UDK 615.012.1: 582.949.2: 581.3

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THE ANTIBACTERIAL ACTIVITY OF CERTAIN *SANSEVIERIA* SPECIES AGAINST *ESCHERICHIA COLI*

Висвітлено дослідження in vitro антимікробної активності етанольних екстрактів сімнадцяти видів роду *Sansevieria [Sansevieria canaliculata* Carrière, *S. trifasciata* Prain, *S. cylindrica* Bojer ex Hook., *S. parva* NEBr., *S. fischeri* (Baker) Marais, *S. kirkii* Baker, S. *aethiopica* Thunb., *S. metallica* Gérôme & Labroy, *S. caulescens* NEBr., *S. francisii* Chahin, *S. arborescens* Cornu ex Gérôme & Labroy, *S. volkensii* Gürke, *S. forskaliana* (Schult. & Schult.f.) Hepper & JRIWood, *S. gracilis* NEBr., *S. hyacinthoides* (L.) Druce, *S. roxburghiana* Schult. & Schult.f., *S. suffruticosa* N.E.Br.] щодо *Escherichia coli* (ATCC 25922). Антимікробну активність визначали за допомогою диско-дифузійного методу. Всі досліджені екстракти виявили різний ступінь інгібування зони росту протестованої бактеріальної культури, що свідчить про протимікробний потенціал цих екстрактів. Тестовий мікроорганізм є сприйнятливим до екстрактів листя *S. kirkii, S. arborescens, S. roxburghiana, S. francisii, S. forskaliana, S. cylindrica, S. trifasciata, S. canaliculata, S. caulescens, S. metallica, S. aethiopica* з діаметром зони пригнічення в інтервалі 12-24 мм. Ізолят *E. coli* був резистентним лише до екстракту S. hyacinthoides, в той час як діаметр зони пригнічення навколо інших досліджуваних екстрактів становив 8-10 мм. Етанольні екстракти, отримані з листя *S. kirkii, S. arborescens, S. roxburghiana, S. francisii, S. forskaliana, S. cylindrica, S. trifasciata, S. canaliculata, S. caulescens, S. metallica, S. aethiopica* мають антимікробні властивості щодо ізолятів *E. coli* і можуть бути використані в медицині як природні антисептики і протимікробні препарати.

Ключові слова: *Sansevieria*, листя, екстракт, антибактеріальна активність, диско-дифузійний метод.

Introduction. It was estimated that 70-80 % of people worldwide rely chiefly on traditional, largely herbal; medicine to meet their primary healthcare needs [10, 12]. The literature search on this issue has shown that *Sansevieria* Thunb., a genus with diverse ethnobotanical uses in its geographical distribution range, has occupy an important place among plant genera applied for treatment of a broad spectrum of diseases and disorders [16, 23, 24]. During the last years, many *Sansevieria* species were screened and plants with high bioactive compounds were identified [1, 9, 15].

Genus *Sansevieria*, belonging to *Asparagaceae* family [19], comprises ca. 70 species worldwide, distributed mainly in dry or arid areas of the Old World tropics and subtropics [23], with a distribution range from Africa to south east Asia and the islands of the Indian Ocean [3]. Representatives of this genus are usually xerophytic perennial rhizomatous plants that occur in dry tropical and subtropical parts of the world [23]. Africa is the center of diversity for *Sansevieria* [6]. Common English names for *Sansevieria* species are snake plant or bowstring-hemp, zebra lily, cow tongue, leopard lily, devil’s tongue, good luck plant along with “mother-in-law’s tongue” for the widely cultivated horticultural plant *S. trifasciata* [23, 24].

