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# The best African plant-derived antibacterial products for clinical perspectives: The state-of-the-art

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## Abstract

**Background:** The global burden of bacterial infections remains a serious health concern. In the present review, we have summarized the best botanicals and phytochemicals from the flora of Africa that deserve clinical studies to develop novel antibacterial drugs to combat enterobacteria, *Pseudomonas aeruginosa*, Gram-positive bacteria, and mycobacteria.

**Methods:** Data were retrieved from scientific databases such as PubMed, Scopus, ScienceDirect, Google Scholar, and Web of Science using the keywords “African country and plant and antibacterial” and plants or phytochemicals with outstanding antibacterial activities following established cutoff point standards were selected.

**Results:** The identified botanicals were from *Acacia polyacantha*, *Alchornea floribunda, Artemisia abyssinica, Beilschmiedia acuta, Eriosema glomeratum, Harungana madagascariensis, Macaranga capensis*, *Macaranga conglomerata, Macaranga kilimandscharica, Mangifera indica, Piper nigrum, Piptadeniastrum africanum,* and *Uapaca togoensis*. The phytochemicals identified included 2-(4-hydroxyphenyl)-ethyltriacontanoate (**1**), 1,3,5,6-tetrahydroxyxanthone (**2**), 1,3,5,7-tetrahydroxyxanthone (**3**), 8,8-bis-(dihydroconiferyl) diferulate (**4**), 2-hydroxy-3-methoxy-9,10-dioxo-9,10-dihydroanthracene-1-carbaldehyde (**5**), allanxanthone D (**6**), *angusticornin* B (**7**), bartericin A (**8**), diospyrone (**9**), dorsmanin C (**10**), gancaonin Q (**11**), isobavachalcone (**12**), isoliquiritigenin (**13**), laburnetin (**14**), $O^1$-demethyl-3',4'-deoxy-psorospermi-3',4' diol (**15**), plumbagin (**16**), and vismiaquinone (**17**).

**Conclusion:** These plant-derived products deserve clinical investigations to develop novel antibacterial agents to combat bacterial infections.

**Keywords:** Africa; antibacterial; botanicals; phytochemicals

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## Background

The global burden of bacterial infections remains a serious health concern. This situation is more complicated as bacteria continually develop various resistance mechanisms to existing and newly discovered antibiotics [1-4]. It was reported that up to 700,000 people worldwide die yearly due to drug resistant infections [5]. It was also projected that by 2050, the number of deaths due to microbial infections will reach 4.73 million in Asia, 4.15 million in Africa, 0.39 million in Europe, 0.392 million in Latin America,0.317 million in North America, and 0.022 million in Oceania [6]. In-depth search of new antibacterial drugs should remain a priority for scientists to limit as much as possible the damage caused by infectious diseases, including those caused by resistant pathogens. The role of medicinal plants as a good source of drugs to tackle human ailments including the various type of diseases with resistant phenotypes has been largely documented [7-35]. Increasingly, new strategies for discovering new bioactive substances from natural sources include the use of multidrug-resistant models. This has been particularly successful in the search for novel anticancer, antibacterial, and antifungal drugs, as well as new antiparasitic and antiviral drugs in the last two decades. Numerous research teams such as those of Professors Thomas Efferth of the University of Mainz in Germany and Victor Kuete of the University of Dschang in Cameroon have invested heavily in recent years in multidrug-resistant models of cancer cells and bacteria overexpressing efflux pumps [36-43]. The role of African plants and their constituents as potential sources of antibacterial agents have deeply been demonstrated [44-46]. The ability of many of the antibacterial plants from the flora of Africa and their constituents to prevent the development of multidrug-resistant (MDR) bacteria has been reported [47-51]. The research for novel plant-derived antibacterial agents has been particularly fruitful in some African countries such as Egypt, South Africa, Nigeria, Tunisia, and Cameroon. In the present review, the state-of-the-art antibacterial drug discovery from the resource of Africa will be highlighted.

