Flavonoids with antimicrobial activity from the stem bark of Commiphora pedunculata (Kotschy & Peyr.) Engl.

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SHORT COMMUNICATION

Flavonoids with antimicrobial activity from the stem bark of *Commiphora pedunculata* (Kotschy & Peyr.) Engl.

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The first reported investigation into the phytochemical constituents of *Commiphora pedunculata* led to the isolation of two flavonoids: kaempferol and dihydrokaempferol from the ethyl acetate-soluble fraction of the methanol extract of the stem bark of the plant. The structures of these compounds were characterised by comparing their spectral data including 1D and 2D NMR with those reported in the literature. The two compounds were active against 6 out of 10 tested microorganisms including two resistant strains [methiciline-resistant *Staphylococcus aureus* and vancomycin-resistant entrococci (VRE)], *Candida albicans* and *Escherichia coli*. The zones of inhibition ranged between 24 and 30 mm for both compounds against the microorganisms. The MIC value was as low as 6.25 μg/mL against VRE and *Staphylococcus aureus*. This is the first report of the isolation of these compounds from the plant.

Keywords: *Commiphora pedunculata*; flavonoids; kaempferol; dihydrokaempferol; 2D NMR; MRSA

1. Introduction

Commiphora pedunculata (Kotschy & Peyr.) Engl. belongs to Burseraceae, a family composed of both trees and shrubs of tropical and sub-tropical geographical distribution (Watson & Dallwitz 1992). Over 200 species of *Commiphora* are recorded to occur in Africa, Arabia, the Indian Ocean Islands and India (Weeks et al. 2005). The Burseraceae family members (also known as the frankinscence or Myrhh family) are characterised by the non-allergic resin produced in virtually all plant tissues and the distinctive smooth, yet flaking aromatic bark (Judd et al. 2008). The resins are of economic, medicinal and cultural values (Langenheim 2003). Traditionally, the stem and root are chewed for treating cough, the decoction of the leaves and stem bark is used for the treatment of dysentery and diarrhoea (Baba Mai Wada, Personal communication). Although this species of *Commiphora* has not been investigated before, other species of *Commiphora* are known to produce flavonoids and other phenolic compounds (Hanuš et al. 2005). In this paper, we report the isolation and characterisation of two flavonoids: kaempferol and dihydrokaempferol from the ethyl acetate-soluble fraction of the methanol extract of the stem bark. We also report the antimicrobial activity of these compounds against a panel of microorganisms including methiciline-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant entrococci (VRE).

2. Results and discussion

Compound **1** was isolated as a yellow crystalline solid. Two maxima at 227 and 370 nm were observed in the UV spectrum of compound **1**, suggesting a flavonol nucleus with conjugated π-electron system (Bohm 1999). The IR spectrum showed a very broad band at 3350 cm^{-1} and another band at 1680 cm^{-1} characteristic of phenolic O—H and carbonyl stretching, respectively (Wade 2006). The ^{1}H NMR spectrum of compound **1** produced the AB-type spin pattern [δ_H 6.4 (1H, d, $J = 1.9$ Hz, H-8), 6.2 (1H, d, $J = 1.9$ Hz, H-6)] and A_2B_2-type spin pattern [δ_H 8.1 (2H, d, $J = 8.8$ Hz, H-2′,6′), 6.9 (2H, d, $J = 8.8$ Hz, H-3′, 5′)] of kaempferol (Klaus-Peter 1999; Hadizadeh et al. 2003; Gangwal et al. 2010). A comparison of the ^{1}H and ^{13}C NMR data of the compound with reported data in the literature for kaempferol showed excellent agreement, for example C-4, 177.4 ppm, C-8, 94.5 ppm, C-6, 99.3 ppm, C-1′, 123.8 ppm and C-4′, 161.0 ppm (Gangwal et al. 2010). Co-TLC of compound **1** and standard sample of kaempferol showed that the two have the same R_f value. Compound **1** was therefore characterised as kaempferol.