The medicinal use of rhizomes and leaves of *S. aethiopica* is widespread in southern Africa. In Zimbabwe, the leaves are heated and the sap is squeezed into the ear to treat ear-infections, while the rhizome is warmed and used for treating toothache [14]. Fresh or boiled rhizome are eaten to treat haemorrhoids, stomach-ache, ulcer, diarrhoea and internal parasites. In Namibia Bushmen apply the heated, pounded leaves to a stiff neck to give relief. Leaf sap is applied to wounds to accelerate healing and to maternal breast to stimulate milk production. Rhizomes and leaves contain ruscogenin and related sapogenins, which have anti-inflammatory and venotomic properties. Nevertheless, antibacterial tests have given negative results [5].

For example, *S. roxburghiana* Schult. & Schult.f. is used for coughs, rheumatism; as an expectorant, febrifuge, purgative, and tonic [11]. The study of Haldar and co-workers (2010) has

demonstrated that the hydroalcoholic extract of *S. roxburghiana* rhizome exhibited remarkable antitumor activity against Ehrlich ascites carcinoma in Swiss mice that is plausibly attributable to its augmenting endogenous antioxidant mechanisms. In addition, diethyl ether, alcohol, and acetone extracts of *S. roxburghiana* rhizome showed antibacterial activity against *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, and *Staphylococcus aureus* [15].

The assessment of antimicrobial activity of the methanolic leaf extract of *S. liberica*, conducted by Adelanwa and Habibu (2015), has revealed that *Bacillus cereus* and *S. aureus* were sensitive to the methanolic extract of *S. liberica* while *Salmonella typhi* and *E. coli* were resistant to the extract [1]. In addition, these authors carried out the phytochemical screening of *S. liberica* leaf extract, which demonstrated the presence of carbohydrate, triterpenes, flavonoids and cardiac glycosides; absence of anthraquinones and alkaloids in the plant. However tannins, saponins and steroids were found to be absent in *S. liberica* [1]. These results are consistent with those of Eze and co-workers (2011), which have assessed the antimicrobial activity of the leaf extract of *S. liberica* [9].

Phytochemical analysis of the crude extract and the fractions showed the presence of various bioactive substances such as alkaloids, saponins, flavonoids, terpenoids, steroids, glycosides, reducing sugars, tannins, resins, carbohydrates, proteins, acidic compounds, fats and oils [9].

Although *Escherichia coli* can be an innocuous resident of the gastrointestinal tract, it also has the pathogenic capacity to cause significant diarrheal and extraintestinal diseases [7]. *E. coli* is a Gram-negative, oxidase-negative, rod-shaped bacterium from the family Enterobacteriaceae. It is able to grow both aerobically and anaerobically, preferably at 37 °C, and can either be nonmotile or motile, with peritrichous flagella. Pathogenic variants of *E. coli* (pathovars or pathotypes) cause much morbidity and mortality worldwide [7].

In addition, the development of bacterial resistance to presently available antibiotics has necessitated the search for new antimicrobial agents. Another challenging factor for the renewed interest in plant antimicrobial agents in the past 20 years has been the threatening rate of plant species extinction [18].

Hence, an attempt has been made to evaluate antibacterial activity of seventeen species of *Sansevieria* genus against *E. coli*. So the present study was conducted to investigate *in vitro* antimicrobial activity of ethanolic extracts of seventeen species of *Sansevieria* genus [*Sansevieria canaliculata* Carrière, *S. trifasciata* Prain, *S. cylindrica* Bojer ex Hook., *S. parva* N.E.Br. (syn. *S. dooneri* N.E.Br.), *S. fischeri* (Baker) Marais, *S. kirkii* Baker, *S. aethiopica* Thunb., *S. metallica* Gérôme & Labroy, *S. caulescens* N.E.Br., *S. francisii* Chahin, *S. arborescens* Cornu ex Gérôme & Labroy, *S. volkensii* Gürke (syn. *S. intermedia* N.E.Br.), *S. forskaliana* (Schult. & Schult.f.) Hepper & J.R.I.Wood, *S. gracilis* N.E.Br., *S. hyacinthoides* (L.) Druce (syn. *S. grandis* Hook.f.), *S. roxburghiana* Schult. & Schult.f., *S. suffruticosa* N.E.Br.] against *E. coli* strain.