## Methods

Data were retrieved from scientific databases such as PubMed, Scopus, ScienceDirect, Google Scholar, and Web of Science using the keywords “African country and plant and antibacterial” and plants or phytochemicals with outstanding antibacterial activities following cutoff point standards earlier established for enterobacteria, *Pseudomonas aeruginosa,* Gram-positive bacteria, and mycobacteria [52-55].

## Results and discussion

*History of the antimicrobial drug research in Africa*

When using the combination of keywords (country + plant + antibacterial) in the PubMed database, though not accurate, an idea of the history of medicinal plant research in Africa about bacterial infections has been determined (Table 1). The first paper on the topic was published on the Egyptian plant *Nigella sativa* L Ranunculaceae) by Toppozada and co-workers in 1965 [56]. In general, in most African countries, this research began in the 70s in Nigeria, Kenya, and Ghana, 80s in Sudan, 90s in South Africa, Cameroon, Morocco, Ethiopia, and Algeria, and even in 2000 in Tunisia. By April 2024, the number of scientific publications in the PubMed database related to the above combination of keywords showed a huge gap between African countries, with countries such as Egypt, South Africa, Nigeria, Tunisia, and Cameroon appearing in the top 5 with more than 300 published papers. Other African countries with more than 100 scientific publications included Morocco, Ethiopia, and Algeria, meanwhile less than 100 papers were found for Kenya, Ghana, and Sudan (Table 1).

*The antibacterial cutoff points*

In 2008, the first threshold values were suggested by Fabry et al. as minimal inhibitory concentration (MIC) values below 8 mg/mL for botanicals with noteworthy antimicrobials [57]. Since then, things have evolved and plant extracts with MIC values above 1000 µg/mL are now considered not active. Later on, Simoes et al. suggested the MIC in the range of 100 to 1000 µg/mL for phytochemicals as antimicrobial agents [58]. Also, Jimenez-Arellanes suggested MICs between 100-200 µg/mL as interesting for crude extracts [59]. In 2010, Kuete [60] suggested ranking the antibacterial effects of plant-derived products as follows: significant (MIC < 100 µg/mL), moderate (100 < CMI≤625 µg/mL) or weak (CMI>625 µg/mL) for crude extracts and also that significant (MIC <10 µg/mL), moderate (10 <MIC ≤ 100 µg/mL), and low (MIC> 100 µg/mL) for natural compounds. In 2017, Tamokou et al. [61] further suggested the following cut-off points for edible parts of the plants: as highly active (MIC below 100 µg/mL), significant (100 ≤ MIC ≤ 512 µg/mL), moderate (512 < MIC ≤ 2048 µg/mL), low (MIC > 2048 µg/mL) and not active (MIC > 10 mg/mL) for botanicals but also the following for phytochemicals: highly active (MIC below 1 µg/mL or 2.5 µM), significantly active (1 ≤ MIC ≤10 µg/mL or 2.5 ≤ MIC < 25 µM), moderately active (10 < MIC ≤ 100 µg/mL or 25 ≤ MIC < 250 µM), low activity (100 < MIC ≤ 1000 µg/mL or 250 ≤ MIC < 2500 µM), and not active (MIC > 1000 µg/mL or > 2500 µM).

In 2023, Kuete and his team provided a rational basis for the classification of the antibacterial activity of plant-based products, taking into account the percentage of active extract in a selected bacterial type; from such basis, the following values were proposed.

