Maerua juncea Pax and *M. schinzii* Pax (Capparaceae): A comparative analysis of their ethnobotany and ethnomedicinal uses

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**ABSTRACT**

*Maerua juncea* Pax and *M. schinzii* Pax have a long history of medicinal use in southern Africa. This study aimed to review the ethnomedicinal uses, phytochemistry and pharmacological properties of the two species. Results of this study are based on data derived from several online databases such as Scopus, Google Scholar, PubMed and Science Direct, and pre-electronic sources such as scientific publications, books, dissertations, book chapters and journal articles. The leaves, roots, stems or whole plant parts of *M. juncea* and *M. schinzii* are mainly used as protective charm and tonic, and traditional medicines for fever, heart problems, headache, earache, skin disorders, fatigue and respiratory problems. This study showed that betaines and quaternary ammonium compounds such as 3-hydroxyprolinebetaine, proline betaine and 3-hydroxy-1,1-dimethyl pyrrolidinium had been identified from the aerial parts of *M. juncea*. In contrast, alkaloids, bitter principles, coumarins, flavonoids, saponins and terpenes have been identified from the leaves of *M. schinzii*. The leaf extracts and compounds isolated from the species exhibited antibacterial, antifungal, anti-HIV and cytotoxicity activities. There is a need for extensive phytochemical, pharmacological and toxicological studies of crude extracts of *M. juncea* and *M. schinzii* to establish the safety profiles of different preparations of the two species.

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and M. triphylla (De Wild.) F. White, M. edulis (Gilg & Gilg-Ben.) DeWolf, M. endlachii Gilg & Gilg-Ben., M. filiformis Drake, M. kirkii (Oliv.) F. White, M. nuda Scott-Eliot, M. oblongifolia (Forssk.) A. Rich., M. parviflora Pax, M. pseudopetalaosa (Gilg & Gilg-Ben.) DeWolf, M. subcordata (Gilg) DeWolf and M. triphylla A. Rich (Bosh et al., 2013; Margaret and Elisabeth, 2013). Apart from used as herbal medicines for similar medicinal conditions, M. juncea and M. schinzii have been recorded in overlapping geographical areas in southern Africa (Figure 1). It is, therefore, within this context that the current review was undertaken aimed at providing a comparative analysis of the botanical, medicinal, chemical and biological activities of M. juncea and M. schinzii.

MATERIALS AND METHODS

Results of the current study are based on a literature search on the botanical, medicinal, chemical and biological activities of M. juncea and M. schinzii using information derived from several internet databases. The databases included Scopus, Google Scholar, PubMed and Science Direct. Other sources of information used included pre-electronic sources such as journal articles, theses, books, book chapters and other scientific articles obtained from the university library.

RESULTS AND DISCUSSION

Botanical description of Maerua juncea and M. schinzii

Both M. juncea and M. schinzii are evergreen shrubs or small trees and often climbing (Palmer and Pitman, 1972). The leaves of M. juncea are simple, trifoliate, alternate, grey-green in colour, narrowly elliptic to ovate, rounded at the apex with a bristle tip. The flowers are bisexual, creamy white and borne singly in the upper leaf axils. The fruit of M. schinzii is ellipsoid with a smooth surface, green in colour when immature and orange when ripe. Maerua juncea is divided into two infraspecific taxa, that is, subsp. juncea and subsp. crustata (Wild) Wild (Wild, 1965). These two species are easily distinguished using fruit characters. The synonyms associated with the name M. juncea include M. Angustifolia Schinz, M. flagellaris (Oliv.) Gilg & Gilg-Ben., M. flagellaris (Oliv.) Gilg & Gilg-Ben. subsp. crustata Wild, M. querichii Pax, M. kassakalla De Wild., M. maschonica Gilg, M. Nervosa (Hochst.) Oliv. Var. flagellaris Oliv. and M. ramosissima Gilg. (Wild, 1960). Maerua juncea has been recorded in hot and dry woodlands in Botswana, the Democratic Republic of Congo (DRC), Eswatini, Namibia, Malawi, Mozambique, Tanzania, Zambia and Zimbabwe at an altitude ranging from sea level to 1370 m above sea level (Wild, 1960; Palgrave and Keith, 2002) (Figure 1). Maerua schinzii is a much-branched tree growing to seven metres in height (Palgrave and Keith, 2002). The species has a dense, rounded crown recorded in arid bushveld, semi-desert areas, along river banks, watercourses and rocks at bases of mountains in Botswana, Namibia and South Africa (Figure 1). The species has been recorded in stony and sandy soils at an altitude ranging from 290 m to 1500 m above sea level (Wild, 1960). Numerous whitish lenticels characterize the branchlets of M. schinzii. The leaves are elliptic to ovate in shape, leathery and yellow-green, rounded at the apex with a bristle tip, base broadly tapering to rounded. The flowers of M. schinzii occur in terminal racemes with many long stamens. The fruit is a long slender pod which is irregularly constricted between the seeds.