Materials and methods. ***Collection of Plant Materials.*** The leaves of *Sansevieria* plants, cultivated under glasshouse conditions, were sampled for antimicrobial potency assessment at M.M. Gryshko National Botanical Garden, National Academy of Science of Ukraine.

Preparation of Plant Extracts. Freshly leaves were washed, weighted, crushed, and homogenized in 96 % ethanol (in proportion 1:19) at room temperature. The extracts were then filtered and investigated for their antimicrobial activity. All extracts were stored at 4°C until use.

Bacterial test strain and growth conditions. For this study, a strain of *E. coli* (ATCC 25922) was used. The cultivation medium was trypticase soy agar (Oxoid, UK), supplemented with 10 % defibrinated sheep blood. Cultures were grown aerobically for 24 h at 37 °C. The cultures were later diluted with sterile solution of 0.9 % normal saline to approximate the density of 0.5 McFarland standard. The McFarland standard was prepared by inoculating colonies of the bacterial test strain in sterile saline and adjusting the cell density to the specified concentration.

Determination of antibacterial activity of plant extracts by the disk diffusion method. Antimicrobial activity was determined using the agar disk diffusion assay [4]. Culture of *E. coli* was inoculated onto Mueller-Hinton (MH) agar plates. Sterile filter paper discs impregnated with extracts were applied over each of the culture plates. Isolates of bacteria were then incubated at 37 ^{o}C for 24 h. The plates were then observed for the zone of inhibition produced by the antibacterial activity of various ethanolic extracts obtained from leaves of *Sansevieria* species. A negative control disc impregnated with sterile ethanol was used in each experiment. At the end of the period, the inhibition zones formed were measured in millimeters using the vernier. For each extract, six replicates were

assayed. The plates were observed and photographs were taken. Zone diameters were determined and averaged.

Statistical analysis. All statistical calculation was performed on separate data from each species (Statistica 8.0, StatSoft, Poland). The following zone diameter criteria were used to assign susceptibility or resistance of bacteria to the phytochemicals tested: Susceptible (S) ≥ 15 mm, Intermediate
(I) = 11-14 mm, and Resistant (R) ≤ 10 mm [20].

Results. The results of antimicrobial activity of ethanolic extracts obtained from leaves of *Sansevieria* species are presented in Figs 1 and 2.

