The phytochemical study of ethyl acetate and n-butanol extracts of *Pteranthus dichotomus* Forsk. led to the isolation and identification of 11 compounds, including three glycolipids 1–3, one lignan 4, three flavonoids 5–7 and four phytosterols 8–11. Structures of the isolated compounds have been elucidated by analysis of 1D and 2D NMR data, and mass spectrometry EI-MS and ESI-MS and by comparison with literature data. Furthermore, the ethyl acetate and n-butanol extracts were examined for their antioxidant and antibacterial activities. The results showed that both extracts (PDAC and PDHU) had a moderate antioxidant activity (IC50 = 375.514 µg/mL and 691.333 µg/mL) respectively.

**Keywords:** Caryophyllaceae; *Pteranthus dichotomus*; glycolipids; flavonoids; NMR; ESI; antioxidant activity; antibacterial activity

1. **Introduction**

Caryophyllaceae family (pink family) contains 80 genera with more than 1800 species (Ozenda 1991). Previous phytochemical investigations on the species of this family indicated the presence of saponins (Böttger & Melzig 2011) and flavonoids (Curini et al. 2004). Caryophyllaceae species possess interesting pharmacological activities such as antitumour (Atta et al. 2013), anti-inflammatory (Balamurugan et al. 2012), antiviral (Simões et al. 1999), cytotoxic (Sowemimo et al. 2009), analgesic and antipyretic (Akindele et al. 2012).
**Pteranthus dichotomus** Forssk. belonging to Caryophyllaceae family is an herbaceous plant, which is also called as *P. echinatus* Desf. (Ozenda 1991). It is found in the northern Algerian Sahara and in the Hoggar region (Quezel & Santa 1963). In Egyptian traditional medicine, the leaves of *P. dichotomus* are used as an ocular antiseptic (El-Seedi et al. 2013). The aqueous extract of this species exhibited strong cytotoxicity (above 97%) against cultured melanoma cell lines (Sathiyamoorthy et al. 1999). Previous investigation on *P. dichotomus* has revealed the presence of flavonoids and polyphenols (Atta et al. 2013). This plant showed good anti-inflammatory and moderate antipyretic effects whereas its alcoholic extract has an antitumour activity (Atta et al. 2013).

In this investigation, we report the isolation and characterisation of 11 known compounds from ethyl acetate and *n*-butanol extracts of *P. dichotomus*. Moreover, the antioxidant and antimicrobial activities of these extracts have been investigated.

### 2. Results and discussion

#### 2.1. Chemical compositions of *P. dichotomus*

This study allowed the isolation of 11 compounds from ethyl acetate (*PDAC*) and *n*-butanol (*PDBU*) extracts of *P. dichotomus*. Their structures were identified on the basis of spectral data and by comparing with those reported in the literature as 1-**O**-palmitoyl-3-**O**-(6-sulfo-**α**-**D**-quinovopyranosyl)-glycerol 1 (Diop & Samb 2004), 1,2-**O**-palmitoyl-3-**O**-(6-sulfo-**α**-**D**-quinovopyranosyl)-glycerol 2 (Plouguerne et al. 2013), soyacerebroside I 3 (Voutquenne et al. 1999), 8-oxo-pinoresinol 4 (Kui-Wu et al. 2013), quercetin 5 (Choi et al. 2006), apigenin 6 (Benabdelaziz et al. 2014), isovitexin 7 (Peng et al. 2005; Obmann et al. 2011), stigmat-7-en-3-ol 8 (Smith & Goad 1975), spinasterol 9 (Ragasa & Lim 2005), **β**-sitosterol 10 (Haba et al. 2007) and **β**-sitosterol-3-**O**-glucoside 11 (Burdi et al. 1991) (Figure 1). Among them, compounds 1–4 and

![Figure 1. Structures of the isolated compounds 1–11 of *P. dichotomus*.](image-url)
were reported from the genus *Pteranthus* for the first time and the compounds 1–4 were obtained for the first time from Caryophyllaceae family.

