Chapter 2

BACKGROUND INFORMATION ON THE SELECTED PLANTS

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Abstract

South African medicinal plants were selected based on information of their traditional medicinal use (traditional healers) in treating symptoms of listeriosis (diseases caused by *L. monocytogenes* infection) and also based on a literature review. The plants selected were *Aloe arborescences*, *Acacia karroo*, *Artmesia afra*, *Clivia miniata*, *Eucomis autumnalis*, *Datura stranomium*, *Drimia altissima*, *Gomphocarpus fruticosus*, *Heteromorpha arborscens*, *Tulbaghia violaceae*, *Senecio inonartus*, *Ziziphus mucronata* and *Plectranthus ecklonii*. The medicinal use, phytochemistry and distribution of each plant are described.

2.1 Introduction

South Africa still utilises a large selection of medicines that are derived from plants and their extracts (Van Wyk *et al*., 1997; Taylor & Van Staden, 2001). In the past and the present herbal medicine has become a topic of augmented global importance, having strong influence on both world health and international trade (Stafford *et al.*, 2005).

2.2 Plants selected for the present study

Thirteen medicinal plants were collected from Gauteng, northern and eastern Free State, South Africa. Different parts of the plants for example, leaves, stem, bark, roots were collected. The symptoms of listeriosis is gastro-enteritis, severe headaches, pulsating fever, nausea, vomiting, stiffness of the neck and back, septicaemia, and abortion. Traditional healers were asked for their treatment they use when patients complain and show these symptoms. The questionnaire (Appendix 3, page 134) was used to get information from the traditional healers. The healers mentioned vernacular name. An effort was made to go with the healers to find out the plants they use. Herbarium specimens were made which assisted to find out the scientific names. The plant species collected were based on information received from experienced traditional healers and elderly indigenous people who are experts on traditional medicine. The selection of these plants were also based on information culled from literature. The samples were taken to the HGWJ Schweickerdt herbarium of the University of Pretoria for identification. The herbarium specimens are preserved in the aforesaid herbarium (Table 2.1).

Table 2.1 Voucher specimen numbers of the selected plants used for the present study.

Plant species	**Voucher Specimen number**	**Plant part used**
Acacia karroo Hayne	MN15	Leaves
Aloe arborescens Mill.var. *natalensis* Berger	MN 5	Leaves
Artemisia afra Jacq.	MN 7	Leaves
Clivia miniata Reg.	MN 3	Whole plant
Datura stramonium L.	MN 8	Leaves
Drimia altissima (L.f.) Ker Gawl	MN 14	Roots Leaves
Eucomis autumnalis (Mill.) Chitt.	MN 11	Bulb
Gomphocarpus fruticosus (L) W.T. Aiton	MN 1	Leaves
Heteromorpha arborescens (Spreng) Cham. &. Schltdl.	MN 4	Stem Leaves
Plectranthus ecklonii Benth.	PRU 96396	Leaves
Senecio inonartus DC	MN 9	Leaves Stem
Tulbaghia violaceae Harv.	MN 2	Leaves
Ziziphus mucronata Wild.	MN 10	Leaves

The detailed descriptions of the selected plants for the present study are as follows:

2.2.1 *Acacia karroo* Hayne

A.karroo is a member of the *Fabacea*e family. It is commonly known as sweet thorn. In the different South African languages it is known by different names in Zulu it is known as