*In Enterobacteriaceae:* outstanding when MIC ≤8 µg/mL; excellent when 8 < MIC ≤64 µg/mL; very good when 64 < MIC ≤128 µg/mL; good when 128 < MIC ≤256 µg/mL, average when 256 < MIC ≤512 µg/mL, weak when 512 < MIC ≤1024 µg/mL, and not active MIC >1024 µg/mL for botanicals, outstanding when MIC ≤2 µg/mL, excellent when 2 < MIC ≤ 4 µg/mL, very good when 4 < MIC ≤8 µg/mL, good when 8 < MIC ≤ 32 µg/mL, average when 32 < MIC ≤ 64 µg/mL, weak when 64 < MIC ≤512 µg/mL, and not active when MIC >512 µg/mL for plant constituents [52];

*In Pseudomonas aeruginosa:* outstanding when MIC ≤ 32 µg/mL, excellent when 32 < MIC ≤ 128 µg/mL, very good when 128 < MIC ≤ 256 µg/mL, good when 256 < MIC ≤ 512 µg/mL, average when 512 < MIC ≤ 1024 µg/mL, weak or not active when MIC values >1024 µg/mL for crude extracts, outstanding when MIC ≤ 4 µg/mL, excellent when 4 < MIC ≤ 32 µg/mL, very good when 32 < MIC ≤ 128 µg/mL, good when 128 < MIC ≤ 256 µg/mL, average when 256 < MIC ≤ 512 µg/mL, weak or not active when MIC values >512 µg/mL for phytochemicals [53];

*In Gram-positive bacteria:* outstanding when MIC ≤ 8 µg/mL, excellent when 8 < MIC ≤40 µg/mL, very good when 40 < MIC ≤128 µg/mL, good when 128 < MIC ≤ 320 µg/mL, average when 320 < MIC ≤ 625 µg/mL, weak when 625 < MIC ≤ 1024

µg/mL and not active when MIC values > 1024 µg/mL for crude extracts, outstanding when MIC ≤ 2 µg/mL, excellent when 2 < MIC ≤ 4 µg/mL, very good when 4 < MIC ≤ 8 µg/mL, good when 8 < MIC ≤ 32 µg/mL, average when 32 < MIC ≤ 64 µg/mL, weak when 64 < MIC ≤ 512 µg/mL, and not active when MIC > 512 µg/mL for phytochemicals [54];

*In mycobacteria:* outstanding when MIC ≤ 6 µg/mL, excellent when 6 < MIC ≤ 16 µg/mL, very good when 16 < MIC ≤ 25 µg/mL, good when 25 < MIC ≤ 39 µg/mL, average when 39 < MIC ≤ 156 µg/mL, weak when 156 < MIC ≤ 2048 µg/mL, and not active MIC >2048 µg/mL for crud extracts, outstanding when MIC ≤ 2.5 µg/mL, excellent when 2.5 < MIC ≤ 5 µg/mL, very good when 5 < MIC ≤ 8 µg/mL, good when 8 < MIC ≤ 10 µg/mL, average when 10 < MIC ≤ 20 µg/mL, weak when 20 < MIC ≤ 512 µg/mL, and not active when MIC >512 µg/mL for for phytochemicals [55].

*The best botanicals and phytochemicals*

In the present review, the latest cut-off points proposed by Kuete and his team will be used to report the botanicals and phytochemicals with outstanding antibacterial effects identified in the flora of Africa against various bacterial species.

