SANSEVIERIA HYACINTHOIDES (L.) DRUCE: A REVIEW OF ITS BOTANY, MEDICINAL USES, PHYTOCHEMISTRY, AND BIOLOGICAL ACTIVITIES

ALFRED MAROYI*

Department of Botany, Medicinal Plants and Economic Development Research Centre, University of Fort Hare, Private Bag X1314, Alice 5700, South Africa. Email: amaroyi@ufh.ac.za

Received: 28 June 2019, Revised and Accepted: 29 July 2019

INTRODUCTION

Sansevieria hyacinthoides (L.) Druce is a member of the Asparagaceae family [1], a classification system that is in agreement with the Angiosperm Phylogeny Group [2]. S. hyacinthoides has also been placed within Agavaceae, Convallariaceae, Dracaenaceae, Liliaceae, and Ruscaceae families [3-18]. According to Plants of the World Online [19], S. hyacinthoides is a synonym of Dracaena hyacinthoides (L.) Mabb. However, according to the plant list, created and managed by the Royal Botanic Gardens (UK) and the Missouri Botanical Gardens (USA), S. hyacinthoides is a valid and accepted name [20]. These observed taxonomical problems associated with S. hyacinthoides corroborate observations made by Dauncey et al. [21] that there are ambiguities and errors in the use of scientific names mainly because of using older names or an out of date taxonomy. Dauncey et al. [21] argued that there is need to use scientific plant names appropriately and unambiguously as a means of ensuring scientific integrity. Therefore, in this study, the name S. hyacinthoides and family Asparagaceae have been adopted and will be used throughout the manuscript. S. hyacinthoides is native to east, central, and southern Africa, but the species has been introduced to several other countries as an ornamental and fiber crop [18,22]. In Bangladesh and South Africa, S. hyacinthoides is grown in home gardens as an ornamental, medicinal, and spiritual plant [23-28]. The leaves and roots of S. hyacinthoides are marketed as herbal medicines in the Eastern Cape and Nkazule-Natal provinces in South Africa [29,30]. S. hyacinthoides is also one of the important medicinal plants in South Africa, included in the book "medicinal plants of South Africa," a photographic guide to the most commonly used plant medicines in the country, including their botany, main traditional uses, and active ingredients [31]. Research by Van Wyk [32] showed that the leaves and roots of S. hyacinthoides have commercial potential as herbal medicines for ear infections, hemorrhoids, and skin ulcers in South Africa. It is within this context that this review was undertaken aimed at reviewing the botany, medicinal uses, phytochemical, and biological activities of S. hyacinthoides so as to provide baseline data required in evaluating the therapeutic potential of the species.

BOTANICAL PROFILE OF S. HYACINTHOIDES

The genus Sansevieria Thunb. is in honor of an Italian Pietro Antonio Sanseverino, Count of Chiaromonte (1724-1771) in whose garden the plant was growing [33]. The specific name hyacinthoides means resembling a hyacinth [33]. The name S. hyacinthoides is associated with the following synonyms: Aletris guineensis (L.) Jacq. A. hyacinthoides var. guineensis L., Aloe guineensis L., A. hyacinthoides L., A. hyacinthoides var. guineensis L., Cordyline guineensis (Willd.) Britton, S. angustiflora Lindb., S. grandis var. zuluenis N.E. Br., S. guineensis (L) Wild., S. metallica Gérôme and Labroy, and S. thyrsiflora (Petagna) Thumb. [4,6,9,10,18]. S. hyacinthoides is native to Kenya, Malawi, Mozambique, Namibia, South Africa, Tanzania, and Zambia and Zimbabwe [4-7,9,10,12,18], but the species has been introduced in America, Asia, Australia, and Europe as an ornamental and fiber crop [18,22,24-36]. S. hyacinthoides has been recorded in all six Dutch Caribbean islands, and it is regarded as a weed [37,38]. S. hyacinthoides was introduced to Florida around 1800, and the species has been categorized as an invasive weed since 1951 and currently regarded as one of the six "worst plant invaders" in Florida [39,40]. S. hyacinthoides is included in the Global Compendium of Weeds [40,41] and currently naturalized in Anguilla, Australia, Bahamas, Barbados, Bermuda, Cayman Islands, Cuba, Florida, Jamaica, Mexico, Puerto Rico, the US Virgin Islands, and West Indies [22,40-46]. Where S. hyacinthoides is naturalized, the species has been recorded in a variety of habitats which include disturbed areas, roadsides, secondary forests, coastal forest, and Shrubland in dry, arid, and semiarid ecosystems [22,40,45].