"umunga" and in Xhosa "umnga", "mookana" in Pedi (Northern Sotho). Its trunk is made up of "rough bark, which is dark brown in colour. The branches have many pairs of white large spines. The small round yellow flowers give the plant its distinct character (Figure 2.1) *A. karroo* is used medicinally to treat diarrhoea, colds, dysentery, conjunctivitis and haemorrhage. The gum from *A. karroo* has been used medicinally as emollients and as pharmaceutical aids such as emulsifiers, stabilisers of suspensions and additives for solid formulations. The gum has also been used to treat mouth ulcers (van Wyk *et al*., 1997; van Wyk & Gericke 2000). In the previous study (Katerere & Eloff, 2004) *A. karroo* was found to have antibacterial activity against *Escherichia coli* and *Staphylococcus aureus*. Compounds which have been isolated from the heartwood (stem) of *A. karroo*, are (2'S,3'R)-3,10-dihydroxy-9-O-(6'-hydroxy-7'-O-methyl-2'-hydroxy-methyldihydrobenzofuran-3-yl)dibenz-[b,d]-pyran-6-one and its 10-O-methyl analogue; 8-O-methylepiprosopin-4β-ol; 8-methoxyfustin; and 7,8,3,4'-tetrahydroxy-3'-methoxyflavone (Malan & Swartz, 1995). The compound, 7,8,3,4'-tetrahydroxy-3'-methoxyflavone has been reported to have antioxidant and antimutagenic activities (Chung *et al*., 1999). The compound has also been reported to have antibacterial activity against the Gram postive bacteria such as *Bacillus cereus*, *Staphylococcus aureus*, *Enterococcus faecalis* and Gram negative bacterium, *Escherichia coli* (Wang *et al*., 1989; Teffo *et al*., 2010). The phenolic acids, cinnamic, caffeic, *p*-coumaric, ferulic acids and chlorogenic acids from fresh fruit and vegetables have been reported to have antilsterial activity (Wen *et al*. 2003). The phenolic acids were also found to be bactericidal against *L. monocytogenes*. These compounds have similar structures to other phenolics compounds that have been isolated from *A. karroo* such as acaciabiuronic acid (DNP, 2010). The leaves were used for the present study.

The Distribution of *A. karroo*

The genus *Acacia* is found in the dry regions of Africa (Katerere & Eloff, 2004; Dube *et al*., 2001), Australia, India and America (Arias *et al*., 2004). *A. karroo* is widely distributed in South Africa (Van Wyk *et al.*, 1997) and is found in all the nine provinces.

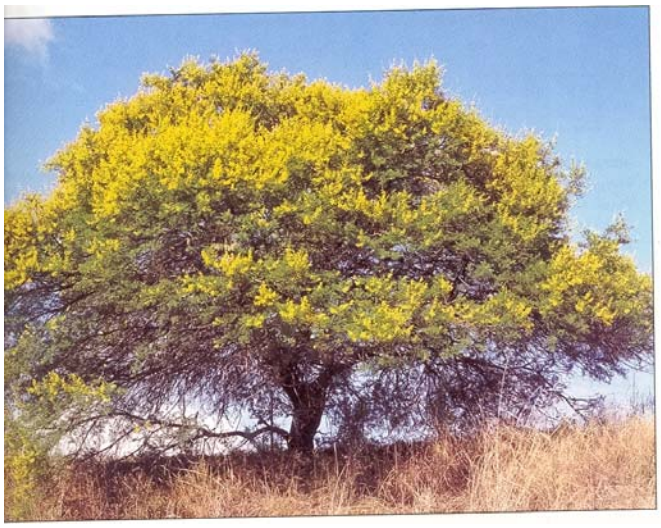

Figure 2.1 *Acacia karroo* a tree with the golden-yellow round flowers (Courtesy: Van Wyk *et al.*, 1997)

2.2.2 *Aloe arborescens* Mill. var. *natalensis* Berger

A. arborescens is a member of the family *Asphodelaceae.* It has long fleshy dull green leaves that have spines along the edges (Figure 2.2). The plant is medicinally used to treat wound and burns. *A. arborescens* has been reported to be used during pregnancy to ease labour (Grace *et al*., 2008). The plant has been reported to have antibacterial, anti-inflammatory anti-ulcer and anticancer activities (Van Wyk & Gericke, 2000; Jia *et al*., 2008). The compounds aloenin, aloenin B, 10-hydroxyaloin A, aloin A and B, and aloe-emodin have been isolated from the leaves of *A. arborescens*. Aloenin has been reported to have purgative and laxative activity (Park *et al*., 1998). *A. arborescens* has been found to be effective in wound healing. The species

has also been found to have antibacterial activity against *Stapyhlococcus aureus*, *Klebsiella pneumonia*, and *Escherichia coli* (Jia *et al*., 2008). The leaves were used for the present study.

Distribution of *A. arborescens*

A. arborescens is widely distributed in the eastern parts of South Africa especially in the Eastern Cape and some parts of Western Cape and KwaZulu -Natal. It is a popular garden plants found in most gardens in South Africa.

Figure 2.2 *Aloe arborescens* (Courtesy: Van Wyk *et al*., 1997)

2.2.3 *Artemisia afra* Jacq.