*Against Enterobacteria*

Number of African plant extracts were investigated against Enterobacteria, mainly *Escherichia coli, Enetrobacter aerogenes, Enterobacter cloacae, Klebsiella pneumoniae,* and *Providencia stuartii*. Many of them displayed outstanding (MIC ≤8 µg/mL) against at least one bacterium belonging to Enterobacteriaceae family. The crude methanol extract from the roots of *Macaranga capensis* Benth. (Euphorbiaceae) displayed MIC values of 4 µg/mL against *E. coli* ATCC8739 and the MDR AG102 and *Enterobacter aerogenes* EA27 strains, 8 µg/mL against *Klebsiella pneumoniae* ATCC11296 and the MDR KP55 and *Providencia stuartii* NAE16 strains [62]; The MIC values of 8 µg/mL or lower were recorded with the bark methanol extract of *Harungana madagascariensis* Lam. ex Poir. (Hypericaceae) against *E. coli* ATCC8739, ATCC10536, and W3110 [63] as well as the stem extract of *Macaranga conglomerata* Brenan (Euphorbiaceae) against *E. coli* ATCC8739, AG102, EA27 strains, KP55 strains [62]. The methanol extract from the roots of *Macaranga kilimandscharica* Pax. Showed MIC value of 8 µg/mL against *Enterobacter aerogenes* ATCC13048, *K. pneumoniae* ATCC11296, *K. pneumoniae* KP55, and *P. stuartii* ATCC29914 strains [62]. The bark methanol extract of *Beilschmiedia acuta* Kosterm (Lauraceae) had a MIC value below 8 µg/mL against *K. pneumoniae* ATCC11296 [64]. The methanol extract of the leaves of *Acacia polyacantha* Willd. (Fabaceae) and *Uapaca togoensis* Pax. (Euphorbiaceae) displayed a MIC value of 8 µg/mL against *P. stuartii* ATCC29914 [65] and PS2636 [66] strains, respectively

Several phytochemicals identified in African plants also displayed outstanding (MIC ≤2 µg/mL) antibacterial activities against Enterobacteria. For instance, the phenylpropanoid 8,8-bis-(dihydroconiferyl) diferulate (**4**) isolated from *Hypericum roeperianum* had MIC value of 0.5 µg/mL against *E. coli* ATCC8739, *K. pneumoniae* KP55, and *P. stuartii* ATCC29914, 1 µg/mL against AG102, and *P. stuartii* NEA16 strains, 2 µg/mL against *E. aerogenes* ATCC13048, CM64, and *K. pneumoniae* ATCC11296 strains [67], meanwhile, two other xanthones isolated from *H. roeperianum*, 1,3,5,7-tetrahydroxyxanthone (**3**) and 1,3,5,6-tetrahydroxyxanthone (**2**) also displayed a MIC value of 2 µg/mL against *E. coli* ATCC8739, *E. aerogenes* ATCC13048, and *K. pneumoniae* KP55 strains [67]. The naphthoquinone plumbagin (**16**) isolated *Diospyros canaliculata, Diospyros crassiflora* had a MIC value of 2 µg/mL against AG100A [68-70]. The chemical structures are shown in Figure 1.

*Against Pseudomonas aeruginosa*

*P. aeruginosa* is frequently resistant to many commonly used antibiotics [71, 72]. This bacterium including its resistant phenotype was sensitive to various African plant extracts and their phytochemicals [14, 45, 47, 64, 73-76]. Many of the reported botanicals (MIC ≤ 32 µg/mL) displayed outstanding and phytochemicals (MIC ≤ 4 µg/mL) against *P. aeruginosa*. For instance, the dichloromethane-methanol 1:1 extract from roots of *M. kilimandscarica* [62] displayed MIC values of 16 µg/mL against *P. aeruginosa* PA01 and the MDR PA124 strain, meanwhile, the MIC of 32 µg/mL was recorded against PA01 with the methanol extract from the bark of *H. madagascariensis* Lam ex. Poir (Hypericaceae) [63] and the bark of *Mangifera indica* Linn. (Anacardiaceae) [77], the fruits of *Piper nigrum* L. (Piperaceae) [47], the root extracts of *M. capensis* and the stem of *M. conglomerata* [62]. Against PA124, the methanol extract from *M. capensis* had a MIC of 16 µg/mL [62], meanwhile, that of the bark of *Beilschmiedia acuta* Kosterm. (Lauraceae) had a MIC of 32 µg/mL [64]. Akoue and his team demonstrated that the methanol extract from the leaves of *Piptadeniastrum africanum* (Hook. F.) Brenan (Fabaceae) and *Tristemma mauritianum* J.F. Gmel (Melastomataceae) displayed MIC a value of 3.13 µg/mL against *P. aeruginosa* PA383 strain, those from the fruits of *Alchornea floribunda* Müller Arg. (Euphorbiaceae) and *Eriosema glomeratum* (Guill. & Perr.) Hook. F. (Fabaceae) had MIC a value of 6.25 µg/mL meanwhile that from the fruits of *Medinilla mirabilis* (Gilg) Jacq.-Fél. (Melastomataceae) displayed a MIC of 12.5 µg/mL [78].