S. hyacinthoides is a succulent, robust, evergreen, stemless, and perennial herb which can grow up to 60 cm in height [9]. S. hyacinthoides has fleshy creeping rhizomes that are sturdy, fibrous, and bright orange in color. The leaves are erect, rigid, loosely clustered, fibrous, flat, and arising from a horizontal underground rhizome. The leaves are lanceolate or narrowly elliptic in shape, the apex acute or obtuse, the blade leathery and dull green but mottled transversely with numerous more or less...
obscure pale green bands and the margins with a fine reddish line. The inflorescence is a many-flowered raceme, with stalkless flowers that are white, cream-colored or greenish-white to pale mauve in color. The flowers form small berry-like fruits, which are green at first, gradually becoming yellow when they ripen.

MEDICINAL USES OF S. HYACINTHOIDES

The leaf sap, leaves, rhizomes, roots, and whole plant parts of S. hyacinthoides are used as ethnoveterinary medicine, magical purposes, to dilate birth canal and as herbal medicine for fever, respiratory problems, intestinal parasites, worms, rheumatism, swellings, skin infections, sexually transmitted infections, hemorrhoids, toothache, diarrhea, stomach problems, insect and snake bites, earache, and infections (Table 1 and Fig. 1). In Bangladesh, the fruits of S. hyacinthoides are mixed with Aconitum napellus L. and Mucuna pruriens (L.) DC. as an herbal medicine for urinary problems [46].

PHYTOCHEMICAL COMPOSITION OF S. HYACINTHOIDES

Gamboa-Angelo et al. [100] identified steroids 25S-ruscogenin and 1β,3β-dihydroxy-5,16-pregnadien-20-one from the leaves of S. hyacinthoides while Khare [8] identified alkaloids aconitic acid and Sansevieria from the leaves and roots of the species (Table 2). Sultana et al. [25] identified a flavonoid isokaemferide and steroids β-sitosterol and daucosterol from the rhizomes of S. hyacinthoides (Table 2). Van Wyk et al. [31] argued that the value of S. hyacinthoides in treating hemorrhoids is due to the presence of various sapogenins, particularly 25S-ruscogenin.

BIOLOGICAL ACTIVITIES OF S. HYACINTHOIDES

The following biological activities have been reported from the leaf and root extracts and compounds isolated from S. hyacinthoides: Anthelmintic [54], antibacterial [25,54,57,69,94,95,101], antifungal [25,57,94,95], and antioxidant [102-105] activities.