A. afra belongs to the family *Asteraceae*. It is known as African wormwood. In Zulu and Xhosa it is known as "umhlonyanae", and "lengana" in Sotho and Tswana. *A. afra* is a perennial shrub with greyish-green leaves (Figure 2.3), and yellow flowers. The leaves are medicinally used to treat coughs, fever, colds, influenza and blocked nasal passages. The plant has antimicrobial and anti-oxidative properties (Van Wyk *et al.*, 1997; Van Wyk & Gericke, 2000).

The methanol extract of *A. afra* has been found to have antibacterial activity against *S. aureus* and *Bacillus subtilis* (Rabe and Van Staden, 1997). The compounds isolated from *A. afra* which have been reported to have antimicrobial properties are: 1.8-cineole, α-thujone, β-thujone, camphor and borneol (Van Wyk *et al.*, 1997; Mangena and Muyima, 1999). These compounds have been isolated from the leaves. The 1.8-cineole, α-thujone, β-thujone isolated from *A. afra* have been found to have broad antibacterial activities against a number of bacteria such as *Salmonella enteretidis*, *S. typhi*, *S. newport*, *Bacillus subtilis*, *Micrococcus luteus*, etc. (Mangena and Muyima, 2009). Dichloromethane, water and ethanol extracts of *A. afra extracts* have been found to have antibacterial activity against *Bacillus cereus, E.coli, Klebsiella pneumonia, S. aureus* and *Mycobaterium aurum* respectively (Buwa and Afolayan, 2009). The leaves were used for this study.

Distribution of *A. afra*

A. afra is a widely distributed, common species in South Africa. It is distributed as far as north as tropical east Africa through to Ethiopia.

Figure 2.3 *Artemisia afra* (Courtesy: Van Wyk *et al*., 1997)

2.2.4 *Clivia miniata* Reg.

C. miniata belongs to the family *Amaryllidaceae.* It is a perennial tuberous rhizamatous plant that does not require exposure to sunlight to grow. It is commonly known as bush lily or orange lily. In Zulu it is known as "umayime." It usually bears orange flowers that develop from the same point of the stalk (Figure 2.4). The rhizome (underground stem) is medicinally used to treat fever and to relieve pain while the whole plant is used in childbirth. Roots and leaves are taken by South African women during pregnancy and childbirth (Louw *et al*., 2002). Compounds such as lycorine, clivacetine, clivonine, cliviasine and clividine have been isolated from *C. miniata*. Lycorine, clivonine and cliviasine have been isolated from the rhizome. Clivacetine and clividine have been isolated from the whole plant. Lycorine has been found to be a respiratory stimulant and has been reported to have antitumour, antiviral and antifungal activity (Van Wyk *et al*., 1997; Pieters and Vlietinck, 2005). The whole plant was used for this study.

Distribution of *C. miniata*

C. miniata is found on the eastern coastal line of South Africa, in the Eastern Cape and KwaZulu-Natal provinces (Van Wyk *et al*., 1997).

(a) (b)

Figure 2.4 *Clivia miniata* flowers (a) and rhizomes (b) (Courtesy: Van Wyk *et al*. 1997)

2.2.1.5 *Datura stramonium* L.

D. stramonium belongs to family *Solanaceae*. The plant is commonly known as the thorn apple. In Zulu it is known as "iloyi". It is has white or purplish tubular flowers and four–locular–fruit capsules which have brown, kidney shape seeds (Figure 2.5) (Van Wyk *et al*., 1997). The leaves of *D. stramonium* are medicinally used to relieve asthma, rheumatism, gout, boils, abscesses, sore throat, tonsillitis and respiratory difficulties. Methanol extract of *D. stramonium* has been found to be active against *Bacillus subtilis* (Rabe and Van Staden, 1997). In previous study (Mdee *et al*., 2009) *D. stramonium* was found to have antifungal activity against several tested fungi such as *Aspergillus niger, A. parasiticus*, etc. Tropane has been isolated from *Datura* species (Rao and Ravishankar, 2002). *D. stramonium* has been reported to contain lubumin, hydroxylubimin, germacrenediol and small amounts of capsidiol (Stoessl *et al*., 1976). Atropine and scopolamine are the two major compounds isolated from *D. stramonium*. The compounds have been isolated from the aerial parts of the plant. It has been reported that scopolamine has

analgesic, anti-inflammatory and antispasmodic activities.