Traditional uses of Maerua juncea and M. schinzii

The fruits of M. juncea and M. schinzii are eaten as a snack in Namibia and South Africa (Sullivan, 1998). In Namibia and South Africa, the fruits of M. schinzii are crushed and mixed with water to make a non-alcoholic beverage or drink. In Botswana, the roots of M. schinzii are boiled or roasted while its leaves are eaten raw. In Namibia, the leaves of M. schinzii are used as a substitute for soap (Eynden et al., 1992; Sullivan, 1998). The foliage and pods of M. juncea and M. schinzii are browsed by livestock and game (Malan and Owen-Smith, 1974; Sullivan, 1998).

The leaves, roots and stems of both M. juncea and M. schinzii are widely used as traditional medicines in southern Africa. The roots and stems of M. juncea are traded as herbal medicines in local informal herbal medicine markets in the Limpopo province in South Africa. Similarly, the roots of M. juncea are traded in local informal herbal medicine markets in Maputo, Mozambique for the treatment of bacterial and parasitic diseases. A total of 24 human and livestock diseases and ailments are treated with herbal concoctions prepared by M. juncea and M. schinzii (Table 1).

The leaves, roots, stems or whole plant parts of both species are used as sources of good luck or protective charm against evil spirits or traditional medicines for body weakness, fatigue and heart problems (Palmer and Pitman, 1972; Semenya and Maroyi, 2018). The leaves, roots, stems or whole plant parts of M. juncea and M. schinzii are mainly used as protective charm and tonic, and traditional medicines for fever, heart problems, headache, ear-
ache, skin disorders, fatigue and respiratory problems (Figure 2). In South Africa, the roots of *M. juncea* are mixed with the bark of *Cassia abbreviata* Oliv. And bulb of *Drimia elata* Jacq. As traditional medicine for fatigue (Semenya and Maroyi, 2018).

Similarly, the compound coumarin is known for its biological activities such as anti-inflammatory, anticoagulant, antibacterial, antifungal, antiviral, anti-cancer, anti-hypertensive, antitubercular, anticonvulsant, antidepressant, anti-inflammatory, and antineuroprotective properties (Venugopala et al., 2013). Many flavonoids and terpenes have anti-inflammatory, anticancer, antioxidant and antiparasitic activities (Sülser et al., 2017). Saponin compound is known to have anticancer, antiphlogistic, anti-allergic, immunomodulating, antihepatotoxic, antiviral, hypoglycemic, antifungal and molluscicidal activities (Lacaille-Dubois and Wagner, 1996).

**Figure 1: Geographical distribution of *Maerua juncea* and *M. schinzii***

**Figure 2: Medicinal applications of *Maerua juncea* and *M. schinzii* derived from literature records**

**Phytochemical and biological activities of *Maerua juncea* and *M. schinzii***

There is very little information available concerning the phytochemistry and pharmacological properties of the crude extracts or compounds isolated from the two species. However, McLean et al. (1996) identified the betaines and quaternary ammonium compounds such as 3-hydroxyprolinebetaine, proline betaine and 3-hydroxy-1,1-dimethyl pyrrolidinum from dried aerial and branches of *M. juncea*. Loontjens (2013) argued that quaternary ammonium compounds are potent biocides widely used in medical applications, cosmetics, disinfectants, surfactants and solvents. Similarly, Hamalwa (2018) identified alkaloids, bitter principles, coumarins, flavonoids, saponins and terpenes from the leaves of *M. schinzii*. Some of these chemical compounds may be responsible for the pharmacological properties of the species. Several studies showed that alkaloids isolated from plants exhibited anticholinesterase, antioxidant, anxiolytic, anti-inflammatory and antidepressant properties (Chaves et al., 2016).