| Medicinal use                           | Parts of the plant used | Country                          | References                          |
|----------------------------------------|-------------------------|----------------------------------|-------------------------------------|
| Blood disorders                        | Rhizomes and roots      | India                            | [47]                                |
| Burns and wounds                       | Leaves and roots        | South Africa                     | [26,48]                             |
| Colic                                  | Leaves                  | Zimbabwe                         | [49,50]                             |
| Contusions                             | Leaves                  | Mozambique                       | [51]                                |
| Diabetes                               | Leaves                  | South Africa                     | [52]                                |
| Diarrhea and stomach problems          | Leaves, rhizomes, roots, and whole plant | Mozambique, Nepal, South Africa, Uganda, and Zimbabwe | [26,31,33,48-61] |
| Dilate birth canal                     | Leaves, rhizome, and roots | South Africa, Swaziland, and Zimbabwe | [49,62-64] |
| Ear ache and infections                | Leaves and rhizomes     | Bangladesh, Nepal, South Africa, Swaziland, Tanzania, and Zimbabwe | [24,31,33,48,55,57,59,60,64-75] |
| Erectile dysfunction                   | Leaves                  | South Africa                     | [52]                                |
| Fever                                  | Leaves                  | Guatemala and India              | [47,76]                             |
| Glandular enlargements                 | Rhizomes and roots      | India                            | [47]                                |
| Hemorrhoids                            | leaves, rhizomes, and roots | Nepal, Mozambique, South Africa, and Swaziland | [31,33,49,51,55,57,59,60,62,67,69,70,77-79] |
| Headache                               | leaves                  | Guatemala                         | [76]                                |
| Heart problems                         | Rhizomes and roots      | India                            | [47]                                |
| Human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) | Roots | South Africa                     | [80-82]                             |
| Infection                              | roots                   | Mozambique                       | [51]                                |
| Insect and snake bites                 | leaves, roots, and whole plant | Bangladesh, Belize, Guatemala, Mexico, Mozambique, and South Africa | [24,56,72,76,83-85] |
| Intestinal parasites and worms         | leaves, rhizomes, and roots | Nepal, South Africa, and Zimbabwe | [31,33,49,55,57,59,60,62,67,69,70,86] |
| Magical purposes                       | leaves, roots, and whole plant | Mexico, Mozambique, South Africa, and Swaziland | [24,33,51,62,64,66,67,70,88] |
| Poisoning                              | leaves                  | Zimbabwe                         | [49]                                |
| Purgative                              | leaves                  | Zimbabwe                         | [49]                                |
| Respiratory problems (chest pains, cough, and labored breathing) | leaves, rhizomes, and roots | South Africa and Zimbabwe | [57,89-91] |
| Rheumatism and swellings               | leaves, rhizomes, and roots | India, Mozambique, South Africa, and Zimbabwe | [47-49,51] |
| Sexually transmitted infections (genital warts, gonorrhea, syphilis, and venereal diseases) | leaves, rhizomes, and roots | India, Mozambique, South Africa, and Zimbabwe | [27,47,49,56,92] |
| Skin infections (chickenpox, leprosy, and measles) | leaves, rhizomes, roots, and whole plant | Guatemala, India, Uganda, and Zimbabwe | [47,49,61,76] |
| Toothache                              | leaves and rhizomes     | Nepal, South Africa, Swaziland, and Tanzania | [31,33,48,49,55,57,59,60,62,67,69,70,88,93-95] |
| Ulcers                                 | Fruits mixed with Aconitum napellus L. and Mucuna pruriens (L.) DC. | Nepal and South Africa | [31,33,49,55,57,59,60,69,78] |
| Urinary problems                       | Fruits, leaf sap, and rhizomes | South Africa, Tanzania, and Zimbabwe | [49,71,96-99] |

Table 1: Medicinal uses of Sansevieria hyacinthoides
Table 2: Phytochemical composition of Sansevieria hyacinthoides

| Phytochemical composition | Plant parts | References |
|---------------------------|-------------|------------|
| Alkaloid                   | Leaves      | [8]        |
| Aconitic acid              | Roots       | [8]        |
| Flavonoid                  | Rhizome     | [25]       |
| Isoflavonoids              | Leaves      | [100]      |
| Steroids                   | Leaves      | [100]      |
| β-sitosterol               | Rhizome     | [25]       |
| Daucosterol                | Rhizome     | [25]       |