Distribution of *D. stramonium*

D. stramonium is widely distributed in South Africa and is found in all the provinces.

Figure 2.5 *D. stramonium* (Courtesy: Van Wyk *et al*., 1997)

2.2.6 *Drimia altissima* (L.f.) Ker Gawl

D. altissima belongs to the family *Hyacinthaceae*. Species of *Drimia* have large underground bulbs, strap-shaped leaves (Figure 2.6) and long thin flowering stalks. The bulbs and leaves are medicinally used as expectorants (promoting secretion, liquefaction or expulsion of the sputum from the respiratory passages), emetics, diuretic and as a heart tonic, to treat fever, bladder and uterus disease (Van Wyk *et al*., 1997; Louw *et al*., 2002). The compound 3-*O*-α-L-Rhamnopyranoside has been isolated from *D. altissima* (DNP, 2010). Bufadienolides and cardioactive C-24 steroids have been isolated from *D. altissima* (Krenn & Kopp, 1998).

Bufadienolides have been isolated from the bulb. In the previous study *D. altissima* was tested for antibacterial activity against methicillin resistant *S. aureus* and was found to have low activity against the pathogen (Heyman *et al*, 2009). The roots and leaves were used for this study.

Distribution of *D. altissima*

D. altissima is widely distributed in South Africa particularly in the region of summer-rainfall region (Crouch *et al*., 2006).

(a) (b)

Figure 2.6 *Drimia altissima* (a) bulbs and (b) leaves

2.2.7 *Eucomis autumnalis* (Mill.) Chitt.

E. autumnalis belongs to the family *Hyacinthaceae*. This bulbous plant is commonly known as the pineapple flower. In Zulu and Xhosa it is known as “umathunga.” It consists of a number of small yellowish-green flowers that are attached to the centrally located stalk (Figure

2.7). The bulb is medicinally used for fever, stomach ache, colic, urinary diseases, diarrhoea, syphilis, easing of childbirth, etc. (Van Wyk, 2008). *E. autumnalis* has been reported to treat chest complaints, coughing and tuberculosis (McGaw et al., 2008). Methanol extract of *E. autumnalis* has been found to have antibacterial activity against *B. subtilis* (Rabe and Van Staden, 1997). *E. autumnalis* serves as an enema for low back pain, fever, colic and urinary diseases (Louw *et al.*, 2002). The compounds previously isolated from the bulb of *E. autumnalis* are eucomanalin, autumnariol and eucosterol (Van Wyk *et al*., 1997; Van Wyk & Gericke, 2000). The bulb was used for this study.

Distribution of *E. autumnalis*

E. autumnalis is widely distributed along the eastern parts of South Africa (Van Wyk *et al.*, 1997). It is predominantly found in the following provinces the Free State, KwaZulu-Natal, Eastern Cape, Mpumalanga, and Gauteng.

(a)

(b)

Figure 2.7 *Eucomis autumnalis* (a) flowers and leaves and (b) bulb (Courtesy: Van Wyk *et al*., 1997)

2.2. 8 *Gomphocarpus fruticosus* (L.) Aiton

G. fruticosus, formerly known as *Asclepias fruticosa* belongs to the family *Asclepiadaceae*. The plant is a small shrub of about 2 meters in height with slender stems and leaves attached opposite to each other. The yellowish-green flowers are borne in swinging clusters. Large round–shaped seed pods are attached to the stem (Figure 2.8). The leaves are used medicinally to treat headaches, stomach pain, tuberculosis and as an emetic. In the previous study quercetin glycosides, rutin and kaempferol and isorhamenetin were isolated from *G. fruticosus* (Heneidak *et a*l., 2006). Other compounds gomphoside, gomphacil, afroside, 5,6-didehydroafroside have been isolated from *G. fruticosus*. Gomphacil and afroside have been isolated from the leaves. Gomphoside is a cardiotonic agent (van Wyk *et al.,* 1997; van Wyk & Gericke, 2000). The leaves were used for the present study.

Distribution of *G. fruticosus*

It is widely distributed in all parts of South Africa.