Several phytochemicals from African medicinal plants displayed outstanding antibacterial (MIC ≤ 4 µg/mL) effects, and consequently be considered as good candidates to develop phytodrugs. In effect. the flavonoid dorsmanin C (**10**) isolated from the Cameroonian medicinal plant *Dorstenia mannii* had a MIC of 4 µg/mL against PA01 strain [79]. Against *P. aeruginosa* CRPA LMP0102U strain, the flavonoid bartericin A (**8**) isolated from *Dorstenia angusticornis* had a MIC of below 0.31 µg/mL [11], the phenylpropanoid 2-(4-hydroxyphenyl)-ethyltriacontanoate (**1**) isolated from *Newbouldia laevis* had a MIC of 0.31 µg/mL [80], anthraquinones 2-hydroxy-3-methoxy-9,10-dioxo-9,10-dihydroanthracene-1-carbaldehyde (**5**) isolated from *N. laevis* [80] and the xanthone allanxanthone D (**6**) isolated from *Allanblackia gabonensis* [81] had a MIC value of 0.61 µg/mL, another anthraquinone, vismiaquinone (**17**), isolated from *Vismia laurentii* displayed a MIC value of 2.44 µg/mL [82]. Against *P. aeruginosa* ATCC27853, Teke et al. recorded a MIC value of 0.62 µg/mL for the flavonoid isoliquiritigenin (**13**) isolated from *Trilepisium madagascariense* [83]. The chemical structures are shown in Figure 1.

*Against Gram-positive bacteria*

Gram-positive bacteria are responsible for several serious hospital and community infections such as nosocomial infections, sepsis, pneumonia, and toxinosis [84, 85]. This antibacterial control of Gram-positive pathogens is hampered by the development of MDR phenotypes [86]. Medicinal plants are an undeniable source of medicine to fight bacterial resistance of Gram-positive bacteria. During the three last decades, number of African medicinal plant extracts and their constituents were successfully screened against Gram-positive bacteria mostly *Staphylococcus aureus* [11, 26, 80,

82, 87-100]. Many of the tested botanicals and phytochemicals inhibited the growth of resistant strains of *S. aureus* [101-108]. Many of the reported botanicals (MIC ≤ 8 µg/mL) displayed outstanding and phytochemicals (MIC ≤ 2 µg/mL) against Gram-positive bacteria. For instance, extract from *M. capensis* displayed MIC values of 4 µg/mL against *S. aureus* MRSA6 and MRSA3, and 8 µg/mL against ATCC25923 and MRSA3 strains [62]. Hashim and his collaborators also reported MIC values of 4 µg/mL against *S. aureus* ATCC25923, and 8 µg/mL against MRSA3 and MRSA6 with the crude extract from *M. kilimandscharica* [62]. *M. conglomerata* crude extract also had MIC values of 8 µg/mL against *S. aureus* ATCC25923 and MRSA6 [62]. The phytochemical **16** was identified as an excellent anti-staphylococcal compound with a MIC value of 2 µg/mL against MRSA4 and MRSA 8 [104]. The flavonoid isobavachalcone (**12**) isolated from *Dorstenia barteri* also had MIC values of 0.3 µg/mL against *Streptococcus faecalis, S. aureus*, *Bacillus stearothermophilus* and 0.6 µg/mL against *Bacillus cereus*, *Bacillus megaterium* and *Bacillus subtilis* [109]. Kuete et al. the outstanding antibacterial effect effects of the flavonoids isolated from *Dorstenia angusticornis,* namely gancaonin Q (**11**) with a Mic value of 0.61 µg/mL against *B. cereus* and *S. faecalis*, 0.61 µg/mL with compound **8** against *B. cereus, S. aureus,* and *S. faecalis*, and 1.22 µg/mL against *B. megaterium* and *B. subtilis*, and 1.22 µg/mLwith angusticornin B (**7**) against *B. cereus*, *B. subtilis,* and *S. faecalis* [11].