Mujovo (2009) evaluated the antibacterial activities of acetone extracts of *M. juncea* leaves against *Bacillus cereus*, *Bacillus pumilis*, *Bacillus subtilis*, *Staphylococcus aureus*, *Enterococcus faecalis*, *Enterobacter cloacae*, *Escherichia coli*, *Klebsiella pneumonia*, *Pseudomonas aeruginosa* and *Serratia marcescens* using the agar dilution method with streptomycin sulfate as a positive control. The extract exhibited activities against *Bacillus cereus*, *Bacillus pumilis*, *Bacillus subtilis*, *Staphylococcus aureus*, and *Enterococcus faecalis* with minimum inhibitory concentration (MIC) value of 1.0 mg/ml. Similarly, Hamalwa (2018) evaluated the antibacterial activities of a semi-purified compound of *M. schinzii* leaves against *Escherichia coli*, *Staphylococcus aureus* and *Enterococcus faecalis* with minimum inhibitory concentration (MIC) value of 1.0 mg/ml. Similarly, Hamalwa (2018) evaluated the antibacterial activities of a semi-purified compound of *M. schinzii* leaves against *Escherichia coli*, *Staphylococcus aureus* and *Klebsiella pneumoniae* using the agar disc diffusion and microdilution methods with ampicillin (25.0 μg) as the positive control. The semi-purified compound exhibited activities against *Klebsiella pneumoniae* with the zone of inhibition and MIC values of 9.0 mm and 2.0 mg/ml, respectively.

Machaba and Mahlo (2017) and Machaba et al. (2018) evaluated the antifungal activities of acetone, methanol, ethanol, hexane, dichloromethane, ethyl acetate and water extracts of *M. juncea* leaves against *Candida albicans*, *Aspergillus fumigatus* and *Cryptococcus neoformans* using microdilution assay. The extract exhibited activities against tested pathogens with MIC values ranging from 0.02 mg/ml to 1.0 mg/ml. Similarly, Hamalwa (2018) evaluated the antifungal activities of a semi-purified compound of *M. schinzii* leaves against *Candida albicans* using the agar disc diffusion and microdilu-
Table 1: Medicinal applications of *Maerua juncea* and *M. schinzii*