Figure 2.8 *Gomphocarpus fruticosus* (Courtesy: Van Wyk *et al.* 1997)

2.2.1.9 *Heteromorpha arborescens* (Spreng) Cham. &. Schltdl

H. arborescens belongs to the family *Apiaceae*. The plant is commonly known as parsley tree. In Zulu and Xhosa it is known as "umbangandlala" and "mkatlala" in Sotho. It is a woody shrub or small tree approximately 15 metres in height. The bark is scale–like and is easily peels off. The flowers are yellow and the flower stalks arise from the same point. The bark and leaves (Figure 2.9) are medicinally used to treat headaches, fever, asthma, coughs, dysentery, infertility, abdominal pains and colic (Van Wyk *et al*., 1997; Lundgaard *et al*., 2008). The compounds falcarindiol, germacrene D, asacirin, sabinene and α-pinene have been isolated from *H. arborescens*. Falcarindiol has been isolated from the roots. Germacrene D, asacirin, sabinene and α-pinene have been isolated from the leaves. Falcarindol has been reported to have antifungal, antibacterial and analgesic activity (van Wyk *et al*., 1997; van Wyk & Gericke, 2000). Falcarindol has been reported to inhibit cyclooxygenase-1 (COX-1) (Lundgaard *et al*., 2008). *H. arborescens* has been reported to have antibacterial activity against Gram positive bacteria such as *Staphylococcus aureus*, *S. epidermidis*, *Bacillus subtilis*, *Micrococcus kristinae* and *Streptococcus faecalis* (Nkomo and Kambizi, 2009). The stem and the leaves were used for this study.

Distribution of *H. arborescens*

H. arborescens is extensively distributed in South Africa.

(a) (b)

Figure 2.9 *Heteromorpha arborescens* (a) bark (b) leaves and flowers (Courtesy: Van Wyk *et al.*, 1997)

2.2.10 *Plectranthus ecklonii* Benth.

Plectranthus ecklonii belongs to the family *Lamiaceae*. *P. ecklonii* is a shrub (Figure 2.10) which grows to about 2 metres tall growing best in a semi shade. *Plectranthus* species including *P. ecklonii* are traditionally used to treat stomachaches, nausea, vomiting and meningitis (Lukhoba *et al*., 2006). The leaves of *P. ecklonii* are used to treat skin infections. *P ecklonii* has been reported to be traditionally used for its anti-inflammatory and antifungal properties (Figueiredo *et al*., 2010). The aqueous extract of *P. ecklonii* has been reported to have antibacterial activity against *Streptococcus mutans* and *Streptococcus sobrinus*. In addition *P. ecklonii* also inhibited the formation of the biofilm of the two bacteria. The *P. ecklonii* extract further inhibited the glucosyltransferase and hence the extract may be used in the prevention of dental carie. The main compound present in *P. ecklonii* said to be responsible for this action is rosmarinic acid (Figueiredo *et al*., 2010). Other species of *Plectranthus* such as *P. laxiflorus* and *P. madagascariensis* have been reported to be used in South Africa for the treatment of tuberculosis

related diseases (McGaw *et al*., 2008). Ecklonoquinone A and B have been previously isolated from *P. ecklonii* (DNP, 2010). Other compounds that have been previously isolated from *P. ecklonii* are: 11-hydroxy-19-(methyl-buten-2-oyloxy)-abienta-5,7,9(11),13-tetraene-12-one),11-hydroxy-2α-(3,4dihydroxy-benzoyloxy)abieta-5,7,9(11),13-tetraene-12-one) and 7α-formyloxy-6β,12-dihydroxy-abieta-8,12-diene-11,14-dione (Van Zyl *et al*., 2007). These compounds were isolated from the leaves and were reported to have antiplasmodial activity (Van Zyl *et al*., 2007). The constituents of *Plectranthus* plants mainly diterpenoids have been found to have antimycobaterial activity (Rijo *et al*., 2010). Other compounds that have been previously isolated from *P. ecklonii* are cirsimaritin, ladanein and salvigenin (Grayer *et al*., 2010). Parviflorn D and F have been isolated from *P. ecklonii* and have been found to have antibacterial activity against *Mycobacterium tuberculosis* and *L. monocytogenes* (Nyila *et al*., 2009). The leaves were used for this study.

Distiribution of *P. ecklonii*

P. ecklonii is widely distributed in South Africa, Australia, New Zealand, Mexico and the United States.

Figure 2.10 Shrubs of *P. ecklonii* with leaves and purple flowers.

2.2.11 *Senecio inornatus* DC

S. inonartus belongs to the family *Asteraceae*. The plant is an herb with a upright stem. The leaves and stem are medicinally used to treat various illnesses such as chest pains, headaches, swellings, burns and sores. *S. inonartus* has been reported as one of the plants that is used in South Africa for the treatment of respiratory or chest complaints and coughing (McGaw *et al*., 2008). *Senecio* species are characterised by the presence of macrocylclic pyrrolizidine alkaloids such as toxic senecionine and the non-toxic plattyphylline. Senecionine has been isolated from the aerial parts of the plant. Senecionine has been reported to have antineoplastic activity (van Wyk *et al.*, 1997). The leaves were used for this study.