Anthelmintic activities

McGaw et al. [54] evaluated anthelmintic activities of hexane, ethanol, and waterleaf extracts of S. hyacinthoides against Bacillus subtilis, Escherichia coli, Klebsiella pneumoniae, and Staphylococcus aureus using the disc-diffusion and microdilution assays, with neomycin (5 μg) as the positive control. Water extract exhibited activities with minimum inhibitory concentration (MIC) value of 6.3 μg/mL against B. subtilis [54]. C. albicans [69] evaluated antibacterial activities of 50% methanol and aqueous leaf extracts of S. hyacinthoides against S. aureus, Pseudomonas aeruginosa, and Mycobacterium smegmatis using a disc-diffusion assay with ciprofloxacin as a positive control. The 50% methanol extract exhibited weak activities against S. aureus and M. smegmatis with MIC values ranging from 7.0 mg/mL to 9.0 mg/mL [25]. Nielsen et al. [57] evaluated antibacterial activities of the methanol leaf and rhizome extracts of S. hyacinthoides against Citrobacter spp., S. aureus, E. coli, K. pneumoniae, P. aeruginosa, and M. smegmatis using the microbroth dilution method with gentamicin and ciprofloxacin as positive controls. The extracts exhibited weak activities with MIC values ranging from 31.25 μg/mL to >2500 μg/mL which were much higher than MIC values of 0.3 μg/mL to 19.5 μg/mL exhibited by the controls [57]. Yorg et al. [101] assessed the antibacterial properties of aqueous and dichloromethane-methanol (1:1) leaf extracts of S. hyacinthoides against K. pneumoniae, Moraxella catarrhals, M. smegmatis, and S. aureus using microdilution assay with ciprofloxacin as the positive control. The extract showed activities with MIC values ranging from 1.7 mg/mL to >16.0 mg/mL [101]. Akhalwaya [94] and Akhalwaya et al. [95] evaluated antibacterial activities of aqueous and dichloromethane: methanol (1:1) leaf and rhizome extracts of S. hyacinthoides against Streptococcus mutans, Streptococcus sanguis, Lactobacillus acidophilus, Lactobacillus casei, Porphyromonas gingivalis, and Fusobacterium nucleatum using the microtiter plate dilution assay with ciprofloxacin (0.1 mg/mL) as a positive control. The extract exhibited activities with MIC values ranging from 0.3 mg/mL to >8.0 mg/mL [94,95].

Antibacterial activities

McGaw et al. [54] evaluated antibacterial activities of aqueous, ethanol, and hexane leaf extracts of S. hyacinthoides against Bacillus subtilis, Escherichia coli, Klebsiella pneumoniae, and Staphylococcus aureus using the disc-diffusion and microdilution assays, with neomycin (5 μg) as the positive control. Water extract exhibited activities with minimum inhibitory concentration (MIC) value of 6.3 μg/mL against B. subtilis [54]. C. albicans [69] evaluated antibacterial activities of 50% methanol and aqueous leaf extracts of S. hyacinthoides against S. aureus, Pseudomonas aeruginosa, and Mycobacterium smegmatis using a disc-diffusion assay with ciprofloxacin as a positive control. The 50% methanol extract exhibited weak activities against S. aureus and M. smegmatis with MIC values ranging from 7.0 mg/mL to 9.0 mg/mL [25]. Nielsen et al. [57] evaluated antibacterial activities of the methanol leaf and rhizome extracts of S. hyacinthoides against C. albicans and Microsporum audouini using the microbroth dilution method with nystatin as a positive control. The rhizome and leaf extracts exhibited MIC values of 156.3 μg/mL and 312.5 μg/mL, respectively, against both fungi species in comparison to MIC value of 19.5 μg/mL exhibited by the control [57]. Akhalwaya [94] and Akhalwaya et al. [95] evaluated antibacterial activities of aqueous and dichloromethane: methanol (1:1) leaf and rhizome extracts of S. hyacinthoides against C. albicans, Candida glabrata, and Candida krusei using the microtiter plate dilution assay with amphotericin B (0.01 mg/mL) as a positive control. The extract exhibited activities with MIC values ranging from 0.5 mg/mL to >8.0 mg/mL [94,95].
Antioxidant activities
Aleri et al. [102] evaluated the antioxidant activities of acetone and methanol leaf and root extracts of *S. hyacinthoides* using the 1,1-diphenyl-2-picrylhydrazyl free radical (DPPH) free radical scavenging assay. The leaf extracts showed activities at 1 mg/ml exhibiting over 80% DPPH activity, while acetone and methanol extracts from the roots at 0.75 mg/ml exhibited 91.4% and 92.8% DPPH scavenging activities, respectively [102]. Tkachenko et al. [103] evaluated the antioxidant activities of leaf extracts of *S. hyacinthoides* by assessing their *in vitro* effects against protein damage in equine erythrocytes using the carbonyl derivatives content of protein oxidative modification (OMP) assay. The extract efficiently inhibited the formation of ketonic derivatives of OMP showing potential in protecting the protein groups and reducing the protein carbonyl content [103]. Tkachenko et al. [104] evaluated the antioxidant activities of leaf extracts of *S. hyacinthoides* by assessing the level of 2-thiobarbituric acid reactive substances (TBARS) as biomarkers of lipid peroxidation in equine erythrocyte suspension induced by treatment of the leaf extracts. The leaf extracts resulted in a significant increase of 29.7% of TBARS concentration in erythrocytes. These results suggest that *S. hyacinthoides* has a promising antioxidant and prooxidant potential.