*Against mycobacteria*

Tuberculosis (TB) is an infectious, endemic disease with a predominant human-to-human transmission, caused by the *Mycobacterium tuberculosis* Complex (MTBC) « *M. tuberculosis*, *M. bovis*, *M. africanum, M. microti*, *M. canettii*, *M. caprae*, *M. pinnipedii*, and *M. mungi* » [110]. It represents one of the top 10 causes of death worldwide [111] and according to the World Health Organization (WHO), an average of 10 million people develop an active form of the disease each year [112]. TB remains a public health concern in many industrialized countries, particularly when it comes to multidrug-resistant forms due to non-adherence to anti-tuberculosis drugs, which have a long treatment duration (> 2 years) [113]. Drug-resistant strains of *M. tuberculosis* (Mtb) are of particular concern worldwide because resistance occurs soon after a new chemotherapeutic agent is introduced into the market just as with other bacterial diseases. Several secondary plant metabolites are reported to have anti-tuberculosis activity comparable to existing anti-tuberculosis drugs. Outstanding (MIC ≤ 6 µg/mL) was recorded on *M. tuberculosis* H37Rv with the methanol extract from the leaves of *Artemisia abyssinica* Schultz Bip. (Lamiaceae) [114]. A, outstanding (MIC ≤ 2.5 µg/mL) antibacterial activity was recorded with $O^1$-demethyl-3',4'-deoxy-psorospermi-3',4' diol (**15**) isolated from *Vismia guineensis* [115] and laburnetin (**14**) isolated from *Ficus chlamydocarpa* [89] against *Mycobacterium smegmatis* with a MIC value of 0.61 µg/mL. Against *M. smegmatis*, diospyrone (**9**) isolated from *Diospyros canaliculata* (MIC of 1.22 µg/mL) [68] and isobachalcone (MIC of 2.44 µg/mL) [116] also had outstanding antimycobacterial effects. Against *M. tuberculosis* H37Rv strain, a MIC value of 2.44 µg/mL was obtained with compounds **9** and **12** [68, 116].