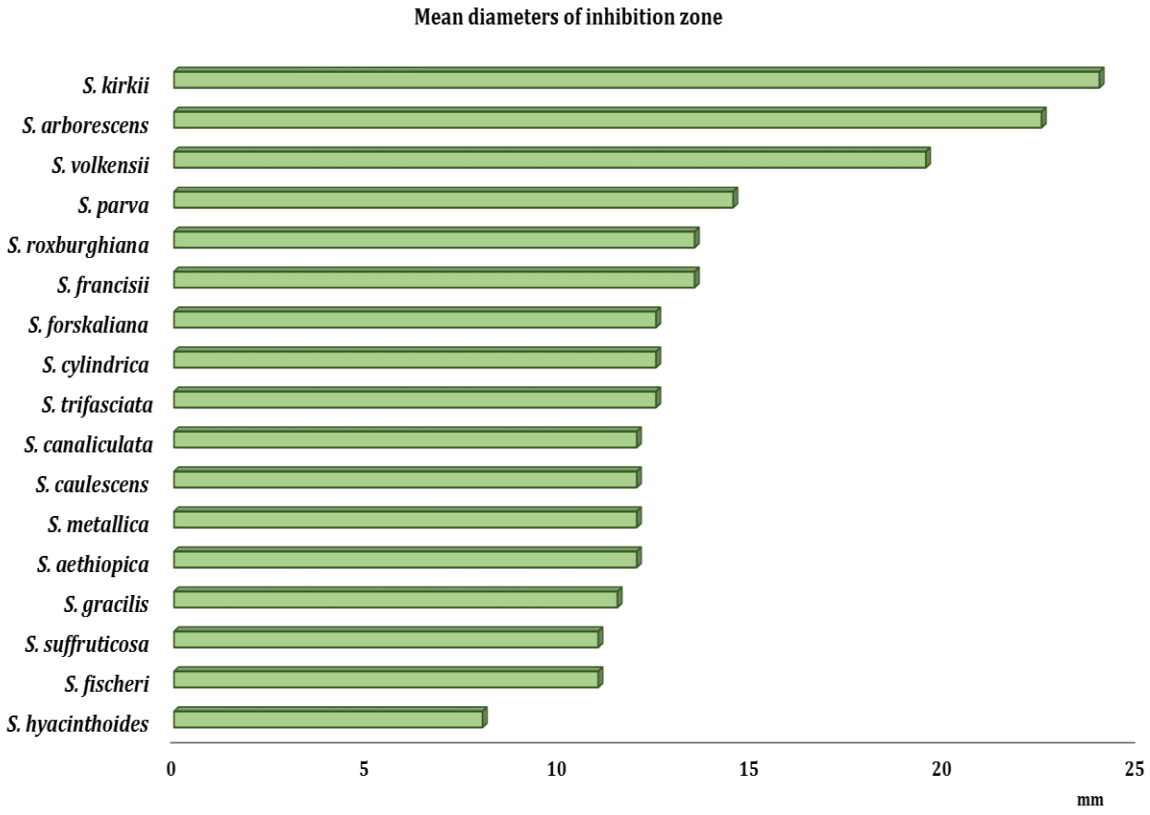
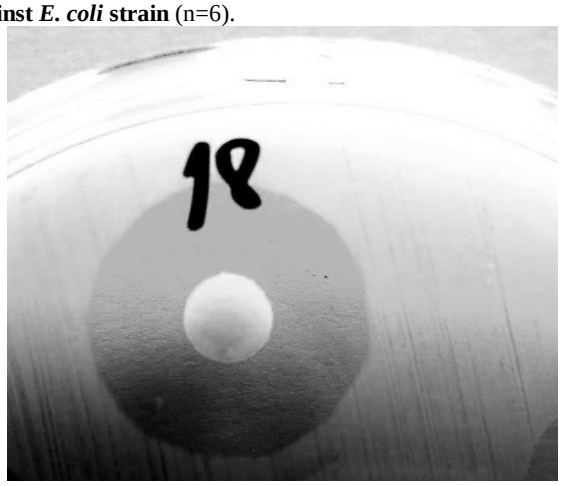
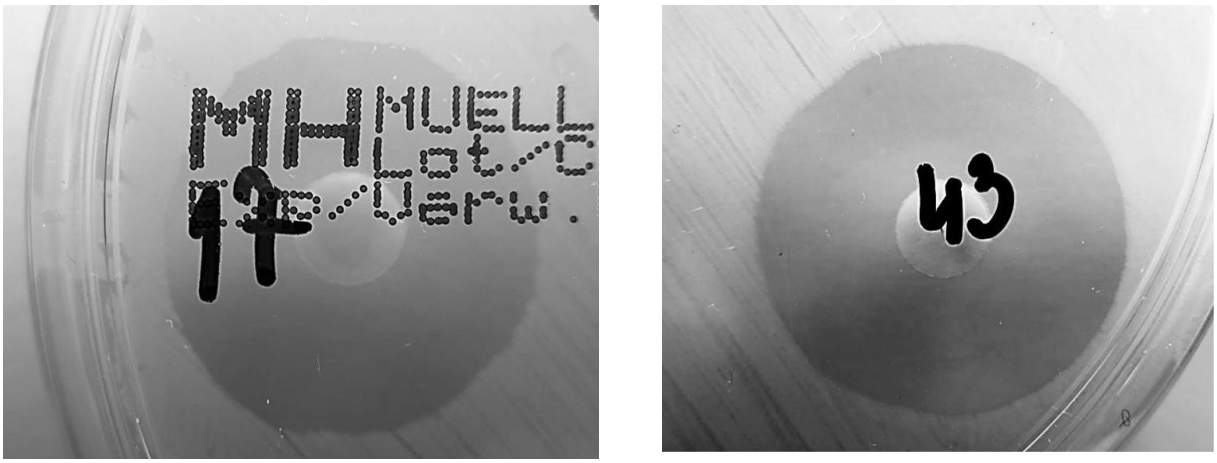