**CONCLUSION**

The present review summarizes the botany, medicinal uses, phytochemistry, and pharmacological properties *S. hyacinthoides*. From a chemical, pharmacological, and toxicological point of view, *S. hyacinthoides* has not received any major emphasis. At present, there is not yet enough data on ethnopharmacological evaluations on the species that can be correlated with its medicinal applications. Therefore, detailed phytochemical, pharmacological, and toxicological studies of *S. hyacinthoides* are recommended.

**ACKNOWLEDGMENTS**

The author would like to express his gratitude to the National Research Foundation, South Africa and Goven Mbeki Research and Development Centre, University of Fort Hare for financial support to conduct this study.

**AUTHOR’S CONTRIBUTIONS**

The author declares that this work was done by the author named in this article.

**CONFLICTS OF INTEREST**

The author declares that there are no conflicts of interest regarding the publication of this paper.

**REFERENCES**

1. Takawira-Nyenya R, Mucina L, Cardinal-Metqague WM, Thiele KR. *Sansevieria (Asparagaceae, Nolinoideae)* is a herbaceous clade within *Dracaena*: Inference from non-coding plastid and nuclear DNA sequence data. *Phytotaxa* 2018;376:254-76.
2. Angiosperm Phylogeny Group. An update of the angiosperm phylogeny group classification for the orders and families of flowering plants: APG III. Bot J Linn Soc 2009;161:105-21.
3. Koller AL, Rost TL. Leaf anatomy in *Sansevieria (Agavaceae)*. In: Van der Maesen LJ, Van der Burgt M, Van de Braak JM, editors. *Interface between Conservation and Primary Health Care*. Paris: Springer; 2006. p. 489-92.
4. Tkawira, R, Ndelal I. The genus *Sansevieria (family Dracaenaceae)* in Zimbabwe. *Acta Hortic.* 2001;572:189-98.
5. Germishuizen G, Meyer NL. *Plants of Southern Africa: An Annotated Checklist*. Pretoria: *Stereletzia* 14. Pretoria: National Botanical Institute; 2003.
6. Tkawira-Nyenya R. A taxonomic study of the genus *Sansevieria (Dracaenaceae)* in Zimbabwe. In: Ghazanfar SA, Beentje HJ, editors. *Taxonomy and Ecology of African Plants, their Conservation and Sustainable Use*. London: Royal Botanic Gardens, Kew; 2006. p. 61-71.
7. Khare CP. *Indian Medicinal Plants: An Illustrated Dictionary*. New York: Spinger; 2007.
8. Mwachala G, Mbugua PK. *Dracaenaceae*. In: Beentje HJ, Ghazanfar SA, editors. *Flora of Tropical East Africa* 1. London: Royal Botanic Gardens, Kew; 2007. p. 10-41.
9. La Croix I. *Dracaenaceae*. In: Timberlake JR, Martins ES, editors. *Flora Zambesiaca*. Vol. 13. London: Royal Botanic Gardens, Kew; 2010. p. 13-35.
10. Patil DA, Rai RM. The floral anatomy and taxonomy of the genus *Sansevieria*. Natl J Life Sci 2010;7:49-52.
11. Manning JC, Goldblatt P. Plants of the Greater Cape Floristic Region 1: The Core Cape Flora. Cape Town: *Stereletzia* 29, South African National Biodiversity Institute, 2012.