Compound **2** was isolated as a cream coloured crystal. Its ^{1}H NMR spectrum produced a spin pattern similar to that of compound **1**. However, two additional oxymethine resonances at 4.5 and 4.9 ppm suggest that it might be a dihydroflavonol. A comparison of the spectral data of the compound with data reported in the literature for dihydrokaempferol showed good agreement, for example C-4, 197.09 ppm, C-8, 94.9 ppm, C-2, 83.5 ppm, C-3, 72.2 ppm, C-1′, 127.8 ppm, C-4′, 157.8 ppm and C-10, 100.1 ppm (Lutskii et al. 1971; Venditti et al. 2012; Trinop et al. 2013). Co-TLC of compound **2** with standard sample of dihydrokaempferol showed that the two compounds have the same R_f value. Compound **2** was therefore identified as dihydrokaempferol (aromadendrin). The structures of these compounds are shown in Figure 1. The antimicrobial activity of the compounds is shown in Table 1. Ten microorganisms were screened, seven bacteria (including MRSA and VRE) and three fungi. Dihydrokaempferol showed activity against MRSA (zone of inhibition, 24 mm), while kaempferol was inactive against MRSA. Both compounds showed activity against VRE and *Escherichia coli* with zones of inhibition of 27 and 24 mm for kaempferol and 29 and 30 mm for dihydrokaempferol, respectively. The zones of inhibition observed with the compounds were slightly lower than those of the standard drugs used (Sparfloxacin and Fluconazole). In general, dihydrokaemferol was more active against the tested microorganisms. The low MIC values suggest that the compounds have good antimicrobial activity, considering that compounds with MIC values less than 100 μg/mL are regarded as having strong antimicrobial activity (Tang et al. 2003).

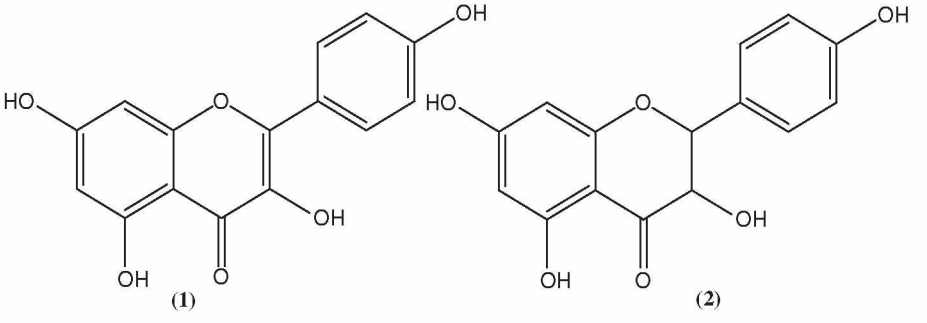


Figure 1. (**1**) kaempferol and (**2**) dihydrokaempferol.

Table 1. Antimicrobial activity of kaempferol and dihydrokaempferol (50 μg/mL).

Test organism	K	DK	SPX (5 μg/mL)	FCZ (5 μg/mL)
MRSA	(–)	24 (12.50/25)	35 (0.312/1.25)	NT
VRE	27 (6.25/25)	29 (6.25/12.50)	(–)	NT
Staphylococcus aureus	30 (6.25/12.50)	28 (6.25/25)	37 (0.156/1.25)	NT
Streptococcus pneumoniae	25 (12.50/25)	(–)	40 (0.312/2.50)	NT
Escherichia coli	24 (12.50/25)	30 (6.25/12.50)	35 (0.156/0.625)	NT
Proteus vulgaris	(–)	(–)	34 (0.312/2.50)	NT
Pseudomonas flourescens	(–)	26 (12.50/25)	(–)	NT
Candida albicans	26 (12.50/25)	29 (6.25/12.50)	NT	35 (0.312/1.25)
Candida tropicalis	(–)	27 (6.25/25)	NT	38 (0.625/1.25)
Candida krusei	28 (6.25/12.50)	(–)	NT	37 (0.625/2.50)

Notes: The values in parentheses indicate minimum inhibitory concentration/minimum bactericidal and fungicidal concentrations for bacteria and fungi, respectively. (MIC/MBC and MIC/MFC, μg/mL), the values outside parentheses are inhibition zones (mm), K, kaempferol; DK, dihydrokaempferol; SPX, sparfloxacin; FCZ, fluconazole; MRSA, methicilline-resistant *staphylococcus aureus*; VRE, vancomycin-resistant entrococci; (–), no activity detected; NT, not tested.

3. Conclusion

This study is the first reported investigation into the chemistry of *C. pedunculata* from Nigeria. Interestingly it led to the isolation of two biologically active flavonoids, indicating that the ethnomedicinal claims ascribed to the plant have scientific backing.

Supplementary material

Experimental details relating to this paper are available online.

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