.05); Ec: *Escherichia coli*; Kp: *Klebsiella pneumoniae*; PM: *Proteus mirabilis*; Pa: *Pseudomonas aeruginosa*; St: *Salmonella typhi*; Stm:
203 *Salmonella typhimurium*; Spa: *Salmonella paratyphi A*; Spb: *Salmonella paratyphi B*; Sa: *Staphylococcus aureus*; BC, *Bacillus cereus*; Tge: *Terminalia glaucescens* stem; Tgr:
204 *Terminalia glaucescens* root; Ks: *Khaya senegalensis*; Pe: *Pterocarpus erinaceus*; Bde: *Boswellia dalzielii* stem; Bdr: *Boswellia dalzielii* root; Ff: *Flacourtia flavescens*;
205 ceftriaxone

206 Table 4: Minimal Inhibitory Concentrations (MIC) in mg / ml of Methanolic crude extract
 207 against bacterial strains

Extract		Ec	Kp	PM	Pa	St	Stm	Sa	Bc	SpA	SpB
Tge (mg/mL)	CMI	3.0	3.0	3.0	3.0	1.5	1.5	1.5	1.5	3.0	1.5
	CMB	>12	12	12	>12	>12	>12	12	12	>12	>12
	CMB/CMI	>4	4	4	>4	>4	>4	>4	>4	>4	>4
Tgr (mg/mL)	CMI	1.5	3.0	1.5	3.0	3.0	3.0	1.5	1.5	3.0	3.0
	CMB	>12	>12	12	>12	>12	>12	>12	6	12	>12
	CMB/CMI	>4	>4	>4	>4	>4	>4	>4	4	>4	>4
Pe (mg/mL)	CMI	0.8	6.0	3.0	3.0	0.8	0.8	0.8	0.8	1.5	1.5
	CMB	6	12	12	12	6	3.0	6	6	12	>12
	CMB/CMI	>4	2	4	4	>4	4	>4	>4	>4	>4
Bde (mg/mL)	CMI	3.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	6.0	3.0
	CMB	>12	>12	>12	>12	>12	>12	>12	>12	>12	12
	CMB/CMI	>4	>4	>4	>4	>4	>4	>4	>4	>4	4
Bdr (mg/mL)	CMI	3.0	3.0	0.8	3.0	3.0	3.0	1.5	3.0	1.5	3.0
	CMB	6	>12	6	6	>12	>12	>12	6	12	>12
	CMB/CMI	2	>4	>4	2	>4	>4	>4	2	>4	>4
Ks (mg/mL)	CMI	1.5	3.0	1.5	6.0	1.5	3.0	3.0	1.5	6.0	1.5
	CMB	6	6	6	>12	>12	12	>12	>12	6	12
	CMB/CMI	4	2	4	>4	>4	4	>4	>4	1	>4
Ff (mg/mL)	CMI	3.0	0.8	6.0	6.0	3.0	3.0	0.8	0.8	1.5	0.8
	CMB	>12	6	12	>12	>12	>12	6	3.0	6	12
	CMB/CMI	>4	>4	2	>4	>4	>4	>4	4	>4	>4
Cef (µg/mL)	CMI	6.25	6.3	12.5	12.5	3.1	6.25	3.1	6.3	12.5	6.3
	CMB	25	25	50	50	25	25	25	50	50	25
	CMB/CMI	4	4	4	4	>4	4	>4	>4	4	4

208 Ec : *Escherichia coli* ; Kp : *Klebsiella pneumoniae* ; Pm : *Proteus mirabilis* ; Pa : *Pseudomonas aeruginosa* ; St :
 209 *Salmonella typhi* ; Stm : *Salmonella typhimurium* ; Spa : *Salmonella paratyphi A* ; Spb : *Salmonella paratyphi B* ;
 210 Sa : *staphylococcus aureus* ; Bc, *bacillus cereus* Tge: *Terminalia glaucescens* stem; Tgr: *Terminalia*
 211 *glaucescens* root; Ks: *Khaya senegalensis*; Pe: *Pterocarpus erinaceus*; Bde: *Boswellia dalzielii* stem; Bdr:
 212 *Boswellia dalzielii* root; Ff: *Flacourtia flavescens*; cef : ceftriaxone

213

214 **4- Discussion**

215 According to the survey in the Vina and mayo-Louti divisions, a total 15 medicinal plants
 216 belonging to 12 botanical families were used in treating different infectious diseases.

217 From table 1, *Pterocarpus erinaceus* and *Boswellia dalzielii* were the most common plants
 218 reported to be used in the management of infectious diseases in the northern region with
 219 frequencies of 8 (13.6%) and 7 (11.86%) respectively. *Boswellia dalzeilii* is a species of the
 220 Genus *Boswellia* that grows in the northern part of Cameroon[31].

221 Three plants species (*Boswellia dalzielii*, *Flacourtia flavescens* and *Terminalia glaucescens*)
 222 presented higher frequencies of citation. This may be linked to their efficacy since these

223 plants are reported, in Cameroon as well as in other parts of the world, to be used for the
224 treatment of infectious diseases [31-33].