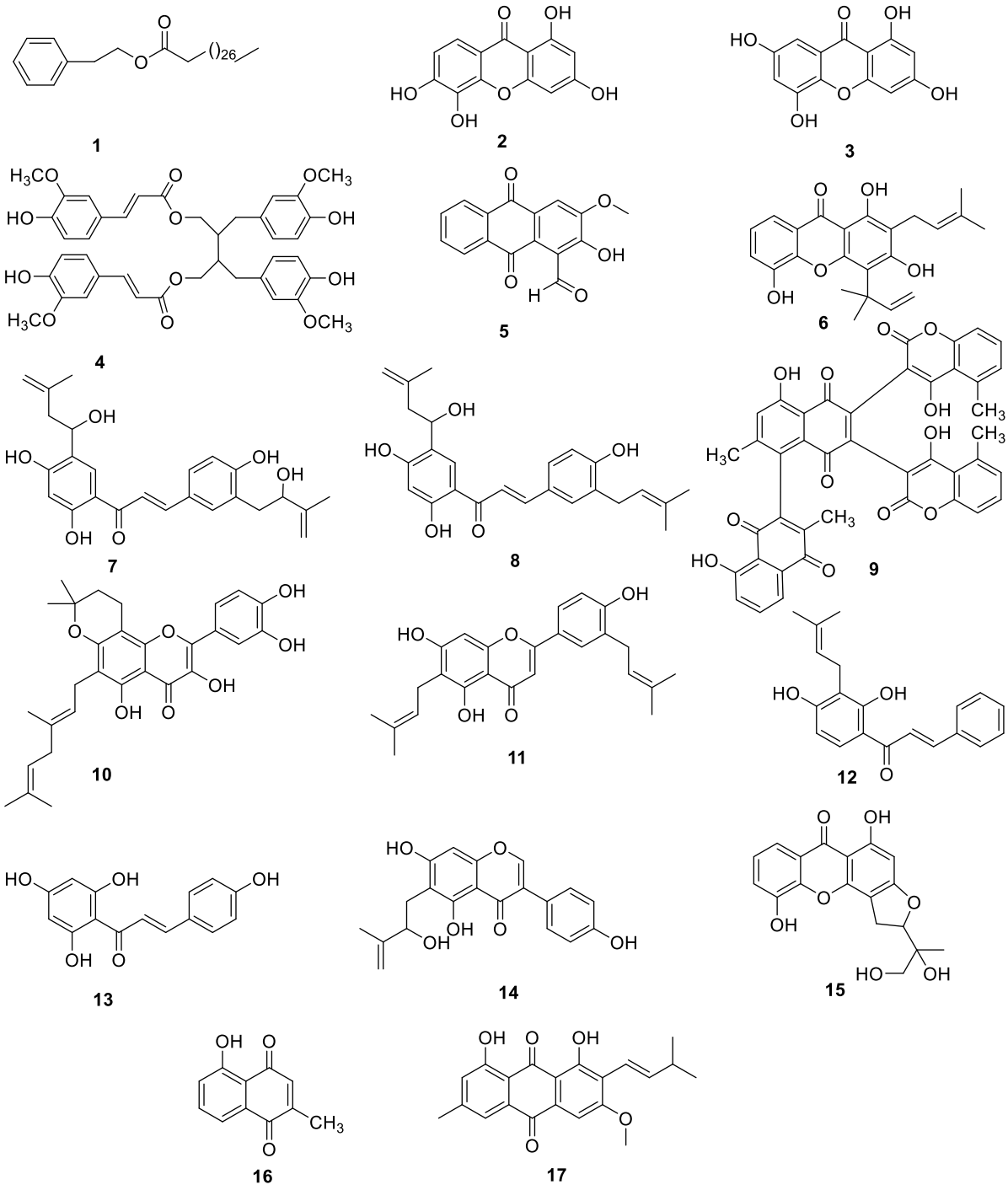


**Figure 1.** Chemical structures of the best antibacterial phytochemicals from the flora of Africa.

**1:** 2-(4-hydroxyphenyl)-ethyltriacontanoate; **2:** 1,3,5,6-tetrahydroxyxanthone; **3:** 1,3,5,7-tetrahydroxyxanthone; **4:** 8,8-bis-(dihydroconiferyl) diferulate; **5:** 2-hydroxy-3-methoxy-9,10-dioxo-9,10-dihydroanthracene-1-carbaldehyde; **6:** allanxanthone D; **7:** *angusticornin* B; **8:** bartericin A; **9:** diospyrone; **10:** dorsmanin C; **11:** gancaonin Q; **12:** isobavachalcone; **13:** isoliquiritigenin; **14:** laburnetin; **15:** $O^1$-demethyl-3',4'-deoxy-psorospermi-3',4' diol; **16:** plumbagin; **17:** vismiaquinone.