Fig. 1. **The diameters of inhibition zone produced by the ethanolic extracts obtained from leaves of *Sansevieria* species against *E. coli* strain** (n=6).

A



B



C D

Fig. 2. **Antibacterial activity of the ethanolic extract obtained from the leaves of *S. parva* (A), *S. volkensii* (B), *S. arborescens* (C), and *S. kirkii* (D) against *E. coli* strain.**

Extracts from the leaves of *S. kirkii* and *S. arborescens* were particularly active against tested organism (diameters of inhibition zones were 24 and 22.5 mm, respectively). It was followed by the activities of extracts from *S. roxburghiana, S. francisii, S. forskaliana, S. cylindrica, S. trifasciata, S. canaliculata, S. caulescens, S. metallica, S. aethiopica* leaves (diameters of inhibition zones were ranged between 13.5 and 12.0 mm). Finally, the ethanolic extracts of *S. gracilis, S. suffruticosa, S. fischeri*, and *S. hyacinthoides* showed less antimicrobial activities (diameters of inhibition zones were ranged from 8 to 11.5 mm) (Figs 1 and 2).

Discussion. The practice of traditional herbal medicine is widespread and natural products derived medicines are widely used for effective infectious disease treatment [22]. The antimicrobial investigation carried out in this study involved the determination of the sensitivity pattern of *E. coli* to the leaf extracts of seventeen species of *Sansevieria* genus. The results revealed the antimicrobial potential of these extracts. The test organism was susceptible to extracts of *S. kirkii, S. arborescens, S. roxburghiana, S. francisii, S. forskaliana, S. cylindrica, S. trifasciata, S. canaliculata, S. caulescens, S. metallica, S. aethiopica* with inhibition zone diameter between 12-24 mm. *E. coli* isolate was resistant only to *S. hyacinthoides* extract and the diameter of inhibition zone around the rest ranged from 8 to 10 mm.

In agreement with the results obtained from the present study, previous research papers documented the noticeable antimicrobial potency of the ethanolic extracts from *S. fischeri, S. francisii, S. parva, S. kirkii, S. aethiopica, S. caulescens*, and *S. metallica* against *Staphylococcus aureus* [8]. The microbial growth inhibition capacity was attributed to the presence of the rich variety of phytochemicals including carbohydrates, saponin, flavonoids, phenols, alkaloid, anthocyanin and cyanine, glycosides, proteins and phytosterols [8]. According to Deepa Philip and co-workers (2011), the methanolic and acetone extracts of leaves of *S. roxburghiana* diluted showed antibacterial activity against Gram-positive bacteria such as *Micrococcus luteus, Bacillus cereus, Enterococcus* spp., *S. aureus*, Gram-negative bacteria such as *Proteus vulgaris, Pseudomonas aeruginosa, P. fluorescense, Salmonella typhi, S. paratyphi, Klebsiella pneumoniae, Shigella sonnie*, and *E. coli*, fungal strains *Cryptococcus* spp. and *Candida albicans* [Deepa Philip et al. 2011]. Ethyl acetate extracts of rhizomes also exhibited appreciable antimicrobial activity against most of the pathogens tested. The minimum inhibitory concentrations (MIC) of the various extracts by agar dilution method ranged from 1.0 to 8.0 mg per mL. The leaf extracts exhibited better antimicrobial activity than rhizomes [8].