225 Indeed, ethnobotanical surveys in many Cameroonian localities reported that *Boswellia*
226 *dalzielii*, *Flacourtia flavescens* and *Terminalia glaucescens* are used for the treatment of
227 malaria, shingles, ringworm [34, 35]. These traditional knowledge on the therapeutic effects
228 of the above medicinal plants are confirmed by various pharmacological study data, which
229 demonstrated immunomodulatory activities of *B. dalzielii* aqueous extract and methanol
230 fraction [31]; the antibacterial activities of *T. glaucescens* of ethanol extract of bark and root
231 with MIC between 0.625 to 1.25 mg/ml[21]; the antioxidant properties of methanolic extracts
232 of *Flacourtia flavescens* [36].

233 From figure 1 it is noted that thirty-one (31) traditional healers were interviewed. The
234 informants were between 20 and over 50 years old, and the modal class was 40 to 50 years
235 old. Among these informants, there were 9 women and 22 men (figure 2). These small
236 number could be due to the fact that traditional healers are scarce throughout our country [37]
237 and thus represent a very little portion of the general population and also because some of
238 them refused to be interviewed. This might also be due to the fact that, young people to
239 whom traditional knowledge on medicinal plants effects could have been transmitted are not
240 eager to learn and exile to city for jobs and better living condition purposes [37]. This
241 situation is the same worldwide since cultural changes as a result of westernization and
242 modernization has contributed enormously in making the younger generation undermine
243 African traditional values [38]. The low representativeness of women in this study is due, on
244 the one hand, to the fact that traditional medicine has long been exercised by men and also to
245 the fact that in these Regions women are not allowed to interact with foreigners.

246 Data from figure 3 showed that, the most commonly used plant parts were the leaves
247 (40.91%). In fact, leaves are known to accumulate plants secondary metabolites such as
248 alkaloids, tannins and saponin, which are active components responsible for many medicinal
249 properties [39]. Moreover, utilization of leaves and stems is advantageous since their harvest
250 does not induce irreversible destruction of plants like that of roots or whole plant [40].

251 Medicinal plants were prepared in different forms including maceration (43.75%), infusion
252 (25.25 %) and decoction (25.00%) (figure. 4). These preparations are made only with water
253 and orally administered. These modes of preparation and administration are the most used in
254 traditional medicine. Similar results were obtained in previous ethnobotanical surveys carried
255 out in Cameroon and other part of the world [38, 41, 42]. The high frequency of maceration is

256 related to the fact that this method does not alter the active principle as infusion and decoction
257 does.

258 **Antimicrobial activity of selected plants**

259 According to Popova et al., [43] scale, which state that natural products with minimum
260 inhibitory concentrations (MIC) range between 100–1000 $\mu\text{g mL}^{-1}$ *in vitro* on at least one
261 Gram-positive and one Gram-negative bacteria can be classified as antimicrobials, crude
262 extract of *Pterocarpus erinaceus* and *Flacourtia flavescens* shown good antibacterial activity
263 (MIC = 750 $\mu\text{g/ml}$).

264 These observations corroborate those authors, who confirmed the use of these plants in the
265 treatment of infectious diseases [34, 43, 44]. This may be ascribed to the different classes of
266 compounds found in these extracts. In fact, the phytochemical screening of these extracts
267 revealed the presence of phenols, tannins, terpenoids, flavonoids, steroids, alkaloids,
268 anthraquinones, anthocyanins, saponins and coumarins. individual antibacterial activities of
269 these secondary metabolites have been demonstrated [46, 47]. Nevertheless, *Boswellia*
270 *dalzielii* root extract was active only against *P. mirabilis*. But, *Terminalia glaucescens* stem
271 extract, *Terminalia glaucescens* root extract and *Khaya senegalensis* extract shown moderate
272 activity (MIC 1500 to 3000 $\mu\text{g/mL}$) depending on the bacterium.

273 The antibacterial activity of *Boswellia dalzielii* from Cameroon are reported here for the first
274 time. The values of the diameters of inhibition, MICs and MBC showed that the degree of
275 activity varied with the bacteria and the extracts. This variation of the activity could be due to
276 the difference of solubility of the active ingredient in each extract on the one hand and to the
277 constitutional or structural variability of the tested germs on the other hand. Also, it could be
278 due to the capacity of the organisms to modify the structure of the active principle [2].
279 Moreover, the differences in susceptibility may be explained by the differences in cell wall
280 composition and/or genetic content of plasmids that can be easily transferred among strains.

281 **Conclusion**

282 This ethnobotanical survey study has revealed that there is high knowledge and use of
283 medicinal plants in northern Cameroon. Methanol crude extract of different plants showed
284 different degrees of antibacterial activities against bacterial strains enteropathogenic used.
285 These biological results allowed us to conclude that the methanol extracts of the *Boswellia*
286 *dalzielii* roots as well *Flacourtia flavescens* and *Pterocarpus erinaceus* barks are the most
287 active. The information from this study can serve as guide for the discovery of new
288 antibacterial drugs from medicinal plant

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