Distribution of *S. inornartus*

The plant is widely distributed in South Africa especially in the eastern part of the country (Brand *et al*., 2009).

2.2.12 *Tulbaghia violacea* Harv.

T. violacea belongs to the family *Alliaceae.* The plant is commonly known as wild garlic. In Zulu is known as "ishaqa". *T. violacea* is a bulbous plant with long leaves arising from the fleshy base. The purple flowers occur in groups at the tip of a thin stalk (Figure 2.11). The plant is characterised by a strong smell of garlic when damaged (Van Wyk *et al.*, 1997). The leaves and bulbs are medicinally used to treat fever, colds, asthma, tuberculosis (Van Wyk,

2008). Alliin is the main sulphur-containing compound of the whole plant. The bulb of *T. violacea* has been previously (Buwa & Afolayan, 2009) found to have antibacterial activity against *Escherichia coli*, *Bacillus cereus* and *Staphylococcus aureus*. The compounds, Bis[(methylthio)methyl] disulfide, Bis[(methylthio)methyl] disulfide 2,2-Dioxide, Bis[(methylthio)methyl] disulfide 4-Oxide and marasmine have been previously isolated from *T. violacea* (DNP, 2010). The leaves were used for this study.

Distribution of *T. violacea*

T. violacea is found mainly in the Eastern Cape and the southern parts of KwaZulu-Natal province.

Figure 2.11 *Tulbaghia violacea* with purple flowers (Courtesy: Van Wyk *et al*. 1997)

2.2.13 *Ziziphus mucronata* Wild.

Ziziphus mucronata belongs to the family *Rhannaceae.* It is commonly known as buffalo-

thorn. In Zulu it is known as "umhlakaniso", "umphafa" in Xhosa, "mokgalo" in Tswana and Pedi. It has a greyish-brown bark and sharp thorns are found on the twigs. The fruits are small round berries (Figure 2.12). The bark or leaves are medicinally used to treat coughs, chest problems, and diarrhoea, sore and glandular swellings. Decoctions of roots and leaves are applied externally to boils, sores and glandular swellings (Van Wyk *et al.*, 1997; Van Wyk and Gericke, 2000). In previous study *Z. mucronata* was found to possess antibacterial activity against *Enterococcus faecalis* and *Staphylococcus aureus* (MacGaw *et al.*, 2007). Also in another study methanol extracts of *Z. mucronata* have been found to have antibacterial activity against *B. subtilis, S. aureus and S. epidermis* (Rabe and Van Staden, 1997). Mucronine D and sanjoinine compounds have been isolated from the stem bark of *Z. mucronata* (Van Wyk *et al.*, 19 97; VanWyk and Gericke, 2000). The leaves were used for the present study.

Distribution of *Z. mucronata*

Z. mucronata is widely distributed in South Africa with the exception of the Western Cape province (van Wyk *et al*., 1997).

(a) (b)

Figure 2.12 *Ziziphus mucronata* (a) tree and (b) fruits (Courtesy: Van Wyk *et al.*, 1997)

2.3 References

ALZOREKY, N.S., NAKAHARA, K., 2003. Antibacterial activity of extracts from some edible plants commonly consumed in Asia. International Journal of Food Microbiology 80, 223-230.

ATES, D.A., ERDOGRUL, O.T., 2003. Antimicrobial activities of various medicinal and commercial plant extracts. Turkish Journal of Biology 27, 157-162.

BUWA, L.V., AFOLAYAN, A.J., 2009. Antimicrobial activity of some medicinal plants used for the treatment of tuberculosis in the Eastern Cape Province, South Africa. African Journal of Biotechnology 8, 6683-6687.

BRAND, R.F., DU PREEZ, P.J., BROWN, L.R., 2009. A classification and description of the shrubland vegetation on Platberg, Eastern Free State, South Africa. Koedoe 51, 1-11.

CHUNG, H. S., CHANG, L. C., LEE, S. K., SHAMON, L. A., VAN BREMEEN, R.B., MEHTA, R. G., FARNSWORTH, N. R., PEZZUTO, J. M., KINGHORN, A. D., 1999. Flavonoid constituents of *Chlorizanthe diffusa* with potential cancer chemopreventive activity. Journal of Agriculture and Food Chemistry. 47, 36-41.