In a study conducted by Poonam Sethi (2013), the ethanolic extract of rhizome of *S. roxburghiana* displayed remarkable antibacterial activity against the four pathogenic bacteria, *S. typhi, P. fluorescens, P. aeruginosa* and *E. coli* [21]. Maximum activity was seen in the case of *P. fluorescens* where the zone diameter was 32 mm (300 μg/ml). The MIC study revealed that the value for the *S. typhi* and *E. coli* as 80 and 60 μg/ml for *P. fluorescens* and *P. aeruginosa* [21]. Hanumanth Kumar and Pramoda Kumari (2015) reported about potential bioactive secondary metabolites and revealed the possible antimicrobial activities of leaf extracts of *S. roxburghiana*. Antimicrobial screening revealed

significant antimicrobial activity against *P. vulgaris, S. typhi, P. aeruginosa, K. pneumoniae*, and *E. coli* [13]. Qualitative analysis, conducted by these authors, confirmed by the presence of various primary and secondary plant metabolites such as alkaloids, terpenoids, flavonoids, saponins, steroids, phenols, tannins, and quinine in selected parts of *S. roxburghiana*.

S. roxburghiana also exhibited good inhibition effect against *S. aureus* and *P. aeruginosa* whereas *S. trifasciata* manifested good antimicrobial effect against *E. coli, S. aureus* and *P. aeruginosa*. It is interesting to note that the combined effect of antibiotics and plant extract has enhanced the antimicrobial effect of the extracts obtained against pathogenic microorganisms. The percentage inhibition of combined effect was calculated and it was observed that the leaves of *S. roxburghiana* possess antimicrobial effect (50 %) against *S. aureus* combined with norfloxacin whereas the leaf extract of *S. trifasciata* when combined with tetracycline it showed 36 % of inhibition against *S. aureus*. The methanolic extract from the leaves of *S. roxburghiana* and *S. trifasiata* was effective against Gram-positive and Gram-negative pathogenic microorganisms. The 50 mg per mL of the methanolic extracts manifested effective antimicrobial effect against pathogens [17].

Also, the results obtained from the present research showed antimicrobial potential of eleven extracts obtained from leaves of *Sansevieria* genus against *E. coli*. So, these plants extracts can be used as antiseptics and antimicrobial agents in medicine. The antibacterial activity in *Sansevieria* genus may be due to presence of alkaloids, saponins, terpenoids, steroids, glycosides, tannins, acidic compounds, fats and oils in their composition. Also flavonoids have several therapeutic effects such as antioxidant and anti-inflammatory [2].

Conclusions. In conclusion, we would like to emphasize that taking into account rapid losses and degradation of natural habitats in the tropics and associated with them catastrophic declines of many species of angiosperms, including *Sansevieria* spp., maintenance of living plants collection *ex situ* and assessment of their medicinal properties are very important.

Thus, our findings demonstrate that the ethanolic extracts obtained from leaves of *S. kirkii, S. arborescens, S. roxburghiana, S. francisii, S. forskaliana, S. cylindrica, S. trifasciata, S. canaliculata, S. caulescens, S. metallica, S. aethiopica* possess antibacterial potency against *E. coli* strain. Considering the medicinal importance of the tested microorganism these extracts may be used as a natural antiseptics and antimicrobial agents in medicine.