12. Menale B, De Luca P, Del Guaccio E. A plea to restore Petagna’s authorship for the genus *Sansevieria*, nom. Cons. (Liliaceae). *Taxon* 2013;62:387-90.
13. Thiede J, Campbell-Barker PT. *Sansevieria burdettii* (Asparagaceae Dracaenaceae): Its history, introduction and distribution, with new localities. *Bradleya* 2015;33:27-33.
14. Singhurst JR, Mink JN, Holmes WC. *Sansevieria hyacinthoides* (Agavaceae) naturalized in Texas. *Phytoneuron* 2016;1:48-56.
15. Philip D, Kaleza PK, Valivittan K. Antioxidant potential of *Sansevieria roxburghiana* Schl. And Schult. *F. Asian J Pharm Clin Res* 2012;5:166-9.
16. Prakash VE. Terpenoids as source of anti-inflammatory compounds. *Asian J Pharm Clin Res* 2017;10:68-76.
17. Newton LE. *Sansevieria rusecane*. In: Eggli U, Nyffeler R, editors. Monocotyledons: Illustrated Handbook of Succulent Plants. Berlin: Springer; 2018. p. 1-37.
18. Plants of the World Online. *Sansevieria hyacinthoides* (L.) Druce; 2019. Available from: http://www.theplantlist.org/tpl1.1/record/kew-287144. [Last accessed on 2019 Apr 09].
19. Zhobolo AM, Mkabela QN. Traditional knowledge transfer of activities practised by Zulu women to manage medicinal and food plant gardens. Afr J Range Forage Sci 2006;23:77-80.
20. Sultana N, Rahman MM, Ahmed S, Akter S, Haque MM, Parveen S, et al. Antimicrobial compounds from the rhizomes of *Sansevieria hyacinthoides*. Bangladesh J Sci Ind Res 2011;46:329-32.
21. Maroji A, Mosina GK. Medicinal plants and traditional practices in peri-urban domestic gardens of the Limpopo Province, South Africa. *Indian J Ind Knowl* 2014;13:665-72.
22. Semeny SS, Potgieter MJ. Medicinal plants cultivated in bapedi traditional healers homegardens, Limpopo Province, South Africa. Afr J Tradit Complement Altern Med 2014;11:52-6.
23. Mosina GKE, Maroji A, Potgieter MJ. Useful plants grown and maintained in domestic gardens of the Capricorn district, Limpopo Province, South Africa. *Ethn Med* 2015;9:43-58.
24. Cunningham AB. African Medicinal Plants: Setting Priorities at the People and Plants Working Paper 1, UNESCO; 1993.
25. Cunningham AB. African Medicinal Plants: Setting Priorities at the People and Plants Working Paper 1, UNESCO; 1993.
26. Cunningham AB. *African Medicinal Plants: Setting Priorities at the People and Plants Working Paper 1, UNESCO; 1993.*
86. Cock IE, Selesho ML, Van Vuuren SF. A review of the traditional use of southern African medicinal plants for the treatment of selected parasite infections affecting humans. J Ethnopharmacol 2018;220:250-64.

87. Cunningham AB. An Investigation of the Herbal Medicine Trade in KwaZulu-Natal. Pietermaritzburg: Institute of Natural Resources Investigational Report 29, University of Natal; 1988.

88. Corrigan BM, Van Wyk B-E, Geldenhuys CJ, Jardine JM. Ethnobotanical Plant uses in the KwaNkatha Peninsula, St Lucia, South Africa. S Afr J Bot 2011;77:346-59.