CROUCH, N.R., DU TOIT, K., MULHOLLAND, D.A., DREWES, S., 2006. Bufadienolides from bulbs of *Urgenea lydenburgensis* (Hyacinthaceae: Urgineoideae. Phytochemistry 19, 2140-2145.

DICTIONARY OF NATURAL PRODUCTS, 2010. Version 19.1. Taylor & Francis, London.

DUBE, J. S., REED, J.D., NDLOVU, L. R., 2001. Proanthocyanidans and other phenolics in *Acacia* leaves of Southern Africa. Animal Feed Science and Technology 91, 59-67.

FIGUEIREDO, N., DE AQUIAR, S.R.M.M., FALÉ, P.L., ASCENCÃO, L., SERRALHEIRO, M.L.M., LINO, A.R.L., 2010. The inhibitory effect of *Plectranthus barbatus* and

Plectrantus ecklonii leaves on the viability, glucosyltransferase activity and biofilm formationof *Streptococcus sobrinus* and *Streptococcus mutans*. Food Chemistry 119, 664-668.

GRACE, O.M., SIMMONDS, M.S.J., SMITH, G.F., VAN WYK, A.E., 2008. Therapeutic uses of *Aloe* L. (Asphodelaceae) in southern Africa. Journal of Ethnopharmacology 119, 604-614.

GRAYER, R.J., ECKERT, M.R., LEVER, A., VEITCH, N.C., KITE, G.C., PATON, A.J., 2010. Distribution of exudates flavonoids in the genus *Plectranthus*. Biochemical Systematics and Ecology 38, 335-341.

HENEIDAK, S., GRAYER, R.J., KITE, G.C., SIMMONDS, M.S.J., 2006. Flavonoids glycosides from Egyptian species of the tribe Asclepiadeae (Apocynaceae, subfamily Asclepiadoideae). Biochemical Systematics and Ecology 34, 575-584.

HEYMAN, H.M., HUSSEIN, A.A., MEYER, J.J.M., LALL, N., 2009. Antibacterial activity of South African medicinal plants against methicillin resistant *Staphylococcus aureus*. Pharmaceutical Biology 47, 67-71.

JIA, Y., ZHAO, G., JIA, J., 2008. Preliminary evaluation: The effects of *Aloe ferox* Miller and *Aloe arboescens* Miller on wound healing. Journal of Ethnopharmacology 120, 181-189.

KATERERE, D. R., ELOFF, J. N., 2004. Variation in chemical composition, antibacterial and antioxidant activity of fresh and dried *Acacia* leaf extracts. South African Journal of Botany 70, 303-305.

KRENN, L., KOPP, B., 1998. Bufadienolides from animal and plant sources. Phytochemistry 48(1), 1-29.

LOUW, C.A.M., REGNIER, T.J.C., KORSTEN, L., 2002. Medicinal bulbous plants of South Africa and their traditional relevance in the control of infectious diseases. Journal of Ethnopharmacology 82, 147- 154.

LUKHOBA, C.W., SIMMONDS, M.S.J., PATON, A.J., 2006. *Plectranthus*: A review of ethnobotanical uses. Journal of Ethnopharmacology 103, 1-24.

LUNDGAARD, N.H., PRIOR, R M., LIGHT, M.E., STAFFORD, G.I., VAN STADEN, J., JÄGER, A.K., 2008. COX-1 inhibition of *Heteromorpha arborescens*. South African Journal of Botany 74, 335-337.

MALAN, E., SWARTZ, P., 1995. A comparative study of the phenolic products in the heartwood of *Acacia karroo* from two different localities. Phytochemistry 39, 791-794.

MANGENA, T., MUYINA, N.Y.O., 1999. Comparative evaluation of the antimicrobial activities of essential oils of *Artemisia afra*, *Pteronia incana* and *Rosmarinus officinalis* on selected bacteria and yeast strains. Letters in Microbiology 28, 291-296.

MCGAW, L.J., VAN DER MERWE, D., ELOFF, J.N., 2007. *In vitro* anthelmintic, antibacterial and cytotoxic effects of extracts from plants used in South African ethnoveternary medicine. The Veterinary Journal 173, 366-372.

MCGAW, L.C., LALL, N., MEYER, J.J.M., ELOFF, J.N., 2008. The potential of South African plants against *Mycobacterium* infections. Journal of Ethnopharmacology 119, 482-500.