**Table 1.** History of the publications related to bacteria and plant in African countries where most investigations were performed as recorded in PubMed.

| Country | Number of papers* | First paper | Publication year | Reference |
|---|---|---|---|---|
| Egypt | 1115 | The antibacterial properties of the Nigella sativa L. seeds. Active principle with some clinical applications | 1965 | [56] |
| South Africa | 771 | Assessment of exposure to chloramphenicol and azathioprine among workers in a South African pharmaceutical plant | 1993 | [117] |
| Nigeria | 399 | The antibacterial properties of the buffer extracts of chewing sticks used in Nigeria | 1975 | [118] |
| Tunisia | 362 | Nauplathizine, a new unusual O-heteroside from *Nauplius aquaticus* (L) | 2005 | [119] |
| Cameroon | 337 | Sigmoidins J and K, two new prenylated isoflavonoids from *Erythrina sigmoidea* | 1994 | [120] |
| Morocco | 271 | Disseminating infection with *Scytalidium dimidiatum* in a granulocytopenic child | 1993 | [121] |
| Ethiopia | 200 | A novel antibacterial diterpene from *Premna schimperi* | 1990 | [122] |
| Algeria | 177 | HM17, a new polyene antifungal antibiotic produced by a new strain of Spirillospora | 1994 | [123] |
| Kenya | 94 | Antibiotic action of *Solanum incanum* Linnaeus | 1976 | [124] |
| Ghana | 83 | Antimicrobial properties of some West African medicinal plants iv. Antimicrobial activity of xylopic acid and other constituente of the fruits of *Xylopia aethiopica* (Annonaceae) | 1977 | [125] |
| Sudan | 66 | Investigation of *Grewia bicolor* Juss. | 1986 | [126] |

*The number of plants recorded in PubMed using keywords "country + plant + antibacterial" up to April 2024.

## Conclusion

In the present review, we have compiled the best botanicals and phytochemicals from the flora of Africa that deserve clinical studies to develop novel antibacterial medication to combat drug sensitive and MDR phenotypes. The infections targeted include were related to enterobacteria, *Pseudomonas aeruginosa*, Gram-positive bacteria, and mycobacteria. The entities include the botanicals from *Acacia polyacantha*, *Beilschmiedia acuta, Harungana madagascariensis, Macaranga capensis*, *Macaranga conglomerata, Macaranga kilimandscharica, Uapaca togoensis* and phytochemicals such as 8,8-bis-(dihydroconiferyl) diferulate (**4**), 1,3,5,7-tetrahydroxyxanthone (**3**), 1,3,5,6-tetrahydroxyxanthone (**2**), and plumbagin (**16**) for infections caused by enterobacteria, the crude extracts from *Alchornea floribunda, B. acuta*, *Eriosema glomeratum, H. madagascariensis, M. conglomerata, M. kilimandscarica, Mangifera indica, Piper nigrum, Piptadeniastrum africanum* and compounds such as 2-(4-hydroxyphenyl)-ethyltriacontanoate (**1**), 2-hydroxy-3-methoxy-9,10-dioxo-9,10-dihydroanthracene-1-carbaldehyde (**5**), allanxanthone D (**6**), bartericin A (**8**), dorsmanin C (**10**), isoliquiritigenin (**13**), and vismiaquinone (**17**), for infections caused by *Pseudomonas aeruginosa,* the crude extract from *M. capensis*, *M. conglomerata, M. kilimandscharica* and plant constituents such as compounds **8**, **16**, *angusticornin* B (**7**), gancaonin Q (**11**), and isobavachalcone (**12**), for infections caused Gram-positive bacteria, the crude extract from *Artemisia abyssinica* as well as compounds such as compound **12**, diospyrone (**9**), laburnetin (**14**), and $O^1$-demethyl-3',4'-deoxy-psorospermi-3',4' diol (**15**) for infections caused mycobacteria. The identified botanicals and phytochemicals deserve clinical investigations to develop novel antibacterial agents to combat bacterial infections.

## Abbreviations

ATCC: American-Type Culture Collection
MDR: multidrug-resistant
MIC: minimal inhibitory concentration

## Authors' Contribution

VK collected the data, draft the manuscript, read, and approved the final version.

## Conflict of interest

The authors declare no conflict of interest.

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