| Medicinal use               | Parts used                                      | Country                          | Reference                                      |
|-----------------------------|-------------------------------------------------|----------------------------------|------------------------------------------------|
| **Maerua juncea**           |                                                  |                                  |                                                |
| Aphonia                     | A root infusion is taken orally                  | South Africa                     | Semenya and Maroyi (2019a)                     |
| Diarrhoea                   | Stem infusion is taken orally                    | Namibia                          | Sullivan (1998)                               |
| Emetic                      | A root decoction is taken orally                 | Namibia                          | El-Kamali *et al.* (2013)                      |
| Fatigue                     | A root infusion is taken orally                  | South Africa                     | Semenya and Maroyi (2018)                     |
| Fatigue                     | Roots mixed with the bark of Cassia abbreviata Oliv. And bulb of Drimia elata Jacq. | South Africa                     | Semenya and Maroyi (2018)                     |
| Heart problems              | Stem decoction is taken orally                   | Namibia                          | Sullivan (1998)                               |
| Protective charm (evil spirits and good luck) | Leaves, roots and whole plant                  | Namibia and South Africa         | Malan and Owen-Smith (1974); Sullivan (1998) |
| Purgative                   | Stem decoction is taken orally                   | Namibia                          | El-Kamali *et al.* (2013)                      |
| Respiratory problems (asthma, flu and tuberculosis) | Leaf, root and stem infusion and decoction are taken orally | Mozambique and Namibia and South Africa | Luo *et al.* (2011); Semenya *et al.* (2019b) |
| Ulcers                      | Stem infusion is taken orally s                  | Namibia                          | El-Kamali *et al.* (2013)                      |
| Ethnoveterinary medicine    | Stem infusion is taken orally                    | Namibia                          | Sullivan (1998)                               |
| **Maerua schinzii**         |                                                  |                                  |                                                |
| Abdominal pains             | Roots infusion taken orally                      | Namibia                          | Sullivan (1998)                               |
| Bladder problems            | The root decoction is taken orally               | Namibia                          | Sullivan (1998)                               |
| Body weakness               | Leaf infusion and decoction are taken orally     | Namibia                          | Eynden *et al.* (1992); Sullivan (1998)       |
| Cough                       | Leaf infusion and decoction are taken orally     | Namibia                          | Eynden *et al.* (1992); Sullivan (1998)       |
| Diuretic                    | A root infusion is taken orally s                | Namibia                          | Sullivan (1998)                               |
| Earache                     | Root decoction applied topically, El-Kamali, 2013| Namibia                          | Eynden *et al.* (1992); El-Kamali *et al.* (2013) |
| Eye problems                | Leaf decoction applied topically                 | Namibia                          | Sullivan (1998)                               |
| Fever                       | Root infusion and decoction are taken orally     | Namibia                          | Eynden *et al.* (1992); Sullivan (1998)       |
| Headache                    | Leaf infusion and decoction are taken orally     | Namibia                          | Eynden *et al.* (1992)                        |
| Heart problems              | Root infusion and decoction are taken orally     | Namibia                          | Eynden *et al.* (1992); El-Kamali *et al.* (2013) |
| Protective charm (evil spirits) | Whole plant                                    | Namibia                          | Palmer and Pitman (1972)                       |
| Skin disorders (acne and boils) | Leaf and root infusion and decoction are taken orally | Namibia                          | Eynden *et al.* (1992); El-Kamali *et al.* (2013) |
| Sores                       | Leaf decoction applied topically                 | Namibia                          | Sullivan (1998)                               |
| Tonic                       | Root infusion and decoction are taken orally     | Namibia                          | Eynden *et al.* (1992); El-Kamali *et al.* (2013) |
tion methods with ampicillin (25.0 μg) as the positive control. The semi-purified compound exhibited activities with the zone of inhibition and MIC values of 12.0 mm and 4.0 mg/ml, respectively.

Mujovo (2009) evaluated the anti-HIV activities of ethanol extracts of M. juncea leaves by assessing their ability to inhibit the enzymes α-glucosidase and β-glucuronidase and reverse transcriptase with doxorubicin as a positive control. The extract showed inhibitory activities against α-glucosidase and β-glucuronidase at a concentration of 200.0 μg/ml with percentage inhibition of 69.3% and 90.4%, respectively. Similarly, Hamalwa (2018) evaluated the anti-HIV activities of the semi-purified compound of M. schinzii leaves against HIV-1 protease and reverse transcriptase with doxorubicin as a positive control. The semi-purified compound inhibited less than 50.0% at the highest concentration tested of 100.0 μg/mL for HIV-1 reverse transcriptase, which is an indication of low inhibitory activity in comparison to activities exhibited by the positive control.

Machaba et al. (2018) evaluated the cytotoxicity activities of acetone, methanol, ethanol, hexane, dichloromethane, ethyl acetate and water extracts of M. juncea leaves against Vero monkey kidney cells using the MTT (3-(4,5-dimethylthiazol)-2,5-diphenyl tetrazolium bromide). All plant extracts were not toxic against the cells with median lethal concentration (LC$_{50}$) values ranging from 0.1 mg/ml and >1.0 mg/ml.

**CONCLUSION**

The present review summarizes the botanical, medicinal, chemical and biological activities of *Maerua juncea* and *M. schinzii*. Based on the presented information, these two species are closely related and deemed as potent traditional medicines for treating and managing fever, heart problems, headache, earache, skin disorders, fatigue and respiratory problems. *Maerua juncea* and *M. schinzii* should be subjected to detailed phytochemical, pharmacological and toxicological evaluations aimed at correlating their medicinal uses with their phytochemistry and pharmacological properties.

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**Conflict of Interest**

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