MDEE, L.K., MASOKO, P., ELOFF, J.N., 2009. The activity of extracts of seven common invasive plant species against fungal phytopathogens. South African Journal of Botany 75, 375-379.

MONFORTE-GONZALEZ, M., AYORA-TALAVERA, T., MALDONADO-MENDEZA, I.E., LOYOLA-VARGAS, V.M., 2007. Quantitative analysis of serpentine and ajmalicine in

plant tissues of *Catharanthus roseus* and hyoscyamine and scopolamine in root tissues of *Datura stramonium* by thin layer chromatography. Phytochemical Analysis 3, 117-121.

NKOMO, M., KAMBIZI, L., 2009. Antimicrobial activity of *Gunnera perpensa* and *Heterormopha arborescens* var. *abyssinica.* Journal of Medicinal Plants Research 3, 1051-1055.

NYILA, M.A., LEONARD, C.M., HUSSEIN, A.A., LALL, N., 2009. Bioactivities of *Plectranthus ecklonii* constituents. Natural Product Communications 4, 1177-1180.

PARK, M.K., PARK, J.H., KIM, N.Y., SHIN, Y.G., CHOI, Y.S., LEE, J.G., KIM, K.H., LEE, S.K., 1998. Analysis of 13 phenolic compounds in *Aloe* species by high performance liquid chromatography. Phytochemical Analysis 9, 186-191.

PIETER, L., VLIETINCK, A.J., 2005. Bioguided isolation of pharmacologically active plant components, still a valuable strategy for the finding of new lead compounds? Journal of Ethnopharmacology 100, 57-60.

RABE, T., VAN STADEN, J., 1997. Antibacterial activity of South African plants used for medicinal purposes. Journal of Ethnopharmacology 56, 81-87.

RAO, S.R., RAVISHANKAR, G.A., 2002. Plant cell cultures: Chemical factories of secondary metabolites. Biotechnology Advances 20, 101-153.

RIJO, P., SIMÕES, M.F., FRANSICO, A.P., ROJAS, R., GILMAN, R.H., VAISBERG, A.J., RODRÍGUEZ, B., MOITEIRO, C., 2010., Antimycobacterial metabolites from *Plectranthus*: Royleanone derivatives against *Mycobacterium tuberculosis* strains. Chemistry and Biodiversity 7, 922-932.

STAFFORD, G.I., JAGER, A.K., VAN STADEN, J., 2005. Effect of storage on the chemical composition and biological activity of several popular South African medicinal plants

Journal of Ethnopharmacology 97, 107-115.

STOESSL, A., STHOTHERS, J.B., WARD, E.W.B., 1976. Sesquiterpenoid stress compounds of the solanaceae. Phytochemistry 15, 855-872.

TAYLOR, J.L.S., VAN STADEN, J., 2001. COX-1 inhibitory activity in extracts from *Eucomis L'Herit* species. Journal of Ethnopharmacology 57, 107-115.

TEFFO, L.S., ADEROGBA, M.A., ELOFF, J.N., 2010. Antibacterial and antioxidant activities of four kaemferol methyl ethers isolated from *Dodonaea viscosa* Jacq. var. *angustifolia* leaf extracts. South African Journal of Botany 76, 25-29.

VAN WYK, B.-E., VAN OUDTSHOORN, B., GERICKE, N., 1997. Medicinal plants of South Africa Briza Publications. Pretoria, pp. 7-22, 24, 130-131, 150-151.

VAN WYK, B.-E., GERICKE, N., 2000. People's plants. Briza Publications. Pretoria, 126, 142-143, 152, 162-163, 196-197.

VAN WYK, B.-E., 2008. A broad review of commercially important southern African medicinal plants. Journal of Ethnopharmacology 119, 342-355.

VAN ZYL, R.L., KHAN, F., DREWES, S., EDWARDS, T., 2007. Antiplasmodial activity of abietane diterpenes form five southern African *Plectranthus* species. Planta Medica 73, 864.

WANG, Y., HAMBURGER, M., GUEHOF, J., HOSTETTMAN, K., 1989. Antimicrobial flavonoids from *Psiadia trinervia* and their methylated and acetylated derivatives. Phytochemistry 28, 2323-2327.

WEN, A., DELAQUIS, P., STANICH, K., TOIVONEN, P., 2003. Antilsterial activity of selected phenolic acids. Food Microbiology 20, 305-311.