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Антибактериальная активность некоторых видов сансевиерий относительно кишечной палочки

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Освещено исследования *in vitro* антимикробной активности этанольных экстрактов семнадцати видов рода *Sansevieria* [*Sansevieria canaliculata* Carrière, *S. trifasciata* Prain, *S. cylindrica* Bojer ex Hook., *S. parva* N.E.Br., *S. fischeri* (Baker) Marais, *S. kirkii* Baker, *S. aethiopica* Thunb., *S. metallica* Gérôme & Labroy, *S. caulescens* N.E.Br., *S. francisii* Chahin, *S. arborescens* Cornu ex Gérôme & Labroy, *S. volkensii* Gürke, *S. forskaliana* (Schult. & Schult.f.) Hepper & J.R.I.Wood, *S. gracilis* N.E.Br., *S. hyacinthoides* (L.) Druce, *S. roxburghiana* Schult. & Schult.f., *S. suffruticosa* N.E.Br.] в отношении *Escherichia coli* (ATCC 25922). Антимикробную активность определяли с помощью диско-диффузионного метода. Все исследованные экстракты показали различную степень ингибирования зоны роста протестированной бактериальной культуры, что свидетельствует о противомикробном потенциале этих экстрактов. Тестовый микроорганизм является восприимчивым к экстрактам листьев *S. kirkii, S. arborescens, S. roxburghiana, S. francisii, S. forskaliana, S. cylindrica, S. trifasciata, S. canaliculata, S. caulescens, S. metallica, S. aethiopica* с диаметром зоны ингибирования в интервале 12-24 мм. Изолят *E. coli* был резистентным лишь к экстракту *S. hyacinthoides*, в то время как диаметр зоны ингибирования вокруг остальных исследуемых экстрактов составлял 8-10 мм. Этанольные экстракты, полученные из листьев *S. kirkii, S. arborescens, S. roxburghiana, S. francisii, S. forskaliana, S. cylindrica, S. trifasciata, S. canaliculata, S. caulescens, S. metallica, S. aethiopica* обладают антимикробными свойствами в отношении изолятов *E. coli* и могут быть использованы в качестве природных антисептиков и противомикробных препаратов в медицине.

Ключевые слова: *Sansevieria*, листья, экстракт, антибактериальная активность, диско-диффузионный метод.

The antibacterial activity of certain *Sansevieria* species against *Escherichia coli*

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The present study was aimed to investigate *in vitro* antimicrobial activity of ethanolic extracts of seventeen species of *Sansevieria* genus [*Sansevieria canaliculata* Carrière, *S. trifasciata* Prain, *S. cylindrica* Bojer ex Hook., *S. parva* N.E.Br., *S. fischeri* (Baker) Marais, *S. kirkii* Baker, *S. aethiopica* Thunb., *S. metallica* Gérôme & Labroy, *S. caulescens* N.E.Br., *S. francisii* Chahin, *S. arborescens* Cornu ex Gérôme & Labroy, *S. volkensii* Gürke, *S. forskaliana* (Schult. & Schult.f.) Hepper & J.R.I.Wood, *S. gracilis* N.E.Br., *S. hyacinthoides* (L.) Druce, *S. roxburghiana* Schult. & Schult.f., *S. suffruticosa* N.E.Br.] against *Escherichia coli* (ATCC 25922). The crude extracts were screened for antimicrobial activity using agar diffusion method. All the extracts showed variable degree of diameters of zone inhibition against tested bacterium. Therefore, the results revealed the antimicrobial potential of these extracts. In fact, the test organism was susceptible to extracts of *S. kirkii, S. arborescens, S. roxburghiana, S. francisii, S. forskaliana, S. cylindrica, S. trifasciata, S. canaliculata, S. caulescens, S. metallica, S. aethiopica* with diameters of inhibition zone from 12 to 24 mm. *E. coli* isolate was resistant only to

S. hyacinthoides extract and the diameter of zone inhibition around the rest ranged from 8 to 10 mm. The ethanolic extracts obtained from leaves of *S. kirkii, S. arborescens, S. roxburghiana, S. francisii, S. forskaliana, S. cylindrica, S. trifasciata, S. canaliculata, S. caulescens, S. metallica, S. aethiopica* possess antibacterial potency against *E. coli* isolates and may be used as natural antiseptics and antimicrobial agents in medicine.

Key words: *Sansevieria*, leaves, extract, antimicrobial activity, paper disc diffusion method.

Надійшла 24.04.2017 р.