89. Semenya SS, Maroyi A. Ethnobotanical survey of plants used by Bapedi traditional healers to treat tuberculosis and its opportunistic infections in the Limpopo Province, South Africa. S Afr J Bot 2019;122:401-21.

90. Semenya SS, Maroyi A. A source of plants used by traditional healers for respiratory infections and related symptoms in the Limpopo Province. J Biol Sci 2019;19:101-21.

91. Semenya SS, Maroyi A. Source, harvesting, conservation status, threats and management of indigenous plant used for respiratory infections and related symptoms in the Limpopo Province, South Africa. Biodiversitas 2019;20:790-811.

92. Asong JA, Ndhlovu PT, Khosana NS, Aremu AO, Otang-Mbeng W. Medicinal plants used for skin-related diseases among the Batswanas in Ngaka Modiri Molema district municipality, South Africa. S Afr J Bot 2019. Doi.org/10.1016/j.sajb.2019.05.002.

93. Hutchings A. Zulu Medicinal Plants. Pietermaritzburg: University of Natal Press; 1996.

94. Akhalwaya S. The Antimicrobial Investigation of Indigenous South African Medicinal Plants against Oral Pathogens. MSc Dissertation. Johannesburg: University of the Witwatersrand; 2017.

95. Akhalwaya S, Van Vuuren S, Patel M. An in vitro investigation of indigenous South African medicinal plants used to treat oral infections. J Ethnopharmacol 2018;210:359-71.

96. Bizimana N. Traditional Veterinary Practice in Africa. Eschborn: Deutsche Gesellschaft für Technische Zusammenarbeit GmbH; 1994.

97. Dold AP, Cocks ML. Traditional veterinary medicine in the Alice district of the Eastern Cape Province, South Africa. S Afr J Sci 2001;97:375-9.

98. McGaw LJ, Eloff JN. Ethnoveterinary use of southern African plants and scientific evaluation of their medicinal properties. J Ethnopharmacol 2008;119:559-74.

99. Nyahangare ET, Mvumi BM, Mutíbvu T. Ethnoveterinary plants and practices used for ecto-parasite control in semi-arid smallholder farming areas of Zimbabwe. J Ethnobiol Ethnomed 2015;11:30.

100. Gamboa-Angulo MM, Reyes-López J, Peña-Rodríguez LM. A natural pregnane from Sansevieria hyacinthoides. Phytochem 1996;43:1079-81.

101. York T, van Vuuren SF, de Wet H. An antimicrobial evaluation of plants used for the treatment of respiratory infections in rural Maputaland, KwaZulu-natal, South Africa. J Ethnopharmacol 2012;144:118-27.

102. Aliero AA, Jimoh FO, Afolayan AJ. Antioxidant and antibacterial properties of Sansevieria hyacinthoides. Int J Pure Appl Sci 2008;2:103-10.

103. Tkachenko H, Buyun L, Maryniuk M, Osadowski Z. A comparative study of effect of various Sansevieria Thunb. Leaf extracts on the lipid peroxidation in the equine erythrocyte suspension. AgroBio Improv Nutr Health Life Qual 2018;5:69-81.

104. Tkachenko H, Buyun L, Powazik-Piński P, Witaszek M, Maryniuk M, Osadowski Z. Extract Obtained from Leaves of Sansevieria hyacinthoides (L.) Druce Reduced Oxidative Damage of Proteins in Equine Erythrocytes. Medicinal Herbs: from Past Experience to New Technologies. Pospelov SV, editor. Poltava: Proceedings of Sixth International Scientific and Practical Conference Dec., 26-27; 2017. p. 206-11.

105. Tkachenko H, Buyun L, Powazik-Piński P, Witaszek M, Osadowski Z. In vitro protective effect of extracts obtained from various Sansevieria species against oxidative damage of proteins in equine erythrocytes. Slupskie Prace Biol 2017;14:247-65.