ABSTRACT

Despite commercial interest and ethnobotanical data, the chemical composition and pharmacological activities of a number of indigenous *Pelargonium* species remain unexplored. Twenty-one *Pelargonium* species, from the section *Pelargonium*, were included in this study.

The volatile compounds of 13 species were extracted by hydrodistillation and their chemical compositions determined by gas chromatography coupled to mass spectroscopy (GC-MS). The essential oil data was chemotaxonomically informative confirming taxonomic relationships between *P. graveolens* and *P. radens; P. papilionaceum* and *P. vitifolium* and between *P. panduriforme* and *P. quercifolium.* New chemical affinities were established among *P. betulinum, P. hispidum* and *P. scabrum*; *P. capitatum* (provenance WSBG), *P. glutinosum* and *P. quercifolium* (provenance SBG) and among *P. graveolens*, *P. radens* and *P. tomentosum*. The non-volatile compounds were extracted with acetone and the extracts were analysed using high performance liquid chromatography (HPLC). The representative flavonoid patterns of the *Pelargonium* species indicated that *P. betulinum*, *P. capitatum*, *P. graveolens*, *P. hispidum, P. panduriforme* and *P. vitifolium* have numerous similarities in their chemical profiles. *Pelargonium scabrum* and *P. sublignosum* share definite chemical patterns. The HPLC fingerprints of *P. papilionaceum* and *P. vitifolium* were chemically diverse.

A microdilution bioassay was performed on the acetone extracts and the essential oils to assess their antimicrobial (both bacterial and fungal) potential. The essential oils and extracts were more selective for the Gram-positive test pathogens than for the Gram-negative bacterium. The crude extracts of *P. glutinosum* (provenance SBG), *P. pseudoglutinosum*, *P. scabrum* and *P. sublignosum* exhibited considerable antimicrobial activity against the Gram-positive bacteria (*B. cereus* and *S. aureus*) with *P. pseudoglutinosum* exerting the highest activity (MIC = 0.039 mg/ml). The essential oils showed reduced antimicrobial activity compared to the plant extracts. Using the DPPH (2,2-diphenyl-1-picrylhydrazyl) assay, exceptional anti-oxidant activity was observed for the crude extracts of *P. betulinum* and *P. crispum* (IC_{50} values of 4.13 µg/ml and 4.49 µg/ml, respectively, compared to ascorbic acid, IC_{50} = 4.72 µg/ml). The essential oils of *P. quercifolium* showed the greatest inhibition of 5-lipoxygenase activity (IC_{50} = 33.24 µg/ml

- 38.67 µg/ml). The antimalarial activity of the non-volatile extracts was evaluated against the choloroquine-resistant Gambian FCR-3 strain of *Plasmodium falciparum* using the hypoxanthine incorporation assay. *Pelargonium panduriforme* (provenance SBG) exerted the greatest activity (IC_{50} = 1.34 ± 0.29 µg/ml). Other species possessing similarly potent antimalarial activity included *P. citronellum* (provenance NBG), *P. citronellum* (provenance SBG), *P. quercifolium* (provenance SBG) and *P. radens.*

A microculture tetrazolium salt reduction (MTT) assay was used to determine the cellular toxicity of the acetone extracts and essential oils against transformed human kidney epithelium (Graham) cells. The acetone extracts of *P. sublignosum* and *P. citronellum* (provenance NBG) displayed the highest toxicities (IC_{50} = 11.89 ± 1.54 µg/ml and 19.14 ± 0.98 µg/ml, respectively). *Pelargonium vitifolium* (IC_{50} = 178.48 ± 5.44 µg/ml) and *P. tomentosum* (provenance SBG) (IC_{50} = 195.13 ± 7.90 µg/ml) appeared to be non-toxic. The *Pelargonium* essential oils proved to be considerably toxic (IC_{50} ≤0.10 µg/ml - 30.30 ± 1.81 µg/ml).

The flavonoid derivatives detected in the *Pelargonium* acetone extracts may have contributed to their positive biological activities. The results from the MTT assay suggested that the antimicrobial and antimalarial activity of the extracts may be ascribed to general cytotoxic effects. The pharmacological properties manifested by the extracts and essential oils of certain *Pelargonium* species substantiates their use in traditional medicines and validates their commercial exploitation in the perfumery, cosmetic, food and pharmaceutical industries; however, their toxicity profiles must be considered.