### 2.2. Total phenol content of *P. dichotomus*

The total phenolic contents of ethyl acetate and *n*-butanol extracts of *P. dichotomus* were calculated as μg gallic acid equivalent (GAE) (Folin-Ciocalteu method). The total phenolic content of PDAC extract (27.140 ± 1.836 μg GAE/mg extract) was higher than that of PDBU (7.007 ± 0.155 μg GAE/mg extract). This difference is mainly due to the presence of lignan 4 and flavonoids 5 and 6 in PDAC extract.

### 2.3. Antioxidant activity

#### 2.3.1. Free radical scavenging ability by the use of a stable DPPH radical (2,2-diphenyl-l-1 picrylhydrazyl)

Antiradical activity was evaluated by measuring the scavenging activity of *P. dichotomus* samples against DPPH free radical. Quercetin, used as reference, showed an antiradical activity value with IC50 of 1.149 μg/mL. The four *P. dichotomus* samples showed a significant (*p* < 0.05) scavenging effect on the DPPH radical in a dose-dependent manner based on the calculated IC50 values presented in Table S1, the samples are ordered for their scavenging activity as follows: compound (7) (358.888 μg/mL) > PDBU (375.514 μg/mL) > PDAC (691.333 μg/mL) > Fr(4+5).5 (912.667 μg/mL). The subfraction Fr(4+5).5 of PDBU containing glycolipids as major compounds displayed a weak activity in comparison with the other extracts. However, the antioxidant capacities of glycolipids may be due to the composition and proportion of mono- and polyunsaturated fatty acids (Kitamoto et al. 2002; Alejandro et al. 2011).

#### 2.3.2. β-Carotene bleaching assay

Antioxidant activity of *P. dichotomus* samples was also estimated by bleaching of β-carotene/linoleic acid emulsion system. Antioxidant activity of samples (PDBU, PDAC, 7 and Fr(4+5).5) is increased in the course of time. All samples have lower antioxidant activity than BHT used as standard. The highest antioxidant activity among the samples was observed for PDBU (71.48%) where Fr(4+5).5 has the lowest antioxidant activity (47.99%) (Figures S1 and S2). This difference could be explained by the richness of PDBU with polyphenol compounds. The β-carotene–linoleate model is similar to an oil-in-water emulsion system, and variations in activities could be attributed to differences in the proportion of hydrophobic and hydrophilic compounds present in each extract (Wijeratne et al. 2006).

### 2.4. Antibacterial activity assay

Extracts of *P. dichotomus* were tested against five bacterial strains (*Staphylococcus aureus* ATCC 25923, *Pseudomonas aeruginosa* ATCC 27853, *Escherichia coli* ATCC 25922, *Klebsiella pneumoniae* BLSE and *Enterobacter* sp. BLSE). The results given in Table S2 showed that, in general, PDBU and PDAC extracts possessed a moderate antibacterial activity. *S. aureus* and *Enterobacter* sp. were the most sensitive microorganisms to the PDAC extract but it did not exhibit any antibacterial activity against *K. pneumonia* and *P. aeruginosa*. The PDBU extract inhibited only the growth of Gram-negative bacteria strains *E. coli* and *K. pneumoniae* indicating zone of inhibition values of 10 and 13.5 mm at 0.5 g/mL and 8 mm at 0.25 g/mL, respectively.
3. Conclusion

According to literature data, all the isolated compounds 1–4 and 6–7 are found for the first time in the genus *Pteranthus*. To the best of our knowledge, compounds 1–4 were obtained from the family Caryophyllaceae for the first time. Further phytochemical studies should be carried out to investigate the fractions of *n*-butanol extract containing particularly flavonoids and lignans. From this study we can conclude that *P. dichotomus* showed moderate antibacterial and antioxidant activities.

Supplementary material

General experimental methods, spectra and NMR data relating to this paper are available online, alongside Tables S1–S2 and Figures S1–S2.

Disclosure statement

No potential conflict of interest was reported by the authors.

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